Coláiste na hOllscoile Corcaigh, Éire
University College Cork, Ireland

Public Evaluations of Novel Food Technologies:

A Qualitative Citizen-Scientist Deliberative Discourse Approach

Submitted by

Gráinne Maria Greehy

Supervisors	Dr. Mary McCarthy Department of Food Business & Development University College Cork
	Dr. Maeve Henchion Department of Agri-food Business and Spatial Analysis Rural Economy and Development Programme Teagasc Food Research Centre Ashtown
Head of Department	Prof. Michael Ward

A thesis on research undertaken at the Department of Food Business and Development, National University of Ireland, Cork and the Department of Agri-food Business and Spatial Analysis, Teagasc Food Research Centre, Dublin, in complete fulfilment of the requirements for the degree of Ph.D. from the National University of Ireland, Cork

April 2015

Table of Contents

Appendices **326**

List of Tables

List of Tables in Appendices

List of Figures

Declaration of Originality

I hereby declare that this thesis is entirely my own work and has not been taken from the work of others, save to the extent that such work has been cited and acknowledged within the text of my work. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged.

I certify that the work in this thesis has not previously been submitted for a degree or diploma either at University College Cork or any other higher education institution.

An abridged version of the analysis presented in Chapter 6 and the discussion relayed in Section 9.2 has been published as an article in Appetite (25th June 2013) and is included in Appendix 1.1 and available online at:
http://www.sciencedirect.com/science/article/pii/S0195666313003097

Signature: ____________________________

Date: ____________________________

Research Dissemination

Peer-reviewed Publications

Greehy, G.M., McCarthy, M.B., Henchion, M.M., Dillon, E.J. and McCarthy, S.N. (2013). Complexity and conundrums. Citizens' evaluations of potentially contentious novel food technologies using a deliberative discourse approach. *Appetite,* 70, 37-46.

Conference Papers and Presentations

Greehy, G. (2013). Exploring consumer acceptance of novel food technologies using qualitative methods. *Safefood Knowledge Network, Qualitative Methods in Public Health Nutrition.* Dublin. 30th January, 2013. Presentation slides available at: http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Professional/Events/Grainne-Greehy.pdf

Greehy, G., McCarthy, M., Henchion, M., Dillon, E. and McCarthy, S. (2012). Food for thought: How citizens frame and process information about novel food technologies. *International Conference on Science Communication.* Nancy, France. 4th-7th September 2012. Conference paper available at: http://www.jhc2012.eu/images/test/greehy.pdf

Dillon, E.J., Greehy, G., Henchion, M., McCarthy, M. and McCarthy, S. (2011). How accepting are Irish consumers of novel food technologies? *Agricultural Economics Society of Ireland*. Teagasc, Ashtown. 24th November, 2011.

Greehy, G., McCarthy, M., Henchion, M., Dillon, E. and McCarthy, S. (2011). Chatting with the experts: Exploring the impact of new information on citizen acceptance of novel food technologies. *20th Society of Risk Analysis (SRA)-Europe Meeting.* Stuttgart, Germany. 5th-8th June 2011.

Greehy, G., McCarthy, M., Henchion, M., Dillon, E. and McCarthy, S. (2011). An exploration of Irish consumer acceptance of food applications of nanotechnology. *40th Annual UCC Food Research Conference.* UCC, Cork. 31st March-1st April 2011.

Greehy, G., McCarthy, M., Henchion, M., Dillon, E. and McCarthy, S. (2011). An exploration of Irish consumer acceptance of nanotechnology applications in food. *5th International European Forum on System Dynamics and Innovation in Food Networks.* Innsbruck-Igls, Austria. 14th-18th February 2011. Conference paper available at: http://centmapress.ilb.uni-bonn.de/ojs/index.php/proceedings/article/viewArticle/145

Conference Poster Presentations

Dillon, E.J., Greehy, G., Henchion, M., McCarthy, M. and McCarthy, S. Functional foods into the future - examining Irish consumer acceptance. *European Association of Agricultural Economists Congress.* Zurich. 30th August-2nd September 2011.

Greehy, G., McCarthy, M., Henchion, M., Dillon, E. and McCarthy, S. Irish consumer acceptance of novel food technologies. *European Federation of Food Science and Technologists Annual Meeting, Food and Health.* Dublin. 10th-12th November 2010.

Greehy, G., and McCarthy, M. Irish consumer acceptance of novel food technologies. *UCC Doctoral Showcase.* 2nd June 2010.

Other Publications

Greehy, G., McCarthy, M., Henchion, M., McCarthy, S. and Dillon, E. (2014). *Irish citizens' evaluations of novel food technologies: Exploring the attitudinal intersection where society, science and food meet.* InterTradeIreland All-Island Innovation Programme. Community of Researchers. Research Briefing, July, 18-19. Available at: http://www.intertradeireland.com/media/AIIPResearchBriefing18.pdf

Henchion, M., McCarthy, M., Williams, G., Greehy, G., McCarthy, S., Dillon, E. and Kavanagh, G. (2013). *Irish consumer and industry acceptance of novel food technologies: Research highlights, implications and recommendations.* Teagasc Food Research Centre, University College Cork and Dublin Institute of Technology. FIRM Research funded by the Department of Agriculture, Food and the Marine. DAFM Reference Number: 08RDTAFRC659. FIRM Research Product Output Report available at: http://www.teagasc.ie/publications/view_publication.aspx?publicationID=2919

Awards/ Achievements

Walsh Fellowship awarded to complete doctoral studies.

Finalist in UCC Doctoral Showcase. 3 Minute Thesis Category. Presentation entitled: *'Will Irish consumers accept new food technologies'.* June 2011.

Received an Honourable Mention (2nd Prize) in UCC Doctoral Showcase. Poster Category: *'Irish consumer acceptance of novel food technologies'.* June 2010.

Acknowledgements

I would like to extend my gratitude to everyone who has made the completion of this thesis and reaching the finish line of this PhD journey possible.

First and foremost, I wish to express my gratitude and indebtedness to my primary supervisor, Dr. Mary McCarthy. I sincerely appreciate her expert guidance and invaluable on-going input and insight into this thesis. Her constant mentoring, support and encouragement that the ‘finish line’ was indeed closer than I thought are, ultimately, what has gotten me to this end point. I am especially thankful for the depth of knowledge she has imparted, particularly about structuring and summarising arguments, communicating a cohesive (and concise!) story, ‘abstracting up’ and effectively applying theory.

I would also like to earnestly thank my other supervisor, Dr. Maeve Henchion, for her constructive feedback, guidance and reinforcement during this process. Working with both of these high calibre professionals has been an honour and an inspiring and rewarding experience, during which I have learn so much and received many professional opportunities, for which I am greatly indebted.

Furthermore, I wish to thank my other Teagasc colleagues, Dr. Sinéad McCarthy and Dr. Emma Dillon, with whom I worked on the relevant FIRM project, for their support and encouragement. I would also like to thank the participating scientists and citizens for their significant contribution to this research. Without their participation, this dissertation would not have been possible. In addition, I am grateful to the anonymous reviewers from the editorial board of *Appetite*, where part of this thesis has been published. Their constructive feedback, particularly concerning the findings of this research, greatly improved this work.

The completion of this research would not have been possible without the financial support received through the FIRM initiative and the Teagasc Walsh Fellowship scheme.

Moreover, I wish to sincerely thank all of the academic and administrative staff within the Department of Food Business and Development for providing such a pleasant work environment. In particular, I wish to thank the Head of the Department, Prof. Michael Ward and Dr. Seamus O’ Reilly for their support and the work-related opportunities that they entrusted to me. I also thank Bríd, Nora, Mary Lucey, Marie, Caroline, Denis, Orla and Stephen for being so kind and supportive to me over the years. Special thanks to the dear friends I have made during the course of this research at UCC; particularly, Aoife, Lana, Karen, Ciana, Gretta, Sarah-Jane and Séan. Thanks for always putting a smile on my face and looking out for me.

I would like to acknowledge the on-going support and reinforcement of my siblings during this challenging process: my sister, Muireann, my brothers, Enda and Colman and my brother-in-law Dermot. You have all been amazing in your own unique ways. I also thank my nephew, Alex, for arriving when he did, to 'brighten up' the writing-up process. Furthermore, I thank all of the people close to me whose continual words of encouragement have been greatly cherished. Special thanks are extended: to my relatives, Bridge, Clodagh, Áine, Maurice (RIP) and Nell; and, to all my friends, especially Grá, Eva, Keara, Dani, Eleanore, Emer, Katie, Mags, the two Eileens, MC, Mary, Caoimhe and Brenda. You have all helped me to stay focused and positive throughout this process. In addition, particular thanks to Méadhbh, Jean, Clodagh and Siobhán, for proving to me that it could be done and your PhD survival tips.

Finally, and most importantly, I wish to thank my parents, Matt and Carmel, for the numerous opportunities they ensured I had growing up. The spirit of positivity and determination my mother instilled in me, which I strive to keep alive in her honour, coupled with my dad's relentless daily words of wisdom to *"keep looking up"* and *"get the head down"* (although somewhat conflicting) are what keep me going. Dad - words cannot express my gratitude for your unwavering financial, emotional and spiritual support.

List of Abbreviations

ABC	Affect, Behaviour and Cognition
APE	Associative-Propositional Evaluation
BNG	Benign and Non-contentious Group
BSE	Bovine Spongiform Encephalopathy
BU	Bottom-up
CAQDAS	Computer Added Qualitative Data Analysis Software
DAFF	Department of Agriculture, Fisheries and Food
DAFM	Department of Agriculture, Food and the Marine
Democs	DEliberate Meetings Of CitizenS
DPMs	Dual-Processing Models
ECG	Emotive and Contentious Group
ELM	Elaboration Likelihood Model
FF	Functional Foods
FIRM	Food Institutional Research Measure
GM	Genetically Modified
HIU	High Intensity Ultrasound
HSM	Heuristic Systematic Model
Irrad	Irradiation
MEC	Means End Chain
MODE	Motivation and Opportunity as DEeterminants
Nano	Nanotechnology
NEF	New Economics Foundation
NFTs	Novel Food Technologies
Non-Therm	Non-thermal (Technologies)
Nut/PNPs	Nutrigenomics & PNPs
PAST	Past Attitudes are Still There
PDI	Post-Discourse Interview
PDILQ	Pre-Discourse Interviewer-Led Questionnaire
PEF	Pulsed Electric Field
PNPs	Personalised Nutrition Products
PSOG	Product and Service Orientated Group
RISP	Risk Information Seeking and Processing
SOPs	Standard Operating Procedures
SRT	Social Representation Theory
TDBU	Top-down/ bottom-up
Therm	Thermal (Technologies)
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action

Abstract

Background and Aim:

The adoption of innovative technologies within the food domain offers potential consumer and societal benefits, and presents the food industry with opportunities to gain a competitive advantage. However, negative public reactions towards certain technological developments mean that public acceptance of Novel Food Technologies (NFTs) cannot be assumed. Given the significant research investment within this area, examination of the mechanisms underpinning citizen attitude formation around these technologies is a worthy research pursuit.

The primary purpose of this qualitative research is to expand understanding of how information about a range of NFTs is used and assimilated, and the implications of this on the evolution of attitudes and acceptance. Meeting this research aim enhances theoretical and applied understanding of citizens' interpretation of information and evaluative processes around these technologies. This dissertation offers some new ideas concerning the affective and cognitive reactions and responses that these technologies evoke, and how the attitudes held may evolve or become embedded, as information is presented.

Methods:

A constructionist philosophy and qualitative approach were applied, involving observations of interactive exchanges between citizens and information providers (i.e. food scientists), during which they discussed a specific technology. The purpose of this flexible, yet structured, approach was to reveal, through an iterative process, how individuals form attitudes and construct meaning around information about specific NFTs. A rich dataset of 42 'deliberate discourse' and 42 post-discourse transcripts was collected from 42 participants.

Data analysis encompassed three stages: an initial descriptive account of the complete dataset based on the top-down bottom-up (TDBU) model of attitude formation, followed by inductive and deductive thematic analysis across the technology groups. This approach to data collection and analysis enabled an in-depth exploration and comprehensive understanding of citizens' dynamic attitude formation and information processing around these technologies, and associated complexities.

Findings:

The preliminary analysis found that TD and BU influences are apparent across the technologies. Subsequently, this paradigm provides insight into individuals' evaluative processes. However, it fails to provide a comprehensive picture of how attitudes form and evolve, or the additional cognitive processes shaping perspectives.

Moving beyond this first analytic stage, the hybrid thematic analysis undertaken identified a Conceptual Model, which represents a holistic perspective on the influences and associated features directing 'sense-making' and ultimate evaluations around three selected technology clusters. These influences include: a person's orientations; their perceived control over the technology's application; and, the assumed relevance of the technology and its applications within different contexts. Although their manifestation and emphases vary, depending on the technology, each influence plays a key role in moulding viewpoints across each technology group.

First, existing beliefs, values and personal experiences provide a framework for interpreting relevant information. These personal orientations represent expressions of individuals' inner sense of standards. Initial reflections are based on one's values, and whether or not the technologies violate these standards. Personality traits and value orientations are the foundations for both affective reactions and reasoned responses. Second, individuals' perceptions of control take account of the interactions between uncertainty, information requirements, trust and regulation on evaluations. Depending on the technology's characteristics, knowledge uncertainty can influence the stability of attitudes, while scientific uncertainty may form the basis for cautious responses. If trust exists; the extent of attitude changes, due to new information, appears minimal. Conversely, the lower the trust level, the more cautiously a person tends to perceive the technology. Third, the perceived relevance of applications and associated products to one's everyday life and core values provides a platform for attitudinal standpoints. Relevance and necessity are linked to perceived risk/ benefit trade-offs, within specific contexts, and depend on the technology and person.

Finally, these three influences form the frame for the creation of sense-making around the technologies, with relative and subjective importance being placed on each influence, guided once again by the characteristics of the technology and individual. The concept of 'making sense of technologies', which is the major component in forming evaluations, concerns the meanings and associations individuals construct when classifying and interpreting information about them. Existing and newly formed interpretative schemas provide frameworks for information contextualisation. Internal negotiations, conflicts and complexities between these mutually shaping influences tend to contribute to attitude ambivalence and instability. These conflicts are particularly apparent in terms of reactive (emotive) and reflective (cognitive) responses. While welcoming the related benefits offered, some display a cautious stance and question the necessity of the technology. Finally, evaluations of the applications, and their risks and benefits, are generally not homogenous, with unique rule books of acceptance being evident.

Research Implications:

This research, particularly the Conceptual Model emerging from this work, has implications for theory and practice. The findings indicate the processes of forming and changing attitudes towards these technologies are: complex; dependent on characteristics of the individual, technology, application and product; and, impacted by the nature and forms of information provided. Evidence that individuals respond differently to relevant information suggests that their rapid, widespread acceptance is unlikely. Contextualisation of information, which impacts the formation of attitudes, is fundamentally based on life experiences and beliefs and values held.

The Government's efforts to engage with the public about these technologies, and industry's efforts to communicate the merits of their adoption, encounter challenges, since personal orientations and levels of knowledge understanding and interest vary, and heuristics tend to shape perspectives. Perceived risks and uncertainty can create a sense of dread, which can weigh on evaluations. Despite welcoming potential benefits, citizens may display a tendency to revert back to a precautionary position, due to lack of knowledge and perceived uncertainty surrounding more controversial NFTs. Consequently, policy makers' creation and preservation of social trust in the technology's application are essential prerequisites to positive evaluations.

Within relevant communications, transparency and openness are necessary, especially in situations of potential uncertainty. Public confidence in the implementation of satisfactory risk assessments and regulations, so as to ensure safety and outcomes, is crucial. In addition, lack of acceptance should not be confused with lack of understanding. Stakeholders should engage with the public about these technologies in innovative and timely ways. Clear, relevant and tangible personal and/ or societal benefits are likely to increase public acceptance. Finally, policy makers and industry should take account for the broader influences impacting attitudes towards these technologies, and govern and develop targeted communications accordingly.

Chapter 1
Introduction

1.1 Overview

The purpose of this thesis is to explore how information about a range of NFTs is used and assimilated, and the implications of this on the evolution of attitudes and acceptance. Within this chapter, the contextual background of this research is presented and the motivations underpinning of the study are embedded throughout. The role that food plays in individuals' lives is explored, in addition to how the concept of society, science and food are intertwined. A brief introduction on novel food technologies (NFTs) is provided. Following this, public attitudes towards these technologies, theoretical perspectives on attitude formation processes and the contextualisation of information are introduced as significant areas for integrated exploration. The specific research questions and research design adopted are then summarised. The anticipated contributions of the findings of this research, from both theoretical and practical perspectives, are then presented. The chapter concludes with a description of the dissertation structure.

1.2 Research Background

The food sector is critically important to the Irish economy (Department of Agriculture, Food and the Marine (DAFM), 2012, 2013). Current Government policies aim to develop Ireland and the European Union as knowledge-based bio-economies. As a result, significant public and private investment in research and development has been undertaken at national (Forfás, 2011, 2013) and European (FoodDrinkEurope, 2012, 2014) levels. National level evidence of this is €20 million being awarded for collaborative inter-institutional research projects under the DAFM's FIRM, Stimulus and CoFoRD (Council for Forest Research and Development) competitive research funding programmes, following the Department's 2014 call for research proposals (Teagasc, 2014).

> *"Research and Development (R&D) are among the main engines of innovation, productivity growth and structural change and hence are essential to guarantee continued competitiveness of the European food industry"* (European Commission, 2009a: 58).

NFTs form a key output from this investment. The adoption of these technologies can support food firms in enhancing current products, and developing new products which can compete effectively in a rapidly changing global food market (Cardello et al., 2007). These technologies can assist food firms in facing challenges, such as price increases and volatility, increasing consumer health concerns and food safety issues (European

Commission, 2009a; DAFM, 2012; Bigliardi & Galati, 2013). While NFTs can help address these challenges, thereby ensuring the future competitiveness of the national (Teagasc, 2008) and international (FoodDrinkEurope, 2012, 2014) agri-food sectors; their application can also create new challenges, for example complex regulatory implications.

Market and consumer trends and advances in science, technology and innovation are two of the driving forces of change in the food sector (Bigliardi & Galati, 2013). Therefore, understanding these forces and their inherent interplay is critical to building a competitive, innovative food sector. As highlighted in Food Harvest 2020, the Irish food sector currently places emphasis on its 'clean green' image, which is focused on prioritising sustainability (DAFM, 2013, 2014). Novel technologies form part of Ireland's and the EU's plan for sustainable food production and the solution to tackling other long-term societal challenges, such as climate change and an increasing global population (Teagasc, 2012).

To date, there has been substantial public investment in food research in Ireland, with funding being offered through, for example, Enterprise Ireland (EI) and the Health Research Board (HRB) (DAFM, 2012). Elsewhere, *Safe*food and the Food Safety Authority of Ireland (FSAI) have undertaken considerable research and engaged in public awareness programmes. In addition, the DAFM facilitates pre-commercial research through grant-in-aid to the Marine Institute and Teagasc, and also via competitive research funding initiatives (DAFM, 2012; Forfás, 2013).

Food Institutional Research Measure (FIRM) is the primary national funding mechanism for food research in Irish public research institutions (Department of Agriculture, Fisheries & Food (DAFF), 2007a). This competitive programme fosters collaboration between institutions, in order to address cutting-edge food research topics and build research capabilities within Irish institutions (DAFF, 2007b).[1] The types of research funded by FIRM range from fundamental through to pre-commercial research (DAFF, 2007a). Research areas covered by FIRM include food safety, food technology, food and health and functional foods. FIRM aims to develop technologies that can underpin competitive, innovative and sustainable food production and marketing (DAFM, 2012). Pertaining to novel technologies, FIRM research is being undertaken in

1 To date, over 240 FIRM projects have been funded to the value of over €140 million (DAFM, 2012)

the areas of functional foods, nanotechnology and thermal and non-thermal processing technologies. More broadly, the Food Research Ireland Report (*Ibid*) outlines key investment areas for the Irish food industry, such as novel processing technologies, nanotechnology, food safety, and quality and functional ingredients/ foods and bio-actives.

Elsewhere, other funding mechanisms enable additional national level research into scientific developments in the area of food technologies. For example, Teagasc, the Irish agriculture and food development authority, began field trials in 2012 on a genetically modified (GM) potato variety (*Desiree*) with improved resistance to late potato blight (*Phytophthora infestans*) with EU funding.[2] Elsewhere, Queen's University, Belfast, and Teagasc have undertaken research, on behalf of *Safe*food, into the opportunities and challenges associated with nanotechnology applications in the food industry (Handford et al., 2014). At a broader EU level, Ireland has been awarded research funding under the European Commission's Framework and Horizon 2020 Programmes; for instance, Sixth Framework Programme funding has been awarded through the ProSafeBeef and Lipgene projects[3].

In light of the considerable national level funding in this area, and the scale of investment required to develop these technologies, it is important to examine which technologies the public (consumers) would welcome, prior to their commercialisation (Henson, 1995; Frewer et al., 2011). Individuals lead diverse, complex lifestyles which encompass a wide array of goals and values, and food choices are heavily influenced by all of these (Furst et al., 1996, 2000; Connors et al., 2001; Bisogni et al., 2002). In addition, advancements in technology have considerably changed, and will continue to evolve, individuals' daily lives (Johnson & Wetmore, 2009).

> *"Technology has extended our life span and provided novel solutions to fulfilling our basic needs, from shelter to transportation, energy, and beyond"* (Hornig Priest, 2011: 1).

2 The Environmental Protection Agency (EPA) granted a licence to Teagasc in July 2012 to commence this research as part of an EC FP7 project. The EPA license is subject to strict monitoring and sampling conditions. Further information on this Teagasc research is available at the following link: http://www.teagasc.ie/news/proposed_gm_potato_research.asp

3 Information on these projects is available at the following links: http://www.prosafebeef.eu/ and http://www.ucd.ie/lipgene/

In addition to the enhancements and benefits that these technologies offer, technological advancements also present new challenges, uncertainty and potential risks (Hornig Priest, 2011). Bearing these contexts in mind, this dissertation positions itself at a junction, in the sense of exploring the complex interactions between society, technology and food.

1.3 Situating Society, Science and Food

In terms of the interplay between science and society, Frewer (2003) and Frewer et al. (2004) posit that the social context surrounding technologies is a key determinant of their development and commercial application. Gupta et al. (2011: 783) expand upon this notion, describing how emerging technologies are *"not isolated from the society in which they are embedded"* and that *"increased societal dependency on technologies necessitates the examination of "society-technology" interactions"*. To this end, Gupta and colleagues (2011) stress that although novel technologies may result in considerable societal benefits, their 'fate' (i.e. adoption) is held by society. The public may: 1) perceive these technologies to be associated with potential risks, and resist their application; 2) value the benefits that their application offers and accept them outright without contention; or, 3) display indifference towards their application for now, but the potential for resistance if negative information materialises. Therefore, public reactions towards applications of these technologies are not necessarily clear cut, i.e. definitive acceptance or rejection of them. This argument supports the view that further research within this area is warranted.

Social implications of technological developments are therefore significant, with these advancements raising important questions about associated benefits and risks (Beck, 1992). For example, concerns may emerge about: 1) access to benefits, e.g. in the case of nutrigenomic testing; 2) ethical implications, e.g. in the case of *in vitro* (lab grown) meat research; 3) exposure to potential associated risks, e.g. proximity in the case of, for example, a nuclear plant; and, 4) economic impacts, such as price implications (Hornig Priest, 2011).

Modern society produces diverse and complex lifestyles across the population. Consequently, the interactions that guide and direct beliefs, and thus responses to new situations and technologies, are many and varied. Einsiedel and Goldenberg (2004: 31) describe how *"a nexus of factors is at work to explain how public's view technology"*. Food forms an integral part of individuals' daily life, being *"of fundamental, unavoidable and everyday interest to all"* (Frewer, 2003: 330). As a result, food holds a variety of multi-faceted and complex meanings, many of which are socially assembled and strongly entrenched (Mintz & Du Bois, 2002; Clery & Bailey, 2010). These meanings, which are driven by deep-rooted beliefs deriving from, for example, cultural, societal and scientific perspectives, provide the frameworks for responses to new food offerings and direct reactions to new information about products and processes (Furst et al., 1996; Tenbült et al., 2008a).

> *"Consider the following analogy: throwing a stone (genetic research) into a pond (public) creates ripples. We are more interested in the ripples (representations of genetics) and what they tell us about the invisible depths of the pond (local concerns and sensitivities), than the stone itself (theories of genetics)"* (Bauer & Gaskell, 1999: 166-167).

Clearly, responses to new situations are guided, both consciously and unconsciously, by existing beliefs and expectations (Eagly & Chaiken, 2007). Therefore, life experiences and social structures form important determinants of responses to new situations, including encounters with new technologies.

Subsequently, it is to be expected that the public may perceive and evaluate both technologies and food in numerous and sometimes unanticipated ways (Cardello et al., 2007). To this end, some technological innovations, for example aviation technology, have been widely accepted as a result of perceived significant benefits, and in spite of associated risks. In contrast, other technologies, such as genetic modification, have experienced opposition, despite limited evidence of associated risks and strong evidence of benefits (Costa-Font & Gil, 2009). In this vein, Hornig Priest (2011: 6) raises an important question of why a particular technology, or group of technologies, may face strong public opposition, while other technologies may be readily accepted *"despite expert opinion that the latter might present important risks alongside its benefits, whereas the risks of the former may be more remote"*. Thus, as investments are made in the development of NFTs, it is imperative to appreciate the evaluative criteria and concerns, if any, used by the public if, and when, such technologies come to the forefront of lay citizens' consciousness (Fischer et al., 2013).

Public trust in the regulatory framework in which these technologies are embedded has been shown to influence reactions towards them (e.g. Siegrist & Cvetkovich, 2000; Bredahl, 2001; Siegrist et al., 2007a, b; Loebnitz & Grunert, 2014). Several food scandals and crises across Europe in recent decades[4] have inevitability influenced public perceptions of, and trust in, food manufacturers and regulators (Cope et al., 2010; Gaskell et al., 2010; Mather, 2012). Government reactions to these crises considerably impact public perspectives during, and in the aftermath of, such eventualities (Miller, 1999; Shepherd, 2008). In light of this, effective and transparent public communication strategies about food related risks and benefits have been stressed as important (Frewer et al., 1998a; Frewer, 2004; House of Lords, 2010).

1.4 Exploring the Concept of Novel Food Technologies

For the purposes of this dissertation, **NFTs are defined as scientific and technological developments or innovations that may be adopted by the food industry** (e.g. genetic modification and nanotechnology) **to alter the way food is produced, processed and packaged.**

In recent decades, NFTs, including thermal processing, non-thermal processing, genetic modification and food irradiation, have been applied to varying degrees in food production, processing and packaging, (e.g. Fuller, 2005; Fryer et al., 2008; Frewer et al., 2011; Bigliardi & Galati, 2013). The application of these technologies may result in, for instance, efficiency gains or product differentiation (Arora & Kempkes, 2008; Barbosa-Canovas & Bermúdez-Aguirre, 2008). For example, specific NFTs may encompass a new way of doing something that is already done to food, e.g. pasteurising milk using high intensity ultrasound, instead of the traditional HTST[5] method. Alternatively, the technology may involve developing a new type of food or food packaging using existing technologies and processes, e.g. using nanotechnology to create 'smart packaging' which encompasses food safety sensors. Furthermore, these technologies may be entirely new discoveries, e.g. nutrigenomics, or it may be their application to food that is novel, e.g. nanotechnology.

4 These crises include the UK salmonella egg crisis, the 2001 foot and mouth crisis, the 2008 pork dioxin crisis in Ireland, the 2011 E. coli outbreak across Europe and perhaps most significantly, the bovine spongiform encephalopathy (BSE) crisis in the UK (see Bánáti (2011) for an overview of these crises). A more recent crisis was the uncovering of unlabelled use of horse meat in ready-made products across Europe.

5 High Temperature/ Short Time.

While NFTs vary in terms of the techniques they apply and the length of time during which they have been applied (Hornig Priest, 2011); they face many similar challenges in terms of gaining public acceptance (Rollin et al., 2011). From a regulatory perspective, these technologies often entail numerous, diverse food related applications, making classification of their associated benefits and risks challenging for food regulators and other stakeholders involved in food communication (Kuzma & Priest, 2010).

Although these technologies can provide the food industry with opportunities to gain a competitive advantage (Sorenson & Henchion, 2011) by satisfying consumers' diverse and increasingly conflicting demands from foods (European Commission, 2009a; Betoret et al., 2011), these technologies may encounter challenges. Most predominately, industry has historically been hesitant to adopt them, in part, due to mixed public reactions towards them, including resistance towards specific technologies (Cardello et al., 2007; Murphy et al., 2011).

Emerging technologies, including those in the food domain, are novel in the context of their embryonic nature. Therefore, in addition to beneficial associations, these technologies may be associated with elements of uncertainty and risk (Kuzma & Priest, 2010; Hornig Priest, 2011). That being said, many food technologies, such as modified atmosphere packaging (MAP) have been widely accepted with minimum, if any, public resistance (Søndergaard et al., 2005). Hence, there is a clear need to understand how conflicts can arise concerning public reactions towards NFTs, so that potentially useful technologies currently being developed are not rejected without due consideration. In this vein, addressing any uncertainty associated with these technologies should be guided by the frameworks and communication strategies implemented to deal with NFTs which have gained public favour, such as vacuum packaging and certain functional foods (Fell et al., 2009).

Although many NFTs and related food products are valued and have become readily accepted as conventional practices, e.g. dehydration; the road to acceptance may prove long and arduous for some of these technologies. As an illustration of this point, Yeung and Morris (2001) have outlined how canned food products took approximately 50 years to overcome public resistance, in spite of the food preservation benefits that this technique offer. Another example of a food technology that has gained public acceptance over time is pasteurisation, which was highly controversial when first invented in the 1850s. However, following several decades, pasteurisation finally became commonly recognised and accepted as a beneficial method of ensuring food safety (DeRuiter & Dwyer, 2002; Evenson & Santaniello, 2004). These examples indicate that duration of application and adoption clearly impact the evolution of benefit and risk perceptions and, in turn, public technology appraisals (Henson, 1995).

The European Commission (2009a: 63) summarises that these technologies *"pose challenges and offer opportunities, and will inevitably change people's lives".* Specific groups of technologies were selected for inclusion in this study. These technology clusters and the factors guiding their selection, which included their characteristics and expected public reactions towards them, are outlined in Chapter 4. Brief summary sheets explaining each of the technologies, using lay terminology, are included in Appendix 1.2.

1.5 Awareness of and Attitudes towards NFTs - Integrating Theoretical Perspectives

> *"Consumers do not ask for technologies, rather they seek products with specific benefits"* (Bruhn, 2007: 555).

Hornig Priest (2011: 8) contends that nearly all novel technologies present associated benefits and risks and subsequently, in addition to positive reactions towards them, *"controversial dimensions may arise"*. Bauer and Gaskell (1999: 180) elaborate upon this point, arguing that *"as new technologies are developed, people tend to position themselves from the positive to the negative in relation to new ideas and innovations"*. As previously described, the public perceive and evaluate both technologies and food based on associated meanings that are socially constructed and strongly rooted, i.e. guided by prior beliefs, values and expectations (Grunert et al., 2003; Perrea et al., 2015). Given the wide array of influences that can intersect and interact in the evaluations of NFTs, it is not surprising that they are neither equally acceptable nor homogeneously evaluated by the public (Fell et al., 2009; Rollin et al., 2011).

Understanding and knowledge are influential, to varying degrees, in shaping public perception of NFTs (e.g. Cardello et al., 2007; Sheldon et al., 2009; Gaskell et al., 2010). From a knowledge perspective, recent studies suggest that public awareness of NFTs, their applications and associated science are generally limited (Frewer et al., 2011).

Nevertheless, the public may be more familiar with some novel technologies than others (Fell et al., 2009). When awareness of these technologies is relatively low, public perceptions of the technologies and associated risks and benefits can be influenced by a multitude of factors, including media coverage (e.g. Scheufele & Lewenstein, 2005; McCarthy et al., 2008; Dudo et al., 2011) and awareness of food production processes in general. In this vein, public awareness and actual and self-assessed knowledge about food production and processing methods appears to be generally low (Clery & Bailey, 2010). In fact, Clery and Bailey found that low levels of measured knowledge about food technologies appear to be associated with increased levels of opposition towards them.

Ho et al. (2013: 609) assert that in instances of low awareness of NFTs, examination of how the public form evaluations on them, and their different applications, is warranted *"at the early stages of the issue attention cycle"*. As public awareness of a technology increases, attitudes are likely to *"crystallize as familiarity with products, risks, and benefits becomes more apparent"* (Frewer et al., 1998b: 29; Frewer, 2003).

Nanotechnology and genetic modification have drawn particular attention from researchers in recent years, and subsequently more information is available on public awareness and acceptance of these technologies relative to others. Exploration of issues surrounding these two technologies highlights matters which are important in the context of NFTs more broadly. Moreover, studies that compare awareness across different technologies and nations provide important contextual insights.

In particular, the findings of the latest Eurobarometer (73.1) survey outline how, between 2005 and 2010, awareness of GM foods and nanotechnology across Europe remained relatively constant at around 80% and 45% respectively (European Commission, 2010). Focusing on national level results, awareness of GM foods and nanotechnology in 2010 were 80% and 33% in Ireland compared to 84% and 46% across the EU-27. Interestingly, the survey findings indicate that awareness of a NFT may influence attitudes either positively (in the case of nanotechnology) or neutrally/ negatively (in the case of GM foods). This research also found that in 2010, 37% of Irish respondents felt that GM foods should be encouraged, compared to 43% in 2005 and 57% in 2002 (Gaskell et al., 2010). This implies that perhaps Irish citizens are becoming more resistant towards GM foods. That withstanding, other statistics reported do not point to such a negative Irish standpoint. In particular, only 32% of Irish respondents (compared to 58% for the EU-27) disagreed that GM foods are safe for future generations. More broadly, Irish citizens appear to be only marginally less positive about the impact of biotechnology and genetic engineering on their lives, compared to EU-27 citizens (*Ibid*). That said, 35% of Irish respondents felt unsure as to whether these technologies would positively or negatively impact on their lives, compared to only 20% of EU-27 respondents.

In general, the survey findings indicate that Irish citizens tend to be considerably more undecided in their opinions regarding NFTs compared to their European neighbours. For example, 49% and 69% of Irish respondents reported themselves to be unsure whether the production of GM and nano foods would harm the environment respectively, compared to only 24% and 44% of EU-27 respondents. In addition, 35% of Irish respondents reported themselves as 'not knowing' if GM foods are good for themselves or their family, while 42% were unsure if their development should be encouraged, compared to only 16% of EU-27 respondents in both cases. Finally, 63% and 60% of Irish respondents were unsure whether nanotechnology is good for the economy or themselves/ their families respectively, in comparison to only 36% of EU-27 respondents in both cases.[6] These general divergences signal that further investigation of Irish citizens' perspectives towards these, and other, NFTs is warranted, to establish why Irish citizens are notably more undecided in their attitudes towards different aspects of NFTs.

The findings of the Eurobarometer survey support the assumptions that NFTs have broadly been met with mixed public reactions and that although some technologies are valued and accepted by the public, claims made about other technologies may be viewed with suspicion (Gaskell et al., 2010).

> *"While food scientists may applaud the progress of science, consumers have been known to take a more conservative approach and do not always readily see the benefit of new processing methods"* (Nielsen et al., 2009: 115).

Elsewhere, a review commissioned by the FSA, UK (Fell et al., 2009) indicates that the majority of Europeans tend to be undecided in their opinions or feel inadequately

6 The prominent undecided attitudes of Irish respondents may have, in part, been influenced by their lower than EU average levels of awareness of nanotechnology.

informed to establish definitive opinions on NFTs; while a minority are either strongly negative or positive.

Understandably, lay citizens may express a desire for transparency in terms of potential risks and benefits associated with these technologies (Bruhn, 2007). Public wariness of these technologies is sometimes explained by the evaluative criteria applied (Slovic, 1987: Hornig Priest, 2011), which Cardello et al. (2007: 82) describe as involving *"perceived"* rather than *"actual"* risks. In fact, Shepherd (2008: 236) suggests that the public may have concerns about food related risks which are outside the *"risk framings"* imposed by scientists and regulators. Consequently, scientists must defend claims made no longer purely at a scientific level, but also incorporating broader 'top-down' evaluative issues including ethical and societal repercussions (Bredahl, 2001; Hansen et al., 2003; Scholderer & Frewer, 2003; Priest et al., 2010). Although the public apply different evaluative criteria to the scientific community when assessing NFTs, the realities of their evaluative processes should not be undervalued, undermined, or underestimated (Einsiedel & Goldenberg, 2004).

Science is no longer considered the authority of objective truth (Beck, 1992). It is instead concurrently viewed as a source and solution to emerging social problems (Beck, 1999). As a result, the sole objective of citizen engagement no longer is to educate individuals about the science behind technologies, i.e. to prescribe to the knowledge deficit model of communication (Rowe et al., 2010). The objective is now to enable citizens to participate *"in a meaningful way in developing decisions involving the wise use of the technology"* (Hornig Priest, 2011: 9). Communication based on meaningful recognition of public perspectives and the *"reasonable questions"* that they raise (*Ibid*: 3) may enhance interaction and engagement between stakeholders (i.e. the public, industry, policy makers and other institutions involved in food communications); in turn, facilitating more informed public decision making around these technologies (Hallman, 2000; Saba & Vassallo, 2002; Ho et al., 2013).

> *"Public engagement is not a panacea; (...) ...it will not always prevent technology from becoming controversial. However, it is hoped that, at a minimum, public engagement will provide an early warning system of public concerns, allowing managers and regulators to consider those concerns"* (Hornig Priest, 2011: 9).

Frewer et al. (2011: 442) have described how historically, engagement with the public in order to establish the determinants directing their views on these technologies *"has occurred subsequent to rejection of a particular application".* Nonetheless, in recent decades the European Commission has begun to emphasise public engagement with science and technology as a priority area (Gaskell et al., 2010). Indeed, public engagement has started to take place more proactively, earlier in the development process, in recent years rather than post commercialisation (Gupta et al., 2011); a case in point being engagement about nanotechnology. Involving the public in discussions regarding new technologies at the early stages of their development may prevent both public controversies (van Kleef et al., 2005; Ho et al., 2013) and expensive industry errors (Grunert et al., 2003), and instead, result in wider public buy-in to them (Shepherd, 2008; House of Lords, 2010).

Many have argued the importance of identifying and incorporating the public's views at an early stage of technological and product development (Siegrist et al., 2008), since their perspectives can directly (e.g. through outright rejection) and indirectly (e.g. through the imposition of stricter regulations) impact the progress of these technologies (Siegrist, 2010). Given the considerable scale of investment required to develop them, which is frequently funded by the taxpayer, it is imperative to establish the evaluative mechanisms used by the public when these technologies come to the forefront of their consciousness, and ideally in advance of the development and commercialisation stages (Frewer et al., 2011). Prior understanding and appreciation of the determinants of public evaluations of NFTs is crucial for any food company focused on developing innovation efficiently, effectively and democratically. Such an understanding can assist with guiding food firms' strategies, and inform government policy of necessary actions to take in order to reflect legitimate concerns that the public may have regarding these technologies in risk assessment, management and communication processes.

Among others, Frewer (2003), McCrea (2005), Siegrist (2008), Neilsen et al. (2009) and Chen et al. (2013) note that investments in these food technologies will not yield desired returns unless accepted by consumers. However, as is evident from public negative reactions towards certain NFTs in the past, acceptance cannot be automatically assumed, in spite of the benefits offered (Henson, 1995; Shaw, 2002; Fischer et al., 2013), and lack of acceptance (i.e. pubic resistance) can result in substantive financial and other losses (Macoubrie, 2006).

Numerous factors have been identified as influencing public perspectives on NFTs (Siegrist, 2008; Fell et al., 2009; Clery & Bailey, 2010). For example, consumers need to be assured of the safety of foods produced using these technologies and value associated benefits, in order to accept them (Bruhn, 2007; European Commission, 2009a; Hornig Priest, 2011). The multitudes of factors that have been found to impact technology evaluations are explored in Chapter 2.

National level research undertaken which explores Irish citizens' evaluations of NFTs is relatively limited. Nevertheless, some research on attitudes towards, for example, GM foods (Vilei & McCarthy, 2001; O'Connor et al., 2005), high pressure processing (Sorenson & Henchion, 2011), animal cloning (Murphy et al., 2011) and nutrigenomics and personalised nutrition products (Stewart-Knox et al., 2013) has been completed.

More broadly, there has been increasing interest in academic spheres in understanding public attitude formation around novel technologies in recent years, as illustrated in the reviews of Fell et al. (2009) and Frewer et al. (2013). However, theoretical perspectives on attitude formation processes and the contextualisation of information require further reflection in future studies on public perceptions of NFTs. Most significantly, it is necessary to establish more than just overriding attitudes towards these technologies, in order to fully appreciate attitudinal contexts (Fell et al., 2009). Variables such as attitude strength, stability, importance, accessibility, ambivalence, associations and measurement, which are discussed in Chapter 3, are therefore important to investigate (Visser et al., 2006). Exploration of these factors can provide valuable insight into how attitudes might be affected by new information (Costa-Font & Mossialos, 2007; Sheldon et al., 2009; Vandermoere et al., 2011).

Within this research, it is recognised that to truly understand how attitudes form and evolve and meanings are constructed, a detailed examination and integration of the theoretical underpinnings of attitude formation processes and the mechanisms of information processing is required. Such an examination will provide insight into how individuals' contextualise and interpret information about NFTs. In particular, the merits of exploring the multiple and often conflicting and complex cognitive processes at play in shaping citizens' attitudes are recognised (Davies, 2011). These processes include: reliance on and integration of prior knowledge, drawing on existing dispositions and experiences to instill meaning in the context of attitude formation; and, the contextualisation of new information (e.g. Renn, 2003).

In light of this, Chapter 3 explores social and cognitive psychology theories to explore citizens' evaluations of NFTs through the lens of attitude formation and information processing procedures. This review will provide an in-depth understanding of how attitudes form. Attitude characteristics including their origins, composition and formation and their relationship with other psychological concepts, including behavioural responses, emotions and information processing, are explored. How explicit (deliberate) and implicit (subconscious) attitudes materialise (Eagly & Chaiken, 2007; Tenbült et al., 2008a), guided by the processing of accessible information (Bohner & Dickel, 2011), is examined.

This review provides the foundations for the theoretical concepts that this thesis builds upon. It illustrates how the characteristics of the information source, the content of the information, the audience, and the cognitive route applied can all impact how information is processed and contextualised. Throughout the undertaking of this study, the impact and complex interplay of the aforementioned attitudinal variables and information processing mechanisms on evaluations of NFTs are carefully considered.

1.6 Research Aims and Objectives

The purpose of this dissertation is to develop a conceptual understanding of how Irish citizens form evaluations on (attitudes around)[7] a range of NFTs. This dissertation explores individuals' construction of meanings around and interpretation of information about these technologies, i.e. their formation and evolution of attitudes. A key aim of this work is to provide insight into how new information about NFTs is used and assimilated, and the implications of this on attitudes and acceptance.

The core research question of this dissertation is as follows:

- What guides and influences citizens' evaluations of NFTs?

7 Throughout this dissertation, the terms 'attitudes' and 'evaluations' are used interchangeably.

Additional research questions that derive from this core question include the following:

- How do citizens construct meaning around and interpret new information on NFTs?
- Do citizens' evaluative processes vary across different NFTs?

These research questions are intentionally broad and serve as 'points of departure'. They are intended to be neither constrictive in scope nor overly prescriptive, given the exploratory nature of this research and the goal of providing meaningful insight into citizens' perspectives on NFTs.

1.7 Research Design

To meet the dissertation aims, this research applies a qualitative approach to delve deeply into Irish citizens' perspectives on and reactionary and reflective responses towards a broad range of NFTs as information is presented. To appreciate the significance of the different features framing citizens' technology assessments, it was necessary to apply a research approach that allows for the unfolding of participants' reflective thinking around novel technologies. Of particular interest was to ascertain how citizens form attitudes, i.e. their evolving perspectives, as information is relayed. Thus, observations of interactive exchanges, where citizens discussed these technologies, formed the basis of this enquiry. The purpose of this approach was to reveal, through an iterative process, how meaning is constructed around, and information is interpreted about, selected NFTs.

In terms of epistemological stances, this approach aligns with interpretivism/ constructionism, which considers reality to be a subjective entity (Saunders et al., 2009) and assumes knowledge to be created by individuals (rather than being discovered), through the assignment of contextual meanings based on interpretation (Andrews, 2012). This interpretivist paradigm, which is the most prevalent philosophy grounding qualitative research (Merriam, 2009), challenges the more positivist view that there is an objective meaning or 'truth' that is quantifiable and measurable through inquiry (Crotty, 1998). Inductive and deductive thematic analysis was undertaken on the data collected, following the approach of Braun and Clarke (2006). Each aspect of the research design process is detailed and justified in Chapter 4.

This dissertation explores citizens' evaluations of NFTs from the perspective of study participants. It explores and interprets the data collected and emerging findings in the context of existing theoretical underpinnings from seminal literature concerning social, risk and cognitive psychology.

1.8 Anticipated Contribution of this Work

Public acceptance of NFTs is an area of continued scholarly attention, as indicated by the numerous publications which have examined the determinants of public assessments of specific technologies (for instance, see Fell et al. (2009) for a comprehensive overview of relevant studies). Withstanding this extensive body of work, Fell et al. (2009: 54) stress *"the lack of good qualitative work examining the links between underlying values, expressed attitudes and actual behaviours"* in terms of NFTs, and the necessity to understand how these elements interact in order to *"gain a full understanding of public perceptions".* In addition, Davies et al. (2009) and the European Commission (2009b: 17) have highlighted the need to engage with citizens about scientific developments and *"to experiment with ways of interaction, and evaluate where they might lead".*

Much of the research to date which explores public reactions towards novel technologies has concentrated on risk perceptions, rather than attitude formation processes (Druckman & Bolsen, 2011; Fischer et al., 2013). In light of this, Davies et al. (2009), among others, have called for additional research to unpick the potential interrelationships between the determinants of attitude formation around novel technologies. This work could extend beyond the relationship between risks and benefits, in order to explore the impact of other psychological factors, including affective responses and reliance on heuristics (Fell et al., 2009). Furthermore, Gupta et al. (2011: 791) reinforce the point that the conundrum of *"why some technologies become societally controversial, whereas others do not"* merits further attention. This dissertation reflects and builds on each of the aforementioned recommendations and considerations, taking them into account through the methodological and analytic approaches adopted. The theoretical underpinnings of attitude formation processes therefore form a critical cornerstone of this thesis.

The studies that have been undertaken on public attitudes towards NFTs in recent years have predominately applied quantitative approaches (e.g. Bredahl, 2001; Grunert et al., 2003; Chen & Li, 2007; Gaskell et al., 2010); which assume attitudes under investigation to be relatively stable. In contrast, this work prescribes to the perspective of Conrey and Smith (2007: 718) that attitudes are inherently flexible, as a result of unique configurations of contextual cues, drawn upon within given contexts to form *"on the spot"* attitudes which are susceptible to change. The issue of attitude stability is further discussed in Chapter 3.

As previously mentioned, studies on public attitudes towards novel technologies to date have primarily focused on associated risk perceptions (Currall et al., 2006; Druckman & Bolsen, 2011). In contrast to focusing on purely establishing overall general opinions on a specific technology, this research applies a qualitative approach to delve more deeply into, and thus provide greater insight into citizens' evolving attitude formation processes and cognitive and affective responses across a broad range of NFTs as information is presented. This work therefore places significant emphasis on the *"lived experiences"* (Cohen & Crabtree, 2008: 334) and predispositions that citizens draw upon when interpreting information about, and evaluating, NFTs. Furthermore, in terms of contributions from a national perspective, this qualitative research adds to the somewhat limited research completed to date exploring Irish citizens' evaluations of NFTs, as previously outlined.

The constructionist stance and qualitative approach applied, involving observations of interactive exchanges between citizens and food scientists, in addition to the theoretical foundations drawn upon, differ to those of previous empirical research undertaken on consumer/ citizen assessments of NFTs. This dissertation therefore contributes to academic research, providing a more holistic and exploratory perspective on citizens' evolving evaluative processes across a variety of technologies. In the vein of bridging schools of thought and theoretical perspectives, this research provides links between existing theories in the areas of social, cognitive and risk psychology. It thereby enables a clearer understanding of the relationship between these theories and how they can be applied and drawn together, rather than focusing on a singular theory or philosophical perspective.

At an applied and prescriptive level, this research contributes to science communication literature. Specifically, recommendations are made for industry and institutions involved in food and science communication, in terms of providing the public with information to aid their evaluations of these technologies. This work therefore provides insight to aid government policies to support a competitive and innovative food industry (DAFM, 2014). Pertaining to industry implications, this research provides information that could potentially support the commercial application and promotion of these technologies.

1.9 Dissertation Structure

This chapter has provided a contextual background for, in addition to the motivations of, this dissertation. It has examined how the concepts of society, science and food are intertwined. Citizens' attitudes towards NFTs, attitude formation processes and the contextualisation of information have been introduced as significant areas for integrated exploration. The specific research questions have been presented, in addition to a brief overview of the research design adopted. The current landscape, in the sense of public acceptance of NFTs, has also been outlined. Finally, the anticipated contributions of the findings of this work were presented.

Chapters 2 and 3 of this dissertation comprise of a literature review. Chapter 2 explores the impact of top-down and bottom-up influences (Bredahl, 2001; Grunert et al., 2003) on technology evaluations. Furthermore, it draws on the psychology of risk perceptions and heuristics (Slovic, 1987) in exploring the determinants of citizens' evaluations. Following this, Chapter 3 relies on social and cognitive psychology theories, to explore citizens' evaluations of these technologies from the perspective of attitude formation (Eagly & Chaiken 2007) and information processing procedures (Wood, 2000; Conrey & Smith, 2007), in order to better understand how evaluative stances manifest. Throughout the undertaking of this work, the influence and complex interplay of the multiple factors shaping citizens' evolving evaluations of NFTs are contemplated on.

Chapter 4 presents the research design and methodology applied to address the research questions. Following the introduction of constructionism as the philosophical assumptions grounding this research, a description and justification of the qualitative approach are provided. An overview of the analytic approach is then presented.

Chapter 5 presents a descriptive account of the complete dataset, in terms of particular influences (discussed in turn) guiding citizens' evaluations across the selected technologies. Following this, Chapter 6, 7 and 8 present analysis of the key themes that emerged in terms of the common features influencing and directing evaluations across different technology groups. Chapter 9 then discusses the emerging themes, drawing on concepts and theories from relevant literature to strengthen the analysis presented. Within this final chapter, the theoretical and practical contributions of this work, the policy and industry related implications of the findings, and the limitations inherent in this qualitative research are outlined.

Chapter 2

Exploring the Determinants of Public Acceptance/ Rejection of NFTs

2.1 Introduction

The purpose of this chapter is to contextualise this research in terms of scholarly work completed to date on the multitude of features found to impact public evaluations of novel food technologies (NFTs). The dearth of literature concerning these determinants is extensive and draws on a variety of theoretical concepts from social psychology, particularly the psychology of risk perception and heuristics. The interplay of these factors on overall evaluations and ultimate acceptance/ rejection of these technologies are carefully reflected upon.

A considerable body of work exists concerning public assessments of food innovations and technologies. For instance, Fell et al. (2009), Frewer et al. (2011) and Rollin et al. (2011) present comprehensive overviews of relevant studies on public perspectives across a variety of NFTs, such as genetic modification, irradiation, nanotechnology, animal cloning, nutrigenomics, functional foods and novel processing methods including high pressure processing and pulsed electric field. Despite the diversity of technologies examined within these academic reviews, research to date has primarily focused on gene technologies. (e.g. Frewer et al., 1994, 1997a, 1999; Bredahl, 2001; Grunert, 2002; Shaw, 2002; Grunert et al., 2003; Gaskell et al., 2010) and more recently, on nanotechnology (e.g. Siegrist et al., 2007a, 2008; Stampfli et al., 2010; Vandermoere et al., 2011; Henchion et al., 2013; Fischer et al., 2013).

Frewer et al. (2011: 451) contend that such a research focus may, in part, be due to more funding, and in turn published literature, being available *vis-á-vis* exploration of public assessments of these *"controversial technologies"*, in comparison to other NFTs and associated products, such as functional foods, which tend to be: 1) more favourably perceived and accepted; and, 2) examined through a market focused lens given their emphasis on associated benefits (Verbeke, 2005). Nevertheless, Frewer et al. (2011: 451) argue that *"broad conclusions can be drawn"* from 'GM- and nano-centric' literature which relate to food technologies more broadly, including those that are more product/ service focused and market orientated, such as nutrigenomics, personalised nutrition products and functional foods.

Moreover, public evaluations of these technologies have been explored, predominately through quantitative methods (e.g., Bredahl, 2001; Grunert et al., 2003; Townsend & Campbell, 2004; Chen & Li, 2007; Gaskell et al., 2010). These studies have primarily focused on measuring explicit general acceptance (rejection) and/ or perceptions of associated risks (and benefits) (Lee et al., 2005; Gupta et al., 2011). Consequently, the theoretical models originating from these research pursuits typically centre on risk and benefit appraisals (Gupta et al., 2011; Frewer et al., 2013). In addition to surveys, other data collection techniques applied within this area include conjoint studies (e.g. Bech-Larsen & Grunert, 2003; Cardello et al., 2007; Siegrist et al., 2009), means-end chain (MEC) (e.g. Bredahl, 1999; Grunert et al., 2001; Boecker et al., 2008; Sorenson & Henchion, 2011) and focus groups (e.g. Shaw, 2002; Lampila et al., 2009; Nielsen et al., 2009; Lee et al., 2015).

Prior research undertaken (for instance, Bredahl, 2001; Sheldon et al., 2009; Saba et al., 2010) suggests that public acceptance of novel technologies is influenced by an array of complex and intertwined factors. These include the characteristics of *both* the technology and individual (e.g. Hamstra, 1995; Fell et al., 2009). These characteristics are reflected within the top-down/ bottom-up (TDBU) model, which is dominant in literature on attitude formation around NFTs (Scholderer et al., 2000; Bredahl, 2001; Grunert et al., 2003; Scholderer & Frewer, 2003; Søndergaard et al., 2005; Nielsen et al., 2009). This paradigm therefore forms the basis of this theoretical review.

2.2 Determinants of Acceptance

The TDBU approach, presented in Figure 2.1, is viewed as embodying *"two basic mechanisms"* through which individuals form attitudes around novel technologies and associated products (Nielsen et al., 2009: 116; Loebnitz & Grunert, 2014).

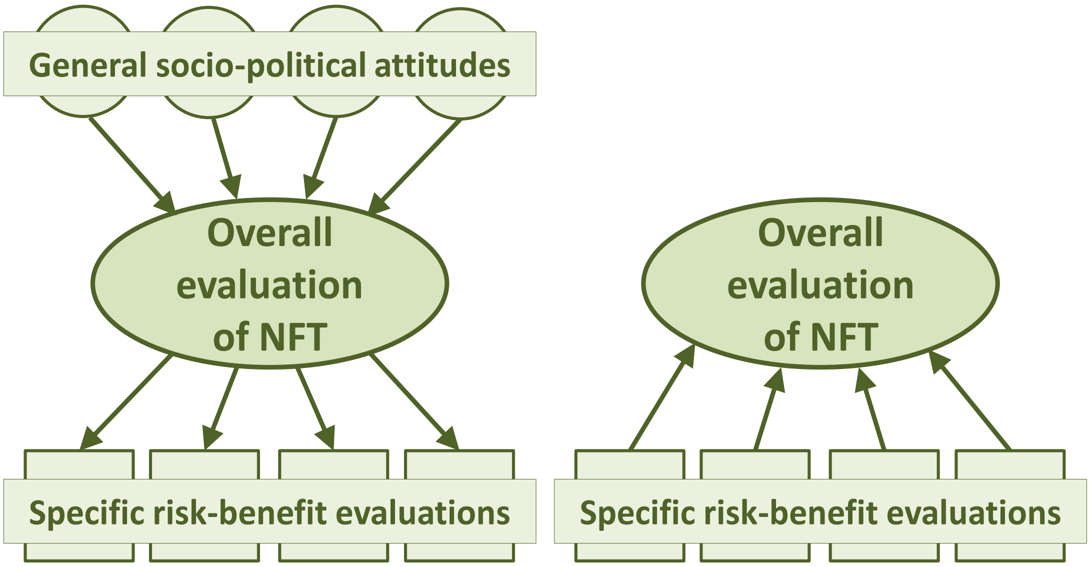

Figure 2.1: *Top-down and Bottom-Up Model of Attitude Structures Influencing Evaluations of NFTs*

Source: Adapted from Søndergaard et al. (2005: 467) based on Scholderer et al. (2000).

TD (top-down) influences focus on general socio-political attitudes and values of the individual (Bredahl, 2001; Scholderer et al., 2000; Scholderer & Frewer, 2003; Søndergaard et al., 2005; Nielsen et al., 2009), while BU (bottom-up) influences centre on the characteristics of the technology and related products, including benefit and risk perceptions (Bredahl, 2001; Grunert et al., 2003; Loebnitz & Grunert, 2014). Many (e.g. Bredahl, 2001; Grunert et al., 2004a; Søndergaard et al., 2005) contend that these two influences are not mutually exclusive, and consequently operate concurrently. These influences, and the relationship between them, are the main consideration of this review.

2.2.1 Top-Down Influences

Bredahl (2001) and Grunert et al. (2003: 440) assert that exploration of TD influences provides valuable insight into the magnitude to which attitudes towards novel technologies are *"deeply rooted"*. Building upon this proposition, Bredahl (2001) argues that the strength of one's attitudes towards a technology is an indication of how entrenched fundamental values and beliefs directing their technology evaluations are. Based on this reasoning, if one forms a strongly negative attitude towards, for example, functional foods, this may, in part, be due to holding strong beliefs about nature. Grunert et al. (2003: 441) further support this premise, describing how attitudes derived from top-down influences are *"not easily influenced or changed"*, since there is a predisposition to maintain congruency between the attitude towards the technology and more central values and beliefs. Søndergaard et al. (2005) and Loebnitz and Grunert (2014: 20) reinforce this point, emphasising that these *"higher-order anchor for evaluations"* are key in guiding overall technology assessments. Moreover, Nielsen et al. (2009) describe how the influence of these 'higher order' attitudes and values on evaluations is dependent on the particular technology. For instance, Nielsen and colleagues describe how general attitudes towards the environment and new technology have a positive impact on consumer perspectives on high pressure processing (HPP) and pulsed electric field (PEF).

"Values can be characterized as enduring beliefs about desirable goals that serve as guiding principles in people's lives" (Bredahl, 2001: 24). Based on the extensive evidence within this area (e.g. Hamstra, 1995; Bruhn, 1998; Bredahl, 2001; Grunert et al., 2003, 2004a; Chen & Li, 2007; Kahan et al., 2007; Henson et al., 2008; Rollin et al., 2011; Loebnitz & Grunert, 2014), the following are commonly cited TD influences shaping risk and benefit assessments and, more broadly, directly impacting evaluations of NFTs: attitudes towards nature (e.g. Vandermoere et al., 2011), the environment (e.g. Frewer et al, 1997a, b) and food and food production/ processing (e.g. Sheldon et al., 2009); science and technological progress (e.g. Søndergaard et al., 2005; Clery & Bailey, 2010); ethical and moral stances (e.g. Bredahl, 1999); general risk sensitivity; cultural and social norms (e.g. Kahan et al., 2009); life experiences (e.g. Burri, 2009) and other personal characteristics; socio-economic factors (e.g. Cardello, 2003); and, social trust (e.g. Siegrist, 2000). Each of these variables is contextualised in due course.

Nature and the environment

Several academics (e.g. Frewer et al., 1997a, b; Søndergaard et al., 2005; Nielsen et al., 2009) have outlined how general values and beliefs about the environment and nature influence reactions towards NFTs. Indeed, Rozin et al. (2004: 147) have argued that *"opposition to genetically modified organisms is clearly related to both respect for nature, and fear of human intervention"* In this sense, Shaw (2002) found that, in spite of recognising the scientific value of genetic modification, the majority of lay citizens were concerned about the effects of these type of technologies on nature, perceiving them to be an inappropriate human intervention.

Attitudes towards food and food production/ processing

General attitudes towards food products and production/ processing methods are reported by many (e.g. Sheldon et al., 2009; Clery & Bailey, 2010) as impacting standpoints on NFTs. For instance, whether a person has been exposed to food poisoning can shape their food safety assessments (Tucker et al., 2006), and subsequently their evaluations of food technologies. As another example of influential food preferences and personality trait around food products, one may have neophobic traits (Pliner & Hobden, 1992; Cox & Evans, 2008) towards certain novel foods, deriving from ingrained beliefs, value systems and social experiences (Bredahl, 1999). These points withstanding, consumers are typically found to be more concerned with associated benefits and risks, rather than processing methods involved (Frewer et al., 1997a; Bredahl, 2001; Grunert et al., 2003; Nielsen et al., 2009; Olsen et al., 2010).

Science and technological progress

A variety of researchers (e.g. Hamstra, 1995; Bruhn, 1998; Bredahl, 2001; Søndergaard et al., 2005; Clery & Bailey, 2010; Vandermoere et al., 2011) suggest that broad-spectrum attitudes towards the role of science and technology in society influence assessments of specific NFTs. Reinforcing this viewpoint, and as an illustrative case in point, Lee et al. (2005) and Stampfli et al. (2010) consider those displaying a positive stance on science and technology to be more likely to form a positive attitude towards nanotechnology. In a similar vein, Stampfli et al. (2010) believe that one's attitude towards gene technology is a strong predictor of acceptance of nanotechnology.

Morals and ethics

Focusing on ethical/ moral stances, several studies (e.g. Sparks et al., 1995; Kuznesof & Ritson, 1996; Frewer et al., 1997a; Bredahl, 1999) have illustrated how ethical and moral beliefs can negatively direct evaluations of technological applications within the food domain. In support for this assertion, Brossard et al. (2009) found strength of religious beliefs to negatively impact citizens' perspectives on nanotechnology. More broadly, many (e.g. Bredahl, 2001; Fell et al., 2009; Sheldon et al., 2009) argue that reliance on these types of top-down influences can results in more emotive types of (affective-based) responses towards NFTs.

General risk sensitivity

Risk-aversion and risk-taking traits are a noteworthy personal characteristic potentially impacting acceptance/ rejection of these technologies, and consequently a focus of scholarly attention. It is universally recognised in risk psychology that individuals display varying *"propensity to take risk"* (Adams, 1995: 14), i.e. different levels of risk sensitivity in their daily life. Tying this assertion to the focus of this work, De Jonge et al. (2007) found that those tending to worry more in general are typically more concerned about food safety. More specifically, a report by TNS-BMRB (2011) for the UK Food Standards Agency outlines how general risk sensitivity appears to impact public acceptance of NFT related products. Within this chapter, theoretical standpoints on perspectives on risk are described and critiqued in turn.

Cultural and social norms

The role that cultural and social norms play in influencing food consumption choices is widely recognised (e.g. Furst et al., 1996; Finucane & Holup, 2005; Hohl & Gaskell, 2008). Food is an elementary part of cultural conditioning and as such, cultural and social factors impact public openness towards technology applications to food (Ronteltap et al., 2007; Hornig Priest, 2011). This postulation is widely supported by previous research on international trends concerning public reactions towards NFTs (e.g. Gaskell et al., 2010). Indeed, Kahan et al. (2009: 87) found that public reactions towards such technologies are likely to be framed by *"psychological dynamics associated with cultural cognition"*. This reflects the tendency of individuals to base their beliefs about the risks and benefits of an activity on their cultural appraisals of it (DiMaggio, 1997).

To this end, Perrea et al. (2015) found food processing technologies, in this particular case high intensity ultrasound and infusion heat treatment, to encounter particular suspicion in Western society, where concerns about food safety are prevalent. In addition, Dean et al. (2007) found country differences to exist in terms of public perceptions of functional grain products across UK, Italy, Finland and Germany, with Britons perceiving there to be considerable benefits, and Germans considering there to be minimal benefits, associated with such products. As a further illustration, a survey carried out by Messina et al. (2008) across eight European countries found that preferences around functional foods, deriving from knowledge and familiarity, vary across countries. Hence, cultural disparities seem to contribute to variation in acceptance levels across countries and cultural boundaries (da Costa et al., 2000; Bredahl, 2001; Søndergaard et al., 2005; Zhang et al., 2010; Loebnitz & Grunert, 2014). Consequently, Costa-Font and Gil (2009) suggest that communication strategies pertaining to the application of NFTs should be targeted towards the culture of specific information receivers.

Life experiences and personal characteristics

Life experiences and personal characteristics also shape attitudes around NFTs (e.g. Burri, 2009; Davies, 2011). Adams (1995: 65) brings this contention to the fore, noting that *"it is common ground shared by psychology and anthropology that the world is experienced through filters that are the product of earlier experience"*. Lending further support to this argument, Macoubrie (2006) details how public concerns about nanotechnology, in this particular case, are driven by prior experiences and knowledge of concrete events, such as the now commonly recognised dangers of asbestos.

Additionally, Furst et al. (1996), Bisogni et al. (2002), Devine et al. (2003) and Dean et al. (2012a) report that the self-identity one wishes to express guides their attitudes and behaviours around food choice and eating. It therefore stands to reason that self-identity potentially influences perspectives on NFTs. The concept of self-identity encompasses self-images that one ascribes themselves to, deriving from their interactions with others, objects and situations (Bisogni et al., 2002). Indeed, individuals may express different identities within different circumstances. Multiple identities may concurrently exist within one individual, with them assigning greater significance to a certain identity within a specific context. For instance, a person may wish to portray themselves as a healthy eater in public who is enthusiastic about nutrigenomic testing, for example, yet concurrently consume unhealthy food in private.

Socio-economic factors

More generally, considering the influence of socio-demographic factors on assessments, age and gender appear to be particularly impactful in determining levels of concern about food related risks (e.g. De Jonge et al., 2007) and food technologies (e.g. Moon & Balasubramanian, 2004; European Commission, 2010; Gaskell et al., 2010). Females and older people tend to exhibit greater levels of concern about novel technologies in general (e.g. Cardello, 2003; Lee et al., 2005; Costa-Font & Mossialos, 2007; Clery & Bailey, 2010), yet often display more positive attitudes, in the specific case of certain functional foods (Fell et al., 2009).

Shaw (2002) has highlighted how older generations are often concerned about the greater cumulative risks in the longer term of gene technology on future generations. Furthermore, Slovic (1999), one of the foremost theorists in risk psychology, found that white males generally display a lower risk aversion than females and those of different races. In addition, level of education is documented as a significant predictor, with more highly educated individuals tending to be less likely to worry about food safety risks (Slovic, 1999; Hallman et al., 2003; Tucker et al., 2006; De Jonge et al., 2007). These findings withstanding, some argue that the aforementioned general attitudes and beliefs are better predictors of public attitudes towards NFTs in general, *vis-á-vis* standard socio-demographic characteristics (Verbeke, 2005; Fell et al., 2009; Clery & Bailey, 2010).

Social trust

Various academics (e.g. Siegrist, 2000; Bredahl, 2001; Frewer et al., 2004; Loebnitz & Grunert, 2014) have stressed the substantive influence of social trust as a strong predictor of attitude formation around technologies. *"Social trust" refers to people's willingness to rely on experts and institutions in the management of risks and technologies"* (Frewer et al., 2003a: 1118). This key heuristic is discussed in detail in Section 2.4.

Although top-down influences appear to dominate evaluations of many NFTs (Bredahl, 2001), specific product characteristics (bottom-up influences) are also classified as being important in guiding technology assessments (Grunert et al., 2003; Nielsen et al., 2009).

2.2.2 Bottom-Up Influences

Consumers choose food based on what is important to them and what they believe it to contain (Clery & Bailey, 2010; Kuznesof, 2010). Hence, how associated risks and benefits are perceived are issues of ongoing scholarly consideration, given their *"immense practical importance"* (Hawkes & Rowe, 2008: 617). It is widely recognised that risk and benefit assessments impact attitudes formed around novel technologies and related products (Fischhoff et al., 1978; Bredahl, 2001; Cardello, 2003; Grunert et al., 2003; Søndergaard et al., 2005; Bruhn, 2007; Henson et al., 2008; Nielsen et al., 2009; Stampfli et al., 2010; Fischer et al., 2013). Risk and benefit assessments *"entail both emotional and cognitive elements"* (Hornig Priest, 2011: 5). While the concept of affective and cognitive attitude formation is further contextualised in Chapter 3, the following sections focus on explicit risk and benefit perceptions and associated trade-offs.

Risk-based responses

Risk is an unavoidable element of life (Anderson, 2000) and, as such, is encompassed to a certain degree within all technological advancements (Mather, 2012). Potts and Nelson (2008: 366) consider risk to be *"associated with a degree of future loss"*, while Maule (2004: 19) describes it as *"the product of the likelihood of some event and the impact, value or utility of its outcome"*. Stakeholders, including regulators and the food industry need to understand how individuals perceive and react to risk (Slovic 1987; Hornig Priest, 2011), since perceptions of food related risks influence attitudes and behaviours regarding purchase and consumption decisions (Yeung & Morris, 2001).

The triggering of risk-based responses and reactions can negatively impact perspectives on foods (*Ibid*; Maule, 2004) and NFTs (Shaw, 2002; Cardello et al., 2007; Hagemann & Scholderer, 2009). The negative impact of risk-centred responses on the market success of GM and irradiated foods is further testament to this point (Cardello, 2003). The move from viewing risk as a solely objective entity to one that is also subjective in nature has occurred in light of *"rising public concerns about unbounded techno-scientific development and the apparent ineptitude of expert systems in managing hazards"* (Lupton, 2006: 1). Thus, both technical and social definitions of risk are now recognised and (somewhat) respected (Frewer et al., 1998b; Verbeke et al., 2007; Shepherd, 2008).

'Mental modes' can be considered as internal representations and reasoning(s) relied upon to explain external reality (Morgan et al., 2002). It seems that the 'mental modes' of citizens differ to those of scientific experts, in terms of their assessments of risk (Shepherd et al, 2006; Shepherd, 2008). Specifically, Hagemann and Scholderer (2007, 2009) describe how citizens' mental modes concerning risk perceptions of novel foods are broader in scope than those of experts.

More broadly, a multitude of academics from a variety of social psychology disciplines (e.g. Slovic, 1987; Rowe & Wright, 2001; Hawkes & Rowe, 2008) highlight the evolution of the concept of risk in recent decades. Social scientists have rejected the view that risk should be viewed solely in 'real' and 'objective' terms (Belton, 2001). Although the subjective nature (Adams, 1995) and broader social dimensions of risk (Slovic et al., 1980) are often difficult to quantify or account for within scientific risk assessment models, many authors within risk research stress that these dimensions warrant due recognition and consideration (Renn, 2003; Maule, 2004). There is now an appreciation that risk assessments should be viewed as inherently subjective and complex (Slovic, 1999; Hansen et al., 2003), since assumptions often have to be made based on *"inherently subjective values"* (Thomas & Hrudey, 1997: 15). Hence, risks *"cannot be viewed independently of the social context in which they are embedded"* (Frewer et al., 1997a: 101).

Lay citizens may have concerns about a problem, such as specific impacts on particular groups within society, which are outside the risk framings imposed by experts and regulators (Slovic et al., 1980; Slovic, 1987; Hansen et al., 2003; Shepherd, 2008; McCarthy & Brennan, 2009). Indeed, Sandman (1987) has outlined how individuals may become more (or less) concerned about a specific risk, depending on the 'outrage' it evokes. For instance, Siegrist et al. (2007b) and Ho et al. (2011) found that the public consider there to be a greater level of risk associated with nanotechnology than experts, while Moon and Balasubramanian (2004) note that 'sense of outrage' plays a part in guiding perspectives, via its bearing on risk perceptions. Individuals clearly consider risk against what is personally important to them, and concepts of risk can mean very different things to different people (Slovic, 1987; De Boer et al., 2005; Potts & Nelson, 2008). Hence, the complex assortment of factors that influence risk-based assessments may differ significantly from one individual to another (Thomas & Hrudey, 1997; Finucane & Holup, 2005).

> *"Psychological research on risk perception brings us a step closer towards an analysis of how society really assesses risk"* (Renn, 2004: 410).

Several schools of thought prevail in terms of psychological perspectives on risk, which have implications for lay citizens' evaluations of NFTs. First and foremost, the work of Ulrich Beck (1992, 1995) instigated significant interest in risk across academic disciplines (Lupton, 2006). Beck's realist 'risk society' perspective contends that threats and dangers facing society are no longer the *"outcome of the natural word"*, as there are now elements of *"human responsibility"* attached to man-made risks (Lupton, 2006: 2).

Another noteworthy psychological perspective on risk is the psychometric paradigm, developed by Fischhoff et al. (1978) and Slovic et al. (1980). This paradigm originated from the work of Starr (1969) concerning methods of weighing technological risks against benefits, and distinguishing between voluntary and involuntary activities. The psychometric model also draws on the previous empirical studies of Tversky and Kahneman (1973) on bounded rationality, cognitive bias and decision-making processes, including heuristics that guide individuals' assessments of probabilities (Wilkinson, 2006), which are discussed in turn.

The psychometric paradigm (Slovic, 1999; Gaivoronskaia & Hvinden, 2006) focuses on the qualitative characteristics of risk. It uses *"psychophysical scaling and multivariate analysis techniques to produce quantitative representations or 'cognitive maps' of risk attitudes and perceptions"* (Slovic, 1987: 281). This model concentrates on how one judges the severity of a risk based on two factors; 'dread risk' and 'unknown risk. 'Dread risk' is defined as a perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits (Fife-Shaw & Rowe, 1996; Maule, 2004; Hornig Priest, 2011). 'Unknown risk' is defined as risk perceived as being unobservable, new, unknown and delayed in its manifestation of harm (Slovic, 1987; Siegrist, 1999). In addition, a third factor, reflecting the number of people exposed to the risk, has been referred to in several studies.

Based on this model, individuals are willing to tolerate higher levels of risk from activities that are perceived as voluntary (Adams, 1995); with risks classified as 'unknown' and 'involuntary' being more negatively perceived (Viklund, 2003). These risk characteristics are correlated with each other. For instance, hazards judged as being voluntary, in terms of personal exposure, tend also to be judged as controllable. Equally, hazards whose adverse effects are delayed tend to be perceived as posing risks that are not well known. This theoretical perspective on risk has been widely applied to capture or account for the risk that is assumed to be associated with different objects and eventualities, including food (e.g. Fife-Shaw & Rowe, 1996; McCarthy & Henson, 2004).

Building upon the theoretical contribution of this paradigm to risk research, Sparks and Shepherd (1994a, b) identified three similar dimensions of risk as follows: severity, known risk, and the number of people exposed.

Wilkinson (2006) has called attention to another distinct social psychological perspective on risk, commonly referred to as 'optimistic bias'. This approach shares many similarities with the psychometric paradigm (Vebeke et al., 2007), such as a reliance on perceived personal control (Frewer et al., 1994). Optimistic bias describes the distortion of judgement concerning risk susceptibility, with a person considering themselves to be less likely to experience negative consequences in certain situations compared to others, and vice versa (Sparks & Shepherd, 1994a, b).

Exploring more cultural perspectives on risk which focus on the characteristics of the individual, the sociological perspective on risk put forward by Douglas (1966, 1985, 1992) and Douglas and Wildavsky (1982) centres on worldviews and *"shared cultural understandings'* (Lupton, 2006: 2-3), in which *"risk is inextricably intertwined with social and cultural norms, concepts and habits"* (*Ibid*: 14). This anthropological approach proffers *"a typology for organizing responses to uncertainty"* (Adams, 1995: 208). This perspective emphasises the shared understanding involved in risk appraisals, in contrast to the individualistic emphasis of psychological-based risk perspectives (*Ibid*). In striving to develop upon the notion that responses to perceived risks are rooted in cultural factors, Douglas and Wildavsky (1982) contend that risk is *"best conceptualized as a "collective construct"* (Hornig Priest, 2011: 122).

There have been some empirical criticisms of both the psychometric model and cultural theory, in terms of their low levels of explained variance (Knox, 2000; Sjöberg, 2000a, b, 2002a, b; Rowe & Wright, 2001). To this end, Viklund (2003) argues that although the psychometric paradigm and cultural theory of risk are informative, the proportion of perceived risk variation explained by these models across different hazards appears to be relatively limited.

Lupton (2006) summarise how the aforementioned divergent perspectives conceptualise risk differently and draw on diverse theoretical underpinnings. Consequently, Lupton (*Ibid*: 21) stresses the importance of remaining cognisant that *"risk concepts are fluid and dynamic over time and space"* and continually undertaking empirical research to *"map the complexities, contradictions and changes in risk understandings"*.

Having explored the notion of risk in detail and related theoretical concepts, the next section focuses on benefit associations and their impact on technology evaluations.

Perceptions of benefits

Empirical research on public acceptance of novel technologies to date seems to have placed greater emphasis on their perceived risks, rather than benefits (Currall et al., 2006; Druckman & Bolsen, 2011; Fischer et al., 2013). In this vein, Gaskell et al. (2004: 193) state that *"the 'Achilles heel' of GM foods is not so much the misperception of the scientific risks, but rather the perceived absence of benefit for the consumer".*

It is widely acknowledged that a clear consumer or societal justification for applying a food technology, i.e. a tangible benefit, is a necessary, but potentially insufficient, condition to ensuring public acceptance of its adoption (Frewer et al., 1994; Fell et al., 2009). In the absence of such benefits, the public are unlikely to react positively towards the technology/ product (Rollin et al., 2011). One needs to perceive that they will benefits, as a citizen and/ or consumer, from its application in order to overcome any potential reservations held (Siegrist, 2008).

Chen and Li (2007) argue that consumer evaluations of NFT related products, GM foods in this particular instance, are primarily determined by benefit perceptions. In a similar vein, O'Connor et al. (2005) found that certain Irish consumers may be open to second generation GM foods that offer direct (health) benefits to consumers. Furthermore, Siegrist et al. (2007a) assert that nano foods may be more acceptable to the public if perceived tangible benefits are associated with them.

Individuals clearly need to feel that the benefits from these different technologies are being extended to them personally, for instance through lower prices or better quality foods, or to other members of society or the environment, rather than solely to profit-oriented stakeholders in the food chain (Frewer et al., 2011). This concept of benefit distribution, as spoken of by Henson (1995), Sheldon et al. (2009) and Frewer et al. (2011), refers to the impact of perceived benefit accrual on public acceptance of NFTs. As an illustration of its influence on technology assessments, Shaw (2002) has outlined how the perceived benefits associated with GM crops are believed to be primarily extended to producers and suppliers, and that this perception can contribute to public scepticism.

It seems that where NFT related products offer unique, tangible benefits of perceived relevance, these benefits potentially outweigh assumed risks, and subsequently contribute to public acceptance (Hamstra, 1995; Wansink & Kim, 2001). Risk-benefit trade-offs are now examined in detail.

Risk-benefit trade-offs

> *"Ordinary citizens may not understand the technical details of how nanotechnology [and other food technologies] works, but they often raise reasonable questions about who will benefit, and who may be differentially exposed to the associated risks"* (Hornig Priest, 2011: 3).

Based on the assertion of Alhakami and Slovic (1994) and Slovic et al. (2004), one's perception of risks (benefits) influences their standpoint on potentially benefits (risks). In terms of risk-benefit trade-offs, Starr (1967) contends that individuals are willing to tolerate higher risks from activities (and technologies) that are considered to be highly beneficial. Gaivoronskaia and Hvinden (2006: 722) and Lampila and Lähteenmäki (2007) build upon this notion of acceptable trade-offs, describing how *"risks perceived to be serious can be acceptable if the source of risk is seen as bringing a benefit"*. Equally, Frewer et al. (1998a) and Bredahl (2001) asserts that perceived benefits are largely explained by perceived risks, i.e. the more risks perceived the harder it becomes to see any associated benefits. Furthermore, Moon and Balasubramanian (2004) posit that perceptions of risks exert a greater effect than assumptions of benefits on public technology assessments. These points withstanding, Siegrist et al. (2007a) consider perceived benefits to be the most important predictor of willingness to purchase, in the case of nano foods. Thus, while mixed results are evident, it could be argued that those assuming there to be a greater number of associated benefits generally perceive there to be fewer risks, and vice versa (Siegrist et al., 2007b, 2008). This argument may, in part, explain why certain functional foods, offering perceived health benefits, are accepted, and perceived to be associated with minimal risks (e.g. Fell et al., 2009). The interdependencies evident between risk and benefits (Fischhoff et al., 1978: Costa-Font & Mossialos, 2007) are referred to by some (e.g. Alhakami & Slovic, 1994) as the 'halo effect', which can be amplified as a result of lack of familiarity with the subject matter (Vandermoere et al., 2011).

Building upon this trade-off premise, a study by Brown and Ping (2003) found that a unique benefit could lower associated risk perceptions. In fact, a body of evidence (e.g. Sigrist, 2008, 2010; Fell et al., 2009; Sheldon et al., 2009) indicates that the relationship between assumed risks and benefits in guiding attitudes towards and acceptance (rejection) of NFTs and related products is multifaceted. To this end, Sheldon et al. (2009) describe how individuals may struggle to weigh the risks and benefits of NFT applications against each other, due to perceived uncertainty surrounding potential types of long-term risks involved. Ronteltap et al. (2007: 5) outline the concept of uncertainty as follows:

> *"Uncertainty exists when details of situations are ambiguous, complex, unpredictable, or probabilistic; when information is unavailable or inconsistent; and when people feel insecure about their own knowledge or the state of knowledge in general".*

The absence of knowledge, which is discussed in due course, seems to play a part in directing technology evaluations (Fell et al., 2009).

Many (e.g. Kuznesof, 2010; Frewer et al., 2011) contend that the perceived relevance of the risks and benefits outlined to the individual, and their assumed accrual, shape public technology assessments. Building upon this argument, research by Sheldon et al. (2009) and TNS-BMRB (2011) has illustrated how the perceived relevance of benefits and risks associated with NFT related products to self and family may result in greater openness/ resistance towards them. Hence, as argued by Frewer et al. (2004, 2011), perceived risks and benefits to the individual, society, the environment and other stakeholders direct technology assessments.

Having outlined how perceived risks, benefits and associated trade-offs effect public perspectives on NFTs, the next section concludes this exploration of bottom-up influences, by examining how the characteristics of the technology, its applications and relevant product attributes shape public acceptance/ rejection.

Technology, application and product characteristics

> *"The importance of the link between application specificity and attitude formation has been a common element in the literature"* (Frewer et al., 1997a: 100).

Frewer et al. (1994, 1997a: 100) stress that the public are likely to accept (reject) technology applications *"on a case-by-case basis"*. Nielsen et al. (2009) echo this view, based on their finding that overall attitudes towards PEF and HPP are formed as a result of trading-offs between perceived benefits and risks of associated products. Subsequently, technology evaluations and ultimate product purchase/ consumption decisions depend not only on the type of technology used (Grunert, 2002), but also on the specific food application and product (Gaivoronskaia & Hvinden, 2006; Fell et al., 2009; Sheldon et al., 2009; Henchion et al. 2013); for instance, whether each application/ product is perceived as being (un)natural (Tenbült et al., 2007, 2008b).

As an illustration, several studies undertaken in Switzerland detail how the public consider nano packaging (nano-outside) as being less problematic, more beneficial and therefore, more acceptable than nano foods (nano-inside) (Siegrist et al., 2007a, 2008; Stampfli et al., 2010). Elsewhere, in the context of genetic modification, medical applications are typically perceived as being more acceptable than food related applications (Sparks et al., 1994b; Frewer et al., 1997a, 1998b). In turn, GM food applications involving plants and microorganisms are generally reported as being more positively perceived than those involving animals (e.g. Sparks & Shepherd, 1994b; Hallman, 2000; Shaw, 2002; Sheldon et al., 2009; Marques et al., 2014). As a further example, in the case of functional foods, the base product for functional ingredients can influence perceptions (Dean et al., 2007). For instance, several studies (e.g. Annunziata & Vecchio, 2011) found consumers to be more in favour of intrinsically healthy, rather than unhealthy, carrier products for functional ingredients.

Subjective and objective (intrinsic and extrinsic) product cues which impact individuals' food purchase and consumption choices in general (Furst et al., 1996; Grunert, 2005; McCarthy & McCarthy, 2007), such as perceived taste, price, healthfulness quality, naturalness and convenience, also influence willingness to purchase or consume foods produced using novel technologies (Kuznesof & Ritson, 1996; Bredahl, 2001; Cardello et al., 2007; Lyly et al., 2007; Siegrist, 2008; Fell et al., 2009). For instance, research by Noussair et al. (2004) indicates that if the price of a related product, GM foods in this particular study, is lower than its traditional counterpart, a significant proportion of consumers may be willing to purchase such a product. By comparison, Costa-Font and Gil (2009) provide an overview of studies undertaken which imply that consumers are willing to pay a price premium to avoid GM foods. Moreover, several studies (e.g. Marette et al., 2009; Siró et al., 2009) indicate that consumers may be willing to pay a price premium for certain functional foods, in light of perceived health benefits.

On a separate, yet related, note, since natural foods are typically perceived as healthier, more environmentally friendly and appealing to the senses than processed alternatives (Rozin et al., 2004; Rozin, 2005), it is not surprising that Shaw (2002) asserts that the characterisation of GM foods as 'unnatural' negatively frames citizens' attitudes towards them. Similarly, Stampfli et al. (2010) contend that a greater preference for healthy and natural foods increases perceived risk and decreased perceived benefit perceptions of nano foods.

More broadly, in the context of the importance of sensory aspects on perspectives on related products (Kuznesof, 2010), several studies, for example Grunert et al. (2004b) and Loebnitz and Grunert (2014: 20) have illustrated how consumer attitudes towards NFT products may become more positive following exposure to *"superior sensory product experience, which induces positive sensory-based affect"*. Elsewhere, research by Nielsen et al. (2009) indicates that while consumers are receptive towards improved sensory and nutritional benefits linked to high pressure processing, they are opposed to any cost increase deriving from the application of the technology.

To conclude, in light of individuals' preoccupation with associated product characteristics, Einsiedel and Goldenberg (2004: 31) suggest the following:

> *"A shift in focus is required from getting people up to speed on the details and arcana of the science to understanding that what counts for publics are such elements as the purposes of an application, how it is to be used, under what conditions, and how its risks and benefits are to be managed".*

This backdrop brings the focus back to the relationship that exists between TD and BU influences in shaping overarching evaluations on these technologies.

2.2.3 The Relationship between Top-down and Bottom-up Influences

Further exploring this relationship, previous research (e.g. Bredahl, 2001; Sheldon et al., 2009) notes the complex relationship that exists between these 'simultaneously operating' features in guiding technology assessments. Explicitly, Bredahl (2001), Søndergaard et al. (2005) and Fell et al. (2009) argue that TD influences tend to shape risk and benefit assessments, and also directly impact technology evaluations. Indeed, Bredahl (2001: 53) postulates that risk and benefit perceptions on GM foods are likely to be *"strongly embedded"* in and influenced by the more general, underlying attitudes and values previously outlined. For example, general risk sensitivity can impact risk aversion, in terms of specific food related risks (Hohl & Gaskell, 2008). Furthermore, risk perceptions may be based simply on safety standards, or may extend to more conceptualised factors such as ethical considerations about the adoption of a new technology (Finucane & Holup, 2005). Expanding upon these arguments, Stampfli et al. (2010) posit that those displaying a preference for natural and healthy food perceive there to be greater risk and fewer benefit associations with these types of products, compared to those who do not hold such general dispositions.

In further support of the interconnections between TD to BU influences, Griffin et al. (1999) describe how the characteristics of the individual direct risk perceptions including: how one perceives possible risk to be addressed by regulators; the magnitude to which they consider it to affect them personally and their general beliefs and values held; and, the extent to which they believe they can self-protect against the risk.

In addition, Means-End Chain (MEC) draws some parallels with the mutually shaping relationship evident between TD and BU influences. MEC analysis is a mechanism of modelling the relationship between values and product characteristics (Gutman, 1982; Olson, 1989; Costa et al., 2004). It focuses on exploring how product attributes are connected to consequences which, in turn, are associated with values. Several studies, including Bredahl (1999), Grunert et al. (2001), Boecker et al. (2008) and Sorenson and Henchion (2011), have applied MEC to explore public evaluations of NFTs and resultant products. For instance, Bredahl's (1999) MEC study found genetic modification to be associated with negative attribute concepts, such as 'artificial', 'unwholesome' and 'unfamiliar'.

The literature reviewed indicates that the extent to which TD versus BU influences dominate the evaluative process depends on the characteristics of the technology *and* the individual (Bredahl, 2001). As an illustration of this point, Nielsen et al. (2009: 124) outline how attitudes towards PEF and HPP products are *"formed mostly on the basis of a bottom-up process"*, while Shaw (2002) describes how general values and beliefs about nature and morality tend to dominate perspectives on genetic modification.

Furthermore, the extent to which each influence shapes one's evaluative standpoint may be partially contingent on their level of awareness and knowledge of the specific technology. Indeed, as argued by Grunert et al. (2003, 2004), TD influences tend to dominate overall evaluations when levels of knowledge of the technology are low.

2.3 Levels of Awareness, Knowledge and Media Effects

As previously mentioned, recent studies (e.g. Clery & Bailey, 2010; Frewer et al., 2011) suggest that public awareness of these technologies, their applications and associated science are generally limited. That withstanding, the public are clearly more familiar with certain technologies than others (Fell et al., 2009). For example, it is postulated that while there are relatively high levels of public awareness of GM foods (Gaskell et al., 2010), there are generally low levels of awareness of nanotechnology (Kahan et al., 2007; Priest et al., 2011; Fischer et al., 2013), food irradiation (Gunes & Tekin, 2006; Frewer at al., 2011) and other non-thermal technologies, such as PEF (Frewer et al., 2011; Lee et al., 2015) and nutrigenomics (Morin, 2009; Frewer et al., 2011; Stewart-Knox et al., 2013). Focusing on recent national level research, Henchion et al. (2013) found there to be low levels of awareness of nanotechnology among Irish citizens, with 22% of survey respondents having heard of this technology, and only 7% being aware of its potential food applications.

An extensive selection of literature (e.g. Frewer et al., 1997a; Grunert et al., 2003; Sheldon et al., 2009; Gaskell et al., 2010) indicates that awareness about and perceived and actual knowledge of a specific technology may positively *or* negatively impact perspectives on it to varying degrees. For instance, Verbeke (2005) report that acceptance of functional foods appears to decrease as levels of claimed knowledge or awareness of this concept increases, while Ares et al. (2008) have found a significant relationship to exist between nutritional knowledge and willingness to try functional foods. It seems that the impact of prior awareness and knowledge on technology assessments is disputably dependent on a variety of factors, including the technology and personal viewpoints held.

Furthermore, lack of awareness and knowledge does not preclude citizens from forming views on these technologies (Hallman, 2000; Grunert et al., 2004b; Costa-Font & Mossialos, 2007). In support of this assertion, Gaskell et al. (2010) present evidence that, on average, Europeans tend to disagree that GM foods are safe or beneficial, no matter how familiar they are with them, while awareness and levels of familiarity and engagement with nanotechnology appear to positively impact perceptions of the safety of the technology.

Further exploring the significance of awareness and knowledge, Teisl et al. (2009) contend that greater self-rated knowledge of NFTs contributes towards positive technology assessments. Gaskell and colleagues (2010) also found that those with prior awareness of nanotechnology tend to also perceive the technology as being beneficial and not of particular concern. Additionally, Shaw (2002) and Clery and Bailey (2010) consider low levels of knowledge about food technologies to be associated with increased levels of opposition towards them. In turn, Clery and Bailey describe how self-assessed and objectively-measured knowledge of food technologies are closely linked.

Elsewhere, while the work of Gaskell et al. (2010) reveals that prior awareness and knowledge may positively *or* negatively influence attitudes towards the technology, research by Vandermoere et al. (2011) does not support this view. Specifically, Vandermoere and colleagues found that level of knowledge were unrelated to support for nano foods, indicating the information provision in order to increase public knowledge of these technologies may be insufficient *"to bridge the gap between excitement some business leaders in the food sector have and the restraint of the public"* towards these technologies (*Ibid*: 195).

Overall, the findings of research to date concerning the impact of prior awareness and knowledge on acceptance (rejection) of NFTs appears mixed. House et al. (2004) speculate that the different methods of measuring knowledge are a potential explanation for the contradictory results evident concerning the impact of knowledge on consumer acceptance of associated products. More broadly, awareness and knowledge seem to be related to interest in obtaining more information. For instance, Henchion et al. (2013)

present evidence that although Irish consumers generally seem to be interested in obtaining more information about food application of nanotechnology; those who are unaware of the technology are less likely to display such an interest.

Moving to explore the impact of information on public perceptions, the findings of prior studies (e.g. Bruhn, 1998; Gunes & Tekin, 2006; Costa-Font & Mossialos, 2007; Sheldon et al., 2009; Lee et al., 2015) indicate that information provision influences citizens' technology assessments in a variety of ways. On one hand, for example, Frewer et al. (2003a) established that information provision had a minimal effect on individuals' attitudes towards, in this case, GM foods. In contrast, Fox et al. (2002) and Hayes et al. (2002) found that positive and negative information presented about food irradiation resulted in the negative information dominating evaluative stances, regardless of the scientific credibility of its source. Thus, it is clear that information provision does not necessarily lead to attitudes becoming more positive (Bredahl, 1999; Scholderer & Frewer, 2003). Chapter 3 explores the concepts of information processing and provision in further detail, exploring the dynamic and complex relationships that exist between initial attitudes, information processing and subsequent attitudes.

While public awareness of many NFTs is relatively low, more information is becoming available in mass media about how these technologies can be applied in food production. Subsequently, public attitudes are forming and cementing, which influence overarching standpoints (Frewer et al., 1998a; Ho et al, 2013). Media coverage is a key public information source and type of heuristic relied upon concerning NFTs, given limited levels of citizen awareness and knowledge (Tucker et al., 2006; Potts & Nelson, 2008; Ho et al., 2013). Media framing of issues surrounding novel technologies has been explored in several studies (e.g. Anderson, 2002; Scheufele & Lewenstein, 2005; Marks et al., 2007; McCarthy et al., 2008; Kjærgaard, 2010; Dudo et al., 2011). In terms of its impact, Miller (1999) and Lee et al. (2005) outline how the intensification of media coverage potentially augments public risk-based responses. As an illustration, negative coverage of genetic modification across Europe has been postulated as contributing towards perceived uncertainty and associated risks (Bredahl, 2001; Görke & Ruhrmann, 2003; Loebnitz & Grunert, 2014). From an Irish perspective, McCarthy et al. (2008: 392) affirm that a significant proportion of Irish newspaper articles on genetic modification have used *"fear appeal"* to attract readers' attention.

Tied to the concept of media portrayals, the social amplification of risk framework (Grunert, 2002; Verbeke et al., 2007; Hornig Priest, 2011) focuses on how risk information can become attenuated or amplified as it is transmitted through society. This framework describes the *"dynamic social processes underlying how people perceive and act in the face of risk"* (Maule, 2004: 18). This framework explains why risks that scientific experts consider to be 'low-risk' (e.g. nuclear energy) can have a high impact in social networks, while other risks (e.g. smoking cigarettes) can become ignored or de-emphasised (Hornig Priest, 2011).

More generally, there is a scholarly consensus that where low levels of awareness and knowledge exist, individuals tend to rely on heuristics when evaluating novel technologies (Slovic, 1987; Mather, 2012). The next section focuses on the different types of heuristics commonly drawn upon to direct technology assessments.

2.4 Reliance on Heuristics

Tversky and Kahneman (1973) illustrate how individuals rely on heuristics, i.e. mental shortcuts or 'rules of thumb' that are either intuitive or learned, when making judgements, in order to simplify decision making in an uncertain, complex world. Moreover, Connors et al. (2001), Furst et al. (1996, 2000) and Falk et al. (2001) have illustrated how individuals call upon these cognitive shortcuts, stored in memory, when making food choices. It therefore stands to reason that, in light of individuals' lack of familiarity and specific knowledge about these technologies, they draw upon heuristics when forming evaluations of them (Lee et al., 2005; Burri, 2009). Recognition and exploration of the reliance on heuristics, particularly where familiarity with the subject matter is limited, was a major development in the area of psychological research on risk perception (Slovic, 1987; Gaivoronskaia & Hvinden, 2006).

The different types of heuristics relied upon include affect, availability and anchoring heuristics (Tversky & Kahneman, 1973; Iyengar, 1990; Morgan et al., 2002: Slovic et al., 2004). Maule (2004) and Gupta et al. (2011) highlight how dependence on the affect heuristic can lead to over reliance on emotional responses to information presented, particularly risk-based information. The availability heuristic concerns judgements of objects and situations, based on contextual information that is easily recalled (Maule, 2004; Gaivoronskaia & Hvinden, 2006; Gomez, 2013). In turn, the concepts of anchoring and accessibility biases are connected to the theoretical underpinnings of Social Representations Theory (SRT).

SRT is concerned with understanding how one contextualises unfamiliar scientific knowledge into everyday 'lay-sense' (Moscovici, 1984; Bäckström et al., 2003). This theory is not tied to a specific methodological approach (Bäckström et al., 2004), and is essentially focused on *"beliefs, images, metaphors and symbols collectively shared in a group, community, society or culture"* (Wagner, 1994: 199). Two processes characterise the formation of these socially constructed representations: 1) anchoring the unfamiliar to a more familiar reference point (Pivetti, 2007); and 2) objectification, which entails translating and transforming the 'abstract' into something more 'concrete', possibly through the use of metaphors (Moscovici, 1984, 1988; Breakwell, 2001).

In addition to a variety of other topics, SRT has been applied to explore public perceptions of novel foods (Bäckström et al., 2003, 2004) and biotechnology (Pivetti, 2007). As an illustration of the insight gained from this type of research approach, Bäckström et al. (2004) present evidence that in the context of food, some novelties trigger concern and resistance, while others are welcomed and readily adopted into daily consumption practices. Although there has been some criticism of SRT due to its perceived 'theoretical vagueness', Pivetti (2007: 138) argues that this broad sweeping paradigm is *"at the crossroads of many socio-psychological concepts and disciplines"*, and therefore a valuable means of exploring social phenomena, including meaning construction around novel technologies,

Building upon the notion of social representations, evaluations of NFTs are likely to be guided by associated concepts and images, as confirmed to be the case by several academics (e.g. Shaw. 2002; Cardello, 2003; Siegrist et al., 2007b; Priest et al., 2011). As reinforcement of this point, several studies, including Cardello (2003) and Gunes and Tekin (2006) postulate that the word 'irradiation' may have negative connotations. As a further example, Kahan et al. (2007) posit that the word 'technology' may influence perceptions of nano'technology'. The notions of anchoring biases, metaphors and analogies are further explored in Chapter 3, where information interpretation and contextualisation are more thoroughly scrutinised.

Trust in stakeholders and perceived personal control are two additional types of heuristic mechanisms prevalently referred to in relevant literature, in terms of their impact on technology assessments.

Trust in others

An abundance of literature (e.g. Siegrist, 1999, 2000; Moon & Balasubramanian, 2004; Lee et al., 2005; Dean & Shepherd, 2007; Siegrist et al., 2007a; Loebnitz & Grunert, 2014) affirms trust's important role as a heuristic guiding public perceptions of novel technologies. This appears to be particularly the case in situations where individuals' knowledge about a technology is lacking (Siegrist & Cvetkovich, 2000; McCrea, 2005) and/ or they lack the motivation/ ability to understand related scientific information. Hence, many academics (e.g. Slovic, 2000; Siegrist & Cvetkovich, 2000; Frewer et al., 2003a; Hansen, 2003; Chen & Li, 2007) detail how social trust often manifests as a substitute for specific knowledge. Wynne (1980) was one of the first scholars to demonstrate how trust can influence lay citizens' risk assessments and overarching evaluative stances, thereby moving the focus from the characterisation of a technology towards individuals' perceptions of the scientists, regulators and other stakeholders involved in assessing associated risks (Allum, 2007).

Substantial evidence suggests that trust in the regulatory system and food industry influences citizens' attitudes and, therefore, may in part determine the future market success of foods produced using novel technologies (Chen & Li, 2007; Fell et al., 2009; Stampfli et al., 2010; Frewer et al., 2011). For example, Siegrist (1999, 2000) has repeatedly demonstrated trust in relevant stakeholders, particularly scientists and regulators, to be a significant determinant of both risk and benefit perceptions, and thereby overall acceptance of NFTs. Interestingly, Siegrist (1999) found that when trust is controlled for, the inverse relationship between risk and benefit perceptions disappears. More recently, Siegrist et al. (2007a, b, 2008) and Stampfli et al. (2010) describe how trust in the food industry and government agencies influences public perceptions of, in this instance, nano foods and associated risks and benefits.

Elsewhere, the TNS-BMRB report for the FSA, UK (2011) and Sheldon et al. (2009) stress that positive evaluations of NFT related products are based on assumptions that they will be adequately regulated and any potential risks will be addressed before such products reach the market. In turn, while Viklund (2003: 727) has identified trust as a significant predictor of perceived risk perceptions across countries, he argues that trust may not be as *"powerful"* an explanatory determinant of risk behaviour as others have postulated.

Relying on trust in the assessments of regulators, scientists and industry reduces the need to depend on one's own risk assessments (Kuttschreuter, 2006). Therefore, confidence in the assessments of others is based on a belief that they shares similar values to lay citizens and are concerned with public interests (e.g. Hallman, 2000; Siegrist, 2000; Allum, 2007). Trust in information communicated about these technologies is consequently dependent on the information source (Scholderer & Frewer, 2003), with some potentially being perceived as having a vested interests (Frewer et al., 1997c; Kuttschreuter, 2006; Dean & Shepherd, 2007; Fell et al., 2009). If an information source is considered to be purely self-serving, this can negatively impact the level of trust placed in it (Renn, 2003; Potts & Nelson, 2008).

A lack of trust can significantly reduce the effectiveness of risk communication (Flynn et al., 1998), while 'effective communication' with the public can help to foster trust in these technologies (Frewer et al., 1999; Siegrist, 1999; Bruhn, 2005). Hence, source credibility is an important determinant of individuals' reaction to information about these technologies (Frewer et al., 1999; Scholderer & Frewer, 2003). Indeed, the communication method, the message communicated and trust in the information source all impact public perceptions (Bier, 2001; Maule, 2004). The concepts of information type and framing are further discussed in Chapter 3.

More deeply examining the relationship between trust and risk information, literature to date (e.g. Renn, 2003; Frewer, 2004; Maule, 2004; Shepherd, 2008; McCarthy & Brennan, 2009) indicates that there are clear challenges encountered when providing scientific information to lay citizens, specifically communicating issues that have a risk component. Broadly speaking, the fragility of this complex 'trust entity' (Hornig Priest, 2011) should not be underestimated. It seems that once trust is violated, it is difficult to rebuild (Henson, 1995; Renn, 2003). To this end, Allum (2007) postulates that judgements about the technical competency of scientists are an important trust-based determinant of lay citizens' technology appraisals.

Reliance on social trust is likely to be particularly important in instances where individuals perceive themselves to have limited personal control over the application of a technology and the personal capacity to assess its risks and benefits (Chen & Li, 2007). Trust is therefore closely related to the concept of perceived control over exposure to these technologies.

Perceived control and choice

A wealth of literature within this area (e.g. Henson, 1995; Frewer et al., 1998b; Bánáti, 2008; Siegrist et al., 2008; Hagemann & Scholderer, 2009) indicates that perceived control and personal choice are desired as a means of limiting perceived uncertainty. Numerous scholars (e.g. Slovic, 1987; Frewer et al., 1994; Shaw, 2002; Ronteltap et al., 2009; Sheldon et al., 2009; López-Vázquez et al., 2012) refer to the impact of perceived personal control and freedom of choice on overall technology evaluations. As an illustration of this argument, Siegrist et al. (2008) found perceived personal control to influence risk and benefit perceptions, and consequently to potentially affect acceptance/ rejection of nano foods.

Breaking down the issue of perceived control, Siegrist, (2008) and the TNS-BMRB (2011) emphasise public demands for product labelling to enable informed voluntary choice concerning purchase/ consumption decisions. More broadly, a variety of studies (e.g. Grove-White et al., 1997; Kuznesof & Ritson, 1996; Hallman, 2000; Gaivoronskaia & Hvinden, 2006; Verbeke et al., 2007; Lampila et al., 2009; Sheldon et al., 2009) indicates strong public desire for information about these technologies, prior to providing evaluations of them.

Having outlined the different types of heuristics that individuals drawn upon to guide their technology assessments, the next section explores theoretical models of acceptance more broadly.

2.5 Theoretical Models of Acceptance of NFTs

Several models have been forwarded, in an effort to better understand the determinants of consumer/ citizen acceptance of novel technologies and associated products that merit attention. As a starting point, Booth and Shepherd's (1988) model of the factors affecting food acceptance has illustrated the impact of 'food', 'individual' and 'environmental' factors on acceptance of products. To this end, they highlight the impact of the 'multiplicity of the individual' on food acceptance.

More recently, models have been presented in an attempt to more cohesively account for, and build upon, the interdependencies between the TD and BU influences and associated concepts previously outlined. Explicitly, these models strive to account for how these influences interact with other determinants (e.g. the specific context) to direct overall acceptance/ rejection and purchase intention decisions around NFTs and resultant products. Two such models are particularly noteworthy.

First, Ronteltap et al. (2007) have developed a conceptual framework (see Figure 2.2) of the determinants of consumer acceptance of technology-based innovations, based on a review of literature within food and non-food domains.

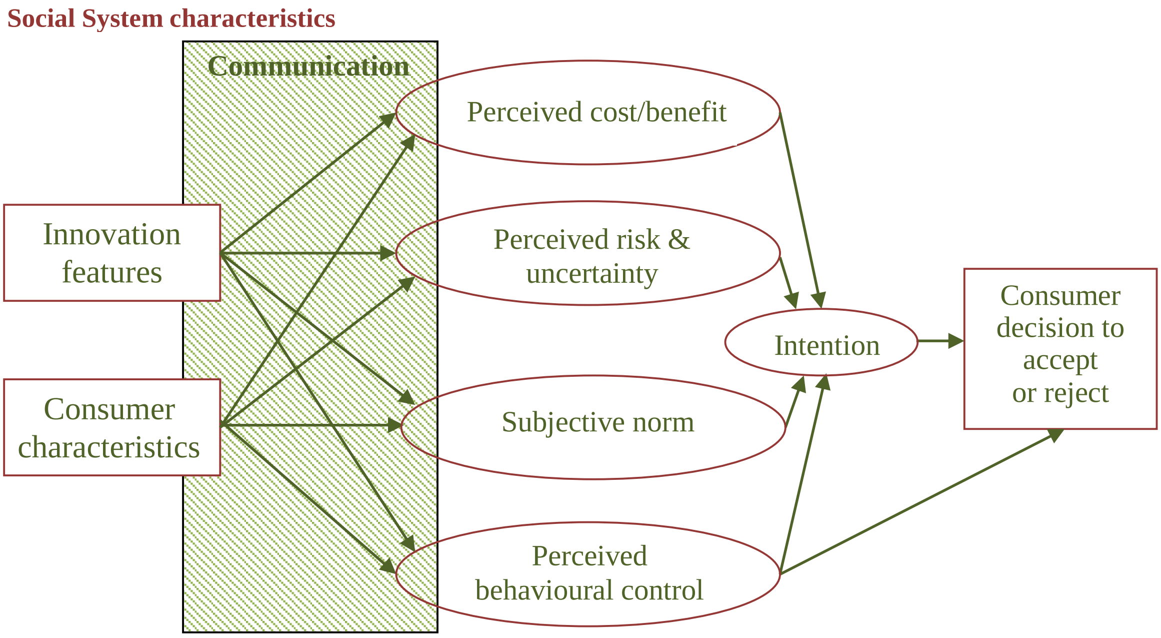

Figure 2.2: *Conceptual Framework for Research on Acceptance of Technology-based Food Innovation*

Source: Ronteltap et al. (2007: 5)

This framework places particular emphasis on the importance of the characteristics of the technology *and* the individual in determining consumer acceptance. In doing so, it distinguishes between 'distal determinants' (i.e. the characteristics of the innovation, the consumer, including their general values, and the social system) and 'proximal determinants' (i.e. perceptions of risk and uncertainty, perceived cost/ benefit considerations, social norms (taking account of what society thinks) and perceived behavioural control). Distal determinants influence willingness to accept an innovation through proximal determinants. Within this framework, 'communication' is influential in connecting the distal innovation features to the proximal features, i.e. consumers' perceptions.

This model attempts to tie together various concepts brought forward from existing models, including the Theory of Planned Behaviour (Ajzen, 1991) (see Section 3.2.2) and Diffusion of Innovation Theory (Rogers, 1995). Roger's theory which has been widely applied in marketing and innovation literature, posits that the following influence adoption of innovation: the nature of the recipient/ society to which an innovation is introduced; the innovation itself; communication channels used to spread information about the innovation; and, time. The concepts of perceived risk and uncertainty, which tie into theories of risk psychology, are also incorporated within this framework as proximal determinants. This framework has been reflected upon in the context of the determinants of acceptance of nutrigenomic based personalised nutrition. A modified version of this framework was strongly supported when tested (see Ronteltap et al., 2009), with cost-benefit appraisals materialising as the most important construct in the process, followed by perceptions of subjective norms.

Second, the more process orientated Model of Consumer Acceptance of Novel Foods (see Figure 2.3) forwarded by Kuznesof (2010) illustrates the complexity and sequential nature of a novel food's 'acceptance path'. This model focuses on systematic decision making around NFT products. Kuznesof describes how consumer acceptance of novel foods can be considered as a staged process, which encompasses a cyclical interplay of multiple 'acceptance states'. These states relate to the consideration, trial and sustained incorporation of a novel food into dietary practices, moulded by personal, product and circumstantial factors. These stages encompass: 1) conceptual acceptance; 2) connective acceptance; 3) evaluative acceptance; 4) trial acceptance; and, 5) dietary acceptance. A description of each stage is provided overleaf. While this model is described as a 'consumer model of acceptance', the initial state centres on the citizen, i.e. the 'conceptual' state, which relates to *"the value systems of individuals that would determine 'in the mind of the individual' whether or not the novel technology (and resulting novel food) would be accepted or rejected"* (*Ibid*: 148.). The proceeding states (i.e. the 'connective', 'evaluative', 'trial' and 'dietary' acceptance states) sequentially move to focus more explicitly on the consumer's perspective.

The underpinnings of this model are in keeping with the interdependencies between TD and BU influences, as previously described, in so far as if one is to ‘actively reject’ the technology/ product at the ‘conceptual state’, i.e. as a citizen, they will most probably also reject the technology at the other, more applied, states, i.e. as a consumer. In this situation, conceptual rejection, deriving from deep-rooted values and belief, will direct decision making at the other states.

The models of Ronteltap et al. (2009) and Kuznesof (2010) adopt a market orientated lens, and thereby emphasise the consumer, as opposed to the citizen. Nevertheless, both models are relevant and worthwhile to explore from a citizen standpoint, since the concepts that they incorporate, such as perceived risk, uncertainty and control, relate to both consumer *and* citizen perspectives.

In undertaking this current research, relevant elements from the aforementioned models are drawn together, in an attempt to explain the reasoning behind public attitude formation around and ultimate acceptance/ rejection of selected novel technologies. Although these models attempt to bring together the aforementioned influences and concepts into testable models, and provide valuable insight into acceptance/ rejection of NFTs, they do not comprehensively address attitude formation per se.

The next section moves to conclude this chapter by presenting research opportunities stemming from the literature reviewed.

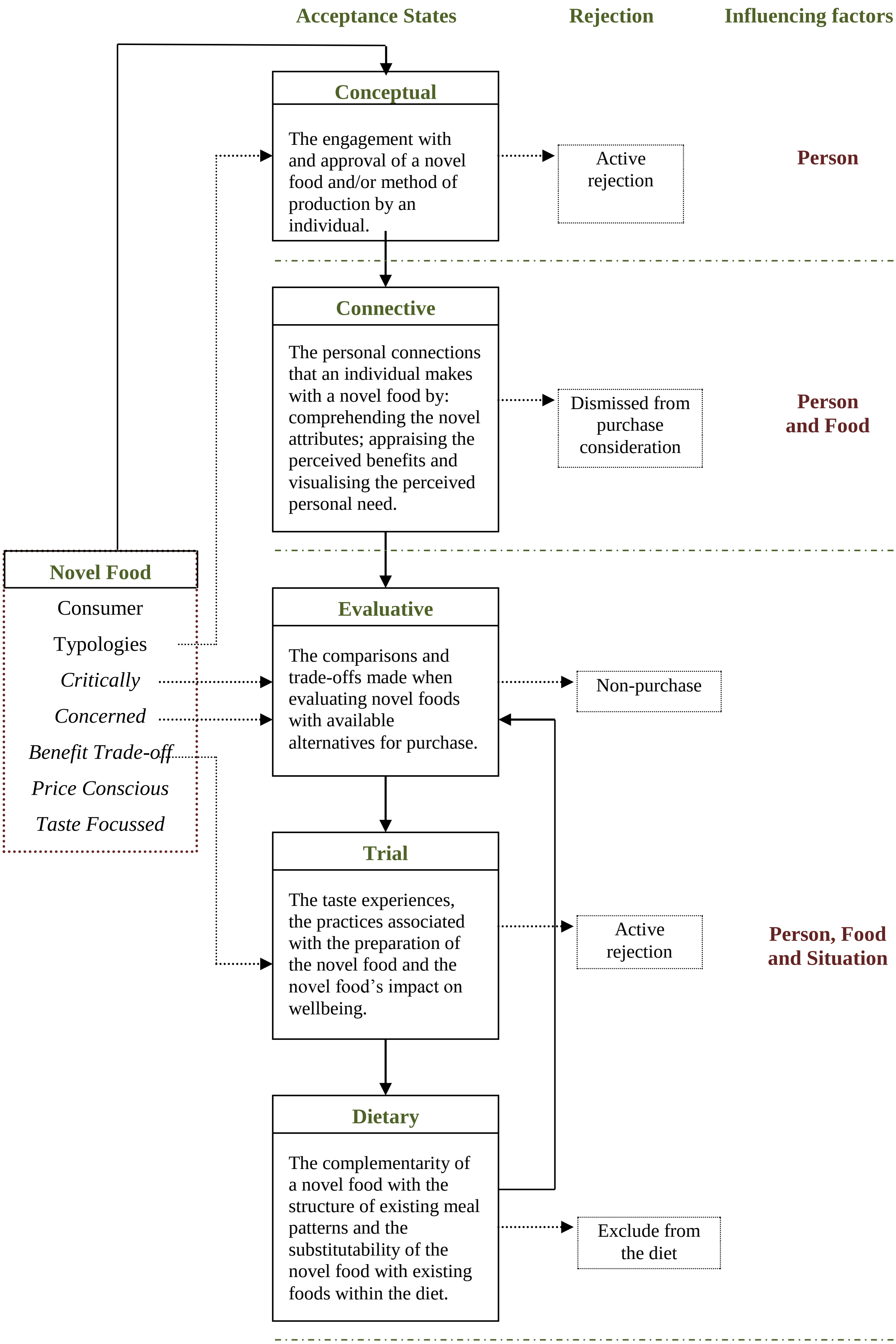

Figure 2.3: *Complete Model of Consumer Acceptance of Novel Foods*

Source: Kuznesof (2010: 214)

2.6 Opportunities for New Research and Conclusion

This chapter has introduced and appraised literature concerning the myriad of factors that have been demonstrated to influence public evaluations and overall acceptance (rejection) of these technologies, examining each variable in depth. Based on this review, it is clear that the body of literature and different theoretical perspectives on the determinants of public acceptance of these technologies is vast. Within this review, links have been made between a variety of theories and concepts from social, risk and cognitive psychology, drawn upon by scholars in an attempt to understand and contextualise public evaluations of novel technologies. In doing so, this review has enabled a greater appreciation of the relationship between these theories, and how they can be applied and synthesised.

The TDBU paradigm formed the theoretical backbone of this review, given its prominence within research in this area. The extent to which TD and BU influences are detectable within the data collected and impact citizens' technology evaluations will be explored within this current study. The TD influences reported as being most impactful on technology assessments include personal characteristics and general outlooks, such as: attitudes towards nature, food and food production/ processing, and technological progress; general risk sensitivity; ethical and moral beliefs; and trust placed in others. In turn, the BU influences that are most apparent encompass perceived personal and societal benefits and risks, their relevance within different contexts and the assumed distribution of associated benefits.

The focus of scholarly work to date on public assessments of NFTs has centred primarily on risk, rather than benefit, perceptions (Currall et al., 2006; Druckman & Bolsen, 2011; Fischer et al., 2013). Subsequently, this review has examined relevant literature concerning the psychology of risk, presenting a brief historic overview on theoretical perspectives on risk. The different types of heuristics called upon when evaluating these unfamiliar technologies have also been explored, drawing on SRT (Moscovici, 1984; Pivetti, 2007).

The determinants of acceptance apparent within this review are summarised in Table 2.1, under the categories of TD and BU influences.

Table 2.1: *Summary of the Determinants of Public Acceptance/ Rejection of NFTs*

<table>
<tr><th>Top-down influences:
At the individual level</th><th>Bottom-up influences:
At the technology/ product level</th></tr>
<tr><td>General attitudes, values, and beliefs, including attitudes towards nature and the environment, food and food production/ processing, science and technological progress, ethical and moral stances and general risk sensitivity (Hamstra, 1995; Sparks et al., 1995; Kuznesof & Ritson, 1996; Frewer et al., 1997a, b; Bredahl, 1999, 2001; Grunert et al., 2003, 2004a; Søndergaard et al., 2005; Chen & Li, 2007; De Jonge et al., 2007; Kahan et al., 2007; Cox & Evans, 2008; Henson et al., 2008; Fell et al., 2009; Nielsen et al., 2009; Sheldon et al., 2009; Clery & Bailey, 2010; Vandermoere et al., 2011; Loebnitz & Grunert, 2014).</td><td rowspan="3">Risk and benefit perceptions (Frewer et al., 1997a; Bredahl, 2001; Grunert et al., 2003; Cardello et al., 2007; Nielsen et al., 2009).
– Assumed relevance of perceived risks and benefits to the individual, society, the environment and other stakeholders (Kuznesof, 2010; Frewer et al., 2011).
– Perceived distribution of associated risks and benefits (Sheldon et al., 2009; Frewer et al., 2011).
– Research to date appears to have placed greater emphasis on risks, rather than benefits (Currall et al., 2006; Druckman & Bolsen, 2011).
  – Technical and social definitions of risk are now recognised (Verbeke et al., 2007).
  – Relevant theoretical perspectives on risk perceptions include: the psychometric paradigm (Fischhoff et al., 1978; Slovic et al., 1980); optimistic bias (Wilkinson, 2006); and, cultural perspectives on risk (Douglas & Wildavsky, 1982).</td></tr>
<tr><td>Cultural and social norms (da Costa et al., 2000; Bredahl, 2001; Ronteltap et al., 2007; Costa-Font & Gil, 2009; Kahan et al., 2009; Gaskell et al., 2010; Zhang et al., 2010; Loebnitz & Grunert, 2014; Perrea et al., 2015).</td></tr>
<tr><td>Life experiences and other personal characteristics (Macoubrie, 2006; Burri, 2009; Sheldon et al., 2009; Davies, 2011).</td></tr>
<tr><td>Socio-economic factors (Shaw, 2002; Cardello, 2003; Moon & Balasubramanian, 2004; De Jonge et al., 2007; Fell et al., 2009; Clery & Bailey, 2010; Gaskell et al., 2010).</td><td>Risk-benefit trade-offs (Alhakami & Slovic, 1994; Bredahl, 2001; Brown & Ping, 2003; Slovic et al., 2004; Siegrist et al., 2008).
– Individuals are willing to tolerate higher levels of risk from activities (and technologies) perceived as being highly beneficial (Starr, 1967; Gaivoronskaia & Hvinden, 2006).</td></tr>
<tr><td>Perceived and actual awareness and knowledge about the technology.
– There are mixed results concerning their impact on assessments (House et al., 2004; Gaskell et al., 2010).
– Lack of awareness does not preclude citizens from forming technology assessments (Hallman, 2000; Costa-Font & Mossialos, 2007; Gaskell et al., 2010).
– Information provision can impact citizens' assessments in a variety of ways (e.g. Hayes et al., 2002; Frewer et al., 2003a; Gunes & Tekin, 2006; Sheldon et al., 2009) and does not necessarily result in attitudes becoming more positive (Bredahl, 1999; Scholderer & Frewer, 2003).</td><td>Characteristics of the technology, application and product (Sparks et al., 1994a, b; Frewer et al., 1997a, 1998b; Hallman, 2000; Siegrist et al., 2007a, 2008; Nielsen et al., 2009; Sheldon et al., 2009; Henchion et al. 2013).
– This includes subjective and objective product attributes, such as perceived taste, price, healthfulness quality, naturalness and convenience, (Kuznesof & Ritson, 1996; Bredahl, 2001; Cardello et al., 2007; Siegrist, 2008; Costa-Font & Gil, 2009; Loebnitz & Grunert, 2014).</td></tr>
</table>

Table 2.1: *Continued*

Top-down influences: At the individual level	**Bottom-up influences: At the technology/ product level**

Reliance on heuristics, especially when unfamiliar with the technology (Slovic, 1987; Lee et al., 2005; Burri, 2009; Mather, 2012). This includes reliance on:
– **Media affects** (Frewer et al., 1998; Miller, 1999; Scheufele & Lewenstein, 2005; McCarthy et al., 2008; Dudo et al., 2011; Ho et al., 2013).
– **Affect, availability and anchoring heuristics** (Tversky & Kahneman, 1973; Iyengar, 1990; Morgan et al., 2002: Maule, 2004; Slovic et al., 2004; Gomez, 2013).
  – Anchoring to familiar concepts and images (Cardello, 2003; Priest et al., 2011) and accessibility bias are connected to SRT (Moscovici, 1984; Bäckström et al., 2003, 2004; Pivetti, 2007).
– **Trust in others** (Siegrist, 1999, 2000; Bredahl, 2001; Frewer et al., 2003a; Allum, 2007; Loebnitz & Grunert, 2014).
  – Social trust often manifests as a substitute for specific knowledge (Hansen, 2003; Chen & Li, 2007).
– **Perceived control** over the technology's application (López-Vázquez et al., 2012), which is connected to product labelling in order to enable informed voluntary choice (Siegrist, 2008; TNS-BMRB, 2011) and information demands more broadly (Hallman, 2000; Verbeke et al., 2007; Sheldon et al., 2009).	

TD and BU influences are not mutually exclusive and operate concurrently (Bredahl, 2001; Grunert et al., 2004a; Søndergaard et al., 2005). – TD influences mould risk and benefit assessments, in addition to directly impacting technology evaluations (Bredahl, 2001; Søndergaard et al., 2005). – The extent to which TD versus BU influences impact evaluations depends on the characteristics of the technology and individual (Bredahl, 2001; Nielsen et al., 2009). Explicitly, where levels of knowledge about the technology are low, TD influences tend to dominate evaluations (Grunert et al., 2003, 2004a).	

This review indicates that the determinants of public acceptance identified in the literature are better predictors of public rejection, rather than acceptance. Therefore, more is known about how consumers will reject, rather than accept, these technologies. Furthermore, based on this review, an array of different approaches and perspectives are evident, which seem to be neither cohesive (Frewer et al., 2013) nor embedded within a common theoretical foundation, aside from the models of Ronteltap et al. (2007) and

Kuznesof (2010) previously outlined. The divergent schools of thought and theories applied, in terms of exploring these determinants, indicate the intricacies associated with public assessments of NFTs, in addition to the on-going quest to better understand why certain technologies are rejected, while others are more readily accepted (Cardello et al., 2007; Gupta et al., 2011; Hornig Priest, 2011).

As previously outlined, research to date has largely adopted quantitative methodological approaches. While some of this these studies have acknowledged, and attempted to account for, the impact of affective-based attitudes on technology evaluations (e.g. Slovic et al., 2004; Siegrist et al., 2007a), for instance through a social representation perspective (e.g. Bäckström et al., 2003, 2004; Pivetti, 2007), on the whole, they do not appear to have truly elucidated the cognitive meanings and associations that drive attitude formation around NFTs (Fell et al., 2009; Gupta et al., 2011).

> *"Although researchers have documented widely divergent attitudes to different food technologies (e.g., organic production versus genetic modification), our knowledge about how consumers develop these attitudes remains limited"* (Loebnitz & Grunert, 2014: 19).

Moreover, although the TDBU approach holds merit, and appears to reflect some of the complexities inherent in attitude formation processes around these technologies (Nielsen et al., 2009), it does not account for the *"the emotional aspects of the [evaluative] process"* (Loebnitz & Grunert, 2014: 20).

Despite the sheer depth of research which has explored the determinants of public evaluations of novel technologies, and the scant attention paid to date to unveiling the inherent cognitive processes and associations at play when contextualising relevant information (e.g. Burri, 2009; Davies, 2011), a nuanced understanding of public attitude formation around these technologies remains lacking. Hence, new approaches to understanding attitude formation are apparently needed, in particular those which centre on the associations potentially triggered, and integrated with other information, when forming attitudes around NFTs at the different citizen/ consumer orientated acceptance (rejection) states outlined by Kuznesof (2010).

In light of these arguments, this research aims to better understand individuals' evaluative processes around these technologies from the perspective of attitude formations and information processing. In doing so, this research will provide useful insight into the impact and complex interplay of attitudes and information processing on overall technology evaluations. This work thereby strives to move beyond measures of risks and benefits, to explore what and how attitudes form, and the cognitive and affective responses and methods of information processing deployed around these technologies. Chapter 3 reports on relevant social and cognitive psychology theories to explore the concepts of attitude formation and information processing in further detail, and specifically the relationships between these variables. The literature examined also appears to have paid minimal attention to the conflicts that manifest between the elements associated with evaluations of these technologies. This work brings this concept forward, striving to unveil potentially associated complexities.

As a final point, the evaluative criteria used by the public can vary across technologies, as evident within this review. Consequently, both general and technology specific research is merited. This point is further reflected upon in Chapter 4, when discussing the selection and grouping of technologies examined within this work.

Chapter 3

Attitude Formation and Information Processing

3.1 Introduction

In recent times, Fell et al. (2009), Gaskell et al. (2010) and Rollin et al. (2011), among others, have drawn attention to the fact that, to date, negative public attitudes have formed towards certain NFTs, while others have been welcomed and positively perceived. Consequently, the purpose of this chapter is to situate the issue of acceptance of NFTs within the broader literature around attitude formation and information processing, in order to better understand how attitudes form.

Attitude formation and information processing remain core areas of investigation and topics of on-going debate within social psychology (Crano & Prislin, 2006). Within this chapter, the origins, composition and formation of attitudes are explored. In addition, the relationship between attitudes and subsequent behavioural, or conative, responses is examined (Spence & Townsend, 2006a). Attitude characteristics, including sentiment, accessibility, importance, certainty, strength, stability, ambivalence, associations and measurement are also outlined. The ways in which explicit (deliberate) and implicit (subconscious) attitudes are formed (Eagly & Chaiken 2007), guided by the processing of accessible information (Bohner & Dickel, 2011), is discussed along with an overview of literature concerning how attitude formation and change relate to information processing and methods of communication.

This review highlights the dynamic and complex relationships that exist between initial attitudes, information processing and subsequent attitudes. Additionally, this review of literature, concerning mechanisms of processing information and associated models, provides a basis for understanding how individuals frame and interpret information. The manner in which the characteristics of the information source, the content of the information, the audience and the cognitive route applied can impact information processing and contextualisation is illustrated. Finally, theories and positions pertinent to cognitive models of information processing are discussed.

3.2 Attitude Formation

> *"People need standards or frames of reference for understanding their world, and attitudes help to supply such standards"* (Katz, 1960: 175).

As they are *"highly consequential"* (Gawronski & Bodenhausen, 2007: 687), attitudes are a central concept of social and cognitive psychology, meriting considerable scholarly attention over the last 100 years. One of the seminal early writers on the concept of attitudes, the psychologist Gordon Allport (1935: 789), argued that attitudes are *"probably the most distinctive and indispensable concept in contemporary American social psychology"*. It seems the essence of Allport's dictum holds as true today as it did in 1935. In light of this focus of interest, it is understandable that the concept of attitudes has evolved over time (Crano & Prislin, 2008; Bohner & Dickel, 2011). Drawing on key authors within this area (e.g. Allport, 1935, 1954; Katz, 1960; Edwards, 1990; Fazio, 1990, 2007; Eagly & Chaiken, 1993; 2007; Petty et al., 1997, 2006; Crano & Prislin, 2006; Bohner & Dickel, 2011), the nature of attitudes, their composition and formation, and their relationship with other psychological concepts and structures such as behavioural responses and emotions and information processing, are explored in turn.

3.2.1 Defining Attitudes

While behaviourism focuses on observable behaviours, cognitive and social psychology concentrate on internal mental states, including attitudes. As mentioned, the emphasis within the psychology of attitudes has a long, evolving and disputed history. Prior to deliberating the formation of attitudes, it is important to define this concept. Seminal authors within psychology have forwarded definitions which establish the nature of attitudes, in addition to their impact on behaviour.

Allport (1935: 810) defined an attitude as *"a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related"*. Twenty five years later, Katz's (1960: 168) definition emphasised the favourability of perspectives, as he perceived an attitude to be *"the predisposition of the individual to evaluate some symbol or object or aspect of his world in a favourable or unfavourable manner"*. Turning to other, more recently relayed, perspectives, Olson and Kendrick (2008: 111) consider attitudes to *"encapsulate positive and negative feelings, beliefs, and behavioural information about all ranges of "attitude objects," from people to frozen pizza"*. Eagly and Chaiken (2007) and Tenbült et al (2008a) outline the concept in a similar way.

Katz (1960) and Ajzen and Fishbein (1977) have further stressed the relationship between attitudes and beliefs. They have argued that attitudes can encompass beliefs, but not all beliefs are necessarily attitudes. In this context, beliefs are considered the subjective knowledge that individuals attain about an object through the processing of information, i.e. cognitive learning. Additionally, Katz emphasises how specific attitudes are organised together into a hierarchical structure to represent individuals' unique value systems. Ajzen and Gilbert Cote (2008) detail how these beliefs can become ingrained, as a result of direct observation or by accepting information from multiple outside sources, including peers and the media. Although our beliefs, whether biased or rational, are not immune to evolution over time, strongly held beliefs are difficult to alter (Frewer et al., 1998b).

Pertaining to the *"nature versus nurture"* debate concerning beliefs and attitude formation (Olson & Kendrick, 2008: 112), the literature indicates that one is not born with entrenched beliefs. Thus, attitudes are acquired rather than inborn (Ajzen & Gilbert Cote, 2008). This theory suggests that attitudes towards novel technologies develop over time, based on experiences as well as deep-seated values and beliefs. Building on this premise, beliefs about, for example, naturalness and resultant attitudes about the (un)naturalness of a NFT food are formed as a result of experiences and environmental influences. Similarly, placing a high value on personal health might positively influence an individual's attitude towards products, such as functional foods or personalised nutrition products (PNPs).

According to Ajzen and Gilbert Cote (2008), the notion that beliefs are the foundations of attitudes is supported by the Expectancy-Value model (Fishbein & Ajzen, 1975) of attitude formation. This model is a commonly recognised framework from which to explore the cognitive basis of attitudes (Olson & Kendrick, 2008). The Expectancy-Value model postulates that attitudes are a function of one's implanted beliefs which are, in turn, a product of both the expectancy and value that the individual associates with relevant attributes of the product or object (*Ibid*). Based on this model, beliefs form about an object based on its associations with specific attributes, including other objects, events or characteristics (Ajzen & Gilbert Cote, 2008). For instance, if an individual associates a specific attitude object (e.g. GM foods) with another attitude object (e.g. animal cloning) towards which they have a positive or negative attitude, this association will impact their attitude towards the primary object (Tenbült et al., 2008a). In the same way, Lee et al. (2005) postulate that public affective responses towards nanotechnology are somewhat impacted by individuals' prior experiences with, and perceptions of, previous scientific controversies. Further exploring the concept of positive and negative associations, Loebnitz and Grunert (2014) found that Evaluative Conditioning[8] can impact consumer acceptance of NFTs, particularly in situations where social trust is high.

At the root of the Expectancy-Value is the assumption that the most accessible and prevailing beliefs guide attitude formation (Ajzen & Gilbert Cote, 2008). This model therefore has some similarities to Information Integration Theory (Anderson, 1971), which contends that the processing and interpretation of information involves its integration with prior beliefs, in order to produce an attitude towards the new information about an attitude object or eventuality (Olson & Kendrick, 2008). This process may involve efforts to reduce cognitive dissonance (Festinger, 1957) (see Section 3.2.7).

More deeply exploring the impact of prior beliefs and values on attitudes, many authors, including Katz (1960) and Nisbet (2005), argue that attitudes are reflective of worldviews. Significantly, Ajzen and Fishbein (1977) consider attitudinal and behavioural entities to consist of the following four elements: the context in which the action occurs, the action involved, the target at which the action is directed, and the time of its occurrence. Similarly, a more recent definition presented by Crano and Prislin (2006: 347) emphasises the evaluative processes associated with an object:

> *"An attitude represents an evaluative integration of cognitions and affects experienced in relation to an object. Attitudes are the evaluative judgments that integrate and summarize these cognitive/affective reactions".*

This definition focuses on the classical ABC (Affect, Behaviour and Cognition) metaphor for understanding and conceptualising attitudes (Kretch & Crutchfield, 1948; Olson & Kendick, 2008). Within this cornerstone 'tripartite model', these three variables are considered the *"omnipresent components of attitude"* (Eagly & Chaiken 2007: 589). Contemporary thinking has, however, queried the merits of focusing purely on this model and questioned the extent of the relationship between attitudes and actual behaviour, as discussed in Section 3.2.2. Specifically, Olson and Kendick (2008) outline how current approaches have moved beyond the tripartite paradigm, by focusing on differentiating between how attitudes form independent of their specific content.

8 Evaluative Conditioning refers to *"a change in the valence of a conditioned stimulus (CS) due to its pairing with another, unconditioned stimulus"* (Loebnitz & Grunert, 2014: 19).

Concerning their widely cited definition of attitudes, Eagly and Chaiken (1993: 1) believe an attitude to be *"a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor".* They stress the significance of the 'object' component of an attitude, considering this to be the distinguishing feature between an attitude and other psychological constructs, such as mood, which are less directed toward a specific object. Eagly and Chaiken's definition encompasses three key features of attitudes: evaluation, tendency and the attitude object which may be either abstract or concrete.

Equally, Petty et al. (1997) describe an attitude as a summary evaluation of an object, along a continuum ranging from positive to negative. Furthermore, Ajzen and Fishein (1977: 889) assert that *"a person's attitude represents his evaluation of the entity in question"*, while Eagly and Chaiken (2007: 583) believe that the conception of attitude differentiates between the *"inner tendency"* (attitude) and the *"evaluative responses that express attitudes".*

Each of the multiple definitions presented holds merit within different contexts (Gawronski & Bodenhausen, 2007). In fact, Bohner and Dickel (2011: 396-397) summarise how definitions presented range across a spectrum, from easily retrievable *"purely memory-based summary evaluations"* to evaluations that are formed as a result of accessible information at a specific point in time. The next section further examines the relationship between attitudes and evaluative-based behaviours.

3.2.2 Relationship between Attitude and Behaviour

A long standing issue, explored most thoroughly by Fishbein and Ajzen (1975), is the relationship between attitudes and behaviour. According to Fazio (2007), attitudes are integral within the functional system whereby attitude formation, through information processing, influences behaviour. Indeed, Fazio (*Ibid*: 605) defends the notion that *"attitudinal reports can sometimes prove strongly predictive of behaviour"*. However, Fazio suggests that this is not always the case and that, contrary to Allport's (1935) stance, definitions of attitudes should not necessarily imply behavioural responses, based on a lack of evidence of such a relationship.

A similar perspective, contended by Spence and Townsend (2006a: 658), is that although these variables are strongly related, *"they are not directly correspondent"*. There is some evidence that attitude-behaviour inconsistencies prevail between individuals' perceptions of how they *would* act/ react and how they *actually* act/ react within a specific situation or towards an attitude object (Katz, 1960; Bredahl, 2001; Smith & Hogg, 2008), for instance towards organic foods (Aschemann-Witzel & Niebuhr Aagaard, 2014).

In an effort to expand beyond the tripartite model, emphasis has been placed on the implicit (subconscious or automatic) and explicit (deliberate) nature of attitude formation (Tenbült et al., 2008a). Although both can encompass automatic properties, explicit attitudes are generally presumed to require more cognitive effort than implicit attitudes. Consequently, explicit attitudes are assumed to be a better predictor of behaviours which are under volitional control (Eagly & Chaiken, 2007). Individuals' implicit and explicit attitudes towards NFTs may not correlate, as Spence and Townsend (2006b) and Tenbült et al. (2008a) found to be the case in their studies of attitudes towards GM foods. Specifically, Tenbült and colleagues found that implicit measurements showed negative associations with GM foods, while explicit measurements showed neutral associations. These incongruities may, in part, be the result of lack of *"introspective access"* to implicitly guide representations (Hoffmann et al., 2005; Tenbült et al., 2008a: 623).

Arts et al. (2011) report on previous research which indicates that consumers' intentions to adopt innovations are often weak predictors of actual adoption behaviours. A reason for this anomaly is that attitude formation (and intention) often occurs in the absence of imagining the circumstances of encountering the attitude object. For example, an individual who generally holds a negative attitude towards functional foods produced using, for instance, nanotechnology may form a more positive attitude when presented with a functional food that offers unique tangible benefits of personal relevance, particularly if the product in question is competitively priced. In this scenario, attitude formation may be more affect-driven in the hypothetical situation and more cognitively-driven in the presence of an associated product with specific attributes.

Ajzen and Gilbert Cote (2008) describe how one can only expect a strong attitude-behaviour relationship to exist if the measures of both constructs (attitude and behaviour) correspond in terms of their action, target, context, and time elements, as previously discussed. In an effort to account for attitude-behaviour inconsistencies, Loewenstein and Schkade (1999: 85) have put forward the concept of *"cold"* and *"hot"* states. They describe how attitudes formed in a 'cold' state, i.e. in the absence of the attitude object, may not necessarily be reflective of actual behaviour in a 'hot' state, i.e. in the presence of the object. It follows then that attitude formation is clearly situation and environment specific (Bohner & Dickel, 2011). In spite of potential attitude-behaviour inconsistencies, exploration of attitude formation in hypothetical situations is still a worthy research pursuit, as it provides valuable insight into the meanings and influences that individuals rely upon when forming attitudes and processing information.

Turning to possible influencers on attitude-behaviour relationships, Petty et al. (1997) contend that attitude strength can have a moderating role on the attitude-behaviour connection and that strong attitudes aid decision-making. In an effort to explain and predict the relationship between attitudes and acquired behavioural predispositions, several theories have been developed.

The first theory of note is the Theory of Reasoned Action (TRA). Fishbein and Ajzen (1975) developed this theory largely as a result of frustration with traditional attitude-behaviour research, which found a relatively weak association between measures of attitude and performance of volitional behaviours (Hale et al., 2003). TRA, which draws on several other attitude related models including Expectancy-Value, is a structured attitudinal model which assumes that intention to perform a specific behaviour is the best predictor of the actual behaviour. According to TRA, behavioural intention is predicted by two components: 1) an individual's attitude towards and evaluation of the behaviour; and 2) subjective norms or perceived social pressure, from, for example, family and friends to behave (or not behave) in a specific way. Subjective norms are included in this model in recognition that it is necessary to incorporate additional variables in order to enhance understanding of the dynamics of the attitude-behaviour relationship (Smith & Hogg, 2008).

TRA assumes that individuals can exhibit volitional control and perform behaviours at will. A distinction between behaviour intention and actual behaviour is clearly made in this model. A schematic representation of TRA is presented in Figure 3.1.

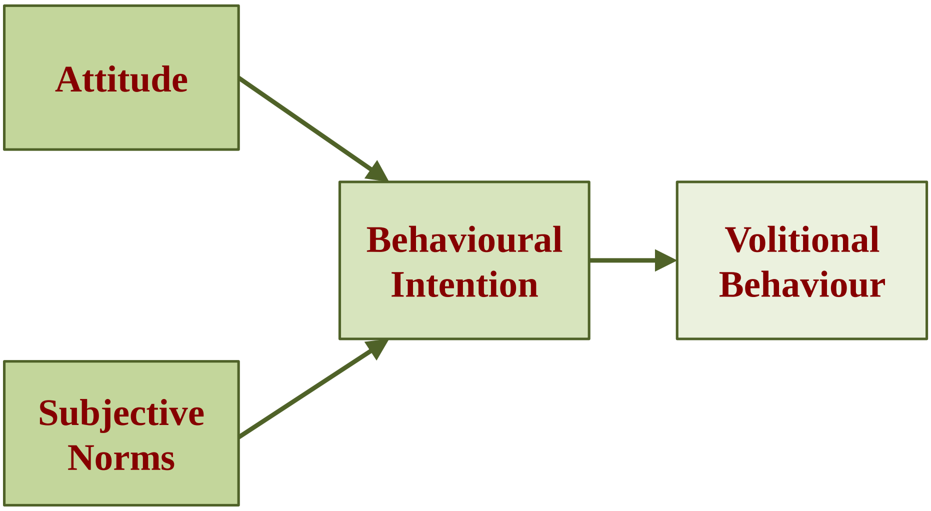

Figure 3.1: *Causal Diagram of Basic Components of TRA*

Source: Hale et al. (2003: 261)

Subsequent criticisms of this model (Hale et al., 2003) have led to its extension to include 'perceived control' as an antecedent of intentions and behaviours, in the Theory of Planned Behaviour (TPB) (Ajzen, 1988, 1991). According to TPB, perceived behavioural control, coupled with behavioural intention, can be applied directly to predict actual behaviours (Ajzen, 1988). Although the attitude-behaviour relationship is still somewhat disputed, many scholars consider TPB to be *"one of the most useful, and widely used, conceptual frameworks used to link attitudes and behaviour"* (Spence & Townsend, 2006a: 658).

Additional theories that have emerged from the original TRA and TPB models include Attitude Representation Theory and dual-processing theories, which, given the significance of the latter, are discussed at length in Section 3.3.2. As summarised by Lord and Lepper (1999: 265), Attitude Representation Theory builds on two basic postulates. The first is the representation postulate. This asserts that an individual's response to any attitude-relevant stimulus depends not only on the perceived properties of the stimulus and the surrounding situation, but also on the individual's subjective representations of the stimulus. The second is the matching postulate. This states that the closer the pairing between the subjective representations and perceived immediate stimulus to which an individual is responding, the greater the consistency in the individual's response. Attitude Representation Theory is therefore closely connected to Social Representation Theory (Moscovici, 1984, 1988: see Section 2.4), with both theories focusing on how representations form.

TRA, TPB and Attitude Representation Theory have been applied in social psychology to strengthen our understanding of attitude formation, behavioural intention and actual behaviour (Crano & Prislin, 2006). In fact, many scholars consider these theories to have demonstrated usefulness in predicting strong correlations between the variables involved in one's reactions towards novel technologies (Mather et al., 2012). Furthermore, these theories, particularly TPB, have been widely adopted in food choice research (e.g. Verbeke & Vackier, 2005), including research into public attitudes towards NFTs, particularly genetic modification (Sparks et al., 1995; Cook et al., 2002; Saba & Vassallo, 2002; Spence & Townsend, 2006a) and organic food products (Dean et al., 2008, 2012a) and, most recently, qualitative research into wine consumption behaviours (Silva et al., 2014).

Ajzen (1991: 199) was not opposed to amendments to the original TPB model, indicating that it is *"in principle, open to the inclusion of additional predictors"*, once they can be proven to account for a substantive proportion of variance in intention or behaviour, in addition to that accounted for by the traditional TPB components. Conner and Armitage's (1998) work is revealing, as it highlights different ways in which TPB could be extended to include additional variables, such as past behavioural habits, breakdown of the structure of the perceived behavioral control construct, belief salience, moral norms, self-identity, and affective beliefs. Evidence suggests that TPB only provides an indication of the determinants of behavior in situations where motivation and opportunity to process information are high, and does not account for more spontaneous information processing and implicit attitudes. In light of this, Conner and Armitage suggest two specific areas for expanding the original TPB. These include: 1) the possibility of incorporating the TPB into a Dual-Processing Model (DPM) of attitude-behaviour relationships; and, 2) expansion of TPB to *"include consideration of the volitional processes determining how goal intentions may lead to goal achievement"* (*Ibid*: 1429).

Building on Ajzen's (1991) and Conner and Armitage's (1998) suggestions, many studies have included additional components (cognitive and affective factors), such as affective influences (anticipated affect), to the original TPB model in an effort to further explain variance in behavioural intentions and/ or actual behaviour. Dean et al. (2012a: 671) have outlined how their TPB study, in addition to various other food behavioural studies, has confirmed self-identity and moral norms to be *"useful"* additional predictive variables for explaining purchase intentions. Furthermore, in their study of British consumers' behaviour toward GM foods, Spence and Townsend (2006a) extended the original TPB to include supplementary components to measure moral norms, self-identity and emotional involvement. In doing so, Spence and Townsend found evidence that self-identity and emotional involvement are significant predictors of behavioural intentions, while moral norms are not. Furthermore, this study found behavioural intention to be a significant predictor of actual behaviour. Elsewhere, Arvola et al. (2008) examined the usefulness of integrating measures of affective and moral attitudes into the TPB model to improve the model's fit and predictive ability when measuring purchase intentions towards organic foods. The results partially supported the usefulness of incorporating these measures into the TPB framework.

In the context of the TRA and TPB models, differences between reported attitudes and actual behaviours may also be explained, in part, by the fact that the methods used to establish attitudes place participants in different roles (Spence & Townsend, 2006a). For instance, individuals may report attitudes in survey instruments as public citizens (e.g. indicate a negative attitude towards GM crops due to perceived potential detrimental impacts on the environment), but behave as private individuals (e.g. be willing to personally purchase GM foods if they are less expensive than conventional alternatives) (Noussair et al., 2004; Clery & Bailey, 2010).

This section has indicated the complex relationship evident between attitudes and behaviour. It is not only this relationship that is intricate; attitude formation is an incredibly multifaceted process, with attitudes comprising of many aspects and components.

3.2.3 Attitude Composition and Formation

> *"Often, more often than we care to admit, our attitudes on important social issues reflect only our preconceptions, vague impressions, and untested assumptions"* (Lord et al., 1979: 2098).

Research into attitude formation has provided valuable insight into the complex structure and function of attitudes (Cunningham & Zelazo, 2007). At the outset, it is important to clarify relevant terms, drawing most predominately on the definitions presented by Visser et al. (2006).

Attitude accessibility refers to how easily or quickly an attitude is retrieved from memory. Visser et al. (2006: 5) define attitude accessibility as *"the character of the relation between an object's representation and its evaluation stored in memory, which regulates the speed and ease with which the attitude springs to mind upon encountering the object"*. It is argued that the quicker an attitude *"comes to mind"*, the more important it is inferred to be (*Ibid*: 7). Attitude importance relates to the *"psychological significance a person ascribes to an attitude"* (*Ibid*: 2). An attitude is considered important to the individual when it is about something they *"care deeply"* about, and are thereby inevitably motivated to protect, express and act upon (*Ibid*: 5). Attitudes are considered to be more important and accessible if they are socially shared among a group (Crano & Prislin, 2006).

In turn, attitude certainty refers to the amount of confidence attached to an attitude: *"some attitudes are durable and impactful, whereas others are weak and inconsequential"* (Visser et al., 2006: 1). Crano and Prislin (2006: 355) describe how attitude certainty can be *"inferred effortlessly from ease of attitude retrieval (accessibility)"* or alternatively, *"through an effortful analytic process of retrieving attitude-pertinent beliefs"*. Given their significance to this research focus, the related concepts of attitude strength and stability are explored in-depth in Section 3.2.6.

Early analysis of attitude composition, for instance Kretch and Crutchfield (1948) and Edwards (1990), detail how attitude formation may be guided by affective[9] and cognitive motivations. Affective motivations encompass positive/ negative emotions or feelings associated with an attitude object (Fabrigar & Petty, 1999, Dickel & Bohner, 2012), for example, possible concerns associated with food processing technologies. It is now widely recognised that feelings have a substantive role in forming attitudes and behaviour (Forgas, 2008). Cognitive motivations, which have traditionally received more scholarly attention than affective responses (Lee et al., 2005), entail beliefs or judgements based on

9 Similarly to the definition adopted by Lee et al. (2005), 'affect' refers here to a multitude of emotions. However, it is recognised that others social psychologists have adopted a more restrictive definition of 'affect' (e.g. Zajonc 1980), considering the term to encompass feelings and preferences, yet not extending the term to entail specific emotions, such as guilt or anger.

prior experience and conditioning about positive/ negative attributes associated with an attitude object (Petty & Cacioppo, 1986).

> *"The cognitive component may be dominant for attitudes acquired in service of reality testing or of a need to explain the external world. On the other hand, affective factors may predominate for attitudes arising in response to need gratification or deprivation, threats to the self-image, or unconscious motives"* (Edwards, 1990: 203).

Edwards (1990: 204) and Olson and Kendick (2008) stress that although two individuals may hold the same attitude towards an object, *"their attitudes may nonetheless exhibit differential susceptibility to persuasion"*, as a result of affect-based or cognition-based formation processes. As an illustration, one individual may be opposed to food irradiation as they may perceive it to interfere with the naturalness of food, i.e. form an affect-based attitude; while another may form a negative attitude towards the technology due to perceptions of the economic benefits of its application only accruing to industry and not consumers, i.e. form a cognition-based response. For instance, Shaw (2002: 281) describes how affective reactions, i.e., *"gut feeling[s]"* can negatively impact lay citizens' attitudes towards GM foods. Moreover, Kahan et al. (2007) and Siegrist et al. (2007a) found that risk perceptions of nanotechnology and its food applications can be affect driven. How the affective or cognitive origins of an attitude subsequently influence the processing of new information and the impact of different methods of persuasion are examined in Sections 3.3.1, 3.3.2 and 3.3.5.

In general, purely affective or cognitive attitudes are unlikely, as affect and cognition typically merge together (Crano & Prislin, 2006) in varying forms and sequences to *"jointly determine the course of attitude acquisition. (...) In reality, attitudes may be positioned along a continuum according to the primacy and relative contribution of affect and cognition in their development"* (Edwards, 1990: 204). Eagly and Chaiken (1993: 423) have postulated a synergistic model which is based on the assumption that affect and cognition function in tandem *"to produce effects that are more attributable to their combination than to either one alone".*

The potentially conflicting relationship between these emotional and rational evaluative components is therefore an important topic for further investigation (Forgas, 2008). Eagly and Chaiken (2007) have argued that, when examining attitude formation, the aforementioned tripartite components of attitudes (cognitive, affective, and behavioural antecedents) are often overemphasised. They believe that these attitudinal components are not always easily distinguishable or necessarily present. Elsewhere, Edwards (1990) describes the inherent diversity of attitude origins, stressing that reason and rationality are not the only key drivers of their formation. Furthermore, in terms of expression of formed attitudes, Edwards (*Ibid*: 211) presents evidence that an attitude is *"expressed with greater confidence or conviction when affect is primary or dominant in its acquisition"*.

In their extensive review of literature from 1992 to 1995, Petty et al. (1997) outline how values and attitude functions are the basis for attitude formation. Elsewhere, Katz (1960) put forward a functionalist theory of attitudes which explained the needs fulfilled by attitudes and therefore, the functions they perform for individuals. This theory is compatible with the conclusions of Petty et al. (1997). Specifically, Katz classifies four functions as follows: 1) adjustive function - to satisfy utilitarian needs including self-interest and avoidance where desired; 2) value expressive function - to align with expression of central values and concept of self; 3) ego-defensive function - to help protect self-esteem; and, 4) knowledge function - to assist with organising, interpreting and creating meaning within an individual's *"unorganized chaotic universe"* (*Ibid*: 175). Katz (*Ibid*: 163) elaborates that the obligatory circumstances to arouse or alter an attitude depend on its *"motivational basis"*, i.e. the psychological need(s) met by holding the attitude. Katz describes how ego-defensive attitudes may be 'aroused' by appeals to hatred, repressed impulses and threats. Subsequently, attitudes can change by the removal of such threats, in addition to self-insight. Additionally, Katz stresses that an attitudes may serve to satisfy one or more of these individualistic motivational processes.

Further building upon Social Representation Theory (Moscovici, 1984; Bäckström et al., 2003) (see Section 2.4), Bohner and Dickel (2011: 402) report how metaphors are often used to express attitudes *"based on concrete physical experiences"*; they refer to the example of a *"warm reception"*. They elaborate how literature, to date, indicates that these metaphors *"are not merely ornaments of everyday discourse, but also have a neural basis that links attitudes to physical perception, bodily responses, and movement"* (*Ibid*). In light of these arguments and in the context of NFTs, the term 'functional foods', for instance, may have connotations with the increased functionality of such products.

To summarise perspectives, bridging both constructionist and memory-based model of attitude formation, Bohner and Dickel (2011: 397) consider attitude formation and change to involve *"both the retrieval of stored evaluations and the consideration of new evaluative information to varying extents"*. This brings attention to the issues of attitude malleability and stability from positive to negative and vice versa, which will be discussed in Section 3.2.6. The complexity associated with attitude formation presents inherent challenges in both measuring and attempting to change attitudes through information provision.

This section has explored the concept of affective (reactive) and cognitive (reflective) attitudinal responses. Closely tied to this concept is that of automatic versus controlled responses, which has become a prominent area of attitudinal research since the 1980s (Cunningham & Zelazo, 2007).

3.2.4 Automatic versus Controlled Responses

The Iterative Reprocessing model explores potential interactions between relatively automatic (reactive) and controlled (reflective) processes, with lower-order automatic processes being influenced by working in tandem with higher-order, reflective processes (*Ibid*). Based on this model, evaluative processing occurs on a continuum from relatively automatic to relatively controlled (*Ibid*). Among others, Bargh (1994) and Conrey and Smith (2007) have referred to the prominence of 'automaticity' as a core aspect of attitude formation. Indeed, Bargh (1994) contends that attitudes are neither completely automatic nor completely controlled.

Building on Bargh's (1994) argument that automatic-controlled distinctions are associated with awareness, efficiency, intention and control, Conrey and Smith (*Ibid*: 725) describe how *"at its heart, the idea of automaticity implies spontaneity - activation occurs both efficiently (without effort) and uncontrollably"*. Conrey and Smith raise the interesting question of what makes an attitude more automatic or controlled in form. Although social psychology has historically focused on clearly distinguishing between these two processes that *"tap separate internal representations, "stored" in separate "places""*, Conrey and Smith (*Ibid*: 726) assert that, in adherence with their Connectionist Model of Representation, these processes interact together *"to construct* *and reconstruct representations"* (*Ibid*: 725), resulting in responses that are both implicit and explicit in representation.

Further scrutinising the concept of automaticity, Tversky and Kahneman (1973) have argued that attitude formation is based on ease of retrieval of associations and occurrences in one's mind. Although there is an obvious relationship between knowledge and attitude formation, the absence of knowledge about emerging technologies does not preclude attitude formation around them (Lee et al., 2005; Hallman, 2000; Grunert et al., 2004b; Costa-Font & Mossialos, 2007). As illustrated in Chapter 2, in such situations heuristics or cognitive shortcuts, including cues from peers and mass media, are drawn upon to form evaluations (Scheufele & Lewenstein, 2005). Automatic and controlled processes therefore encompass aspects of Dual-Processing Models (DPMs) (Cunningham & Zelazo, 2007) (see Section 3.3.2).

The diversity of influencers, including social influences and norms, is often subconscious to the individual and, as a result, is challenging to establish and understand (Forgas, 2008). Smith and Hogg (2008: 337) emphasise that although attitudes are held by individuals, they *"are rarely idiosyncratic"* and are most probably embedded in the groups to which individuals belong, or aspire to be associated with, and thereby serve to define and indicate specific relationships with these groups. Indeed, Bargh (1994) outlines the different ways in which an individual may be unaware of the mental processes at play when forming attitudes. They may be unaware of the stimulus itself, or the way(s) in which the stimulus event is categorised or perceived. Equally, they may be unaware of the influences that are determining their evaluations (*Ibid*).

Elsewhere, Crano and Prislin (2006) and Conrey and Smith (2007) speak of the relationship between attitudes and cultural knowledge, detailing how knowledge of others' attitudes, e.g. public general consensus about an issue, has an informational impact. As previously mentioned in Chapter 2, pertaining to food, Finucane and Holup (2005) and Hohl and Gaskell (2008) argue that cultural and social factors are important determinants of evaluations of food risk assessments and communications. In turn, cultural and social factors have been found (e.g. Gaskell et al., 2010; Loebnitz & Grunert, 2014) to impact public acceptance of NFTs.

Inter-attitudinal structures (Tesser & Shaffer, 1990) is another area of scholarly interest, in terms of how attitudes connect with each other as part of the underlying psychological structures of individuals' 'value systems' (Katz, 1960). In a similar vein, Eagly and Chaiken (2007: 584) argue that an attitude to one object can leave a *"mental residue"*, which subsequently influences attitude formation when the attitude object or similar objects are encountered. Hence, Eagly and Chaiken describe how the enduring nature of attitudes is variable, with some mental residues fading based on the subjective importance placed on the attitude object. This is a result of an individual's desire to *"understand the events which impinge directly on their own life"* (Katz, 1960: 176).

Davies and Harré (1990) refer to the multiplicities of self and, according to Wood (2000), there are associated multiplicities of attitudes which contribute to cognitive dissonance (see Section 3.2.7). In the context of how inter-attitudinal structures effect attitudinal change over time, Conrey and Smith (2007: 726) outline how *"new representations may be activated [and equally]; currently active representations may decay"*. Therefore, strength of association, in addition to depth of cognition, as in deep versus shallow information processing, can impact the strength and stability of attitudes formed (Petty et al., 1997). Having explored attitude composition, formation and associations, these important characteristics of attitude strength, stability and ambivalence (Visser et al., 2006) are examined in detail. However, prior to this, the issue of attitude measurement is discussed.

3.2.5 Measurement of Attitudes

It is possible to analyse any measure of an attitude in terms of Ajzen and Fishbein's (1977) four elements which entail; the object being evaluated, and whether this *"evaluative measure"* entails a specific context, action and/ or time (Ajzen & Gilbert Cote, 2008: 299). Several self-reported scales have been developed to establish individuals' explicit attitudes. However, efforts to try and predict in which ways attitudes will form and change can often be a futile activity, as attitude formation can occur in *"haphazard ways"* (Druckman & Bolsen, 2011: 660).

In light of the varied origins of affective and cognitive attitudes, their measurement is an inherently intricate and volatile activity, since attitudes may vary in terms of their strength, stability, importance and accessibility (Visser et al., 2006; Bohner & Dickel, 2011). For example, although two individuals may report the same opinion on nano foods, the attitude of one may be stronger and more stable based on, for instance, their level of knowledge about nanotechnology, and thereby less susceptible to persuasion.

A person's report opinion is the best indication of their actual attitude (Thurstone, 1928). Schwarz (2008: 49) elaborates how although asking individuals to report on their attitudes will *"almost always result in an answer"*; the meaning of the answer may remain unclear. Bohner and Dickel (2011: 394) describe how several implicit attitude measures have been developed in an effort to *"minimize motivated response biases"* and *"investigate aspects of attitudes that are not open to introspection".* These implicit attitude measures, which are response-time based, include Implicit Association Text (Greenwald et al., 1998) and Evaluative Priming Task (see Bohner and Dickel (2011) for a detailed discussion on these measures).

Given their lack of direct observance (Frewer, 2003), from a measurement perspective, attitudes can really only be inferred from individuals' behaviour and self-reporting, which may often be misaligned. It has been noted that consumers who *"talk the talk"* in surveys, do not inevitably *"walk the walk"* when it comes to *"innovation adoption"* (Arts et al., 2011: 134; Bohner & Dickel, 2011). When answering questions posed about specific attitudes, individuals rely on accessible information that they consider most important to guiding their evaluations of the attitude object. It may therefore be difficult to measure attitudes towards NFTs that the public are particularly unfamiliar with (Tenbült et al., 2008a).

Loewenstein and Schkade (1999) and Schwarz (2008) effectively summarise the many challenges encountered when attempting to measure individuals' attitudes towards situations and objects. The most significant of these challenges include self-norming and lack of introspection of true feelings in the context of responses. In particular, minor alterations in the wording or sequencing of attitudinal questions can substantively impact responses, as illustrated by Schwarz (2008). Fazio (2007: 622) describes how other factors, including *"comprehension, scale interpretation, and the use of appropriate standards of comparison"*, may impinge upon accurate reporting and measurement of attitudes. Measuring the strength, certainty and importance of an attitude is particularly challenging, as these variables depend on both context and information accessibility.

In spite of these challenges, several models and scales have been developed and tested in an attempt to measure implicit and explicit attitudes and attitude change in terms of strength, stability, importance and direction (positive versus negative). For instance, efforts have been made to measure attitudinal ambivalence (see Section 3.2.7) by asking respondents to separately rate the extent of their negative and positive assessments of an attitude object, which are then compared in order to estimate attitudinal ambivalence (Visser et al., 2006). However, an important challenge lies in measuring change in attitude direction and, more broadly, measuring attitude stability and strength. Therefore, the concept of attitude change is the primary concentration of the next section.

3.2.6 Attitudes: Strength and Stability

The strength and stability of attitudes, which are important foci of this research, are issues of contention and continual investigation (Petty et al., 2006; Fazio, 2007). Focusing first on strength, Crano and Prislin (2006) outline how variation in attitude strength impacts resistance and attitude-behaviour consistency. As such, attitude strength impacts the durability or susceptibility of attitudes to new information (Fazio, 2007). Strongly held cognitive and affective based attitudes are less susceptible to change in response to persuasive contra-attitudinal information (Wood, 2000). The impact of different types of information on cognitive and affective based attitudes is discussed in Section 3.3.

It is widely recognised that a strongly formed attitude is more likely when the subject matter or attitude object is valued and considered important to the individual, causing them to reflect upon, and possibly attain information about, the object/ subject. Attitude strength is evidently a complex concept, which is considered, in turn, to impact attitude stability (Bohner & Dickel, 2011: 394):

> *"The assumption is that strong attitudes are more stable across situations and over time and, hence, can consistently be recalled from memory, whereas weak attitudes are less accessible and thus more susceptible to context influences".*

McGuire (1985) and Visser et al. (2006) reinforce this argument, speculating that strong attitudes are resistant to change, stable over time and have a significant influence on thought processes and subsequent evaluations/ behaviours.

In addition, distinction between affect-based and cognition-based attitude structures has implications for attitude change (Crano & Prislin, 2006). In fact, Katz (1960: 168) states that *"the intensity of an attitude refers to the strength of the affective component"*, and therefore attempts to change an 'intense attitude' should appeal to its emotive component.

Further exploring the notion of stability, a body of literature has examined the transient and temporal nature of attitudes (Cunningham et al., 2007). Although attitudes towards an object can form within an instant, it is postulated that attitudes change is a function of experience and evolution of perspectives: "*When meaning changes, attitudes change accordingly"* (Wood, 2000: 550). As such, the concept of attitude change has been longstanding in social psychology and an issue of on-going debate (Crano & Prislin, 2006).

Many authors within this area, including Lord and Lepper (1999) and Eagly and Chaiken (2007), perceive attitudes to be relatively stable entities, based on associations and evaluations *"stored in memory"*. Indeed, drawing on the Iterative Reprocessing model previously outlined, Cunningham et al. (2007) and Cunningham and Zelazo (2007) support the premise of attitude stability.

Conversely, other academics perceive attitudes to be relatively unstable, and focus on the temporary constructions guiding their formation. In particular, Conrey and Smith (2007) stress the flexibility of attitude formation, supporting the *"distributed, connectionist"* perspective, which assumes that attitude formation derives from the reconstruction of unique configurations of inputs (contextual cues) drawn upon within given contexts. They argue that attitudes are *"time-dependent states of the system rather than as static 'things' that are 'stored' in memory",* thereby supporting the premise that attitude formation occurs *"on the spot"* and that attitudes are more open to change (*Ibid*: 718). However, Conrey and Smith recognise that while 'old attitudes' may be *"slowly overwritten by new experiences"*, in the *"right circumstances"* aspects or features of the old attitudes may influence behaviours (*Ibid*: 731).

Delving deeper into exploring what happens to 'old attitudes', in support of Petty et al.'s (2006) 'Past Attitudes are Still There' (PAST) model, Bohner and Dickel (2011: 396) suggest that perhaps the old attitudes remain *"stored in memory"* yet *"tagged as invalid"*. Based on this model, 'before information' and 'after information' attitudes are not independent, indicating that the influence of information processing on attitudes, and vice versa, is both dynamic and complex. Figure 3.2 provides a graphical illustration of the PAST model, to account for an individual's change in attitude towards nano foods as a result of 'tagging' certain past information as false or invalid in their mind.

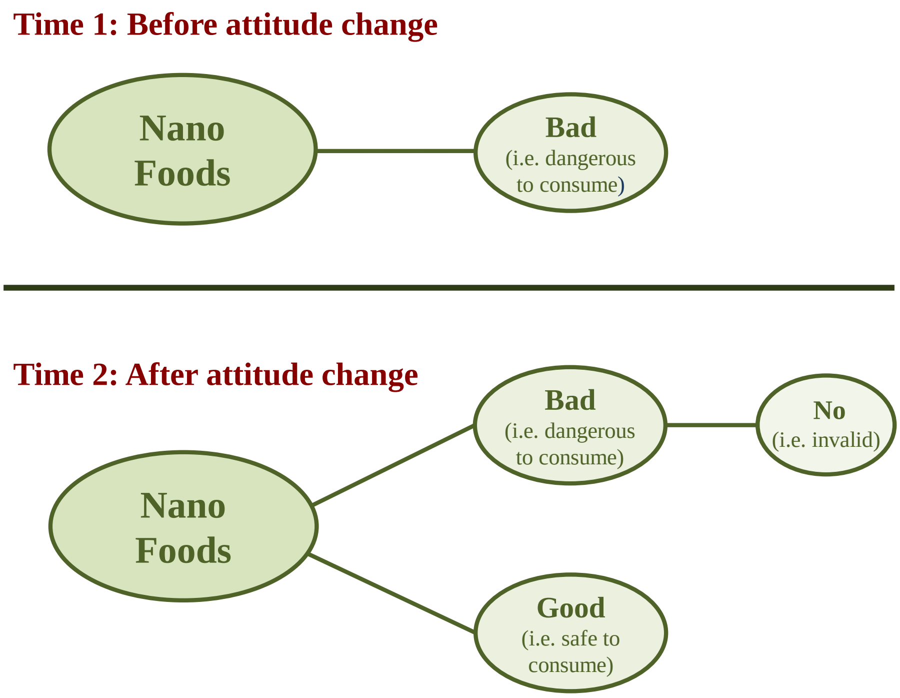

Figure 3.2: *Attitude Change based on the PAST Model using Attitude towards Nano Foods as the Graphical Illustration*

Source: Adapted from Petty et al. (2006: 22)

In this example, following the provision of information about the safety of consuming nano foods, the individual formed a positive attitude towards such products. The original negative attitude however remains stored, although it is now tagged as 'false' or 'invalid'. Bohner and Dickel (2011) summarise how based on the PAST model, attitude change should be considered as attitude formation in addition to the tagging of stored attitudes as either valid or invalid. Importantly, Petty et al. (2006: 23) elaborate how *"people who have rejected a prior attitude as false must retrieve this tag for the old evaluative habit not to operate, at least in the initial period following change"*. Therefore, as a result of the original attitude remaining stored in memory, at least in the short term, this model predicts that attitudinal ambivalence may exist (*Ibid*).

Another theory of note pertaining to attitude change is the Associative-Propositional Evaluation (APE) model (Gawronski & Bodenhausen 2006), which attempts to account for the inherent interplay between implicit and explicit attitude change (Bohner & Dickel, 2011). APE assumes attitudes to be embedded in two types of concurring mental processes: 1) associative evaluations, which are activated automatically to form the basis of implicit attitudes; and, 2) propositional reasoning, including syllogistic inferences and judgement-based and tested propositions, which forms the basis of explicit attitudes. These associative evaluations lean on the previously mentioned Connectionist Theory (Conrey & Smith 2007). According to the APE model, changes on implicit measures are assumed to be caused by incremental changes in *"associative structure"* and temporal changes in the *"activation of preexisting patterns"* (Gawronski & Bodenhausen 2006: 697). In contrast, changes on explicit measures are assumed to result from: (a) change(s) to the associative evaluation of the object in question; (b) change(s) in the group of propositions which are perceived as pertinent to the judgment; or, (c) change(s) in the approach used to achieve uniformity within a specific set of propositions (*Ibid*).

> *"According to the APE model, a given factor may influence the activation of associations in memory or processes of propositional reasoning (or both)"* (*Ibid*: 702).

Therefore, Gawronski and Bodenhausen (2006) suggest that while a change in implicit attitudes may indirectly result in a change in explicit attitudes and vice versa, this is not necessarily guaranteed. Equally, although explicit (implicit) attitudes may change, implicit (explicit) attitudes may not. In terms of overriding perspective on the stability of attitudes, Bohner and Dickel (2011) and Dickel and Bohner (2012) therefore suggest that it may be useful to account for situation specific variables and stable aspects of attitudes in different motivational states.

Many scholars have postulated that information accessibility and knowledge can influence attitude stability in either a positive or negative direction (Fazio, 2007): *"Attitudes - both positive and negative - that are based on knowledge are more likely to be resist change"* (Bauer et al., 2007: 84). In addition, Katz (1960) argues that the susceptibility of an attitude to change depends on its centrality; the attitude's role as part of a value system which is built upon the individual's concept of self. This notion ties back to the impact of top-down influences on attitude formation. As an illustration of this point, if a portrayed negative attitude towards GM foods is strongly ingrained in a value system centred on naturalness and the self-concept of only consuming natural foods, this negative attitude may be deeply ingrained and particularly resistant to change.

If one is to support the instability of attitudes, one must still recognise the challenges encountered in attempting to alter an individual's attitude towards a specific object.

> *"In view of the diversity of attitudes' origins, the range of psychological needs they may fulfil, and the varying composition of affective and cognitive processes that shape the process of attitude acquisition, the process of changing an attitude presents a formidable challenge"* (Edwards, 1990: 203).

Additionally, Loewenstein and Schkade (1999: 85) highlight that one's *"intuitive"* standpoints are *"often resistant to change"*. Indeed, Katz (1960) contends that changing attitudes involves changing general beliefs and feelings. Taking a broader perspective, Wood (2000) describes how public changes in attitude may conflict with privately held, deeply entrenched attitudes.

As mentioned in Chapter 1, one needs to establish more than just overriding attitudes to fully appreciate attitudinal contexts (Fell et al., 2009). One must also account for variables such as attitude strength, stability, associations, importance, accessibility and ambivalence, and how attitudes may be impacted by new information (Visser et al., 2006). To truly understand how attitudes form and evolve and associated complexities; a more substantive exploration around the multidimensional and often conflicting cognitive processes at play, reliance on prior knowledge and integration of new information is required.

3.2.7 Attitudinal Ambivalence and Cognitive Dissonance

"Me, ambivalent? Well, yes and no" (Anonymous).

As argued by Ronteltap et al. (2007), perceived uncertainty impacts on public attitudes towards novel technologies. Indeed, attitudes, in and of themselves, may encompass elements of uncertainty and multiplicity (Wood, 200); which can result in attitudinal ambivalence (Fischer et al., 2013). Scott (1969) and Gardner (1987: 241) consider such ambivalence to be a psychological state in which *"a person holds mixed feelings (positive and negative) towards some psychological object"*. For instance, a person may hold an ambivalent attitude towards thermal and non-thermal food processing, deriving from their strongly held positive and negative attitudes towards associated benefits and risks respectively. Crano and Prislin (2006) outline how ambivalence is strengthened if mutually opposing attitudes are simultaneously accessible.

> *"The concept of attitudinal ambivalence neatly encapsulates those situations in which attitudes are not polarized and where positive and negative attitudes are expressed simultaneously toward an object"* (Conner & Armitage, 2008: 261).

A neutral attitude may indicate high or low ambivalence, with high ambivalence residing when both strongly positive and negative perspectives on an object exist, and low ambivalence emerging when neither strongly positive nor negative standpoints exist.

Crano and Prislin (2006) detail how information processing is more effortful when high levels of attitudinal ambivalence exist, and describe how this can result in a weak attitude-behaviour relationship. Interestingly, Cunningham et al. (2007: 753) argue that attitudinal ambivalence, in part, explains the complex and flexible nature of attitudes formed: *"Often, the root of ambivalence comes from holding two conflicting, but strong attitudes".* Conner and Armitage (2008: 280) document how *"intercomponent ambivalence refers to conflict between components"*. An example of intercomponent ambivalence could be simultaneously perceiving a GM food as 'unethical' and/ or 'unnatural' (a negative affect-based evaluation), yet 'competitively priced' (a positive cognition-based evaluation). Such discrepancies can result in weaker overall attitude forming (*Ibid*).

In Fischer et al.'s (2013) study, where participants were provided with different risk-benefit information on nanotechnology applications in food, the provision of such pro and contra information resulted in some individuals becoming more positive and less ambivalent (12%), while others became more negative and less ambivalent (42%) towards nano foods. Interestingly, a third group (46%) maintained a neutral attitude and displayed increased ambivalence. In light of these findings, Fischer and colleagues stress the importance of continually monitoring attitude formation, including attitude polarisation and ambivalence, towards emerging technologies during the early stages of their development when attitudes are crystallising.[10] The literature indicates that some individuals, including a significant cohort in Fischer et al.'s study, may be content to remain ambivalent in terms of specific attitudes, and thereby do not have a desire to reduce cognitive dissonance.

---

10 The group in Fischer et al.'s study that did not change their attitudes and became more ambivalent following the provision of information are noteworthy. They appeared content to maintain cognitive dissonance and accept high levels of uncertainty in their attitudes. Their ambivalence may have, in part, been influenced by the lack of nano foods available on the market at present, i.e. the products' perceived distance from being a consumer reality.

Cognitive Dissonance (Festinger, 1957; Festinger & Carlsmith, 1959; Cooper & Fazio, 1984) is a motivational theory of how attitudes change to maintain cognitive consistency. Wood (2000: 549) describes how a multitude of motivations underlying attitudes can foster dissonance. Festinger (1957: 3) details how cognitive dissonance can be perceived as an *"antecedent condition which leads to activity oriented toward dissonance reduction".* He likens cognitive dissonance to the concept of engaging in hunger reducing activity when one is hungry. According to Cognitive Dissonance theory, individuals are often motivated to restore psychological consistency (reduce dissonance), and resolve the problem of simultaneously holding inconsistent cognitions about an attitude object. They engage in this process by actively discarding information that supports the opposing side of an argument and focusing instead on information that supports their perspective, thereby becoming more positive and less ambivalent or, equally, more negative and less ambivalent (Gawronski & Bodenhausen, 2006; Poortinga & Pidgeon, 2006; Fischer et al., 2013).

Cognitive dissonance has implications for biased information seeking and processing behaviours. In an effort to uphold consistency of the cognitive structure of attitudes, individuals prioritise and seek out new information that confirms their existing attitudes, i.e. *"congenial information"*, and concurrently 'side-step' or ignore contradictory information that potentially opposes their attitude, i.e. *"uncongenial information"* (Bohner & Dickel, 2011: 407). Existing studies indicate that this *"congeniality effect"* is heightened in instances where individuals are motivated, or challenged, to defend their position, and weakened when they are motived to be accurate and unbiased in their view (Hart et al., 2009: Bohner & Dickel, 2011).

Dissonance can occur when presented with information that is in conflict with what is already believed to hold true. Specifically, Wood (2000: 546) reports how dissonance can occur as a result of an individual failing to behave in a way that is consistent with *"some valued self-standard"*, be it a behaviour that is perceived as inconsistent with personal self-standards or normative self-standards of others. This dissonance theory is similar in premise to Balance Theory (Heider, 1958), which is a motivations theory of attitude change based on consistency motives to maintain individual beliefs and values.

The aforementioned theories form an interesting point of departure from which to investigate the varied ways in which individuals engage in information processing.

3.4 Levels of Information Processing and Relationships with Attitudes

As previously illustrated, attitudes form in the presence and absence of information, as they are influenced by *"multiple factors beyond factual information"* (Druckman & Bolsen, 2011: 660). In saying this, attitude formation and change are clearly related to information processing, information provision and methods of persuasion (Crano & Prislin, 2006; Eagly & Chaiken, 2007).

> *"Given the ubiquity and importance of persuasion in today's world it is hardly surprising that its explanation has had high priority on the research agenda of many social psychologists"* (Kruglanski & Thompson, 1999: 83).

The characteristics of the information source, the content of the information, the audience and the cognitive route applied can all impact the persuasiveness of information (Renn, 2003). Bohner and Dickel (2011: 403) define persuasion as *"the formation or change of attitudes through information processing in response to a message about the attitude object"*.

Individuals' prior affect- and cognition-based attitudes can substantively influence how information is interpreted, indicating that there are mutually shaping and complex relationships between attitudes and information processing. Equally, as illustrated earlier, the provision of new information can impact the formation, sentiment/ direction and stability of attitudes. In fact, Tormala et al. (2006) and Fischer et al. (2013) have outlined how repeated exposure to confirmatory (opposing) information can increase (decrease) the certainty of an existing attitude, without causing the attitude to become more positive or negative.

In spite of almost 100 years of research into information processing, this topic continues to foster scholarly dispute and debate. The sections that follow explore the most significant theories and positions pertaining to cognitive structures of processing information and empirical research supporting these theoretical underpinnings (Frewer, 2003). The following sections details the different levels at which information is processed, in addition to outlining different cognition and affect based models of information processing. The concepts of framing and cognitive structures, including schemas, are then investigated.

3.3.1 Information Processing - Reactive, Reflective and Routine Levels

Building on Conrey and Smith's (2007) argument previously outlined that an attitude can be automatic or controlled in form; Ortony et al. (2005) describe how information processing can occur interchangeably at reactive, routine and reflective levels. They describe how the most elementary of these is the reactive level, which is more associated with the present situation at hand, rather than the past or future. Drawing on the concept of pattern matching (Lord & Lepper, 1999: 197) to identify stimuli for a specific situation, *"the reactive level is the home of rapid detection of states of the world and immediate responses to them"*.

The second level, routine, is focused on the acting out of learned behaviours and somewhat influenced by *"primitive emotions"*, such as fear or excitement, deriving from information processing that may, in some instances, be inherently future orientated (*Ibid*: 175). In contrast, the more advanced and nuanced reflective level is a nexus for more in-depth contemplative cognitive processing. Thereby, this third level is concerned not only with the past and present, but also with hypothetical future scenarios (*Ibid*). In the context of attitude composition, the tripartite components of affect, behaviour and cognition can influence attitude formation at each of these different levels (Kazemifard et al., 2012).

As mentioned, the relationships between affect-based and cognition-based attitudes and information processing have been a significant area of exploration within social psychology. *"In nearly all cases (...) feeling is not free of thought, nor is thought free of feelings"* (Zajonc, 1980: 154). Edwards (1990: 211) presents evidence that attitude type, i.e. affect-based or cognition-based, impacts the susceptibility of that attitude to counter-attitudinal information.

This relationship between attitude type and means of persuasion suggests that where the origins of an attitude are primarily affective, persuasive information that relies on cognitive reason and rational arguments may not result in attitudinal change (Zajonc, 1980; Edwards, 1990; Fabrigar & Petty, 1999). Ideally, method of persuasion should match the attitude type (Petty et al., 1997), be it affect- or cognition-based. While Fabrigar and Petty (1999) posit that affect-based persuasions are more susceptible to change affect-based, rather than cognition-based, attitudes; they contend that the obverse relationship is not necessarily supported; it may not be the case that cognition-based attitudes are more susceptible to cognition-based persuasion. Fabrigar and Petty (1999) go so far as to assert that since an attitude may not necessary be cognitive but will always be affective at a rudimentary level, affect-based persuasion can generally be considered more impactful than cognition-based persuasion. Some academics hold the view that communications about novel technologies have often failed in their objective, as they attempt to change public attitudes through the wrong method of persuasion (Frewer et al., 1998b).

Elsewhere, Ortony et al. (1988) indicate that certain emotions, e.g. repulsion, encompass significantly less conscious or unconscious cognitive processing than others, e.g. jealousy. Indeed, Edwards (1990) describes how attitude formation is based on needs, emotions and feelings in addition to reason, and that in light of the diversity of attitudes' origins and composition, succeeding to change an individual's attitudes is a challenging goal. It follows then that though two individuals may hold the same overall attitude, they may *"exhibit differential susceptibility to persuasion as well as different properties of expression"* (Edwards, 1990: 204; Conrey & Smith, 2007). Information processing, at the levels outlined therefore appears individualistic.

Several models have been forwarded in an effort to better understand how individuals process information through an anomaly of complex means. The following section explores these models in detail.

3.3.2 Models of Information Processing and Attitude Formation

Scholars within cognitive psychology have presented several models and theories in an effort to better understand cognitive and affective processes and structures involved in information processing, particularly the acts of organising, storing and subsequently retrieving information (Bartlett, 1932; Katz, 1960).

Craik and Lockhart (1972) put forward the Levels of Processing framework which builds on the premise that memories occurs on a continuum from shallow to deep, thereby linking to the concept of attitude accessibility. They posit that memory storage, i.e. the retention of information, and consequent accessibility of information depends upon levels of processing and relatedness to past memories, i.e. congruency with existing cognitive nodes or networks.

Interestingly, Todorov et al. (2002: 196) have outlined the *"environmental and cognitive constraints on information processing"*. In this regard, Ho et al. (2013) have recently described how individuals rely on recurring mental strategies to cope with and process the vast amount of information encountered, based on selective use of time and cognitive resources. Specifically, Ho and colleagues (*Ibid*: 610) detail how elaborative information processing, in terms of cognitive involvement, entails inferring links between new information and current knowledge, to seek out and establish "*congruity with precedents"*. In their study on public risk-benefit perceptions of nanotechnology, Ho et al. illustrate the complex procedures involved in individuals' risk and benefit evaluations of novel technologies.

Moreover, several models have been developed in an attempt to better understand how individuals cope with the constant plethora of competing information that they encounter (Druckman & Bolsen, 2011). Of particular interest, Fiske and Taylor (1991), Nisbet (2005) and Scheufele and Lewenstein (2005) summarise how individuals can be 'cognitive misers' or 'satisficers', who only seek out as much information about a specific issue as they perceive to be necessary to form an evaluation or make a decision. These 'misers' rely instead on heuristics, as previously outlined in Section 2.4, when forming attitudes. This cognitive miser concept builds on the premise that individuals are *"economy-minded"*, and thereby only willing to engage in cognition-based information processing when equipped with the cognitive capability/ capacity and motivation to do so (Todorov et al., 2002: 196). This metaphor therefore holds similarities with the Heuristic Systematic Model of Information Processing, which is discussed in turn.

In contrast to the Knowledge Deficit model and the associated Scientific Literacy approach (Druckman & Bolsen, 2011), the cognitive miser concept assumes that decision-making in the absence of comprehensive knowledge *"is not just part of human nature but may in fact make rational sense"* (Scheufele & Lewenstein, 2005: 660), based on perceived pay-offs from and effort involved in engaging in such behaviour (Burri, 2009).[11] As outlined in Chapter 2, an individual may decide to trust in the judgements of

11 The cognitive miser concept is similar in concept to Popkin's (1994) Low-Information Rationality model.

others, in place of engaging in detailed cognitive processing of information (Scheufele & Lewenstein, 2005).

This model is based on two key assumptions (Fiske & Taylor, 1991). The first is that individuals do not use all available information when forming evaluations, and instead rely on heuristics. The second is that this miser concept describes overall social patterns and therefore, may not be representative of some highly interested individuals and specific social groups. These particular individuals may display strong needs for information and cognition, and not relying heavily on heuristics.

From a comparative perspective, this model aligns with the information sufficiency concept that Griffin et al. (1999) speaks of when discussing the Risk Information Seeking and Processing (RISP) model. RISP accounts for heterogeneity in terms of information seeking behaviours among individuals (Wansink & Kim, 2001; Huurne et al., 2009). Drawing on concepts from several disciplines and schools of thought including risk and social psychology and risk communication, RISP adapts and fuses aspects of Ajzen's (1991) TPB and DPMs, including Chaiken's (1980) and Eagly and Chaiken's (1993) Heuristic Systematic Model (HSM) of Information Processing, discussed in turn. According to RISP, information sufficiency and collation capacity impact the extent of an individual's risk seeking and systematic processing behaviours (Griffin et al., 1999).

Systematic processing depends on one's ability to critically and comparatively think, their knowledge structures, and also their perceptions of the credibility and usefulness of information (*Ibid*). In contrast, heuristic processing is *"a limited mode of information processing that requires less cognitive effort and fewer cognitive resources"* (Eagly & Chaiken, 1993: 327). Both forms of information processing can occur simultaneously (Kruglanski & Thompson, 1999).

The RISP model postulates that information sufficiency, perceived information gathering capacity, and relevant channel beliefs are influenced by: affective responses to the risk; subjective norms about knowledge and information gathering about the risk; the perceived characteristics of the risk; and, specific characteristics of the individual, e.g. their general risk sensitivity. In terms of stances on attitude stability, RISP builds on the premise that individuals who engage in more active information seeking and processing, and have a greater need for cognition (Cacioppo & Petty, 1982; Zhang & Buda, 1999), are more likely to develop risk related cognitions, attitudes, and behaviours that are more stable over time (Griffin et al., 1999; Huurne et al., 2009). More generally, Eagly and Chaiken (1993) and Crano and Prislin (2006) argue that attitudes formed as a result of thorough cognitive information processing are more resistance to counter-information, and therefore more stable and likely to influence actual behaviours.

Concerning the context of information to the individual, Frewer et al. (1997c) report that perceived personal relevance impacts the extent of reflection upon, and internalisation of, new information. Fazio (2007: 610) states that some individuals may exhort *"a greater propensity to form attitudes across a variety of domains"* than others. Elsewhere, Wood (2000) postulates that when individuals are motivated and capable of processing information, they formed more systematic-based and reflective attitudes. In this sense, Druckman and Bolsen (2011) summarise that attitude formation is dependent on both information processing motivations and ability.

> *"…not the actual level of knowledge is the key variable determining the search for (more) information, but the perceived discrepancy between this actual level of knowledge and the desired level of knowledge. This discrepancy, which the authors call "information sufficiency," in fact indicates the extent to which the individual has a need for information"* (Kuttschreuter, 2006: 1048).

Building on the arguments of Scheufele and Lewenstein (2005) and Druckman and Bolsen (2011), motivation to learn and cognitive capacity to acquire information about novel technologies is generally low, due to the benefit of information acquisition and processing being generally unclear.

Additional substantive models concerning attitude formation and information processing are DPMs, which centre information processing on both intuition and deliberative reasoning (Cunningham & Zelazo, 2007; Kim et al., 2013). Crano and Prislin (2006) maintain that these models *"remain today's most influential persuasion paradigms"*, within which message and source are key influential variables, in addition to motivation and ability to process information, which together determine overall outcomes of persuasive information. Indeed, these models are considered effect tools to illustrate the multifaceted ways in which information is processed and attitudes subsequently form (Wood, 2000; Cunningham et al., 2007), with each mode placing different emphasis on the stability of attitudes.

Exemplars of DPMs include Petty and Cacippo’s (1986) Elaboration Likelihood Model (ELM) and Chaiken’s (1980) HSM of Information Processing (Crano & Prislin, 2006: Olson & Kendrick, 2008). These models, which share many commonalities (Kruglanski & Thompson, 1999), have been applied in the past to examine the impact of food risk communications on public perceptions. Most notably, Frewer et al. (1997c) applied ELM in a study of food risk perceptions, which found that types of risk and source credibility are important determinants of effective food risk communication strategies.

The ELM contends that information is processed through one of two routes of persuasion, central and peripheral, which are linked to an audience’s interest in a subject (Frewer et al., 1998b). The central route involves in-depth cognitive analysis of information to form a structured attitude, while the peripheral route involves less depth of analysis and a reliance on heuristics. Similarly to the RISP model, route selection is dependent on cognitive ability to process information and motivation and interest to do so (Frewer et al., 1997c). ELM suggests that attitude change only occurs through central processing incorporating cognitive and affective components, as opposed to peripheral, heuristics-based processing. Taking a somewhat conflicting stance to that of Fabrigar and Petty (1999) previously outlined, ELM therefore posits that information persuasion based purely on emotion will not be effective in changing attitudes. Nevertheless, Renn (2003: 12) stresses that these two routes of persuasion are intertwined, as individuals will not exclusively pursue one route, and therefore communications should contain *“a sufficient number of peripheral cues to initiate interest in the message, but also enough ‘rational’ argumentation to satisfy the audience with central interest in the subject”*.

The HSM of Information Processing (Chaiken, 1980) similarly describes two depths in terms of concurrent information processing; systematic (high-involvement and high-effort) processing and heuristic processing (Eagly & Chaiken, 1993; Todorov et al., 2002). Both the ELM and HSM contend that individuals with high levels of cognitive and attentive capacity and motivation are more inclined to partake in deep (central and systematic) information processing (Wood, 2000; Dickel & Bohner, 2012).

Another DPM of significance is Motivation and Opportunity as DEeterminants (MODE) forwarded by Fazio (1990). This model focuses on individuals’ motivations and opportunities for deliberative attitude related behaviour to occur. Once again, motivation is determined in this instance by the perceived personal relevance of the topic and cognitive ability to process associated information. An assumption of MODE is that attitudes are relatively stable entities (Bohner & Dickel, 2011), guiding behaviour either through immediately spontaneous (automatic) or deliberate (reasoned and controlled) processes (Crano & Prislin, 2006; Fazio, 2007).

The MODE model prescribes to attitudes being defined as *"a learned association in memory between an object and a positive or negative evaluation of that object"* (Ajzen & Gilbert Cote, 2008: 297). This model therefore centres on accessibility, assuming 'stronger' attitudes to be more accessible than 'weaker' attitudes, as reflected by respondents' response times to attitudinal questions posed. Similarly to Cognitive Dissonance theory, the MODE model supports the premise that biased information processing occurs (*Ibid*). Based on this model, two individuals could review the same information about, for example, nutrigenomic testing and PNPs, and evaluate it as indicating that they are beneficial or not, depending on their initial positive or negative attitude towards them. This illustration further implies the interplays that exist between initial attitudes, the processing of new information and subsequent attitudes formed around NFTs.

A key premise of DPMs that *"distinct low effort and high-effort modes of persuasion"* occur has been challenged in recent years (Bohner & Dickel, 2011: 403). Kruglanski and Thompson (1999) counter this dual approach with the proposition of a 'Unimodel', i.e. single process account. Although this Unimodel shares many of the assumptions of DPMs, it suggests integration of the two processing systems (either in the context of ELM or HSM) into one. Among others, Gawronski and Bodenhausen (2006) support this Unimodel and note its alignment with many of the assumptions of the previously discussed APE model; most significantly, the notion that cognitive processing builds on propositional reasoning.

Further exploring the concept of biased processing, Lodge and Taber (2008: 33) describe how new information can lead to existing attitudes coming *"inescapably to mind, whether consciously recognized or not, and for better or worse these feelings guide subsequent thought"*, thereby resulting in motivated reasoning, which may not necessarily be objectively accurate. In this vein, building on the work of social psychologists, such as Allport (1954); Lord et al. (1979) and Frewer et al. (1998b) have explored the notion of biased assimilation and the consequences of introducing counter-attitudinal information. The subject matter in the case of Lord et al.'s study was capital punishment as an effective deterrent to murder, given the strong opinions that form around this topic. This study indicates that strong attitudes can remain intact, in spite of the introduction of subsequent non-supportive evidence, if initial attitudes are based on entrenched beliefs. In fact, new information may be interpreted so as to support or align with prior beliefs. The core components of these biased assimilation processes include:

> *"…a propensity to remember the strengths of confirming evidence but the weaknesses of disconfirming evidence, to judge confirming evidence as relevant and reliable but disconfirming evidence as irrelevant and unreliable, and to accept confirming evidence at face value while scrutinizing disconfirming evidence hypercritically"* (Lord et al., 1979: 2099).

Scholderer and Frewer (2003: 130) have similarly argued that the extent to which a specific attitude is ingrained in *"a system of fundamental attitudes"* in a broader sense, the more resistant that attitude will be to change. Elsewhere, Loewenstein and Schkade (1999: 97) have referred to the parallel concept of *"differential salience"*, arguing that individuals place *"disproportionate emphasis"* on the foci of their attention. When filtering information and forming attitudes, individuals can concentrate on certain information communicated, e.g. potential risks, to the exclusion of other information, e.g. potential benefits (Fischer et al., 2013).

Pertaining to the subject matter of this thesis, Druckman and Bolsen's (2011) study on information effects found that factual information disseminated about GM foods is of limited utility and no more significant than other background factors and values, in influencing attitudes. Interestingly, this study found evidence of biased processing of information and motivated reasoning, with initial attitudes shaping the processing of pro and contra factual information and subsequent attitudes towards GM foods. Hence this finding reaffirms the interdependent and complex relationship that exists between attitudes and the processing of information. Scholderer and Frewer (2003) have presented further evidence that additional information is likely to activate inherent attitudes already held, which in the case of this study led to decreased consumers' preference for GM foods. Thus, the effects of information provision seems to depend, not only on the characteristics of the individual (e.g., their risk sensitivity), but also the characteristics of the information (Ronteltap et al., 2007; Fell et al., 2009).

A recent focus of empirical work has been the effectiveness of two-sided persuasive messages on attitude formation, where subjectively related pro and contra arguments are presented. Studies by Bohner et al. (2003)[12] and Renton (2008) found two-sided communications to be more effective than their one-sided counterpart in certain circumstances. Beyond the studies of Renton (2008) and Druckman and Bolsen (2011), there appears to be limited exploratory focus to date on two-sided communications within research centred on attitudes towards NFTs. This is therefore an avenue worthy of further investigation, given that information relayed about these technologies often includes such pro and contra arguments.

This review of literature concerning mechanisms of processing information and associated models provides a basis for understanding how individuals frame and interpret information. The concept of information framing is now examined, presenting associated theoretical perspectives.

3.3.3 Information Framing

Closely linked to the concepts of attitude formation and information processing, is that of information framing (Druckman, 2004), which has *"considerable currency"* in the social sciences (Benford & Snow, 2000: 611) and fits within the vein of social constructionism (Gamson et al.. 1992; D'Angelo, 2002; Van Grop, 2007). Since first proposed by Goffman (1974), references to different concepts and categories of frames have been prevalent in a multitude of academic spheres, including psychology (Tversky & Kahneman, 1981), sociology (Goffman, 1974), communication and media studies (Pan & Kosicki, 1993), economics (Tversky & Kahneman, 1973), communication (Iyengar, 1991; Entman, 1993) and political science and policy studies (Gitlin, 1980).

Numerous definitions of this framing concept exist, generating conceptual and theoretical confusion among scholars (Chong & Druckman, 2007; Dewulf et al., 2009). Among others, Gamson et al. (1992), Scheufele (1999) and Van Gorp (2007) describe how, as a result of the numerous meanings of the words 'frame' and 'framing', research

12 An example of a two-sided persuasive messages relayed within the study by Bohner et al. (2003) is an advertisement claiming that: 1) a restaurant serves only fresh food (positive attribute); and, 2) it includes only a small selection of dishes on its menu (negative attribute). Accordingly to Bohner et al. (*Ibid*: 455), individual who believe that *"restaurants featuring a small selection of dishes serve fresh food" (major premise)"* should believe, as a result of the negative claim about the limited menu choice, that the positive claim about the freshness of its food is actually true.

within this arena has been characterised by theoretical and empirical vagueness and ambiguity. Some scholars are critical of the perceived lack of an agreed theoretical model underlying framing research. Indeed, Van Gorp (2007: 61) goes so far as to assert that the multitude of perspectives on the precise nature of the framing concept and diversity of research approaches has resulted in this concept becoming a *"passe-partout"*. However, others, including D'Angelo (2002), have suggested that the multitude of contemporary concepts of 'frames' harnesses theoretical creativity.

Focusing on commonly recognised scholarly definitions of frames and framing, one of the seminal scholars in this area, Goffman (1974: 21), considers framing to embody the way people define situations, conceiving frames to be *"schemata of interpretation"* that enable individuals *"to locate, perceive, identify, and label"* occurrences within their lives. He elaborates how individuals draw on these schemata or *"primary frameworks"* (*Ibid*: 24) to classify and interpret information and make sense of the surrounding world.

Similarly, Gamson and Modigliani (1987: 143) define framing as *"a central organizing idea or story line that provides meaning to an unfolding strip of events, weaving a connection among them"*. Benford and Snow (2000: 614) build upon this definition, perceiving frames to assist with *"render[ing] events or occurrences meaningful and thereby function to organize experience and guide action"*. In some ways, these definitions of frames and framing emulate the connotations of Allport's (1935) definition of attitudes (previously referred to) as mechanisms of organising information and experiences in order to influence responses to related objects and situations.

Another commonly cited definition of frames is that of Gitlin (1980: 7) who considers them to encompass *"persistent patterns of cognition, interpretation, and presentation, of selection, emphasis and exclusion by which symbol-handlers [e.g. journalists] routinely organize discourse"*. Finally, Van Gorp (2007) believes framing to be an effective means of bridging the concepts of culture and cognition. Within the context of this dissertation, building on the aforementioned definitions, frames are perceived to be lenses through which individuals assess objects and situations, which highlight certain elements of a topic based on one's perception of reality.

Information framing is traditionally referred to from the perspective of media (message) framing of an issue or topic (de Vreese, 2005). This emphasis focuses on how an information sender intentionally or unintentionally frames or codes a message communicated (Scheufele, 2000) through the images, words, phrases, and presentation styles used (Tversky & Kahneman, 1981; Gamson et al., 1992). These are driven by embedded values and beliefs and the impact that such message framing has on the receivers of that message (i.e. on their attitudes) (Scheufele & Tewksbury, 2007). In this regard, mass media is the key connection point between the public and science and its influence on the framing, and subsequent forming, of public attitudes concerning such matters should not be underestimated (Scheufele, 2000).

Drawing on Pan and Kosicki's (1993) and Reese's (2001) position that the framing concept should not be restricted to a media (exo-level) perspective, this research focuses on framing at the individual (micro) level. It explores how citizens decode information received, and what other information and wider environmental influences they rely upon, in order to *"construct meaning"* (Gamson et al., 1992: 373) and form, and possibly change, attitudes.

At this micro level, Brewer et al. (2005: 935) argue that *"people use frames to simplify complex issues that may implicate numerous values"*. Frames impact evaluations by highlighting specific values and information, *"endowing them with greater apparent relevance to the issue"* than may be the case in the context of different frames (Nelson et al., 1997: 569). Indeed, Gamson et al. (1992) highlight the importance of understanding how information is decoded once received, as dominant meanings may not be inertly accepted by all.

Cognitive framing (Dewulf et al., 2009) at both the construction (media) and decoding (audience) level can be both a conscious and unconscious process (Entman, 1993); individuals may, in fact, be unaware of the factors framing their attitudes (Murphy, 2008). Furthermore, framing of information can occur at different levels of abstraction (Gamson et al., 1992), based on the cognitive structures drawn upon. In this sense, intended message framing by the media, or other communicators, can generate unintended framing processes and effects in the minds of information receivers, *"especially when members of the audience associate additional thoughts with the message that are not congruent with the frame the journalist wanted to apply"* (Van Grop, 2007: 66).

Moving beyond unintended consequences, early psychological studies indicate the substantive effect that framing (in the context of information provided) can have on individuals' appraisals when processing information. Most significantly, Tversky and Kahneman's (1981) Prospect Theory, which explores decision-making under conditions of uncertainty, effectively illustrates the power of framing and the way it operates by selecting and highlighting some features of reality, while omitting others. Tversky and Kahneman demonstrate how different presentations of ultimately the same information (e.g. 5% unemployment rate versus 95% employment rate) in decision-making scenarios can influence one's choices and evaluations of various options.

Building upon these concepts, Entman (1993) and Cobb (2005) describe the impact of the cognitive processes of selection, salience and accessibility, which are core components of framing, on attitudes formed. Salience involves the meaningfulness, memorability and prominence of information (Fiske & Taylor, 1991) and focuses on how individuals consciously augment emphasis on specific considerations (Nelson et al., 1997). The more salient relevant information is in one's mind, the more impactful it will be in guiding attitude formation (Benford & Snow, 2000). Among others, Scheufele (2000) has described the influential role that mass media can pay in impacting the salience of a particular issues and its ease of retrieval from memory by public audiences.

As previously discussed, the concept of accessibility, which is *"a foundation of a memory-based models of information processing"* (*Ibid*: 229) draws on the notions of memory traces (Watkins & Tulving, 1975) and activation tags (Collins & Loftus, 1975). In considering attitudes and attitude accessibility from the perspective of the Connectionist Model of Representation (Conrey & Smith, 2007), Fazio (2005, 2007: 608) describes how associations can differ in terms of their strength and thereby their *"accessibility from memory"*. Fazio (2007: 611) elaborates that the accessibility of an attitude impacts the extent of *"automatic activation of the attitude"* during the processing of new information. In turn, building on the arguments of Collins and Loftus (1975), Scheufele (2000) details how accessibility mechanisms impact the processing of new information.

> *"When a concept is primed, activation tags are spread. (...) When another concept is subsequently presented, it has to make contact with one of the tags left earlier and find an intersection"* (Collins & Loftus, 1975: 409).

Elsewhere, in further support of the impact of beliefs on attitude formation, Nelson et al. (1997: 236) describe how frames *"activate [selected] existing beliefs and cognitions, rather than adding something new to the individual's beliefs about the issue"*. One of the most influential cognitive psychologists, Bartlett (1932), refers to these memory-based structures of cognition as 'schemas' or 'schemata' rather than frames (Dewulf et al., 2009). Building on Bartlett's (1932) Schema Theory of Memory, Minsky (1975: 213) developed the premise of Cognitive Frame theory which embodies the concept of frames as cognitive representations *"contain[ing] a great many details whose supposition is not specifically warranted by the situations"* stored in memory that are drawn upon when processing information and interpreting new situations.

The next section focuses greater attention on this concept of cognitive representations and structures, in light of their influence on both attitude formation and information processing.

3.3.4 Cognitive Structures - Scripts and Schemas

A consensus resides among scholars within cognitive psychology that individuals draw on and activate relevant knowledge (cognitive) structures, known as schemas and scripts, from long-term memory to guide their contextualisation and interpretation of information (Markus, 1977; Bozinoff & Roth, 1983; Peter et al., 1999; Erasmus et al., 2002). The terms frames (at the micro level construct), scripts and schema are sometimes used interchangeably within the social sciences (Fiske & Taylor, 1991; Korobov, 2010). However, Erasmus et al. (2002) contend that scripts and schemas are more appropriately considered as mechanisms of assisting and guiding the processing of frames, which should be considered as broader definitions of social reality. Scheufele (2000: 309) provides additional clarity on this distinction, stating that *"framing influences how audiences think about issues, not by making aspects of the issue more salient, but by invoking interpretive schemas that influence the interpretation of incoming information"*.

Similarly to attitudes, these scripts and schemas can be implicit and explicit in nature. Having distinguished frames from scripts and schemas, Bozinoff and Roth (1983) move to differentiate between schemas and scripts. They perceive schemas to consist of frameworks for organising information about a concept in a meaningful way, while scripts are considered temporally ordered schemas stored in long-term memory. Erasmus et al.

(2002: 3) provide clarification on these differences, considering scripts to represent habitual, event and routine specific *"social schema with specific characteristics"*.

Turning attention specifically to schemas, originating in the work of Bartlett (1932) and Piaget (1932), schemas are essentially knowledge structures that are relied upon to create meanings and representations around salient concepts, objects, behaviours and events (Peter et al., 1999). Gamson and Modigliani (1989: 2) and Bandura (1991) describe how individuals bring their own unique perspectives, based on experiences and *"psychological predispositions"* to the process of constructing meaning(s) around issues and topics: *"They approach an issue with some anticipatory schema, albeit sometimes with a very tentative one"*. In this vein, Markus (1977: 64) outlines how schemas function as *"selective mechanisms"* determining importance attached to information, in addition to its subsequent integration with prior beliefs and experiences.

The concept of schemas continues to form an integral part of present day paradigms in cognitive psychology (Erasmus et al., 2002). Although some debate prevails around the construction of schemas, they are generally perceived as being created based on a complex intertwining of experiences, memories, attitudes, feelings, beliefs and values developed over time. Schemas are drawn upon to control information processing and focus attention on selected stored knowledge.

> *"Any information that an individual is exposed to is organized in memory through schemata, to give meaning to stimuli and to enable interpretation and comprehension of any situation as new, familiar or unique"* (Erasmus et al., 2002: 3).

In a similar vein, Schurr (1986) describes how schemas assume the operation of four central processes. These include: 1) the selection of incoming stimuli for conscious representation; 2) the abstraction of the meaning(s) of this information; 3) interpretation using prior experiences and knowledge to aid understanding and interpretation; and, 4) integration of these meanings into stored memory. The literature indicates that these cognitive and knowledge structures influence the memory of previously held information, in addition to the coding of new information. In effect, exiting schemas may be triggered and new schemas may be formed (Erasmus et al., 2002). Similarly to attitudes, schemas should therefore not be perceived as entirely static entities.

Classification enables the use of knowledge about categories to create schemas and networks of meaning around specific categories. To this end, Tenbült et al. (2007) provide the useful example of how an individual sees an apple, rather than a round green or red object with a stalk. In essence, identifying an object as belonging to a certain category leads to inferences being made about that object (*Ibid*). Based on these arguments, broccoli, for instance, is categorised as a vegetable, and vegetables are classified as generally healthy foods; thereby broccoli is inferred as being healthy. Connections between concepts may be stronger for some concepts, in comparison to others. For example the concept of functional foods may be more strongly associated with (probiotic) dairy products than unhealthy 'junk food'. Furthermore, the activation of one concept may spread to the activation of another related concept, depending on the strength of their association (*Ibid*). For instance, thinking about genetically modified foods may lead one to think about tomatoes; depending on how exposed s/he has been to media coverage of genetic modification.

Pertaining to information processing about novel, and often unfamiliar, technologies, Burri (2009) and Davies (2011) bring these points out by arguing that schemas that draw on experiences of everyday life are used by the individual when evaluating novel technologies. Elsewhere, Blake and Bisogni (2003) speak of the concepts of 'meaning', 'behavioural scripts' and 'schemas' in the context of food choices more broadly. The next section more closely examines information processing in the context of NFTs.

3.3.5 Attitudes Formation and Information Processing towards NFTs

In recent years, there has been increasing interest in academic spheres in understanding public attitudes around novel food technologies (Fell et al., 2009). Information and the mechanisms of how it is transmitted appear to simultaneously impact affect-based and cognition-based attitudes around NFTs (e.g. Shaw, 2002; Lee et al., 2005). Nonetheless, conflicting studies demonstrate that the direction of influence of additional information about these technologies remains unclear (Grunert et al., 2003; Costa-Font & Mossialos, 2007; Cox et al., 2007).

In the context of information processing and provision about NFTs, initial evaluations and incentives, driven by general attitudes, can significantly impact the processing of subsequent information (Bredahl, 2001; Scholderer & Frewer 2003; Chen & Li, 2007; Fell et al., 2009; Druckman & Bolsen, 2011). A study undertaken by Frewer et al. (1998b) on public attitudes towards GM foods found that, as predicted in adherence with Social

Judgment Theory (SJT) which emphasises the importance of initial attitudes on reactions to subsequent information, prior attitudes were an important determinant of post-intervention attitudes, further illustrating the dynamic interchange between information and attitudes. The intervention in this case was the provision of persuasive information about GM foods which varied in terms of source attribution and indication of associated risk uncertainty. The findings indicate that in the case of GM foods, prior attitudes impact perceptions of both source credibility and information quality, and may therefore be significant in influencing reactions towards new information (*Ibid*).

Slovic (1987), Grunert et al. (2004a) and Druckman and Bolsen (2011) highlight that initial opposition to a technology will not necessarily dissipate in the presence of scientific evidence supporting the technology, due to resistance to change and biasing information processing, as previously illustrated. That said, information provision and the sources of such information can impact citizens' attitudes towards NFTs in a variety of positive and negative ways (Bruhn, 1998; Gunes & Tekin, 2006; Rollin et al., 2011).

For instance, a study by Sheldon et al. (2009) for the FSA, UK on public attitudes towards GM foods found that attitudes evolved in one of two ways after participating in workshops where information was disseminated. For some, attitudes either transitioned from negative, neutral, or positive to a more strongly positive position. For others, no distinct change in overall attitudes towards GM foods was evident but rather, a variety of more discrete changes in specific outlooks occurred. Moreover, Wilson et al. (2004: 1320) found that although exposure to balanced information about GM foods did not change attitudes towards associated products, it did augment the *"importance"* attributed to the issue. These findings affirm the inherent complexity of attitude formation and change towards NFTs. Those who became more positive in their attitudes towards GM foods indicated that the information provided had reassured them of their existing position, thereby strengthening their positive stance. In contrast, those who were negative or undecided in their attitude displayed more emotional responses, which were, in part, based on confusion about the processes involved, i.e. low levels of cognitive capacity (Kruglanski & Thompson, 1999). Interestingly, yet unsurprisingly based on the literature previously reviewed, this Sheldon et al. (2009) study found that variation was evident in terms of how individuals engaged with the information provided based on their initial attitude towards GM foods. These original attitudes were, in turn, shaped by underlying worldviews and experiences.

Finally, Gupta et al. (2011: 784) argue that, although they can occur concurrently, in the case of novel technologies, *"cognitive evaluation and emotional response do not necessarily align"*. Whether these responses align, in addition to how information is contextualised, warrants further exploration and reflection in future studies on public evaluations of NFTs. As previously mentioned, as more information becomes available in mass media about how these technologies, particularly the more novel ones such as nutrigenomics and nanotechnology, can be applied in food production, views and attitudes will form and crystallise which will subsequently influence public acceptance (Dudo et al., 2011; Ho et al., 2013).

3.4 Research Opportunities

A body of work exists that measures public assessments of NFTs (e.g. Grunert et al., 2003; Chen & Li, 2007; Sheldon et al., 2009; Druckman & Bolsen, 2011). Research to date has generally focused on either measuring general acceptance or rejection of NFTs, or public perceptions of associated benefits and risks (Lee et al., 2005; Druckman & Bolsen, 2011). Furthermore, many of these studies (e.g. Bredahl, 2001; Grunert et al., 2003; Scholderer & Frewer, 2003) assume attitudes under investigation to be relatively stable. While recognising that attitudes may be resistant to change, building upon this review, this work supports Bohner and Dickel's (2011: 394) perspective that attitudes can be flexible and *"situationally variable"*. However, this research does not go so far as to support the view that attitudes are *"momentary constructions"*; a notion which has been criticised by Fazio (2007: 619).

Although some quantitative-based attitudinal studies (e.g. Bredahl, 2001; Grunert et al., 2003; Townsend & Campbell, 2004; Chen & Li, 2007; Gaskell et al., 2010) have been undertaken to measure public attitudes towards NFTs, it appears that in-depth studies that investigate citizens' evolving attitude formation processes towards these technologies are lacking. How attitudes towards these technologies form, rather than the establishment of what attitudes form, is a relatively unexplored territory (Davies, 2011). It is therefore not surprising that Gupta et al. (2011) have stressed the need for further examination of the interrelationships between the determinants of attitude formation around novel technologies, which extend beyond traditional approaches that focus purely on risk (and benefit) perceptions. Specifically, Gupta and colleagues call for a more nuanced investigation of additional psychological factors, such as affective responses and reliance on heuristics, which the literature outlined has clearly indicated to impact attitudes formed. Based on the scholarly work reviewed, an opportunity presents itself to: 1) establish whether attitudes towards different types of NFTs vary in terms of their strength, stability and accessibility; 2) establish whether information provision activates similar or specific meanings and schemas across different technologies; and, 3) explore the complex impact of information processing on attitudes and vice versa.

This research takes these recommendations and opportunities on board, by exploring citizens' evolving attitude formation and affective and cognitive responses towards different types of NFTs as information is presented, in addition to how initial attitudes influence information processing and subsequent attitudes form. In doing so, this research aligns with Bohner and Dickel's (2011) viewpoint that attitudes, although resistant to change, are not necessarily stable. Furthermore, this research is novel in the context of moving away from the *status quo* focus to date on establishing overall general opinions on NFTs.

3.5 Conclusion

Drawing on literature from across the social sciences, several concepts were introduced within this chapter relating to attitude formation and information processing, in an effort to better understand how attitudes form. Table 3.1 summarises the key issues and concepts embedded within this chapter.

Table 3.1: *Summary of the Key Issues and Concepts Explored*

Key Issues & Concepts	Key Points	Key Authors Referenced
Attitude Formation	– Attitudinal definitions range from easily retrievable memory-based evaluations, to centering on formation as a result of time specific accessible information. – Some definitions emphasis the favourability of perspectives, while others focus on feelings evoked. – Building on the Expectancy-Value model, individuals are not born with entrenched beliefs and consequently attitudes are acquired. – Attitudes towards NFTs are complex and develop over time, based on experiences and values/ beliefs. – Attitudinal and behavioural entities consist of four elements: context, action, target and time. – The ABC metaphor for understanding and conceptualising attitudes is important. However, some query its pertinence. – Emphasis is placed on the implicit and explicit nature of attitudes, with the former generally presumed to require more cognitive effort and to be a better predictor of behaviours.	Allport (1935, 1954), Katz (1960), Ajzen & Fishbein (1977), Fishbein & Ajzen, (1975), Edwards (1990), Eagly & Chaiken (1993, 2007), Petty et al. (1997, 2006), Crano & Prislin (2006, 2008), Fazio (2007), Olson & Kendrick (2008), Bohner & Dickel (2011).
Relationship between Attitude & Behaviour	– A complex relationship exists between attitudes and behaviour. Some evidence exits that attitude-behaviour inconsistencies prevail, particularly concerning NFTs. – Attitudes are situation/ environment specific. – Despite potential inconsistencies, exploration of attitude formation in hypothetical situations is warranted; it provides insight into meanings drawn upon when processing information. – Several theories have been developed, including TRA, TPB and Attitude Representation Theory, to try to explain/ predict the relationship between attitudes and behaviours.	Katz (1960), Fishbein & Ajzen (1975), Loewenstein & Schkade (1999), Fazio (2007), Smith & Hogg (2008), Arts et al. (2011), Bohner & Dickel (2011).
Attitude Composition & Formation	– Attitude formation is a multifaceted/ multicomponent process. – Exploration of attitude direction, strength, stability, importance, accessibility, ambivalence, associations and measurement provides insight into how attitudes are affected by information. – Attitudes may be jointly guided by affective and cognitive motivations. The (potentially conflicting) relationship between these components is important to explore. – Values and attitude functions are the basis for attitudes. The functionalist theory of attitudes explains needs fulfilled by attitudes and the functions they perform. – Metaphors are often used to express attitudes.	Katz (1960), Edwards (1990), Eagly & Chaiken (1993), Petty et al. (1997), Fabrigar & Petty (1999), Crano & Prislin (2006), Visser et al. (2006), Forgas (2008), Bohner & Dickel (2011).

Table 3.1: *Continued*

Key Issues & Concepts	Key Points	Key Authors Referenced
Automatic Versus Controlled Responses	– Formed attitudes can be automatic (reactive) or controlled (reflective) responses. – Based on the Iterative Reprocessing model, formation occurs on a continuum, from relatively automatic to controlled responses. – Attitude formation is neither completely automatic nor controlled, and therefore encompasses aspects of DPMs. – The absence of knowledge about NFTs does not preclude attitude formation. – Individual may be (un)aware of the mental processes directing their attitude formation.	Katz (1960), Bargh (1994), Lee et al. (2005), Cunningham & Zelazo (2007).
Measurement of Attitudes	– Attitude measurement is complex, as attitude strength, certainty, stability, importance and accessibility vary. – Attitudes are inferred from individuals' behaviour and self-reporting, which may be misaligned. – Challenges are encountered when attempting to measure attitudes include self-norming and lack of introspection. – Several models/ scales have been developed in an attempt to measure implicit/ explicit attitudes and attitude change.	Thurstone (1928), Greenwald et al. (1998), Loewenstein & Schkade (1999), Schwarz (2008), Arts et al. (2011).
Attitudes: Strength & Stability	– Strength of association and depth of cognition impact attitude strength and stability and, in turn, attitude susceptibility to new information. – Many consider attitudes as stable entities, formed based on associations stored in memory. Others define them as being relatively unstable and context specific, and thus formed on the spot from the reconstruction of unique configurations of inputs. – If supporting 'attitude instability', one must still recognise challenges faced in attempting to change attitudes. – Attitudes appear to change as a function of experience and evolution of perspectives. – Previously held attitudes influence how information is processed and new attitudes form. – The PAST model aids understanding of what happens to 'old attitudes', i.e. their tagging as invalid. Due to original attitudes remaining stored in memory, PAST predicts attitudinal ambivalence may occur. – The APE model attempts to account for interaction between implicit and explicit attitude change; one may occur without the other happening. – Attitude formation/ change relates to information accessibility, knowledge, information processing and methods of persuasion. – One needs to establish more than just overriding attitudes to fully appreciate attitudinal contexts. One must account for variables such as attitude strength, stability, associations, importance, accessibility and ambivalence, and how new information affects attitudes. – More substantive exploration of the multidimensional and conflicting cognitive processes at play, reliance on prior knowledge and integration of new information is required.	Katz (1960), Edwards (1990), Petty et al. (1997, 2006), Lord & Lepper (1999), Wood (2000), Gawronski & Bodenhausen (2006), Visser et al. (2006), Conrey & Smith, (2007), Cunningham et al. (2007), Cunningham & Zelazo (2007), Eagly & Chaiken (2007), Fazio (2007), Bohner & Dickel (2011).

Table 3.1: *Continued*

Key Issues	Key Points	Key Authors
Attitudinal Ambivalence & Cognitive Dissonance	– Attitudes may encompass element of uncertainty and multiplicity; which can result in attitudinal ambivalence. Ambivalence is strengthened if mutually opposing attitudes are simultaneously accessible. – Neutral attitudes may indicate high or low ambivalence. – Information processing is more effortful when high levels of ambivalence exist (resulting in weak attitude-behaviour relationships). Attitudinal ambivalence, in part, explains the complex and flexible nature of attitude formation. – It is important to monitor attitude ambivalence towards NFTs during the early stages of their development, when attitudes are crystallising. – Cognitive dissonance has implications for biased information seeking and processing behaviours.	Festinger (1957), Wood (2000), Crano & Prislin (2006), Cunningham et al. (2007), Fischer et al. (2013).
Levels of Information Processing & Connections to Attitudes	– Provision of information is a key element in the formation of attitudes and thus information processing. – The characteristics of the information source, the information content, the audience and the cognitive route applied impact information processing/ contextualisation. – Prior attitudes influence interpretation of new information. – Mutually shaping relationships exist between attitudes and information processing. – Intricacy associated with attitude formation presents challenges in attempting to change attitudes through information provision.	Kruglanski & Thompson (1999), Frewer (2003), Crano & Prislin (2006), Eagly & Chaiken (2007), Bohner & Dickel (2011), Fischer et al. (2013).
Reactive, Reflective & Routine Levels	– Information processing can occur at each of these levels. – Cognitive, emotional and behavioural components can influence attitude formation at each level. – Information processing, at these levels, is individualistic.	Kazemifard et al. (2005), Ortony et al. (2005).
Models of Information Processing & Attitude Formation	– Models and theories have been forwarded to better understand cognitive processes/ structures, particular the acts of organising, storing and retrieving information. – The Levels of Processing framework builds on the premise that memories occurs on a continuum, from shallow to deep. – The cognitive miser concept builds on the premise that individuals are only willing to engage in cognition-based information processing when equipped with the cognitive capability and motivation to do so. – The RISP Model accounts for heterogeneity in terms of information seeking behaviours among individuals. – Both systematic and heuristic-based information processing can occur simultaneously. – Attitudes formed as a result of thorough information processing are more resistance to counter-information, and thus more stable and indicative of actual behaviours. – Perceived personal relevance impacts the extent of reflection upon and internalisation of information.	Bartlett (1932), Katz (1960), Craik & Lockhart (1972), Lord et al. (1979), Chaiken (1980), Petty & Cacippo (1986), Fazio (1990, 2007), Fiske & Taylor (1991), Eagly & Chaiken (1993), Frewer et al. (1997c, 1998b), Chaiken & Trope (1999), Griffin et al. (1999), Kruglanski & Thompson (1999), Loewenstein & Schkade (1999),

	– When motivated to, and capable of, processing information, more systematic-based and reflective attitudes form. – Motivation to learn and cognitive capacity to acquire information about NFTs is low, due to the benefit of information acquisition/ processing being unclear. – DPMs are effective in illustrating the complex ways in which information is processed and attitudes form, with each DPM placing different emphasis on attitude stability. – According to DPMs, those with high levels of cognitive capacity and motivation are more inclined to partake in deep (central and systematic) information processing. – The Unimodel counters the DPM approach, suggesting integration of the two processing systems. – It seems that strong attitudes can remain intact, despite the introduction of subsequent non-supportive evidence. – Recurring mental strategies are relied upon to cope with and process information encountered about NFTs, based on selective use of time and cognitive resources. – Evidence of biased information processing and motivated reasoning towards NFTs exists, with initial attitudes shaping the processing of pro and contra information and subsequent attitudes formed. – The impact of two-sided communications on attitudes towards NFTs is an avenue worthy of further investigation.	Wansink & Kim, (2001), Todorov et al. (2002), Scholderer & Frewer (2003), Nisbet (2005), Scheufele & Lewenstein (2005), Crano & Prislin (2006), Gawronski & Bodenhausen (2006), Cunningham et al. (2007), Druckman & Bolsen (2011), Fischer et al. (2013), Ho et al. (2013).
Information Framing	– Information framing is traditionally referred to from the perspective of media (message) framing of an issue or topic. However, the framing concept should not be restricted to a media (exo-level) perspective. – Individuals assess objects and situations through frames (lenses), which highlight certain topic elements based on perceptions of reality. – This research explores framing at the individual (micro) level; how information is decoded and other information and wider environmental influences relied upon to construct meaning and form (possibly reform) attitudes. – It is important to understand how information is decoded once received, as dominant meanings may not be accepted. – Framing can occur at different levels of abstraction, based on the cognitive structures drawn upon, and substantively effects appraisals when processing information. – Cognitive processes of selection, accessibility and salience are core components of framing, which impact information processing and attitudes formed.	Goffman (1974), Collins & Loftus (1975), Minsky (1975), Watkins & Tulving (1975), Gitlin (1980), Tversky & Kahneman (1981), Gamson & Modigliani (1987), Gamson et al. (1992), Entman (1993), Pan & Kosicki (1993), Scheufele (2000), Reese (2001), Cobb (2005), de Vreese (2005), Van Gorp (2007).

Table 3.1: *Continued*

Key Issues	Key Points	Key Authors
Cognitive Structures - Schemas	– Schemas are cognitive knowledge structures relied upon from existing dispositions and experiences to guide information contextualisation and instil meaning. – Schemas act as information processing mechanisms. – Schemas create meanings around concepts, objects and behaviours, based on intertwining of experiences, attitudes and beliefs, which control information processing and focus attention on stored knowledge. – Exiting schemas may be triggered and new schemas may form; they are not static. Activation of one concept may spread to another, depending on strength of association. – Schemas that draw on experiences of everyday life are used when evaluating NFTs.	Bartlett (1932), Bozinoff & Roth (1983), Schurr (1986), Gamson & Modigliani (1989), Peter et al. (1999), Scheufele (2000), Erasmus et al. (2002), Tenbült et al. (2007), Burri (2009), Davies (2011).
Attitudes Formation & Information Processing towards NFTs	– Information and the mechanisms of its transmission appear to simultaneously impact affect- and cognition-based attitudes formed. – Conflicting studies demonstrate an unclear direction of the influence of additional information. – Initial evaluations and incentives, driven by general attitudes, can significantly impact information processing. However, information provision (and sources) can still influence attitudes. – Attitude formation/ change around NFTs is inherently complex, based on the varied ways in which individuals engage with and process information. – Cognitive evaluation and emotional responses may not align. – As information about NFTs becomes available, attitudes form/ crystallise, subsequently influencing perspectives on these technologies.	Bruhn, (1998), Frewer et al. (1998b), Bredahl (2001), Shaw (2002), Scholderer & Frewer (2003), Wilson et al. (2004), Lee et al. (2005), Fell et al. (2009), Sheldon et al. (2009), Druckman & Bolsen (2011), Gupta et al. (2011).
Research Opportunities	– A more holistic perspective on citizens' evolving evaluative processes towards these technologies, which extends beyond risk/ benefit evaluations, is needed. – Opportunity exists to: establish whether attitudes towards NFTs vary in terms of their strength, stability etc.; establish whether information provision activates similar or specific meanings across different NFTs; and, explore the influence of information processing on attitudes and vice versa. – This research takes these opportunities into account by exploring citizens' evolving attitudes formation processes and affective and cognitive responses towards NFTs as information is presented, in addition to interdependencies between attitude formation and information processing.	Fell et al. (2009), Bohner & Dickel (2011), Gupta et al. (2011).

Attitude origins, composition and formation procedures have been outlined within this chapter. Many authors within the area of social psychology define attitudes as relatively stable entities formed based on associations and evaluations stored in memory, while others define them as being relatively unstable, and focus on the temporary constructions guiding their formation (Bohner & Dickel, 2011). The concepts of attitude accessibility, importance, certainty, strength, stability, ambivalence, associations and measurement have been explored. The literature discussed has illustrated that the concept of attitudes has had a *"rich history"* to say the least (Fazio, 2007: 604), and that implicit and explicit attitude are complexly formed (Gawronski & Bodenhausen, 2007) based on their numerous origins and evolutionary paths. As part of this complexity, attitudes, although flexible, may be resistant to change, as a result of solidified values and beliefs which potentially bias the processing of subsequent information. The literature clearly indicates that both cognition and affect pay intertwined roles in forming implicit and explicit attitudes.

Furthermore, the literature explored indicates that the provision of information is a key element in attitude formation processes. Indeed, the influence of information processing on attitudes, and vice versa, is both dynamic and intricate, with mutually determining relationships existing between attitudes and information processing. As illustrated, information processing can occur at reactive, routine and reflective levels (Ortony et al., 2005). Indeed, cognitive, emotional and behavioural components can influence attitude formation at these different levels (Kazemifard et al., 2005). This chapter has also provided an overview of how attitude formation and change relates to information processing and methods of persuasion. Furthermore, the multifaceted cognitive structures, known as schemas, that individuals draw upon from existing dispositions and experiences to instill meanings when forming attitudes have been examined. This review suggests that attitudes towards NFTs develop over time, based on one's experiences and embedded values and beliefs.

The exploration of seminal literature in this and the previous chapter has provided the foundations for the theoretical concepts that this thesis builds upon. This review indicates that to truly comprehend and appreciate how attitudes towards NFTs form and evolve, and associated complexities, a more substantive exploration around the multidimensional and often conflicting cognitive processes at play, reliance on prior knowledge and integration of new information is required.

Throughout the undertaking of this study, the impact and compounded interplay of information processing mechanisms on attitude formation are carefully considered. Specifically, this research explores the *"mentally stored clusters of ideas that guide individuals' processing of information"* (Entman, 1993: 53); in effect, the factors, including schemas, guiding citizens' evolving attitudes towards selected technologies as information is presented. In doing so, it contributes to literature to date, by providing a more holistic perspective on attitude formation and the contextualisation of information about NFTs, which extends beyond risk and benefit based evaluations (Gupta et al., 2011).

An outcome of the reviews presented here, and in the previous chapter, is a fruitful bridging of schools of thought, by providing links and associations between existing theories in the areas of social, risk and cognitive psychology. The literature reviewed forms a critical theoretical cornerstone of this dissertation. It situates the issue of public acceptance of NFTs within the broader literature around attitude formation and information processing, to better understand how attitudes form. Explicitly, this review has enabled a distinct understanding of the relationship between relevant theories and how they can be applied and drawn together, where possible, to provide theoretical underpinnings from which to analyse citizens' evaluations of NFTs.

In advance of linking theory with analysis, Chapter 4 presents the research design and methodology applied to address the research questions posed. The methodological approach incorporates relevant perspectives from the literature review on attitude formation and information processing procedures. Specifically, the steps taken to overcome the challenges faced in attempting to establish citizens' evolving affect-based and cognition-based attitudes towards the technologies are described.

Chapter 4
Methodology

4.1 Overview

The purpose of this chapter is to provide an overview of the methodological considerations associated with this research. The philosophical assumptions and rationale for each methodological decision made, in adherence with the principles of good qualitative research, are presented. In particular, justifications for the inclusion and grouping of particular technologies, in addition to the qualitative approach adopted more broadly, are relayed.

Adoption of a constructionist approach enabled exploration and appreciation of citizens' attitude formation and information contextualisation processes around selected technology groups. The qualitative approach applied involved observations of a one-to-one interaction between citizens and information providers, during which they discussed these technologies. The different stages involved in this interaction, in addition to the supplementary data collection phases, are detailed and justified. The purpose of this approach was to reveal through an iterative process how individuals form attitudes around information about these technologies. Following this, an overview of the different stages involved in the analytic approach are described.

Throughout this chapter, justifications for the data collection and analytic approaches, including steps taken to ensure the trustworthiness (Lincoln & Guba, 1985) and strengthen the reflexivity of these procedures, are outlined.

4.2 Addressing the Research Objectives and Questions

The most suitable method of data collection depends on how best to address the specified research questions. As outlined in Chapter 1, this research addresses the following core question: *What guides and influences citizens' evaluations of NFTs?*

Underlying this question is the goal of exploring how individuals' construct meanings around and interpret information about these technologies, as such, how attitudes form and evolve with the provision of information. In essence, this research provides insights into how information about these technologies is used and assimilated, and the implications of this on attitudes formation and acceptance. As a starting point to articulating the methodological approach taken, an overview of the research design is presented.

4.3 Overview of Research Design

Yin (1994: 18) defines a research design as *"the logic that links the data to be collected to the initial questions of study".* The design process concerns the overall plan of how research is conducted, and involves 'interconnected choices', in terms of data collection, sampling methods and the analysis and interpretation of findings (Saunders et al., 2009). In terms of the research design process choices made for this current study, the chosen research philosophy of this work is constructionism, as part of a hybrid inductive and deductive approach (Hyde, 2000; Fereday et al., 2006). The research methodology applied is a cross-sectional, multi-method approach, involving interactive exchanges with citizens and debriefing interviews. A detailed account and justification of each aspect of the research design process follows an overview of the epistemological stance taken.

4.4 Epistemological Approach Underpinning the Research Design

Deriving from assumptions about the nature of existence (ontology), a methodology provides *"a theoretical perspective that links a research problem with a particular method or methods"* (Hesse-Biber, 2010: 456). Lincoln and Guba (1985) stress the importance of definitively establishing and stating the philosophical paradigm at the outset of engaging in a process of inquiry. Cohen and Crabtree (2008: 333) note that *"there is ample evidence to suggest researcher motivations and preconceptions shape all research"*. Throughout the undertaking of this work, the social context of undertaking research, and therein the inevitable impact of individuals' personal assumptions and perspectives on data collection and analysis, are recognised.

In terms of epistemological stances (Hesse-Biber, 2010), this research is grounded in constructionism, which assumes knowledge to be created rather than discovered (Andrews, 2012). Indeed, Berger and Luckmann's (1966: 27) assertion that knowledge is created by the interactions of individuals within society is a central tenant of constructionism. This approach is often compared to, and paralleled with, an interpretivist philosophy (Creswell, 2009). Interpretivism builds on the premise that each interpretation is context, setting, and situation specific, and consequently reality is considered to be *"multiple, fluid and co-constructed"* (Cohen & Crabtree, 2008: 336). In fact, this interpretivist perspective, which *"assumes no single, observable reality"* (Merriam, 2009: 8), is the most prevalent philosophy grounding qualitative research.

Originating from sociology, constructionism similarly assumes a multiplicity of perspectives and focuses on comprehending *"the social construction of reality"* (Bisogni et al., 2002: 129) from study participants' standpoints. This constructionist perspective focuses on interpreting the subjective meanings motivating the actions of actors. Gergen (1985: 266) describes how this constructionist worldview is *"principally concerned with explicating the processes by which people come to describe, explain, or otherwise account for the world (including themselves) in which they live"*. Thus, constructionism asserts that reality is constructed by individuals as they assign meaning to the world around them. Constructionism thereby builds upon the premise that meaning is created by individuals' interactions with and interpretations of objects.

This perspective challenges the more positivist view that there is an objective meaning or 'truth', which is quantifiable and measurable through inquiry (Crotty, 1998). As Merriam (2009) summarises, positivists seek to describe and generalise human behaviour, whereas constructionists strive to understand it. Table 4.1 summarises the key differences between positivist and interpretivist/ constructionist epistemological stances.

Table 4.1: *Overview of Epistemological Perspectives*

	Positivist/ Postpositivist	**Interpretivist/ Constructionist**
Purpose	Predict, control, generalise	Describe, understand, interpret
Types	Experimental, survey, quasi-experimental	Phenomenology, ethnography, grounded theory, naturalistic/ qualitative
Reality	Objective, external, 'out there'	Multiple realities, context-bound

Source: Adapted from Merriam (2009: 11)

'Constructionism' can be considered at the individual level, while 'social constructionism' encompasses a broader societal, rather than an individual, perspective (Andrews, 2012). This research aligns with the constructionist standpoint that individuals formulate multiple meanings and perceive situations, as a consequence of their historic experiences, worldviews and *"multiple constructions of reality"* (Whiteley et al., 2003: 5). In doing so, they construct their own 'knowledge'. As an illustration of this point, a person's negative prior experience with food safety may positively influence their attitude towards an application of a technology that enhances the safety of food. Moreover, the multiple meanings that individuals draw upon tend to result in a complexity of views, rather than a limiting of perspectives (Creswell, 2009). Subsquently, a 'constructionist lens' supports thorough exploration of the complex array of factors influencing food choice (e.g. Furst et al., 1996) and, in turn, evaluations of NFTs (e.g. Davies, 2011).

Aligned with a constructionist perspective, although the researcher's values were external to data collection (see Section 4.6.2), their experiences and background shaped their interpretation of the data. However, adoption of a three-phased consultative approach during data analysis (described in Section 4.7.2), which involved the dissertation supervisors continually and constructively questioning the researcher's assumptions, and peer debriefing, resulted in analytic interpretation from a variety of perspectives. This strengthened the trustworthiness and reflexivity of the analytic process (Jootun et al., 2009), and minimised any potential interpretative bias. Each of these concepts is discussed in turn.

The next section moves the focus from epistemological underpinnings to methodological approaches.

4.5 Justification of Qualitative Approach

Salmon (2003: 25) posits that *"whether to be quantitative or qualitative in any specific study should be decided by 'fit' with the phenomenon being studied".* As outlined in Chapter 3, this dissertation takes the position that attitudes, although resistant to change, can be flexible and situation specific, and thereby susceptible to evolution with new information (Bohner & Dickel, 2011). Thus, a core goal of this research is to unpick citizens' evolving attitudes around these technologies. How these attitudes form, rather than the establishment of what overall attitudes form, is the focus of this work.

As detailed in Chapter 2, public attitudes towards NFTs have predominately been explored through quantitative methods (e.g. Bredahl, 2001; Grunert et al., 2003; Chen & Li, 2007; Gaskell et al., 2010). Quantitative research focuses on developing generalisations, and *"emphasize[s] the measurement and analysis of causal relationships between variables, not processes (…) within a value-free framework"* (Denzin & Lincoln, 2005: 8). Hence, these studies tend to focus on measuring either general acceptance or rejection of NFTs, or perceptions of associated risks and benefits (Lee et al., 2005;

Druckman & Bolsen, 2011). Several of these quantitative studies have presented models which offer a valuable point of departure for this research. Specifically, these models suggest that general attitudes and values, perceived knowledge of the technology, social trust and the reliance on heuristics are significant predictors of risk and benefit perceptions and, in turn, overall technology evaluations (e.g. Bredahl, 2001; Chen & Li, 2007; Siegrist et al., 2007a).

These points withstanding, Frewer et al. (2013) note a lack of cohesion in approaches to examine public perspectives on NFTs (genetic modification in the case of this particular study). Furthermore, as previously outlined (see Section 3.2.5) challenges may be encountered when measuring attitudes towards NFTs through quantitative methods, including poor comprehension of questions, scale (mis)interpretation (Fazio, 2007; Schwarz, 2008) and lack of introspection of true feelings in the context of responses (Loewenstein & Schkade, 1999; Schwarz, 2008). It seems that, while a quantitative approach proffers insights into measures of public technology appraisals and associated determinants, it fails to provide a *"richly descriptive"* (Merriam, 2009: 14) account of the complex and intertwined features guiding citizens' thought processes around these technologies. Subsequently, a quantitative approach is not fit for the purposes of this research.

On the alternative 'methodological hand', qualitative research is a means of truly comprehending and appreciating how attitudes form and evolve, in addition to associated complexities (Fell et al., 2009). Focusing on the social construction of reality, qualitative approaches *"emphasize the value-laden nature of inquiry"* (Denzin & Lincoln, 2005: 8). Qualitative researchers are primarily interested in exploring the meanings that individuals construct around objects and circumstances, and how they 'make sense' of their experiences and encounters (*Ibid*). A qualitative approach thereby offers *"a multilayered view of the nuances of social reality"* (Hesse-Biber, 2010: 456), and provides a greater appreciation of how information is used and integrated and the implications of this on attitudes.

Hence, a qualitative approach offers a better fit for this work, in the context of meeting the research aims and addressing the research question posed. Specifically, it can effectively explore attitude formation and multidimensional cognitive processes around novel technologies. This extends to exploring and understanding whether information provision activates similar or specific meanings across different NFTs.

Numerous qualitative research approaches have been widely applied, including in-depth interviews, focus groups and ethnography (Denzin & Lincoln, 2005). Furthermore, these methods have increasingly been applied to explore food purchase and consumption habits (Furst et al., 1996; Cronin & McCarthy, 2011; Hollywood et al., 2013; Spence et al., 2013; Delaney & McCarthy, 2014) and evaluations of NFTs (e.g. Shaw, 2002; Nielsen et al., 2009). Irrespective of the approach taken, 'high quality' in the execution of the approach is central.

4.5.1 Principles of 'Good' Qualitative Research - Criteria of Trustworthiness

Cohen and Crabtree (2008) argue that the aim of good qualitative research is to understand and contextualise complex views on, and interpretations of, specific topics under investigation. The concepts of validity and relevance must be operationalized differently in qualitative, versus quantitative, studies, in order to reflect qualitative research's distinctive objectives (Merrick, 1999; Mays & Pope, 2000; Bryman & Bell, 2007).

Many authors have argued the importance of making a conscious effort to ensure the validity of qualitative research (Lincoln & Guba, 1985; Denzin & Lincoln, 1998; Creswell & Miller, 2000). To this end, constructionists and naturalists have *"moved away from the strict scientific definitions of reliability and validity"*, perceiving them to be *"confining definitions"* (Lewis, 2009: 4) which limit qualitative research's ability to accurately and comprehensively report data collected (Denzin & Lincoln, 1998). Traditional validity checks, such as the accuracy of the measurement tool(s) and selection of the sample, have been replaced with the concept of credibility, which is focused on *"internal validity"*, in terms of emphasising *"the truthfulness of what the researcher reports"* (Lewis, 2009: 4). Within the qualitative milieu, the notion of internal validity is important throughout research design, data collection and data analysis (Creswell & Miller, 2000). Concerning related concepts, Morse et al. (2002: 14) contend that *"without rigor, research is worthless, becomes fiction, and loses its utility"*. In turn, Mays and Pope (2000: 52) argue that *"systematic, self-conscious research design, data collection, interpretation, and communication"* are an effective strategy to ensuring rigour within qualitative research.

Further exploring the principles of good qualitative research, Guba and Lincoln (1982) and Lincoln and Guba (1985) have replaced validity and reliability in the traditional quantitative sense with the parallel concept of 'trustworthiness'. *"Trustworthiness encompasses elements of "good practice" that are present throughout the research process"* (Merrick, 1999: 30). The seminal work of Guba and Lincoln presents the following four criteria of trustworthiness, which should be applied throughout qualitative research: 1) credibility, i.e. upholding the 'truth' of the findings in the context of how the research was undertaken; 2) transferability, i.e. identifying key aspects of the context from which findings emerge and the degree to which findings may be transferable to other contexts; 3) confirmability, i.e. illustration of evidence from participants and the research perspective that corroborates the findings; and, 4) dependability, i.e. the extent to which the research would produce similar or consistent findings if carried out as described elsewhere. To ensure the trustworthiness of qualitative research, Guba and Lincoln (1982, 1989) and Lincoln and Guba (1985) recommend specific methodological strategies and guidelines, such as maintaining credibility through peer debriefing and maintaining a clear audit trail.

> *"A peer reviewer provides support, plays devil's advocate, challenges the researchers' assumptions, pushes the researchers to the next step methodologically, and asks hard questions about methods and interpretations*" (Creswell & Miller, 2000: 129).

Building upon the concept of 'trustworthiness', Cohen and Crabtree (2008: 333) recommend adherence to the following principles of good qualitative research: *"carrying out ethical research"*; *"clarity and coherence of the research report"*; *"use of appropriate and rigorous methods"*; *"importance of reflexivity or attending to researcher bias"*; *"importance of establishing validity or credibility"* and *"importance of verification or reliability"*. Similarly, Caelli et al. (2003) advocate noting the researcher's position, identifying their analytic lens, and explicitly stating how procedural rigour is maintained.

Further exploring the notion of reflexivity, Ely et al. (1991) highlight the importance of recognising that qualitative research is inherently recursive and reflective in nature, as a result of the researcher being the primary instrument for data collection and analysis. This *"human instrument has shortcomings and biases that might have an impact on the study"* (Merriam, 2009: 15). It is essential to identify and monitor these shortcomings, since they inevitably shape data collection and interpretation (Merrick, 1999). To this end, Cohen and Crabtree (2008: 333) consider *"a hallmark of good research"* to be *"understanding and reporting relevant preconceptions through reflexive processing"*. Jootun et al. (2009: 45) build upon this assertion, arguing that the *"subjectivity"* of qualitative research, stemming from the *"values, beliefs, experience and interest of the researcher"*, influences data collection and interpretation. Thus, the centrality of reflectivity to safeguarding the trustworthiness of the research process is paramount. Reflexivity is perceived as being vital to ensuring a clear understanding of the phenomenon being examined and the researcher's role within the study (*Ibid*).

Each of the aforementioned criteria, and associated strategies, for instance peer reviewing, are considered fundamental to preserving high standards and 'quality in qualitative research' (Morse et al., 2002). How each of these principles was accounted for and incorporated throughout the research process is highlighted in turn.

In order to establish the variety of potential influences directing attitude formation (Forgas, 2008) around these technologies, it was necessary to include a breadth of technologies and a diversity of individuals within this study. This next section describes and justifies the specific research methods employed, commencing with an overview of how the technologies were selected and grouped for this study.

4.6 Data Research Methods

This section provides a description of how the technologies were selected and grouped. Following this, the data collection process is outlined and justified. As part of this overview, the recruitment and sampling protocols and procedures are relayed. The different stages involved in data collection are then detailed.

4.6.1 Description and Justification of Technology Selection and Grouping

As illustrated in Chapter 2, citizens' evaluations of NFTs are influenced by a multitude of factors, including the type of technology and application in question (e.g. Frewer et al., 1994, 1997a; Fell et al., 2009; Henchion et al., 2013). Consequently, Frewer et al. (2011) advocate a specific need for comparative studies that simultaneously focus on a variety of food technologies, rather than on one singularly. As evident within the literature previously reviewed, the evaluative criteria applied by the public can vary across technologies. Subsequently, both general and technology specific research is merited. Moreover, Gupta et al. (2011: 791) argue that *"the question of why some technologies become societally controversial, whereas others do not, is worthy of further research"*. Building upon this assertion, Gupta and colleagues suggest that exploration of public evaluations of non-controversial technologies should be undertaken, to more broadly and comprehensively identify the factors driving public evaluations across *both* controversial and non-controversial technologies.

In light of these viewpoints, it was important to clearly establish, at the research outset, the breadth and scope of NFTs to investigate, so as to assure the transferability, confirmability and dependability of data analysis. Examination of too few technologies would limit observance of emerging patterns across the technologies, while examination of too many could result in an excessive array of source influences and data saturation not being reached. To ensure thorough exploration of citizens' attitude formation around NFTs and, specifically, evaluative patterns across them, a range of technologies with varying characteristics was selected for inclusion and systematically grouped. Pre-defining technology groups increased the transferability and strengthened the confirmability of this work (Guba & Lincoln, 1982, 1989; Lincoln & Guba, 1985). In effect, it facilitated data saturation across a breadth of technologies, within the context of limited resources.

Relevant literature (e.g. Siegrist, 2008; Fell et al., 2009; Frewer at al., 2011) was drawn upon to establish the most important core factors to consider during technology selection and subsequent grouping. The literature within this area (e.g. Fell et al., 2009) highlights that individuals' attitude formation around these technologies occurs beyond initial awareness of them. Drawing upon the premise of the PAST model (Petty et al., 2006; Bohner & Dickel, 2011), attitudes towards these technologies are potentially subject to evolution over time (Frewer et al., 2004; Marques et al., 2014), with the provision of new information (e.g. Costa-Font & Mossialos, 2007), and/ or as motivations and needs evolve (Katz, 1960). Consequently within this research, it was important to include technologies which the public are reported as being more familiar with and having varying levels of awareness and knowledge of (e.g. genetic modification), in addition to those which they are generally unfamiliar with (e.g. nutrigenomics) (Frewer et al., 2011; Stewart-Knox et al., 2013). In addition to familiarity, dread is a key dimension of technology assessment (see Section 2.2.2). Thus, both familiar and unfamiliar technologies, which engender both emotional and apathetic responses, along a continuum, were included.

The overarching factors that guided technology selection and grouping were predicted public reactions, in particular scope for risk-based responses (Slovic, 1987; Griffin et al., 1999), and the technologies' expected characterisations. Evidence suggests that general attitudes towards these technologies have been noted as somewhat predictable along these features (Fell et al., 2009). Variation in terms of these technologies being product (e.g. functional foods) or process (e.g. thermal technologies) orientated also influenced selection/ grouping decisions. The three groups of technologies selected for inclusion, and associated common attributes, are summarised in Table 4.2. These groups included an Emotive and Contentious Group (ECG), a Benign and Non-contentious Group (BNG) and a Product and Service Orientated Group (PSOG).

Table 4.2: *Selected Technology Groupings based on Expected Reactions and Characterisations*

Group	**Technologies included**	**Expected Overall General Reactions**	**Characterisation of the Technologies/ associated Products**
Emotive & Contentious Group (ECG)	- **Genetic modification** - **Nanotechnology**[13] - **Food irradiation**	Predominately emotional and one of resistance. However, reactions are likely to depend on the specific application/ product.	Potentially contentious and threatening. Process and technology orientated.
Benign & Non-contentious Group (BNG)	- Radio Frequency Heating and Ohmic Heating, hereafter referred to as **Thermal Technologies** - High Voltage Pulsed Electric Field and High Intensity Ultrasound, hereafter referred to as **Non-thermal Technologies**	Apathetic.	Most likely benign, and similar to conventional alternatives processing methods. Process orientated.
Product & Service Orientated Group (PSOG)	- **Functional foods** - **Nutrigenomics and Personalised Nutrition Products** (PNPs)	Along a spectrum from potentially emotional (in both a positive and negative direction) to apathetic, depending on the specific service/ product.	Potentially benign, beneficial, and/or contentious, depending on the product/ service in question. Product and service orientated, and market driven.

13 Where nanotechnology is referred to throughout this work, it is generally in the context of its food applications. For the purposes of this dissertation, 'nano foods' refer to foods and food packaging produced using nanotechnology.

Figure 4.1 depicts where the selected technology groups lie along two spectrums. These entail: 1) predicted public (emotional versus apathetic) reactions; and, 2) the technology groups' expected characterisations, i.e. science/ technology/ process orientated versus product/ consumer orientated. It is noted here, and discussed further in Chapter 9, that a different study may not have grouped nutrigenomics/ PNPs and functional foods together. In lieu of this particular grouping, an alternative approach may have been to include two separate product/ consumer orientated and market driven technology clusters, each of which could have been expected to result in emotional and apathetic reactions respectively. The PSOG examined is expected to cuts across *both* types of reactions.

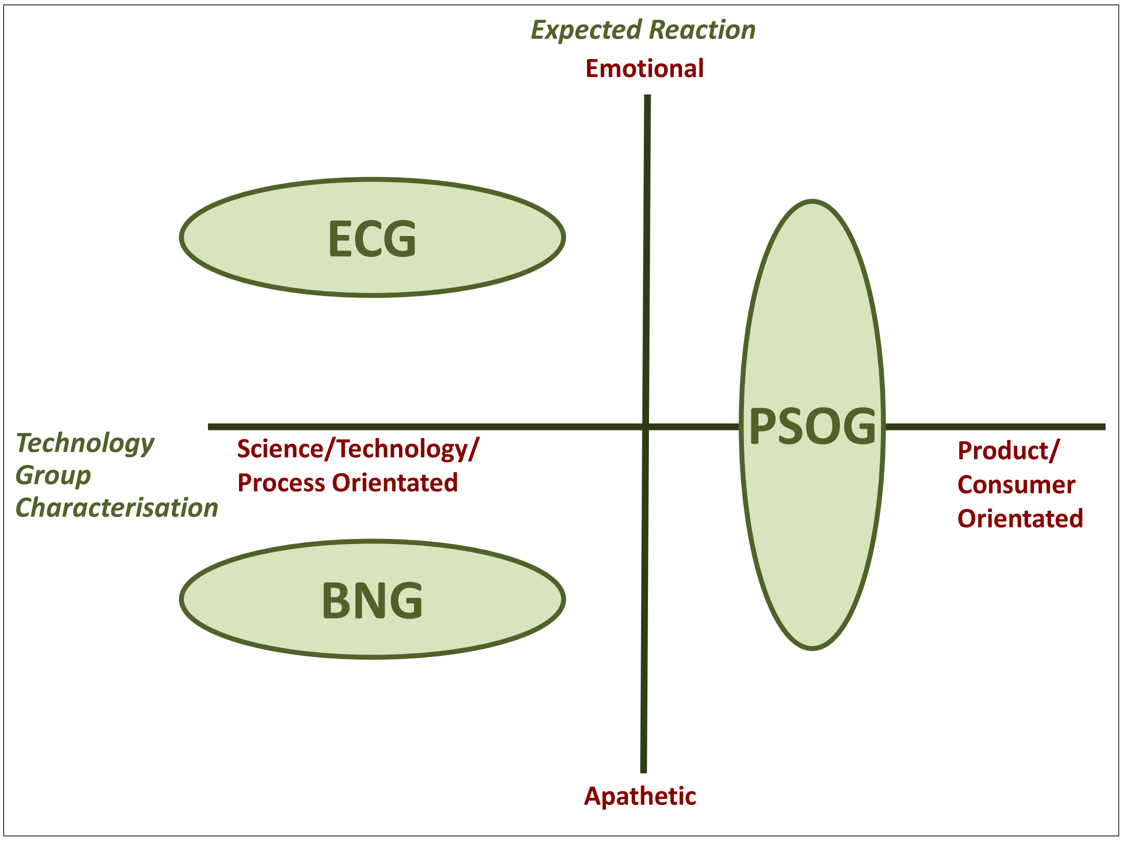

Figure 4.1: *Technology Groupings based on Expected Reactions and Characterisations*

Futher discussing the profile of each technology set, the ECG is particularly influenced by emotional reactions and affective responses (Fell et al., 2009), and has the potential for contention from a public acceptance perspective (Costa-Font & Gil, 2009; Frewer et al., 2011). Thus, while the three technologies included in this cluster differ in terms of public awareness, novelty, proximity to market and the techniques they apply; they face many similar challenges *vis-á-vis* gaining public acceptance (Fell et al., 2009; Rollin et al., 2011).

In contrast, the BNG, which has already been applied within food production to varying degrees (Nielsen et al., 2009; Pereira & Vicente, 2009), is considered more attenuated and non-controversial (Fell et al., 2009). These processing technologies are also often positively compared to conventional alternative methods, such as pasteurisation (Olsen et al., 2010). In addition, the ECG and BNG are process oriented, with their application not necessarily resulting in discernible differences in associated products, subject to labelling requirements.[14]

Since PNPs are essentially more scientifically advanced and targeted forms of functional foods (Ronteltap et al., 2007), the technologies included in the PSOG fit well together. Moreover, each of these technologies is health focused and therefore potentially positively perceived, due to possible emotional responses around suggested health benefits. Certain functional foods have been available on the market place for some time (Weststrate et al., 2002), while nutrigenomics and PNPs are relatively new concepts (Ronteltap et al., 2009; Fallaize et al., 2013). However, each of these technologies is market driven and product (or service in the case of nutrigenomics) oriented (Stewart-Knox et al., 2013). They also span all food product categories (Siró et al., 2009) and are associated with health and lifestyle orientated products.

Grouping the technologies in this way enabled depth of analysis across a wide breadth of technologies (Merriam, 2009). It facilitated systematic exploration of emergent evaluative patterns across both controversial and non-controversial technologies, thereby addressing Gupta et al.'s (2011: 791) call for further exploration as to *"why some technologies become societally controversial, whereas others do not".* Having provided a description of and justification for the technology selection and groupings, the next section provides an overview of the data collection procedures employed.

14 At present, European regulations specify that GM and irradiated foods, or foods contain such ingredients, must be labelled accordingly. In the context of nano foods, it is proposed that under EU Food Information Regulations, any permitted ingredient contained in food or drink in the form of engineered nanomaterials must be indicated as such on the packaging (European Parliament and of the Council, 2011). However, this legislation is currently under review (Nanotechnology Industries Association, 2014). Regulatory issues surrounding nanotechnology applications to food are an issue of on-going debate. Finally, foods produced or processed using thermal or non-thermal technologies do not need to be labelled accordingly.

4.6.2 Overview and Justification of the Data Collection Process - The Deliberative Discourse Approach

This section presents the rationale for the chosen research approach and the decisions made at the different stages of the process. Careful reflection on and planning of how best to introduce relevant information to citizens, to capture their reactive and reflective responses and thought processes around these technologies, was undertaken. The approach taken had to enable observance of meaningful patterns, in the context of citizens' technology evaluations, and be in keeping with the principles of good qualitative research.

Appendix 4.1 presents a contextual background, by providing an overview of historic perspectives on engaging with the public on scientific issues. It then discusses the different research approaches applied to date to establish citizens' attitudes towards specific topics, including NFTs. These approaches include focus groups (Krueger, 1988; Kitzinger, 1994; Kuznesof & Ritson, 1996; Lunt & Livingstone, 1996; Grove-White et al., 1997; Morgan, 1997; Lampila et al., 2009), consensus conferences (Einsiedel & Eastlick, 2000; Kleinman et al., 2007; Powell & Kleinman, 2008), citizens' juries (Einsiedel & Eastlick, 2000; Rowe & Frewer, 2000) and DEliberate Meetings Of CitizenS (Democs) (NEF, 2005, 2006; Bruce, 2007, 2010). This Appendix highlights the benefits and drawbacks of each approach, which are summarised in Table 4.3.

Table 4.3: *Research Approaches applied to establish Citizens' Attitudes towards Specific Topics*

Approach *(note: all of these approaches focus on the group perspective)*	**Outcome**	**Weaknesses**	**Strengths**
Focus groups (Number of participants varies)	Establish perspectives on a particular issue (Krueger, 1988)	Individuals' attitudes are directly influenced by 'groupthink' (Janis 1972; Chioncel et al., 2003; Hollader, 2004) and views of peers (Morgan, 1997). Establish attitudes as they are, rather than observing how they might evolve with new information.	Not concerned with reaching a particular conclusion. Provides immediate insight into the impact of social influences.
Citizens' juries (which draw on the premise and several practices of a legal trial by jury) and consensus conferences (Citizens' juries: panel of 12-20 lay citizens) (Consensus conferences: group of 10-16 citizens)	Achieve a majority consensus among a group of participants or a particular outcome (Powell & Kleinman, 2008; Kleinman et al., 2011)	Focus on achieving a consensus among a group of participants, which may involve influencing the attitudes of some participants and differences in participants' opinions being masked.	Extend beyond simply gauging attitudes, to exploring determinants underlying perspectives. Facilitate the provision of information which participants are asked to question and form opinions on. Thereby, citizens partake in a process of learning about the topic (Kleinman et al., 2007). Provides immediate insight into the impact of social influences and information provision. Considered an effective means of engaging in public participation about specific topics.
Democs (interactive conversation-based card games, where information is revealed through distribution of different cards) (Usually involves 6-8 lay citizen 'players')	Stimulate discussion, learning and a subsequent (potentially divergent) vote on the specific issue (NEF, 2005; Bruce, 2007)	Information provided is limited to what is written on the cards, due to the lack of an expert or facilitator. This can present challenges, given the information's complex nature. Voluntary participation potentially leads to over-representation of particular interest groups.	Aim is not to achieve a consensus. Extend beyond conventional focus groups through information provision (the game cards). Accessibility and flexibility, and does not require the presence of external experts/ facilitators, thereby requiring less formal planning/ co-ordination. Provides useful insight into public views regarding particular issues (Bruce, 2007, 2010).

More recently, Bell et al. (2005) developed a novel method of interacting with citizens, which encompassed a type of discourse exchange involving observations of one-to-one interactions between lay citizens and scientific experts. This approach focused on attitude formation following information provision at the individual level. The purpose of this approach was to explore its potential as a means of facilitating and investigating learning between individuals from different backgrounds, and the impact of this interaction on lay citizens' perspectives on the scientific/ environmental issues discussed and participating scientists.[15] This discourse exchange provided some valuable insight, in terms of exploring a new form of deliberative interaction, which minimises the immediate impact of social influences on attitude formation. Furthermore, relative to the methods of interaction previously outlined, several of which focus on facilitating a particular outcome, Bell and colleagues' approach enabled an exploration of how the perspectives of individuals and experts can differ on scientific issues and how they interact in this one-to-one environment.

Consequently, this discourse exchange approach offers an interesting point of departure, in terms of designing an approach to interacting with citizens about NFTs. This approach offers many benefits that fit with the key research goals. Specifically, it provides depth, in comparison to other methods of interaction, including focus groups, in the context of understanding the evolving perspectives of an individual, as information is presented. This type of discourse approach allows for information to be introduced in a staged manner. Responses to this information by the individual can then be observed in a controlled environment, without the direct effect of 'groupthink' (Janis, 1972; Chioncel et al., 2003), which aligns with the aim of exploring attitude formation at the individual level. Hollader (2004: 610) describe how 'groupthink' *"involves a "bandwagon effect" where people endorse more extreme ideas in a group than they would express individually"*.

Drawing from Bell and colleagues' approach, the specific discourse exchange that formed the basis for data collection in the current study was a one-to-one 'deliberative discourse' between a citizen and an information provider, where they discussed a technology. Henriques et al. (1984: 105) consider discourse to encompass *"the way in*

15 The issues covered within these exchanges included genetic modification, local environment, climate change, energy, biodiversity and animals, and land use and the countryside. Each participating lay citizen completed six rounds of exchanges on each of these six topics.

which things are discussed and the argumentation and rhetoric used to support what is said". For the purposes of this research, a deliberative discourse is defined as a structured, interactive conversation, during which a question or issue is discussed and examined in detail.

Reflecting on Bell et al.'s (2005: 33) recommendation to focus future discourse exchanges on *"a single (more narrowly defined) topic"*, each deliberative discourse undertaken focused on only one technology. Discussing more than one technology in sufficient detail to reveal the underlying features directing individuals' attitudes and reflective stances would not have been feasible within reasonable time constraints. Although participants discussed different technologies, a common approach was applied to facilitate data comparability. For instance, while the examples discussed were technology specific, the issues arising were (relatively) common across the technologies. This commonality facilitated comparative analysis across the particular technologies and technology groups.

Since attitude formation and change relate to information provision and processing, it was important to carefully reflect upon what technology specific information should be presented to citizens. To this end, several academics (e.g. Cook & Fairweather, 2007; Siegrist et al., 2007a; Cacciatore et al., 2011; Frewer et al., 2013, 2014) have noted that studies of public perspectives on NFTs often examine attitudes in a general sense, rather than towards explicit applications, which may vary considerably. Elsewhere, Fischer et al. (2013) have argued that risk and benefit information play important roles in directing evaluations of novel technologies. Furthermore, Bell et al. (2005: 33) suggest that further applications of a discourse type of exchange between individuals should include *"methodological developments"*; namely the presentation of arguments (information), which individuals can react to in an elaborative way. Building upon these arguments, the objective was to design an exchange between a citizen and another individual where; 1) information requirements would be dealt with when needed; 2) changing views could be accommodated; and 3) underdeveloped citizen awareness of NFTs could be addressed. The content of the risk/ benefit information that was presented during the discourse is outlined in turn.

Given the potential impact of information source on citizen perspectives (e.g. Bruhn, 1998; Renn, 2003; Scholderer & Frewer, 2003), as previously outlined, it was important to select the most suitable type of individual to impart this information, to meet these objectives. The information provider needed to display confidence in their understanding of the technology, be credible and have an ability to respond to a broad range of technology specific questions. Otherwise, the quality of the data collected could be compromised. Thus, scientists with relevant expertise in one of the technologies were selected to participate in the interactions with the citizens, as they could respond to and expand upon any questions posed, and provide scientifically accurate information (Kleinman et al., 2007).[16] Their direct (or indirect) involvement with the technology, and thereby tactic knowledge, meant that they were the most appropriate person to engage with, and provide relevant information to, the citizen. From a communication perspective, scientists are informed, and relatively trusted, conveyers of information. Nonetheless, they may also use academic and technical language and jargon and be 'held in awe'. Hence, their involvement provided the best, but not ideal, opportunity of facilitating 'delayering' of attitude formation and information contextualisation processes. Furthermore, their involvement guided individuals towards more reflective types of responses.

The scientist was essentially the 'lead actor' in this discourse performance (Goffman, 1959). They were 'equipped' with a 'script' (the Discourse Guide and hypothetical scenarios, discussed in turn) to work from, in order to establish participants' reactions and responses towards specific information. The deliberative discourse mechanism essentially created a 'stage', where two individuals from different backgrounds, in terms of their expertise and possibly life experiences (Bell et al., 2005), acted out particular 'roles' (Davies & Harré, 1990).

Building upon the concept of role enactment, theories of practice as described by Warde (2005: 138) emphasise processes, such as tactic knowledge, positioning in practice, routine and habituation:

---

16 Within Bell et al.'s (2005) study, the participating scientific experts were not necessarily professionally familiar with the topics they discussed. The participating scientists often emphasised, and somewhat struggled with, this fact during the course of the interactions. Bell and colleagues therefore recommend that any future applications of this type of discourse exchange involve experts who have *direct* involvement in the issue under discussion.

> *"Social practices do not present uniform planes upon which agents participate in identical ways but are instead internally differentiated on many dimensions (...) depend[ing] on past experience, technical knowledge, learning, opportunities, available resources, previous encouragement by others, etc."*.

Warde elaborates on this concept by describing how various agents, the citizen and scientist in this case, may act and react differently based on their roles and positions within practice, which may impact the *"potential contribution of agents to the reproduction and development of the practice"* (*Ibid*). Hence, theories of practice are concerned with appreciating the varied roles that meaning, understanding, *"know-how"* and verdict play in shaping individuals' perspectives on and participation in different practices (*Ibid*: 147). These variables are important to reflect upon in the context of the current research aims and approach.

The deliberative discourse was not a naturalistic environment. This point withstanding, in recognition that attitude formation can occur in *"haphazard ways"* (Druckman & Bolsen, 2011: 660), this interaction enabled a detailed exploration of citizens evolving attitude formation and information processing mechanisms around NFTs, rather than establishing overall general technology appraisals across a large sample group. Analytic, rather than statistical generalizability was the objective of this qualitative study (Hyde, 2000). The approach therefore provided depth of analysis across a wide breadth of technologies (Merriam, 2009). It enabled exploration of attitude formation around technologies, which individuals are both familiar and unfamiliar with (Tenbült et al., 2008a). Furthermore, this data collection mechanism ensured the technology was brought to the forefront of citizens' consciousness, to iteratively reveal how individuals construct meaning around (Goffman, 1974), and engage in the practice of consuming (Warde, 2005), information.

Davies and Harré (1990: 45) have described how *"a conversation unfolds through the joint action of all the participants as they make (or attempt to make) their own and each other's actions socially determinate"*. The deliberative discourse was, in effect, a dialogue between those directly involved in the production of knowledge and the audience for whom meanings associated with this knowledge are just as, if not more, important that the knowledge itself. In keeping with a constructionist ethos (Steedman, 2000), the focus was on the construction and understanding of knowledge, rather than its creation (Andrews, 2012).

Posing explicit closed-ended questions in a non-interactive format results in rational, reason-based responses, which may conceal *"not only the symbolic but also the emotional and experiential material that drives cognition and behaviour"* (Joffe, 2011: 212). This discourse approach moves away from the quantitative positivist approach, as well as the more traditional in-depth interview where a direct 'questioning and answering approach' often forces participants to provide definitive answers. The approach adopted supported both reactive *and* reflective types of 'multidimensional' response (Davies, 2011), and facilitated questioning and reflection by participants. It thereby provided the opportunity to observe the 'unfolding' of citizens' thought processes on and attitudes around these technologies. This approach also proffered the opportunity to reveal the multiple, potentially interdependent, influences directing technology evaluations as information was presented (Bell et al., 2005). In doing so, it enabled exploration of individuals' integration of new information with prior knowledge to form attitudes.

While a detailed set of procedures were specified to add to the credibility and dependability of data collection, the discourse approach offered flexibility in terms of the two-way nature of this interaction. The structure and format of this methodological approach were clearly defined in consultation with the dissertation supervisors, as part of a reflective research design procedure. Standard Operating Procedures (SOPs) (included in Appendix 4.2) were specified for each stages of data collection, to ensure structure and consistency to the process (Lewis, 2009) and the credibility and dependability of this research. The SOPs facilitated minimisation of the impact of external factors, in addition to the likelihood of experiencing any significant data collection problems.

Data collection was completed by the researcher (25 of the 42 discourses and post-discourse interviews) and another researcher based in Teagasc Food Research Centre, Ashtown (17 of the discourses and post-discourse interviews) while they were both employed as researchers on a FIRM project (funded by the DAFM) which examined consumer and industry acceptance of NFTs. Each of the data collection stages, presented in Figure 4.2, are discussed in turn.

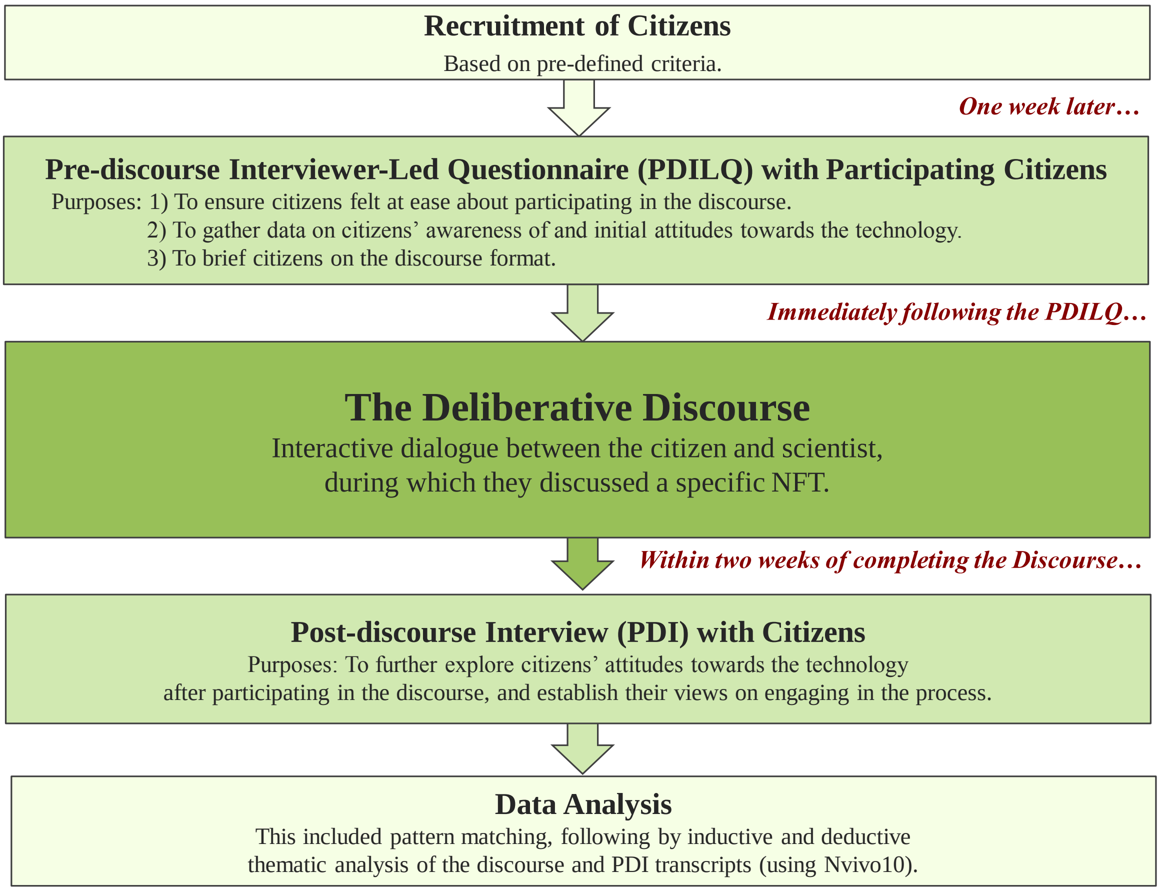

Figure 4.2: *Overview of Stages Involved in Data Collection*

4.6.3 Recruitment of and Preparatory Engagement with the Scientists

For each technology, a scientist with relevant expertise was selected to participate. Expertise was determined based on s/he either currently researching the specific technology or being familiar with it in the case of the more novel technologies, i.e. nutrigenomics and PNPs.[17] Their familiarity meant that they could comfortably respond to questions posed, thereby eliciting more questioning and facilitating more reflection and responding by citizens (Loewenstein & Schkade, 1999; Schwarz, 2008). The scientists' backgrounds varied in terms of research experience, discipline, gender and age. Each scientist participated in a minimum of five discourses. The participating scientists were therefore an essential 'cogwheel' in the data collection 'mechanism'.

17 Working on the related FIRM project while completing this dissertation facilitated gaining access to the necessary data and commitment from the relevant scientists to participate. Several of the participating scientists were involved in other FIRM projects concerning the development of specific NFTs.

Several measures were put in place to prepare each scientist for the interaction, and facilitate a comparable format and structure across the discourses. Most significantly, a detailed Discourse Guide (see Appendix 4.3) was prepared for the scientists. This guide helped the scientists to navigate through the discourse process and maintain a level of consistency. The guide provided the framework for a two-way discussion within specified boundaries. The information presented was the same in principle, while focusing on the relevant technology. Consequently, the deliberative discourse enabled flexibility in responses, while maintaining elements of structure and comparability.

As an active participant, the scientists' values were not external to the deliberative discourse. Subsequently, steps were taken to minimise the impact of their values on citizens' evaluative stances, and to aid the citizens in feeling comfortable to express their opinions. At a pre-discourse preparatory meeting with each scientist, they were asked not to explicitly declare their position or personal views on the technology during the exchange, in so far as possible. Tying into the premise of *"power differential"* between the citizen and scientist (Foucault, 1972; Kleinman et al., 2007: 155; Davies et al., 2009); since language used within social and cultural practices is a potentially *"contentious issue"* (Rouse, 2006: 500), the scientists were encouraged to use lay terminology when articulating related concepts, given the risk of them potentially being 'held in awe'. They were facilitated in doing so through supporting material provided, which included a summary sheet written in non-scientific language and hypothetical scenarios. Each of these documents is discussed in turn. Prior to this, the citizen recruitment criteria are outlined.

4.6.4 Recruitment of Citizens

Qualitative research *"does not seek 'generalizability' or 'representativeness' and therefore focuses less on sample size and more on sampling adequacy"* (Bowen, 2008: 140). Since a diversity of social and cultural factors influence attitude formation around NFTs (Gaskell et al., 2010; Loebnitz & Grunert, 2014), it was important to ensure the inclusion of a diversity of citizens within this research. Moreover, to enhance the transferability and dependability (Guba & Lincoln, 1982, 1989) of this work, it was necessary to recruit a diversity of citizens to participate in the discourses across the technologies. Cognisant that *"sample selection has a profound effect on the ultimate quality"* of qualitative research (Coyne, 1997: 623), and in keeping with the principles of good qualitative research, citizens were actively recruited, one week prior to data collection, based on clearly pre-defined exclusion and inclusion criteria presented in a screening questionnaire (see Appendix 4.4). To ensure that the pre-defined criteria were met, and the inclusion of a breadth of participants within each group of individuals discussing a specific technology, citizens were purposefully recruited[18] (Lincoln & Guba, 1985; Kuzel, 1992) from the general public: "…*the selection of each participant [was] contingent upon the characteristics of others already intercepted and intertwined"* (Furst et al., 1996: 249). Specifically, participants were actively recruited based on ensuring diversity across: gender; age; occupational status; educational status; marital status; parental status; and, subjective knowledge and concern about food production and processing. The explicit variation attained across these attributes is detailed in turn.

Concerning the particular inclusion and exclusion recruitment criteria, citizens were not recruited if they: were younger than 18 years of age; or, had partaken in a survey or focus group in the last six months, as these individuals may provide answers which they perceive as being the 'right answer' sought by the researcher. Citizens were also not recruited if they were employed within food marketing, research or product development areas, as this may have resulted in them having strongly formed views and/ or knowledge of the technology's food applications. Scientists by profession or training were also excluded, as their expertise may have resulted in these persons having a greater knowledge than the average lay citizen of these technologies and related scientific concepts. Furthermore, individuals were only recruited if directly involved, mainly or jointly, in food purchase decisions, as these individuals can influence the food consumption decisions of their households, and are more likely to have formed opinions about food (Zepeda et al., 2006). This criterion thereby increased the probability of participants reacting to, and having opinions on, the concepts and related trade-offs, in terms of the product attributes presented during the discourse. Throughout this dissertation, participants are described as citizens, rather than consumers, as they were asked about products and services which they may never consume or avail of.

In addition, to ensure that the interaction between the scientist and participant was maintained, it was important that the participant would have the confidence to engage

18 Purposive sampling involves the recruitment and selection of participants based on specific characteristics (Babbie, 2001).

with the scientist. Therefore, another criterion was that individuals displayed moderate to high level of generalised self-confidence, thus increasing the likelihood of good interaction with the scientist.[19] Generalised self-confidence was determined based on scoring 16 or above on a four statement agreement scale.[20] Participants' scores ranged from 18 to a maximum of 28 for this measure of self-confidence, with an average score of 24.4 across the sample. While it is recognised that screening for generalised self-confidence resulted in those with lower self-confidence being excluded from this study, breadth of perspectives across the sample was ensured in terms of socio-economic backgrounds.

Gender (Flynn et al., 1994; Finucane et al., 2000; Lee et al., 2005), age (Tucker et al., 2006; De Jonge et al., 2007; European Food Safety Authority, 2010) and education (Slovic, 1999) have been found to be significant determinants of risk sensitivity. More specific to this study and as previously mentioned, older and/ or female respondents tend to exhibit greater levels of concern about NFTs (Cardello, 2003; Moon & Balasubramanian, 2004; Costa-Font & Mossialos, 2007; Clery & Bailey, 2010; Gaskell et al., 2010). Furthermore, less well educated individuals generally display greater risk sensitivity and a tendency to worry more about food related risks (Sparks et al., 1994a: Slovic, 1999). Consequently, to ensure views were gathered about the technologies from a broad range of Irish citizens, the sample encompassed a diverse mix in terms of: age (ranged from 19-65); gender; marital status (married/ co-habiting versus single/ divorced/ separated/ widowed), being a parent or not; educational qualification (ranged from no formal secondary education to post graduate level) and occupations of each participant and their spouse/partner (if relevant) (ranged from students to retirees). Citizens discussing each technology displayed similar characteristics to those discussing the other technologies, to facilitate comparative analysis. An overview of participants' profiles is presented in Table 4.4 and a detailed socio-economic profile of each participant is included in Appendix 4.5.

19 Questions posed were adapted from a scales developed by Day and Hamblin (1964).
20 Each statement was score on a scale from 1 to 7, where 1 was disagree strongly, 7 was agree strongly and 4 was neither disagree nor agree.

Table 4.4: *Overview of Socio-economic Profile of Participating Citizens*

Variable	**Number of Participants *(n = 42)* or relevant description**	
Gender	Each grouping of individuals discussing a specific technology (which included a minimum of 5 people) comprised at least 2 males and 2 females.	
Age	Within each grouping of individuals, variety across age ranges was ensured.	
Marital Status	24 participants: married/co-habiting.	18 participants: single/ divorced/ separated/ widowed.
Parental Status	15 were parents of children that they cook and food shop for.	27 were not.
Level of Education	Within each grouping of individuals, at least one participant's highest level of education was secondary school and at least one's was a third level degree.	
Occupational Status	Each grouping included individuals with various occupation statuses and occupations.	

Given the objective of ensuring data saturation at the population level, and the fact that attitudes towards food and food processing influence evaluations of NFTs (Clery & Bailey, 2010), it was important to: 1) establish levels of subjective knowledge and assess concerns about food production/ processing; and, 2) ensure recruited participants held diverse perspectives about food and food processing. Thus, relevant measures were included in the screening questionnaire. Variety was ensured (i.e. responses ranged from 2 to 7[21]) in terms of reported understanding ($\bar{x}$ = 5.4) and concern about food production ($\bar{x}$ = 5.0). Pertaining to food seeking behaviours, diversity was also attained in terms of the extent to which individuals consider themselves to search for natural ingredient ($\bar{x}$ = 5.4) and pursue organic food products ($\bar{x}$ = 3.2). In addition, both those reporting themselves as being suspicious and unsuspicious about food products promising additional health benefits were recruited (with responses ranged from 1 to 7; $\bar{x}$ = 4.8).

A monetary incentive (€50 cash payment or voucher) was provided to citizens to participate in the study, about which they were informed at the recruitment stage.[22] This incentive was provided to ensure participants completed each stage of data collection.

Ethical approval was sought for this research and received in March 2010 from the University College Cork Social Research Ethics Committee.[23] All of the documentation pertaining to data collection, i.e. the screening questionnaire, the pre-discourse

21 Scale was from 1 to 7, where 1 was disagree strongly, 7 was agree strongly and 4 was neither disagree nor agree.
22 The relevant FIRM funded project provided funding for citizen recruitment.
23 Ethical principles including informed consent and anonymity were adhered to in undertaking this research.

interviewer-led questionnaire, post-discourse interview guide and Discourse Guide for participating scientists, was included with the ethics application (see Appendix 4.6). Informed consent was received from all participants (the relevant form is included in Appendix 4.7). Having outlined the recruitment process, the next section discusses sampling and theoretical saturation issues.

4.6.5 Sample Size

Aligned with reaching theoretical saturation (Lee et al., 1999), a key consideration was the sample size, which was determined based on resource constraints. Given such constraints, it was necessary to set a target number of interactions with citizens in advance of commencing data collection.

Building on the work of Glaser and Strauss (1967) and Strauss and Corbin (1998), Bowen (2008: 139) argues that data or theoretical saturation is *"integral to naturalistic inquiry"*. Theoretical saturation is effectively *"the point at which no new insights are obtained, no new themes are identified, and no issues arise regarding a category of data"* (*Ibid*: 140). Hyde (2003: 48) contends that although no definitive rules reside in terms of the determination of saturation, *"it needs to be derived from a coherent and rigorous process of data condensation and interpretation that accounts for all possible explanations"*. To this end, Bowen (2008) recommends explicitly stating the steps taken to confirm data or theoretical saturation.

The ECG was selected for initial analysis, given its greater potential for controversy and thereby emotional reactions (Fell et al., 2009; Gupta et al., 2011), which are expected to contribute to a variety of features influencing attitude formation around this set. In addition, as highlighted by Fell et al. (2009), genetic modification, which is included in this group, is often used as a benchmark technology when exploring perspectives on other technologies. Subsequently, a quota of a minimum of 17 interactions was set for this technology group, to increase the likelihood of reaching theoretical saturation for this cluster. This number was pre-defined based on the suggestion of Bertaux (1981) and Guest et al. (2006) that theoretical saturation in qualitative research can be reached between 12 and 15 in-depth observations. Subsequently, the target number of the other technology groups was set at 15 interactions. However, no new features appeared to be influencing attitude formation around the BNG, i.e. theoretical saturation seemed to have been achieved, following seven interactions for this group. Subsequently, data collection of the processing technologies ceased after ten interactions. Hence, 15 and ten interactions were completed for the PSOG and BNG respectively.

Concerning the overall sample, 42 citizens were recruited in total. This overall figure was guided by theoretical views about saturation, the target sample and checking for theoretical saturation during data analysis.

4.6.6 Stages Involved in Data Collection

Before and after participating in the deliberative discourse, citizens completed a pre-discourse interviewer-led questionnaire (PDILQ) (questionnaire included in Appendix 4.8) and a post-discourse interview (PDI) (interview guide included in Appendix 4.9) with the researcher; the purposes of which are outlined in due course. The main data collection stage was therefore supplemented with two additional interactions with participants. This multi-method approach thereby involved three interactions with each participant. The pre-discourse and post-discourse data collected were part of the overall dataset analysed, in order to ensure observation of patterns in the context of citizens' evolving attitude formation and information processing around the technologies.

The open-ended questions included in the PDILQ and PDI guide enabled the researcher to ensure the conversation focused on the specific technology, while encouraging participants to elaborate on issues relevant to the subject matter. Probes (e.g. 'please explain why you feel this way') were used to elicit additional information on emerging issues (Guba & Lincoln, 1989). The sections that follow provide an overview of each stage of data collection.

4.6.7 Pre-Discourse Interviewer-led Questionnaire

The PDILQ (see Appendix 4.8) included both open-ended and close-ended questions and took approximately 10 minutes to complete. The objectives of this initial interaction with participants were to:

1) ensure they felt at ease about their participation in the discourse;
2) gather data on how participants' viewed the technology prior to the introduction of information, particularly their awareness/ knowledge of and initial attitudes towards the technology; and,

3) familiarise them with the format that the discourse would take, and clarify their role in the process, thus ensuring they were adequately prepared to engage in the two-way interaction.

In order to gather some information on participants' initial perspectives on the selected technologies, awareness of and attitude towards them and willingness to purchase associated food products were measured through close-ended questions. Following this, open-ended questions explored participants' attitude towards the specific technology that they would be discussing in detail. These questions concerned: what, if anything, they had heard about the specific technology; what connotations (positive or negative) they associated with it; and whether, given their current level of awareness of it, they would purchase/ consume associated products. The initial responses and attitudes recorded formed part of the qualitative dataset.

In an attempt to minimise the impact of external factors, participants were recruited *"topic blind"* (Townsend & Campbell, 2004: 1391) to control for proactive information searching on the technology they were assigned to discuss. Instead, in an effort to make sure they felt comfortable posing questions and expressing their opinions, it was stressed to them that they were not expected to be familiar with any of the technologies. At the end of completing the PDILQ, participants were informed about the format of the discourse and encouraged to express their honest opinions and reactions to the questions that the scientist would pose. Although the participants did not have the opportunity to familiarise themselves with the technology in advance, they were informed and clearly understood the format that the discourse would take.

As previously outlined (see Section 2.3), public awareness of NFTs is generally low (e.g. Fell et al., 2009). Berger and Luckmann (1966) speak to the influence of subjective knowledge on both the actions and perceptions of social actors during the act of deliberation. To this end, the study by Bell et al. (2005: 30) found that perceived *"inequalities of knowledge and status"* somewhat influenced the deliberative exchanges undertaken between lay citizens and scientific experts. Consequently, as a means of attempting to minimise any perceived 'power/ knowledge differentials' between the citizen and scientist (Foucault, 1972; Kleinman et al., 2007) during the discourse, participants were given a summary sheet to read immediately prior to the discourse. This sheet included some factual, neutral information about the relevant technology (each summary sheet is presented in Appendix 1.2).[24] The information on each technology is similar in content and structure to that provided by Siegrist et al. (2009) in a conjoint study on food applications of nanotechnology.

These summary sheets were distributed as a means of ensuring participants: 1) had a minimum standard level of information and basic awareness about the technology prior to the discourse; and, 2) could engage in the two-way conversation with more confidence. Hence, their distribution was a mechanism of facilitating *"adequate citizen preparation"* for the deliberative discourse (Kleinman et al., 2007: 165; Kahan et al., 2009). The information contained in each summary sheet was a platform from which the citizen could converse with the scientist. During the deliberative discourse, the scientist was able to clarify and build upon this information.

The PDILQ and deliberate discourses were completed at the relevant university (either UCC or UCD) or Teagasc Food Research Centre, depending on the work location of the participating scientist.

4.6.8 The Deliberative Discourse Process

As previously indicated, the discourse commenced immediately after the participant had reviewed the summary sheet. The researcher observed the deliberative discourses as an inactive non-participant observer (Casey, 2007). Other qualitative methods, such as ethnography[25], often involve active researcher participation in a social context. In contrast to these 'active' methods, the researcher was (relatively) uninvolved in this deliberative exchange. However, their presence meant that they were not completely external to the process. The scientist was the person chosen to interact directly with the citizen, given their relevant expertise which enabled them to best respond to and expand upon specific questions posed. Thus, as previously asserted, their involvement supported reactive *and*

---

24 The summary sheets were piloted on a range of individuals from different socio-demographic backgrounds to ensure clarity and comprehension. The sheets were also circulated to the relevant participating scientist for review and comment. In spite of a conscious effort to ensure the presentation of neutral unbiased information on each technology, it is recognised that the presentation of completely neutral information about scientific issues is problematic since the decision to include or exclude certain facts is guided by one's ideological beliefs and perspectives (Sturgis et al., 2010).

25 Ethnographic studies are cultural descriptions that illustrate how individuals describe and structure their world (Marshall & Rossman, 1994; Agar 1996).

reflective participant responses. Observational notes were taken by the researcher during the discourse, as part of the reflexive research process (Baxter & Jack, 2008).

Each discourse commenced with the scientist explaining the technology and its potential food applications using ‘lay’ terminology. The participant considered the initial information provided, i.e. the summary sheet, and questioned the scientist on this. The scientist then added information that the participant reacted to and reflected upon. Throughout this two-way interaction, the participant had the opportunity to question the scientist on any aspect of the technology about which they were unclear. An excerpt from one of the nanotechnology discourse transcripts is included in Appendix 4.10 to illustrate the format of this interaction.

As previously outlined, many challenges are encountered when attempting to measure attitudes towards situations and objects, including self-norming and lack of introspection of true feelings in the context of responses (Loewenstein & Schkade, 1999; Schwarz, 2008). This work is concerned with overcoming attitude measurement challenges and understanding the potential influence of product characteristics on individuals’ potential multiplicities of attitudes (Wood, 2000) formed around different technology applications. Given this aim, the scientists presented a number of hypothetical scenarios of various applications of the technology.[26&27] Assuming that attitude formation is guided by both affect- and cognition-based responses (Edwards, 1990; Ortony et al., 2005), information was presented within these scenarios to generate both reactive (automatic) and reflective (controlled) types of responses (Bargh, 1994; Conrey & Smith, 2007). This approach thereby supported introspection (Hoffmann et al., 2005; Tenbült et al., 2008a; Bohner & Dickel, 2011) by participants, in the context of the features guiding their attitudes. Furthermore, presentation of these pre-defined scenarios facilitated comparative analysis of citizens’ perspectives and underlying evaluative influences at technology specific and group levels.

26 The scenarios were developed following a review of literature, deliberation among the FIRM research team, which included the researcher and dissertation supervisors, and consultation with the participating scientists (during preparatory meetings and via phone and email) to elicit their expert opinions on the varying applications and benefits and risks associated with the particular technology.

27 The scientists stressed that the scenarios were hypothetical, so as to ensure citizens understood that the risks and benefits presented were only discussion points and some of the product examples are unavailable on the market at present.

Information can be communicated in episodic or thematic (abstract and general) terms (Iyengar, 1991; Scheufele, 2000). The type of information presented within the scenarios was predominately episodic in nature, since concrete examples of hypothetical foods produced using applications of the technologies were presented. However, thematic contexts were also explored, particularly in the case of the more novel, and therefore abstract and conceptual technologies, i.e. nutrigenomics and PNPs. Concerning the more familiar of the technologies examined, such as functional foods, the scenarios relayed included novel applications.

Naturally, the discussion within each group of individuals discussing a specific technology centred on the product attributes and application that each scenario focused on. Importantly, all of the scenarios (summarised in Table 4.5 and detailed in Appendix 4.11) had a similar overarching framework to support deductive analysis (discussed in turn). To this end, across all of the scenarios, hypothetical two-sided claims (Renton, 2008; Druckman & Bolsen, 2011) were incorporated about benefits, negative aspects and known and unknown risks of different applications of the technology, from a consumer, societal, environmental and industry perspective.

Table 4.5: *Overview of Hypothetical Scenarios of Applications of the Technologies*[28]

NFT	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Genetic Modification	Food processing: using a GM processing aid in cheese production in place of rennet.	Agricultural production: growing GM wheat crops.	Animal production: breeding a GM pig (that is healthier and more environmentally friendly).	Food production: enhancing foods (e.g. shelf life and health characteristics of fruits) through genetic modification.
Nanotechnology	Food processing: removing unhealthy ingredients without compromising taste.	Food processing: adding healthy ingredients without compromising taste.	Food packaging: to increase shelf life and indicate food spoilage etc.	Food production: 'nanocoatings' on machinery to increase food safety and reduce the need for cleaning agents.
Food Irradiation	Irradiating fresh fruits and vegetables (at low doses) to prolong shelf life.	Irradiating spices (at low-medium doses) to kill insects/ reduce micro-organisms and bacteria.	Applying irradiation (at medium doses) to meat products to kill disease causing micro-organisms (e.g. E-coli).	Applying irradiation (at high doses) to sterilise foods for consumption by specific consumer groups.
Thermal Technologies	Food processing: applying Ohmic Heating (OH) in peeling fruits and vegetables (e.g. tomatoes for inclusion in sauces).	Food processing: applying OH to preserve canned foods (e.g. sweet corn).	Food processing: applying Radio Frequency (RF) heating to dry (post-bake) biscuits, crackers and other snack products.	Food processing: applying RF heating to cook meat (for industrial slicing).
Non-thermal Technologies	Food processing: applying Pulsed Electric Field (PEF) to extract juice from fruit.	Food processing: applying PEF to preserve liquid foods (e.g. fruit juice).	Food processing: applying High-Intensity Ultrasound (HIU) to emulsify and homogenise products (e.g. a yoghurt based fruit smoothie).	Food processing: applying HIU to extract bioactives from plant sources (e.g. potato peel to use as an ingredient in cereal bars).
Functional Foods	Food processing: adding functional ingredients to foods to enhance (gut) health.	Food processing: adding functional ingredients (and drugs) to foods to prevent/treat disease.	Food processing: creating 'cosmeceuticals' i.e. adding functional ingredients to foods with 'beautifying' benefits.	Food production: adding functional ingredients to animal feed (e.g. cattle) to produce healthier foods products (e.g. beef).
Nutrigenomics and PNPs	Genetic testing of individuals and provision of dietary advice to reduce/ prevent diet related diseases.	Developing personalised nutrition products that have associated health benefits.		

28 The specific risks and benefits associated with each of these scenarios are presented in Appendix 4.11.

Presentation of the scenarios enabled unveiling of individuals' attitude formation processes around the different applications, concepts and products presented. Each scenario built upon itself, and expanded upon the previous one, as part of an iterative process. Expanding on the scenarios in this way enabled an understanding of citizens' *"flexibility or 'fluidity' of positioning"* (Murphy, 2008: 72), in terms of their evolving attitudes towards the technology and associated applications and product concepts in question.

Similarly to the argument forwarded by Macoubrie (2006), there was no expectation that the presentation of these scenarios would result in specific pre-empted responses. Rather, it was postulated that individuals would draw on various general attitudes and values to provide unique and varied responses and reactions towards the information presented. Citizens were probed at each stage of scenario expansion to establish their reactive and reflective standpoints, in addition to any changes in their attitudes in light of additional information. Examples of such probing questions are included in Table 4.6.

Table 4.6: *Examples of Questions Posed to Citizens during Presentation of Scenarios*

Based on this (additional) information:	
1	What is your opinion about using the technology in this way? Why do you feel like this?
2	Would you be open to the supply of this type of food product in Ireland and if so, why?
3	Would you purchase/ consume foods produced in this way and if so, why?
4	Would you have any concerns about this type of food product and if so, what concerns would you have?
5	What kinds of people do you think would be interested in such food products, and why do you think so?
6	Has this additional information changed your views in any way? Why is this?
9	In your opinion, should industry adopt this technology? Why do you feel this way?

> *"A good qualitative researcher moves back and forth between design and implementation to ensure congruence among question formulation, literature, recruitment, data collection strategies, and analysis"* (Morse et al., 2002: 17).

In keeping with Moore's recommendation, two pilot discourses, and associated PDILQs and PDIs, were completed. Initial analysis of these transcripts indicated that the proposed format of these interactions was an effective means of revealing citizens' attitude formation processes around the technologies, and associated influencers and nuances. The pilot PDIs, and debriefing with the participating citizens and scientist, also suggested that they felt comfortable in freely engaging with each other. The scientist in the pilot discourses did not participate in the other discourses. However, the pilot data are included in this analysis, as no significant alterations were made to the approach following the pilots.

Across the sample, discourses ranged from 32 to 72 minutes in duration and averaged 52 minutes. They were audio recorded and later transcribed verbatim by a commercial transcription company. The transcriptions include features potentially pertinent to interpretation of their content, such as pauses and laughter. This added to data authenticity (Davidson, 2009), thereby strengthening the credibility of the data collected.

4.6.9 Post-discourse Interviews with Citizens

As a follow-up interaction, a debriefing interview took place with each citizen (see Appendix 4.9 for the relevant interview guide) within two weeks of completing the discourse. These interviews lasted between 18 and 48 minutes, and averaged 25 minutes. The purpose of these interviews was to establish participants' attitudes towards the technology following their participation in the discourse, and their views on engaging in the process. In the context of 'power/ knowledge differentials' previously outlined, this interview was a means of probing whether participants felt at ease expressing their views to the scientist during the discourse.

Although the main goal of this work is to examine attitude formation as information is revealed, these debriefing interviews enabled further exploration of citizens' reflective responses towards these technologies. Participants' attitudes towards the technology, including perceptions about associated risks and benefits, following the discourse's completion, were established. During this interview, participants also indicated whether their attitudes had changed during and since the discourse and if so, in what way(s). In addition, their views on the regulation and labelling of associated products were ascertained. Whether participants had looked for more information on the technology, in the time that had lapsed since partaking in the discourse, was also determined. Furthermore, their perspectives on partaking in the discourse process were established.

Specifically, participants provided feedback on: their opinion on the scientists' explanation of the technology; how comfortable and confident they felt expressing their views during the discourse; how they felt the scientist reacted to their views; and, whether the discourse had impacted their level of understanding of the technology. Finally, their more general views on the current level of information available and communicated to the public about NFTs were determined.

4.7 Data Analysis

In keeping with the principles of credibility and confirmability, Bowen (2008) and Whiteley et al. (2003) reinforce the importance of explicitly reporting data analysis procedures adopted. Data analysis encompassed three different stages, as outlined in Figure 4.3. The overall aim of employing this analytic approach was to develop a comprehensive understanding and appreciation of attitude formation and information processing around these technologies, and the complexities associated with these activities.

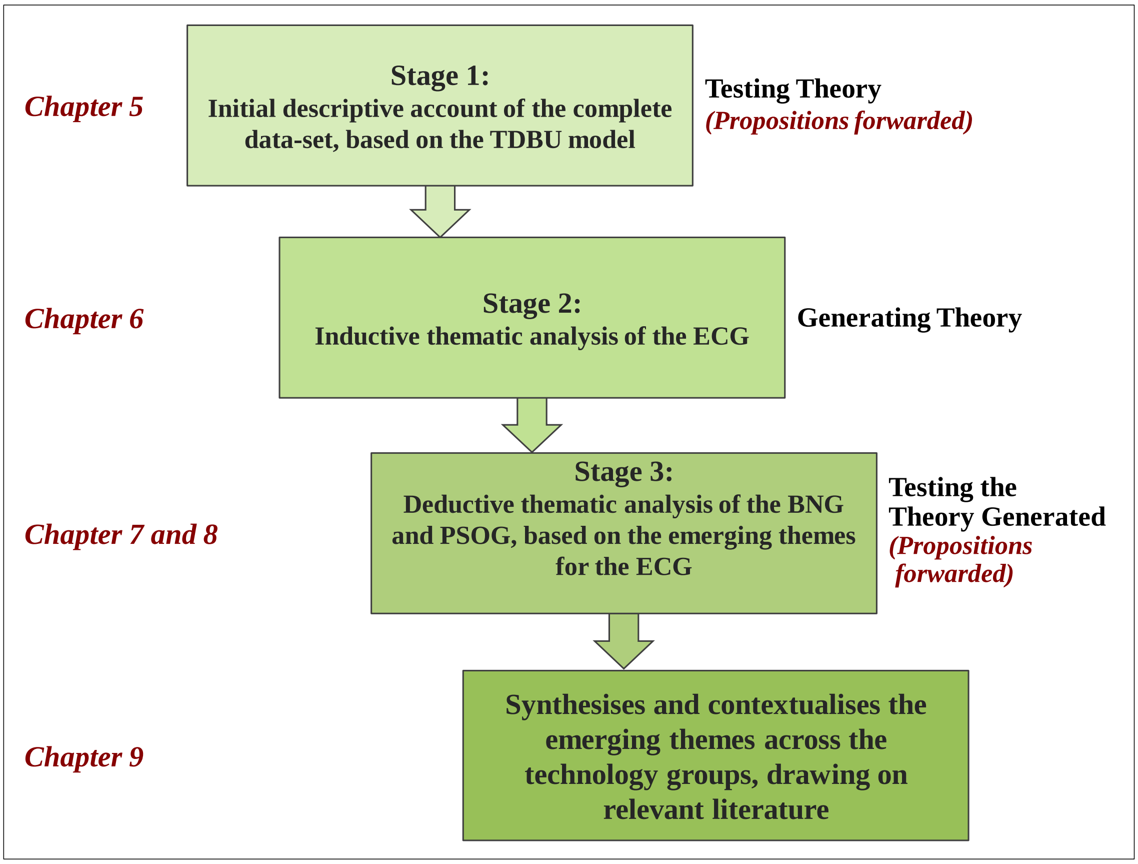

Figure 4.3: *Overview of Data Analysis Stages*

The first analytic stage (presented in Chapter 5) involved theoretically mapping (Braun & Clarke, 2006) to understand the extent to which the TDBU influences, outlined in Chapter 2, are evident within this dataset. Pattern matching (Campbell, 1966; Trochim, 1989; Hyde, 2000; Yin, 2003), based on the features associated with this framework, was therefore undertaken. This stage of inquiry set a theoretical backdrop for the more detailed and nuanced inductive and deductive thematic analysis that followed. It also explored the appropriateness of the pre-defined technology groups for thematic analysis purposes.

The second stage of analysis encompassed inductive thematic analysis of the key emerging themes, in terms of common features directing citizens' evaluations of the ECG. The third stage involved deductive analysis, to explore if the emerging themes for the ECG have relevance for the less contentious technology clusters (Patton, 1991).

> *"Deductive reasoning is a theory testing process which commences with an established theory or generalisation, and seeks to see if the theory applies to specific instances"* (Hyde, 2000: 83).

Although this final stage was predominately deductive, as part of this analytic stage these two data sub-sets were also examined for unique manifestations of materialising themes and patterns, and their features and emphases.

In keeping with Perry's (1997) suggestion to pursue theoretical replication across different cases along a continuum, and the principles of referential adequacy (Lincoln & Guba, 1985), different data were used as the source of theory to that used to test the theory (Cressy, 1953; Hyde, 2000) (i.e. inductive analysis of the ECG and deductive analysis of the BNG and PSOG). The approach of commencing with an inductive stage of analysis, followed by a theory testing deductive phase, has been advocated by others. For instance, Hyde (2000: 84) has argued that qualitative research does not need to be supplemented with quantitative research, but rather what is necessary is *"an inductive stage followed by a deductive one".* Similarly, Patton (1991: 194) and Schadewitz and Jachna (2007) have described how a qualitative researcher can move from an inductive to a deductive approach: *"…as the enquiry reveals patterns and major dimensions of interest, the evaluator will begin to focus on verifying and elucidating what appears to be emerging, a more deductive approach to data collection and analysis".* Others (e.g. Fereday et al., 2006) have demonstrated how a hybrid process of inductive and deductive thematic analysis can be an effective means of reaching different levels of interpretative understanding. Moreover, Kirk and Miller (1986) and Hyde (2000: 83) argue that good qualitative analysis alternates between inductive and deductive approaches, and that *"it is important for researchers to recognise and formalise these processes"*.

Indeed, Hyde (2000), Fereday et al. (2006) and Schadewitz and Jachna (2007) stress the importance of formally recognising and acknowledging when inductive and deductive analyses are applied within qualitative research. Inductive and deductive analyses are distinguishable in terms of the coding of textual data. Essentially, an inductive approach uses the data to generate theory, while a deductive approach commences with a theoretical concept or framework, and draws on the data in question, to confirm or disprove the theory/ concept (Holloway, 1997; (Schadewitz & Jachna, 2007).

As indicated in Figure 4.3, the analytic approach taken was essentially 'test-generate-test'. The TDBU model was initially tested through pattern matching, followed by generating theory through the inductive thematic analysis of the ECG, which was subsequently explored in the context of its relevance to the remaining technology groups.

> *"Most qualitative research strives to generate, elaborate, or test theories"*
> (Lee et al., 1999: 164).

In qualitative research, where a research aim is to build on the structure of a prevailing theory, proposition testing can be a useful means of identifying common threads within the data (Whetten, 1989; Yin, 1994; Lee et al., 1999). Propositions are essentially predictions about associational, sequential or causal interactions between features which are logically inferred from a general theory (Dubin, 1978; Shanks & Parr, 2003). Within the remaining chapters, propositions are forwarded for investigation, based on the TDBU theory being tested in Stage 1 and the emerging Conceptual Model being tested in Stage 3. Investigation of these propositions places a clear purpose on these analytic stages (Yin, 1994; Stake, 1995), with each proposition retaining a distinct focus (Baxter & Jack, 2008).

Prior to detailing the sequential 'analytic steps' taken, the next section discusses the conceptual underpinnings of thematic analysis.

4.7.1 Overview of Thematic Analysis

Rooted in the more traditional approach of content analysis, which has a more objective epistemological perspective (Joffe, 2011), thematic analysis involves identifying, coding, analysing and reporting themes within the data and interpreting these emerging themes in the context of research questions (Braun & Clarke, 2006).

> *"Thematic analysis enables scholars, observers, or practioners to use a wide variety of types of information in a systematic manner that increases their accuracy or sensitivity in understanding and interpreting observations about people, events, situations and organizations"* (Boyatzis, 1998: 5).

Now recognised as *"a method in its own right"*, thematic analysis *"strives to provide the more systematic transparent form"* of qualitative analysis, by moving beyond implicit observations to examine the transformative nature of representations (Joffe, 2011: 210). This process of *"encoding qualitative information"* (Boyatzis, 1998: iv) is not tied to a particular theoretical framework and can therefore be conducted when using a multitude of theories and epistemological stances, thus attaining an element of flexibility (Braun & Clarke, 2006). Aligned to constructionism, thematic analysis can *"trace how a particular representation develops"* and enables the establishment of the *"'reality' of an issue"* (Joffe, 2011: 211).

The detailed inductive and deductive thematic analysis (Stages 2 and 3) undertaken (Gibbs, 2007) on the discourse and PDI transcripts, was facilitated by a qualitative software package (NVivo10 provided by QSR International). In terms of data management, the NVivo dataset comprised the data for the three stages of data collection (i.e. the discourse and PDI transcripts and responses to the PDILQ).

4.7.2 Steps Involved in Thematic Analysis

Attride-Stirling (2001) reiterates the importance of explicitly accounting for how thematic analysis was undertaken. Drawing on the suggested phases of thematic analysis outlined by Braun and Clarke (2006), a structured approach was applied to the inductive and deductive stages of thematic analysis. The steps taken included: familiarisation with the data and identifying items of interest; compiling and designing the NVivo database; designing a coding framework and generating initial codes for the ECG; grouping codes and 'searching' for themes; reviewing emerging themes; defining and naming overarching themes; and, constructing and 'writing up' these themes. Each of the steps is discussed in detail in Appendix 4.12. In recognition that *"qualitative research [including analysis] is iterative rather than linear"* (Morse et al., 2002: 17), although these steps are sequential in nature, fluidity presided in moving forwards and backwards between them as part of an iterative and evolving reflexive analytic approach (Fereday et al., 2006). Although there is no definitive set of guidelines to maintaining the credibility of qualitative research (Mays & Pope, 2000), adherence to these steps was a mechanism of ensuring structure and rigour to data analysis and interpretation, and ultimately led to the establishment of the overarching themes presented and discussed in the chapters that follow.

For the first stage of the analytic process, preliminary codes were defined based on theoretically mapping the TDBU influences. This descriptive, broad sweeping, stage of analysis involved manually coding across the complete dataset, as described by Braun and Clarke (2006: 89), *"by writing notes on the texts you are analysing, by using highlighters or coloured pens to indicate potential patterns"*.

Following this initial stage, preliminary codes (based on the features influencing individuals' technology evaluations) were identified within NVivo for the ECG transcripts, using a 'bottom-up' inductive thematic analysis approach, which was data-driven. *"An inductive approach is the "purest form" of qualitative analysis"* (Srivastava & Hopwood, 2009: 77). The codes identified for this technology set were therefore strongly linked to the data collected, rather than a pre-existing coding frame or preconceptions about what pre-defined themes should emerge (Braun & Clarke, 2006). The inductive analysis undertaken therefore formed the foundational cornerstone of the deductive analysis that followed (Schadewitz & Jachna, 2007).

"Analysis is the interplay between the researcher and the data" (Strauss & Corbin, 1998: 13). Cognisant that *"data are not coded in an epistemological vacuum"* (Braun & Clarke, 2006: 84), data coding and analysis are unavoidably an interpretative act (excluding literal coding), completed through the researcher's conscious or unconscious analytic lens. Data analysis is impacted by the researcher's values, perspectives, experiences, including research experiences and assumptions, conscious or otherwise, about the subject topic. Fereday et al. (2006: 91) reiterate the importance of ensuring *"multiple perspectives from a variety of people with differing expertise"* during data analysis. To ensure the reliability and credibility of data analysis (Cohen & Crabtree, 2008) and minimisation of any potential researcher interpretative bias (Caelli et al., 2003),

all stages of data analysis and interpretation involved a three-phased consultative approach.

Once the researcher had completed each stage of analysis (Phase 1), detailed consultation with the on-site UCC supervisor regarding the emerging codes and themes was completed (Phase 2). As part of this second phase, during the data coding stages, several of the discourse transcripts were independently coded by the on-site UCC supervisor to strengthen reflexivity (Jootun et al., 2009) and ensure inter-coder reliability (Miles & Huberman, 1994). This course of action was a means of ensuring that no relevant codes or themes, common across the ECG, had been overlooked. Following this phase, the researcher and primary supervisor reviewed the emerging codes and themes, in consultation with the other supervisor and additional members of the researcher team during project meetings (Phase 3).

This three-phased review process was a means of ensuring that the emerging codes and themes were interpreted through a broader set of analytic lenses (Caelli et al., 2003), thereby reinforcing analytic credibility (Joffe & Yardley, 2003; Lewis, 2009). Specifically, the involvement of the supervisors, and other researchers, with a variety of perspectives and backgrounds in consumer behaviour, risk psychology, economics and nutrition minimised any potential interpretative bias (Lincoln & Guba, 1985; Baxter & Jack, 2008; Jootun et al., 2009).[29&30] In addition, the publication process for the dissertation findings presented in Chapter 6 provided a valuable opportunity for the analysis and interpretation to face double blind peer-review. In addition, the findings of this research and methodological approach were peer-reviewed when presented at various international conferences (see the Research Dissemination Section).

Together, the aforementioned analytic stages provide a holistic and integrated view of citizens' evolving attitude formation around a diverse range of both controversial and non-controversial food technologies. Following these three stages, the materialising themes and their manifestation across the technology groups were compared and

---

29 The following link provides an overview of Dr. McCarthy's research interests: http://research.ucc.ie/profiles/B010/mmccarthy/Research#ResearchInterests

30 The following link provides an overview of Dr. Henchion's research interests: http://www.teagasc.ie/food/research/staff/MaeveHenchion.asp

contrasted, and contextualised in the context of relevant literature, to further strengthen this analysis.

4.8 Limitations

Inexorable constraints prevail within all research (Merriam, 2009). Although the endeavour was to maximise the contribution and minimise the limitations of this work, the research decisions made brought with them a set of limitations. Most notably, the outcomes observed may have been influenced by: 1) the information presented, in particular, the applications and associated risks and benefits; 2) the manner and style in which this information was relayed (Kaufman et al., 2003); 3) the interpersonal dynamics, i.e. rapport and trust, between the scientist and citizen; and, 4) the types of questions posed. Nevertheless, the breadth of observations in terms of citizens' reactions and responses militates against this. Furthermore, information *had* to be presented within the interaction, in order to instigate reactions, reflection and questioning on the part of the citizen. In addition, citizens' evaluations were situated in the absence of real-life products or purchase/ consumption decisions. Therefore, when analysing and interpreting the data, it was noted that evaluations may not reflect individuals' true reactions as a consumer, in a real-life situation (Grunert et al., 2010).

As a non-participant observer (Casey, 2007), the researcher did not actively participate in the discourses, except to introduce the participants and thank them for partaking. The scientist, rather than the researcher, probed questions during the interaction given the research aims. However, the researcher was able to seek further clarity and elaboration on citizens' perspectives on the issues arising and underlining influences during the reflexive PDI.

The sample was designed to produce heterogeneous responses and was not intended to be representative (Calder, 1977) or generalizable (Marshall & Rossman, 1994; Hyde, 2000). This point withstanding, the sample included a diverse profile of citizens (Warde, 2005) and theoretical saturation (Hyde, 2003; Bowen, 2008) was comfortably achieved, across even the smallest of the technology groups (i.e. the BNG). In accordance with a constructionist approach, across this varied sample, diversity and complexity in terms of the factors influencing citizens' technology evaluations became apparent, as is illustrated in the proceeding chapters. The inherent limitations of this work are further discussed in Section 9.5.

4.9 Conclusions

Despite the limitations outlined, the research design and methodological approach underlying this work enabled thorough exploration and understanding of citizens' evolving evaluative stances on NFTs. Specifically, the constructionist stance, and deliberative discourse and staged analytic approach, which have been described and justified, proved effective in revealing the multiple, intertwined features impacting citizens' attitude formation around the selected technology groups. Indeed, the discourse approach provided valuable insight into attitude formation and change at the individual level, as information about a specific NFT was presented in a controlled environment.

The approach taken enabled a rich dataset to be collected based on the research strategy and design which encompassed a flexible, yet structured, approach. This qualitative approach enabled the researcher to establish a holistic perspective and conceptual understanding of citizens' evolving attitude formation and information processing around NFTs, which extends beyond general risk and benefit based evaluations (Davies, 2011; Druckman & Bolsen, 2011; Gupta et al., 2011).

How the methodological decisions made, and the procedures taken at each stage of the research process, minimised biases and maintained the credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985) of data collection and interpretation have been clearly illustrated. The steps taken included the adoption of a three-phased analytic review process, which entailed peer review/ debriefing.

Having outlined the three analytic stages of this research, the proceeding chapters relay the findings of the analysis. Chapter 5 presents a descriptive analysis of the issues impacting citizens' evaluations across the technologies based on the features associated with the TDBU model. Following this, Chapter 6 outlines the findings of the inductive analysis which explores the key features shaping evaluations across the ECG. Chapters 7 and 8 then present the deductive analysis of the relevance of these emerging themes to the other technology groups. Finally, Chapter 9 synopsises and contextualises the emerging themes, drawing on concepts and theories from relevant literature to strengthen this analysis. Within this chapter, the practical and theoretical contributions of this work are outlined. Policy and industry related implications and recommendations of this work, as well as its inherent limitations, are also relayed.

Chapter 5
Descriptive Analysis across the Technologies

5.1 Introduction

Prior to exploring the emerging themes in terms of the features directing citizen evaluations across the pre-defined technology groups, this chapter presents a preliminary exploration of the extent to which the characteristics of the individual and the technology are evident within the dataset, in terms of the factors impacting perspectives on each NFT. These characteristics are encompassed within the top-down/ bottom-up (TDBU) model.

Aligning with existing literature on this paradigm (e.g. Eagly & Chaiken, 1993; Scholderer et al., 2000; Bredahl, 2001; Grunert et al., 2003; Scholderer & Frewer, 2003; Søndergaard et al., 2005; Fell et al., 2009; Nielsen et al., 2009) as previously discussed in Chapter 2, this initial contextual analysis examines the top-down (TD) and bottom-up (BU) influences evident and how they guide attitudes formed. To achieve this goal, pattern matching (Campbell, 1966; Trochim, 1989; Hyde, 2000; Yin, 2003), based on the features associated with this framework, was undertaken.

TD influences centre on general attitudes and values, while BU influences focus on the characteristics of the technology and related products, including benefit and risk perceptions. As previously outlined, these influences can operate simultaneously and are not mutually exclusive (Bredahl, 2001; Grunert et al., 2004a; Søndergaard et al., 2005). This model therefore reflects *some* of the complexities inherent in attitude formation processes around NFTs (Nielsen et al., 2009). Specifically, it suggests that explicit risk and benefit perceptions can impact overall evaluations of NFTs, in addition to being impacted by broader TD influences (Bredahl, 2001; Søndergaard et al., 2005). Subsequently, this paradigm serves as an effective skeletal framework which theoretically grounds this initial analysis (Hyde, 2000).

Guided by relevant literature which explores these two sets of influences, a series of propositions are forwarded for testing. Following this, analysis is presented from the perspective of confirming the appropriateness of the pre-defined technology groupings. However, prior to this, individuals' awareness and knowledge of each technology is reported.

5.2 Awareness and Knowledge of the Technologies

Research to date, such as Clery and Bailey (2010) and Gaskell et al. (2010), suggests that public perceptions are impacted to varying degrees by individuals' perceived and actual knowledge about the specific technology. Olsen et al. (2010: 465) contend that although the BU approach is a valuable mechanism of understanding public attitudes towards NFTs, *"it fails to explain attitude formation in cases where knowledge about risks and benefits is limited".* In instances where knowledge is low, TD influences tend to dominate overall evaluations (Grunert et al., 2004a). In light of these arguments, an overview of awareness levels is presented at the outset.

Qualitative analysis of the pre-discourse interviewer-led questionnaires (PDILQs) indicates that levels of awareness of these technologies' application to food vary considerably (Table 5.1). The literature within this area (e.g. Fell et al., 2009) highlights that attitude formation around these technologies occurs beyond initial awareness of them. While most were aware of the concept of genetic modification, few were aware of non-thermal processing technologies and nutrigenomics/ personalised nutrition products (PNPs). Although reported awareness of the terms functional foods and nutrigenomics was low, familiarity with and knowledge of associated concepts, such as adding functional ingredients to food, and food intolerance and genetic testing in the case of nutrigenomics, was evident.

The findings presented here provide a useful contextual backdrop to the analysis of the BU influences shaping technology evaluations, since attitudes towards associated products derive from perceived and actual knowledge about the specific technology, product and related attributes (Bredahl, 2001; Grunert et al., 2004a).

Table 5.1: *Individuals' Awareness of the Technologies*

	Emotive & Contentious Group (ECG)			**Benign & Non-contentious Group (BNG)**	**Product & Service Orientated Group (PSOG)**	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing** *(grouped together in these tables given similarity of findings)*	**Functional Foods**	**Nutrigenomics & Personalised Nutrition Products (PNPs)**
Awareness of the technology	High, due to media coverage of GM foods and the availability of GM products on the market in the United States.	Low; although citizens are familiar with the related concept of functional foods.	Low to medium; citizens display a poor factual understanding of food irradiation.	Low; although citizens are very familiar with conventional alternative technologies, i.e. pasteurisation and microwaving.	High; products are already on the market. However, citizens are more familiar with the concept than the term 'functional foods'.	Low; although they are familiar with the related concepts of food intolerance, genetic testing and supplementary functional ingredients being added to food.
Levels of awareness measured during PDILQ	*35 of 42 were aware of genetic modification prior to commencing the discourse.*	*7 of 42 were aware of nanotechnology.*	*21 of 42 were aware of food irradiation.*	*None were aware of any of the non-thermal processing methods listed (i.e. pulsed electric field and high-intensity ultra sound).* *5 of 42 were aware of the thermal processing methods listed (i.e. radio frequency heating and ohmic heating).*	*14 of 42 were aware of functional ingredients. However, during the discourse it emerged that participants are aware of specific functional food products.*	*None of the five participants who completed this specific discourse were aware of nutrigenomics and PNPs.*[31]

31 Since it was not originally within the remit of the associated FIRM research project to explore citizens' perspectives towards nutrigenomics/ PNPs, awareness of this technology was only measured within this specific discourse group.

5.3 Examination of the Impact of TDBU Influences on Evaluations

This stage of analysis involved theoretically mapping (Braun & Clarke, 2006), to understand the extent to which these influences are apparent within this dataset. Hence, propositions are forwarded to enable examination of the expected impact of these influences in guiding evaluations of and reactions towards information about the selected technologies.

Many (e.g. Bredahl, 2001; Scholderer et al,, 2000; Scholderer & Frewer, 2003; Søndergaard et al., 2005; Nielsen et al., 2009) consider general socio-political attitudes of the individual to be important *"higher-order attitudes"* (Grunert et al., 2003: 439) which come to bear on attitudes formed around novel technologies. Indeed, Grunert et al. (2003) propose that exploration of these TD influences provides valuable insight into the magnitude to which attitudes towards novel technologies are embedded. As summarised in Table 2.1, literature to date indicates that attitudes towards nature, food and food production/ processing, ethical and moral beliefs, and social trust guide assessments of NFTs.

Given the emphasis on the characteristics of the individual in directing attitude formation around NFTs, it is expected that these influences exist and will be prominent within the dataset. Explicitly, the following proposition is forwarded:

> **Proposition 1:** The characteristics of the individual guide responses to information about applications of the technology. Specifically, personal characteristics and general outlooks, including general risk sensitivity and attitudes towards technological progress and food and production/ processing; ethical and moral beliefs; attitudes towards nature; and, perceived control and trust placed in others, are evident within the dataset and impact technology assessments.

Aligned with the focus of the TDBU model on specific risk and benefit characteristics of the technology and related product attributes (Bredahl, 2001; Grunert et al., 2003; Søndergaard et al., 2005; Nielsen et al., 2009), it is also proposed that BU influences will guide technology evaluations. BU characteristics include perceived associated personal, societal and environmental risks and benefits (e.g. Frewer et al., 2011). Furthermore, many (e.g. Fell et al., 2009; Sheldon et al., 2009) describe how the perceived relevance of such risks and benefits to the individual and the distribution of benefits impact technology assessments. Hence, the second proposition is as follows:

Proposition 2: The perceived benefit and risk characteristics of the technology and associated applications/ products, as expressed by individuals, influence their technology evaluations. The specific BU influences apparent within the data, in terms of the features shaping technology evaluations, include perceived personal, societal, and environmental benefits and risks, their relevance to the individual, and the assumed distribution of ensuing benefits.

The propositions delineated derive from the TDBU paradigm, (Dubin, 1978; Ardichvili et al., 2003) and are subject to empirical testing of the ‘truth’ that they hold in operation (Dubin, 1978; Hyde, 2000). Presentation of evidence to support these propositions enhances confidence in the validity of the model’s concepts and accompanying relationships, whereas, disconfirmation of same will indicate where opportunities exist to refine the theory (Hyde, 2000). The following sections present a descriptive account of the findings of analysis which investigates these propositions, by exploring the extent to which both sets of influences are detectable within the dataset and impact evaluations.

5.3.1 Investigation of Proposition 1: The Influence of Top-down Characteristics

As proposed, TD influences are apparent in terms of guiding reactions and responses to information about the technologies. As summarised in Table 5.2, personal characteristics and general outlooks, attitudes towards nature, ethical and moral beliefs, and, perspectives on social trust and perceived control are salient influences impacting technology evaluations. Additionally, this analysis supports Bredahl (2001), Søndergaard et al. (2005) and Fell et al.’s (2009) view that these influences tend to direct risk and benefit assessments, and also directly impact technology assessments.

The main influences impacting perspectives appear to depend on the technology, with each triggering distinct beliefs, values and ideals. There is evidence that one’s attitude towards technological progress and general risk sensitivity offer a basis for evaluations: *“I would be open-minded as regards new technologies. (...) Initially there might be issues, but I mean the future technologies that we could get out of it could be something* *amazing that could change a lot"* (Nano1, M, 25-34 years of age).[32&33] In addition, family status, experiences including those with foodborne illness and food safety issues, and personal and familial health status and life stage influence technology assessments to varying degrees, depending on the particular individual and technology.

Perspectives on functional foods, nutrigenomics and PNPs appear to be particularly impacted by life stage and health status: "*I would actually be quite enthusiastic as I have got older. I actually think maybe younger people mightn't take it [nutrigenomic testing] as serious [sic]. But, because of my age, I think (...) I would be very, very interested in it"* (Nut/PNPs2, F, 55-64). Elsewhere, attitudes towards technological progress and nature (especially, the naturalness of processed foods), prior knowledge of food processing methods and taste perceptions seem to play roles in guiding evaluations for the thermal and non-thermal processing technologies: *"It is an obvious way for food production to go. (...) It's kind of the next step where innovation would go with food technology and food production"* (Therm3, PDI, F, 35-44).

Ingrained values and beliefs, such as attitudes towards nature and ethical considerations about food production, are frequently raised when discussing the more contentious technologies and nutrigenomics and PNPs: *"It [genetically modifying animals] would be cruelty to animals. (...) I don't know if that's fair: (...) I suppose in a way I am an animal lover"* (GM5, M, 25-34). Indeed, some of the applications of these technologies presented are considered more unnatural and 'invasive' than others. For instance, nano-inside food applications tend to be more negatively perceived than nano-outside applications, due to the use of inorganic nanoparticles in nano-packaging. As another example, modifying the genetic make-up of animals is believed by many to be *"an uncomfortable step towards humans"* (GM2, M, 35-44).

32 Within Chapters 5-8 and Appendices 9.1 and 9.2, where quotations are taken from the Pre-Discourse Interviewer-Led Questionnaire (PDILQ) or Post-Discourse Interview (PDI), it is explicitly stated. Otherwise, the quotations are taken from the deliberative discourses. It is indicated in brackets following each quotation: 1) which specific technology the participant deliberated on; 2) their gender (male or female, as indicated by the letters 'M' or 'F' respectively); and 3) their age. In terms of abbreviations used: GM = Genetic Modification; Irrad = Irradiation; Nano = Nanotechnology; Non-Therm = Non-thermal Technologies; Therm = Thermal Technologies; FF = Functional Foods; and, Nut/PNPs = Nutrigenomics & PNPs.

33 Quotations have been edited and irrelevant exclamations and repetitions are omitted. The omission of words or sentences (undertaken to condense quotations and only when such editing did not alter the meaning of the quotation) is indicated with a bracketed ellipsis: (...). An ellipsis without brackets indicates a pause. Finally, text presented in square brackets represents implicit parts of the conversation, expressed in the preceding discussion.

In contrast, functional foods and, to a certain degree, thermal and non-thermal processing, are perceived as being relatively natural. Nevertheless, this view is contingent on the product/ process in question and one's imbued beliefs about nature. For instance, certain functional foods, including medicinal foods, cosmeceuticals and animal products with increased functionality resulting from 'functional animal feed', are not believed to be as natural as traditional types of functional foods: *"I know that the chitin (...) …cattle wouldn't usually eat it. (...) Putting that into their diet; I think I would just prefer to stick to (...) a natural diet, instead of putting that stuff into the diet"* (FF5, M, 18-24).

Elsewhere, ethical and moral values and beliefs appear to be key in guiding perspectives on nutrigenomics and PNPs. Explicitly, ethical and moral standpoints about 'genetic privacy' of test results and social equality implications direct attitudes towards nutrigenomic testing and associated dietary advice. These viewpoints result in apprehensions being expressed about fear of *"playing God"* (Nut/PNPs4, M, 25-34) and whether young children should undergo such testing. Ethical and moral values and beliefs are also a basis for resistance to certain gene technology applications, which are viewed as possibly tampering with nature and divine law: *"The pig isn't designed to have a million litters of piglets; so, I think that [genetically modifying a pig to enhance its reproductive performance] is not right. (...) They have opinions. They have brains; a vegetable does not"* (GM1, F, 18-24). However, these beliefs and values do not seem to be as influential in determining evaluations of the other technologies, particularly thermal and non-thermal processing methods.

Furthermore, social trust, particularly in regulatory processes, and perceptions of control, tend to impact assessments: *"In this day and age, when something is out there, it's kind of relatively safe, isn't it"* (Irrad2, F, 45-54). Generally speaking, a desire for control over the technologies generates a demand for information: *"I think the consumer has a right to know before they buy it [a GM food product]"* (GM1, PDI, F, 18-24). Indeed, information provision is considered a control enhancing mechanism which enables informed voluntary choices at point of purchase/ consumption: *"I think that they should all be labelled as to how they are produced. (...) I can choose to buy it, or I can choose to leave it"* (Therm1, M, 25-34).

In general, openness towards the technologies is heightened in instances where control over them is perceived to exist, as a result of protective regulatory frameworks and compulsory labelling in the case of the more contentious technologies: *"I probably would trust the government on it, if they had done their research and they reckoned it [the nano food] was OK"* (Nano5, M, 35-44). Informed choice about these technologies is believed to be facilitated through appropriate labelling information: *"It should be still stated on the product. (…) Some people could say, 'oh God no…I am not into that [the technology being applied]'"* (Non-Therm5, F, 18-24). Elsewhere, desire for control can result in expressions of anxiety about access to nutrigenomic test results and genetic privacy issues: *"If I thought that the information [from nutrigenomic testing] was being handed over to an insurance company, (…) I would be very nervous about that. I really would. I thought anything that went on between a doctor and you was confidential"* (Nut/PNPs2, F, 55-64).

On a separate note, functional foods and nutrigenomics are favourably perceived to support self-empowerment over personal and familial health status, i.e. to strengthen personal capability to take preventative action, whether desired or not to do so: *"So they are going to know [as a result of nutrigenomic testing] that maybe in 20 years time, God forbid, that I could get a cancer or heart disease. (…) All this would have to be positive. (…) I would say, 'this is what could happen, but this is what I could do to prevent it'"* (Nut/PNPs1, F, 35-44). Perceived control in this context seems to be internalised, rather than externalised.

Table 5.2: *Responses and Reactions Deriving from Top-down Influences on Evaluations* **-** *The Individual's Characteristics*

	ECG			BNG	PSOG	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Key personal characteristics and general outlooks guiding evaluations	Familial connections with rural area, general risk sensitivity.	Attitude towards technological progress and general risk sensitivity.	Preference for natural foods, family status, experiences with foodborne illness and food safety.	Attitude towards technological progress, prior knowledge of food processing methods and taste perceptions.	Life stage, health status and goals (personal and familial) and prior knowledge of food production and processing methods.	Life stage, health status and goals (personal and familial) and lifestyle implications.
Influence of general attitude towards nature on evaluations and perceptions of naturalness	Evaluations are strongly influenced by attitude to nature. The technology is viewed as interfering with nature and natural order. Some applications (e.g. GM animals) are considered more unnatural than others (e.g. GM plants).	Evaluations are influenced by attitude to nature. Nanotechnology is perceived as interfering with nature/ the naturalness of food, with some applications (i.e. nano-inside) being considered more unnatural than others (i.e. nano-outside packaging applications) due to the use of inorganic nanoparticles.	Attitude to nature influence technology evaluations. Food irradiation is perceived by some as interfering with the naturalness of foods and traditional methods of food production/ processing, depending on the specific application.	Technologies are not considered in general to be unnatural. However, this perspective depends on general beliefs about nature and perceptions of the naturalness of conventional alternatives methods currently used.	Perceived overall to be relatively natural. However, judgements of naturalness are based on general beliefs about nature and the product/ process in question, i.e. probiotic dairy products versus CLA enriched meat.	Evaluations are influenced by perceptions about tampering with and the boundaries of interfering with nature and the naturalness of food.

Table 5.2: *Continued*

	ECG			BNG	PSOG	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Influence of ethical and moral beliefs on evaluations and perceived ethical/ moral implications associated with the technology	Ethical and moral beliefs have an important influence on evaluations. Perceived ethical implications are medium to high; the technology is viewed, to a certain extent, as tampering with nature and divine law.	Such beliefs do not emerge as a dominant influence. In turn, ethical concerns are relatively low, once adequate labelling and regulations are perceived to be implemented.	These beliefs are not a prevailing influence. Ethical concerns are quite low, based on a set of assumptions about labelling, monitoring and safety standards being implemented.	Ethical and moral beliefs are not a dominant influence and therefore no specific ethical or moral concerns are raised.	Although ethical and moral beliefs are not a dominant influence, the implications of medicalising food and dosage issues are raised.	Ethical and moral beliefs strongly influence evaluations. Perceived ethical implications are high; concerns are raised about 'genetic privacy' and social equality issues, fear of *"playing God"* and whether young children should undergo such testing.
Outlooks on social trust and control over the technology *(Note: labelling information is generally considered important to enable informed voluntary choice)*	Through compulsory labelling of GM foods, medium levels of perceived control over the technology are evident. However a lack of trust undermines perceived control.	Medium levels of perceived control over the technology are evident, through perceived high levels of trust in regulatory frameworks and scientists.	Through compulsory labelling of irradiated foods, medium levels of perceived control over the technology's application are apparent. Duration of application also attenuates safety concerns.	High levels of trust placed in regulatory frameworks are evident and drawn upon if, and when, personal control over these benign technologies is perceived to be lacking.	High levels of perceived control due to trust in science and regulation. These products are generally assumed to be safe. The technology is also seen to support self-empowerment over personal/ familial health status.	Concerns voiced about control over, i.e. the privacy of, test results. Nutrigenomics is considered to support self-empowerment over personal/ familial health status, i.e. the ability to take preventative action, whether desired or not to do so.

Having explored the validity of Proposition 1 and presented evidence of the presence and impact of abstract TD influences on evaluations of the technologies, the next section focuses on examining the extent to which more applied BU influences exist throughout the dataset.

5.3.2 Investigation of Proposition 2: The Influence of Bottom-up Characteristics

As postulated, the perceived risk and benefit characteristics of the technology, and associated product attributes, play an important role in guiding responses and reactions towards new information, and subsequent evaluations formed. As illustrated in Table 5.3, these include assumed personal, societal and environmental benefits and risks, the perceived relevance of these to the individual and presumed benefits to industry, i.e. the distribution of benefits.

Perceived personal and societal benefits include health benefits, improved taste and increased food safety, quality and shelf life; if and when these benefits align with individual and familial goals: *"If I thought I was eating a product and it had extra benefits to it, to me that would be a positive"* (FF1, F, 35-44). While associated benefits offered are recognised and frame evaluations for the processing technologies, their impact on assessments is minimal since these benefits are also considered to be offered through conventional processing methods. Conversely, in the case of nutrigenomics, PNPs and functional foods, evaluations appear to be strongly led by personal and societal health implications: *"I think it's a great idea if it prolongs life for people…especially people who are suffering. (…) I think that's fantastic"* (Nut/PNPs3, M, 45-54).

More generally, the magnitude to which resultant societal and environmental benefits are believed to exist and frame perspectives depends on the technology and application, as illustrated here: *"It [GM crops] could prevent starvation…so, that's a huge obvious benefit. (…) I think taste is probably good enough where it is at the moment. (…) I don't think that [applying GM to improve taste] would be a huge factor, compared to preventing famine"* (GM2, PDI, M, 35-44). As another case in point, nanotechnology and food irradiation are positively perceived in the context of potential societal health benefits and environmental effects deriving from increased food safety and reduced food wastage: *"It's always positive to have healthier things on the market"* (Nano1, M, 25-34). To a certain extent, thermal and non-thermal applications are also associated with positive environmental implications and efficiency gains: *"Consumers would be happy that there was less waste and that there was more being salvaged from food"* (Non-Therm2, F, 45-54).

Distribution of benefit impacts evaluations to different degrees, depending on the particular technology. The view that industry, rather than individuals, benefits from the applications presented can result in some expressing resistance towards them. However, this does not look to be the case for the processing technologies. Although their applications are considered to primarily be of relevance to manufacturers, this perception does not seem to negatively influence attitudes formed, given perceptions of limited associated risks: *"The profit thing really wouldn't bother me. (...) They are out to make money, so that's their foremost concern. (...) If it works for them then fine, provided that there is actual substance to what the consumer is getting."* (Therm1, M, 25-34). Conversely, focusing on functional foods, benefits are predominately viewed from a consumer, rather than an industry, perspective: *"I mean if you are going to buy it, I think it's OK for it to be more expensive, because you know it's helping you in a way"* (FF4, F, 18-24).

The most influential personal and societal undesirable implications moulding evaluations of the contentious technologies relate to the potential unknown consequences of their adoption on both human health and the environment: *"It's hard to say if it would be positive or negative in the future…or will we create a huge problem that we can't reverse"* (GM2, M, 35-44). Less serious risks and negative consequences shaping viewpoints include conceivable adverse impacts on the taste, naturalness and price of such products. Once again, no major personal or societal risks emerge as a trigger of negative assessments for the processing technologies, and consequently their application is not considered to be particularly relevant to individuals: *"It sounds great for say the guy who is producing them. (...) [For] the consumer…I don't know whether I really would be hugely concerned"* (Therm5, M, 35-44).

In contrast, the potential negative societal implications associated with nutrigenomics and PNPs generate some opposition towards them. The explicit features driving this perception and resistance include genetic privacy and social inequality issues: *"I would be worried that it [nutrigenomic test results] could be passed on to employers"* (Nut/PNPs2, F, 55-64). Specifically, holding the view that a lack of financial resources may limit access to such testing/ dietary advice appears to heighten negative standpoints: *"That [nutrigenomic* *testing] sounds really good, except for the people that can't afford it"* (Nut/PNPs5, F, 18-24). The impact of these types of ethical, legal and social equality influences on attitudes formed reaffirm the scope of nutrigenomics' perceived wide-reaching implications. Furthermore, stemming from general values and beliefs, concern are expressed about information provision regarding disease susceptibility negatively affecting life choices, and resulting in increased risk aversion and mental anguish: *"It could change their whole psychology. You could end up with people being so over-cautious that they never take a risk, and that could affect them (…) right the way through to their death, even if they lived to 120. If they have lived a life of such caution, was it worth their while?"* (Nut/PNPs4, M, 25-34). Finally, the practicalities of purchasing, preparing and consuming PNPs emerge as salient factors determining evaluations.

Table 5.3: *Responses and Reactions Deriving from Bottom-up Influences on Evaluations* - *The Technology's/ Product's Characteristics*

	ECG			**BNG**	**PSOG**	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Significant perceived personal and familial benefits associated with the technology, and their assumed relevance to individuals	Varies, i.e. health benefits are perceived to be associated with certain applications.	Applications offering improved taste and increased food safety, shelf life and health characteristics are perceived as beneficial, if these attributes align with individual and familial goals.	Varies, i.e. some value increasing food safety/ extending shelf life, if these attributes align with personal and familial goals.	Benefits such as increased food safety, quality and extended shelf life are recognised but are not always highly valued, as they are perceived by some to also be offered by conventional alternative methods.	Health benefits are valued and perceived to be relevant to individuals and their families.	Health benefits, particularly in terms of disease prevention and prolonging life, are valued and perceived as highly relevant to individuals and their families.
Significant perceived societal and environmental benefits associated with the technology	Potentially increasing food supply and security, and societal health benefits in developing countries.	Societal health benefits and positive environmental impacts, through reduced packaging and food waste as a result of increased food safety and shelf life extension.	Increasing food safety, extending shelf life, reducing food waste and trade barriers, and standardising sanitation levels.	Environmental benefits, as a result of increased efficiencies, i.e. energy savings and waste reduction.	Potential societal health benefits, such as reducing health care costs in the long-term.	Societal health benefits, which are considered to potentially be extremely high. These include reduced health care costs in the long-run.

Table 5.3: *Continued*

	ECG			BNG	PSOG	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Perceived associated benefits to industry (i.e. the distribution of benefits)	Concerns about benefits accruing primarily to industry.	Concerns about benefits accruing to industry, in addition to consumers/ citizens.	Some concerns about benefits accruing primarily to industry.	Associated benefits are perceived to accrue mainly to industry. However, this is generally not a major concern, given limited perceived associated risks.	Benefits are primarily viewed from the consumer's perspective.	Minimal concerns about benefits accruing to industry, in addition to their considerable perceived accrual to individuals and society at large.
Significant perceived personal and familial risks (and/ or negative consequences) associated with the technology	Uncertainty associated with scientific knowledge about GM technology, potentially leading to unforeseen consequences on individuals' health.	Potential unknown negative consequences on human health.	Applications of the technology affecting the naturalness or impairing the quality of food, and potentially causing the food to become carcinogenic or have other detrimental impacts on individuals' health.	No substantive associated personal risks are perceived to exist. However, some applications are not valued or considered to be particularly relevant to individuals.	Perceived uncertainty associated with dosage (quantity/ monitoring) issues and the medicalisation of food, any associated price premiums and also affecting the naturalness of food.	Information regarding disease susceptibility negatively affecting life choices and resulting in increased risk aversion and mental anguish. Also, concerns about price implications and the practicalities of purchasing, preparing and consuming PNPs.
Significant perceived societal and environmental risks (and/ or negative consequences) associated with the technology	Animal welfare issues, impacts on farmers' livelihoods, the environment (i.e. biodiversity), threats to 'natural order', scientific uncertainty and general lack of control.	Unknown consequences of adopting the technology on human health and the environment, i.e. the ecosystem.	Traceability issues, insufficient regulation and safety assurances for irradiation factory workers and the environment surrounding the factory.	No particular risks are perceived to exist.	Similar to perceived personal risks/ negative consequences (previously outlined).	'Genetic privacy' and social inequality issues; particularly, financial restrictions limiting access to testing/ dietary advice. Concerns also expressed about who should endorse such services.

Overall, there is evidence to support the propositions forwarded, with an array of BU and TD influences impacting evaluations. Although the impact of these influences depends on the particular technology, patterns are evident in terms of these features across the pre-defined technology groups. The next section reassesses the appropriateness of these technology clusters, in light of the insights from this analytic phase.

5.4 Analysis from the Perspective of the Technology Groupings

The analysis presented is useful in confirming the appropriateness of the systematically 'pre-grouped' technologies (see Section 4.6.1), based on their characteristics and expected public reactions, given the similar emerging trends among the technologies included in each set.

Specifically, the findings presented confirm that the ECG form a logical joining, as emotional reactions about negative unknown consequences and attitudes towards nature underlie expressions of concern about potential interference with nature/ natural order. These perceptions, in turn, result in some resistance towards these particular technologies: *"I would be afraid [of irradiated food]. (...) I would be trying to avoid it"* (Irrad4, PDILQ, F, 55-64). Furthermore, evaluations of this group are influenced by personal, societal and environmental negative and positive implications, i.e. perceived risks and benefits, as demonstrated here: *"I just think it's about your digestion…long terms effects [of genetically modifying animals]. You could be ill…because you are injecting something from another animal into another animal. That [GM] animal, it might be healthy, but it also might be unhealthy in different ways. While you are injecting the good part into it, you are possibly injecting some bad characteristics of that animal into it as well"* (GM1, F, 18-24).

In comparison, evaluations of the BNG seem to occur at a more applied and prescriptive level, based on their attenuated nature: *"I would be interested [in non-thermal technologies] as long as the taste was alright. (...) It wouldn't bother me how you got the [orange] juice out"* (Non-Therm3, F, 55-64). Furthermore, it appears that these technologies are not perceived to offer the same potential value or relevance to individuals as the others. Attitudes towards the ECG and PSOG seem to be more notably impacted by emotive TD influences, and thereby possibly more stable and strongly held, as previously postulated by Grunert et al. (2003) and Scholderer and Frewer (2003).

Although functional foods are widely available in different forms, in comparison to the relatively new concepts of nutrigenomics and PNPs, these technologies encounter many similarities. The PSOG are characterised as both benign and contentious, depending on the specific product/ service and perceived risks and benefits. In addition and as envisaged, affective reactions and cognitive responses are evident for these technologies. Furthermore, perspectives seem to be predominately contextualised in terms of one's health status and goals, and centre on health orientated product and service attributes and outcomes: *"I would find it very, very interesting that this [nutrigenomic testing] will be available to me. I would look at it as an investment. (...) It would pay [health related] dividends down the line"* (Nut/PNPs2, F, 55-64). Perceived personal and societal repercussions associated with these technologies are therefore high, driven by individuals' health status and motivations, life expectancy and lifestyle implications: *"If you have high cholesterol…if you can get a spread or a butter that will take down your high cholesterol…it's brilliant. (...) I would buy it"* (FF8, F, 45-54).

Overall, the similar patterns across the technologies included within each group outlined proffer a logical rationale for thematically analysing the pre-defined clusters in detail.

5.5 Conclusion

The specific features of the TDBU model formed the basis of this initial stage of analysis. As the first stage of this inquiry, this broad sweeping analysis has presented evidence that the two propositions put forward are supported. Both types of influences are apparent and play simultaneously operating roles in guiding technology evaluations. Insight into the extent to which these influences determine perspectives on each technology have been presented. Explicitly, aligned with the literature previously discussed, TD characteristics of the individual, including: deep-seated attitudes and beliefs about nature and technological progress; ethical and moral stances; and, outlooks towards social trust and control influence standpoints on these technologies. BU influences, including personal, societal and environmental benefits and risks perceptions associated with each technology and associated products, are evidently also impactful.

This qualitative analysis extends empirical testing of this model and enhances confidence in the validity of its concepts. The insights from this analysis indicate the value of this paradigm as an appropriate theoretical basis from which to commence more in-depth exploration of the key factors directing citizens' evaluations across the selected technology groups. Although it is widely recognised that these TDBU influences are interrelated and not mutually exclusive (Bredahl, 2001; Søndergaard et al., 2005), this model does not indicate: the ways in which these influences interact to guide overall evaluative stances; which influence potentially dominates attitude formation in particular contexts; and, what additional factors, such as need for cognition, possibly come to bear on attitudes formed. Furthermore, although the propositions are supported, this paradigm fails to incorporate inherent cognitive processes which may perform pivotal roles in the contextualisation of information about, and subsequent evaluations around, these technologies, as implied based on the review of relevant literature (Chapter 3). Indeed, closer examination indicates that the TD and BU influences explored are not fully representative of the dataset, with a wealth of data not being reflected within this initial analytic phase. Therefore within the ensuing chapters, detailed analysis is presented on the impact of the complex array of cognitive interpretative mechanisms and associations and types of responses that citizens may draw upon when processing information and forming attitudes around these technologies.

This stage of inquiry has set a theoretical backdrop for the more detailed and nuanced thematic analysis presented in Chapter 6, which relays the key emerging themes in terms of common features directing citizens' evaluations of the ECG. This group was selected for inductive examination, as the first stage of thematic analysis for the reasons previously outlined (see Section 4.6.5). Following this, Chapters 7 and 8 present the findings of deductive analysis which tests if the materialising themes for the ECG are relevant to the other technologies. This analytic approach therefore considers the extent to which the technologies are evaluated using similar processes. In addition, the remaining technology clusters are examined for anything distinctive in the context of emergent themes and patterns and their features and emphases. Chapter 9 then compares and contrasts the manifestation of apparent themes across the technology groups, drawing on concepts and theories from relevant literature, to strengthen this analysis and provide insight.

Chapter 6
Citizens' Evaluations of NFTs: The ECG

6.1 Introduction

Following on from the initial deductive analysis, the purpose of this chapter is to explore and conceptualise a common framework across the technologies, in terms of the sources of influences on individuals' attitude formation around NFTs when provided with information. To this end, inductive thematic analysis is presented of the key themes, in terms of the common features shaping evaluations across the Emotive and Contentious Group (ECG), and the relationships between these themes. As previously mentioned, the technologies encompassed in this group include genetic modification, nanotechnology and food irradiation. The ECG was selected for preliminary investigation, as it is potentially the most emotive and potentially contentious of the three technology sets (Fell et al., 2009; Gupta et al., 2011), and thereby expected to contribute to a variety of features influencing attitude formation around this group. The features influencing its evaluation may be transferable to the others groups. Subsequently, in keeping with the principles of 'good' inductive and deductive qualitative analysis (see Section 4.7), particularly the contention of Cressy (1953) and Hyde (2000) that data used to generate theory and test such theory should be separate, Chapters 7 and 8 seek to establish whether the emerging themes and features outlined here are relevant to the other technologies.

6.2 Key Emerging Themes

Four themes were identified to represent the overarching mechanisms through which individuals evaluate these contentious technologies. A person's orientations, their perceived control over these technologies' application and the assumed relevance of their different applications appear to determine how an individual 'makes sense' of these particular technologies and ultimately, their overall evaluations of them.

The first, personal orientations, speaks to the basic framework for individuals' interpretation of information about the technologies. The second, individuals' perceptions of power and control, takes account of the interactions between uncertainty, information requirements, trust and regulation on evaluations. The third theme, 'perceived relevance', focuses on the impact of perceived benefits and risks on evaluations. Each of these themes represents different concepts and influences that interact together to form a scaffold of influences, leading to the formation and creation of 'sense-making' around the technologies. This concept of 'making sense of technologies', which is the major factor in the evaluative process, concerns the meanings and associations individuals construct when classifying and interpreting information about the technologies. These meanings are formed and created by the influences represented in the other themes.

Miles and Huberman (1984), Whetten (1989) and Imenda (2014) argue that a graphical depiction of concepts is useful in situations where the relationships between the features under consideration are complex. Building upon this suggestion, a Conceptual Model[34] (Figure 6.1) is generated from this analysis, which incorporates the four key influences and associated features found to impact technology evaluations. This Model will be used throughout the remainder of this chapter.

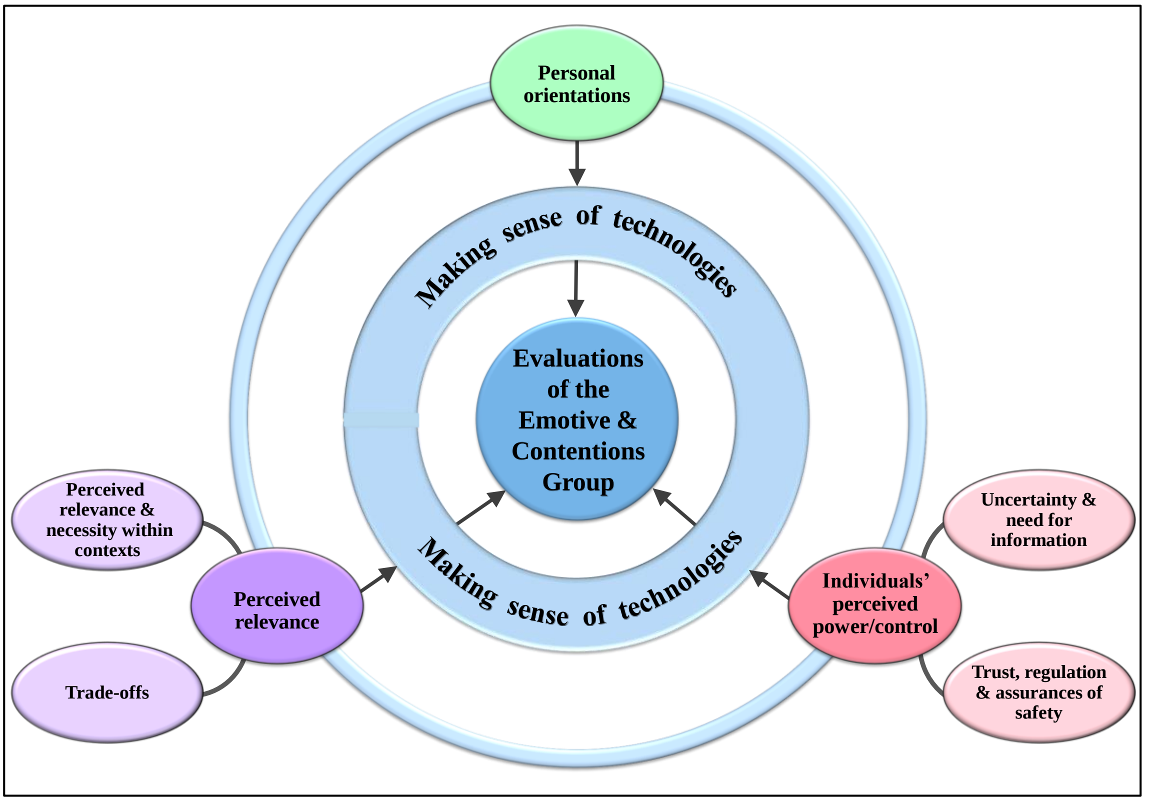

Figure 6.1: *Emerging Conceptual Model of Features Influencing Individuals' Evaluations of the ECG*

The Conceptual Model resembles the steering wheel (helm) of an old ship, with the influences (spokes) moving inwards towards the central 'evaluative hub'. The arrows pointing inwards from the interdependent source influences to the major component, 'making sense of technologies', and subsequently, to the 'evaluative' centre point, depict the hierarchical relationships that exist, with the outer components giving rise to and informing sense-making and, in turn, overall evaluations.

34 Theoretical frameworks are more associated with deductive reasoning, while conceptual frameworks are more associated with qualitative research, primarily applying inductive reasoning (Liehr & Smith, 1999; Imenda, 2014).

Prior to discussing the interactions between these influences, each of these themes and its features are outlined, using quotations from the data to support the analysis.

6.2.1 Theme 1: Personal Orientations

Personal orientations represent the expression of an individual's inner sense of standards. Initial reflections on the ECG are based on what is valued and whether or not these specific technologies are perceived to violate these standards or undermine core values and beliefs. Personality traits and value orientations provide the framework for responses to information about these technologies and are the foundations for both emotional reactions and reasoned responses. In particular, attitudes to nature, food and food production/ processing, science and technology and general risk sensitivity play important, and sometimes conflicting, roles in forming perspectives.

A protectionary stance in terms of man's relationship with nature aligns to general risk sensitivity around food production. Furthermore, this can manifest as moral and ethical objections to the technologies, and as a form of food anxiety. Those who view nature as fragile, and value the protection of nature, worry about the content of food and the potential consequences of applying these technologies: *"Man is always trying to control things. But there's always something that will actually outwit us in the end you know…surpass us some way or other. (…) We have a responsibility (…) so how far do you go? (…) There's huge possibilities but there are huge issues. (…) I think that extreme caution has to be exercised"* (Nano3, F, 55-64). The sense of unease around the advancement and application of these technologies is evident in the precautionary stance displayed and questioning as to where the limits lie in terms of humans' interference in nature. Concerns are voiced about potential long term *"side effects"* that may be *"hard to reverse"*: *"It's not natural…there's less natural properties I think"* (GM1, F, 18-24).

In contrast, a strong belief about man's dominance over nature contributes towards open enthusiasm for them, less risk sensitivity and a more *lassiez-faire* perspective in terms of evaluations: *"We will never get anywhere if we are just going to be afraid of everything. (…) There's a risk with everything, isn't there"* (Nano4, F, 35-44). Equally, focusing on outlooks towards science and technology, those reacting positively towards these novel technologies often portray themselves as techno-enthusiasts, supportive of technological progress: *"I think it's far better to have the technology than not…because* *who knows what else it will lead onto? (...) Initially there might be issues. But, I mean the future technologies that we could get out of it could be something amazing (...) I think I am still fairly positive about it"* (Nano1, Discourse and PDI, M, 25-34). However, for those whose principles centre on maintaining traditions and natural processes, these beliefs are in internal conflict with their desire to support the fostering of scientific progress and developments.

Life experiences and, in turn, experiential knowledge offer mechanisms for processing information, and existing understandings of one's social world is a platform for interpretation of the technologies. Thus, the internalised sense of 'standards' that supports initial evaluations is based on factors such as work roles, educational experiences, family lifestyles and health experiences. Here, evidence of professional experience aligns with value orientations towards health and long term effects: *"You see that's my own [nursing] background…my own profession. (...) I would be more kind of about (...) long term health. So I would be kind of worried about that [GM foods]. (...) The long term effects (...) I would mind if it [genetic modification] was in most of the food out there"* (GM1, F, 18-24, Nurse). Individuals use technical terms associated with their professions to anchor their evaluations, drawing on existing views from their 'professional worlds' to create meanings and associations. Specifically, business professionals (e.g. accountants) draw on these prior experiences, referring to economic impacts of adopting the particular technology on food prices, suppliers, and stock and export levels; while caregivers (e.g. social workers) focus on potential enhanced safety characteristics associated with its application: *"I suppose from the suppliers point of view, they have a little bit longer to get rid of the stock [by prolonging shelf life through food irradiation]. (...) I suppose I am just thinking like an accountant"* (Irrad3, M, 25-34).

Personal orientations, which represent expressions of an inner sense of standards, are clearly drawn upon to form initial evaluations. Perceptions of the technologies violating these 'standards' may result in expressions of the need for both a precautionary approach and control over exposure to them.

6.2.2 Theme 2: Individuals' Perceived Power/ Control

Two types of uncertainty, knowledge and scientific, are observed which result in distinct responses. Knowledge uncertainty, i.e. uncertainty surrounding awareness of associated benefits and risks, can result in a demand for further information and impacts the stability of emerging attitudes. The existence of scientific uncertainty, i.e. indication of possible negative consequences of applying the technology, is the basis for immediate reassessment of one's viewpoint. Expressions of dread are closely related to knowledge uncertainty and lack of personal control over potential hazards. Trust in science and regulatory frameworks are therefore considered important where personal control is perceived to be lacking.

Uncertainty and need for information

Each type of uncertainty (scientific and knowledge) appears to impact perspectives on the technologies. Scientific uncertainty communicated about potential hazards negatively influences evaluations: "*I suppose that's the reason why the whole world is half afraid of those two words, genetically modified…that we don't know what it's going to bring about"* (GM3, F, 55-64). This uncertainty impacts the stability of attitudes: *"You see until you told me about those particles…I was grand. But now that I am thinking about them. (…) I wouldn't deliberately buy something that I know would have particles that may lodge in my body or my friends or my family's"* (Nano3, F, 55-64).

In addition, knowledge uncertainty clearly impacts evaluations: *"I don't think I would have a problem in eating it [irradiated food]. But I suppose I am a bit ignorant to it in that I don't understand it… (…) how it could be harmful in some way?"* (Irrad1, F, 25-34). In fact, many are cognisant of the impact of both scientific and knowledge uncertainty on their evaluations: *"It's very easy to generate fear from the unknown"*, and while suspicious and fearful of the potential unknown risks, they recognise that *"concrete proof"* that the novel technologies are *"bad for you"* is lacking (GM2, M, 35-44).

While initial evaluations are often fashioned by personal orientations, a tendency towards lower concern is evident in cases of low levels of perceived knowledge uncertainty. In particular, the prolonged debate and media discourse around GM foods has contributed towards increased familiarity with the technology, which seems to foster less anxious responses: *"10 years ago I would have been horrified…I would have actually been very emotional about it. I would have said, 'absolutely not'. (…) I mean as the years go on, I am getting less and less against GM"* (GM3, PDILQ, F, 55-64).

The lack of evidence of associated dangers supports positive technology assessments: *“There’s no stories coming out saying that these [GM] foods are harmful. (...) I don’t see the harm in them at the moment”* (GM2, M, 35-44). In the case of a long established technology that has received little media attention, the duration of its existence is taken into account: *“I think after 30 years we might know that something was particularly bad”* (Irrad2, F, 45-54). However, limited exposure to discussion about this technology contributes towards it being viewed with a general sense of dread. Overall, knowledge uncertainty can result in a precautionary stance being taken: *“You would need information on it. (...) If I just saw nanotechnology I’d kind of…just wonder what’s it about”* (Nano2, F, 18-24). A need for further information is therefore evident. To this end, the view is generally expressed that the public *“wouldn’t have a clue”* (Irrad1, F, 25-34) about these technologies and that accessible information is therefore *“key (...) [in order to] take the fear and the uncertainty away”* (GM2, M, 35-44).

The importance of openness and transparency is stressed in situations where uncertainty persists about potential ensuing risks: *“If you don’t know…the repercussions of certain things, then you have to be honest with the public”* (Nano7, F, 25-34). Subsequently, demand for personal control and freedom of choice frame evaluations. Thus, acceptance, while not guaranteed, is conditional on the provision of comprehensive information, such as label information, that allows individuals to make informed voluntary choices: *“I would think a majority of consumers would want to know…where their food has come from and what it’s gone through”* (Irrad1, PDI, F, 25-34). However, it appears the demand for information may not be ubiquitous: *“It wouldn’t bother me (...) the fact that it was…the food was irradiated (...) I wouldn’t see a need for labels”* (Irrad3, M, 25-34). Therefore, while some attempt to limit knowledge uncertainty through information seeking, others use heuristics and tend to display emotional reactions. The latter seem to display limited need for cognition and interest in acquiring and processing relevant information; particularly if they place high levels of trust in the regulatory system.

Trust, regulation and assurances of safety

Trust in scientists and regulators to control any potential technological risk appears to act as a heuristic in guiding evaluations: *“From a consumer point of view, if I went into a supermarket and something is on the shelf, I would just presume that it has been passed* *by all the authorities that say, 'right, this can be sold here, there's nothing wrong with it, it's safe'"* (Irrad5, M, 35-44). Individuals' perceptions of low personal control/ power are offset, to varying degrees, by their trust in other stakeholders to ensure protection against potential risks. Desiring personal control over exposure to such risks is tempered with a recognition that this had to be ceded to regulators, due to perceived personal inability to assess safety risks.

That withstanding, concerns with safety are pervasive and evidence of the need for a precautionary approach is, once again, apparent: *"It's all about being tried and tested"* (Nano4, F, 35-44). The need for adequate regulation, transparency and risk assessments is stressed and *"rigorous testing"* and safety assurances are demanded. In fact, positive evaluations are based on the assumption that the technologies will be adequately regulated.

Trust, regulation and information requirements are closely linked to uncertainty. This perceived uncertainty influences perspectives, with knowledge uncertainty influencing the stability of attitudes and scientific uncertainty forming the basis for cautious responses. In turn, the perceived relevance of scientific uncertainty impacts evaluations.

6.2.3 Theme 3: Perceived Relevance

Individuals classify associated products based on their views of the technologies and associated benefits offered. Following this, they negotiate these products based on the prioritisation of associated values in given contexts, in order to shape overall evaluations. While guided at a more abstract level by individuals' personal orientations, the perceived relevance of benefits offered by foods produced using these technologies and their alignment with self-identities also impact perspectives. Foods classified as offering value on dimensions considered important in given contexts are received more favourably: *"If it's prolonging the shelf life and (...) if there's other health benefits there as well then…I would be all for it [food irradiation]"* (Irrad3, M, 35-34). The most notable of these are health, taste, price, safety, and shelf life characteristics. Evaluations are generally positive in cases where current offerings on the market place are seen as sub-optimal, and the technologies offer an alternative that eliminates perceived sacrifices between highly valued attributes, particularly health and taste.

This theme addresses the concept of perceived relevance and necessity within different contexts. Following this, it examines the formation of perceived risk/ benefit trade-offs and their impact on evaluations.

Perceived relevance and necessity within contexts

The perceived relevance of related product benefits to the individual, their family, society, the environment and other stakeholders, and the perceived necessity of the applications presented, impact on openness towards the technologies: *"At the moment now, I live on my own. (...) I suppose when you are buying food…you are buying food for one. (...) There's always wastage. (...) If it [irradiated food] lasted a little bit longer (...) you would get more out of it"* (Irrad3, M, 25-34). This openness, however, depends on individuals' overall general values and priorities, and the identities they wish to portray. For example, some feel that, subject to any potential risks being adequately addressed, associated foods that can enhance the health of the nation should be welcomed: *"If it [a health promoting nano food] will improve people's lives, well and good"* (Nano3, F, 55-64). In fact, if societal benefits are viewed as great enough, personal reservations are set aside and, while not necessarily willing to purchase such products, they believed that they should be made available: *"For myself (...) I wouldn't like that [GM crops]. But again, I am also aware of (...) the third world countries…poverty and all that. (...) I can see how **they would benefit**…but **I wouldn't benefit** from it really"* (GM3, F, 55-64).

Those voicing concerns about the impacts of human behaviour on the environment appear open to applications that offered environmental benefits. Furthermore, the suggestion of any environmental risks causes these individuals to reassess their initial positive evaluations: *"If it did have negative effects on the surrounding environment (...) it would put me off it…I would see that as dangerous"* (GM1, F, 18-24). Those holding a more *lassiez-faire* attitude towards the environment are less exercised about environmental benefits, and are also less concerned about potential environmental risks: *"I mean most of the packaging now isn't eco-friendly at all anyway. (...) That wouldn't be a major concern for me, because…I know it's kind of a dark view, but we are already pumping stuff into the environment that's not doing it any good anyway"* (Nano1, M, 25-34). Furthermore, although the potential impacts of these technologies on other stakeholders, including food companies and their employees and farmers (i.e. their expertise, practices and livelihoods and local produce) are raised, such references are secondary to individual and familial implications: *"It [potential impacts on food companies and their employees] wouldn't be as high on the list as knowing what I have on my plate or…what I give to whoever in the family is safer. (…)…that they are not going to get E-coli from me not cooking it very well"* (Irrad2, F, 45-54).

In addition, timelines and measurability issues tend to impact benefit and risk assessments, with distinctions being made between immediate and long-term implications: *"I would be more for [genetic] modifications that have immediate…more sort of quantifiable results. (…) Something like greenhouse gases …I still think it's a bit theoretical at the moment"* (GM2, M, 35-44). Indeed, some perceive current efficiency gains from adopting these technologies to outweigh potential unknown negative consequences, with this perception subsequently contributing towards positive evaluative stances: *"Personally I think it's [GM crops] progressive and it's good and it makes food production more efficient…which in my mind is more important right now than possible dangers that we don't know about yet"* (GM2, M, 35-44).

Not all applications are viewed as offering additional benefits, and in these cases, their necessity is questioned, in part due to the perceived adequacy of current food products: *"Food is healthy already…why are you making it even more. I would be afraid of the long term effects"* (GM1, F, 18-24). For example, some consider it unnecessary to enhance the health characteristics of fruit and vegetables, while others view food safety levels and/ or shelf life to be at a satisfactorily high standard: *"I haven't heard of anybody who is dying or in serious trouble because of the way that they are producing food at the moment"* (Irrad3, M, 25-34). Closely aligned to the concept of perceived necessity, is that of perceived benefit distribution. Generally speaking, benefits viewed as not accruing to individuals receive a more muted response. For example, nano coating on equipment is perceived as "*really only of benefit to the manufacturer*" (Nano5, M, 35-44). In turn, relevance and necessity are linked to perceived trade-offs between benefits and risks and are context specific.

Trade-offs

Deliberation over potential risk/ benefit trade-offs is central to product and application explicit evaluations. These trade-offs are particularly evident when assessing applications that offer increased food safety and extended shelf life. For many, perceived losses in terms of naturalness, freshness and healthiness of associated products are weighed against additional safety and/ or shelf life benefits: *"I suppose if you have something for longer, you are going to accept that it's not going to be as nutritious as something you eat straight from the garden"* (Irrad2, F, 45-54). Compounding these trade-offs, and creating an element of tension, is the possibility of further benefits, related to reducing waste, for the environment and their wallets.

Price is another key element used in trade-off negotiations. Price premiums are often considered acceptable if associated personal benefits are very apparent: "*In general, I suppose if the health benefits [of the nano food] far outweigh the other products on the market, then I think you would be happy to pay..."* (Nano1, M, 25-34). These trade-offs are also reflected on in the context of others: *"I suppose for me, it [the price premium] wouldn't really be a big issue, but I would suspect that for many people (...) [the] cost factor would be huge*" (Nano3, F, 55-64). Some feel that although they might personally be willing to pay a price premium to avoid these products, given their lack of knowledge of associated risks, they could also *"see why other people would go for it…if it was 10% to 20% cheaper"* (GM1, F, 18-24).

Tensions are also apparent concerning these perceived trade-offs, particularly in terms of perceived benefits of such foods and concern over potential unknown future consequences of interfering with nature as a result of applying the technologies: *"If a pro is a rasher [from a GM pig] that tastes a little bit better (...) and the con is something really disastrous that we don't know about yet; (...) it's hard to measure up the two things"* (GM2, M, 35-44). In such instances, a tendency may prevail for certain product values to dominate assessments, and thereby overcome attribute-based tensions.

The emerging trade-offs derive from individuals' classifications of the technologies and related product characteristics, which are more broadly impacted by their personal orientations. Furthermore, the dynamics of these trade-offs mould, in turn, how individuals create 'meanings' around the technologies.

6.2.4 Theme 4: Making Sense of Technologies

The set of source influences represented in the previous three themes interact and result in the materialisation and establishment of sense-making around the technologies. As part of this process, subjective weightings appear to be placed on each source influence, with these weightings being guided by the characteristics of the individual and technology. Therefore, this overarching component of the evaluative process, 'making sense of technologies', relates to the associations and meanings individuals construct and rely upon when categorising and interpreting information about the technologies, drawing on the reciprocally underlining influences. As such, these stimuli influences can be considered a mix of 'ingredients', which blend together, with the measurement of each source ingredient establishing the variety, measurement and consistency of the core 'sense-making ingredient' which is the central component of the 'evaluative mix'.

As part of the construction and establishment of scaffolds of meaning, interpretative schemas, a term used by Scheufele and Tewksbury (2007) to describe knowledge structures that represent salient concepts, appear to be used by individuals to make sense of the technologies; essentially to form evaluations.[35] Both existing schemas, drawn upon from memory and newly formed schemas provide links and associations, and thus frameworks for the contextualisation of information.

Pragmatic reasoned thinking acts as one of the mechanisms for forming/ creating these schemas around the technologies and prioritising risk and benefit assessments. In an effort to place the technologies within a context, comparisons are often made to risks and benefits associated with other technologies and innovations. For example, comparisons are made between food irradiation and chemical fumigation, and between BSE and genetically modifying animals: *"…definitely not [in favour of genetically modifying] my meat…because especially with mad cow disease. (...) I just think that animals….that [GM] meat could be even more dangerous for that reason"* (GM1, F, 18-24). This reasoned thinking, based on such comparisons, does not necessarily result in citizens reaching the same conclusions as scientists regarding their assessments of these technologies.

Evaluations of these unfamiliar technologies seem to be based on what is known. In fact, a tendency is evident to superimpose the technologies onto pre-existing interpretive schemas, e.g. irradiation to x-rays and cancer. In some cases, this may result in misinterpretation of the information presented. Word associations also support the formation of interpretative schemas. Specific images are generated by individuals around

35 Goffman (1974: 24) has also referred to such schemas as *"primary frameworks"*.

the technologies. For example, images conjured include: the *"injection of substances into food"* (genetic modification), "*tiny robots"* and computers (nanotechnology), and *"radiation"* (food irradiation). In fact, the image associations and superimposed interpretative schemas for 'irradiation' appear to act as a particular barrier to acceptance: *"The name would kind of put you off… (…) It's just to get away from the…radiation…part of the name. (…) If it had a different name I think (…) it could take off in a big way"* (Irrad3, M, 25-34).

The unknown consequences of technology adoption clearly play on individuals' minds: *"With technology like this…you have to go 30 years down the road before you realise the consequences"* (Nano5, M, 35-44). In fact, such concerns result in comparisons to risks now known to be associated with smoking, asbestos, excessive use of x-rays and some food colourants; generally these comparisons raise concerns. However, reflections around established food technologies (e.g. microwaving) appear to cause a positive re-evaluation of initial negative opinions and 'intuitive' stances on these novel technologies: *"Microwaves seem safe enough. (…) I suppose it's a similar enough technology…in a way. And if (…) it's prolonging the shelf life (…) I would be all for it"* (Irrad3, M, 25-34). In fact, an internal tension is evident, with concern about these technologies being set against evidence of the success and benefits of more well-established food technologies: *"Now…I would much prefer to buy pasteurised milk rather than unpasteurised milk. So it [nanotechnology] may go the same way…"* (Nano3, PDI, F, 55-64). Indeed, while desiring a precautionary approach, it is suggested that it is *"unfair"* that these novel technologies have to *"prove"* themselves through testing, while conventional technologies already in use do not: *"We don't know the effects of the old stuff either. (…) It would be slightly unfair to suddenly say it's the new stuff causing the problems"* (Nano6, F, 45-54).

Meanings associated with these technologies are also influenced by additional information. For example, perceptions of naturalness appear to change with the presentation of supplementary information. The naturalness of foods seems to initially be perceived by some to be compromised by adopting the technologies: *"The idea of it sounds good but the fact that it just seems very unnatural"* (Irrad1, F, 24-34). However, perceptions of unnaturalness change somewhat when contra arguments, e.g. alternative processing methods, are considered.

While evaluations often appear to be based on the use of interpretative schemas, "*emotional response[s]”* and *“gut reactions”* are also displayed in an effort to make sense of technologies, particularly when personal orientations guide evaluations: *“I have no scientific basis, but…just an intuitive sort of suspicion and fear…because you can do what you want to wheat but…when you are getting closer to living things…”* (GM2, M, 35-44). Affective reactions appear particularly influential when individuals lack, or perceive themselves to lack, the ability or motivation to understand the information presented, particularly the scientific knowledge to justify their negative opinions: *“It’s lack of knowledge linked with this (...) so fear comes in or some pre-conditioning”* (Nano3, F, 55-64).

Individuals also display *“rational”* and *“logical”* responses, guided by reflective processing. For example, some consider it *“quite logical”* and reasonable that companies wish to maximise profits through applying these technologies: *“I can see it’s quite logical that they would do it [apply the technology] taking into account finances and all the rest (...) once people knew what they were getting…I don’t think it’s unreasonable for a company to maximise their profit”* (Irrad2, F, 45-54).

Internal conflicts emerge when the mutually determining source influences come together to form and support the construction of networks of ‘meaning’. Specifically, tensions are evident in terms of conflicting reactive and reflective responses. For instance, concerns are voiced about the technologies, while their applications are concurrently viewed as *“reasonable”* and *“rational”* (Irrad2, F, 45-54). A further conflict is apparent in terms of adopting a precautionary stance, due to scientific uncertainty and the desire to encourage technological process: *“Nobody can predict what’s going to happen tomorrow, let alone in 100 years time. So…it’s very unfair to put a stop on it because someone says, ‘in 100 years time it could be bad’”* (GM5, M, 25-34).

The meanings constructed around, and in turn evaluations of, the technologies and associated risks and benefits are not homogenous across the sample. Evaluations are based on the relative importance of each influence to the individual. Subsequently, unique ‘rule books’ of acceptance form, shaped by the influences represented in the other themes. A key component of these rule books is individuals’ classification of the applications and products, and the associated meanings reflected upon when forming evaluations. For example, individuals’ personal rule books may vary in terms of what they perceived as natural. As an illustration, some consider GM foods to be an acceleration of a natural process "*just on a more fundamental level"* (GM2, M, 35-44), while others view them as unnatural: *"When you can grow it [GM crops] anywhere (…) it's not natural. (…) I don't think it's right to have wheat growing somewhere where you wouldn't normally have it"* (GM1, F, 18-24).

As part of this rule book, individuals display what Hallman (2000: 15) refers to as a *"hierarchy of approval"* in terms of their acceptance of the applications, based on the aforementioned influences. For instance, irradiating meat to increase food safety is generally considered more acceptable than irradiating fruit to prolong shelf life. GM plant applications are also perceived to be more acceptable than GM animal applications, due, in part, to perceptions of unnaturalness.

These rule books are an important 'tool' drawn upon to provide a skeleton for contextualising information and constructing meanings around the technologies. These individualised rule books aid classification and prioritisation of product attributes, and guide overall assessments of technology applications. In fact, these heuristic mechanisms appear to serve as an effective frame of reference to direct and streamline the evaluative process. Nonetheless, there may be circumstances where negative affect-based reactions, deriving from embedded beliefs and values, lead individuals to reject the technology outright, without reaching the stage of subconsciously, or indeed consciously, drawing on these internalised rule books as a method of processing information.

6.3 Discussion and Conclusion

Within this chapter, analysis has been presented of the key themes that are apparent in terms of the common features impacting and directing evaluations across the ECG. The analysis illustrates the complex set of influences, in addition to reflective responses and more affective reactions, drawn upon as a basis from which to form evaluations.

'Making sense of technologies' concerns the associations individuals construct when classifying and interpreting relevant information. This process involves the use of interpretative schemas, including existing memory-based schemas and newly formed schemas, which are created to provide the framework for information contextualisation. These 'meanings' form within the context of personal orientations, perceived trust and control and personal relevance of applications. Additionally, individualised rule books materialise and are relied upon as a means of expediting and simplifying sense-making around and information processing about the different applications and products within different contexts. The characteristics of the individual appear to impact the prominence of each influence in guiding implicit and explicit 'rule formulation' and overarching attitudes formed. Certainly, these rule books illustrate the uniqueness of technology evaluations to the individual's beliefs, general values, and experiences and their prioritisation of product values.

Personal orientations and risk and benefit assessments of product characteristics play fundamental roles in contextualising information and shaping evaluations. These two themes are similar in character to the top-down and bottom-up influences examined in Chapter 5. However, these themes and associated features move beyond the TDBU paradigm, by developing a more comprehensive appreciation and contextualisation of the interwoven and intricate relationship between these constructs and their associated features, thereby enhancing understanding of this topic. As postulated, this inductive analysis confirms that the TDBU influences do not account for the complete picture of how attitudes towards the technologies form and evolve. Focusing solely on the features of the TDBU Model overlooks the critically important and complex cognitive associations (i.e. sense-making mechanisms) outlined. Indeed, the findings presented illustrate that these associations and interpretative schemas are a contextual cornerstone guiding information processing around overall evaluations of these technologies.

Personal orientations provide the basic framework for individuals' interpretation of information about the technologies. These orientations can result in the formation of inner 'standards' which are a strong basis for making sense of the technologies, by providing existing schemas upon which to form perspectives. Subsequently, perceptions of these technologies violating these standards may result in the demand for a precautionary approach.

Perceived control and trust in science and regulators are a basis for attitudes to change, if any scientific or knowledge uncertainty is evident. If trust exists; the extent of attitude change due to new information may be somewhat moderated. Openness to the technologies is therefore influenced by trust and perceived control; the lower the trust level, the more cautious a person is with regard to the novel technology.

The perceived relevance of the technology and associated product attributes appears to be guided, more broadly, by individuals' beliefs, values and experiences. Additionally, the perceived relevance and necessity of the applications and associated products to a person's everyday life and important values provide a platform for evaluations. These values have the potential to become deciding factors in forming evaluations, depending on their weighting, prioritisation and alignment with individuals' goals and self-identities. Furthermore, relevance and necessity are linked to perceived risk/ benefit trade-offs within specific contexts.

Having discussed each emerging influence, the focus now moves to further contextualising the relationships between these features. The centrality of the Conceptual Model (Figure 6.1), previously presented, to the analysis is its visual delineation of the complex interplay and mutually determining relationships that endure between the influences, which ultimately shape technology evaluations (Leshem & Trafford, 2007; Imenda, 2014).

The salience and weighing of each influence and associated features, in terms of the manner and extent to which they impact evaluations, may become greater or lesser depending on the characteristics of the individual (e.g. whether s/he is generally risk sensitive) and the technology (e.g. how (un)natural it is perceived to be). Thus, the relationship between these factors is complex and, in many instances, interdependent with reciprocal swaying occurring between and within these influences. The relationships between these influences may also be inharmonious and conflicts may arise. This may particularly be the case where tensions are apparent between reactive (emotional) and reflective (cognitive) responses, and may result in attitude ambivalence and instability. Therefore, in addition to mutually moulding and reinforcing each other, these influences may also compete with each other.

Furthermore, the boundaries between these dimensions may be permeable; however, the central theme and features of each influence are distinguishable. As an illustration of this penetrability, the perceived relevance of the technology and associated product attributes appears to be guided, more broadly, by an individual's beliefs, values and experiences. In addition, high levels of trust in regulatory frameworks may contribute to positive safety assessments of associated products encompassing attributes which individuals potentially value. In fact, causality between these influences is sometimes unclear, due to the complex interchange and interaction between them.

Despite this permeability, for some, a particular influence may dominant sense-making and evaluative processes to the extent that its impact outweighs and supplants that of the other factors. This eventuality may result in an individual accepting or rejecting the technology outright, without reflecting upon the other features that might impression their attitude, or (sub)consciously reverting to their internal rule books as an information processing technique. As a case in point, personal orientations, e.g. resistance towards the technology based on embedded attitude about interfering with tradition and traditional food practices, may dominate to the extent that these general beliefs and values eclipse the impact of the other influences on attitudes formed. In effect, reliance on trust in others and the perceived relevance of associated product characteristics may be outstripped by the impact of personal orientations on sense-making around the technologies. Alternatively, the perceived relevance of associated product attributes may be so influential that their impact outweighs and overcomes any reservations held about the technology deriving from engrained beliefs, values and experiences.

This analysis provides a greater conceptual understanding of citizens' attitude formation around emotive and contentious technologies, which is grounded in individuals' construction of meaning around information presented. Leshem and Trafford (2007) argue that a conceptual model evolves as the research and analytic process advances. This inductive phase of the thematic analysis has presented a preliminary conceptualisation of the features impacting evaluations of the ECG within a working Model. Chapters 7 and 8 present deductive analysis which establishes the relevance of this Conceptual Model to the other less contentious technologies. The Model presented is therefore a conceptual lens through which to view the rest of the dataset. To this end, the following propositions form the basis of the remaining stages of inquiry:

Proposition 3: Personal orientations provide a foundation for individuals' contextualisation of information about and, in turn, evaluations of the BNG and PSOG.

Proposition 4: Individuals' perceptions of power and control over these technologies' application influence their 'sense-making' around and, subsequent, evaluations of these technologies.

Proposition 5: The perceived relevance of these technologies and associated risk and benefit characteristics are a key influence determining how individuals contextualise and evaluate information about them.

Proposition 6: Personal orientations, individuals' perceptions of power/ control and perceived relevance interact together to construct sense-making around these technologies when classifying and interpreting information about them.

Hence, the analysis that follows further investigates if citizens' evaluations depend not only on the characteristics of the individual, but also on the characteristics of the technology. In addition, although the thematic analysis presented is predominately deductive; the data has also been analysed to examine for anything distinctive or novel in the context of the emergent themes and their features and emphases.

Following this, Chapter 9 comprises a discussion on the materialising themes and how they manifest across the technology clusters. Concepts and theories from relevant literature are drawn upon to strengthen this analysis and provide insights into how this Conceptual Model applies to the different technologies.

Chapter 7

Citizens' Evaluations of NFTs: Testing the Emerging Conceptual Model for the BNG

7.1 Introduction

In this chapter, consideration is given to the relevance of the Conceptual Model (see Figure 6.1) representing the features influencing evaluations of contentious NFTs to less contentious ones. This analytic phase is therefore in keeping with Perry's (1997) suggestion to explore conceptual replication across different cases along a continuum.

Essentially, this stage of analysis seeks to establish whether personal orientations, perceived control and risk/ benefit perceptions support 'sense-making' and, consequently, evaluations around the BNG. This group encompasses thermal and non-thermal processing technologies. In order to test if the themes and related features for the ECG are relevant to these processing technologies, the following propositions are forwarded as the basis for this stage of inquiry:

Proposition 3a: Personal orientations provide a foundation for individuals' contextualisation of information about and, in turn, evaluations of the BNG.

Proposition 4a: Individuals' perceptions of power and control over these technologies' application influence their 'sense-making' around and, subsequent, evaluations of these technologies.

Proposition 5a: The perceived relevance of these technologies and associated risk and benefit characteristics are a key influence determining how individuals contextualise and evaluate information about them.

Proposition 6a: Personal orientations, individuals' perceptions of power/ control and perceived relevance interact together to construct sense-making around these technologies when classifying and interpreting information about them.

This sub-set of the dataset was also analysed to examine for anything unique, in the context of emergent themes and patterns not already encompassed within the Conceptual Model. If and where the emphasis of the themes and features differs, it is clearly indicated as such divergences emerge.

7.2 Proposition Testing - Key Emerging Themes

In order to explore whether each proposition holds for the BNG, empirical evidence and supporting quotations are presented.

7.2.1 Personal Orientations - Proposition 3a

When presented with information on the more benign technologies, participants' personal orientations guide their initial reactions and are used in expressing internalised standards and self-definitions, which originate from general values and beliefs. The values most impactful in setting these standards and the rigidity of individuals' attachment to them seem to vary. Nonetheless, attitudes towards nature, food production/ processing and technological progress appear to be the most salient, meaningful factors underpinning preliminary responses.

Attitudes towards nature and the preservation of naturalness are key: *"I think people would like minimally processed… that certainly appeals to me. The less done to a product that I buy, the better as far as I can see"* (Therm5, M, 35-44). Thus, views on processed food look to be one of the factors guiding evaluations: *"I suppose I avoid purchasing food products that are processed in any way if I know about it. So maybe I would say that I am unlikely to [purchase such products]"* (Therm5, PDILQ). Although perspectives on nature are influential, moral and ethical issues are not raised in the evaluation of these technologies.

Despite attitudes towards nature manifesting as a driver of resistance towards the technologies for some, others view them as an emulation of natural processes and a representation of a harmonious relationship between nature and technological progress: *I think the technologies like ultrasound (…) to an extent, it happens in nature. I wouldn't have any fear of it because (…) what we are doing in the last century (…) we are gathering what nature was doing all along and we are just recreating it in technology. (…) On a personal level, I wouldn't have any fear of that"* (Non-Therm4, M, 45-54).

Aligning with this perspective, there is evidence of an influence of attitudes towards technological progress: *"There has to be progress. (…) We can't stand still"* (Non-Therm3, F, 55-64). Indeed, concerns are expressed by techno-enthusiasts about the failure to adopt these technologies leading to society lagging behind, in terms of progress: *"I think it [non-thermal processing] is positive. (…) I think we have to go along with progress or we'll be in the dark ages"* (Non-Therm3, PDILQ, F, 55-64). In this vein, strong belief in societal benefits of technological advancement curbs any initial scepticism about them: *"I have seen people who have been sick, and I have seen them with modern technology, and how much everything has improved. So we have to go* *forward. (…) That [any possible risks associated with the technology] wouldn't bother me at all"* (Non-Therm2, F, 45-54).

In spite of apparent apathetic reactions towards the technologies, unforeseen implications of their application trigger risk-based responses for some, which tend to moderate positive perceptions: *"It [radio frequency] seems like a perfect application of technology (…) as long as there's no side effects to me. You know that keeps striking a chord (…) …as long as it doesn't do anything to me at the end of the day, I am happy enough"* (Therm5, M, 35-44). However, for many, presumptions about the technologies' non-threatening characteristics result in risk-based responses not being triggered and explicit moral and ethical stances not being referred to.

As previously outlined in the context of the ECG, intuitive stances held reflect the vocalisation of tacitly inherited internalised standards, deriving from embedded values and beliefs and prior experiences. These stances impact how one believes they might behave (react) when faced with a real-life purchase/ consumption situation concerning related products: *"I suppose I avoid purchasing food products that are processed in any way if I know about it, so maybe I would say that I would be unlikely to [purchase thermally processed products]"* (Therm4, PDILQ, M, 45-54). In effect, past, present and perceived future experiences constitute a basis from which to understand and interpret new information about these technologies. Specifically, initial evaluations are driven by stances which are rooted in and derive from values, roles and experiential knowledge. These include prior knowledge of food safety issues, food purchase and preparation habits and, to a certain extent, individuals' health status and familial implications. The following quotation illustrates the impact of these experience- and value-based standards on evaluations: *"It [the extremely low possibility of trace amounts of metal particles potentially being released during PEF] wouldn't really concern me, because (…) if you are using tinned product and (…) you open a tin of fruit and leave it in the fridge overnight and you need to use it the next day (…) …how safe can something be? No matter what technology is used, you are never going to be 100% [guaranteed safety]. And then we have fillings which are mercury…so you can get a system as good as you can get a system"* (Non-Therm2, F, 45-54).

Where the technologies are believed to undermine standards and/ or compromise individuals' core values, resistance towards their application is evident: *"When we shop,* *we don't buy tins or jars, we tend to make everything from raw ingredients. I find it cheaper and I'm more aware of what's in the product then. We have a daughter too and I'm conscious of what's going into her mouth. So, generally I don't like to hear food has been messed with or tampered with"* (Therm5, PDILQ, M, 35-44). Hence, acceptance is dependent on one's perception whether the technology supports or violates personal and familial routines, needs, desires, ideals and internalised standards.

Nonetheless, contrary to the case for the ECG, specific life course events and experiences, including work roles and educational experiences, do not emerge during these particular deliberative discourses as factors supporting preliminary evaluations of the processing technologies. Their perceived benign characteristics and lack of personal relevance may contribute to these experiences not being consciously drawn upon by participants when forming attitudes around the BNG. Moreover, initial apathetic perspectives, and perceived alignment with internalised standards and orientations, impact the extent to which control over these technologies is commanded.

7.2.2 Perceived Power/ Control - Proposition 4a

Although these technologies are generally considered *"fairly innocent*" (Therm4, M, 45-54) and to be associated with minimal risks; nonchalant risk assessments do not nullify the demand for perceived personal control through information provision: *"I would prefer to know about it [the application of PEF] because I would see it as quite a harmless treatment"* (Non-Therm2, F, 45-54). The desire for personal control and freedom of choice thereby plays a role in guiding evaluations. Where personal control is believed to be deficient, trust in regulatory frameworks is relied upon as an infrastructural support for positive evaluations. The control related concepts of information requirements, trust, regulation and assurances of safety are discussed in turn.

Need for information

Limited awareness of the technologies and their applications result in a demand for information: *"Because people are so used to the way things are being done now, they should know if it [the product] has been changed and what the process is and the way it has being done and everything"* (Non-Therm5, F, 18-24). Positive evaluations are apparently conditional on relevant information being provided and understood: *"If I understand the process and I think it appears to be safe, (...) I would happily buy the* *product…if I understood and I knew the methodology behind it"* (Therm5, M, 35-44). Subsequently, openness and transparency about the technologies' application is demanded: *"I wouldn't see any problem with it [PEF]…as long as we are informed as to what's going on"* (Non-Therm3, F, 55-64). In fact, some feel that information concealment could foster anxiety about potential unknown consequences: *"I think it is good that everything is spoken about because if it's not announced, then it can come across as if you are hiding something…and there's something bad in it"* (Non-Therm2, F, 45-54).

While several questioned whether they would, in reality, be informed about the technologies' adoption, personal control through information provision is considered essential: *"If the technology was going to change and be accepted (...) you [would] have to put the information out first to say to people, 'this is safe'"* (Non-Therm4, M, 45-54). Informed voluntary choice is perceived as a mechanism of facilitating individuals' control over the purchase and consumption of related products: *"Once it's on the label, then it's up to you to make the decision, whether you buy it or you don't buy it"* (Non-Therm3, F, 55-64). Conversely, for others, product labelling is considered to be unnecessary, since alternative processing methods are not believed to be overtly stated on labels.

Many do not believe that labelling products as such would negatively influence purchase intentions, once relevant background information on the technology is provided: *"If I was aware of it [the application of the technology], then (...) it wouldn't have a negative impact on me whatsoever…probably more positive"* (Non-Therm1, M, 25-34). However, some argue that the absence of such information, coupled with products being labelled accordingly, could negatively influence their evaluations: *"If I saw it [radio frequency applied] on a packet, I would be very sceptical. (...) Maybe if I had a complete explanation…but if I just saw it on a label, I would be very sceptical"* (Therm4, F, 55-64).

In spite of the majority reporting that *"consumers should be informed"* (Non-Therm2, F, 45-54) about these technologies, expressing a desire for transparency and appropriate product labelling, and identifying themselves as information seekers; many do not portray information seeking tendencies about food products in general: *"If I can't taste the difference (...) and it's not written on the product…it's the same as anything else that's in front of me… (...) I would try it"* (Therm5, M, 35-44). Therefore, for some, a conflict is apparent between how individuals wish to portray, or even perceive, themselves and actual information seeking behaviours. Equally, others indicate their general lack of awareness and interest in actively engaging in information searching and processing about food production/ processing methods: *"I might pick up a can of beans, and say, 'yes, OK, they look nice'. But then, (…) I don't know how they are produced and it doesn't bother me"* (Therm1, M, 25-34).

Limited motivation to acquire and reflect on information appears to stem from perceptions about the technologies' non-controversial characteristics: *"Some people, (…) it [application of the technology] wouldn't bother them so much"* (Therm5, M, 35-44). Instead, evaluations of technologies that are perceived as low risk tend to focus on *"end results"* (Non-Therm3, F, 55-64). *"…if they taste the same at the end of the day, it [applying the technology] is fine"* (Non-Therm1, M, 25-34). Indeed, such low, or in some cases non-existent, risk perceptions seems to be linked to several persons expressing a demand for information about associated consumer implications, for instance impacts on taste and nutritional content, in lieu of technical details about the processes involved. Nevertheless, some display a greater need for cognition: *"I would have to understand [the technology]. (…) It might not be the case for everyone [but]…I definitely would have to understand at least some of how it's produced"* (Therm4, F, 55-64).

Overall, conflicting views and ambivalent attitudes on the desire and need for information are evident; with many advocating appropriate product labelling, yet concurrently suggesting that, to a certain extent, *"ignorance is bliss"* (Therm1, M, 25-34). Although information is demanded, in light of the perceived non-threatening nature of the technologies, contrary to the case for the ECG, perceived scientific uncertainty does not emerge as a feature guiding evaluations. Furthermore, requests for information are not as prevalent when high levels of trust are placed in regulatory authorities to safely govern the technologies. Trust is therefore an important heuristic, repeatedly leaned on, when forming attitudes towards the applications presented.

Trust, regulation and assumptions of safety

Trust in regulatory systems presents as a salient dimension of perceived control, which underlies positive evaluations: *"I think the processes that foods go through to be prepared are governed so well that (…) if something is going to get onto the shelf (…) it has to pass* *all the different tests and (...) it's governed correctly"* (Therm3, F, 35-44). This type of trust is considered particularly important by those who perceive personal control over the technologies to be deficient, due to the types of processed foods involved, which may contain several ingredients.

Trust appears to stem, in part, from a belief that these technology applications will not result in negative consequences. Hence, trust is clearly linked to the technologies' benign characteristics and the lack of perceived, associated risks. These supposed non-threatening qualities contribute to the ease with which trust is placed in the regulatory system to govern these technologies. Therefore, trust and risk perceptions seem interdependent, with the concept of risk triggering questions around regulatory frameworks and, equally, reliance on trust in others being grounded in a presumption of associated risks being manageable or non-existent. In fact, for some, low risk perceptions lead not only to a heuristic of technology acceptance, but also to a perceived absence of a need to rely on trust in regulators.

Broadly speaking, an assumption prevails that these technologies are adequately regulated: *"It would have to be up to standard. But it would never get onto the shelf, I would presume…if it wasn't up to standards and regulations. So…I would presume that would be done"* (Therm3, PDI, F, 35-44). This trust in regulators generates openness towards the technologies: *"I wouldn't have any problem with any new technology food wise or anything (...) as long as proper standards…background research has been applied (...) I really have no problem with advancements like that (...) if they are not hidden away (...) and standards are properly adhered to"* (Non-Therm4, M, 45-54).

Moreover, assumptions of safety guide evaluative stances, in lieu of a demand for assurances of safety (as was previously found to be the case for the ECG). Hence, the 'control' aspect of the Conceptual Model differs somewhat for this technology group. Although apathy towards these processing technologies and assumptions of safety are widely evident, some query the existence of any associated risks, and this questioning frames their evaluations: *"The only question I would have about it [PEF] is (...) are there any questions as regards long terms effects on people"* (Non-Therm4, M, 45-54). For some, positive assessments are therefore partially contingent on there being no *"residual side effects"*: *"I mean provided that it is safe and (...) it doesn't change the food in any way, then yes, I wouldn't have any problem with it"* (Therm1, M, 25-34). That withstanding, in the main limited safety concerns are expressed and presumptions of safety prevail, given the technologies' perceived benign features: *"I don't think I would have an objection. (...) because I don't think there is a disadvantage or anything"* (Therm4, F, 55-64). Furthermore, for many, despite expressing a desire for information, assumptions of safety appear to mitigate the need for product labelling: *"If there are tests done on it and there's literally no change whatsoever…it's just a different way of doing it, I mean putting it on the label really, at the end of the day, just doesn't matter"* (Non-Therm1, M, 25-34).

Overall, perceptions of adequate regulatory procedures to ensure safety tend to restrain any resistance expressed towards the applications: *"If the technology was to advance and be acceptable (...) it would have to be shown (...) the possibility of something like this [trace amounts of metal particles potentially being released after applying PEF] happening is very low or non-existent. You are talking about very strict safety standards. You are talking about imposing (...) maybe new standards if necessary"* (Non-Therm4, M, 45-54).

In conclusion to this section, clear evidence has been presented to support the proposition that individuals' perceived power and control over these technologies' application influence their evaluations of these technologies. In addition to views on perceived control, safety and regulatory issues, perspectives on the technologies' relevance to the individual and other stakeholders impact perspectives.

7.2.3 Perceived Relevance - Proposition 5a

Perceived relevance of associated product attributes emerges as key to the contextualisation of information and formation of attitudes around these technologies. This bottom-up based influence, focused on risks and benefit assessments, is a central component moulding evaluations. Indeed, classification and negotiation of associated product attributes appears to be an important information processing technique relied upon: *"Quality would influence me. I wouldn't just want the cheapest [product]. Quality would be important"* (Therm4, F, 55-64). Consequently, evaluations appear to be influenced by reflection, negotiation and prioritisation around the product values that are considered most important to individuals when making food choices within given contexts. Arising from personal orientations, the perceived relevance of the benefits offered influences perspectives: *"I would have to see a list of benefits. (...) I would consider switching [to the PEF product] if I could see what I was getting from it"* (Non-Therm2, F, 45-54).

As part of this categorisation dimension of the evaluative process, specific product attributes including taste, price, quality, safety, naturalness and nutritional characteristics manifest as important to reflect upon when forming evaluations: *"If there was a health reason for it and I saw it in the newspaper, I would say, 'OK, cool, yes'...if the price is right"* (Non-Therm1, M, 25-34). Products that offer *"apparent"* (Non-Therm1) enhancement of these characteristics, in isolation or combination, are more favourably assessed: *"I mean if it's increasing the quality of food (...) ...that's a pretty positive side effect"* (Therm1, M, 25-34).

Price materialises as an important attribute of consideration when evaluating associated products: *"If it drives the price up, then obviously that's a problem"* (Non-Therm1, M, 25-34). Taste implications are another important characteristic directing evaluation. Receptive stances hinge upon these characteristics being uncompromised following the technology's adoption: *"As long as it didn't taste bad, I wouldn't mind [the technology being applied]"* (Therm2, F, 18-24).

Similar to the emphasis for the ECG, this theme focuses on perceived relevance within various settings and the influence of risk/ benefit negotiations on evaluations.

Perceived relevance within contexts

Although these technologies are perceived to present potential benefits, their personal significance is considered to be relatively limited. Indeed, many of the applications (e.g. using radio frequency to prevent biscuits from breaking) do not register as noteworthy on consumers' agendas. As a result, reactions towards the applications presented are often expressions of indifference: *"As a consumer, it doesn't bother me in the slightest (...) whether they shorten the bake time [through applying radio frequency]. I am only concerned with the product that comes up on the table in front of me"* (Therm5, M, 35-44).

Furthermore, questioning of the personal relevance of these technologies attenuates positive evaluations: *"Generally, I think it's smart technology...but as a consumer I don't* *think there would be huge benefits"* (Therm5, PDI, M, 35-44). Overall, benefits associated with these technologies, such as increasing food safety and quality, extending shelf life and reducing waste, are recognised and somewhat valued. Nevertheless, these benefits do not seem to be a particular stimulus of evaluations in a positive direction, since they are not perceived to be exclusively attainable through adopting these novel technologies.

Broadly speaking, personal relevance is prioritised over implications for other stakeholders: *"I would consider switching [to the PEF product] if I could see what* ***I was getting*** *from it"* (Non-therm2 F, 45-54). However, it is generally felt that the benefits of applying these technologies are primarily extended to industry, rather than individuals. In fact, several persons go so far as to question the technologies' relevance beyond their significance to food manufacturers: *"It's great, the technology (...) but from a consumer's point of view, [I question] whether it's hugely relevant to me. It sounds like you could sit down and it's a business argument almost to convince the producer"* (Therm5, M, 35-44). Notwithstanding this fact, the technologies' apparent non-threatening nature underwrites a lack of opposition to industry benefiting through associated efficiency gains and cost savings: *"It wouldn't really make a difference to me [if a company did not pass on the cost savings]...I suppose because I would be paying the same price for it as other things anyway"* (Therm2, F, 18-24). That said, not all reactions are of indifference towards the concept of companies not passing on cost savings to consumers.

More generally, responsiveness towards the technologies within different contexts depends on individuals' prioritisation of deep-seated beliefs and values. While the social significance of these technologies is, by and large, judged to be minimal, some express a personal notion that increased societal emphasis on healthier eating would result in these technologies being well received if they are associated with health benefits: *"If it [the thermal product] was a big health thing, I suppose they might like it better"* (Therm2, F, 18-24).

Environmental implications are another factor guiding evaluations, with efficiency gains, i.e. energy savings and waste reduction, being welcomed and highly valued: *"I mean if it [the technology] is energy efficient, then it's obviously better"* (Therm3, F, 35-44). For several persons, environmental repercussions are influential, depending on the prioritisation of product attributes: *"For consumers, I think it [reducing energy* *consumption] is becoming more important. (...) So, if you could say it has a positive effect on the environment (...) that would have a positive impact on whether I buy it or not"* (Non-Therm1, M, 25-34).

Although Proposition 3a, on the influence of perceived relevance on attitude formation around the BNG, is supported, the necessity of applying these technologies does not appear to be questioned during these particular interactions: *"I understand food has to be processed…it has to go through…unfortunately these processes to get to us. So, I probably wouldn't have a huge difficulty with it [ohmic heating] (...) now that I understand it"* (Therm5, M, 35-44). The characteristics of the technologies, the apparent lack of ethical and moral concerns, and limited perceived personal relevance may cause the dearth of questioning about whether these particular technologies should fundamentally be applied during these discourses. These attributes also impact risk and benefit perceptions, which, in turn, influence trade-offs made in the context of associated product attributes.

Trade-offs

Salient product characteristics are negotiated and subsequently traded-off against each other as an information processing technique. Sensory perceptions, most notably taste, and monetary considerations tend to generate internal tensions and necessitate considerable prioritisation around, and trading-off between, these attributes, as a mechanism of overcoming such conflicts.

Deriving, in part, from their non-threatening qualities, the most apparent risk and benefit trade-offs centre around deliberations on price implications: *"It's hard to know whether you would buy one [an ohmic heated product] that was (...) more expensive. (...) If it was nutritionally better, then yes, I would probably buy it"* (Therm1, M, 25-34). Indeed, some declare that they personally would be willing to pay a premium for associated products which offer benefits over conventional alternatives, yet concurrently express a belief held about others possibly being unwilling to do so: *"You don't mind paying the extra €2.50 because you are getting something which is fresh. (...) Some people would say no (...) but on a personal level, I wouldn't mind paying extra"* (Non-Therm4, M, 45-54).

The negotiation, prioritisation and trade-off techniques employed, which originate from classification of the applications and associated product attributes, consequently delineate and shape meanings associated with these technologies.

7.2.4 Construction of Sense-making around the Technologies - Proposition 6a

Similar to the findings for the ECG, the combination of the aforementioned source influences ultimately acts as a means of making sense of these technologies. As part of this theme, individuals categorise and interpret information at multiple levels, by building upon the features comprised in the other themes, to make sense of the technologies in dynamic and complex ways. Once again, existing interpretative schemas, which build on imbued associations and personal denotations, are drawn upon to contextualise and create meanings around information provided and guide evaluations.

Lack of familiarity can lead to initial questioning and expressions of uncertainty about how to react to and embed meaning around the technology concepts: *"It [applying the technology] probably wouldn't put me off, unless I knew it was going to harm me and I don't know that, so it probably wouldn't put me off"* (Therm3, PDILQ, F, 35-44). As a result of limited awareness, image connotations are restricted. Nevertheless, some associate ultrasound with its medical usage within hospital settings. Furthermore, it is argued that the technology names may trigger negative public perceptions, in the absence of explanatory information.

Once the technologies are explained, associations with familiar conventional processing methods and product attributes are used to categorise and contextualise the novel technologies. In several occurrences, reliance on these comparative contextual cues alleviates initial scepticism: *"[Application of] the technology wouldn't bother me…as long as I knew that it wasn't going to (...) do me any harm…more so than eating any other processed food"* (Therm3, F, 35-44). Examples of comparisons made include microwaving and pasteurisation. Stemming from prior experiences and enduring values and beliefs, these associative meanings impact overall evaluations of the BNG. For example, thermal processing technologies, specifically ohmic heating applications, are considered a 'natural' process compared to using chemical solutions (lye) and similar to using steam, when these alternative methods are presented: *"I see it as [an] improvement* *on the conventional. (...) I didn't really perceive any negative things about it"* (Therm4, PDI, F, 55-64).

Where the technologies are anticipated to possibly offer benefits, including improved taste, increased nutritional content and/ or less invasive processing methods, relative to conventional alternatives, these associations positively influence evaluations: *"If it [ohmic heated food] was nutritionally better then yes, I would probably buy it"* (Therm3, F, 35-44). In this vein, some consider these technologies to be advancements on traditional methods: *"I mean we use microwaves every day of the week. And we accepted it. (...) The technology is already there. It's just another step. Every technology moves on and on and on, so…that's why I wouldn't have any real problem with it [a non-thermal technology]"* (Non-Therm4, PDI, M, 45-54).

Comparisons to conventional processing methods equally result in negative associations and evaluations, depending on views held about these counterparts' (un)naturalness, which, yet again, are more broadly impacted by personal orientations: *"It [radio frequency] just sounded too much like microwaving food to me. (...) It just didn't sound natural. And, as a result, it doesn't sound good (...) I have no reason to doubt that it's perfectly good, but I just do"* (Therm1, PDI, M, 25-34). In several instances, these types of negative comparisons, based on perceived knowledge, contribute to emotional reactions: *"I mean maybe it [radio frequency] doesn't affect the quality of the food…but in some irrational way in my mind, it probably would. (...) This is probably where my ignorance comes in. It does sound more like microwaving food, and I just don't like the idea of the whole process"* (Therm5, M, 35-44).

In general, the applications presented are broadly considered to be reasonable, especially from the producer's perspective. Indeed, a perceived dearth of personal relevance appears to contribute towards indifferent and blasé attitudes being expressed towards the applications: *"It [applying high intensity ultrasound] wouldn't have any effect [on me] whatsoever (...) if it's made one way and it's made another way. (...) If it drives the price up obviously that's a problem (...) but, there would be nothing that would sort of drive me away from buying a product that was made like that"* (Non-Therm1, M, 25-34). Attitudes of indifference are heightened in instances where the technologies are compared to food processing methods more broadly: *"I am pretty sure there are probably* *far worse ways of producing [food], so I don't think it would bother me too much"* (Therm1, M, 25-34).

Evaluative stances on these technologies appear to be formed in the moment, due to their perceived benign characteristics. Indeed, some seem to essentially question the merits of investing 'cognitive energy' in forming attitudes around these technologies: *"Once it doesn't alter the taste of the food (...) it doesn't bother me what way it [the product] comes through"* (Non-therm3, F, 55-64). In actuality, attitudes held by some are indifferent to the point of these individuals overlooking personal implications when assessing the technologies, and essentially excluding themselves from the 'evaluative equation': *"It [applying the technology] wouldn't bother me (...) if they found a better way to do something. (...) I think with all those things you have described, there's no risk attached to anything. So in that case, it's just a matter of a better…maybe a more efficient process of doing things, that makes sense from a business point of view"* (Therm4, F, 55-64).

Similar to the emerging finding for the controversial technologies, lack of homogeneity in terms of individuals' contextualisation of information and overall evaluations indicates that unique 'rule books' of acceptance are an apparent means of sense-making around these technologies. These individualistic, multidimensional sets of rules, which derive from inherent values beliefs and experiences, are created and drawn upon to streamline and simplify information processing.

Perceptions of conventional alternative technologies are a key component of these personal information processing systems. In addition, product classification and associated meanings are another rule book features which impacts openness towards the different applications. Evidence of this is illustrated by the following assessment of the concept of purchasing meat cooked using radio frequency: *"Well I would probably automatically pick the conventional way. (...) I suppose it's because it's meat. (...) My Mom has always drilled it into me (...) [that] meat has to be cooked properly. (...) I just have this automatic thing where I wouldn't trust it (...) …it's not as well known. (...) You automatically know that you are going to cook your meat in an oven"* (Therm2, F, 18-24).

Furthermore, some distinguish between the different thermal and non-thermal technologies, therefore displaying a hierarchy of approval, as previously referred to in Chapter 6. These rule books therefore illustrate the distinctiveness of evaluations to the specific technology, in addition to the individual. However, others consider the various technologies to be different methods of reaching the same overall objective: *"I just saw them [radio frequency and ohmic heating] as two different things that were really achieving the same [aim]"* (Therm4, PDI, F, 55-64). Furthermore, the extent to which individuals draw on these rules depends on: 1) their motivation to cognitively reflect upon the applications which, as previously illustrated, may be lacking given the technologies' assumed benign qualities; and, 2) the extent to which instilled beliefs and values dominate the evaluative process.

The internal 'rules', meanings and associations outlined are relied upon to contextualise information, eventually leading to the formation of evaluations. As postulated, these information processing techniques originate from the assembly of influences embodied in the other themes. In particular, evaluations appear to be predominately guided by: the technology's characteristics, including perceptions of both minimal ensuing risks and personal relevance; associated product attributes and value negotiations; and, comparisons to conventional processing methods.

7.3 Discussion and Conclusion

The analysis presented in this chapter offers support for the four propositions forwarded. The Conceptual Model used as the basis for these propositions allowed for a comprehensive analysis of the dataset for these specific technologies. In other words, themes outside of the Model were not identified. Consequently, in spite of the obvious characteristic differences between the two technology clusters examined in this and the previous chapter, attitude formation around each group evidently originates from the same source influences and information processing mechanisms.

Where manifestation of these influences/ themes differs, and features of the Model were not apparent during these specific deliberative discourses, have been outlined as they emerged. The frame of reference (technology) and its context seem to be a reason why certain features that were evident for the ECG were not overtly discernible during the interactions with participants about the BNG. Specifically, given the technology set's perceived non-controversial qualities, moral and ethical stances were not referred to by participants when discussing these technologies, despite the evidential impact of other general values and beliefs, such as attitudes towards nature, on perspectives. In addition, although information is generally demanded to increase perceptions of power and control, scientific and knowledge uncertainty play a limited role in guiding evaluations for these non-threatening novel processing methods. Another deviation from the original Conceptual Model is that trust reveals itself differently, with assumptions of safety, rather than a demand for assurances of safety, guiding evaluations, once again due to the characterisation of the BNG. Finally, although perceived relevance (or lack thereof) considerably influences evaluations for the contentious technologies, perceived necessity is not questioned by participants when reflecting on these particular technologies.

In spite of these minor alterations, the analysis presented confirms that the Conceptual Model is an appropriate lens through which to view and explain the interdependent influences impacting evaluations of the BNG (see Figure 7.1).

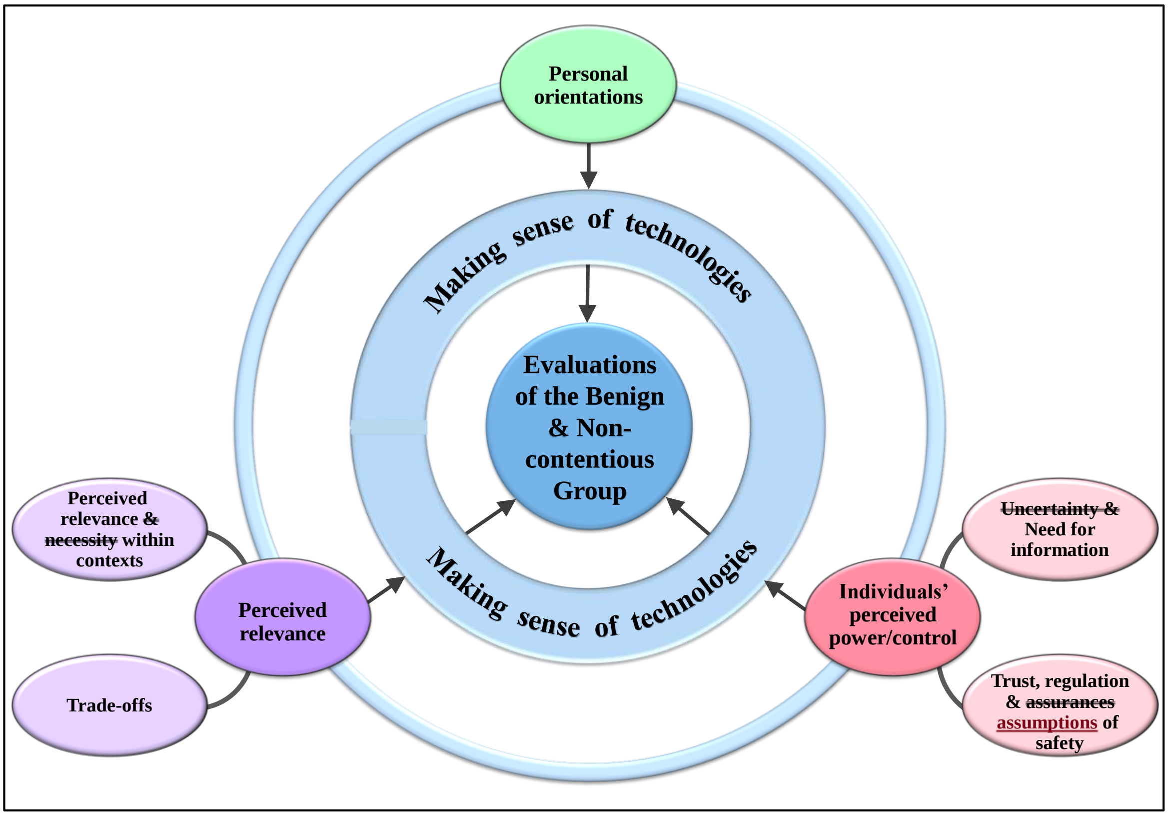

Figure 7.1: *Conceptual Model of Features Influencing Individuals' Evaluations of the BNG*

Despite the relevance of the Model to this technology group, alternative perspectives could be taken when analysing this data sub-set. Although the Model reasonably explains this sub-set of the data, it is recognised that it is one of a variety of lenses through which to examine it. A multitude of alternative perspectives could be adopted during data analysis. These include a sole focus on the impact of product specific trade-offs on acceptance levels, or tipping points in acceptance of the different applications presented.

In terms of the Conceptual Model used, as is the case for the ECG, the relationship between the associated influences is reciprocally determining, yet also potentially competitive, with these core components informing sense-making, and evaluations around the BNG. As expected, personal orientations, which represent the expression of internalised standards, provide a foundation to guide information contextualisation and the formation of schemas, in turn, directing responses. However, the benign characteristics of these technologies can result in certain personal orientations, such as risk-based responses, not being triggered, in comparison to their impact on evaluations of the more contentious technologies, for which concerns about violation of such standards are more prevalently expressed. A lack of risk-based responses when assessing applications of the non-controversial technologies may result in acceptance or expressions of indifference. It therefore seems to be the characteristics of the technology that result in certain orientations being triggered, as a broad spectrum of individuals were included within each technology group.

Building on the analysis here and in the previous chapter, personal orientations can be a salient factor guiding evaluations. In saying this, it is acknowledged that if the Conceptual Model had not formed the basis of this analytic stage, personal orientations may not have emerged as a definitive standalone influence guiding attitude formation around the BNG. Instead, it may have been inherently embedded as a feature directing the other influences.

Generally speaking, it appears that, depending on the individual and technology in question, reliance on these orientations can result in unquestionable technology acceptance or rejection, based on emotional, intuitive stances. In instances of such reliance, the reaction is not to engage in further information processing, i.e. not to reflect on the other influences. However, where one's assessment is not definitively impacted by personal orientations, they move to rely on the other (potentially moderating) influences when forming evaluations, as part of a reflective, iterative process of attitude evolution and information integration.

In spite of expressing a desire for information about these technologies, many do not generally portray information seekers behaviours about food production methods. This inconsistency between product labelling demands and seeking/ processing behaviours can be a source of conflict and attitude ambivalence. Furthermore, although a demand for information is expressed by many, low motivation to seek out and process this information is evident, relative to the motivation observed for the more controversial technologies. This low motivation can, yet again, be attributed to the non-threatening qualities of the BNG. Therefore, information demands and processing/ seeking behaviours depend not only on the individual, but also on the technology.

In light of participants' responses during these particular deliberative discourses, it is unlikely that strong reactions would occur towards these benign technologies in a real-life purchase or consumption situation. For these specific technologies, public reactions may be even more apathetic or indifferent in an actual purchase/ consumption setting; indeed, their adoption would most probably be a 'non-issue'. In such circumstances, it is possible that if an individual does engage in information seeking and processing about these non-threatening technologies, such activities will focus on trading-off associated product attributes. Nevertheless, reactions in this 'artificial' deliberative discourse environment do provide insight into the issues that would dominate the discussion if relevant information was disseminated to the public in a direct and targeted way.

Based on the research findings, limited safety concerns are expressed about these technologies, due to their supposed benign characteristics, with assumptions of safety mitigating, to a certain extent, the perceived need for labelling information. This lack of concern contributes towards attitudes of indifference towards the applications presented. Thus, scientific uncertainty does not materialise as a prevalent feature shaping evaluations during these deliberative discussions. Instead, trust in regulators tends to be relied upon when processing information, and is a basis for indifferent technology assessments. Overall, the BNG do not appear to trigger responses by participants to the same extent as the ECG.

Evaluations of the non-controversial technologies seem to be strongly guided by product characteristics. The prevalence of bottom-up influences is attributed to certain higher order orientations not being triggered as potentially under threat or violation as a result of the technologies' adoption, based on their attenuated nature. These perspectives descend, partly, from individuals' views on limited associated risks and personal significance. In fact, some question the relevance of these technologies beyond their significance to manufacturers. Notwithstanding this, relevance within different contexts is linked to perceived risk and benefit trade-offs. Assessments therefore occur at an applied, rather than an abstract or conceptual, level. Hence, the context of the technology, rather than the characteristics of the individual, is the key driver of evaluations occurring at a more direct, and less in-depth, level. Finally, comparisons to conventional alternative methods, based on perceived and actual knowledge, are heavily depended upon when classifying and interpreting information and making sense of these technologies. Therefore, the interpretative schemas drawn upon as part of this process centre around food production/ processing methods of which individuals have prior awareness and experience. Reliance on these comparisons reaffirms the practical level at which these technologies are contextualised. That withstanding, it is noted that for some actual knowledge of conventional alternatives, and food processing/ production, methods more broadly, appears to be relatively limited.

To conclude, this deductive analysis reinforces that the impact of each influence and associated features on citizens' evaluations of NFTs varies, depending on both the characteristics of the specific individual and technology. Building on the findings to date, the next chapter conveys further analysis which assesses the extent to which the original Conceptual Model is relevant to the outstanding technology group.

Chapter 8

Citizens' Evaluations of NFTs: Testing the Emerging Conceptual Model for the PSOG

8.1 Introduction

As the final stage of analysis, this chapter examines the relevance of the Conceptual Model (see Figure 6.1) that emerged from the analysis of the Emotive and Contentious Group (ECG) data to the Product and Service Orientated Group (PSOG). This group comprises functional foods and nutrigenomics/ personalised nutrition products (PNPs). In effect, the analysis presented considers whether personal orientations including beliefs, values and experiences, perceived control over the technologies' advancement and application and risk/ benefit trade-off perceptions guide how one makes sense of these technologies. Similar to case for the BNG, the following propositions form the basis of this analytic stage:

Proposition 3b: Personal orientations provide a foundation for individuals' contextualisation of information about and, in turn, evaluations of the PSOG.

Proposition 4b: Individuals' perceptions of power and control over these technologies' application influence their 'sense-making' around and, subsequent, evaluations of these technologies.

Proposition 5b: The perceived relevance of these technologies and associated risk and benefit characteristics are a key influence determining how individuals contextualise and evaluate information about them.

Proposition 6b: Personal orientations, individuals' perceptions of power/ control and perceived relevance interact together to construct sense-making around these technologies when classifying and interpreting information about them.

In addition to the Conceptual Model forming the grounding for this analysis, in the same way to the case for the benign technologies, this data sub-set was examined for distinct manifestations in terms of materialising themes and patterns. Anywhere the emphasis of the features and themes differs or additional themes or sub-themes, which are in a similar vein yet a unique orientation, are evident is indicated within the analysis relayed. Hence, any deviations from the Model are highlighted as they emerge.

8.2 Proposition Testing - Key Emerging Themes

Each of the aforementioned themes is examined in turn. The body of evidence, or otherwise, is presented with the use of illustrative quotes.

8.2.1 Personal Orientations - Proposition 3b

Reactions and responses to the PSOG are guided by personal orientations which represent expressions of stances stemming from a variety of prior beliefs, values and experiences. These include general risk sensitivity, attitude towards nature, food and food production/ processing, moral and ethical beliefs, attitude towards scientific and technological progress, and roles and experiences, such as routines and habits, life stage, heath status and priorities.

Similar to the emphasis found to be evident for the contentious technologies, general risk sensitivity plays a role in guiding initial perspectives for some: *"It would kind of have your alarm bells ringing alright…having a pharmaceutical product in a food like that… (…) it might scare you…"* (FF9, M, 18-24). When forming assessments, several comment that they are "*cautious about their life"*:*"I am not too sure [about nutrigenomics]…Would it be (…) …pushing to the boundaries of a person's life? (…) I would be kind of cautious [from a risk perspective]"* (Nut/PNPs4, M, 25-34). However, others appear to be less risk sensitive in their evaluations: *"There's no harm in them [functional foods]. (…) I think that it's not putting a risk that wasn't there before. (…) [Traditional] food can cause problems too for people…so I think that it [functional foods] can only really be positive"* (FF4, PDI, F, 18-24). It seems that risk-based responses are more readily triggered for those who are traditional and resistant to change: *"While it [functional foods] seems ideal and everything, one doesn't know the long term effects of doing this kind of process. There is that sort of a feeling in it. I suppose I am conservative. I feel that well, generations of us, the human race have survived quite well on the traditional foods, eaten in the traditional way. So I suppose, I am traditional in that sense"* (FF10, PDI, F, 55-64). Certain applications presented seem to actively trigger these types of responses, as illustrated by the following quotation: *"I would be concerned about (…) feeding them [cattle] the shellfish. (…) Is there any kind of side effects to the cattle from feeding them another animal product? (…) For some reason, I don't really know why…I am more sceptical of them being fed animal products. Is there more risk of the cattle getting sick from feeding them that stuff? (…) I don't know if I would be that enthusiastic about it [that type of functional food]"* (FF6, F, 18-24). Cautious reactions seem to be grounded in a desire to preserve nature and tradition.

Subsequently, attitudes to nature are a basis from which internalised standards form, which in turn direct evaluations. These standards trigger a sense of unease about *“tampering”* (Nut/PNPs3, PDI, M, 45-54) with nature, which looks to moderate positive preliminary assessments: *“I don’t like the idea of changing a product that’s already there and is good and natural. I don’t see why we must change it. And maybe even if we find benefits to start with…usually after some years, you begin to see other disadvantages that maybe didn’t appear in the beginning. (…) I am just generally against altering something that’s been good”* (FF10, F, 55-64). Whether the different processes, products and services in question are considered to involve *“a lot of processing”* (FF10) or *“seem natural”* (FF5, PDILQ, M, 18-24) shapes views: *“It [functional foods] wouldn’t be as good as natural food…as the natural way of producing it”* (FF4, PDILQ, F, 18-24). Successively, perceived “*crossing (…) of boundaries”* (FF6, F, 18-24) in terms of interfering with nature (and thus food) frame evaluations: *“I think sometimes…you fiddle about too much with food and it’s just not a good thing. Food ceases to be just food”* (FF3, F, 55-64).

Aligning with this stance on interference, many evaluate nutrigenomics and PNPs through the lens of explicit ethical and moral values and beliefs: *“For me, there are a lot of ethical/ moral considerations. (…) I still don’t know whether it [nutrigenomics and PNPs] is a good or a bad thing; whether there’s a moral issue of should you know exactly how your life could pan out? (…) I could definitely see the benefits. And then, I could also see the possible risks, if it goes to the absolute extreme of creating the perfect race kind of situation”* (Nut/PNPs4, PDI, M, 25-34). Moral and ethical preoccupations directing standpoints centre on pragmatic considerations, including social equality and ‘genetic privacy’ implications and whether young children should undergo this testing: *“How far does the information [about one’s nutrigenomics profile] stretch…to insurance companies…to the government?”* (Nut/PNPs4). Explicitly, trepidations about financial restrictions limiting equitable access to such testing and dietary advice impact perspectives: *“Nutrigenomics is brilliant. I think it’s a fantastic idea, but it’s got to be within the grasp of the ordinary person. (…) It’s got to be for everybody”* (Nut/PNPs3, M, 45-54). In support of egalitarianism, many express the belief that although *“health is wealth for most people in the world”* (Nut/PNPs4, M, 25-34), all members of society *“should be given a fair chance”* (Nut/PNPs3, M, 45-54) to avail of such testing.

Deriving from religious and theological beliefs, rhetorical questions raised about whether it is *"morally right"* to know about your disease susceptibility, and also to be able to defy your *"destiny*", guide evaluations: *"How far can you go without maybe going too far? I would be religious to an extent. (…) I believe in God. (…) I know God has given us the ability to go this far, [but] should we go this far? (…) Where does it [nutrigenomics] stop?"* (Nut/PNPs4, M, 25-34). Apprehensions about moral boundaries in terms of *"playing God"* (Nut/PNPs4) and interfering with divine law and natural order result in the adoption of a precautionary stance towards nutrigenomics: *"You might be tampering with things as well that you shouldn't be messing around with. (…) Maybe it's only mapped out for you that you are going to live until you are 50. (…) Are you tampering with fate?"*(Nut/PNPs3, PDI, M, 45-54). Thus, reflections on one's 'food life' within a larger moral/ ethical space fashion perceptions. For some, moralistic standpoints tend to conflict with a more *lassiez-faire* outlook towards scientific progress.

Perspectives on scientific and technological research and the role of scientists appear to direct attitude formation around these technologies: *"It [nutrigenomics] is so space age. (…) It's fantastic. (…) That's the way forward really. (…) It's so positive. (…) I do believe all scientists are there for the good of mankind. (…) If it [nutrigenomics] can save lives, at the end of the day, go for it"* (Nut/PNPs3). For example, those wishing to depict themselves as techno-enthusiasts focus on the positive outcomes of such advancements in their contemplations: *"It [developing functional foods] is using science positively"* (FF2, PDI, M, 45-54). These include health and life longevity related outcomes: *"Nutrigenomics will come…all the other scientific stuff will come eventually. (…) People are obviously living longer and it must be something to do with their diets"* (Nut/PNPs3, PDI, M, 45-54). In doing so, they portray their enthusiasm to *"go with science (...) to develop eating habits*" (FF8, F, 45-54), and their belief that these technologies form a valuable stage of sequential scientific advancement, which potentially has considerable societal and cultural implications: *"It [nutrigenomics and PNPs] is the way forward, it's the next step. Health foods are going that way. It's the next big, big step"* (Nut/PNPs2, PDI, F, 55-64). The perceived inevitable progression of these technologies is acknowledged: *"You can't stop progress either. (…) You [the scientist] are not going to stop doing what you are doing. And I think (…) it [functional foods] is part of a natural progression"* (FF10, PDI, F, 55-64).

Despite generally positive initial reactions towards *"next big step"* nutrigenomics and PNPs, undercurrents of apprehension and tension are apparent when envisioning where the boundaries of nutrigenomics, PNPs and functional foods lie, and how they could transform and reconfigure lifestyles, social norms, nature and the relationships between these variables: *"Functional foods have to go ahead. People have to progress all the time. (...) But, how far can it go? Where does this stop? Will we be not eating at all…only injecting something into our veins in 30 or 40 years time?"* (FF7, PDI, M, 65+). Hence, their perceived wide-reaching long-term impacts on resources and society are a source of internal conflict for many: *"I can see all the benefits [of nutrigenomics], but (...) we already have enough problems trying to maintain [a population of] 6 billion. (...) And obviously by expanding lifespans of people with something like this [nutrigenomics] beyond the 100 years, you have a larger, older population. (...) It depletes food sources obviously. (...) It's going to divide society more"* (Nut/PNPs4, PDI, M, 25-34).

As previously found, the intuitive stances underlying evaluations derive from prior experiences and roles, including tried and tested food habits and practices: *"We are creatures of habit. (...) We go on what we are used to. We accept things that have been tried and tested"* (FF10, F, 55-64). Perceptions of these technologies supporting (challenging) established food purchase, management and consumption routines and behaviours seems to influence openness (resistance) towards them. Given the health emphasis surrounding these technologies, orientations and experiences around health and lifestyle are key influencers of attitudes formed: *"I would pay the extra [for a PNP] if it's going to benefit me health wise. (...) I am that way because of my health problems. I will pay the extra for the better quality…for the more natural ingredients, rather than the processed [food]. I won't buy the jar of spaghetti sauce. I will go and I will make it from scratch myself because of the way it makes me feel…"* (Nut/PNPs1, F, 35-44). Indeed, evaluations seem to hinge upon one's beliefs and judgements about the value and role that health plays in their life, and that of others: *"I think, in general, people would be very interested in it [nutrigenomic testing] because people are becoming more health conscious. They are more [concerned with] what they put into their body. (...) I think it's exciting, (...) [but] I suppose it depends [on] how you value your health"* (Nut/PNPs2, M, 45-54).

Thus, it appears that a person's health status and goals tend to materialise as a source of self-identity drawn upon when processing information: *"To me, it [nutrigenomics] sounds very exciting (...) because I am interested in health and food"* (Nut/PNPs2, F, 55-64). Experiential knowledge, about the relationships that exist between longevity, diet, health, wellbeing and lifestyle, underlies assessments: *"From my own education on my own diet, I know [what] I can eat to make me feel the way I feel. (...) You are what you eat. And, if there was a [nutrigenomic] test [that] in a few years' time they know, 'right you don't eat this because it will prevent this', it can't be anything but a huge advance in technology for us"* (Nut/PNPs1, F, 35-44). Many describe their commitment to purposeful enactment of a healthy diet and lifestyle, and how these technologies might facilitate the development and maintenance of health strategies: *"Nutrigenomics can be nothing but positive. (...) I am an optimist, so I am going to say it is totally beneficial, because I firmly believe that what we put into our body and what we are eating has a huge repercussion on the way we feel in ourselves. (...) I would feel a little bit excited now [about] what's going to come next from this"* (Nut/PNPs1, PDI, F, 35-44). Guided by their orientations around health, some are so receptive towards associated health benefits that this results in open enthusiasm for the products and services presented.

This health orientation appears to be closely tied to life stage and interest in developing and prioritising health maintenance strategies, which tend to augment their responsiveness towards the technologies: *"I would go for it [nutrigenomics & PNPs]. (...) I just kind of think it's [due to] my age; as I am getting older, I am becoming more aware. Whereas, when you are younger, you just eat whatever is at home…and if it's healthy or not, you don't really care; you don't really think about it."* (Nut/PNPs2, PDI, F, 55-64). While older persons seem to focus on their current health situation when contextualising information, younger persons appear to concentrate their reflections on how they might (re)value and subsequently integrate these products/ services into their diet and lifestyle, if and when specific health issues come to the fore. Thus, in their evaluations, many recognise that their health related priorities and values may evolve over their life course.

Experiences and roles, both health related and otherwise, create internal standards, which are a platform from which to digest information. For instance, familial roles at different life course stages direct perspectives: *"If I had kids…I would maybe move down* *that [nutrigenomics] line. (...) I would want to know exactly how to make my child as healthy as possible. (...) There would definitely be a very strong possibility that a lot of people would be in favour of it and the possibility of knowing how to prevent future family catastrophes"* (Nut/PNPs4, PDI, M, 25-34). Similar to the case for the ECG, work roles impact assessments, with professional experiences being drawn upon when contextualising information: *"I think it [nutrigenomics] would be a very good idea. (...) It would decrease hospital stays. It would increase people's lifespan. (...) It would make healthier and better living for people. (...) It seems like a really good idea, especially from the hospital side. (...) It would just cut out a load of problems... (...) especially if it prevents cancers"* (Nut/PNPs5, PDI, F, 18-24, Nurse).

To summarise and as postulated, personal orientations, experiences and roles act as a foundation from which to build standards, and consequently direct responses towards information about these technologies. In instances where the technologies are perceived to undermine these standards, this results in opposition towards them. From here, one can consider the second proposition on perceived power and control.

8.2.2 Perceived Power/ Control - Proposition 4b

Knowledge uncertainty can lead to expressions of a need for information about the technologies, while scientific uncertainty results in scepticism about associated benefits being *"true"* (FF9, M, 18-24)[36]. As previously found to be the case for the other technology groups, perceived scientific and knowledge uncertainty is linked to a desire for personal control through freedom of choice. Where control is considered to be absent, reliance on trust in science and regulatory frameworks materialises as an apparent 'influential cog' in one's 'evaluative wheel' which curbs initial scepticism expressed. Furthermore, specific to nutrigenomics and PNPs, these technologies are perceived to result in the creation of a sense of both empowerment and disempowerment, as a result of information being provided about the person rather than the product/ application, which consequently impacts perspectives. Each of these concepts is discussed in turn.

36 As outlined in Chapter 6, within this work knowledge uncertainty is considered to be uncertainty surrounding awareness of the technology's associated benefits and risks, while scientific uncertainty refers to the indication of possible negative consequences of applying the technology.

Uncertainty and need for information

Unknown consequences and scientific uncertainty are evident in framing evaluations, and in some instances result in weakly formed attitudes around each of the technologies: *"I would be middle of the road at the moment…until I found out more about it [nutrigenomics and PNPs]. But, I guarantee we are going to get this scare…down the road. (…) It's only in the teething process at the moment, and might never be perfected. (…) We just have to wait and see…"* (Nut/PNPs3, PDI, M, 45-54). Emerging attitudes seem to have the potential to change and become stronger, as additional information becomes available.

Scientific uncertainty tends to be linked to knowledge uncertainty, and a subsequent demand for information: *"I think there's a serious lack of information about all these possible food technologies. (…) You would like to know where people are advancing to, and the possible implications of all these technologies"* (Nut/PNPs4, PDI, M, 25-34). In this context, the more novel and unfamiliar functional foods and PNPs presented give rise to questioning and *"suspicion"*: *"Could it [microencapsulation of functional compounds] have possible side effects? (…) It might make you want to know more about the process involved"* (FF5, M, 18-24). Consequently, perceived uncertainty appears to create concerns about credibility, which are heightened when reflecting on certain concepts, including the medicalisation of nutrition and cosmeceuticals: *"Some parts [functional foods] seem OK and like they could be of benefit. And, other parts, (…) down the pharmaceutical line…put into just everyday food, seems scary"* (FF9, M, 18-24). This also results in explicit questions being raised about monitoring and dosage issues, which successively impact technology assessments: *"How do you quantify it? Does it say, 'if you eat this [cosmeceutical] bread non-stop for six months…you will see a noticeable improvement in your skin'?"* (FF2, M, 45-54).

In general, knowledge uncertainty can contribute towards expressions of a demand for accessible and 'understandable' information *"in layman's terms"* (Nut/PNPs3, PDI, M, 45-54): *"You would need to understand how to use them [functional foods] before they would make any real positive difference"* (FF2, PDI, M, 45-54). Providing explanatory information about associated claims is believed to augment enthusiasm for the products and services presented: *"If they say 'high in CLA' alone, you wouldn't buy it. You would be saying, 'what's CLA?' But if they explained that it has good [health] effects, then I* *would buy it"* (FF6, F, 18-24). Furthermore, perceived uncertainty contributes towards a demand for *"freedom of choice"* (Nut/PNPs3, PDI, M, 45-54) over purchase, consumption and testing decisions: *"I suppose everyone wants to see what you are drinking or what you are eating, (…) so you can choose whether you want to put that into your body or not"* (FF9, M, 18-24). While, unsurprisingly, labelling is perceived as a mechanism of enabling informed choice: *"If it [the functional food] was labelled and it told me exactly what was happening, then OK, you can make an [informed] choice"* (FF3, F, 55-64), some do not appear to be explicitly focused on the need for 'adequate' product labelling, due in part to presumptions of safety. The complex nature of these technologies and the benefits that they offer lead several to consider broader dissemination of relevant information as being more important: *"To get people to understand what it's about is (…) more important than the actual labelling, because a lot of people don't read the labelling"* (Nut/PNPs5, PDI, F, 18-24).

Some display a considerable need for cognition and *"going into the detail"* (FF7, M, 65+) of the technologies and food production methods more universally: *"I think it [nutrigenomics] is a good idea. (…) I would like to know more about it…"* (Nut/PNPs5, F, 18-24). Conversely, others exhibit minimal motivation to acquire and process relevant information, postulating instead that *"sometimes a bit of ignorance is bliss might come into play"* (Nut/PNPs4, M, 25-34): *"I am not a man for reading labels that much…I would [read] some labels, (…) but normally, I take a lot of things for granted"* (FF7, M, 65+). Need for cognition appears to be more broadly influenced by the general values and beliefs previously outlined: *"I am a great believer in conspiracy theories. I don't think all that glitters is gold. (…) I am interested. I would see something like [nutrigenomics] and I would say, 'I wonder what that's all about' and I would look it up"* (Nut/PNPs3, PDI, M, 45-54).

In addition to prompting a demand for information, both knowledge and perceived scientific certainty induce a request for *"tight regulations"* (FF6, PDI, F, 18-24). Trust related issues are discussed in turn. Prior to this, analysis is presented which illustrates how, in the particular case of nutrigenomics and PNPs, evaluations are influenced by feelings of (dis)empowerment perceived to surround these technologies in terms of how information provided about the individual potentially impacts one's life.

Empowerment and disempowerment ***(specific to nutrigenomics and PNPs)***

This additional sub-theme, which is a deviation from the Model, is similar in focus to the other power/ control ones, yet it is also unique in its orientations around (dis)empowerment and its focus on information about the person (i.e. their genotype) rather than the technology/ associated products. Desire to opt-in or opt-out of knowing this information about one's potential disease susceptibility, and resistance towards it being available to other interested parties, both play distinctive roles in influencing views on nutrigenomics and PNPs.

From an empowerment perspective, guided by the ingrained values and beliefs previously outlined, this information is perceived to enable the individual to take preventative action concerning their future health: *"In the long run, I think it's a very good idea, because it [nutrigenomics] is a prevention rather than a cure, and prevention is always better than a cure"* (Nut/PNPs5, PDI, F, 18-24). Moreover, several consider this information to facilitate renegotiation of one's health pathway through life: *"It would be just brilliant if there was a such a thing like that [nutrigenomics]. You could sort of look at food in a way that it is a prevention for certain diseases. (...) Hopefully in my lifetime, there being such a test"* (Nut/PNPs1, PDI, F, 35-44). Perceived control in this empowering context is reflected inwards rather than outwards, and is thereby contextualised both similarly and differently for this technology.

Equally, apprehensions expressed about this information potentially disempowering individuals unnecessarily in terms of their life choices, in addition to intensifying their general risk sensitivity and aversion, contribute towards internal angst about the decision to acquire it: *"I don't know if I would want to know every failure inside me. (...) You could end up with a very, very restrictive diet. (...) It's one thing to be preventative; it's another thing to be just ridiculously over-cautious. You have to live as well. (...) It [nutrigenomics and PNPs] could impact culture, lifestyle…"* (Nut/PNPs4, M, 25-34). For some, the potentially debilitating 'power' of this information, in terms of *"dictating a person's lifestyle and also maybe putting the fear of God into them",* taints positive preliminary stances and contributes towards cautious overall responses: *"If you are telling me about something that hasn't happened, but possibly could happen, you are changing a person without them actually having to react to something that has happened.*

(…) I know that prevention is better than a cure…but at the same time, being too preventative can be very over-cautious" (Nut/PNPs4).

For some, this sense of disempowerment results in a feeling of anxiety about access to and the privacy of this sensitive information, which subsequently negatively frames views: *"They could use that information against me. (…) That would have to be made clear if the information could be passed on. (…) That is the only thing that would stop me getting the test or buying the [personalised] products"* (Nut/PNPs2, PDI, F, 55-64). Limited personal control over one's genetic privacy and the eventuality of *"differentiating people based on what could happen, not [on] what has happened"* (Nut/PNPs4, M, 25-34) negatively impact perspectives and, for some, generate *"worry"* and *"fear"*: *"I definitely would not want anybody to have the menu of my diseases. (…) There's no way an insurance salesman should have access [to that information]"* (Nut/PNPs3, M, 45-54). In light of the reservations underlying perspectives, many feel that policies and legislation would have to be implemented to ensure genetic privacy is protected.

Generally speaking, perceived uncertainty of outcomes and outlooks on fatalism, personal choice and control, and probability underlie the decision whether to be tested: *"The future is there to be explored, not to be known in advance. Would it [this information] hinder your life going forward? Would it make me more risk adverse? (…). Would it just restrict my life completely? (…) Why do you want to know exactly what's going to happen? (…) I think maybe leave it wide open and see how it goes…"* (Nut/PNPs4, PDI, M, 25-34). The perceived far-reaching implications of this information lead many to reiterate the importance of personal choice: *"Some people might not want to know about what [diseases] they are predisposed to. (…) People should be allowed to have the choice to find out"* (Nut/PNPs3, M, 45-54). In this sense, nutrigenomics seems to unearth novel and powerful choice dilemmas, for instance about whether younger cohorts of the population should undergo this testing: *"I don't believe you should be genetically mapping a two month old baby going forward to save a few euros [on healthcare]. (…) Whereas, when a person reaches over 18 they should be able to come in and say, 'look, I am ready, I want to get tested and take control of my own life'"* (Nut/PNPs4, M, 25-34).

Overall, the direction of perceived (dis)empowerment appears to be linked to individuals' personal orientations as described in the first theme and, specifically, how they *"are psychologically"* (Nut/PNPs5, F, 18-24) and the optimistic or pessimistic disposition they generally hold: *"I couldn't find a negative in looking ahead. (...) I am an optimist all the way, so I would sort of say, (...) 'if I do this with my diet and I take this thing or that thing and I could prevent it [a disease from developing]'. Well then, I would only see that [nutrigenomic testing] could be a positive"* (Nut/PNPs1, F, 35-44). In turn, these control related concepts are connected to perceived trust and assurances of outcomes.

Trust, regulation, assurances of outcomes and assumptions of safety

Uncertainty contributes towards a recurring reliance on trust in regulatory authorities, scientists, endorsing entities and the food industry to create a sense of control when envisioning how one would react towards these technologies. Indeed, a perceived lack of personal control generally results in a reliance on this heuristic and the presumption that *"standards would be put in place"* (Nut/PNPs2, PDI, F, 55-64): *"I suppose we would have to put our faith and trust in the people that are making them [PNPs], that it is what it says on the tin"* (Nut/PNPs1, F, 35-44). Trust is therefore a virtual security 'firewall' over the technologies' advancement: *"If it's regulated and it's gone through all the process of being checked out by the EU, and if they are found to be beneficial, to be honest with you, I wouldn't have any problem with people buying it, because it's purely a matter of choice"* (FF2, M, 45-54). In addition to control, trust appears to be closely linked to the concepts of personal choice and assurances of outcomes, in the context of associated products and services provided: *"It's all about choice. (...) People (...) can buy the [cosmeceutical] bread... [but] the message has to be very straight, that it's not a 'wonder bread'. It's not going to change your life drastically. Obviously if it says it can enhance [your hair, nails and skin], there has to be evidence to prove that"* (FF2).

Apprehensions about violation of trust constrain enthusiasm for the technologies, and consequently indicate its fragility: *"You are playing with people's health and people's wellbeing. People could go out and spend fortunes on stuff...thinking that it was going to make them better. It could be all a bit of a scam"* (FF2, PDI). Depending on one's trust level, which stems from their underlining values and beliefs outlined in the previous theme, varying degrees of scepticism and *"disbelief"* (FF10, F, 55-64) are exhibited about credence-based claims: *"I would immediately be sceptical [of cosmeceuticals]. (…) That's kind of a vain product. (…) The idea that you would eat a [cosmeceutical] bread instead of applying a moisturiser… (…) how could it be true? They are trying to fool me. How silly do they think we are?* (FF1, F, 35-44). Scepticism vocalised about companies exaggerating associated health claims and/ or *"profit[ing] upon a person's [health related] fears"* (Nut/PNPs4, PDI, M, 25-34) causes some to reiterate the need for tight regulations. Thus, openness towards the PSOG is distinctively contingent on assurances of outcomes and claims being *"scientifically proven"* (FF5, M, 18-24): *"If the research has been done on it, OK… (…) …if it could be backed up with proof"* (Nut/PNPs3, M, 45-54). 'Assurances of outcomes' is an additional feature to the Conceptual Model, which materialises for these particularly technologies due to their emphasis on associated benefits rather than risks and, explicitly, their focus on the health-orientated credence based characteristics of these products and services.

Knowledge of regulatory policies tends to strengthen trust levels: *"You have to go through so many tests to get it stated on the box (…) so I kind of would believe it"* (Nut/PNPs5, F, 18-24). Similarly, familiarity with more traditional functional foods increases openness towards and trust placed in the products and services presented and their *"health enhancing"* benefits (FF7, M, 65+): *"I suppose I have been buying fortified milk since it came out. Looking at my kids, I think they are fairly healthy and I do think that it has helped. So that's kind of the way I view it [functional foods]. Now I can't say, categorically…but I do think it [fortified milk] has certainly helped"* (FF2, M, 45-54). In addition, for many, risk-based responses are not overtly triggered and high levels of trust are apparent, due to general assumptions of safety: *"I would have seen it [the functional food product] as a positive thing (…) because I am assuming [based on trust placed in others] that they [functional foods] are safe and that there is no negative"* (FF1, F, 35-44). Thus, as also previously found to be the case for the BNG, assumptions of safety, rather than a demand for assurances of safety, direct perspectives.

Overall, positive assessments of these products and services appear to be based on presumptions of safety, assurances of adequate regulatory frameworks being implemented and stated heath claims being validated. To conclude, control in terms of perceived knowledge and scientific uncertainty, information needs and impacts, feelings of (dis)empowerment, trust, regulation and assurances of outcomes materialise as driving forces of information processing and attitudes formed. Therefore the proposition that one's perceived power/ control over the technologies' progression impacts evaluations is supported. In addition to assumed control and information implications, perceived relevance within different contexts is, once more, found to impact evaluations.

8.2.3 Perceived Relevance - Proposition 5b

Similar to the case for the other groups, the perceived relevance of the product and service attributes plays an important role in information processing and contextualisation around the PSOG. Perceived benefit and risk characteristics negotiated and prioritised to direct food purchase and consumption decisions more broadly, such as health, price, naturalness and taste, appear to be key in shaping reactions and reasoned responses around these novel products and services: *"It comes down to the taste at the end of the day"* (Nut/PNPs3, M, 45-54). Consequently, compromising on these characteristics is viewed as a negative, and in certain instances unacceptable, outcome of these technologies: *"If I look at a probiotic added yoghurt that's twice the price… (…) it would definitely be a deterrent [to purchasing such a product]"* (FF3, F, 55-64). Once again, this theme focuses on perceived relevance and necessity within different contexts and assumed risk/ benefit weightings and prioritisation as information processing techniques directing attitudes formed.

Perceived relevance and necessity within contexts

The assumed personal and societal relevance of these technologies guiding assessments centres on their associated health characteristics and outcomes: *"If I thought for myself going forward that I could improve my health [through nutrigenomics], I would be very open to it. I find it very exciting"* (Nut/PNPs2, PDI, F, 55-64). Responsiveness appears to increase in instances where unique benefits, which align with personal and familial health goals and priorities, are perceived to be offered: *"I feel myself that my own diet would be deficient in the fish oils and the Omegas...so if that was added, then I would probably be more inclined to buy that [functional] product"* (FF10, PDI, F, 55-64). In this vein, the explicit and exclusive personal, rather than broad sweeping, significance of PNPs is particularly welcomed: *"I am kind of more open to it now that I have kind of understood it more. (…) It [PNPs] is actually tailored to you specifically. (…) It's not general [or] (…) broad spectrum. It is specifically for you…"* (Nut/PNPs5, F, 18-24).

Willingness to purchase and consume such products/ avail of such services depends on individuals' views "*on what personally the food could do*" for them (FF5, PDI, M, 18-24), and if and how they possibly envision incorporating these products into their diet and lifestyle under relevant health circumstances: *"I would be in favour of them [cholesterol lowering functional food products] being available. I don't have high cholesterol…my husband doesn't have high cholesterol, so I wouldn't be inclined to buy them myself. (…) [But] if I was in a situation where either of us had high cholesterol and we wanted to avoid medication, I certainly would try that [functional food] first"* (FF3, F, 55-64).

In terms of perceived societal implications influencing attitudes, on one hand, reflections on the detrimental social impact of disease and illness *"which could all possibly be prevented with this type of food technology"* (Nut/PNPs5, PDI, F, 18-24) positively frame perspectives. However, equally, concerns impacting evaluations are based on the cost of such products and services *"segmenting the population"* further, by *"basically putting a bigger gap between the social classes"* (Nut/PNPs4, M, 25-34), i.e. creating a 'genomics divide'. Benefits are primarily viewed from an individual and societal perspective, while many still recognise the technologies' potential positive consequences on the food industry and healthcare system. Due to the nature of the applications presented, environmental consequences were not raised during these particular interactions.

Similar to the findings for the ECG, the perceived need of certain products and services, such as medicalised functional foods and *"luxury"* (FF7, M, 65+) cosmeceuticals is questioned: *"Personally, I would rather just go and take my capsule (…) rather than taking it [medicine] in a drink. (…) I personally don't think there's a need for it [the medicalisation of functional foods]"* (FF8, F, 45-54). Necessity appears to be connected to the significance attributed to the benefits offered and perceptions of self-efficacy. Expressions of confidence in personal (versus societal) ability to maintain one's health, through lifestyle and dietary behaviours, impact on perceptions of necessity: *"I wouldn't see any necessity for it [cosmeceutical bread] because I make my own brown bread and I put in loads of stuff [healthy ingredients] in it"* (FF3, F, 55-64). While questioning necessity from a personal perspective, due in part to health maintenance strategies deployed, some express a belief that these products and services would be more relevant to others who have poor diets and lifestyles: *"The addition of nutrients into sliced* *bread or milk, I think it's probably a very good thing for some people (…) that have poor diets. (…) I generally try to have…a good balanced diet. (…) I definitely am not eating sliced white bread every day. But then I know there are some kids and that's as good as they are going to get"* (FF10, F, 55-64). They consider themselves to be more capable of taking care of themselves, versus the capability of others. These individuals appear to be somewhat conflicted in their stances, due to their inherent interest in health maintenance and disease prevention. On one hand, based on their beliefs about others, they make judgements that these technologies are *less* relevant to them personally than they are to others, given their own healthy diet and lifestyle (which maintains their health and prevents disease). Equally, they consider the technologies to be *more* relevant to them personally, due to their reported interest in living a healthy lifestyle and consuming healthy foods.

Tied to the concepts of necessity and subjective 'worth', timeline and measurability issues influence benefit and risk assessments, with tension materialising between positive perspectives on the health benefits offered and perceived uncertainty about the measurability of outcomes over time: *"I would be a bit dubious about that one [cosmeceuticals]. I would rather rub something [a cosmetic face cream] on…you can feel the sensation of it there and then. (…) I would say the process of taking it in food would be maybe too long; you might be waiting for the results for six months to a year"* (FF7, M, 65+). These types of conflicts, in addition to perceived relevance and necessity more broadly, contribute to trade-offs being made between contrasting product and service attributes.

Trade-offs

Risk and benefit trade-offs constructed between product/ service characteristics are viewed as an information processing mechanism to overcome divergent goals: *"You are basically just going to have to accept the costs in order to be preventative"* (Nut/PNPs4, M, 25-34). These trade-offs primarily concentrate on judging, and possibly offsetting, price, naturalness and taste attributes against potential health benefits: *"The price would be [assessed] in relation to how good the product is. So, if you were seeing really good benefits (…) it [the functional food] would be worth paying the excess"* (FF5, M, 18-24). These salient considerations are weighed against each other, with many considering the 'health stakes' to be *"worth"* (FF5, M, 18-24) compromising on these other attributes:

"If you don't buy me...you might be dead. So you are asking people to pay 60%, for example, for a longer life" (Nut/PNPs4, M, 25-34). Specifically, some appear to be willing to accept sub-optimal taste or price premiums, if relevant health benefits are perceived to be offered: *"As a consumer, I would expect the product with the healthy options to not taste as good as the [non-functional] ones. (...) I would say, 'I am going to make the choice to have the [functional] one, because it's better for me'"* (FF1, F, 35-44). However, others do not appear to be willing to make such compromises in order to reap health benefits: *"If I didn't like the taste of it [the functional food], it would never again be tasted. (...) If I don't like it…that's it"* (FF8, F, 45-54).

Capacity to make trade-offs between *"money"* and *"health"* (Nut/PNPs1, F, 35-44) is thought to be limited by financial means: *"They say health is wealth, but wealth is health as well. (...) You have got to see what's within your price range"* (Nut/PNPs3, M, 45-54). Indeed, many consider financial restrictions to be a *"stumbling block"* potentially overruling the desire to purchase / consume such products and/ or avail of such services: *"Whether I would buy it [a functional food] or not (...) would all depend on how much money I have in my purse at the end of the day"* (FF8, PDI, F, 45-54). Some go so far as to make a societal judgement based on their belief that while they personally would be willing to pay for these relatively expensive products and services, since they are *"an investment in your health"* paying longer term dividends, others may not hold this view, due to a lack of interest and/ or the financial resources to pay accordingly: *"Maybe people again who have not much money [sic] to spend on food and who are not too interested [sic] probably would pass it [functional foods] by… (...) but I would be willing to pay it [an associated price premium]"* (FF10, F, 55-64). Furthermore, an individual versus social trade-off is perceived to exist between enhancing personal health status and compromising on quality and *"enjoyment"* (Nut/PNPs3, PDI, M, 45-54) of life, with the reference being made to potentially becoming *"the healthiest hermit in the world"* (Nut/PNP3, M, 45-54) after undergoing nutrigenomic testing.

As postulated, evaluations of the products and services presented depend on the emphasis and weighting allotted to various attributes in different contexts, and the trade-offs subsequently made. In addition to guiding perceived relevance and emerging trade-offs, habitual food and health deliberations, decisions, prioritisations and experiences, descending from the inherent orientations previously outlined, influence sense-making around these technologies.

8.2.4 Construction of Sense-making around the Technologies - Proposition 6b

Analogous to the case for the other groups, the source influences previously outlined interlink to reciprocally generate meanings and associations when interpreting and classifying information about the PSOG. Yet again, this key stage in the evaluative process encompasses 'sense-making' and the contextualisation of information at a multitude of interdependent levels, drawing on variable weightings of the features represented in the other themes. Therefore, interpretative schemas, deriving from in-built orientations and associations, are once more called upon from memory and newly formed as part of this reflective process.

Initial assessments seem to be guided by prior knowledge and experiences. For instance, reported familiarity with conventional functional foods, such as probiotic dairy products, and accompanying health benefits are a basis for reasoned thinking about and enthusiasm for the more novel products presented. Many report having actively purchased and consumed such products and, accordingly, have already 'made sense' of certain functional foods: *"They [functional foods] would have attracted my attention before"* (FF1, PDILQ, F, 35-44). Despite reported product awareness, participants are generally unfamiliar with the term, 'functional foods': *"I would have been aware of them [functional foods]…but not their title"* (FF3, PDI, F, 55-64). That withstanding, association with the term seem to be largely positive: *"Functional is the functioning of your body, so it's good for the functioning of your body. That's the way I would interpret it"* (FF3, PDILQ). Explicit images stimulated include healthy people, food supplements, fortified milk, healthy foods *"full of goodness"* that you would *"give to astronauts or soldiers"* (FF2, PDILQ, M, 45-54), and *"food that has extra stuff in it that will benefit you"* (FF1, PDILQ, F, 35-44).

Elsewhere, lack of familiarity with the terms 'nutrigenomics' and 'PNPs' results in questioning, the generation of word and image associations and analogies, and imagining future scenarios in an effort to form meaningful associations: *"It [PNPs] sounds kind of good if it is personalised. (…) What you need yourself compared to anyone else…specifically for you, your needs"* (Nut/PNPs5, PDILQ, F, 18-24). For instance, PNPs are associated with *"nutrients (...) flying around (...) a petri dish"* (Nut/PNPs1, PDILQ, F, 35-44) and *"health and gyms and people in running gear, running forever, to get home and eat their nutrigenomic food [laughter]"* (Nut/PNPs3, PDILQ, M, 45-54). As a method of reflective sense-making and active thinking, this technology is anchored to a diverse range of abstract concepts, including *"designer babies"*, *"space age"*, science fiction, *"conspiracy theories"* and *"Aryanism"*.

The breadth of images and conceptions engendered around both of these technologies indicates the complex sense-making undertaken. For example, the following quotation illustrates the associations and analogies made with science fiction and a dystopian society: *"It seems like the future it spells for me is spotless buildings with perfect air. And you have got your little dispenser over there, and you press your button, and you are having your snack and it's a pill. (…) Where's the enjoyment in it?"* (Nut/PNPs3, PDI). The perceived futuristic and hypothetical nature of some of the applications presented indicates that situational contexts and duration of existence are important in shaping sense-making around these technologies: *"Maybe…as it [nutrigenomics] becomes more widely used; I will consider it more acceptable. (…) I assume the first time there was IVF, there was probably outrage over how people could accept this when it's all against God's will. But now, it's acceptable by pretty much everyone. (…) So, maybe in 20 years' time, when it [nutrigenomics] is used 10 years…I will be saying, 'it's the greatest idea ever'"* (Nut/PNPs4, M, 25-34). Therefore, from a temporal perspective, many believe that 'time will tell' in terms of uptake of these technologies: *"Things can grow on the consumer too (…) gradually. I think [that there are] things that we are probably buying and consuming now that maybe some years ago we would have said, 'no, we would not'. You can gradually get used to the idea"* (FF10, F, 55-64).

Due, in part, to perceived uncertainty and unknown consequences, contemplations on embedded habits and experiences fashion assessments. Specifically, contextualisation of information tends to occur through the lens of accustomed food related experiences and practices and concomitant meanings, in addition to outlooks on the role that food plays in one's life. For instance, those who view food as a fuel for the body appear to form more pragmatic and stable attitudes, compared to others who conceptualise food as a broader representation of self-worth, hedonism, lifestyle and culture. In turn, assessments are guided by meditations on how functional foods, PNPs and information on one's genotype fit with food routines and rituals within different social settings, including shopping, storage, preparation, cooking and catering: *"People's diet could be just all those [personalised nutrition] foods. They could adopt it as a way of life. (…) It could affect every day that they go to the shops. (…) I could see that happening"* (Nut/PNPs2, F, 55-64). Hence, while preliminary reactions are positive, further speculative reflection on the complexities inherent in incorporating these products into an individual's ingrained food habits impacts positive initial assessments: *"When I first heard it [PNPs], I thought it was brilliant about the different [personalised nutrition] sauces and stuff. (…) But, when I was talking about it…I saw that it would kind of be a bad idea. (…) I just think it would be very hard to incorporate [into one's diet]…and very costly to [sic] people"* (Nut/PNPs5, PDI, F, 18-24). Seemingly, some grapple to envision how associated products and services would be negotiated within the larger food system. However, where these technologies are perceived to facilitate and promote healthy eating and lifestyles, this appears to augment enthusiasm for them.

Comparisons and associations, based on prior experiences, are found to be a mechanism of contextualising these technologies. For instance, experience of previous negative interferences in the food chain, such as growth promoting hormones and BSE, looks to temper positive standpoints: *"As long as it [feeding cattle functional ingredients to increase the CLA content of beef] was enhancing the beef, I would go for it. (…) But, there was a product there about 10 or 12 years ago; they used to call it angel dust. (…) It was a hormone. (…) When that [angel dust] was in full swing, every time I would eat a steak I used to get an allergy from it. (…) I could tell you what heifer was after being fed angel dust"* (FF7, M, 65+). Additionally, the technologies are comparatively anchored to risks and benefits associated with other technologies and processes. For example, positive comparisons are made: between allergy/ food intolerance/ genetic testing and nutrigenomic testing; between adding healthy ingredients when home baking/ cooking and functional foods; and, between corn-fed chicken and increasing the CLA content of beef through 'functional' cattle feed. As another comparative illustration, originating from strongly held beliefs held about the preservation of nature, these novel products are considered to be a more appealing and natural alternative to taking medications for specific health ailments: *"Personally I would think taking a natural product instead of taking a medication is a positive, because the idea of taking those medications...if I* *thought there was a natural alternative, I would think that is positive. (…) I would still see it as a food"* (FF1, F, 35-44).

Elsewhere, their potential personal lifestyle and health implications results in an apparent willingness to invest time and thought in reflecting on these technologies, especially nutrigenomics and PNPs. Furthermore, the perceived non-threatening nature of functional foods leads many to base their evaluations primarily on bottom-up influences. Product characteristics tend to particularly important in directing assessments of the more conventional functional products presented, due to high levels of reported familiarity with these products and associated benefits and perceptions of their easy incorporation into food consumption and purchasing habits. In addition, PNPs appear to be assessed at a more concrete level compared to nutrigenomics, given the former's product emphasis: "*I think nutrigenomics sounds very scientific, whereas personalised nutrition kind of sounds more consumer-friendly"* (Nut/PNPs5, PDI, F, 18-24). Conversely, nutrigenomics seems to be primarily influenced by top-down orientations and duration of application, based on its abstract nature and potentially broad-reaching contexts.

Corresponding to the findings for the ECG, tensions are apparent when these influences interdependently direct sense-making and ultimate evaluative stances. Once again, dilemmatic thinking often originates from conflicting reactive (affective) reactions and reflective (cognitive) responses. For example, the divergent goals of: 1) enhancing the health characteristics of food through these technologies; and, 2) concurrently minimising interference with the naturalness of food, creates an element of tension: *"Are they [functional foods] going too far? (…) Maybe they are going against the law of nature. Would they be maybe putting too much into it? I mean…your own human body is designed to look after itself and repair itself naturally without any of these [products]. But, if they can help it or maybe give you more energy…I would be for it"* (FF7, PDI, M, 65+). Another source of conflict is the desire to increase one's health status and prolong life, versus trepidations about these technologies detrimentally impacting quality of life and the non-functional, more social, aspects of food. In illustrating this point, the humorous allusion made to becoming *"the healthiest hermit in the world"* (Nut/PNP3, M, 45-54) is, once again, referred to.

Once more, stemming from the relative importance of the other source influences, individualistic ‘rule books’ of acceptance are apparent, with acceptance of the applications and associated products and services being heterogeneous and existing along a continuum. For example, while seeming to be open towards the technologies and related health benefits, due in part to beliefs about how ‘food should remain food’, many express resistance towards the premise of cosmeceuticals, the ‘medicalisation’ of nutrition, and purchasing PNPs on prescription in a pharmacy: *“Having a pharmaceutical product in a food (…) might scare you a bit. (…) If you go into a restaurant or a fast food place, the last thing you expect to be taking is a pharmaceutical product inside in your food”* (FF9, M, 18-24). However, others tend not to be as overtly opposed to these applications and concepts: *“If I need a drug…I need the drug full stop. I think the food product enhances it and I suppose it’s an easier way of doing it. Although it’s still a drug, it’s now part of a food. So…in my mind, it’s just a different way of taking the drug”* (FF2, M, 45-54).

The specific benefits offered are an important rule book feature of consideration. For example, individuals are sceptical of and subsequently less open to cosmeceutical products with purported ‘beautifying’ benefits, as opposed to functional foods which offer distinct health benefits: *“The term cosmeceuticals…I would say if I saw something like that on a label, I certainly wouldn’t go near it. (…) Are we going a bridge too far here? You have the health stuff, which is very ethical and noble, and then you have this thing [cosmeceuticals] which seems to be more vain [sic]”* (FF2, M, 45-54).

In addition, beliefs held about the importance of maintaining ‘food as food’, through its link with nature and limited interference by man, are influential in establishing ‘acceptance rules of thumb’: *“Buying [personalised nutrition] butter in a chemist…I think that’s kind of going a step too far nearly, because you buy vitamin supplements and things like that in the chemist, but you don’t go there to buy your food. So I kind of would be against that”* (Nut/PNPs5, PDI, F, 18-24). Perceptions of acceptability therefore appear to be guided by ingrained beliefs about the boundaries of food versus pharmaceuticals: *“I would be willing to try it [nutrigenomics and PNPs], without a doubt. (…) I don’t see how damaging it can be…just testing different foods. (…) If you were pumping me with tablets now, I would be very nervous of that. (…) I would be hugely concerned; but not with food. (…) Putting different foods into your body according to the gene pool type that you are, (…) just using foods; I wouldn’t have a problem with that”*

(Nut/PNPs1, PDI, F, 35-44). Moreover, the perceived boundaries of interference with nature (thus food) also guide perspectives. As an illustration, some view animal products with increased functionality resulting from ‘functional animal feed’ to be less natural than more traditional functional products; while others consider these types of application to seem relatively natural and thereby acceptable: *“It [increasing the chitin concentration in beef by feeding cattle ground shells of shellfish] is natural…it’s not produced in a lab. (…) The cows are eating it and it’s just coming naturally in the meat. (…) It doesn’t sound harmful. It doesn’t sound scary. (…) It would be acceptable”* (FF9, M, 18-24).

An additional rule book component is personal preference for suitable carrier products, which derives from prior food experiences and predispositions: *“I suppose one gets used to the idea that they [probiotics] are in yogurt or in the dairy area, that it would seem strange at first to get used to them being elsewhere [in another product category]. (…) I suppose, [I am] just so used to it [probiotics] being associated with yogurt…the fermentation of milk, that it [another carrier product] would seem odd”* (FF10, F, 55-64). Several display a preference for intrinsically healthy carrier products, while others believe that *“the foods that are causing the [health] problems for people”* should be *“targeted”* (Nut/PNPs2, F, 55-64).

Overall, individualistic rule books associated with these technologies seem to feature classification and negotiation of different product attributes, and to be guided by reflections on ‘higher-order’ values and beliefs. The magnitude of these higher-order influences can result in dynamic and flexible stances being taken or resolute acceptance (rejection) of the products and services. Reliance on these rule books appears to depend, not only on fundamental values, but also on willingness to engage in cognitive information processing and contextualisation. To this end, many participants note that information gathering and processing around nutrigenomics and PNPs would require considerable effort on their part, in order to leverage the (speculative) benefits that this information and associated products potentially offer them.

In summary, the final proposition, that the three source influences interact to construct sense-making around these technologies when classifying and interpreting information, is supported.

8.3 Discussion and Conclusion

The analysis presented here offers support for the four propositions put forward. Indeed, the Conceptual Model, which formed the foundation for these propositions, enabled a comprehensive analysis of this data sub-set. Hence, this analysis strengthens the argument previously made, that despite the overt characteristic differences between the technology groups, evaluations formed around each cluster derive from the same source influences and mechanisms of information processing. Nevertheless, the findings illustrate the instances where these influences/ themes manifest differently for the PSOG.

As illustrated in Figure 8.1, an additional sub-theme 'empowerment and disempowerment' has been identified and incorporated under the 'perceived power/ control' theme for nutrigenomics and PNPs. This sub-theme is relevant to nutrigenomics and PNPs, due to perception of (dis)empowerment as a result of their unique focus on the impact of information about the person's disease susceptibility, rather than product information. In this sense, nutrigenomics and PNPs fulfil a different role to more traditional food products. This additional sub-theme further indicates the influence that different types of information can have on attitude formation around novel technologies.

More generally, for the PSOG, the trust and regulation sub-theme is connected to 'assumptions of safety *and* assurances of outcomes', rather than solely to 'assurances of safety', as was found to be the case for the ECG. Similar to the situation for the BNG, assumptions of safety, in lieu of a demand for assurances of safety, guide evaluations. 'Assurances of outcomes' materialises as an additional feature guiding evaluations of this technology group, due to its focus on associated benefits rather than risks, and particularly on health-orientated credence based characteristics.

The analysis suggests that the four key themes are evident, in terms of the features directing evaluations across the PSOG. The Conceptual Model provides a valuable and relevant framework for examining attitude formation and information processing around these specific technologies, based on the body of evidence presented.

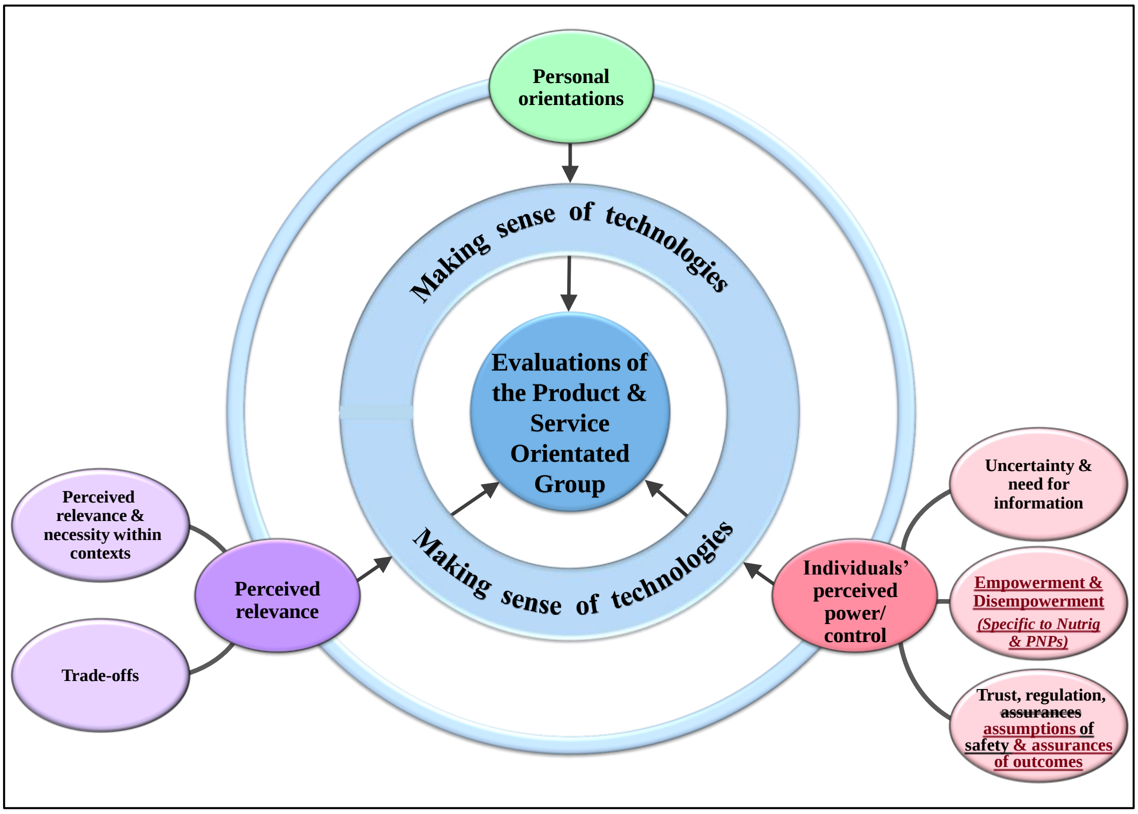

Figure 8.1: *Conceptual Model of Features Influencing Individuals' Evaluations of the PSOG*

However, it is recognised that alternative analytic lenses could be adopted when interrogating this data sub-set. Building on the suggestions made in Chapter 7, an alternative focus could centre on the risks and benefits, and subsequent trade-offs, associated with each product/ service in an applied and prescriptive way. Equally, the focus could be on explicit concerns and barriers potentially impinging on technology uptake, or the context and circumstances in which these products and services would be accepted.

This analysis supports the argument previously made that the interrelationships between these influences are mutually shaping, yet also concurrently competitive. Depending on the characteristics of the individual, orientations around, for example, health may materialise in perceived health implications being so important that they result in unmitigated acceptance without moving to reflect on other, potentially moderating, influences which could impact the strength, stability and (possibly) direction of attitudes formed. Alternatively, perceived uncertainty may be so impactful that it renders positive perceptions of associated health benefits irrelevant. Therefore, these findings confirm that one influence may be so important that its impact outweighs that of others, leading to outright technology acceptance (or rejection) without participating in further information processing. Supplementary to this, the interplay between these influences may, in part, be undistinguishable, as a result of the intricate interactions between them. In this vein, it seems that the boundaries between personal orientations and perceived relevance are particularly blurred for the PSOG. Individuals' health status, standards and experiences, coupled with their perceptions of the relevance and necessity of these products/ services and the health benefits offered within different contexts, appear to be key in determining evaluations. The personal and societal relevance of these technologies is largely viewed to be considerable and linked to perceived risk and benefit trade-offs made.

Due, in part, to the intangible and hypothetical nature of the services and some of the products presented, personal orientations, signifying expressions of internalised standards, are central to contextualising information and forming attitudes. While the evaluative stances of many centres around personal values and experiences around health, those of others are guided by a broader spectrum of orientations, including beliefs about appropriate boundaries in terms of interfering with food, nature, tradition and attitudes towards scientific progress. Furthermore, the characteristics of the technologies result in explicit moral and ethical considerations emerging only for nutrigenomics and PNPs. It is recognised, once again for this sub-set, that if the Conceptual Model had not formed the interpretative bedrock of this analytic phase, personal orientations may not have materialised as an isolated influence directing viewpoints.

Perceived uncertainty surrounding these technologies, especially of their outcomes, generally results in a desire for information, to increase a sense of personal control. However, as was already found to be the case for the BNG, demands for relevant information and seeking/ processing behaviours can be inconsistent and conflicting. Although many demand information in an abstract sense, their apparent need for cognition and motivation to seek out and process relevant information tends to be limited, if not wavering. That withstanding, the impact of information about one's personal genotype is considered to be particularly important, due to its perceived wide-stretching *"big step"* implications, and the potential novel choice dilemmas and concerns arising. This information is therefore carefully and cautiously reflected on. Hence, information seeking behaviours are circumstantial, in addition to hinging upon the individual, technology and product/ service in question.

In light of the health-orientated credence based characteristics of these products and services, the importance of trust, assurances of outcomes, and specifically the regulation of associated claims, in underwriting evaluations cannot be underestimated. Many trust in the safety of these technologies, due to risk-based responses not being overtly triggered, yet concurrently appear sceptical of claims made. While they seem generally responsive towards associated claims, they express apprehensions about assurances of outcomes and subsequently demand evidence of proof. In the context of the type of information demanded, the findings indicate that relatable and contextual health claim information, rather than nutrition information, is demanded, given the importance of the voracity of claims made.

Elsewhere, the findings indicate that, deriving from personal beliefs held, judgements are readily made about the reactions and responses of others towards these technologies. For instance, many believe the PSOG to be more, or less, relevant to themselves personally compared to others, depending on their values and priorities, prior experiences, perceived and actual knowledge about diet and food, perceptions of personal control and self-efficacy, and personal health maintenance strategies. Hence, one may be more receptive towards these technologies and associated products/ services as a citizen, but less receptive as a consumer, or vice versa. In a similar sense, it is important to reflect on whether those perceiving these products and services to have personal and/ or societal relevance consider there to be an actual need for them.

Many have already 'made sense' of certain functional foods which they are familiar with. This point withstanding, the deliberative discourse is an opportunity to bring this technology and associated products and concepts to the reflective fore of one's mind-set. In doing so, it unearths the underpinnings of their contextualisation processes. While evaluations mostly commence with an overt health emphasis, further contemplation results in broader consideration and focus on a multitude of concrete and abstract dimensions.

In terms of this overarching influence guiding evaluative stances, the interpretative schemas and contextual anchors drawn upon as sense-making mechanisms are broad and diverse, especially for nutrigenomics and PNPs. For instance, deliberations on the ethical, legal and societal repercussions of nutrigenomics signpost the extent to which perceived expansive repercussions shape assessments. As a further illustration, the personalisation connotations associated with PNPs extend beyond the food domain into broader areas, including personalised physical fitness. These types of associations indicate that what has origins in other lifestyles domains provide a basis for analogies around PNPs. Broadly speaking, apprehensions and tensions are apparent, principally when questioning where the boundaries of these technologies lie and envisioning how they might transform lifestyles and social structures. The findings presented raise interesting questions about the role of food in one's life, social isolation and science in society; for instance, whether foods could become individualised to the point that its social dimension disappears.

These technologies are perceived as being either benign or contentious, depending on the product or service and associated benefits and risks. A broad range of responses are evident, with apathetic and emotional reactions and affective responses guiding sense-making and attitude formation. Apathetic reactions, primarily deriving from product-orientated assessments, are more evident for functional foods. On the contrary, affective reactions, originating from higher-order orientations including moral and ethical values and beliefs, more prevalently direct perspectives on nutrigenomics and PNPs. In contrast to the case for the BNG, public reactions towards these health focused technologies may be more emotive in an actual purchase/ consumption situation, given high levels of perceived personal relevance, potentially wide-reaching social implications and price premiums involved. Furthermore, reactions and responses expressed within this deliberative discourse environment provide insight into the issues that may emerge, if and when these services and the more novel products presented are commercialised. Both product/ service and broader technology characteristics evidently guide standpoints, indicating the complex attitude formation that occurs around these technologies at both abstract and concrete levels.

Subsequently, the findings presented further supports the argument forwarded that the characteristics of the technology and the individual, including their general values and beliefs and roles and experiences, guide attitude formation around NFTs. In turn, these characteristics play key roles in forming unique rule books of acceptance, which are, yet again, found to expedite information processing and sense-making. Moreover, this analysis indicates that alignment of benefits, products and individuals is essential to ensuring technology acceptance. This concept is further explored in the next, and final, chapter which concludes this dissertation.

Chapter 9 discusses the emergent themes and their exhibitions across the groups. Relevant arguments and theories are relied upon to reinforce and contextualise this analysis and provide insight into this Conceptual Model's relevance across the technologies. The strengths, limitations, theoretical and practical contributions and implications of this research are discussed. Recommendations for future avenues of inquiry are also suggested.

Chapter 9
Discussion and Conclusions

9.1 Introduction

The primary objective of this research was to develop a conceptual understanding of how Irish citizens form attitudes around a range of NFTs. The overarching research question was as follows:

- What guides and influences citizens' evaluations of NFTs?

Additional research questions, deriving from this core question, were included:

- How do citizens construct meaning around and interpret new information on NFTs?
- Do citizens' evaluative processes vary across different NFTs?

This research sought to develop a greater understanding about what happens at the attitudinal intersection where society, science and food meet. To meet this aim, a thorough review of relevant literature concerning the impact of TD and BU influences, the psychology of risk perceptions and heuristics was undertaken. Following this, social and cognitive psychology theories were explored, to better understand perspectives on these technologies through the 'bifocal lenses' of attitude formation and information processing. Building upon the literature reviewed and throughout the undertaking of this work, the complex interplay of the multiple influences found to shape evolving evaluative stances on these technologies, in addition to the link between attitude formation and information processing, have been reflected upon.

The methodological considerations associated with this research and the philosophical assumptions and rationale of the researcher have been presented. The constructionist perspective and inductive/ deductive qualitative approach applied have been described and justified, including the selection and grouping of three technology clusters, based on their characteristics and expected public reactions.

The approach applied involved observations of one-to-one interactions between food scientists and citizens, during which they discussed a specific technology. This staged approach to data collection and analysis enabled an in-depth exploration and appreciation of how individuals construct meaning and form attitudes around these technology groups. It also revealed the inherent complexities associated with these activities.

This approach enabled a comprehensive exploration of individuals' reactionary and reflective responses towards the different technology sets, which are not necessarily easy to capture via quantitative methods (Davies et al., 2009). This work moves beyond measuring overall opinions on these technologies, to understanding how attitudes form and change, and relevant information is contextualised. This study highlights the importance of a person's orientations, their perceived control over the technology's application and the assumed relevance of the different application to them, in determining how individuals 'make sense' of these technologies and ultimately, their overall evaluations of them. Each of these influences are contextualised in turn, drawing on concepts and theories from relevant literature. Following this, the implications and recommendations of this work are detailed. The original theoretical contributions, and strengths and limitations inherent in this research, are then considered. Furthermore, directions for future research are proposed.

9.2 Evaluations of NFTs - the Contribution and Value of the Conceptual Model

As an initial phase of analysis, theoretically mapping (Braun & Clarke, 2006) of the specific features of the top-down bottom-up (TDBU) paradigm highlights the apparent simultaneously operating roles that these influences play in guiding evaluations across the technologies. The TD characteristics evident include: embedded attitudes, values and beliefs about nature, technological progress and food and food production/ processing; ethical and moral stances; and, outlooks towards social trust and control; while the BU influences encompass personal, societal and environmental benefits and risks perceptions associated with each technology and related products.

This preliminary stage of analysis was useful in confirming the appropriateness of the pre-defined technology groupings for thematic analysis purposes, due to the similar emerging trends across the technology groups. Despite the insight gained from this 'scene-setting' analytic stage, the TDBU paradigm represents only one approach to examining the data. This approach fails to reflect a 'complete picture' of the (potentially competing) relationships between these influences and supplementary features, including inherent cognitive processes, shaping attitude formation around these technologies.

In order to fully represent the data, the second phase of analysis moved away from the TDBU model, and considered, using a group of potentially contentious technologies, how citizens' attitudes form and evolve with information provision. This inductive stage generated propositions, which were examined in the final analytic phase (Chapters 7 and

8), where the relevance of the identified Conceptual Model was examined for the two other technology groups. Thus, the data used to generate and test theory differed (Cressy, 1953; Hyde, 2000). Although the final stage was predominately deductive, the data sub-sets were also examined for unique manifestations of materialising themes and patterns, and their features and emphases. Each of these themes is considered and contextualised in turn. Together, the analytic stages provide a holistic and integrated view of citizens' evolving attitude formation around a diverse range of both controversial and non-controversial food technologies.

This research indicates that, in addition to TD and BU influences, a complex array of cognitive associations appear to play a key role in guiding evaluations. This work focuses on exploring how attitudes form, rather than measuring explicit technology assessments and conditions of acceptance. Nonetheless, to supplement the analysis presented as evidence of TDBU influences in directing evaluations across each technology, Appendix 9.1 presents an overview of the cognitive associations and types of responses that emerged as important in impacting evaluations, at the technology specific level. In turn, Appendix 9.2 summarises the overall perspectives and general conditions of acceptance apparent for each technology.

Throughout data analysis and interpretation, following deep immersion in the data, it was essential to continually move up levels of abstraction to ensure context and understanding brought 'meanings' to the analysis. The analytic process was therefore an iterative journey of contextual discovery (Merriam, 2009). This work has established that although the features guiding evaluations of these technologies may manifest differently depending on the type of technology, their origins are ultimately the same. The contribution and value of the Conceptual Model is now further explored, drawing on relevant literature to contextualise the findings across the technology groups.

9.2.1 Contribution and Value

In terms of addressing the core research question, the following influences are found to guide citizens' evaluations across the technologies: personal orientations; perceived control over the technology's application; and the relevance of the technology and its application in different contexts. In turn, these influences guide how individuals 'makes sense' of the technologies and ultimately their evaluations of them. Some of these influences and associated features have previously been referred to by others (e.g. Siegrist, 2008; Fell et al., 2009; Frewer et al., 2011). Quantitative and qualitative studies, typically centring on either nanotechnology or genetic modification, have highlighted the importance of the following influences in guiding public evaluations: general attitudes and values (e.g. Bredahl, 2001; Scholderer & Frewer, 2003; Søndergaard et al., 2005; Nielsen et al., 2009; Vandermoere et al., 2011); perceived control (e.g. Henson, 1995; Siegrist & Cvetkovich, 2000; López-Vázquez et al., 2012) in the context of perceived uncertainty (e.g. Shaw, 2002; Hagemann & Scholderer, 2009) and trust in others (e.g. Vandermoere et al., 2011; Loebnitz & Grunert, 2014); and, perceived relevance in different contexts (e.g. Bredahl, 1999; Sheldon et al., 2009; Dean et al., 2012b). That withstanding, a key contribution of this work is exploring the interdependent relationships between these influences. Building on the analysis presented, the interplay and linkages between these influences, and how they materialise across the technology groups, are further examined here.

In addressing the research question about whether evaluative processes vary across different technologies, it seems that while the aforementioned influences impact evaluative stances for the three technology clusters, some variation exists in terms of their manifestation and emphases, depending on the specific technology or group. Essentially, the original Conceptual Model (Figure 6.1), which represents the influences and associated features guiding evaluations for the ECG, holds relevance to the other technology groups, despite the overt differences between the characteristics of these technology clusters.

This Conceptual Model (Figure 9.1) provides a holistic perspective on the features influencing citizens' attitude formation across the technology sets. As indicated (underlined) in the figure, the salience and relative importance of each influence may increase or decrease, depending upon the characteristics of the technology and the citizen, i.e. their perspectives, priorities and agendas.

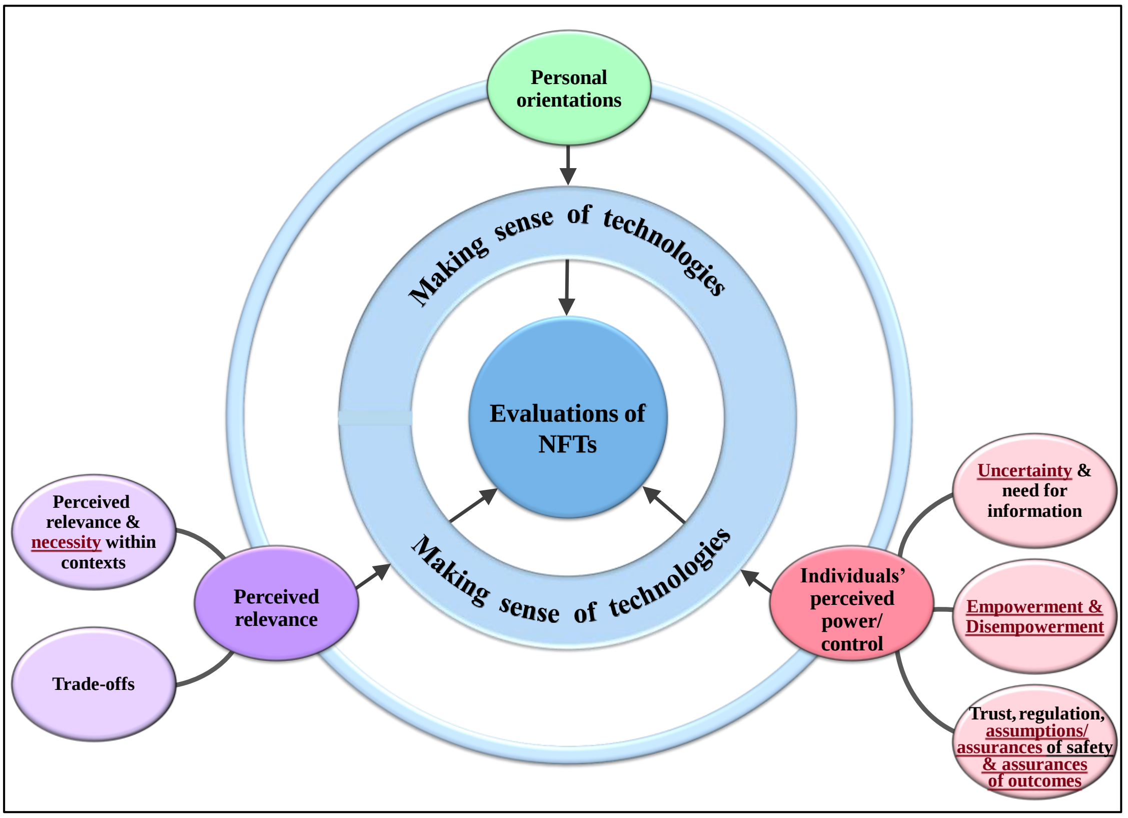

Figure 9.1: *Conceptual Model of Features Influencing Individuals' Evaluations across the Technology Groups*

In portraying the relationships between these interlinked influences and associated features, this Conceptual Model facilitates a more comprehensive appreciation of the dynamic and complex origins of public attitude formation and information processing around NFTs. In addition, the internal conflicts and tensions evident within and between these influences indicate that they also compete with each other. Subsequently, although the margins between these influences are clearly distinguishable, drawing on the descriptor applied by Furst et al. (1996: 252), they can also be considered *"fuzzy"*.

This conceptualisation of attitude formation around these technologies provides insight into how individuals categorise information to support the construction of symbolic meanings around them, and how they apply these meanings when forming evaluations. This research consequently relays important emic perspectives on how individuals form attitudes, exposing how explicit (deliberate) and implicit (subconscious) attitude formation (Eagly & Chaiken, 2007; Tenbült et al., 2008a) is reactively and reflectively driven by multiple intertwined influences.

Personal orientations around nature, ethics and morality, tradition and technological progress, in addition to prior experiences and the perceived roles of food can create internalised ‘standards’ which direct responses towards information provided about these technologies. Based on one’s orientations, information about the technology can trigger, for instance, a negative emotive response about tampering with nature and/ or tradition. This analysis therefore supports the proposition of Bredahl (2001) and Fell et al. (2009) that ‘higher order’ influences can shape risk and benefit assessments, in addition to guiding overarching attitudes formed. Pertaining to the importance of personal orientations across the technology groups, the BNG does not appear to ‘trigger’ inherent general values and beliefs to the same extent, possibly given its non-contentious nature.

Similar to the findings of previous studies, such as Shaw (2002) and Davies (2011), perceived uncertainty surrounding yet unknown detrimental repercussions of adopting these technologies negatively frames perspectives. Specifically, knowledge uncertainty influences the strength, stability and (possibly) direction of attitudes, while scientific uncertainty tends to typically be the foundation for the formation of cautious responses. Perceived uncertainty appears to be attenuated through familiarity i.e. duration of existence, as illustrated in this work to be the case for genetic modification and food irradiation. Once more, the demand for personal control and freedom of choice does not seem to be as important in directing evaluations for the BNG, most likely given this group’s associated low level of perceived risks and uncertainty. On the other hand, labelling seems to be more important to enable the consumer to ‘opt-out’ in the case of the ECG and to ‘opt-in’ for the PSOG, in light of associated health-orientated credence based claims.

The desire for personal control tends to be ceded to regulatory authorities, due to individuals’ perceived (and real) inability to personally assess safety risks. Moreover, perceived control links to the other influences, with increased trust placed in others appearing to attenuate risk-based responses and manifest as a means of overcoming perceived uncertainty. This fragile entity therefore plays an important role in shaping evaluations around each of the selected groups.

As risk-based responses and emotional reactions become more overtly triggered, assurances of safety, rather than assumptions of safety, become a focal point of evaluations. Furthermore, assurances of outcomes appear to be influential for the PSOG, given its focus on credence-based health claims. Hence, a precautionary approach, from a policy perspective, appears to be more prevalently demanded for the ECG, since concerns about safety are not as prevalent for either the BNG or PSOG.

The findings conveyed illustrate how perceived relevance of associated benefits and risks can result in self-reported conscious avoidance or adoption of NFT products. Specifically, where associated products are perceived to enhance health, taste, shelf life, or safety characteristics, or equally, to reduce price or food wastage, this positively impacts evaluations. Yet again, the BNG technologies are not perceived to present the same potential benefits or risks of personal relevance to individuals, in comparison to the other groups. This perception, coupled with risk-based responses not being overtly triggered, results in attitudes of indifference generally forming around these processing technologies. In turn, their assumed benign characteristics contribute to their perceived necessity not being questioned.

The presentation of benefit and risk information generally results in product attributes being negotiated and weighted against each other, depending on their perceived relevance within different contexts. Trading-off of associated attributes is undertaken, particularly trading-off current gains for future potential losses (i.e. potential negative unknown consequences). Offsetting of attributes in this way is especially evident for the more novel, potentially contentious and 'game changing' technologies, which are assumed to incorporate more substantive and far-reaching risks and benefits.

Concerning the research question about how individuals construct meaning around and interpret information about these technologies, the 'sense-making tools' relied upon when contextualising information depend, yet again, on the characteristics of the individual and technology. By the same token, Ronteltap et al. (2007: 6) have described a reliance on these characteristics in their review of literature to develop the conceptual framework of the determinants of acceptance of technology-based innovations in food (see Figure 2.2).

As postulated by Edwards (1990), Crano and Prislin (2006) and Kim et al. (2013) and in keeping with Eagly and Chaiken's (1993) Synergistic model, information provision seems to activate cognitive reactions and affective responses. Furthermore, similar to the connotations described in prior studies (e.g. Shaw, 2002; Cardello, 2003; Gunes & Tekin, 2006; Priest et al., 2011; Kronberger et al., 2012), an array of complex meanings, analogies, and word and image associations seem to be drawn upon in order to construct meaning around information provided.

Across the sample, comparisons to risks and benefits associated with other technologies and innovations are a ‘contextual cornerstone’ of sense-making. While comparisons to conventional alternative technologies, and food processing methods which individuals have prior awareness and experience of, are more prevalently relied upon when contextualising the BNG, broader and more abstract anchoring comparisons and analogies are applied for the ECG and PSOG. In addition, given the non-threatening characteristics of the BNG, tensions and conflicts, particularly in terms of conflicting reactive and reflective responses, do not appear to materialise to the same extent as they do for the other technology groups.

More broadly, questions are raised about where the boundaries of these technological advancements lie in terms of permeating and transforming lifestyles and social conventionalities in the longer-term. This is particularly in the case of nutrigenomics and PNPs. Shaw (2002) found similar expressions of concern to exist about appropriate boundaries for gene technology innovations.

Across the technologies, reliance on ‘rule books’ as an information processing strategy to help individuals manage and prioritise their sense-making around these concepts is evident. Idiosyncratic rules of acceptance for the ECG and PSOG seem to be highly influenced by perceived classification of specific applications, with certain ones (e.g. GM plants) appearing to be more acceptable than others (e.g. GM animals). This finding fits well with previous research by Siegrist et al. (2007a) and Henchion et al. (2013), which found that the application in question is an important determinant of acceptance of the adoption of nanotechnology to food. Unsurprisingly, given the arguments previously made, apparent rule books for the BNG tend to be less complex and nuanced *vis-á-vis* the other groups, with many considering there to be no real distinctions between the different thermal and non-thermal technologies and applications presented.

While the ECG and BNG are generally characterised as contentious and non-threatening respectively, characterisation of the PSOG does not appear to be as clear cut. Similar to Furst et al.’s (1996) model of food choice processes, the Conceptual Model reflects evaluative processes that can be highly reflective (cognitive) or automatic (affective) or, indeed, a mixture of both, depending on these characterisations. Reactions and responses towards the BNG seem to be particularly apathetic or indifferent and non-emotive given its perceived characteristics, with sense-making tending to occur at a more applied level. Dholakia (2000: 1353) make a similar argument concerning *"low-involvement purchases"* not triggering risk-based, emotional responses.

In comparison, both affect-based and cognition-based responses appear to interchangeably direct reactions and responses towards the other technology sets. The (potentially dominant) influence of general values and beliefs, and their perceived broad-reaching contexts, contribute to attitudes formed around them being more 'invested', deeply embedded and thus, strongly held. This work therefore builds on the arguments of Grunert et al. (2003) and Scholderer and Frewer (2003) concerning the impact of top-down influences on the stability of attitudes. Furthermore, while a technology emphasis materialises for the ECG, a product emphasis emerges for the BNG, and emphases on both are evident for the PSOG.

The findings of the analysis suggest that the Conceptual Model presented is a significant step towards improving understanding of how individuals construct meaning and form evaluations around NFTs. More broadly, it has implications for theoretical models around attitude formation and information processing.

Generally speaking, this work has provided insight into how different types of information are assimilated, used and, in turn, frame perspectives across the various technologies. For instance, in the case of nutrigenomics and PNPs, information provision about the individual, rather than the technology/ product, is perceived as having an empowering and/ or disempowering effects. More broadly, the health-orientated credence based characteristics of the PSOG can lead to a demand for relatable and contextual health claim information, rather than nutrition information, which poses challenges for the food industry in light of EU legislation around nutrition and health claim. In accordance with DPMs (Petty & Cacioppo, 1986; Frewer et al., 1997c), it seems the characteristics and content of the information, the audience and the cognitive route applied all impact information persuasiveness (Bohner & Dickel, 2011).

Figure 9.2 presents an overview of information processing and attitude formation processes, in an effort to further depict a complete picture of how these processes direct individuals' perspectives on different types of NFTs.

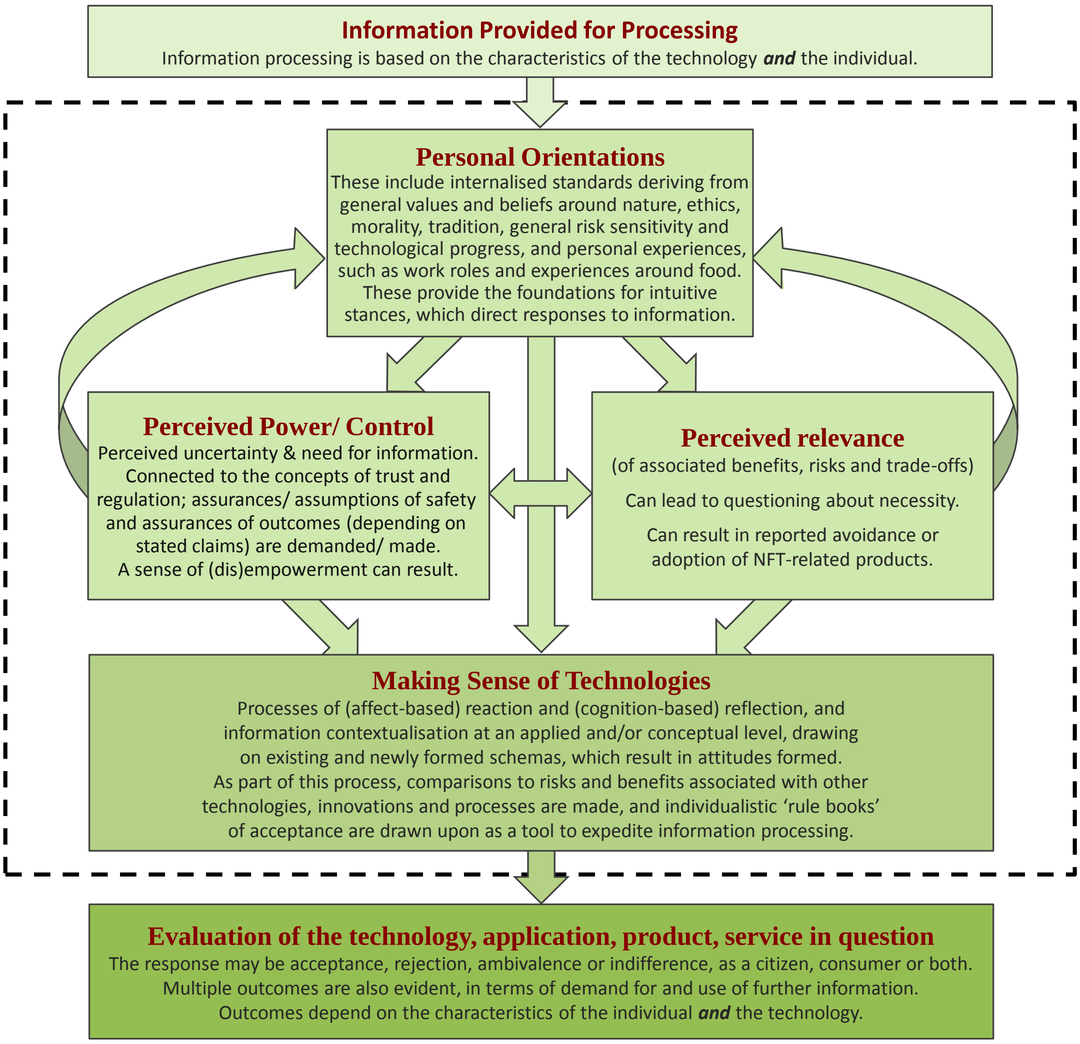

Figure 9.2: *Process Model of Information Processing and Attitude Formation for Different Technology Groups*

This 'Process Model' outlines what each influence encompasses and provides further clarity on the reciprocally determining, yet potentially competing relationships between these features in guiding overarching evaluations. For instance, personal orientations can form intuitive stances which directly impact sense-making and, in turn, evaluative stances, i.e. lead to unquestionable acceptance/ rejection of the technology. This can occur without reflecting on the other influences, as illustrated by the downward arrow in the centre of the Model. In addition, these stances can impact the level of perceived control one considers to be necessary over the technology's application. Furthermore, depending on the technology, perceptions of there being considerable associated personal and/ or societal benefits could lead to certain higher order orientations, such as apprehension about the technology interfering with nature (deriving from beliefs about nature), being reassessed, i.e. 'overcome' (as indicated by the feedback loops into 'personal orientations'). Therefore, the arrows depicting relationship directions illustrate the complexity of the information processing and attitude formation mechanisms involved.

This Model portrays the information processing features which result in sense-making and ultimate perspectives on the technologies. In support of the Levels of Processing framework (Craik & Lockhard, 1972: see Section 3.3.2), the processes through which citizens make sense of these technologies occur at both reflective and shallow levels (Petty et al., 1997), depending on their personal orientations, the specific technology and perceived uncertainty and control. This finding has implications on attitude stability. On a related note, information processing mechanisms and strategies employed by some appear more complex and intricate, while others attempt to simplify these processes by relying on a few key strategies and influences in forming their evaluations. Those emphasising 'simple repertoires' in their contemplations tend to let one of the aforementioned key influences dominate their appraisals.

Although individuals may form similar technology assessments, they seemingly often draw on different rationalities and contexts in guiding their evaluations and interpreting information. This finding brings Booth and Shepherd's (1988) premise about the 'multiplicity of the individual' impacting food acceptance into focus yet again. Successively, there is a need to understand, not only overall assessments but also, the reflective processes contributing towards such assessments at the various citizen and consumer focused 'acceptance states' previously outlined (Kuznesof, 2010: see Figure 2.3).

This Model further contextualises the various iterative cognitive processes at play, and demonstrates the individualistic 'reflective journey' potentially undertaken when forming attitudinal standpoints towards different NFTs. As previously mentioned, although the salience and weighing of each influence may vary and these processes may manifest differently depending on the characteristics of the technology, their origins remain consistent. This point withstanding, focusing on information processing around less emotive, processing orientated, technologies, the findings indicate that individuals are unlikely to engage considerable effort in processing information about these technologies. Information processing around these particular technologies appears likely to be more direct and less complex, given their perceived non-threatening characteristics. Indeed, it seems likely that if one is to engage in information processing about these more benignly perceived technologies in a real-world purchase/ consumption situation, their reflections would probably focus on comparisons to conventional alternative methods, i.e. the technology's application would most likely be a 'non-issue'. This point withstanding, the food industry should not become blasé about public reactions towards these types of 'non-threatening' NFTs, since any emerging controversy surrounding them could negatively impact public perceptions. In light of these findings, future quantitative methodological approaches, such as survey questionnaires, concerning attitude formation and information processing around NFTs should be designed for each specific technology.

Scientists are, by and large, focused on risk-benefit attribute trade-offs associated with these technologies and their various applications (e.g. price increases versus quality improvement). Nevertheless, as the findings indicate, and this Process Model demonstrates, many other features and associated relationships impact public attitudes towards various NFTs. Thus, while trade-offs are a key feature, they should not be the sole focus of stakeholders. This work is concerned with establishing and understanding the features encompassed in the 'black box' (represented by a dashed-line box within Figure 9.2), where information is processed and attitudes form. It thereby theorises and provides insight about possible ways in which information is integrated and processed, in addition to the factors that potentially impact this process.

This proposed Process Model provides the basis for testing, through quantitative measures, explicit causality between these influences and outcomes in terms of the factors impacting information processing and attitude formation, for different types of contentious and non-contentious technologies. Depending on the specific technology (group), the influences that are more or less salient may vary. Future research could test the strength of links and directions of relationships between these influences.

9.2.2 Research Implications in Context

Having examined the emerging themes and mechanisms of processing information and forming attitudes, it is clear that each theme provides a description of a key influence directing citizens' attitude formation and evaluative processes around the technology groups. These themes are now scrutinised in terms of their relevance beyond the realms of this dissertation.

An intricate 'journey' of schematic reflection

This research strengthens our understanding of the directly related, in addition to broader nexus of, multidimensional concepts and connotations that individuals draw upon when presented with new information about NFTs.

> *"If there were only one truth, you couldn't paint a hundred canvases on the same theme"* (Pablo Picasso, 1966).

The findings indicate that although individuals may form the same overall viewpoint on a specific technology, be it positive or negative, they may draw on various 'networks of meaning' and cognitive processes when forming their overarching attitude. Hence, aligning with the arguments of Edwards (1990) and Olson and Kendcik (2008), they may be more, or less, susceptible to altering their attitude following the provision of additional information. Therefore, building on the recommendation of others, such as Murphy (2008) and Davies (2011), it is important to examine the 'reflective journey' that a person travels to reach their attitudinal end point.

This thesis has focused on how information is assimilated to ultimately guide citizens' perspectives on NFTs. 'Making sense of technologies' involves the use of interpretative schemas; a term used by Scheufele & Tewksbury (2007) (but also see Goffman (1974) and Burri (2009)). These include existing schemas drawn upon from long-term memory (Peter et al., 1999), and newly formed schemas (Erasmus et al., 1992) which are created to provide a contextual 'familiarisation framework' for information processing (Gamson et al., 1992). Accordingly, the findings of this research correspond with the argument of Davies (2011: 318) that *"meaning is produced within a particular context"* and the view of Blake and Bisogni (2003: 291) that food choice schemas do not appear to be *"static phenomena*". Indeed, for the more unfamiliar and abstract NFTs, many appear to readily form new schemas, in addition to drawing on prevailing ones, given their dearth of an in-built and pre-set 'attitudinal navigator' for the particular technology. Thus, the findings of this research draw several parallels with the memory-based models of attitude formation, as described by Bohner and Dickel (2011).

The varying levels of awareness and evident lack of explicit knowledge of these technologies (see Section 5.2) seem to result in reliance on analogies to the familiar as a *"discursive tool"*; thereby indicating further connections with the findings of Davies (2011: 317). In terms of the contextual analogies made and networks of meaning formed, it is clear that although science is an important component in internal reflections on issues around NFTs, it is not the sole foundation of this 'personal debate'. Indeed, non-scientific issues playing a distinctive and important role in guiding perspectives represents a view also held by Murphy (2008) and Davies (2011).

Triggering of in-built 'standards' and sense of uncertainty

The internalised standards stemming from one's 'higher order' values and beliefs, present a strong basis for sense-making, by providing existing schemas upon which to form opinions. Perceptions of the technologies violating these standards result in a demand for a precautionary approach. To this end, drawing from Sir Bradford Hill's (1965) work on causality, Wiedemann (2009: 560) contends that individuals evaluate risks based on their perceptions of *"what is at stake"*. Building on Wiedemann's (2009) assertion, depending on the specific issue and context, weak evidence may be sufficient to ignite preventative measures and consequential action or, alternatively, strong evidence may have to be presented prior to any such course of action being taken.

Concerns voiced about potential unknown consequences of trying to control nature through the adoption of these technologies, and man's right to do so, resonate with the findings of Shaw (2002: 280), who refers to the power of nature in terms of triggering concerns about GM foods *"fiddling with nature"*. Beliefs expressed about these technologies being in balance or conflict with nature and the potential negative consequences of interfering with nature mirror several concepts presented in Adam's (1995) four myths of nature. Furthermore, in support of the postulations of Vandermoere et al. (2011) and Loebnitz and Grunert (2014), perspectives on and values around nature appear to present a competing frame for novelty and innovation, and to subsequently create elements of 'evaluative tension' in individuals' minds. More broadly, the findings presented raise interesting questions about how and why individuals' standards around nature and, in turn, perceptions of naturalness vary, in the context of different technologies, process and products, both within and beyond the food domain. On a separate note, attitudinal stances which stem from ethical and moral beliefs draw comparisons with Delaney and McCarthy's (2014: 111) conceptualisation of the *"moral space of food"* in terms of the eating habits of older adults.

The sense of dread descending from perceptions of associated risks and uncertainty can weigh considerably on overall evaluations, often appearing to result in the adoption of a precautionary stance, based on intuitive (emotive) reactions. This seems to be particularly the case for the more contentious technologies. In spite of welcoming potential associated benefits, citizens may display a tendency to revert back to this precautionary position, due to a lack of knowledge and apprehensions about perceived scientific and knowledge uncertainty. Hagemann and Scholderer (2009: 1043), Ronteltap et al. (2009) and Rollin et al. (2011) speak to this when discussing the role that perceived uncertainty can play as a *"driving force"* behind consumer evaluations, stating that general perceived uncertainty, rather than specific risk perceptions, contribute towards technology resistance.

Consequently, in support of the theoretical underpinnings of the psychometric paradigm (Starr, 1967; Fischoff et al., 1978; Slovic, 1987, 2000), due consideration should be given to the important influence of low levels of awareness and high levels of uncertainty on public reactions towards these technologies (Frewer et al., 2004; Ronteltap et al., 2007). Individuals seem to worry not only about what they do not know, but also about what scientists and policy makers may be unaware that they do not yet know, i.e. 'unknown unknowns'. Hence, it appears that the absence of evidence of risks is not equated to the evidence of risks being absent. In a similar sense, the demonstration of benefits by industry does not necessarily equated to consumer perceptions of benefits.

Perceived control and impacts of trust on evaluations

Trust in science and regulators are drawn upon in instances where perceived scientific or knowledge uncertainty exist about the technology. Reliance on trust in other stakeholders tends to impact the extent of attitude changes due to risk-based information. Supporting the principles of TPB (Ajzen, 1988, 1991: see Section 3.2.2), openness towards the technology is therefore influenced by perceived control through trust placed in others. Hence, building and maintaining a robust regulatory framework, capable of managing and controlling any technological risk, verifying claims made, and ensure transparency and openness with the public in the face of any associated uncertainty, scientific or otherwise, appear to be essential prerequisites to ensuring public responsiveness towards these technologies. It seems that the lower the trust level, the more cautious a person is with regard to the technology, and vice versa (Simons et al., 2009). This finding indicates that trust and risk/ benefit perceptions tend to be interdependent. In this sense, Renn (2003) argues that in order to build trust, it is essential to listen attentively to lay citizen concerns and, if necessary and appropriate, engage in two-way communication. In a similar way, Davies et al. (2009: 8) describe how policy makers face a challenge in terms of remaining *"sensitive"* to public concerns, while concurrently regulating in a way that fosters and facilitates innovation and technological progress.

Perceived relevance, necessity and self-identity

The perceived relevance and necessity of the applications and associated products to one's daily life and core value systems provides grounding for evaluations. In a similar vein, Dean et al. (2012b) found perceived relevance and, in turn, necessity to be important motivational factors underpinning individuals' health claim usage and, more broadly, perceptions on functional foods. Elsewhere, Furst et al. (1996: 257) have described how *"a central component of people's personal systems [around food choice] was the weighing and accommodation of values salient to a person in a particular situation"*. Building upon this previous research, this dissertation clearly indicates that product attribute weightings, prioritisation, relevance and necessity are linked to perceived risk/ benefit trade-offs within specific contexts.

In turn, perceived alignment of product attributes, knowledge of the technology, and self-identity seem to impact assessments. To this end, this research echoes some of the issues of previous studies, such as Furst et al. (1996), Bisogni et al. (2002), Devine et al. (2003), and Dean et al. (2012a), which have found the concept of self-identity to be impactful in directing attitudes and behaviours around food choice and consumption. Furthermore, the findings of this work support Katz's (1960) functionalist theory of attitudes, previously outlined. In particular, it supports the premise that attitudes can serve as a 'value expression function' by aligning and supporting expressions of central values and self-concept(s), and also as an 'adjustive function' by satisfying utilitarian needs such as self-interests.

When assessing the technologies, individuals seem to reflect on the identity (health-orientated or otherwise) that they wish to portray, and whether they consider the technology or product in question to violate or be congruent with *"some valued self-standard"* (Wood, 2000: 546) or self-identity. In fact, conflicts may become apparent between the identities individuals wished to display and their reported behaviours in various circumstances, particularly in the context of information seeking tendencies, which are further explored in turn.

'Sense-making mechanisms'

Examining the overarching thematic narratives more closely, personal orientations and comparisons to other technologies are important in providing what Burri (2009: 507) refers to as *"interpretative patterns that served as tools in decision making"*: *"such narratives constitute the epistemic foundations on which the actors drew in their assessments"*. Where knowledge uncertainty exists, individuals tend to make analogies to what is familiar, based on experiential knowledge. The action of (sub)consciously *"anchoring the unfamiliar to a familiar reference point"* is consistent with Pivetti's (2007: 137) premise about SRT (see Section 2.4) and the formation of such representations.

Concerning anchoring biases (Tversky & Kahneman, 1974; Kronberger et al., 2012), individuals tend to make comparisons to risks and benefits associations with other technologies, innovations and processes, in an effort to make sense of these less familiar technologies. This action is in accordance with Moscovici's (1984, 1988) and Pivetti's (2007) proposition that a means by which social representations form is through transforming abstract and unfamiliar concepts into those that are more concrete and relatable. Moreover, there are clear parallels between the findings of this work and Macoubrie's (2006) and Visschers et al.'s (2007) contention that, due to the many unknown risks associated with nanotechnology, consumers use their perceptions of known risks to judge potentially unknown risks. Similarly, Davies (2011: 321) describes how comparisons and analogies to other technologies *"can be used to argue both 'for' and 'against' nanotechnology"*, and are subsequently a *"rich resource for the construction of stances".* Depending on the novel technology, conventional alternative technologies can be an important comparative *"rhetorical device"* and contextual cue directing assessments: "*…what is known, in other words, is taken and used to build* *responses to what is not. (…) The familiar is a resource for dealing with the unknown and uncertain"* (*Ibid*: 323).

In further accordance with SRT (Moscovici, 1984, 1988; Wagner, 1994; Bauer & Gaskell, 1999; Bäckström et al., 2003, 2004; Pivetti, 2007), these novel technologies appear to be contextualised in terms of their perceived representations, based on what is already known in a broader context. This view is in keeping with Priest et al.'s (2011: 14) description of individuals bringing a *"technology "template"*, rather than a *"completely blank slate"*, to their thought processes concerning nanotechnology. Consequently, an individual with a greater multiplicity of attitudes (Wood, 2000) concerning, for example, technology and food, may draw on a breadth of influences, associations and anchors when forming attitudes around NFTs.

Attitude ambivalence

Holding a complex set of, potentially conflicting, values and beliefs, for example being a techno-enthusiast who holds a strong religious faith, may increase the variability of reactions and uncertainty of attitudes (Wood, 2000) towards the technology. This consequently results in attitude ambivalence (Visser et al., 2006; Fischer et al., 2013). Both within this research and elsewhere (Macnaghten et al., 2005; Kahan et al., 2009; Fischer et al., 2013), ambivalent public attitudes have been documented concerning emerging technologies. As an illustrative example, depending on the simultaneously accessible (Crano & Prislin, 2006) orientations directing one's evaluative process at a contextual point in time, s/he could perceive a technology to be tampering with nature and divine law, yet also consider it to be a progressive technological advancement. Hence, this work reinforces the argument that positive and negative perspectives can concurrently influence evaluations, subsequently generating ambivalence. This evident ambivalence goes some way towards explaining why Irish citizens tend to be more 'undecided' in their attitudes towards different aspects of NFTs, compared to their European counterparts (Gaskell et al., 2010), as previously outlined.

Information provision and processing

Building on the research findings of Fischer and colleagues (2013) concerning the impact of information provision on attitudes towards nano foods, the analysis presented here indicates that the potential malleability and ambivalence of attitudes may result in additional information altering the direction, stability or strength of attitudes (Visser et al., 2006). Drawing on the postulation of Frewer (2003), Vandermoere et al. (2011) and Kronberger et al. (2012), among others, it should however be noted that increasing awareness of a technology does not necessarily increase public acceptance. This work reinforces the argument made here and previously by others (e.g. Costa-Font & Mossialos, 2007) that the direction of influence of additional information remains unclear (see Section 3.3.5). Stakeholders should remain cognisant that different publics 'use' information differently (Grunert et al., 2010).

Initial attitudes, originating from one's worldview and ingrained values and beliefs, seem to guide emerging standpoints on NFTs and can bias (positively or negatively) the processing of new information (Kahan et al., 2009; Bohner & Dickel, 2011; Rollin et al., 2011). As additional information is contextualised and integrated, some citizens appear to become stronger in their convictions and initial attitudes, while the evaluations of others become more malleable, depending on the technology and its perceived alignment to personal priorities. This work therefore supports the view of Conrey and Smith (2007) and Bohner and Dickel (2011) that attitudes, although resistant to change, can be flexible in particular contexts, and therefore potentially open to reformulation following information provision. Indeed, this sequencing of 'attitudinal events' seems to occur even in instances where citizens recognise their lack of knowledge, and thereby initial frames of reference, about the technology.

That withstanding, analogous to the findings of studies, such as those of Sheldon et al. (2009) and the TNS-BMRB report for the FSA, UK (2011), a need for further information about these technologies is generally expressed by citizens. The impact and relevance of information on evaluations varies depending on the technology, specific application and product, as previous postulated (Bruhn, 1998; Frewer et al., 2003a; Costa-Font & Mossialos, 2007; Sheldon et al., 2009), in addition to individuals' characteristics and interpretations of it. Moreover, the findings presented concerning nutrigenomics and PNPs illustrate the important role that information type has on citizens' perspectives, i.e. whether the information is about the technology, associated products or the individual. Building on the argument of Furst et al. (2000: 347) concerning food choice more broadly, evaluations of these technologies are *"dependent on the communication environment in which they were embedded"*.

The extent to which one is willing to consciously reflect on the technology and associated attributes, and actively seek and process relevant information, depends once again on the characteristics of the person and technology and specific circumstances. As found to be the case in this work, and previously reported by Fell et al. (2009) and Sheldon et al. (2009), many tend to rely on intuition, rules of thumb and associative evaluations in their technology assessments, due in part to these technologies not being a high priority issue in individuals' lives (as evident in participants' comments during the discourses). This presents an interesting question about how science can be better integrated into everyday societal life.

Need for cognition

Conflicting views, on the desire and need for information, are evident in this work. For instance, many advocate appropriate product labelling to enable freedom of choice, yet concurrently suggest that, to a certain extent, 'ignorance is bliss' in terms of information about these technologies (for example, the information necessary to understand the label). Hence, despite the expansive cognitive ability of individuals evident across the sample, need for cognition (Cacioppo & Petty, 1982; Zhang & Buda, 1999) appears to vary, depending on the technology (Nielsen et al., 2009) and one's embedded values and beliefs (Wansink & Kim, 2001), as previously described. In fact, some seem to be more content than others to maintain a conscious lack of knowledge about these technologies and, instead, to rely on heuristics (Tversky & Kahneman, 1974; Slovic, 1987). These particular individuals are considered to be *"cognitive misers"* (Fiske & Taylor, 1991; Scheufele & Lewenstein, 2005: 660), exhibiting limited effort and interest in acquiring and processing relevant information (Ho et al., 2013). This view is closely connected to that made by Bredahl (1999: 344) about food product choices often being made with *"low motivational involvement"*. This may be due, in part, to lack of ability or interest in reviewing relevant information (Grunert, 2002; Grunert et al., 2010).

Hence, this finding points to the 'information sufficiency' concept that Griffin et al. (1999) speak of when outlining the RISP model (see Section 3.3.2). While these types of individuals recognise that they are unfamiliar with the procedures that the food they consume undergoes, they tend not to actively search for information about these processes, particularly if they place high levels of trust in *"contemporary technoscience governance"* (Davies et al., 2009: 8). Some appear to be outright cognitive misers, while others seem to be information seekers (about associated risks and benefits) to a point. For the latter, further probing may reveal cognitive miser tendencies. This outcome resonates with Grunert et al.'s (2014) research concerning the relationship between consumer understanding, motivation and use of sustainability product labels. Grunert and colleagues note that expressions of concern about sustainability issues may be greater in an abstract, rather than a concrete (food product choice), sense.

In further accordance with the RISP model (Griffin et al., 1999; Kuttschreuter, 2006), information demands and processing/ seeking behaviours depend on the characteristics of the person and the technology. For instance, the cognitive effort required in terms of gathering and processing information about nutrigenomics (i.e. about one's genotype and potential disease susceptibility) and, in turn, suitable PNPs to purchase and consume would be considerable. However, the benefits of investing this 'cognitive energy', and amending one's diet and lifestyle according, may be considered by some to be worthwhile, in light of speculative health gains. It seems that novel products and services, such as PNPs and nutrigenomic testing, entail trade-offs, in the context of information seeking and processing decisions. The potential benefits offered require substantial cognitive processing on the part of the individual, in order to be leveraged. This is even the case in instances where information processing is undertaken purely to reach an informed opinion as to whether the benefit(s) offered are legitimate. This argument relates back to the findings about individuals' expressed need for assurances of claims made. Although information processing is primarily 'thought of' in the context of associated risks, stakeholders should remain cognisant that effort is also required by consumers (and regulators) to process information about associated benefits/ claims made.

Impact of NFT related attributes on information demands and processing

Where the application and associated product focus on altering experiential attributes, such as taste and texture, a demand for additional information does not tend to be as evident. Conversely, NFT applications and products centred on credence-based attributes are generally associated with a desire for additional information, and in particular, evidence of claims and assurances of outcomes. Consumers' demand for product labelling information is generally to enable them to opt-out of, i.e. avoid, purchasing/ consuming, associated products. In cases where product benefits are demanded by consumers, industry will communicate the presence of resultant benefits from the technology's application, in the hope of providing information which incentivises targeted consumers to opt-in to purchasing the product.

Product labelling

An absence of active information seeking seems to be particularly apparent in instances where individuals place high levels of trust in the regulatory system. That withstanding, labelling NFT products accordingly without providing explanatory information may negatively impact public perceptions, as it may be interpreted as a warning about potential risks (Siegrist, 2008; 2010). In this vein, Siegrist and Keller (2011) highlight that mandatory labelling in the case of nano foods, may result in higher perceived risks and lower perceived benefits, since such labelling may be perceived as a signal of there being associated risks. Ergo, lack of provision of sufficient information can result in an over-simplification of the process and associated issues.

On a similar note, Grunert and Wills (2007) describe how product labelling is further complicated by potential anomalies between objective and subjective understanding of this information and varying levels of interest across products, people and circumstances. Use of multi-layered labels or mobile optical recognition devices, e.g. QR codes on product labelling, could be effective means of providing supplementary information, if desired, to consumers.

Prior awareness, embedded beliefs and levels of acceptance/ rejection

On a different, but related, point, despite having already purchased and consumed products which apply certain NFTs, some people may be unaware that these novel technologies, or alternative comparable technologies in the case of thermal and non-thermal processing, have been applied. Consequently, when probed for their perspectives, they may react negatively towards the technology's adoption, despite having 'innocently' purchased and/ or consumed such products (Clery & Bailey, 2010).

These technologies are contextualised within a broader food and life context. Ideals and symbolic meanings associated with food, such as perception of naturalness, form a basis for information processing and sense-making around them. In a similar sense, Belton (2001: 35) argues that *"the ritual aspects of food play a very important role in acceptability".* Furst et al. (1996: 263) have also referred to the notion of routine in the context of food choices more broadly, describing how *"most choices involve decisions that pass through value negotiations, with varying intensity of consideration of these values, and having passed through value negotiations in the past become routine or automatic"*. Hence, imbued ideals and repertoires about food and technology formed over one's life course (Furst et al., 1996, 2000; Macnaghten et al., 2005) appear to provide dynamic and evolving 'personal food and technology operating systems' (Furst et al., 2000; Connors et al., 2001; Mintz & Du Bois, 2002; Clery & Bailey, 2010), which form the bedrock for attitude formation around these technologies.

Furst et al. (1996) draw attention to the processes enacted by individuals during the emergence of their food choice trajectories, suggesting that individuals: prioritise values; classify foods based on these values in given contexts; and, then select foods in accordance with these. Within this research, perceptions of associated products' fit, at a practical and conceptual level, with one's life may result in either outright rejection of the technology, acceptance of the technology but active rejection of related products, or both acceptance of the technology and associated products. They may accept (reject) the technology based on their deep-seated values and beliefs, including moral, ethical and societal standpoints (Bredahl, 1999), or alternatively based on associated product specific characteristics or associations. Although some may not be opposed to the technology being applied in principle, they may be unwilling to purchase/ consume associated products, possibly due to lack of perceived relevant benefits.

Essentially, they may accept the technology as a citizen but reject it as a consumer, or vice versa. This finding is in accordance with the assertion of Clery and Bailey (2010) that an individual could be open towards the concept of a food technology in an abstract sense, yet concurrently exhibit resistant towards specific applications and/ or purchasing and consuming associated products, or their family members doing so. Equally, yet conversely, one should not assume that consumer acceptance automatically results in societal acceptance.[37] Hence, for a technology to be truly accepted and adopted, acceptance needs to occur at both philosophical and consumption levels.

37 An illustration of this is the case of Sainsbury's and Safeway supermarkets selling clearly labelled and advertised cans of GM tomato purée, where societal rejection occurred after consumers had readily accepted this product (Harvey, 2000; Krebs, 2000). In this instance, public rejection was attributed mainly to the food scandals that occurred in the UK following the product's commercialisation (Tencalla, 2006).

'Rules books' of acceptance

On a separate note, this work has illustrated how evaluations of these technologies, and associated risks and benefits are not homogenous, with rule books of acceptance being evident at the individual level. To this end, what is perceived as 'natural', 'harmful' or 'convenient' varies depending on personal perspectives deriving from unique mélanges of experiences, values and beliefs. As an illustration of such internalised rules, some appear to be more in favour of genetically modifying animals using animal genes, whereas others prefer the concept of modifying animals using plant genes. Evidence of a hierarchy of approval (Hallman, 2000) concerning different applications indicates that the development trajectory of a technology needs to carefully consider the application(s) that may be more, or less, acceptable to citizens/ consumers.

On a related conceptual thread, Davies (2011: 324) describes *the "tools which laypeople use to put across their opinions - the kinds of resources they reach for in creating their arguments"*. Understanding the type of 'rules' generated and 'tools' drawn upon, which are apparent in this current study, can facilitate greater understanding of public and consumer attitude formation around these technologies. Nonetheless, despite the influence of these rule books in directing reflective processes, there may be situations where negative affect-based reactions, deriving from deep-rooted values and beliefs, result in a person rejecting the technology prior to drawing on these internally generated rules.

Risk and benefit trade-offs

This work builds on the argument made by many scholars (e.g. Starr, 1967; Alhakami & Slovic, 1994; Bredahl, 2001; Brown & Ping, 2003; Slovic et al., 2004; Gaivoronskaia & Hvinden, 2006; Siegrist et al., 2008; Fischer et al., 2013) that the public do not consider risks and benefits independently, and instead, perform trade-offs in their assessments. It seems that, regardless of the technology in question, related products must offer unique tangible benefits, in order to offset any potential associated risks. The degree to which assumed benefits can compensate perceived risks has been widely explored and debated (e.g. Bredahl, 1999; Grunert et al., 2001). The public do not appear to believe that these technologies are 'magic bullets' that result in considerable benefits without any associated risks (typically costs), and subsequently presume that trade-offs will have to be made. They therefore ascribe to the *"no risk, no reward"* notion forwarded by Adams

(1995: 17). In light of this, Davies et al. (2009: 6) encourage policy makers to *"develop a healthy scepticism about the rhetoric of the win-win situation characteristic of much discourse"* surrounding novel technologies.

Currall et al. (2006: 153) argue that, to date, much of the debate about the future of nanotechnology, and in turn, NFTs more broadly, has focused on the *"types and magnitudes of [potentially associated] risks"*. However, perceived risks are only one aspect of the *"complex decision-making calculus"* that citizens apply (*Ibid*: 155) when assessing these technologies. Thus, while it is essential to continually appraise and monitor potential short-, intermediate- and long-term risks, attention should also be paid to the benefits that these technologies might bring to consumers, society and industry (Fischer et al., 2013), to support balanced debate and informed decision making.

Complexities and conflicts

While individuals appear to attempt to classify these technologies and their applications as 'good' or 'bad', 'positive' or 'negative' and 'safe' or 'threatening', in order to simplify information processing, internal complexities, contradictions and conundrums are evident in their evaluations. Thus, this work reinforces the argument that the issue of public evaluations of these technologies is not black or white (Rowe, 2004; Davies et al., 2009), but instead, various shades of 'attitudinal grey'. This research therefore aligns with the finding of Vandermoere et al. (2011) and Fischer et al. (2013) that people tend to be ambiguous in their attitudes towards nano-inside and nano-outside food applications.

Furst et al. (1996), Falk et al. (2001) and Bisogni et al. (2005), among others, describe how similar internal complexities are apparent for food choice decision processes more broadly. While minimal attention has been paid to date to the internal conflicts which manifest in terms of attitude formation around NFTs, this research, in addition to that of Rowe (2004) and Davies et al. (2009), highlights the challenges that they potentially create, particularly in terms of developing relevant communication strategies.

These internal tensions are created, to a large degree, due to personal orientations and product relevance anomalies. As an illustration of these incongruities, while embracing the related benefits offered, many are cautious about potential associated risks and question the necessity of certain applications. Furthermore, internal conflicts may be evident in terms of reactive (linked to emotions) and reflective (linked to cognitive) responses (Ortony et al., 2005); with the latter potentially resulting in the former being 'rationalised' to the point of internal dismissal. Such internal tensions appear on-going, and there is a broad spectrum upon which they exist. Support of this assertion is evinced in Adams' (1996: 202) description of how *"our lives are compartmentalized in ways that permit us to hold beliefs that are mutually inconsistent"*.

> *"Emerging technologies, surrounded by ambivalence and conflicting narratives of utopia and dystopia, provide fertile ground in which the moral dilemmas of modernity are rehearsed"* (Macnaghten et al., 2005: 279).

One approach to managing these conflicting views and reducing attitude ambivalence and cognitive dissonance (Festinger, 1957) is to attempt to alter negative perspectives which one may hold about the technology so as to support, and no longer oppose, another more central, positive view held about it. For instance, in accordance with the PAST model (Petty et al., 2006) (see Figure 3.2), information might be presented that leads a person to discard their initial attitude that the technology is unnatural, and instead adopt the standpoint that it is a natural process, which aligns with their positive stance on the personal relevance of the tangible benefits it offers, and as a result, cognitive dissonance is reduced.

While lack of awareness and knowledge of the technology often leads to a sense of dread and triggers more emotional (Grunert et al., 2004a), and potentially negative, responses, rationality appears to compete with emotions for longer standing technologies, in keeping with Slovic et al.'s (2004) premise about the interplay between these interrelated 'attraction poles'. Subsequently, both the intuition and reasoning aspects of DPMs (Crano & Prislin, 2006; Cunningham & Zelazo, 2007) appear to be activated when forming attitudes.

The evolutionary path to public acceptance (rejection)

This research supports Roger's (1995) seminal theory on the adoption of innovation, which posits that the following factors influence adoption: 1) the nature of the recipient/ society to which it is introduced; 2) the innovation itself; 3) the communication channels used to spread information about the innovation; and, 4) time. Hence, this work highlights, yet again, the inherent complexity between these factors and that attitudes are "*inherently interactional"* (Davies, 2011: 318). Focusing on the temporal dimension of

Roger's theory, this research reaffirms that acceptance tends to be an evolutionary, rather than a revolutionary, process, unless unique and highly valued benefits of relevance are evident. In this sense, the public may become 'passive', rather than 'active', acceptors of NFTs over time (Henson, 1995; Kuznesof, 2010; TNS-BMRB, 2011). General speaking, expectations and assumptions about these technologies, which derive from personal orientations, may be challenged and/ or altered in the future, as new information comes to light, and/ or their application becomes more prevalent and associated products become commercially available.

Targeted communication and product development/ characterisation implications

The analysis presented indicates that, in general, citizens tend not to be uniformly anti-technology, and subsequently uncertainty and fear can be reduced through appropriate communications. In instances where distinctive, tangible benefits are clearly defined and communicated, which are perceived to be of significance, this may offset initial concerns and result in more quickly arriving at a public acceptance end point (Lusk, 2003).

As highlighted in this analysis and previously by Bruhn (2007), consumers seek products with explicit benefits of personal relevance, rather than specific technologies. Therefore, if an objective of a communication is to successfully market and sell related products, the *modus operandi* for food companies should be to anchor benefits offered in concrete examples of product characteristics relevant to individuals' demands from food (Siegrist, 2008) and effectively communicate these benefits. In this sense, Nielsen et al. (2009: 116) posit the following:

> *"…from a managerial point of view, it is therefore important to understand how attitudes towards new processing technologies are formed, and to understand if marketers can influence this attitude formation through providing consumers with information about the technology".*

There is still time to 'fine tune' different applications of these technologies to societal and consumer preferences and perceived needs, and to link the benefits offered to the food attributes that are most significant to individuals when classifying and selecting products.

This work reiterates the importance of aligning associated benefits and carrier products with the demands and expectations of specific consumer segments (Krutulyte et al., 2011), given the central importance of need satisfaction (Rollin et al., 2011). Following alignment of benefits, products and consumers, effective communication of such targeted benefits is necessary to ensure consumer buy-in. Information communicated should be framed in a way that enables the individual to align the message(s) communicated to their values, beliefs and outlooks (Kahan et al., 2009). That said, the focus should not be solely on marketing associated products, but also on placing science more centrally within society, and educating scientists about how to more effectively communicate science to the wider public (Murphy et al., 2011).

In support of the sensory basis for acceptance of NFT related products (e.g. Grunert et al., 2004b; Kuznesof, 2010; Loebnitz & Grunert, 2014), certain product characteristics are evidently more influential and less negotiable than others, depending on the technology, product and person. For instance, certain individuals may be unwilling to compromise on taste, irrespective of the benefits that the technology may offer.

Once applications of the technology have been developed and the product is near to market, the importance of credence attributes, in terms of communication, and subsequent consumer perceptions of them, needs to be carefully considered (Grunert, 2002). Credence attributes, such as ‘healthier’, and endorsements such as ‘organic’ or ‘sustainable’ require high levels of trust by consumers in order to be believed and valued. Grunert (*Ibid*: 280) speaks of the role of trust as a *“credibility-enhancing device”* for claims made. Similarly, the role of regulatory authorities in monitoring and legislating claims has been identified in this analysis, particularly in situations where perceived personal control is lacking and knowledge uncertainty exists. This finding links to Einsiedel and Goldenberg’s (2004: 31) view that trust can act as *“an important surrogate for information”*.

Overall, the findings of this work build on the recommendations of previous studies (e.g. Frewer et al., 1998a; Lee et al., 2005; Davies et al., 2009) about the need to develop effective communication and outreach strategies within this area. For instance, the analysis indicates that distribution of associated benefits is important to address in communications to the public about these technologies. Henson (1995), Shaw (2002), Kuznesof (2010) and Frewer et al. (2011) also speak of the impact that perceived benefit accrual can have on overall technology assessments.

Overcoming challenges through effective and transparent communication and engagement

More broadly, the numerous challenges associated with engaging with the general public about these technologies have been outlined. These challenges stem from variability in terms of levels of public knowledge and (subjective and objective) understanding of, and interest in, these technologies (Grunert, 2002; Renn, 2003; Potts & Nelson, 2008; Bostrom & Lõfstedt, 2010). Indeed, public engagement about these technologies seems to be complicated, and potentially constrained, by the variability across these factors. As a result, oversimplified assumptions about citizens' attitude formations and acceptance (rejection) of NFTs may lead to counterproductive communication strategies.

Industry, policy makers, researchers and other institutions involved in food/ science communications should take account of the numerous and varied existing schemas drawn upon by the public when evaluating food applications and related products, as evident in this research. These include past experiences and awareness of applications of the technology in other sectors. Reliance on these schemas can potentially result in misinterpretation of the processes that food undergoes; a phenomena which has similarly been observed by Sheldon et al. (2009) concerning genetic modification. Hence, targeted communications should differentiate between different technology applications, as evaluations of them may not be homogenous, as demonstrated here. The information provided should be *"clear, easily understandable, meaningful, adequate, accurate and complete"* (Bánáti, 2008: 443) and comprehensive, yet not overly technical.

Within any communication about NFTs, openness and transparency are necessary (Frewer et al., 1998b, 1999, 2003b; McCrea, 2005; House of Lords, 2010). However, as previously argued by Van Wassenhove et al. (2012: 569), transparency should not be *"misused by bombarding people with large quantities of information"* which they potentially struggle to understand. Instead, *"quality should take priority over quantity"*, in the context of information disseminated (*Ibid*). This is clearly important in light of the tendency of individuals to be cognitive misers apparent within this work. Grunert (2002: 281) and Sheldon et al. (2009) make a similar point, noting that information overload can lead to its *"misuse and misinterpretation"*.

Transparency is particularly necessary in cases of perceived uncertainty. Failure to involve and adequately inform citizens can fuel resistance and rejection (European Commission, 2009a). Wiedemann (2009: 561) underlines the importance of characterising any uncertainty surrounding associated known and unknown risks, in a way that *“enables the audience to understand the strengths as well as the weakness of the available evidence”.* Hence, both biased and conflicting public information should be addressed, to support informed public decision making about these technologies (McCrea, 2005; House of Lords, 2010). In a similar vein, the food industry and those framing policy should heed the following warning of Einsiedel and Goldenberg (2004: 32):

> *“If there is anything that the evolutionary path of biotechnology has taught us, it is the greater danger of keeping the social at bay when developing or discussing technology”.*

That withstanding, the question of when to introduce specific information into the public realm presents further challenges. Specific communication strategies are required for the different stages of a technology’s development trajectory, especially where elements of uncertainty exist or negative connotations arise.

In addition, the dominance of TD versus BU influences in directing evaluations may change as a technology moves along its development trajectory. For instance, BU, rather than TD, influences may become more impactful as a NFT related product is commercialised, depending on how a person characterises the technology/ product and the strength of their ‘higher order’ values and beliefs. Hence, it is not only attitudes that potentially evolve, but also the processes through which one interprets, contextualises and evaluates the technology. These points withstanding, as the findings indicate, public confidence in the implementation of (non-specified) ‘adequate regulations’ and risk assessments throughout a technology’s trajectory, in order to guarantee safety and assurances of outcomes, is essential (Simons et al., 2009).

Lack of acceptance should not be confused with lack of understanding. Presumptions of naïve public rejection may be viewed by lay citizens as condescending. In acknowledging that the Knowledge Deficit approach to communicating about these technologies has failed (Hansen et al., 2003; Rowe et al., 2010), the focus now moves from educating the public towards engaging with them (European Commission, 2009b), in innovative and timely ways (Van Wassenhove et al., 2012) using, for example, social media in order to stimulate interest and public debate (Rutsaert et al., 2013). It is clear that the media's continued role in influencing public attitudes should not be underestimated (Dudo et al., 2011).

As a final point, this work illustrates how proactive public engagement, at the early stages of a technology's development, can provide an initial 'scoping-out' of where the specific technology lies along the public perception spectrum, from benignly to contentiously perceived NFTs.

> *"Public engagement is not a panacea; its purpose is public empowerment through informed consultation, and it will not always prevent technology from becoming controversial. However, it is hoped that, at a minimum, public engagement will provide an early warning system of public concerns, allowing managers and regulators to consider those concerns"* (Hornig Priest, 2011: 9).

Stakeholders should also reflect on how quickly the public would like to see certain NFT related products coming onto the marketplace, if at all. In addition to focusing on awareness and considering more nuanced approaches to public engagement, relevant stakeholders, particularly policy makers, should take account of the diverse influences directing citizens' technology evaluations, as evident within this work, when communicating with the public (Frewer et al., 2003a, 2004). These include general attitudes towards science, technology, nature and food production/ processing. For example, they should examine the role individuals consider science to play in everyday life. This discussion leads us to consider some implications and recommendations for practice and policy.

9.3 Implications, Recommendations and Contribution to Practice/ Policy

Reflecting on the 'story' behind each of the aforementioned themes, core observations (summarised in Table 9.1) can be made on how citizens are likely to respond to information about different NFTs. These observations lead us to reflect upon some policy and/ or industry implications and recommendations.

The first observation is that the characteristics of the technology and individual need to be recognised and accounted for. It seems that meanings and associations generated around the technology are functions of its characteristics and individuals' personal belief systems, values and life experiences. Consequently, communications about these technologies should be designed to accommodate various states of understanding and acceptance. Second, technologies viewed as tampering with nature result in more emotional, and potentially negative, responses. Subsequently, perceptions of nature and naturalness should be carefully considered in communications with the public and policy initiatives about NFTs.

Third, people tend to rely on intuition, rules of thumb, trust in others and associative evaluations in forming attitudes, and do not normally deliberate too deeply on issues concerning NFTs. This can impact the stability of attitudes, and may result in new information leading to reassessments. However, initial attitudes do appear to shape further evaluations and bias the processing of subsequent information. Thus, trust placed in relevant authorities to control associated risks, verify claims made and regulate the technology should be fostered and maintained. Moreover, individuals' reliance on heuristics and associations in their assessments presents challenges when communicating with the public about the merits of adopting cutting edge technologies in food production.

The fourth observation is that people can reject (accept) a technology based on moral, ethical and societal grounds, and/ or based on associated product specific characteristics. Stakeholders should therefore recognise that public acceptance needs to occur at both personal and societal levels, in order to ensure the stability of positive evaluations. They should also reflect on how the technology is likely to be evaluated at different levels of abstraction. In addition, they should introduce applications and/ or associated products that are most congruent with consumers' demands from food and belief systems.

Fifth, it is also observed that people seek products with tangible and unique benefits of supposed significance to them, and are cautious in the face of perceived risk/ uncertainty. Since risk and benefit information influences evaluations in diverse, and sometimes unexpected, ways, responses towards these technologies tend not to be homogeneous. Industry should therefore align products and benefits to targeted consumer segments, given the central importance of need satisfaction. How any risks associated with the technology are being addressed should be clearly communicated in a time-sensitive manner.

Sixth, people feel powerless to influence the direction of technological change, but seek control over this change in their lives. In turn, they generally adopt a precautionary stance in the face of uncertainty and demand labelling information about NFTs, to enable voluntary choice. Stakeholders should therefore empower the public with accessible information, to enable freedom of choice. Furthermore, a robust regulatory framework capable of managing and controlling any technological risk, in addition to verifying claims made, should be maintained. Seventh, people can hold complex and conflicting views, which may result in attitude ambivalence. Competing emotional and rational responses have the potential to heighten internal conflicts. As a result, industry should ensure clarity in their communications about the risks and benefits associated with these technology and associated products, to enable consumers to make informed trade-offs in terms of perceived technology/ product attributes.

Finally, public acceptance of many novel technologies appears to be an evolutionary, rather than a revolutionary, process, unless unique, tangible benefits of relevance are apparent. Hence, industry and policy makers should expect, and prepare to respond to, expressions of concern and recognise the need for the public to become familiar with the technology over time. Depending on the concerns expressed, stakeholders should attempt to strike a balance between contending with public expressions of 'reasonable' concerns and responding to concerns in a way that prevents further amplification of public risk-based responses.

The relevance of the recommendations outlined is contingent on multiple factors, including the regulatory landscape of the technology, industry and policy research agendas and commercial objectives. Hence, they are broad in focus, and by no means intended to be considered as a 'one size fits all' solution to overcoming public resistance towards a particular NFT. Whether each recommendation relates to policy makers, industry or both is clearly indicated in the table overleaf.

Table 9.1: *Key Finding and Implications and Policy/ Industry Recommendations*

Key Findings	**Policy and/ or Industry Implications and Recommendations** ***(the letters following each recommendation indicate its particular pertinence to Policy makers (P) and Industry (I) or both)***
1. The characteristics of the technology and individual need to be recognised and accounted for. 1.1. The extent to which personal orientations create internalised standards which direct evaluative stances depends on the individual and technology. 1.2. Meanings and associations generated around the technology are a function of personal belief systems, values and life experiences. 1.3. A person's lack of awareness and knowledge of the technology can often trigger more emotional reactions (e.g. fear, worry, curiosity), leading to a sense of dread and, in turn, (risk-based) cautious responses.	**Individual focussed:** Design communications that accommodate various states of awareness, understanding and acceptance; and support two-way deliberation and discussion ***(P & I).*** Identify the sources of emotional reactions and account for these, in a balanced and measured way, in communication strategies ***(P & I).*** **Technology focussed:** In designing communications about the technology, supply relatable and easily understandable frames of reference. In particular, pay attention to how associated scientific definitions are translated into layman's language ***(P & I).***
2. Technologies viewed as tampering with nature result in more emotional (and negative) responses. 2.1. Socially constructed meanings and internalised standards relating to nature and naturalness often present a competing frame for novelty and innovation, and may consequently create elements of tension when considering the technology and potential associated benefits.	Establish how (un)natural the public perceive the technology, its different applications and associated products to be ***(P & I).*** In turn, provide strategically designed information in an attempt to alter any views potentially held by the public about the technology's perceived unnaturalness and interference with nature. This information may lead people to discard initial negative attitude held about the technology's unnaturalness, and instead to adopt the standpoint that it is a natural process ***(I).*** Reflect on how the technology's perceived characteristics potentially (mis)align with the company's brand values. Depending on the technology, if the brand value is, for example, focused on naturalness, the technology might not be appropriate to apply ***(I).*** In the development of policy and communications with the public, recognise and address citizens' potential fears and worries about the technology interfering with nature ***(P).***

Table 9.1: *Continued*

Key Findings	Implications and Recommendations
3. People tend to rely on intuition, rules of thumb and associative evaluations in forming attitudes. Many do not normally deliberate too deeply on the issues concerning NFTs. 3.1. Assessing the technology through shallow, rather than reflective, processes reduces the stability of attitudes, and may result in new information leading to reassessments. 3.2. Initial attitudes can shape further evaluations (i.e. bias the processing of subsequent information). 3.3. In the absence of direct personal control over technological advancements and applications, many rely on trust in other stakeholders (particular regulators) to protect them from any potential risks. 3.4. Those displaying greater levels of trust in science are generally less cautious about NFTs. However, trust is fragile, and a violation of trust with one application may result in suspicion of all applications. 3.5. A low level of effort (interest) may be evident in terms of actually acquiring and processing relevant information, in spite of individuals stressing the need for such information.	Given the reliance on heuristics, ensure that trust placed in relevant stakeholders to control associated risks, verify claims made, and regulate the technology is fostered and maintained ***(P).*** Understand how citizens think, or do not think, about NFTs and associated concepts, and recognise prevalent response patterns ***(I).***
4. People can reject/ accept NFTs based on moral, ethical and societal grounds, and/ or based on associated product specific characteristics. 4.1. Some are not opposed to the technology being applied in principle, but are unwilling to purchase or consume associated products, due to a lack of perceived personal benefits of relevance. Others reject the technology based on their moral and/ or ethical standpoints.	Recognise that public acceptance needs to occur at both personal and societal levels, in order to ensure the stability of positive technology evaluations ***(I).*** Establish and monitor the state of acceptance/ rejection (Kuznesof, 2010) that the technology seems to be at, and design appropriate communications ***(P & I)*** and public engagement fora accordingly ***(P).*** Reflect on how the technology is likely to be evaluated (if at all) at different levels of abstraction, i.e. philosophical and consumption levels ***(P & I).*** Introduce the technology to the market in an iterative manner. Initially introduce applications and/ or associated products that are most congruent with consumers' demands from food and belief systems. Continually gauge consumers' reactions throughout this staged process ***(I).***

Table 9.1: *Continued*

Key Findings	Implications and Recommendations
5. People seek products with tangible and unique benefits of supposed significance to them, and are cautious in the face of perceived risk/ uncertainty. 5.1. Responses towards NFTs are not homogeneous, and risk and benefit information influences evaluations in diverse, and sometimes unexpected, ways. 5.2. Social structures and prior experiences are influential features guiding evaluations. Thus, even simple communication can lead to different interpretations across the population. Ensuring the public at large understand what is being communicated is therefore challenging. 5.3. People need, at a minimum, an immediate and tangible benefit of relevance to them personally (or their family or society), so as to offset any potential risks. 5.4. Perceived risks and/ or uncertainty about negative outcomes communicated to the public can outweigh any associated benefits, and result in the adoption of a precautionary stance or even outright rejection.	Align products and benefits to targeted consumer segments, given the central importance of need satisfaction ***(I).*** Effectively use the precautionary principle (NRC, 2002) in practice ***(P).*** Within communications, clarify (in a timely manner) how any risks associated with the technology are being dealt with ***(P & I).*** Explicitly define who is responsible for associated risks, in terms of identifying and monitoring them and militating against them ***(P).*** These actions should go some way towards limiting any public perceptions of scientific uncertainty surrounding the technology and preserving trust that has been created. While ensuring transparency, reflect carefully on media framing (the social amplification of risk) and stakeholders' agendas prior to communicating any uncertainty about negative outcomes of the technology within public domains ***(P & I).***
6. People feel powerless to influence the direction of technological change, but seek control over this change in their lives. 6.1. People generally adopt a precautionary stance in the face of uncertainty. They therefore demand labelling information about NFTs to enable voluntary choice. Nevertheless, they may not actively search for or read such information, particularly if placing high levels of trust in the regulatory system. 6.2. Labelling such products accordingly, without providing adequate explanatory information, may negatively impact public perspectives, as it may be interpreted as a warning about potential risks.	Empower the public with easily accessible information ***(P & I)***. Design engagement fora ***(P)*** and ensure the provision of supporting information to enable freedom of choice regarding purchase/ consumption decisions ***(P & I).*** That said, there should be some differentiation in terms of information provided across technologies, to avoid generating unnecessary concern/ negativity ***(P & I).*** Maintain a robust regulatory framework capable of managing and controlling any technological risk and verifying claims made, and ensure transparency and openness with the public in the face of any associated uncertainty (scientific or otherwise) ***(P).***

Table 9.1: *Continued*

Key Findings and Implications	Implications and Recommendations
7. People can hold complex and conflicting views, which may result in attitude ambivalence. 7.1. Drawing on numerous 'networks of meaning' when evaluating NFTs may cause conflicts in the minds of some, in terms of their overall assessments. 7.2. Competing emotional and rational responses have the potential to create further internal conflicts.	Ensure clarity on the risks and benefits associated with the technology, and the weighing, prioritisation and (potential) offsetting that may occur between these perceived features in individuals' minds ***(I).***
8. Public acceptance of many novel technologies is normally an evolutionary, rather than a revolutionary, process. 8.1. The length of time the technology has been applied in food production impacts evaluations, unless unique, tangible benefits of relevance are apparent.	Expect, and prepare to respond to, expressions of concern and recognise the need for citizens/ consumers to become familiar with the technology over time. Attempt to strike a balance between contending with public expressions of 'reasonable' concerns and responding to such concerns ***(P & I).*** Provide updates about NFTs to the public on an on-going basis in a timely manner, using innovative approaches (e.g. social media given its capacity to reach a broad audience and mobile optical recognition devices, e.g. QR codes on product labelling) ***(P & I).***

These observations, implications and recommendations facilitate greater understanding of consumer behaviour, information processing and attitude formation around NFTs. Further exploring the issue of industry and policy implications, this conceptualisation of attitude formation around specific technologies proffers some new ideas for policy makers, social scientists, consumer behaviourists, market researchers and industry.

Deep understanding of public and consumer reactions and responses to the development and application of novel technologies is crucial to any organisation focused on undertaking democratic, efficient and effective innovation. Within this body of work, insights into the features influencing rejection or acceptance of associated products have been identified, in addition to common barriers to citizen acceptance and suggested ways of overcoming these.

Focusing on the implications of this research for policy makers, in considering science and technology as a political agent, this research indicates that the focus should not solely be on directing funding decisions. Building upon the comments of Murphy et al. (2011), this work highlights the ethical and moral issues associated with science and technology. Specifically it indicates the challenges that policy makers face in balancing competiveness benefits, ethical concerns about, and power and control over these types of technologies (particularly concerning nutrigenomics and PNPs).

This research facilitates greater understanding of how and why certain attitudes form around NFTs (Davies et al., 2009). How stakeholders, including Government and industry, might better design citizen engagement and dissemination mechanisms, and tailor communications about these technologies, in order to aid public evaluations of them, have been reflected on.

This research also sheds light on the type of automatic reactions and reflective responses that these technologies evoke. To truly understand and influence public perspectives on NFTs, it is important to recognise these affect- and cognition-based associations shaping evaluations when communicating with the public (Fabrigar & Petty, 1999; Hornig Priest, 2011). In turn, this work strengthens understanding of how information disseminated may be interpreted and *"complex public concerns"* (Hornig Priest, 2011: 21) may inform policy and interventions concerning NFTs. Moreover, the Conceptual Model serves as a valuable foundational framework for industry- and

Government-led research and practice. The Conceptual Model and Process Model may be useful to stakeholders interested in further exploring the interdependent influences directing thought processes around, and ultimate acceptance/ rejection of, emerging technologies.

Concentrating on commercially-orientated outcomes, Table 9.2 summaries the key questions that food companies and research agencies should consider, prior to commercially applying these technologies (van Kleef et al., 2005). Several of the questions posed are also important for policy makers to reflect upon (explicitly questions 1, 2, 5-9 and 11 as highlighted in the table).

Table 9.2: *Key Questions that should be addressed before Applying NFTs*

1	Are consumers likely to be concerned about the technology and if so, which types of consumers are more likely to be concerned?
2	Are consumers reactions and responses towards the application of the technology likely to be affect-based (emotional and automatic) or cognition-based (reflective and rational)?
3	What associations and comparisons are consumers most likely to draw upon when assessing the specific technology/ product?
4	What benefits, if any, can the technology/ product offer consumers, and how, if at all, are different consumer segments likely to perceive these benefits?
5	How much and what type of information are consumers likely to demand about the technology and associated products when making a purchase/ consumption decision, and prior to these stages?
6	To what extent should information provided focus on the technology's characteristics or resultant product attributes?
7	What role(s) and implication(s) are labelling likely to have on public perceptions and consumer acceptance (rejection) of the technology's application? In turn, is labelling relevant products accordingly likely to incentivise consumers to opt-in or opt-out of purchasing/ consuming associated products?
8	Who will consumers trust to convey information about the technology and associated products?
9	How can peer groups/ opinion leaders influence the development trajectory of the technology?
10	How has the technology been framed in the media to date?
11	How does the current regulatory framework help (hinder) the adoption of the technology?

Building upon the practical and policy implications and recommendations presented, the next section summaries the core contribution of this work to theory.

9.4 Original Contribution to Theory and the Knowledge Base

> *"…we clearly still have much to learn about the adoption (or rejection) of technology by society. Social research has not yet uncovered all of the reasons that some technologies may be embraced while others are rejected in particular social, political, and cultural contexts"* (Hornig Priest, 2011: 47).

This research enhances theoretical and conceptual understanding of how individuals form attitudes around and interpret information across a diverse range of NFTs. A detailed contextualisation of the features impacting public acceptance and rejection of these technologies has been presented. As previously outlined, the Conceptual Model depicting the relationship between these influences proffers a framework for future research within the area of public/ consumer attitude formation and information processing around novel technologies.

This work imparts contextual insight into the cognitive processes framing citizens' evolving evaluative processes, illustrating the complexity and conflicts inherent in their thinking, which often present as attitude ambivalence. This research provides illustration and heightened appreciation of the complex relationships that exist between initial attitudes, information processing mechanisms and subsequent attitudes, as described by Bohner and Dickel (2011). In succession, these interdependencies are shown to be contingent on the direction, strength and stability of initial attitudes held. Concerning the impact of information, this thesis supports the long-standing view of past work (e.g. Lord et al., 1979; Sheldon et al., 2009; Druckman & Bolsen, 2011) that attitudes towards NFTs may evolve, or become embedded, following information provision, due to biased processing and motivated reasoning originating from initial attitudes held.

This dissertation focuses on citizens' evolving perspectives on and information processing mechanisms around specific NFTs, rather than focusing purely on the establishment of overall general opinions. The findings reaffirm the need to steer a 'theoretical course' away from the preoccupation of scholarly work to date on risk (and benefit) perceptions (Druckman & Bolsen, 2011), in order to appreciate the broader contexts in which attitudes towards NFTs are situated (Davies, 2011).

This work responds to Fell et al.'s (2009: 54) call for research to more fully explore and understand *"the links between underlying values"* and *"expressed attitudes"* towards NFTs. In addition, it goes some way towards addressing Davies et al.'s (2009: 21) request to capture evaluative processes which *"are not easily encapsulated in tick box surveys"*. In doing so, it contributes to the body of evidence within this area, contextualising the complex relationships and emphases between the key influences, described earlier, and how they culminate to direct sense-making.

> *"Many social scientists would now subscribe to the view that qualitative and quantitative methodologies can both lead to valid research findings in and of their own right. Neither approach need rely on the other as its source of respectability"* (Hyde, 2000: 83).

Building upon Hyde's reasoning, this research calls attention to the on-going necessity to qualitatively investigate, as well as quantitatively confirm, citizens' attitude formations around these technologies; as the stability of such attitudes cannot be assumed (Conrey & Smith, 2007). A nuanced understanding of the complex meanings that individuals attach to an issue can really only be unearthed through a *"richly descriptive"* (Merriam, 2009: 14) qualitative approach.

Since public evaluations of NFTs are shaped by a multitude of intertwined influences (Davies, 2011), as affirmed by this research, it would have been reductive and restrictive to concentrate on a singular theoretical perceptive in undertaking this work. The multidisciplinary approach applied, which entailed the merging of a broad range of perspectives from social psychology, allowed for data interpretation from several lenses and viewpoints. Subsequently, this work contributes towards broadening the theory and the knowledge base, by providing a more holistic conceptualisation of the influences framing citizens' evolving evaluative processes around the selected technology groups.

A wider theoretical contribution of this work is expanding understanding of the linkages evident between relevant theoretical underpinnings in the areas of risk, social and cognitive psychology, given its multidisciplinary approach. This dissertation integrates theories and concepts from attitude formation and information processing literature, to provide a more comprehensive explanation of how the public evaluate NFTs. Reinforcing and building upon existing literature enables a greater appreciation of how connections between social science perspectives can be cohesively drawn together, rather than focusing on each separately. Identification of these linkages thereby strengthens theoretical connections between concepts. This work supplements, and indeed complicates, what is already known about these concepts, and consequently enhances the knowledge base within relevant fields. It highlights how the determinants of evaluations and acceptance/ rejection of NFTs are not standalone concepts, and therefore there is merit in viewing these holistically, rather than in isolation.

The analysis presented expands existing theoretical frameworks for understanding the determinants of attitude formation around NFTs, by directing attention to the mutually shaping influences guiding information processing and evaluative stances. This work presents new insight into how the aforementioned influences and associated features interact, to ultimately guide sense-making and attitude formation around different technology groups.

9.4.1 Contribution of Methodological and Analytic Approach

The technologies included in this research were systematically grouped, based on their characteristics and expected public reactions. Grouping as such enabled depth of analysis across a wide breadth of technologies (Merriam, 2009). Indeed, building on Hornig Priest's (2011: 46) contention that *"particular group of technologies (...) evokes particular opinions and reactions"*, clustering them in this way enabled systematic exploration of emergent patterns in terms of citizens' evaluations across both controversial and non-controversial, in addition to science/ technology- and consumer/ product-oriented, technologies.

Pre-defining the technology groupings increased the transferability and strengthened the confirmability of this work (Guba & Lincoln, 1982, 1989; Lincoln & Guba, 1985). Indeed, the multiple-case approach, i.e. three technology groups, applied extends beyond the single or double case (technology) approach of the majority of previous academic research within this field. In doing so, this dissertation goes some way towards filling the gap which Frewer et al. (2011) consider to prevail in terms of studies that concurrently focus on a multitude of technologies.

The discourse methodological approach applied, coupled with the pre- and post-discourse interviews, have provided greater understanding of the evolution of attitude formation and information contextualisation, in comparison to other, more traditional, methods of interacting with citizens (Bell et al., 2005). The approach supported introspection (Tenbült et al., 2008a; Bohner & Dickel, 2011) by participants, in the context of the features influencing their attitudes. Moreover, it has proffered valuable insight into the 'multiple meanings' that individuals construct around the technologies, illustrating a nuanced complexity, rather than a limited number, of views (Creswell, 2009).

In addition, the discourse approach can also be considered distinctive, in the context of a scientist with relevant expertise, rather than the researcher, being the 'lead actor' (Davies & Harré, 1990; Goffman, 1959) in the exchange. Their involvement enabled participants' information requirements and underdeveloped citizen awareness of the technology to be addressed, as they could respond to and expand upon any questions posed and provide scientifically accurate information (Kleinman et al., 2007). In effect, this exchange was an opportunity to observe one-to-one interactions between an expert who is directly involved in the production of knowledge about a specific technology and a citizen for whom meanings associated with this knowledge are equally, if not more, important that the scientific knowledge.

> *"…understanding public opinion of emerging technologies (…) can be aided by close attention to the ways that laypeople come to form arguments and stances in interactional settings"* (Davies, 2011: 322).

Relative to other methods of citizen interaction, the deliberative discourse provided the opportunity to observe the explicit unfolding of the individual's attitudes. This approach revealed the multiple and complex array of features impacting perspectives, in addition to reactive and reflective responses (Ortony et al., 2005) as information was presented (Bell et al., 2005). It enabled exploration of individuals' reliance on prior knowledge and their integration of new information to direct attitude formation, thereby establishing a comprehensive conceptual understanding of citizens' attitude formation around NFTs.

The three analytic stages resulted in greater comprehension of attitude formation around the selected NFTs, and a broadening of perspectives on how relevant information is contextualised. Essentially, this approach has enabled exploration of conceptual replication across different cases (technology groups) along a continuum (Perry, 1997).

Overall, the theoretical foundations drawn upon and the data collection and analytic approach adopted differ to those of previous empirical research undertaken on this topic, thereby extending understanding of these matters. Although the endeavour was to maximise the contribution and minimise the limitations of this work, inexorable constraints were encountered.

9.5 Limitations and Boundaries of this Work

Similar to any research, this work has a number of limitations that warrant due consideration. Pre-defined technology groupings based on their characteristics and expected public reactions ensured depth of analysis across a breadth of technologies, and strengthened the transferability and confirmability of this work. Nevertheless, a different study may not have grouped nutrigenomics/ PNPs and functional foods together. In lieu of this particular grouping, an alternative approach may have been to include two separate product/ consumer orientated and market driven technology groups, each of which could have been expected to result in emotional and apathetic reactions respectively. The PSOG examined was expected (as illustrated in Figure 4.1), and subsequently found, to cuts across both types of reactions.

Nutrigenomics and PNPs seem to be unique in their creation of a sense of (dis)empowerment, due to their distinct focus on the impact of information about the person's disease susceptibility, rather than product information. Although this specific sub-theme does not relate to functional foods, i.e. these technologies deviate on this particular aspect, there is enough commonality between these technologies to justify grouping them together, in a meaningful way, from an analytic perspective. Thus, this pre-defined technology group is not undermined.

On a separate note, the small purposive sample was designed to produce heterogeneous responses across a diverse group of citizens and was not intended to be representative (Calder, 1977, Furst et al., 1996; Bisogni et al., 2002) or generalisable (Marshall & Rossman, 1994; Hyde, 2000). Despite this fact, the sample included a varied profile of citizens (Warde, 2005) and data saturation (Hyde, 2003; Bowen, 2008) was comfortably achieved, across even the smallest of the technology groups (i.e. the BNG).

Throughout this research, due consideration was taken of the researcher's role as part of the data collection process (Saunders et al., 2009). Although data interpretation was inevitably influenced by the researcher's and supervisors' background, several steps were taken to minimise any potential researcher interpretative bias (Caelli et al., 2003; Jootun et al., 2009). Specifically, the adoption of a three phased consultative process, involving peer debriefing, ensured analytic interpretation from a variety of perspectives (Cohen & Crabtree, 2008). Additionally, the findings of this research were peer-reviewed when presented at various international conferences (see the Research Dissemination Section). These steps strengthened the trustworthiness and reflexivity of the analytic process (Lincoln & Guba, 1985).

In terms of the mechanisms of acquiring information, information about food is usually received from typical sources, such as peers and popular media, rather than directly from a food scientist. Hence, information provision within this research diverges from real-world eventualities. However, since the focus of this work was on attitude formation, the iterative provision of information, which acted as the bedrock of this research, enabled the unveiling of 'meaning construction' (Denzin & Lincoln, 2005) and thinking around selected technologies and product concepts.

Whetten (1989: 492) has described how based on the *"contextualist perspective"*, meaning originates from circumstances and *"observations are embedded and must be understood within a context"*. Indeed, one's perceptions are influenced by how they encounter or engage with an issue and thus, the outcomes observed may have been influenced by: 1) the information provided, in particular, the applications and associated risks and benefits; 2) the manner and style in which the information was presented (Kaufman et al., 2003), i.e. the personality of the participating scientists; 3) the interpersonal dynamics, i.e. rapport and trust, between the scientist and citizen; and, 4) the types of questions posed by participants. However, the breadth of observations in terms of reactions and responses militates against this.

In saying this, *"the dispositions of agents to act within a practice are deeply entrenched and embodied"* and often *"emotional"* (Warde, 2005: 140). Therefore, interpersonal dynamics inevitably played a role in influencing the content and quality of the dialogue between the scientist and citizen. Naturally, the personalities of each scientist and citizen impacted the manner and style in which they interacted with each other and the rapport established. Based on participants' feedback provided during the debriefing PDI, each scientist was effective in explaining the technology, building a rapport and interacting with participants, thus ensuring they felt comfortable expressing their opinions. Furthermore, participants reported that the scientist stressing that they were not advocating the technology contributed towards their sense of ease in vocalising their opinions during the interaction.

Screening for generalised self-confidence resulted in those with lower self-confidence being excluded from this study. However, those scoring lowest on this measure did appear less interactive, indicating the value of this screening criterion in the context of the overall research aims and necessity for two-way interaction to ensure insight into the factors guiding reactive and reflective responses. In addition, breadth of perspectives across the sample was ensured in terms of participants' socio-economic backgrounds.

As previously outlined in Chapter 3, attitude-behaviour inconsistencies (Katz, 1960; Ajzen & Gilbert Cote, 2008) may be apparent. Evaluative stances may differ in an actual purchase/ consumption scenario, compared to those expressed in a hypothetical, abstract sense (i.e. cold state) (Loewenstein & Schkade, 1999; Smith & Hogg, 2008; Arts et al., 2011). Concrete product attributes and habitual shopping/ consumption practices may become more influential in guiding product evaluations and purchase decisions (Grunert et al., 2010) in reality. In this vein, Murphy (2008: 72) has described how hypothetical issues discussed are often *"removed from the intensity of the real and placed into a space which Boltanski (1999) calls a 'distant morality'"*. Within this research, individuals only discussed the technology and did not actually purchase/ consume related products. Therefore, when analysing and interpreting the data, it was noted that their evaluations may not reflect individuals' true reactions in a real-life situation (Grunert et al., 2010). However, exploration of attitude formation in conjectural situations is a commendable research pursuit, as it provides valuable insight into the influences and meanings directing attitude formation and information contextualisation (Davies, 2011). The deliberative discourse approach allowed for reflection and deep information processing about abstract situations. Establishing reactions and responses in this controlled, 'artificial' environment enabled understandings of the issues that could potentially dominate public discussion, if information about these technologies is disseminated in a manner that gains (emotive) public traction.

As a final caveat, participants solely from the Republic of Ireland were involved. As previously mentioned, Irish citizens have been reported as being notably undecided in their attitudes towards NFTs, compared to their European counterparts (European Commission, 2010; Gaskell et al., 2010). Therefore, although it is likely that the Conceptual Model emerging from this work holds relevance for different socio-demographic and cultural groups, additional research across different geographic locations would be necessary to confirm this. Expanding on this point, other potential avenues for scholarly investigation, deriving from this study, are now suggested.

9.6 Directions for Future Research

This dissertation has provided a stepping stone for further research on both the specific issues addressed and broader related concepts. Indeed, the empirical and methodological research opportunities that originate from this work are diverse and plentiful. Scholarly research from the areas of cognitive psychology and risk psychology examined provide a theoretical grounding for the design and interpretative lens of future research studies.

This thesis reaffirms that research on public perceptions of novel technologies should move beyond measures of risks and benefits (Davies et al., 2009; Gupta et al., 2011), to investigate the complex influences interdependently guiding attitudinal standpoints on them. To this end, within this chapter, the Conceptual Model has been translated into a proposed Process Model (Figure 9.2), for the purpose of testing, through quantitative measures, explicit causality between these influences and outcomes in terms of the factors impacting information processing and attitude formation, for different types of contentious and non-contentious technologies. Depending on the specific technology (group), the influences that are more or less salient may vary. Future research could contribute to an even greater understanding of the complex processes involved in attitude formation and information contextualisation around novel technologies, by testing the strength of links and directions of relationships between these influences.

This thesis is a testament to the inherent complexity ingrained in individuals' evolving views on food, technology and wider issues. As highlighted in Chapter 1, and argued by Frewer et al. (2004) and Marques et al. (2014), public perspectives on these concepts are open to reassessment over time. The historic 'acceptance paths' of canned food (Yeung & Morris, 2001) and pasteurisation (DeRuiter & Dwyer, 2002; Evenson & Santaniello, 2004) are illustrative cases in point. Therefore, what is perceived as novel and to potentially raise a resistance ‘red flag’ at a particular point in time may, in fact, transition into a commonly accepted practice. Equally, technologies and processes which are widely accepted may become focal points of public resistance if new information, substantiated or otherwise, comes to the reflective fore: *“New issues may emerge, and debate may shift in unexpected directions”* (Davies et al., 2009: 11). Examples of this occurrence include the case of certain food colorants (Löfstedt, 2009) and lean finely textured beef, i.e. ‘pink slime’ (Greene, 2012; Adams, 2014; Yadavalli & Jones, 2014). Hence, associated risks being socially amplified can contribute to a technology becoming more contentious and public resistance towards its application (Grunert, 2002; Verbeke et al., 2007; Hornig Priest, 2011) (see Rollin et al. (2011) for an overview of different NFT case studies).

It is recognised that this analysis is time and context specific. Hence, building on previous work (e.g. Priest et al., 2011) and echoing the argument of others (e.g. Fell et al., 2009; Sheldon et al., 2009; Frewer et al., 2011; Vandermoere et al., 2011; Marques et al., 2014), understanding of public and consumer perceptions of NFTs may benefit from longitudinal studies on the determinants of attitude formation over time, as a specific technology and its applications are commercialised and media coverage increases. Previous research on media coverage and framing (e.g. Anderson, 2002; Scheufele & Lewenstein, 2005; McCarthy et al., 2008; Dudo et al., 2011) could be drawn upon to explore the potential evolution, if any, of public sentiment, as coverage of selected technologies intensifies.

Alternatively, research could explore whether expressions of both concern and demand for information about NFTs translate into actual behaviours. Equally, building upon the research of Clery and Baily (2010), there is scope to further explore the links between citizens’ understanding and perceived and actual knowledge of food production/ processing practices and attitudes towards NFTs. These points withstanding, the insights from this work hold value within evolving circumstances, and the influences identified, and depicted, should continue to play key roles in shaping sense-making and evaluative processes around NFTs. Frewer (2003: 323) supports this assertion by stating that this type of social research can help to build recommendations for *“best practice”* in designing communications about novel technologies.

Elsewhere, the concept of attitude ambivalence could be more thoroughly examined, developing on this research and that of Poortinga and Pidgeon (2006) and Fischer et al. (2013). In light of the role that attribute weighing, prioritisation and self-identity play in guiding evaluations around NFTs, MEC (Gutman, 1982; Olson, 1989) theory could also be applied in future research. Identity and value orientations around NFTs could be further explored through a more applied and prescriptive MEC lens. A starting point for this work would be to draw on previous MEC studies, concerning NFTs, including Bredahl (1999), Grunert et al. (2001), Boecker et al. (2008) and Sorenson and Henchion (2011). As previously mentioned, empirical research on public assessments of novel technologies to date seems to have primarily focused on associated risk perceptions (Currall et al., 2006; Fischer et al., 2013). Building upon this work, future research should focus on exploring how risk *and* benefit perceptions, and associated trade-offs, guide attitude formation around these technologies, and the factors that are likely to contribute to them being accepted, in addition to being rejected.

The applicability of the identified influences and thematic concepts to attitude formation around other, more radical, technologies emerging on stream, both within (e.g. synthetic biology) and outside the food domain could be explored. In addition to focusing on a different set of technologies, research pursuits could concentrate on a specific cohort of the population or segment of consumers. For instance, it could centre on those with a particular vested interest or older and/ or health-orientated individuals. A more nuanced comprehension of the attitude formation and information processing mechanisms of explicitly defined segments or cohorts could proffer a better understanding of the impact of socio-economic and demographic factors on technology evaluations, given the mixed results to date on their influence on public acceptance/ rejection of NFTs, once other determining factors are controlled for (Vandermoere et al., 2011).

Additionally, given the importance of trust and perceived control in guiding assessments of NFTs, researchers could more intensely explore how trust around these technologies might be created, fostered or potentially destroyed. Linked to the concept of control, another interesting avenue of enquiry would be to investigate how citizens believe food is, and should be, regulated.

From a methodological standpoint, forthcoming research could apply the deliberative discourse approach to offer insights into attitude formation, information processing and two-way communication dynamics around other technologies. Adoption of a similar approach, which encompasses the provision of pre-defined hypothetical scenarios, could further unpick individualistic ‘rule book of acceptance’ and ‘hierarchies of approval’ possibly evident across different applications.

Having outlined the various directions for future research, the next section concludes this dissertation.

9.7 Concluding Comments

Using a constructionist perspective and an inductive/ deductive qualitative approach, this dissertation has expanded understanding of how citizens use and assimilate information about a range of NFTs, and the implications of this on their evolving evaluative stances. In doing so, it has enhanced theoretical and applied understanding of citizens’ interpretation of information and affective and cognitive reactions and responses around different novel technologies, in addition to approaches to researching attitude formation. Within this chapter, the theoretical and practical contributions of this work and avenues for further research have been outlined, in addition to inherent research limitations.

Bibliography

Adams, J. (1995). *Risk.* London: UCL Press.

Adams, R.A. (2014). Consumer deception or unwarranted product disparagement? The case of lean, finely textured beef. *Business and Society Review,* 119(2), 221-246.

Agar, M. (1996). Recasting the "ethno" in "epidemiology". *Medical Anthropology,* 16(4), 391-403.

Ajzen, I. (1988). *Attitudes, personality, and behavior.* Chicago: Dorsey Press.

Ajzen, I. (1991). The theory of planned behavior. *Organization Behavior and Human Decision Process,* 50, 179-211.

Ajzen, I. and Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin,* 84(5), 888-918.

Ajzen, I. and Gilbert Cote, N. (2008). Attitudes and the prediction of behaviour. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 289-312). New York: Psychology Press.

Alhakami, A.S. and Slovic, P. (1994). A psychological study of the inverse relationship between perceived risk and perceived benefit. *Risk Analysis,* 14, 1085-1096.

Allport, G.W. (1935). Attitudes. In: Murchison, C. (Ed.). *Handbook of Social Psychology* (pp. 798-884). Worcester, Mass.: Clark University Press.

Allport, G.W. (1954). The historical background of modern social psychology. In: Lindzey, G. (Ed.). *Handbook of Social Psychology* (Vol. 1, pp. 3-56). Cambridge, M.A.: Addison-Wesley.

Allum, N. (2007). An empirical test of competing theories of hazard-related trust: The case of GM food. *Risk Analysis,* 27(4), 935-946.

Anderson, A. (2002). In search of the Holy Grail: Media discourse and the new human genetics. *New Genetics and Society,* 21(3), 327-337.

Anderson, N.H. (1971). Integration theory and attitude change. *Psychological Review,* 78(3), 171-206.

Anderson, W.A. (2000). The future relationship between the media, the food industry and the consumer. *British Medical Bulletin,* 56(1) 254-268.

Andrews, T. (2012). What is social constructionism? *The Grounded Theory Review,* 11(1), 39-46.

Annunziata, A. and Vecchio, R. (2011). Functional foods development in the European market: A consumer perspective. *Journal of Function Food,* 13, 223-228.

Ardichvili, A., Cardozo, R. and Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business Venturing,* 18, 105-123.

Ares, G., Giménez, A. and Gámbaro, A. (2008). Influence of nutritional knowledge on perceived healthiness and willingness to try functional foods. *Appetite,* 51, 663-668.

Arora V.K. and Kempkes, M. (2008). Industry perspective and roles. *Food Science and Technology International,* 14, 455-457.

Arts, J.W., Frambach, R.T. and Bijmolt, T.H. (2011). Generalizations on consumer innovation adoption: A meta-analysis on drivers of intention and behavior. *International Journal of Research in Marketing,* 28, 134-144.

Arvola, A., Vassallo, M., Dean, M., Lampila, P., Saba, A., Lähteenmäki, L. and Shepherd, R. (2008). Predicting intentions to purchase organic food: The role of affective and moral attitudes in the theory of planned behaviour. *Appetite*, 50, 443-454.

Aschemann-Witzel, J. and Niebuhr Aagaard, E.M. (2014). Elaborating on the attitude-behaviour gap regarding organic products: Young Danish consumers and in-store food choice. *International Journal of Consumer Studies,* 38(5), 550-558.

Attride-Stirling, J. (2001). Thematic networks: an analytic tool for qualitative research. *Qualitative Research,* 1(3), 385-405.

Babbie, E. (2001). *The practice of social research.* 9th Edition. Belmont, CA: Wadsworth Thomson.

Bäckström, A., Pirttilä-Backman, A.M. and Tuorila, H. (2003). Dimensions of novelty: A social representation approach to new foods. *Appetite,* 40, 299-307.

Bäckström, A., Pirttilä-Backman, A.M. and Tuorila, H. (2004). Willingness to try new foods as predicted by social representations and attitude and train scales. *Appetite,* 40, 75-83.

Bánáti, D. (2008). Fear of food in Europe? Fear of foods in Europe through Hungarian experience. *Trends in Food Science & Technology,* 19, 441-444.

Bánáti, D. (2011). Consumer response to food scandals and scares. *Trends in Food Science & Technology,* 22, 56-60.

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organisational behaviour and Human Processes,* 50, 248-287.

Barbosa-Canovas, G.V. and Bermúdez-Aguirre, B. (2008). Emerging food processing technologies in North America. *Food Science and Technology International,* 14, 403-409.

Bargh, J.A. (1994). The Four Horsemen of automaticity: Awareness, efficiency, intention, and control in social cognition. In: Wyer, R. S. Jr. and Srull T.K. (Eds.). *Handbook of social cognition* (2nd Edition, pp. 1-40). Hillsdale, NJ: Erlbaum.

Bartlett, F.C. (1932). *Remembering: A study in experimental and social psychology.* New York: Cambridge University Press.

Bauer, M.W. and Gaskell, G. (1999). Towards a paradigm for research on social representations. *Theory of Social Behaviour,* 29(2), 163-186.

Bauer, M.W., Allum, N. and Miller, S. (2007). What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science,* 16, 79-95.

Baxter, P. and Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report,* 13(4), 544-559.

Bazeley, P. (2009). Analysing qualitative data: More than 'identifying themes'. *Malaysian Journal of Qualitative Research,* 2, 6-22.

Bech-Larsen, T. and Grunert, K.G. (2003). The perceived healthiness of functional foods. A conjoint study of Danish, Finnish and American consumers' perception of functional foods. *Appetite,* 40, 9-14.

Beck, U. (1992). *Risk society: Towards a new modernity.* London: Sage Publications Ltd.

Beck, U. (1995). *Ecological politics in an age of risk.* Cambridge, UK: Polity Press.

Beck, U. (1999). *World risk society*. Malden, M.A.: Polity.

Bell, D., Thompson, N., Deckers, J., Brennan, M. and Gray, T. (2005). *Deliberating the environment.* Newcastle upon Tyne: University of Newcastle, Centre for Rural Economy. Newcastle Upon Tyne.

Belton, P. (2001). Chance, risk, uncertainty and food. *Trends in Food Science & Technology,* 12, 32-35.

Benford, R.D. and Snow, D.A. (2000). Framing processes and social movements: An overview and assessment. *Annual Review of Sociology,* 26, 611-639.

Berger, P.L. and Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge.* London: Penguin Books.

Bertaux, D. (1981). From the life-history approach to the transformation of sociological practice. In: Bertaux, D. (Ed.). *Biography and society: The life history approach in the social sciences* (pp. 29-45). London: Sage Publications Ltd.

Betoret, E., Betoret, N., Vidal, D. and Fito, P. (2011). Functional foods development: Trends and technologies. *Trends in Food Science & Technology,* 22, 498-508.

Bier, V.M. (2001). On the state of the art: risk communication to the public. *Reliability Engineering and System Safety,* 71, 139-150.

Bigliardi, B. and Galati, F. (2013). Innovation trends in the food industry: The case of functional foods. *Trends in Food Science & Technology,* 31, 118-129.

Bisogni C.A., Connors, M., Devine, C.M. and Sobal, J. (2002). Who we are and how we eat: A qualitative study of identities in food choice. *Journal of Nutrition Education and Behavior,* 34, 128-139.

Blake, C. and Bisogni, C.A. (2003). Personal and family food choice schemas of rural women in upstate New York. *Journal of Nutrition Education and Behavior,* 35(6), 282-293.

Boecker, A., Hartl, J. and Nocella, G. (2008). How different are GM food accepters and rejecters really? A means-end chains application to yogurt in Germany. *Food Quality and Preferences,* 19, 383-394.

Bohner, G. and Dickel, N. (2011). Attitudes and attitude change. *Annual Review of Psychology,* 62, 391-417.

Bohner, G., Einwiller, S., Erb, H-P. and Siebler, F. (2003). When small means comfortable: Relations between product attributes in two-sided advertising. *Journal of Consumer Psychology,* 13(4), 454-463.

Booth, D.A. and Shepherd, R. (1988). Sensory influences on food acceptance: The neglected approach to nutrition promotion. *Nutrition Bulletin*, 13, 39-54.

Bostrom, A. and Löfstedt, R.E. (2010). Nanotechnology risk communication past and prologue. *Risk Analysis*, 30(11), 1645-1662.

Bowen, G.A. (2008). Naturalistic inquiry and the saturation concept: A research note. *Qualitative Research,* 8, 137-152.

Boyatzis, R. (1998). *Transforming qualitative information: Thematic analysis and code development*. Thousand Oaks, CA: Sage Publications Ltd.

Bozinoff, L. and Roth, V.J. (1983). Recognition memory for script activities: An energy conservation application. *Advances in Consumer Research,* 10, 655-660.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3, 77-101.

Breakwell, G., Smith, J. and Wright, D. (2012). *Research methods in psychology.* London: Sage Publications Ltd.

Breakwell, G.M. (2001). Mental models and social representations of hazards: The significance of identity processes. *Journal of Risk Research,* 4(4), 341-351.

Bredahl, L. (1999). Consumers' cognitions with regard to genetically modified foods. Results of a qualitative study in four countries. *Appetite,* 33, 343-360.

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods - Results of a cross-national survey. *Journal of Consumer Policy,* 24, 23-61.

Bredahl, L., Grunert, K.G. and Frewer, L.J. (1998). Consumer attitudes and decision-making with regard to genetically engineered food products - A review of the literature and a presentation of models for future research. *Journal of Consumer Policy,* 21, 251-277.

Brewer, P.R. and Gross, K. (2005). Values, framing, and citizens' thoughts about policy issues: Effects on content and quantity. *Political Psychology,* 26(6), 929-948.

Bringer, J.D., Johnston, L.H. and Brackenridge, C.H. (2004). Maximizing transparency in a doctoral thesis: The complexities of writing about the use of QSR*NVIVO within a grounded theory study. *Qualitative Research,* 4(2), 247-265.

Bringer, J.D., Johnston, L.H. and Brackenridge, C.H. (2006). Using computer-assisted qualitative data analysis software to develop a grounded theory project. *Field Methods*, 18(3), 245-266.

Brossard, D., Scheufele, D.A., Kim, E. and Lewenstein, B.V. (2009). Religiosity as a perceptual filter: examining processes of opinion formation about nanotechnology. *Public Understanding of Science,* 18, 546-558.

Brown, J.L. and Ping, Y. (2003). Consumer perception of risk associated with eating genetically engineered soybeans is less in the presence of a perceived consumer benefit. *Journal of the American Dietetic Association,* 103 (2), 208-214.

Bruce, D. (2007). *Engaging citizens on nanobiotechnology using the DEMOCS game.* Interim Report on DEMOCS games on nanobiotechnology played in the UK and the Netherlands. NanoBio-Raise EC FP6 Co-ordination Action, Work Package 3. Edinburgh, Edinethics Ltd.: 1-47.

Bruce, D. (2010). *Playing DEMOCs game to explore synthetic biology.* Edinethics Ltd. Available at: http://www.edinethics.co.uk/synbio/synbio%20democs%20report.pdf

Bruhn, C.M. (1998). Consumer acceptance of irradiated food: Theory and reality. *Radiation Physics and Chemistry,* 52(1-6), 129-133.

Bruhn, C.M. (2007). Enhancing consumer acceptance of new processing technologies. *Innovative Food Science and Emerging Technologies,* 8, 555-558.

Bryman, A. and Bell, F. (2007). *Business research methods.* Oxford: Oxford University Press.

Burri, R.V. (2009). Coping with uncertainty: Assessing nanotechnologies in a citizen panel in Switzerland. *Public Understanding of Science,* 18(5), 498-511.

Cacciatore, M.A., Scheufele, D.A., and Corley, E.A. (2011). From enabling technology to applications: The evolution of risk perceptions about nanotechnology. *Public Understanding of Science,* 20, 385-404.

Cacioppo, J.T. and Petty, R.E. (1982). The need for cognition. *Journal of Personality and Social Psychology,* 42, 116-131.

Caelli, K., Ray, L. and Mill, J. (2003). 'Clear as mud': Toward greater clarity in generic qualitative research. *International Journal of Qualitative Methods,* 2(2), 1-24.

Calder, B.J. (1977). Focus groups and the nature of qualitative marketing research. *Journal of Marketing Research,* 14, 353-364.

Campbell, D.T. (1966). Pattern matching as an essential in distal knowing. In Hammond, K.R. (Ed.). *The psychology of Egon Brunswik* (pp. 81-106). New York: Holt, Rinehart & Winston.

Cardello, A.V. (2003). Consumer concerns and expectations about novel food processing technologies: Effects on product liking. *Appetite,* 40(3), 217-233.

Cardello, A.V., Schutz, H.G. and Lesher, L.L. (2007). Consumer perceptions of foods processed by innovative and emerging technologies: A conjoint

analytic study. *Innovative Food Science and Emerging Technologies,* 8, 73-83.
Casey, D. (2007). Findings from non-participant observational data concerning health promoting nursing practice in the acute hospital setting focusing on generalist nurses. *Journal of Clinical Nursing,* 16(3), 580-592.
Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology,* 39, 752-766.
Chen, M-F and Li, H-L. (2007). The consumer's attitude toward genetically modified foods in Taiwan. *Food Quality and Preference,* 18(4), 662-674.
Chen, Q., Anders, S. and An, H. (2013). Measuring consumer resistance to a new food technology: A choice experiment in meat packaging. *Food Quality and Preference*, 28, 419-428.
Chioncel, N.E., Van Der Veen, R.G.W., Wildemeersch, D. and Jarvis, P. (2003). The validity and reliability of focus groups as a research method in adult education. *International Journal of Lifelong Education,* 22(5), 495-517.
Chong, D. and Druckman, J.N. (2007). Framing theory. *Annual Review of Political Science,* 10, 103-126.
Clery, E. and Bailey, R. (2010). *Food technologies, Findings from the 2008 British social attitudes survey.* Report prepared for the UK Food Standards Agency. Available at: http://www.food.gov.uk/multimedia/pdfs/bsa08foodtechnologies.pdf
Cobb, M.D. (2005). Framing effects on public opinion about nanotechnology. *Science Communication,* 27, 221-239.
Cohen, D.J. and Crabtree, B.F. (2008). Evaluative criteria for qualitative research in health care: Controversies and recommendations. *Annals of Family Medicine,* 6(4), 331-339.
Collins, A.M. and Loftus, E.F. (1975). A spreading-activation theory of semantic processing. *Psychological Review,* 82(6), 407-428.
Conner, M. and Armitage, C. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology,* 28(15), 1429-1464.
Conner, M. and Armitage, C.J. (2008). Attitudinal ambivalence. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 261-286). NewYork: Psychology Press.
Connors, M., Bisogni, C.A., Sobal, J. and Devine, C.M. (2001). Managing values in personal food systems. *Appetite,* 36, 189-200.
Conrey, F.R. and Smith, E.R. (2007). Attitude representation: attitudes as patterns in a distributed, connectionist representational system. *Social Cognition,* 25, 718-35.
Cook, A.J. and Fairweather, J.R. (2007). Intentions of New Zealanders to purchase lamb or beef made using nanotechnology. *British Food Journal,* 109(9), 675-688.

Cook, A.J., Kerr, G.N. and Moore, K. (2002). Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology,* 23, 557-572.

Cooper, J. and Fazio, R.H. (1984). A new look at dissonance theory. In: Berkowitz L. (Ed.). *Advances in experimental social psychology* (Vol. 17, pp. 229-266). New York: Academic Press.

Cope, S., Frewer, L.J., Houghton, J., Rowe, G., Fischer, A.R.H. and de Jonge, J. (2010). Consumer perceptions of best practice in food risk communication and management: Implications for risk analysis policy. *Food Policy*, 35, 349-357.

Costa, A. I. A., Dekker, M. and Jongen, W.M.F. (2004). An overview of means-end theory: potential application in consumer-oriented food product design. *Trends in Food Science and Technology,* 15(7-8), 403-415.

Costa-Font, J. and Mossialos, E. (2007). Are perceptions of risks and benefits of genetically modified food (in)dependent? *Food Quality and Preference,* 18, 173-182.

Costa-Font, M. and Gil, J.M. (2009). Structural equation modelling of consumer acceptance of genetically modified (GM) food in the Mediterranean Europe: A cross country study. *Food Quality and Preference,* 20, 399-409.

Cox, D.N. and Evans, G. (2008). Construction and validation of a psychometric scale to measure consumers' fears of novel food technologies: The food technology neophobia scale. *Food Quality and Preference,* 19, 704-710.

Cox, D.N., Evans, G. and Lease, H.J. (2007). The influence of information and beliefs about technology on the acceptance of novel food technologies: A conjoint study of farmed prawn concepts. *Food Quality and Preference,* 18, 813-823.

Coyne, I.T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of Advanced Nursing*, 26, 623-630.

Craik, F.I.M. and Lockhart, R.S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior,* 11(6), 671-684.

Crano, W.D. and Prislin, R. (2006). Attitudes and Persuasion. *Annual Review of Psychology,* 57, 345-374.

Cressy, D.R. (1953). *Other people's money: A study of the social psychology of embezzlement.* New York: Free Press.

Creswell, J.W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches.* 3rd Edition. USA: Sage Publications Ltd.

Creswell, J.W. and Miller, D.L. (2000). Determining validity in qualitative inquiry. *Theory into Practice,* 39(3), 124-130.

Cronin, J. and McCarthy, M. (2011). Preventing game over: A study of the situated food choice influences within the videogames subculture. *Journal of Social Marketing,* 1(2), 133-153.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* London: Sage Publications Ltd.

Cunningham, W.A. and Zelazo, P.D. (2007). Attitudes and evaluations: A social cognitive neuroscience perspective. *Trends in Cognitive Sciences,* 11, 97-104.

Cunningham, W.A., Zelazo, P.D., Packer, D.J. and van Bavel, J.J. (2007). The iterative reprocessing model: A multilevel framework for attitudes and evaluation. *Social Cognition,* 25(5), 736-760.

Currall, S. C., King, E.B., Lane, N., Madera, J. and Turner, S. (2006). What drives public acceptance of nanotechnology. *Nature nanotechnology*, 1, 153-155.

D'Angelo, P. (2002). News framing as a multi-paradigmatic research program: A response to Entman. *Journal of Communication,* 52(4), 870-888.

da Costa, M.C., Deliza, R., Rosenthal, A., Hedderley, D. and Frewer, L. (2000). Non conventional technologies and impact on consumer behaviour. *Trends in Food Science & Technology,* 11, 188-193.

Davidson, C. (2009). Transcription: Imperatives for qualitative research. *International Journal of Qualitative Methods,* 8(2), 36-52.

Davies, B. and Harré, R. (1990). Positioning: The discursive production of selves. *Journal for the Theory of Social Behaviour,* 20(1), 43-63.

Davies, S., Macnaghten, P. and Kearnes, M. (2009). *Reconfiguring Responsibility: Lessons for Public Policy (Part 1 of the report on Deepening Debate on Nanotechnology).* Durham: Durham University.

Davies, S.R. (2011). How we talk when we talk about nano: The future in laypeople's talk. *Futures,* 43(3), 317-326.

Day, R.C. and Hamblin, R.L. (1964). Some effects of close and punitive styles of supervision. *American Journal of Psychology,* 69(5), 499-510.

De Boer, M., McCarthy, M., Brennan, M., Kelly, A. and Ritson, C. (2005). Public understanding of food risk issues and food risk messages on the Island of Ireland: The views of food safety experts. *Journal of Food Safety,* 25, 241-265.

De Jonge, J., Van Trijp, H., Renes, H.J. and Frewer, L. (2007). Understanding consumer confidence in the safety of food: Its two-dimensional structure and determinants. *Risk Analysis,* 27(3), 729-740.

de Vreese, C.H. (2005). News framing: Theory and typology. *Information Design Journal & Document Design,* 13(1), 52-61.

Dean, M. and Shepherd, R. (2007). Effects of information from sources in conflict and in consensus on perceptions of genetically modified food. *Food Quality and Preference,* 18, 460-469

Dean, M., Lampila, P., Shepherd, R., Arvola, A., Saba, A., Vassallo, M., Claupein, E., Winkelmann, M. and Lähteenmäki, L. (2012b). Perceived

relevance and foods with health-related claims. *Food Quality and Preference,* 24, 129-135.
Dean, M., Raats, M.M. and Shepherd, R. (2008). Moral concerns and consumer choice of fresh and processed organic foods. *Journal of Applied Social Psychology,* 38(8), 2088-2107.
Dean, M., Raats, M.M and Shepherd, R. (2012a). The role of self-identity, past behavior, and their interaction in predicting intention to purchase fresh and processed organic food. *Journal of Applied Social Psychology,* 42(3), 669-688.
Dean, M., Shepherd, R., Arvola, A., Vassallo, M., Winkelmann, M., Claupein, E., Lahteenmaki, L., Raats, M.M. and Saba, A. (2007). Consumer perceptions of healthy cereal products and production methods. *Journal of Cereal Science,* 46, 188-196.
Delaney, M. and McCarthy, M. (2014). Saints, sinners and non-believers: the moral space of food. A qualitative exploration of beliefs and perspectives on healthy eating of Irish adults aged 50-70. *Appetite,* 73(1), 105-113.
Delgado, A., Kjølberg, K.L. and Wickson, F. (2010). Public engagement coming of age: From theory to practice in STS encounters with nanotechnology. *Public Understanding of Science,* 20(6), 826-845.
Denzin N.K. and Lincoln, Y.S. (2005). Introduction: The discipline and practice of qualitative methods. In: Denzin, N.K. and Lincoln, Y.S. (Eds.) *Handbook of qualitative research* (3rd Edition, pp. 1-20). Thousand Oaks, C.A.: Sage Publications Ltd.
Department of Agriculture, Fisheries and Food Agriculture. (2007b). *Quality food founded on science. IRM 2007 research achievements.* Dublin: DAFF. Available at: http://www.agriculture.gov.ie/media/migration/research/FIRMbooklet2007.pdf
Department of Agriculture, Fisheries and Food. (2007a). *Value for money. Review of the food intuitional research measure (FIRM).* Dublin: DAFF. Available at: http://www.agriculture.gov.ie/media/migration/research/VFM_FIRM.pdf
Department of Agriculture, Food and the Marine. (2012). *Food Research Ireland. Meeting the needs of Ireland's food sector to 2020 through research and innovation.* Dublin: DAFM. Available at: http://www.agriculture.gov.ie/media/migration/research/FoodResearchIreland.pdf
Department of Agriculture, Food and the Marine. (2013). *Food harvest 2020. Milestones for success 2013.* Dublin: DAFM. Available at: http://www.agriculture.gov.ie/media/migration/agri-foodindustry/foodharvest2020/Milestones2013110913.pdf
Department of Agriculture, Food and the Marine. (2014). *Food Harvest 2020. Milestones for success 2014.* Dublin: DAFM. Available at: http://www.agriculture.gov.ie/media/migration/agri-foodindustry/foodharvest2020/Milestones201415ArtFINALLayout1170914.pdf

DeRuiter, F.E. and Dwyer, J. (2002). Consumer acceptance of irradiated foods: Dawn of a new era? *Food Service Technology,* 2, 47-58.

Devine, C.M., Connors, M.M., Sobal, J. and Bisogni, C.A. (2003). Sandwiching it in: Spillover of work onto food choices and family roles in low- and moderate-income urban households. *Social Science & Medicine,* 56, 617-630.

Dewulf, A., Gray, B., Putnam, L., Lewicki, R., Aarts, N., Bouwen, R. and van Woerkum, C. (2009). Disentangling approaches to framing in conflict and negotiation research: A meta-paradigmatic perspective. *Human Relations,* 62(2), 155-193.

Dholakia, U.M. (2000). A motivational process model of product involvement and consumer risk perception. *European Journal of Marketing,* 35(11/12), 1340-1360.

Dickel, N. and Bohner, G. (2012). Minority and majority influence on attitudes. In: Rossi, G. (Ed). *Psychology - selected papers* (pp. 249-274). Zagreb: InTech.

DiMaggio, P. (1997). Culture and cognition. *Annual Review of Sociology,* 23, 263-287.

Douglas, M. (1966). *Purity and danger: An analysis of the concepts of pollution and taboo.* London: Routledge and Kegan Paul.

Douglas, M. (1985). *Risk acceptability according to the social sciences.* New York: Russell Sage Foundation.

Douglas, M. (1992). Risk and blame: *Essays in cultural theory.* London: Routledge.

Douglas, M. and Wildavsky, A. (1982). *Risk and culture: An essay on the selection of technical and environmental dangers.* LA: University of California Press.

Druckman, J.N. (2004). Political preference formation: Competition, deliberation, and the (ir)relevance of framing effects. *American Political Science Review,* 98(4): 671-686.

Druckman, J.N. and Bolsen, T. (2011). Framing, motivated reasoning, and opinions about emergent technologies. *Journal of Communication,* 61, 659-688.

Dubin, R. (1978). *Theory building.* 2nd Edition. New York: Free Press.

Dudo, A., Choi, D.H. and Scheufele, D.A. (2011). Food nanotechnology in the news. Coverage patterns and thematic emphases during the last decade. *Appetite,* 56, 78-89.

Eagly, A.H. and Chaiken, S. (1993). *The psychology of attitudes.* San Diego: Harcourt Brace.

Eagly, A.H. and Chaiken, S. (2007). The advantages of an inclusive definition of attitude. *Social Cognition,* 25(5), 582-602.

Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change. *Personality and Social Psychology,* 59(2), 202-216.

Einsiedel, E.F. and Eastlick, D. (2000). Consensus conferences as deliberative democracy. *Science Communication,* 21, 323-343.

Einsiedel, E.F. and Goldenberg, L. (2004). Dwarfing the social? Nanotechnology lessons from the biotechnology front. *Bulletin of Science, Technology & Society,* 24(1), 28-33.

Einsiedel, E.F., Jelsøe, E. and Breck, T. (2001). Publics at the technology table: The consensus conference in Denmark, Canada, and Australia. *Public Understanding of Science,* 10, 83-98.

Ely, M., Anzul, M., Friedman, T., Garner, D. and Steinmetz, A.M. (1991). *Doing qualitative research: Circles within circles*. London: Falmer.

Entman, R.M. (1993). Framing: Toward clarification of a fractured paradigm. *Journal of Communication,* 43(4), 51-58.

Erasmus, A.C., Boshoff, E. and Rousseau, G.G. (2002). The potential of using script theory in consumer behaviour research. *Journal of Family Ecology and Consumer Sciences,* 30, 1-9.

European Commission. (2009a). *Report on the competitiveness of the European agro-food industry.* Report produced by the High Level Group on the Competitiveness of the AgroFood Industry. Enterprise and Industry Directorate General: Food Industry Unit. Available at: http://ec.europa.eu/enterprise/sectors/food/files/high_level_group_2008/documents_hlg/final_report_hlg_17_03_09_en.pdf

European Commission. (2009b). *Challenging futures of science in society: Emerging trends and cutting-edge issues.* Report of the MASIS Expert Group setup by the European Commission. Directorate-General for Research: Science in Society. Available at: ftp://ftp.cordis.europa.eu/pub/fp7/sis/docs/sis_masis_report_en.pdf

European Commission. (2010). *Eurobarometer 73.1: Biotechnology.* Special Eurobarometer 34.1/Wave 73.1. Conducted by TNS Opinion & Social on request of the European Commission. Survey co-ordinated by Directorate General Research. Brussels.

European Food Safety Authority. (2010). *Special Eurobaromoter Report (354): Food-related risks.* Conducted by TNS Opinion & Social at the request of the EFSA. Available at: http://www.efsa.europa.eu/en/factsheet/docs/reporten.pdf

European Parliament and of the Council. (2011). Regulation (EU) No 1169/2011 of 25 October 2011. *Official Journal of the European Union,* L304/18.

Evenson, R.E. and Santaniello, V. (2004). Introduction. In: Evenson, R.E. and Santaniello, V. (Eds.) *Consumer acceptance of genetically modified foods* (pp. xi-1). Cambridge, M.A.: CABI Publishing.

Fabrigar, L.R., and Petty, R.E. (1999). The role of the affective and cognitive bases of attitudes in susceptibility to affectively and cognitively based persuasion. *Personality and Social Psychology Bulletin,* 25, 363-381.

Falk, L.W., Sobal, J., Bisogni, C.A., Connors, M. and Devine, C.M. (2001). Managing healthy eating: Definitions, classifications, and strategies. *Health Education & Behavior,* 28, 425-439.

Fallaize, R., Macready, A.L., Butler, L.T., Ellis, J.A. and Lovegrove, J.A. (2013). An insight into the public acceptance of nutrigenomic-based personalised nutrition. *Nutrition Research Reviews,* 26, 39-48.

Fazio, R.H. (1990). Multiple processes by which attitudes guide behavior: The MODE model as an integrative framework. In: Zanna, M.P. (Ed.). *Advances in experimental social psychology* (Vol. 23, pp. 75-109). New York: Academic Press.

Fazio, R.H. (2007). Attitudes as object-evaluation associations of varying strength. *Social Cognition,* 25, 603-637.

Fell, D., Wilkins, C., Kivinen, E., Austin, A. and Fernandez, M. (2009). *An evidence review of public attitudes to emerging food technologies.* A Brook Lyndhurst Report for the Food Standards Agency, UK. Available at: www.food.gov.uk/multimedia/pdfs/emergingfoodtech.pdf

Fereday, J. and Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods,* 5(1), 80-92.

Festinger, L. (1957). *A theory of cognitive dissonance.* Stanford, C.A.: Stanford University Press.

Festinger, L. and Carlsmith, J.M. (1959). Cognitive consequences of forced compliance. *Journal of Abnormal and Social Psychology,* 58(2), 203-210.

Fife-Schaw, C. and Rowe, G. (1996). Public perceptions of everyday food hazards: A psychometric study. *Risk Analysis,* 16, 487-500.

Finucane, M.L. and Holup, J.L. (2005). Psychosocial and cultural factors affecting the perceived risk of genetically modified food: an overview of the literature. *Social Science & Medicine,* 60, 1603-1612.

Finucane, M.L., Slovic, P., Mertz, C.K., Flynn, J. and Satterfield, T.A. (2000). Gender, race, and perceived risk: The `white male' effect. *Health, Risk and Society,* 2(2), 159-172.

Fischer, A.R.H., van Dijk, H., de Jonge, J., Rowe, G. and Frewer, L.J. (2013). Attitudes and attitudinal ambivalence change towards nanotechnology applied to food production. *Public Understanding of Science,* 22(7), 817-831.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S. and Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Sciences,* 9, 127-152.

Fishbein, M. and Ajzen, I. (1975). *Beliefs, attitude, intention, and behaviour.* New York: Wiley.

Fiske, S.T. and Taylor, S.E. (1991). *Social cognition*. 2nd Edition. New York: McGraw-Hill.

Flynn, J., Peters, E., Mertz, C.K. and Slovic, P. (1998). Risk, media and stigma at Rocky Flats. *Risk Analysis,* 18(2), 715-727.

Flynn, J., Slovic, P. and Mertz, C.K. (1994). Gender, race, and perception of environmental health risk. *Risk Analysis,* 14, 1101-1108.

FoodDrinkEurope. (2012). *Priorities for the development of an EU industrial policy for food. Competitiveness Report.* Available at: http://www20.gencat.cat/docs/DAR/DE_Departament/DE02_Estadistiques_observatoris/27_Butlletins/02_Butlletins_ND/Fitxers_estatics_ND/2012_fitxers_estatics/0111_2012_fooddrinkeurope.pdf

FoodDrinkEurope. (2014). *Promoting an EU Industrial Policy for Food and Drink. Competitiveness Report 2013-2014.* Available at: http://www.fooddrinkeurope.eu/uploads/publications_documents/Promoting_an_EU_industrial_policy_for_food_and_drink.pdf

Forfás. (2011). *Strategy for science, technology and innovation.* Indicators, December, 2011. Dublin: Forfás. Available at: http://www.djei.ie/publications/science/2011/SSTI_Indicators_December2011.pdf

Forfás. (2013). *Research prioritisation: Framework for monitoring public investment in science, technology and innovation.* Dublin: Forfás. Available at: http://www.agriculture.gov.ie/media/migration/research/researchprioritactionplans/FrameworkforMonitoringPublicInvestmentinSTI.pdf

Forgas, J.P. (2008). The role of affect in attitudes and attitude change. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 131-160). New York: Psychology Press.

Foucault, M. (1972). *The Archaeology of Knowledge.* New York: Random House.

Frewer, L. (2003). Societal issues and public attitudes towards genetically modified foods. *Trends in Food Science & Technology,* 14, 319-332.

Frewer, L. (2004). The public and effective risk communication. *Toxicology Letters*, 149, 391-397.

Frewer, L. J., Howard, C., Hedderley, D. and Shepherd, R. (1997b). Consumer attitudes towards different food-processing technologies used in cheese production - The influence of consumer benefit. *Food Quality and Preference,* 8(4), 271-280.

Frewer, L., Lassen, J., Kettlitz, B., Scholderer, J., Beekman, V. and Berdal, K.G. (2004). Societal aspects of genetically modified foods. *Food and Chemical Toxicology*, 42, 1181-1193.

Frewer, L.J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., Siegrist, M. and Vereijken, C. (2011). Consumer response to novel agri-food technologies: Implications for predicting consumer acceptance of emerging food technologies. *Trends in Food Science and Technology*, 22, 442-456.

Frewer, L.J., Gupta, N., George, S., Fischer, A.R.H., Giles, E.L. and Coles, D. (2014). Consumer attitudes towards nanotechnologies applied to food production. *Trends in Food Science & Technology,* 40, 211-225.

Frewer, L.J., Howard, C. and Shepherd, R. (1994). The influence of realistic product exposure on attitudes towards genetic engineering of food. *Food Quality Preference*, 7(1), 61-67.

Frewer, L.J., Howard, C. and Shepherd, R. (1997a). Public concerns in the United Kingdom about general and specific applications of genetic engineering: Risk, benefit and ethics. *Science, Technology and Human Values*, 22, 98-124.

Frewer, L.J., Howard, C. and Shepherd, R. (1998a). Understanding public attitudes to technology. *Journal of Risk Research*, 1(3), 221-235.

Frewer, L.J., Howard, C. and Shepherd, R. (1998b). The influence of initial attitudes on responses to communication about genetic engineering in food production. *Agriculture and Human Values*, 15, 15-30.

Frewer, L.J., Howard, C., Hedderley, D. and Shepherd, R. (1999). Reactions to information about genetic engineering: Impact of source characteristics, perceived personal relevance, and persuasiveness. *Public Understanding of Science*, 8, 35-50.

Frewer, L.J., Howard, C., Hedderley, D. and Shepherd, R. (1997c). The elaboration likelihood model and communication about food risks. *Risk Analysis*, 17(6), 759-770.

Frewer, L.J., Hunt, S., Brennan, M., Kuznesof, S., Ness, M. and Ritson, C. (2003b). The views of scientific experts on how the public conceptualize uncertainty. *Journal of Risk Research*, 6(1), 75-85.

Frewer, L.J., Scholderer, J. and Bredahl, L. (2003a). Communicating about the risks and benefits of genetically modified foods: The mediating role of trust. *Risk Analysis*, 23(6), 1117-1133.

Frewer, L.J., van der Lans, I.A., Fischer, A.R.H., Reinders, M.J., Menozzi, D., Zhang, X., van den Berg, I. and Zimmermann, K.L. (2013). Public perceptions of agri-food applications of genetic modification - A systematic review and meta-analysis. *Trends in Food Science & Technology*, 30, 142-152.

Fryer, P.J., Versteeg, C. and CSIRO Food Futures Flagship, North Ryde NSW, Australia (2008). Processing technology innovation in the food industry. *Innovation: Management, Policy & Practice*, 10, 74-90.

Fuller, G.W. (2005). *New Food Product Development*. 2nd Edition. London: CRC Press.

Furst, T., Connors, M., Bisogni, C.A., Sobal, J. and Falk, L.W. (1996). Food choice: A conceptual model of the process. *Appetite*, 26, 247-266.

Furst, T., Connors, M., Sobal, J., Bisogni, C. and Falk, L.W. (2000). Food classifications: Levels and categories. *Ecology of Food and Nutrition*, 39, 331-355.

Gaivoronskaia, G. and Hvinden, B. (2006). Consumers with allergic reaction to food: Perception of and response to food risk in general and genetically modified food in particular. *Science Technology Human Values*, 31, 702-730.

Gamson, W. A. and Modigliani, A. (1987). The changing culture of affirmative action. In: Braungart, R.D. (Ed.). *Research in political psychology* (Vol. 3, pp. 137-177). Greenwich, CT: JAI Press.

Gamson, W.A. and Modigliani, A. (1989). Media discourse and public opinion on nuclear power: A constructivist approach. *The American Journal of Sociology*, 95(1), 1-37.

Gamson, W.A., Croteau, D., Hoynes, W. and Sasson, T. (1992). Media images and the social construction of reality. *Annual Review of Sociology*, 18, 373-393.

Gardner, P.L. (1987). Measuring ambivalence to science. *Journal of Research in Science Teaching*, 24, 241-247.

Gaskell, G., Stares, S., Allansdottir, A., Allum, N., Castro, P., Esmer, Y. et al. …Wagner, W. (2010). *Europeans and biotechnology in 2010: Winds of change?* A report to the European Commission's Directorate-General for Research on the Eurobarometer 73.1 on Biotechnology, FP7 Project Sensitive Technologies and European Public Ethics (STEPE). Available at: http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_winds_en.pdf

Gawronski, B. and Bodenhausen, G.V. (2006). Associative and propositional processes in evaluation: an integrative review of implicit and explicit attitude change. *Psychological Bulletin*, 132, 692-731.

Gawronski, B. and Bodenhausen, G.V. (2007). Unraveling the processes underlying evaluation: attitudes from the perspective of the APE model. *Social Cognition*, 25, 687-717

Gergen, J.K. (1985). The social constructionist movement in modern psychology. *American Psychologist,* 40(3), 266-275.

Gibbs, G. (2007). *Analysing qualitative data.* London: Sage Publications Ltd.

Gitlin, T. (1980). *The whole world is watching: Mass media in the making and unmaking of the New Left*. Berkeley, C.A.: University of California Press.

Glaser, B. and Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* New York: Aldine Publishing Company.

Goffman, E. (1959). *The presentation of self in everyday life.* Garden City, New York: Doubleday.

Goffman, E. (1974). *Frame analysis: An essay on the organization of experience.* New York: Harper & Row.

Gomez, P. (2013). Common biases and heuristics in nutritional quality judgments: A qualitative exploration. *International Journal of Consumer Studies,* 37,152-158.

Görke, A. and Ruhrmann, G. (2003). Public communication between facts and fictions: On the construction of genetic risk. *Public Understanding of Science,* 12, 229-241.

Greene, J.L. (2012). *Lean finely textured beef: The "Pink Slime" controversy.* Congressional Research Service: Analyst in Agricultural Policy. 7-5700: R42473. April 6th. Available at: http://fas.org/sgp/crs/misc/R42473.pdf

Greenwald, A.G., McGhee, D.E., and Schwartz, J.L.K. (1998). Measuring individual differences in implicit cognition: The implicit association test, *Journal of Personality and Social Psychology*, 74, 1464-1480.

Griffin, R.J., Dunwoody, S. and Neuwirth, K. (1999). Proposed model of relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research,* Section A, 80, S230-S245.

Grove-White, R., Macnaghten, P., Mayer, S. and Wynne, B. (1997). *Uncertain world. Genetically modified organisms, food and public attitudes in Britain.* Lancaster: Centre for the Study of Environmental Change, Lancaster University.

Grunert K.G. (2005). Food Quality and Safety: Consumer perception and demand. *European Review of Agricultural Economics*, 32(3), 369-391.

Grunert, K.G, Sondergaard, H. and Scholderer, J. (2004a). *How can we know what we like when we don't understand it? Consumer attitude formation towards complex technical issues.* 73. Aarhus V, Denmark: MAPP - Centre for Research on Customer Relations in the Food Sector, Aarhus School of Business.

Grunert, K.G. (2002). Current issues in the understanding of consumer food choice. *Trends in Food Science & Technology,* 13, 275-285.

Grunert, K.G. and Wills, J.M. (2007). A review of European research on consumer response to nutrition information on food labels. *Journal of Public Health,* 15, 385-399.

Grunert, K.G., Bech-Larsen, T., Lähteenmäki, L., Ueland, Ø. and Åström, A. (2004b). Attitudes towards the use of GMOs in food production and their impact on buying intention: The role of positive sensory experience. *Agribusiness*, 20(1), 95-107.

Grunert, K.G., Bredahl, L. and Scholderer, J. (2003). Four questions on European consumers' attitudes toward the use of genetic modification in food production. *Innovative Food Science & Emerging Technologies,* 4, 435-445.

Grunert, K.G., Fernández-Celemín, L., Wills, J.M., Storcksdieck genannt Bonsmann, S. and Nureeva, L. (2010). Use and understanding of nutrition information on food labels in six European countries. *Journal of Public Health,* 18, 261-277.

Grunert, K.G., Lähteenmäki, L., Nielsen, N.A., Poulsen, J.B., Ueland, Ø. and Åström, A. (2001). Consumer perceptions of food products involving genetic modification - Results from a qualitative study in four Nordic countries. *Food Quality and Preference,* 12, 527-542.

Guba, E.G. and Lincoln, Y.S. (1982). Epistemological and methodological bases of naturalistic enquiry. *Educational Communication and Technology Journal,* 30, 233-252.

Guba, E.G. and Lincoln, Y.S. (1989). *Fourth Generation Evaluation.* Newbury Park, CA: Sage Publications Ltd.

Guest, G., Bunce, A. and Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods,* 18(1), 59-82.

Gunes, G. and Tekin, M.D. (2006). Consumer awareness and acceptance of irradiated foods: Results of a survey conducted on Turkish consumers. *LWT,* 39, 443-447.

Gupta, N., Fischer, A.R.H. and Frewer, L.J. (2011). Socio-psychological determinants of public acceptance of technologies: A review. *Public Understanding of Science*, 21(7), 782-795.

Gutman, J. (1982). A means-end chain model based on consumer categorisation processes. *Journal of Marketing*, 46, 60-72.

Hagemann, K. and Scholderer, J. (2007). Consumer versus expert hazard identification: A mental models study of mutation-bred rice. *Journal of Risk Research,* 10(4), 449-464.

Hagemann, K.S. and Scholderer, J. (2009). Hot potato: Expert-consumer differences in the perception of a second-generation novel food. *Risk Analysis*, 29(7), 1041-1055.

Hale, J. L., Householder, B.J. and Greene, K.L. (2003). The theory of reasoned action. In: Dillard J.P. and Pfau, M. (Eds.). *The persuasion handbook: Developments in theory and practice* (pp. 259-286). Thousand Oaks, CA: Sage Publications Ltd.

Hallman, W.K. (2000). *Consumer concerns about biotechnology: International perspectives.* Food Policy Institute, Publication No. RR-0602-003. Rutgers: The State University of New Jersey.

Hallman, W.K., Hebden, H.C., Aquino, H.L., Cuite, C.L. and Lang J.T. (2003). *Public perceptions of genetically modified foods: A national study of American knowledge and opinion.* New Brunswick, NJ: Food Policy Institute, Cook College, Rutgers, State University of New Jersey.

Hamstra, A.M. (1995). *Consumer acceptance model for food biotechnology - Final report*. The Hague: The SWOKA Institute.

Handford, C.E., Dean, M., Spence, M., Henchion, M., Elliott, C.T. and Campbell, K. (2014). *Nanotechnology in the Agri-Food industry on the island of Ireland: applications, opportunities and challenges.* Report produced on behalf of Safefood. ISBN: 978-1-905767-45-8. Available at: http://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Publications/Research%20Reports/Nanotechnology.pdf

Hansen, J., Holm, L., Frewer, L., Robinson, P. and Sandøe, P. (2003). Beyond the knowledge deficit: Recent research into lay and expert attitudes to food risks. *Appetite,* 41, 111-121.

Hart, W., Albarracín, D., Eagly, A.H., Brechan, I., Lindberg, M.J. and Merrill, L. (2009). Feeling validated versus being correct: A meta-analysis of selective exposure to information. *Psychological Bulletin,* 135, 555-588.

Harvey, M. (2000). Genetically modified food: A suitable case for an economic sociology treatment. *Economic Sociology,* European Economic Newsletter, 1(3), 6-11.

Hawkes, G. and Rowe, G. (2008). A characterisation of the methodology of qualitative research on the nature of perceived risk: Trends and omissions. *Journal of Risk Research,* 11(5), 617-643

Heider, F. (1958). *The Psychology of Interpersonal Relations.* New Jersey: Lawrence Erlibaum Associates, Inc.

Henchion, M., McCarthy, M., Williams, G., Greehy, G., McCarthy, S., Dillon., E. and Kavanagh, G. (2013). *Irish consumer and industry acceptance of novel food technologies: Research highlights, implications and recommendations.* Teagasc Food Research Centre, University College Cork and Dublin Institute of Technology. FIRM Research funded by the Department of Agriculture, Food and the Marine. DAFM Reference Number: 08RDTAFRC659. Available at: http://www.teagasc.ie/publications/view_publication.aspx?publicationID=2919

Henriques, J., Hooloway, W., Urwin, C., Venn, C. and Walkerdine V. (1984). *Changing the subject*. London: Methuen.

Henson, S. (1995). Demand-side constraints on the introduction of new food technologies: The case of food irradiation. *Food Policy,* 20(2), 111-127.

Henson, S., Annou, M., Cranfield, J. and Ryks, J. (2008). Understanding consumer attitudes toward food technologies in Canada. *Risk Analysis,* 28(6), 1601-1617.

Hesse-Biber, S. (2010). Qualitative approaches to mixed methods practice. *Qualitative Inquiry,* 16, 455-468.

Hill, A.B. (1965). The environment and disease: Association or causation? *Proceedings of the Royal Society of Medicine,* 58, 295-300.

Ho, S.S., Scheufele, D.A. and Corley, E.A. (2013). Factors influencing public risk-benefit considerations of nanotechnology: Assessing the effects of mass media, interpersonal communication, and elaborative processing. *Public Understanding of Science,* 22(5), 606-623.

Hoffman, W., Gawronski, B., Gschwendner, T., Le, H. and Schmitt, M. (2005). A meta-analysis on the correlation between the implicit association test and explicit self-report measures. *Personality and Social Psychology Bulletin,* 31(10), 1369-1385.

Hohl, K. and Gaskell, G. (2008). European public perceptions of food risk: Cross-national and methodological comparisons. *Risk Analysis,* 28(2), 311-324.

Hollader, J.A. (2004). The social contexts of focus groups. *Journal of Contemporary Ethnography,* 33(5), 602-637.

Hollywood, L.E., Cuskelly, G.J., O'Brien, M., McConnon, A., Barnett, J., Raats, M.M. and Dean, M. (2013). Healthful grocery shopping. Perceptions and barriers. *Appetite,* 70, 119-126.

Hornig Priest, S. (2011). *Nanotechnology and the public: Risk perception and risk communication.* London: CRC Press.

House of Lords. Science and Technology Committee. (2010). *Nanotechnologies and food, Volume I: Report. 1st Report of Session 2009-*

10. Authority of the House of Lords. London: The Stationery Office Limited. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:304:0018:0063:EN:PDF

House, L., Lusk, J., Jaeger, S., Traill, W.B., Moore, M., Valli, C., Morrow, B. and Yee, W.M.S. (2004). Objective and subjective knowledge: Impacts on consumer demand for genetically modified foods in the United States and the European Union. *AgBioForum,* 7(3), 113-123.

Huurne, E.F.J ter., Griffin, R.J. and Gutteling, J.M. (2009). Risk information seeking among U.S. and Dutch residents. An application of the model of risk information seeking and processing. *Science Communication,* 31(2), 215-237.

Hyde, C.A. (2003). Multicultural organization development in non-profit human service agencies: Views from the field. *Journal of Community Practice,* 11(1), 39-59.

Hyde, K.F. (2000). Recognising deductive processes in qualitative research. *Qualitative Market Research: An International Journal,* 3(2), 82-89.

Imenda, S. (2014). Is there a conceptual difference between theoretical and conceptual frameworks? *Journal of Social Science,* 38(2), 185-195.

Irwin, A. and Wynne, B. (1996). *Misunderstanding science? The public reconstruction of science and technology.* Cambridge, UK: Cambridge University Press.

Iyengar, S. (1990). The accessibility bias in politics: Television news and public opinion. *International Journal of Public Opinion Research,* 2(1), 1-15.

Iyengar, S. (1991). *Is anyone responsible? How television frames political issues.* Chicago: University of Chicago Press.

Janis, I. (1972). *Victims of groupthink: A psychological study of foreign-policy decisions and fiascos.* Boston: Houghton Mifflin.

Joffe, H. (2011). Thematic analysis. In: Harper, D. and Thompson, A.R. (Eds.*). Qualitative methods in mental health and psychotherapy: A guide for students and practitioners* (pp. 209-223). Chichester: Wiley.

Joffe, H. and Yardley, L. (2003). Content and thematic analysis. In: Marks., D.F. and Yardley, L. (Eds.). *Research methods for clinical and health psychology* (pp. 56-68). London: Sage Publications Ltd.

Johnson, D.G. and Wetmore, J.M. (2009). Introduction. In: Johnson, D.G. and Wetmore, J.M. (Eds.) *Technology and society: Building our sociotechnical future* (pp. xi-1). Cambridge, M.A.: MIT Press.

Jootun, D., McGhee, G. and Marland, G.R. (2009). Reflexivity: Promoting rigour in qualitative research. *Nursing Standard,* 23(23), 42-46.

Kahan, D.M., Braman, D., Slovic, P., Gastil, J. and Cohen, G.L. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature Nanotechnology,* 4, 87-90.

Kahan, D.M., Slovic, P., Braman, D., Gastil, J. and Cohen, G.L. (2007). *Affect, values, and nanotechnology risk perceptions: An experimental* *investigation.* GWU Legal Studies Research Paper No. 261; Yale Law School, Public Law Working Paper No. 155. 2nd Annual Conference on Empirical Legal Studies Paper. Available at: http://ssrn.com/abstract=968652

Katz, D. (1960). The functional approach to the study of attitudes. *Public Opinion Quarterly,* 24(2), 163-204.

Kazemifard, M., Ghasem-Aghaee, N. and Ören, T.I. (2012). Emotive and cognitive simulations by agents: Roles of three levels of information processing. *Cognitive Systems Research,* 13(1), 24-38.

Kim, S-H., Kim, J-N. and Besley, J.C. (2013). Pathways to support genetically modified (GM) foods in South Korea: Deliberate reasoning, information shortcuts, and the role of formal education. *Public Understanding of Science,* 22(2),169-184.

Kirk, J. and Miller, M.L. (1986). *Reliability and validity in qualitative research.* Newbury Park, C.A.: Sage Publications Ltd.

Kitzinger, J. (1994). The methodology of focus groups: The importance of interaction between research participants. *Sociology of Health & Illness,* (16)1, 103-121.

Kjærgaard, R.S. (2010). Making a small country count: nanotechnology in Danish newspapers from 1996 to 2006. *Public Understanding of Science,* 19(1), 80-97.

Kleinman, D.L., Delborne, J.A. and Anderson, A.A. (2011). Engaging citizens : The high cost of citizen participation in high technology. *Public Understanding of Science,* 20, 221-240.

Kleinman, D.L., Powell, M., Grice, J., Adrian, J. and Lobes, C. (2007). A toolkit for democratizing science and technology policy: The practical mechanics of organizing a consensus conference. *Bulletin of Science, Technology & Society,* 27(2), 154-169.

Knox, B. (2000). Consumer perception and understanding of risk from food. *British Medical Bulletin,* 56(1), 97-109.

Korobov, N. (2010). A discursive psychological approach to positioning. *Qualitative Research in Psychology,* 7, 263-277.

Krebs, J.R. (2000). GM foods in the UK between 1996 and 1999: Comments on "Genetically modified crops: risks and promise" by Gordon Conway. *Conservation Ecology,* 4(1), 11. Available at: http://www.consecol.org/vol4/iss1/art11/

Kretch, D. and Crutchfield, R.S. (1948). *Theory and problems in social psychology.* New York: McGraw-Hill.

Kronberger, N., Holtz, P. and Wagner, W. (2012). Consequences of media information uptake and deliberation: focus groups' symbolic coping with synthetic biology. *Public Understanding of Science,* 21(2), 174-187.

Krueger, R.A. (1988). *Focus groups: A practical guide for applied research.* Newbury Park, C.A.: Sage Publications Ltd.

Kruglanski, A.W. and Thompson, E.P. (1999). Persuasion by a single route: A view from the unimodel. Target article. *Psychological Inquiry,* 10(2), 83-109.

Krutulyte, R, Grunert, K.G., Scholderer, J., Lähteenmäki, L., Hagemann, K.S., Elgaard, P., Nielsen, B. and Graverholt, J.P. (2011). Perceived fit of different combinations of carriers and functional ingredients and its effect on purchase intention. *Food Quality and Preference,* 22(1), 11-16.

Kuttschreuter, M. (2006). Psychological determinants of reactions to food risk messages. *Risk Analysis,* 26(4), 1045-1057.

Kuzel, A.J. (1992). Sampling in qualitative inquiry. In: Crabtree, B.F. and Miller, W.L. (Eds.). *Doing qualitative research* (pp. 31-44). Newbury Park: Sage Publications Ltd.

Kuzma, J. and Priest, S. (2010). Nanotechnology, risk, and oversight: Learning lessons from related emerging technologies. *Risk Analysis,* 30(11), 1688-1698.

Kuznesof, S. and Ritson, C. (1996). Consumer acceptability of genetically modified foods with special reference to farmed salmon. *British Food Journal,* 98(4/5), 39-47.

Kuznesof, S.A.B. (2010). *Consumer acceptance of novel foods: A grounded theory study.* School of Agriculture, Food and Rural Development, Newcastle University. PhD thesis submitted to and available from Newcastle University.

Lampila, P and Lähteenmäki, L. (2007). Consumers' attitudes towards high pressure freezing of food. *British Food Journal,* 109(10), 838-851.

Lampila, P., van Lieshout, M., Gremmen, B. and Lähteenmäki, L. (2009). Consumer attitudes towards enhanced flavonoid content in fruit. *Food Research International,* 42, 122-129.

Lee, C-J., Scheufele, D.A. and Lewenstein, B.V. (2005). Public attitudes toward emerging technologies: Examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology. *Science Communication,* 27, 240-267.

Lee, P.Y., Lusk, K., Mirosa, M. and Oey, I. (2015). Effect of information on Chinese consumers' perceptions and purchase intention for beverages processed by high pressure processing, Pulsed-electric field and heat treatment. *Food Quality and Preference,* 40, 16-23.

Lee, T.W., Mitchell, T.R. and Sablynski, C.J. (1999). Qualitative research in organizational and vocational psychology, 1979-1999. *Journal of Vocational Behavior,* 55, 161-187.

Leshem, S. and Trafford, V. (2007). Overlooking the conceptual framework. *Innovations in Education and Teaching International*, 44(1), 93-105.

Lewis, J. (2009). Redefining qualitative methods: Believability in the fifth moment. *International Journal of Qualitative Methods*, 8(2), 1-14.

Liehr, P. and Smith, M.J. (1999). Middle range theory: Spinning research and practice to create knowledge for the new millennium. *Advances in Nursing Science*, 21(4), 81-91.

Lincoln, Y.S. and Guba, E.G. (1985). *Naturalistic Inquiry.* Newbury Park, C.A.: Sage Publications Ltd.

Lodge, M. and Taber, C.S. (2008). The rationalizing voter. *Unpublished paper.* New York: Stony Brook University. Available at: http://www.uky.edu/AS/PoliSci/Peffley/pdf/Taber&Lodge_The%20Rationalizing%20Voter.pdf

Loebnitz, N. and Grunert, K.G. (2014). Evaluative conditioning of food technologies in China: Moderating effect of social trust. *Food Quality and Preference*, 37, 19-26.

Loewenstein, G. and Schkade, D. (1999). Wouldn't it be nice? Predicting future feelings. In: Kahneman, D., Diener, E. and Schwarz, N. (Eds.). *Well-being: The foundations of hedonic psychology* (pp. 85-105). New York: Russell Sage Foundation Press.

Löfstedt, R. (2009). Risk communication and the FSA: The food colourings case. *Journal of Risk Research,* 12(5), 537-558.

López-Vázquez, E., Brunner, T.A. and Siegrist, M. (2012). Perceived risks and benefits of nanotechnology applied to the food and packaging sector in México. *British Food Journal*, 114(2), 197-205.

Lord, C.G. and Lepper, M.R. (1999). Attitude representation theory. *Advances in Experimental Social Psychology*, 31, 265-343.

Lord, C.G., Ross, L. and Lepper, M.R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology,* 37(11), 2098-2109.

Lunt, P. and Livingstone, S. (1996). Rethinking the focus group in media and communication research. *Journal of Communication*, 46(2), 79-98.

Lupton, D. (2006). Sociology and risk. In: Mythen, G. and Walklate, S. (Eds.). *Beyond the risk society. Critical reflections on risk and human security* (pp. 11-24). New York: Open-University Press.

Lyly, M., Roininen, K., Honkapaa, K., Poutanen, K., & Lähteenmäki, L. (2007). Factors influencing consumers' willingness to use beverages and ready-to-eat frozen soups containing oat beta-glucan in Finland, France and Sweden. *Food Quality and Preference*, 18(2), 242-255.

Macnaghten, P., Kearnes, M.B. and Wynne, B. (2005). Nanotechnology, governance, and public deliberation: What role for the social sciences? *Science Communication*, 27(2), 268-291.

Macoubrie, J. (2006). Nanotechnology: Public concerns, reasoning and trust in government. *Public Understanding of Science*, 15, 221-241.

Marette, S., Roosen, J., Blanchemanche, S. and Feinblatt-Mélèze, E. (2010). Functional food, uncertainty and consumers' choices: A lab experiment with enriched yoghurts for lowering cholesterol. *Food Policy*, 35, 419-428.

Marks, L.A., Kalaitzandonakes, N., Wilkins, L. and Zakharova, L. (2007). Mass media framing of biotechnology news. *Public Understanding of Science*, 16, 183-203.

Markus, H. (1977). Self-schemata and processing information about the self. *Personality and Social Psychology,* 35(2), 63-78.

Marques, M.D., Critchley, C.R. and Walshe J. (2014). Attitudes to genetically modified food over time: How trust in organizations and the media cycle predict support. *Public Understanding of Science,* DOI: 10.1177/0963662514542372.2014.

Marshall, C. and Rossman, G.B. (1994). *Designing qualitative research*. 2nd Edition. Thousand Oaks, CA: Sage Publications Ltd.

Mather, D.W., Knight, J.G., Insch, A., Holdsworth, D.K., Ermen, D.F. and Breitbarth, T. (2012). Social stigma and consumer benefits: Trade-offs in adoption of genetically modified foods. *Science Communication,* 34(4), 487-519.

Maule, A.J. (2004). Translating risk management knowledge: The lessons to be learned from research on the perception and communication of risk. *Risk Management*, 6(2), 17-29.

Mays, N. and Pope, C. (2000). Qualitative research in health care: Assessing quality in qualitative research. *British Medical Journal*, 320, 50-52.

McCarthy, M. and Brennan, M. (2009). Food risk communication: Some of the problems and issues faced by communicators on the Island of Ireland. *Food Policy,* 34, 549-556.

McCarthy, M. and Henson, S. (2004). Irish consumer perceptions of meat hazards and use of extrinsic information cues. *Acta Agriculturae Scandanavian - Food Economics,* 1(2), 99-106.

McCarthy, M. and McCarthy, P. (2007). Parents' perceptions of pork sausages as a meal solution. *Journal of Food Products Marketing,* 13(4), 1-22.

McCarthy, M., Brennan, M., De Boer, M. and Ritson, C. (2008). Media risk communication - what was said by whom and how was it interpreted. *Journal of Risk Research,* 11(3), 375-394.

McCrea, D. (2005). Risk communication related to animal products derived from biotechnology. *Rev. sci. tech. Off. int. Epiz.,* 24(1), 141-148.

McGuire, W.J. (1985). Attitudes and attitude change. In: Lindzey, G. and Aronson, E. (Eds.). *Handbook of social psychology* (3rd Edition, Vol. 2, pp. 233-346). Volume II: Special fields and applications. New York: Random House.

Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation.* San Francisco: Jossey-Bass.

Merrick, E. (1999). An exploration of quality in qualitative research: Are "reliability" and "validity" relevant? In: Kopola, M. and Suzuki L.A. (Eds.). *Using qualitative methods in psychology* (pp. 25-36). Thousand Oaks, C.A.: Sage Publications Ltd.

Messina, F., Saba, A., Turrini, A. and Raats, M. (2008). Older people's perceptions towards conventional and functional yoghurts through the repertory grid method: A cross-country study. *British Food Journal,* 110(8), 790-804.

Miles, M.B. and Huberman, M. (1994). *Qualitative data analysis: A sourcebook of new methods.* 2nd Edition. CA: Sage Publications Ltd.

Miller, D. (1999). Risk, science and policy: Definitional struggles, information management, the media and BSE. *Social Science & Medicine,* 49, 1239-1255.

Miller, S. (2001). Public understanding of science at the crossroads. *Public Understanding of Science,* 10(1), 115-120.

Minsky, M. (1975). A framework for representing knowledge. In: Winston, P.H. (Ed.). *The psychology of computer vision* (pp. 211-277). New York: McGraw-Hill.

Mintz S.W. and Du Bois, C.M. (2002). The anthropology of food and eating. *Annual Review of Anthropology,* 31, 99-119.

Moon, W. and Balasubramanian, S.K. (2004). Public attitudes toward agrobiotechnology: The mediating role of risk perceptions on the impact of trust, awareness, and outrage. *Review of Agricultural Economics,* 26(2), 186-208.

Morgan, D. (1997). *Focus groups a qualitative research.* Thousand Oaks, C.A.: Sage Publications Ltd.

Morgan, G.M., Fischhoff, B., Bostrom, A. and Atman, C.J. (2002). *Risk communication: A mental models approach.* Cambridge, U.K.: Cambridge University Press.

Morin, K. (2009). Knowledge and attitudes of Canadian consumers and health care professionals regarding nutritional genomics. *OMICS A Journal of Integrative Biology,* 13(1), 37-41.

Morse, J.M., Barrett, M., Mayan, M., Olson, K. and Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods,* 1(2), 13-22.

Moscovici, S. (1984) The phenomenon of social representations. In Farr, J. and Moscovici, S. (Eds). *Social Representations* (pp. 3-69). Cambridge, UK: Cambridge University Press.

Moscovici, S. (1988). Notes towards a description of social representations. *European Journal of Social Psychology,* 18, 211-250.

Murphy, C., Henchion, M., McCarthy, M. and Williams, G.A. (2011). The prospects for acceptance of animal cloning in the European food chain: Early insights from an Irish sentinel group. *AgBioForum,* 14(2), 83-93.

Murphy, P. (2007). *Nanotechnology: Public engagement with health, environment and social issues.* EPA STRIVE Programme 2007-2013 (2007-FS-EH-1-M5). STRIVE Report 61. Prepared for the Environmental Protection Agency.

Murphy, P. (2008). Come on, be serious: positioning and framing in the power play of classroom-based reproductive and genetic technology debates. In: Bell, A., Davies, S. and Mellor, F. (Eds.). *Science and its publics* (pp. 57-77). Newcastle: Cambridge Scholars Publishing.

Nanotechnology Industries Association. (2014). *EC to present revised Nano Food Proposal to European Parliament.* Available at:

http://www.nanotechia.org/news/news-articles/ec-present-revised-nano-food-proposal-european-parliament

National Research Council (NRC). (2000). *Genetically modified pest-protected plants: Science and regulation*. Washington, DC: National Academy Press.

Nelson, T.E., Oxley, Z.E. and Clawson, R.A. (1997). Towards a psychology of framing effects. *Political Behavior*, 19(3), 221-246.

New Economics Foundation. (2005). *DEMOCs for Schools.* Available at: http://www.neweconomics.org/publications/P230

New Economics Foundation. (2006). *Just like a bed of roses. DEMOCs and discussion based learning in the classroom.* Report written by Duensing, S., Smith, K. and Windale, M. Available at: http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Project-files/Bed-of-Roses-report.pdf

Nielsen, H.B., Sonne, A.M., Grunert, K.G., Banati, D., Pollák-Tóth, A., Lakner, Z., Olsen, V.N., Zontar, T.P. and Peterman, M. (2009). Consumer perception of the use of high-pressure processing and pulsed electric field technologies in food production. *Appetite,* 52(1), 115-126.

Nisbet, M.C. (2005). The competition for worldviews: Values, information, and public support for stem cell research. *International Journal of Public Opinion Research* 17(1), 90-112.

Noussair, C., Robin, S. and Ruffieux, B. (2004). Do consumers really refuse to buy genetically modified food? *Economic Journal*, 114, 102-120.

O'Connor, E., Cowan, C., Williams, G., O'Connell, J. and Boland, M. (2005). Acceptance by Irish consumers of a hypothetical GM dairy spread that reduces cholesterol. *British Food Journal,* 107(6), 361-380.

Olsen, N.V., Grunert, K.G. and Anne-Mette Sonne, A-M. (2010). Consumer acceptance of high-pressure processing and pulsed-electric field: A review. *Trends in Food Science & Technology,* 21(9), 464-472.

Olson, J.C. (1989). Theoretical foundations of means-end chains. *Werbeforschung and Praxis,* 5, 174-178.

Olson, M.A. and Kendrick, R.V. (2008). Origins of attitudes. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 111-130). NewYork: Psychology Press.

Ortony, A., Clore, G.L. and Collins, A. (1988). *The cognitive structure of emotions.* Cambridge, UK: Cambridge University Press.

Ortony, A., Norman, D. and Revelle, W. (2005). Affect and proto-affect in effective functioning. In: Fellous, J and Arbib, M. (Eds.). *Who needs emotions: The brain meets the machine* (pp. 173-202). New York: Oxford University Press.

Ozkan, B.C. (2004). Using NVivo to analyze qualitative classroom data on constructivist learning environments. *Qualitative Report,* 9(4), 589-603.

Pan, Z. and Kosicki, G.M. (1993). Framing analysis: An approach to news discourse. *Political Communication,* 10, 55-76.

Patton, M.Q. (1991). *Qualitative evaluation and research methods.* 2nd Edition. Newbury Park, C.A.: Sage Publications Ltd.

Pereira, R.N. and Vicente, A.A. (2010). Environmental impact of novel thermal and non-thermal technologies in food processing. *Food Research International,* 43, 1936-1943.
Perrea, T., Grunert, K.G. and Krystallis, A. (2015). Consumer value perceptions of food products from emerging processing technologies: A cross-cultural exploration. *Food Quality and Preference,* 39, 95-108.
Peter, J.P., Olsen, J.C. and Grunert, K.G. (1999). *Consumer behaviour and marketing strategy.* European Edition. London: McGraw-Hill.
Petty R.E. and Cacioppo, E. (1986). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology,* 19, 123-205.
Petty, R.E., Tormala, Z.L., Brińol, P. and Jarvis, W.B.G. (2006). Implicit ambivalence from attitude change: An exploration of the PAST model. *Journal of Personality and Social Psychology,* 90, 21-41.
Petty, R.E., Wegener, D.T. and Fabrigar, L.R. (1997). Attitudes and attitude change. *Annual Review of Psychology,* 48, 609-647.
Piaget, J. (1932). *The moral judgment of the child.* New York: Free Press.
Picasso, P. (1966). Quoted in Parmelin, H. Truth. In *Picasso Says* (trans. 1969.). London: Allen & Unwin.
Pivetti, M. (2007). Natural and unnatural: Activists' representations of animal biotechnology. *New Genetics and Society,* 26(2), 137-157.
Pliner, P. and Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite,* 19, 105-120.
Poortinga, W. and Pidgeon, N.F. (2006). Exploring the structure of attitudes toward genetically modified food. *Risk Analysis: An International Journal,* 26(6), 1707-1719.
Popkin, S.L. (1994). *The reasoning voter: Communication and persuasion in presidential campaigns*. 2nd Edition. Chicago, IL: University of Chicago Press.
Potts, M. and Nelson, R. (2008). Understanding the effect of stigmatization on food consumer knowledge, perception and behaviour in Northern Ireland. *International Journal of Consumer Studies,* 32, 366-373.
Powell, M. and Kleinman, L.D. (2008). Building citizen capacities for participation in nanotechnology decision-making: The democratic virtues of the consensus conference model. *Public Understanding of Science,* 17, 329-348.
Priest, S., Greenhalgh, T. and Kramer, V. (2010). Risk perceptions starting to shift? U.S. citizens are forming opinions about nanotechnology. *Journal of Nanoparticle Research,* 12, 11-20.
Priest, S., Lane, T., Greenhalgh, T., Hand, L.J. and Kramer, V. (2011). Envisioning emerging nanotechnologies: A three-year panel study of South Carolina citizens. *Risk Analysis,* 31(11), 1718-1733.
Prislin, R. and Crano, W.D. (2008). Attitudes and attitude change: The fourth peak. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 3-18). New York: Psychology Press.

Reese, S.D. (2001). Framing public life: A bridging model for media research. In: Reese, S.D., Gandy Jr., O.H. and Grant, A.E. (Eds.). *Framing public life: Perspectives on media and our understanding of the social world* (pp. 7-31). Mahwah, N.J.: Lawrence Erlbaum.

Renn, O. (2003). Hormesis and risk communication. *Human & Experimental Toxicology,* 22, 3-24.

Renn, O. (2004). Perception of risks. *Toxicology Letters,* 149, 405-413.

Renton, M.S. (2008). Influencing consumer perceptions of a social issue: an experiment on the effects of credibility of the source, message sidedness and inward/outward focus on consumer attitudes toward genetically modified foods. PhD Thesis, University of Canterbury, New Zealand. Available at: http://ir.canterbury.ac.nz/bitstream/10092/874/1/thesis_fulltext.pdf

Richards, L. (1999). Data alive!: The thinking behind NVivo. *Qualitative Health Research*, 9(3), 412-428.

Richards, T. (2002). An intellectual history of NUD*IST and NVivo. *International Journal of Social Research Methodology,* 5(3), 199-214.

Rogers, E.M. (1995). *Diffusion of innovations.* 4th Edition. New York: Free Press.

Rollin, F., Kennedy, J. and Wills, J. (2011). Consumers and new food technologies. *Trends in Food Science & Technology,* 22, 99-111.

Ronteltap, A., van Trijp, J.C.M. and Renes, R.J. (2009). Consumer acceptance of nutrigenomics-based personalised nutrition. *British Journal of Nutrition,* 101, 132-144.

Ronteltap, A., van Trijp, J.C.M., Renes, R.J. and Frewer, L.J. (2007). Consumer acceptance of technology-based food innovations: Lessons for the future of nutrigenomics. *Appetite,* 49, 1-17.

Rouse, J. (2006). Practice theory. In: Turner, S. and Risjord, M. (Volume Eds.) and Gabbay, D.V., Thagard, P. and Woods, J. (Handbook Eds.). *Handbook of the philosophy of science* (Volume 15, pp. 499-540). Philosophy of Anthropology and Sociology, Elsevier.

Rowe, G. (2004). How can genetically modified foods be made publicly acceptable? *Trends in Biotechnology,* 22(3), 107-109.

Rowe, G. and Frewer, L.J. (2000). Public participation methods: A framework for evaluation. *Science Technology Human Values,* 25(1), 3-29.

Rowe, G. and Wright, G. (2001). Differences in expert and lay judgments of risk: Myth or reality? *Risk Analysis*, 21(2), 341-356.

Rowe, G., Rawsthorne, D., Scarpello, T. and Dainty, J.R. (2010). Public engagement in research funding: A study of public capabilities and engagement methodology. *Public Understanding of Science,* 19(2), 225-239.

Rozin, P. (2005). The meaning of “natural”. Process more important than content. *Psychological Science*, 16(8), 652-658.

Rozin, P., Spranca, M., Krieger, Z., Neuhaus, R., Surillo, D., Swerdlin, A. and Wood, K. (2004). Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines. *Appetite,* 43, 147-154.

Rutsaert, P., Regan Á., Pieniak, Z., McConnon, Á., Moss, A., Wall, P. and Verbeke, W. (2013). The use of social media in food risk and benefit communication. *Trends in Food Science & Technology,* 30(1), 84-91.

Saba, A. and Vassallo, M. (2002). Consumer attitudes towards the use of gene technology in tomato production. *Food Quality and Preference,* 13, 13-21.

Saba, A., Vassallo, M., Shepherd, R., Lampila, P., Arvola, A., Dean, M., Winkelmann, M. and Lähteenmäki, L. (2010). Country-wise differences in perception of health-related messages in cereal-based food products. *Food Quality and Preference,* 21, 385-393.

Salmon, P. (2003). How do we recognise good research? *The Psychologist,* 16(1), 24-27.

Sandman, P.M. (1987). Risk communication: Facing public outrage. *Environment Protection Assessment Journal,* 13, 21-22.

Saunders, M., Lewis, P. and Thornhill, A. (2009). *Research methods for business students.* 5th Edition. England: Financial Times/Prentice Hall.

Schadewitz, N. and Jachna, T. (2007). Comparing inductive and deductive methodologies for design patterns identification and articulation. *International Design Research Conference* IADSR 2007, Emerging Trends in Design Research. 12-15 November 2007, Hong Kong.

Scheufele, D.A. (1999). Framing as a theory of media effects. *Journal of Communication,* Winter, 103-122.

Scheufele, D.A. (2000). Agenda-setting, priming, and framing revisited: Another look at cognitive effects of political communication. *Mass Communications & Society,* 3(2&3), 297-316.

Scheufele, D.A. and Lewenstein, B.V. (2005). The public and nanotechnology: How citizens make sense of emerging technologies. *Journal of Nanoparticle Research,* 7, 659-667.

Scheufele, D.A. and Tewksbury, D. (2007). Framing, agenda setting, and priming: The evolution of three media effects models. *Journal of Communication,* 57, 9-20.

Scholderer, J. and Frewer, L.J. (2003). The biotechnology communication paradox: Experimental evidence and the need for a new strategy. *Journal of Consumer Policy,* 26, 125-157.

Scholderer, J., Bredahl, L. and Frewer, L. (2000). Ill-founded models of consumer choice in communication about food biotechnology. In: van Raaij, F. (Ed.), *Marketing communications in the new millennium: New media and new approaches* (pp. 129-152). Rotterdam: Erasmus University.

Schurr, P.H. (1986). Four script studies: What have we learned? *Advances in Consumer Research,* 13, 498-503.

Schwarz, N. (2008). Attitude measurement. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 41-60). New York: Psychology Press.

Scott, W.A. (1969). Structure of natural cognitions. *Journal of Personality and Social Psychology,* 4, 261-278.

Shanks, G.G. and Parr, A.N. (2003). Positivist single case study research in information systems: a critical analysis. *Proceedings of the European Conference on Information Systems.* Naples, June 2003. (pp. 1760-1774).

Shaw, A. (2002). "It just goes against the grain". Public understandings of genetically modified (GM) food in the UK. *Public Understanding of Science,* 11, 273-291.

Sheldon, R., Cleghorn, N., Penfold, C., Brown, A. and Newmark, T. (2009). *Exploring attitudes to GM food.* Report prepared for the Food Standards Agency, UK. Social Science Research Unit. Available at: http://www.food.gov.uk/multimedia/pdfs/gmreportnov09finalreport.pdf

Shepherd, R. (2008). Involving the public and stakeholders in the evaluation of food risks. *Trends in Food Science & Technology,* 19, 234-239.

Shepherd, R., Barker, G., French, S., Hart, A., Maule, J. and Cassidy, A. (2006). Managing Food chain risks: Integrating technical and stakeholder perspectives on uncertainty. *Journal of Agricultural Economics,* 57(2), 313-327.

Siegrist M., Stampfli N. and Kastenholz. H. (2009). Acceptance of nanotechnology foods: A conjoint study examining consumers' willingness to buy. *British Food Journal,* 111(7), 660-668.

Siegrist, M. (1999). A causal model explaining the perception and acceptance of gene technology. *Journal of Applied Social Psychology,* 29(10), 2093-2106.

Siegrist, M. (2000). The influence of trust and perceptions of risk and benefits on the acceptance of gene technology. *Risk Analysis,* 20, 195-204.

Siegrist, M. (2008). Factors influencing public acceptance of innovative food technologies and products. *Trends in Food Science & Technology,* 19, 603-608.

Siegrist, M. (2010). Predicting the future: Review of public perception studies of nanotechnology. *Human and Ecological Risk Assessment,* 16, 837-846.

Siegrist, M. and Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis,* 20, 713-719.

Siegrist, M. and Keller, C. (2011). Labelling of nanotechnology consumer products can influence risk and benefit perceptions. *Risk Analysis,* 31(11), 1762-1769.

Siegrist, M., Cousin, M.-E., Kastenholz, H. and Wiek, A. (2007a). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite,* 49, 459-466.

Siegrist, M., Keller, C., Kastenholz, H., Frey, S. and Wiek, A. (2007b). Laypeople's and experts' perception of nanotechnology hazards. *Risk Analysis*, 27, 59-69.

Siegrist, M., Stampfli, N., Kastenholz, H. and Keller, C. (2008). Perceived risks and perceived benefits of different nanotechnology foods and nanotechnology food packaging. *Appetite*, 51, 283-290.

Silva, A.P., Figueiredo, I., Hogg, T. and Sottomayor, M. (2014). Young adults and wine consumption a qualitative application of the theory of planned behavior. *British Food Journal*, 116(5), 832-848.

Simons, J., Zimmer, R., Vierboom, C., Härlen, I., Hertel, R. and Böl, G.F. (2009). The slings and arrows of communication on nanotechnology. *Journal of Nanoparticle Research*, 11, 1555-1571.

Siró, I., Kápolna, E., Kápolna, B. and Lugasi, A. (2008). Functional food. Product development, marketing and consumer acceptance - A review. *Appetite*, 51, 456-467.

Sjöberg, L. (2000a). Perceived risk and tampering with nature. *Journal of Risk Research*, 3(4), 353-367.

Sjöberg, L. (2000b). Factors in risk perception. *Risk Analysis*, 20(1), 1-11.

Sjöberg, L. (2002a) Attitudes toward technology and risk: Going beyond what is immediately given. *Policy Sciences*, 35(4), 379-400.

Sjöberg, L. (2002b). Are received risk perception models alive and well? Commentary. *Risk Analysis*, 22(4). 665-669.

Slovic, P. (1987). Perception of risk. *Science*, 23, 280-286.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis*, 19(4), 689-701.

Slovic, P. (2000). *The perception of risk.* London: Earthscan Publishing.

Slovic, P., Finucane, M.L., Peters, E. and MacGregor, D.G. (2004). Risk as analysis and risk as feeling: Some thought about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Slovic, P., Fischhoff, B. and Lichtenstein, S. (1980). Facts and fears: Understanding perceived risk. *American Statistician*, 36(3), 240-255.

Smith, J.R. and Hogg, M.A. (2008). Social identity and attitudes. In: Crano, W.D. and Prislin, R. (Eds.). *Attitudes and attitude change* (pp. 337-360). New York: Psychology Press.

Søndergaard, H.A, Grunert, K.G and Scholderer, J. (2005). Consumer attitudes to enzymes in food production. *Trends in Food Science & Technology*, 16, 466-474.

Sorenson, D. and Henchion, M. (2011). Understanding consumers' cognitive structures with regard to high pressure processing: A means-end chain application to the chilled ready meals category. *Food Quality and Preference*, 22(3), 271-280.

Sparks, P. and Shepherd, R. (1994a). Public perceptions of the potential hazards associated with food production and food consumption: an empirical study. *Risk Analysis*, 14(5), 799-806.

Sparks, P., Shepherd, R. and Frewer, L., (1994b). Gene technology, food production and public opinion: A UK study. *Agriculture and Human Values,* 11(1), 19-28.

Sparks, P., Shepherd, R. and Frewer, L.J. (1995). Assessing and structuring attitudes toward the use of gene technology in food production: The role of perceived ethical obligation. *Basic and Applied Social Psychology,* 16, 267-285.

Spence, A. and Townsend, E. (2006a). Examining consumer behavior toward genetically modified (GM) food in Britain. *Risk Analysis*, 26(3), 657-670.

Spence, A. and Townsend, E. (2006b). Implicit attitudes towards genetically modified (GM) foods: A comparison of context-free and context-dependent evaluations. *Appetite,* 46(1), 67-74.

Spence, M., Livingstone, M.B.E., Hollywood, L.E., Gibney, E.R., O'Brien, S.A., Pourshahidi, L.K. and Dean, M. (2013). A qualitative study of psychological, social and behavioral barriers to appropriate food portion size control. *International Journal of Behavioral Nutrition and Physical Activity,* 10, 1-10.

Spiggle, S. (1994). Analysis and interpretation of qualitative data in consumer research. *Journal of Consumer Research*, 21(3), 491-503.

Srivastava, P. and Hopwood, N. (2009). A practical iterative framework for qualitative data analysis. *International Journal of Qualitative Methods,* 8(1), 76-84.

Stake, R.E. (1995). *The art of case study research.* Thousand Oaks, C.A.: Sage Publications Ltd.

Stampfli, N., Siegrist, M. and Kastenholz, H. (2010). Acceptance of nanotechnology in food and food packaging: A path model analysis. *Journal of Risk Research*, 13(3), 353-365.

Starr, C. (1969). Social benefit versus technological risk. *Science*, 165, 1232-1238.

Steedman, P. (2000). On the relations between seeing, interpreting and knowing. In: Steier, F. (Ed.). *Research and Reflexivity* (pp. 53-62). London: Sage Publications Ltd.

Stewart-Knox, B., Kuznesof, S., Robinson, J., Rankin, A., Orr, K., Duffy, M., Poínhos, R., et al. …Frewer, L.J. (2013). Factors influencing European consumer uptake of personalised nutrition. Results of a qualitative analysis. *Appetite*, 66, 67-74.

Stoneman, P. and Sturgis, P. (2011). *Methods for understanding public opinion about emerging technologies.* Newsletter for the ESRC National Centre for Research Methods. Winter. Available at: http://www.ncrm.ac.uk/news/show.php?article=5244

Strauss, A. and Corbin, J. (1998). *Basics of qualitative research. Techniques and procedures for developing grounded theory.* 2nd Edition. London: Sage Publications Ltd.

Sturgis, P. and Allum, N. (2004). Science in society: Re-evaluating the deficit model of public attitudes. *Public Understanding of Science,* 13, 55-74.

Sturgis, P., Brunton-Smith, I. and Fife-Schaw, C. (2010). Public attitudes to genomic science: An experiment in information provision. *Public Understanding of Science*, 19(2), 166-180.

Sturgis, P., Cooper, H. and Fife-Schaw, C. (2005). Attitudes to biotechnology: Estimating the opinions of a better-informed public. *New Genetics and Society*, 24(1), 31-56.

Taylor, G.W. and Ussher, J.M. (2001). Making sense of S&M: A discourse analytic account. *Sexualities*, 4(3), 293-314.

Teagasc. (2008). *Towards 2030 foresight report: Teagasc's role in transforming Ireland's agri-food sector and the wider bio-economy.* Volume 1. Dublin: Teagasc. Available at: http://www.teagasc.ie/publications/2008/20080609/ForesightReportVol1.pdf

Teagasc. (2012). *Statement of strategy 2012-2015.* Dublin: Teagasc. Available at: http://www.teagasc.ie/publications/2012/1289/Teagasc-Strategy-Statement.pdf

Teagasc. (2014). *Minister Coveney announces grant awards of over €20M for Agri-Food and Forest Research.* Press Release, 10th December. Available at: http://www.teagasc.ie/news/2014/201412-10b.asp

Teisl, M.F., Fein, S.B. and Levy, A.S. (2009). Information effects on consumer attitudes toward three food technologies: Organic production, biotechnology, and irradiation. *Food Quality and Preference*, 20, 586-596.

Tenbült, P., de Vries, N. K., Dreezens, E. and Martijn, C. (2008a). Intuitive and explicit reactions towards “new” food technologies: Attitude strength and familiarity. *British Food Journal*, 110, 622-635.

Tenbült, P., de Vries, N.K., Dreezens, E. and Martijn, C. (2007). Categorizing genetically modified food products: Effects of labelling on information processing. *British Food Journal*, 109, 305-314.

Tenbült, P., De Vries, N.K., Van Breukelen, G., Dreezens, E. and Martijn, C. (2008b). Acceptance of genetically modified foods: The relation between technology and evaluation. *Appetite*, 51, 129-136.

Tencalla, F. (2006). Science, politics, and the GM debate in Europe. *Regulatory Toxicology and Pharmacology*, 44, 43-48.

Tesser, A. and Shaffer, D.R. (1990). Attitudes and attitude change. *Annual Review of Psychology*, 41, 479-523.

Thomas, S.P. and Hrudey S.E. (1997). *Risk of death in Canada: What we know and how we know it.* Calgary, Canada: The University of Alberta Press.

Thurstone, L.L. (1928). Attitudes can be measured. *American Journal of Sociology*, 33, 529-554.

TNS-BMRB. (2011). *Citizens forums: Nanotechnology and food.* JN 219186. Report produced on behalf of the Food Standards Agency, UK. Available at: http://www.food.gov.uk/multimedia/pdfs/publication/fsacfnanotechnologyfood.pdf

Todorov, A., Chaiken, S. and Henderson, M.D. (2002). The heuristic-systematic model of social information processing. In: Dillard, J. and Pfau, M. (Eds.). *The persuasion handbook: Developments in theory and practice* (pp. 195-211). Thousand Oaks, CA: Sage Publications Ltd.

Tormala, Z.L., Clarkson, J.J. and Petty, R.E. (2006) Resisting persuasion by the skin of one's teeth: The hidden success of resisted persuasive messages. *Journal of Personality and Social Psychology*, 91(3), 423-435.

Townsend, E. and Campbell, S. (2004). Psychological determinants of willingness to taste and purchase genetically modified food. *Risk Analysis,* 24(5), 1385-1393.

Trochim, W.M.K. (1989). Outcome pattern matching and program theory. *Evaluation and Program Planning,* 12, 355-366.

Tucker, M., Whaley, S.R. and Sharp, J.S. (2006). Consumer perceptions of food-related risks. *International Journal of Food Science and Technology,* 41, 135-146.

Tversky, A. and Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology,* 5, 207-222.

Tversky, A. and Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science,* 211(4481), 453-458.

Van Gorp, B. (2007). The constructionist approach to framing: Bringing culture back in. *Journal of Communication,* 57, 60-78.

van Kleef, E., Van Trijp, H.C.M. and Luning, P. (2005). Consumer research in the early stages of new product development: A critical review of methods and techniques. *Food Quality and Preference,* 16, 181-201.

Van Wassenhove, W., Dressel, K., Perazzini, A. and Ru, G. (2012). A comparative study of stakeholder risk perception and risk communication in Europe: A bovine spongiform encephalopathy case study. *Journal of Risk Research*, 15(6), 565-582

Vandermoere, F., Blanchemanche, S., Bieberstein, A., Marette, S. and Roosen, J. (2011). The public understanding of nanotechnology I the food domain; the hidden role of views on science, technology and nature. *Public Understanding of Science,* 20(2), 195-206.

Verbeke, W. (2005). Consumer acceptance of functional foods: Socio-demographic, cognitive and attitudinal determinants. *Food Quality and Preference,* 16, 45-57.

Verbeke, W. and Vackier, I. (2005). Individual determinants of fish consumption: Application of the theory of planned behaviour. *Appetite,* 44, 67-82.

Verbeke, W., Frewer, L.J., Scholderer, J. and De Brabander, H.F. (2007). Why consumers behave as they do with respect to food safety and risk information. *Analytica Chimica Acta,* 586, 2-7.

Viklund, M.J. (2003). Trust and risks perception in Western Europe: A cross national study. *Risk Analysis*, 23(4), 727-738.

Vilei, S. and McCarthy, M. (2001). *Consumer acceptance and understanding of genetically modified food products.* Discussion Paper

No. 33, Department of Food Business and Development, National University of Ireland, Cork Ireland. Available at: http://www.ucc.ie/en/foodbus/research/discussion/thirtyonetoforty/documentfile-32496-en.pdf

Visschers, V. H.M., Meertens, R.M., Passchier, W.F. and deVries, N.K. (2007). How does the general public evaluate risk information? The impact of associations with other risks. *Risk Analysis*, 27, 715-727.

Visser, P.S., Bizer, G.Y. and Krosnick, J.A. (2006). Exploring the latent structure of strength-related attitude attributes. *Advances in Experimental Social Psychology*, 38, 1-67.

Wagner, W. (1994). Fields of research and socio-genesis of social representations: A discussion of criteria and diagnosis. *Social Science Information,* 33(2), 199-228.

Wansink, B. and Kim, J. (2001). The marketing battle over genetically modified foods: False assumptions about consumer behavior. *American Behavioral Scientist,* 44(8), 1405-1417.

Warde, A. (2005) Consumption and theories of practice. *Journal of Consumer Culture*, 5, 131-151.

Watkins, M.J. and Tulving, E. (1975). Episodic memory: When recognition fails. *Journal of Experimental Psychology: General*, 104(1), 5-29.

Weststrate, J.A., van Poppel, G. and Verschuren, P.M. (2002). Functional foods, trends and future. *British Journal of Nutrition*, 88(2), S233-S235.

Whetten, D.A. (1989). What constitutes a theoretical contribution? *Academy of Management Review,* 14(4), 490-495.

Whiteley, A., McCabe, M., Buoy, L., Howie, F., Klass, D., Latham, J., et al. (1998). *Planning the qualitative research interview.* GBS Working Paper, No. 15. Reprint 2003. Perth, Australia: Curtin University of Technology Graduate School of Business.

Wiedemann, P. (2009). Is there a risk? Disclosing the tipping points of regulatory action: comments to R. Loftstedt. *Journal of Risk Research,* 12(5), 559-561.

Wilkinson, I. (2006). Psychology of risk. In: Mythen, G. and Walklate, S. (Eds.). *Beyond the risk society. Critical reflections on risk and human security* (pp. 25-42). New York: Open-University Press.

Wilson, C., Evans, G., Leppard, P. and Syrette, J. (2004). Reactions to genetically modified food crops and how perception of risks and benefits influences consumers' information gathering. *Risk Analysis,* 24(5), 1311-1321.

Wood, W. (2000). Attitude change: Persuasion and social influence. *Annual Review of Psychology,* 51, 539-570.

Wynne, B. (1980). Technology, risk and participation: On the social treatment of uncertainity. In Conrad, J. (Ed.). *Society, technology and risk assessment* (pp.173-208). New York: Academic Press.

Yadavalli, A. and Jones, K. (2014). Does media influence consumer demand? The case of lean finely textured beef in the United States. *Food Policy,* 49, 219-227.

Yeung, R.M.W. and Morris, J. (2001). Food safety risk: Consumer perception and purchase behaviour. *British Food Journal,* 103(3), 170-186.

Yin, R.K. (1994). *Case study research: Design and method.* 2nd Edition. Thousand Oaks, C.A.: Sage Publications Ltd.

Zajonc, R. (1980). Feeling and thinking: Preference needs no inferences. *American Psychologist,* 35,151-175.

Zepeda, L., Chang, H-S. and Leviten-Reid, C. (2006). Organic food demand: A focus group study involving Caucasian and African-American shoppers. *Agriculture and Human Values,* 23, 385-394.

Zhang, Y. and Buda, R. (1999). Moderating effects of need for cognition on responses to positively versus negatively framed advertising messages. *Journal of Advertising,* 28(2), 1-15.

Zhanga, X., Huang, J., Qiub, H. and Huang, Z. (2010). A consumer segmentation study with regards to genetically modified food in urban China. *Food Policy,* 35, 456-462.

Appendices

Appendix 1.2: Technology Specific Summary Sheets Presented to Citizens in Advance of Participating in the Deliberative Discourse

Genetically Modification Summary Sheet

New and advanced food technologies are constantly being developed. Genetic modification is one of these technologies.

- Genetic modification is also sometimes referred to as genetic engineering. Genetic modification uses a series of technologies to alter the genetic makeup of organisms in a way that does not occur naturally. This alteration could involve inserting genes from one organism into another organism.
- An organism is any living animal or plant including a bacterium or virus that is capable of replication or of transferring genetic material. Plants and animals are composed of many different cell types and each cell contains copies of its genes. Genes are made of DNA and hold the information that determines the organism's particular function(s). Certain characteristics of an organism may be linked to a particular gene or combination of genes, e.g. the redness of meat.
- Genetic modification involves introducing, removing or enhancing particular traits so that an organism is capable of producing more of existing substances or new substances, or performing new functions.
- For centuries, people have been breeding animals and new varieties of plants to enhance or avoid certain qualities. Genetic modification allows plants, animals and micro-organisms to be produced with specific characteristics more accurately and efficiently than through traditional methods. It allows genes to be transferred from one species to another to develop targeted characteristics that would be very difficult or impossible to achieve through traditional breeding.
- Genetic modification can be used in a number of ways in food production. For example, crops, such as corn, can be genetically modified to increase their yield (growth).
- GM food is processed in the same way by the body as non-GM food (i.e. the digestive systems break down the DNA in the food).
- European regulations specify that products produced with genetic modification technology (e.g. cheese produced with GM enzymes) do not have to be labelled as such. Products such as milk and meat from animals fed on GM animal feed also do not have to be labelled accordingly.
- Intentional use of GM food ingredients that become part of the final food product must be labelled.
- GM foods intended for sale in the EU are subject to safety assessments. However, final authorisation rests with Member States who vote on authorising GM food on a case-by-case basis.

Nanotechnology Summary Sheet

New and advanced food technologies are constantly being developed. Nanotechnology is one of these technologies.

- Nanotechnology is the experimental process of manipulating and controlling matter (particles) at dimensions between approximately 1 and 100 nanometres (at a scale of 1/100th the width of a human hair), where unique phenomena enable novel applications.
- A nanometre is one-billionth of a metre (the sheet of paper that you are holding is about 100,000 nanometres thick).
- Dimensions between approximately 1 and 100 nanometres are known as the nanoscale. Unique physical, chemical, and biological properties can emerge in materials at this scale.
- In addition to being engineered, nanoparticles are also naturally occurring. For instance, the human body uses natural nanoscale materials, such as proteins, to control the body's many systems and processes. Other examples are nanoscale fibres that give meat/muscle its structure and nanoscale particles that make milk appear white.
- These are different types of nanomaterials which derive their names for their individual shapes and dimensions (i.e. particles, tubes, fibres and films that have one or more nanosized dimension).
- In recent years scientists have been researching how different types of nanotechnologies can be applied in food products, production and packaging.

Food Irradiation Summary Sheet

New and advanced food technologies are constantly being developed.
Irradiation is a technology that has been applied to foods and has been in use in some countries for over 30 years.
Irradiation involves exposing food to a defined dose of ionising radiation.
Radiation is a form of energy that travels in a wave pattern.

- It is a preservation technique that can be used to increase shelf-life and food safety.
- Food irradiation is carried out in a special facility. The food is placed close to but does not come in contact with the radioactive source. The level of exposure depends on the food product and the source of the irradiation (gamma rays, X-rays or electron beam).
- Beams of radiation pass into food and transfer energy which causes the formation of short-lived molecules known as free radicals, which kill micro-organisms, such as bacteria, and interact with other food molecules. Free radicals can also form in food by other processing techniques (e.g. cooking). Irradiation also disrupts some of the chemical bonds in the DNA of food as well as those of contaminating micro-organisms or insects. As a result these micro-organisms should no longer be able to grow and divide and this should prevent food spoilage. The energy waves are not retained in the food after irradiation.
- Individuals are exposed to low levels of radiation on a daily basis from a variety of natural (e.g. rocks) and man-made (e.g. televisions) sources. Irradiation does not add to the naturally occurring radioactivity present in food products. Irradiating food does not make it radioactive - just as microwave heated food does not give out microwaves. Irradiation is often referred to as ‘ionizing radiation’. Other terms used are ‘cold pasteurisation’ and ‘irradiation pasteurisation’ since the results achieved are similar to heat-based pasteurisation, although irradiation is a very different process. Irradiation is currently undertaken in 56 countries. Within Ireland, there are currently no irradiation facilities. Irradiated foodstuffs or ingredients on the Irish market are imported. Ireland does not ban or restrict the import of foods irradiated by other Member States. Any irradiated food, or food containing an irradiated ingredient within Ireland and the EU must display the word ‘irradiated’ as part of the label.

Thermal Technologies (Ohmic and Radio Frequency Heating) Summary Sheet

New and advanced food technologies are constantly being developed. Ohmic heating and radio frequency heating are two such novel food technologies used to preserve and process food.

- Thermal (heat) technologies have been used in food processing for many years. The application of heat is both an important method of preserving foods and a means of developing texture, flavour and colour.
- Two new examples of thermal technologies used in food processing are ohmic heating (OH) and radio-frequency heating (RF).
- These are volumetric thermal technologies, meaning that heat is generated within the food product, producing an inside-out heating pattern which is much faster than conventional outside-in heating such as baking or steaming.
- With OH, an electric current is applied directly to the food; RF uses radio frequency (electronic magnetic energy) to heat the food.
- OH and RF have numerous potential applications for preserving different foods. They can also be used in blanching (e.g. to preserve the colour and nutrients of vegetables that are subsequently frozen) and defrosting. RF can also be used in dehydration and peeling.
- OH can be used to heat preserve liquid foods such as juices, soups and sauces.
- The main application of RF is in drying baked goods (e.g. biscuits), herbs, spices and snack foods. RF has also been applied in drying, cooking and thawing frozen meat and in meat processing.

Non-thermal Technologies (High Voltage PEF and HIU) Summary Sheet

New and advanced food technologies are constantly being developed. High voltage pulsed electric field (PEF) and high-intensity ultrasound (HIU) are two such novel food technologies.

- Thermal (heat) technologies (e.g. heat pasteurisation) have been used in food processing to preserve and process food for many years.
- Non-thermal technologies are now being developed as an alternative to heat processing with less impact on quality, flavour, colour and texture.
- Non-thermal technologies can be used to extract juice from fruit. They can also be used to extract beneficial ingredients (known as bioactives) from plants.[38]
- Two examples of non-thermal technologies are high voltage pulsed electric field (PEF) and high-intensity ultrasound (HIU).
- PEF technology is based on applying pulses of high voltage electricity to the food product (usually for microseconds which is quicker than a blink of an eye). The food is placed between two electrodes in a treatment chamber and the pulsed electric field is applied.
- When the food is subjected to the electric field any micro-organisms (e.g. bacteria) present are killed as the intensive electric pulses burst their cell membranes.

38 Bioactives occur naturally in plant and animal products and can be added to other foods/supplements to improve their nutritional value. Such foods are sometimes referred to as ‘functional’ foods.

- PEF is potentially a type of low temperature alternative to pasteurisation. PEF treated products need to be refrigerated similarly to pasteurised products such as milk or fresh juices.
- PEF technology is mainly intended to preserve pumpable fluid or semi-fluid foods such as milk, fruit juices and soups.
- High frequency ultrasound (HIU) can also be used in drinks (e.g. milk and fruit juice) to kill bacteria.
- HIU involves applying ultrasonic waves to the liquid, which causes holes or bubbles inside the liquid and breaks the cell walls and kills the micro-organisms.
- HIU can also be applied to enhance extraction of sugars, proteins and other nutrients from e.g. potato skins and grains so that they can be added as ingredients to other foods.
- HIU can also be used as an alternative to homogenisation in blending emulsions e.g. mayonnaise.

Functional Foods Summary Sheet

New and advanced food technologies are constantly being developed. The application of functional ingredients in food products is one of these new food technologies.

- A greater understanding of the relationship between diet and health is now being used to enhance food. Food and nutrition science has moved from identifying and correcting nutritional deficiencies to designing foods that promote optimal health and reduce the risk of disease.
- A functional food is defined as one that may provide added health benefits following the addition/concentration of a beneficial ingredient or the removal/substitution of an ineffective or harmful ingredient.
- Most of us are familiar with fortified foods/drinks (e.g. vitamins/ minerals added to breakfast cereals, milk, etc. or fluorine added to water). Fortified foods can be considered the original functional foods.
- Some functional food ingredients occur naturally e.g. antioxidants in red wine help to lower 'bad' cholesterol and elevate 'good' cholesterol. In addition, many functional foods have functional ingredients added during food production and processing. These added functional ingredients can be of plant, animal or microbial origin and added to other foods e.g. probiotics added to dairy products. Some ingredients require chemical extraction from plant or marine sources which are then added to foods. Others may also involve a mechanical phase (e.g. crushing/grinding).
- Examples of functional foods include foods that contain additional minerals, vitamins, fatty acids or dietary fibre and foods with added biologically active substances such as naturally occurring plant compounds.
- Functional foods have been developed in virtually all food categories and offer something extra in terms of health benefits than the basic food item, e.g. probiotic-enriched yoghurt versus ordinary yoghurt.
- Functional foods are intended to be consumed as part of a normal healthy diet and lifestyle.

Nutrigenomics and Personalised Nutrition Products Summary Sheet

New and advanced nutrition focused technologies are constantly being developed. Nutrigenomics is one of these novel technologies.

- Nutritional genomics (referred to as nutrigenomics) is the science of how nutrients interact with an individuals' unique set of genes. Nutrigenomics seeks to understand how common nutrients in the diet affect health by altering the structure of an individual's genome (their hereditary information). The premise underlying nutrigenomics is that the impact of diet on health depends on an individual's genetic makeup.
- Nutrigenomics is the junction between health, diet, and genomics. Genomics is defined as the approach describing the mapping, sequencing, and analysis of all genes present in the genome of a given species.[39]
- Nutrigenomics studies how different foods interact with specific genes to increase/decrease or change the risk of common chronic diseases such as heart disease and certain cancers, which individuals may be genetically predisposed to. It aims to identify the genes that influence the risk of diet related diseases and to understand what is causing these genetic predispositions.
- A practical application of nutrigenomics could involve the use of genetic testing for predisposition to diseases that can be reduced through dietary interventions.
- Nutrigenomics involves genetic testing to find indicators (markers) of the early phase of diet related diseases; the phase at which intervention with nutrition can return the patient to health. In theory, once an indicator is found and measured in an individual, the extent to which they are susceptible to the development of that disease can be quantified and personalised dietary recommendation can be provided.
- Therefore, in the future, nutrigenomics could impact individual consumers through the development of personalised nutrition food products based on genetic testing of individuals' gene profiles. This could involve segmenting the population based on predisposed illnesses and developing functional food products based on these profiles.
- The concept of adapting an individual's nutrition to specific personal considerations is not new. Individuals have been distinguished by age or other physiological factors for many years.
- Although it is a rapidly emerging science, nutrigenomics is still in the early stages of development. Further research is needed to enable efficient/reliable measurements of nutrient/gene interactions

39 Mutch, D.M., Wahli, W and Williamson, G. (2005). Nutrigenomics and nutrigenetics: the emerging faces of nutrition. *FASEB J.* 19, 1602-1616.

<u>Appendix 4.1:</u> Research Approaches Applied to Establish Citizens' Perspectives

Science governance has historically been *"a policy domain driven almost entirely by 'elites'"* (Stoneman & Sturgis, 2011: 1). Nevertheless, in recent years there has been a conscious effort, at EU government level, to involve the lay public in discussions about science and technology, and to understand and appreciate their perspectives on specific technologies (Rowe & Frewer, 2000; Miller, 2001; Murphy, 2007), including food applications of biotechnology (e.g. Einsiedel et al., 2001) and more recently, nanotechnology (e.g. Delgado et al., 2010). Ongoing debate resides in policy spheres about the extent to which citizens should participate in discussions on the adoption of novel technologies, in addition to how they should participate in such processes (Einsiedel & Eastlick, 2000).

The move towards more 'upstream engagement' (Macnaghten et al., 2005; Hornig Priest, 2011), prior to final decisions being made about technologies, is more involved and inclusive than scientific literacy (Burri, 2009) and knowledge deficit perspectives (Hansen et al., 2003; Rowe et al., 2010) of communicating with the public (Hornig Priest, 2011). These particular models are perceived to have failed as a result of attributing public resistance to novel technologies to informational deficits and lay ignorance (Renn, 2003; Sturgis et al., 2005), and consequently ignoring the impact of factors such as societal values and priorities (Hansen et al., 2003). Social science's criticism of these models is therefore understandable (Irwin & Wynne, 1996; Anderson, 2002; Sturgis & Allum, 2004; Bauer et al., 2007). There is now a greater acceptance of the need to understand *"science and society"* (Frewer, 2003: 330) and take the views of both experts *and* 'publics' on board (Maule, 2004). Resistance to the notion of simply transferring information from scientific experts to lay citizens is apparent (Rowe & Frewer, 2000).

As highlighted in Chapter 2, it is now commonly recognised that lay citizens, although most probably lacking in specific scientific information, have *"legitimate concerns that are typically omitted from expert risk assessments"* (Slovic, 1987: 285). Focus has therefore moved from ‘educating’ the public about novel technologies towards ‘engaging’ with them (Frewer, 2003; European Commission, 2009b), in order to understand their viewpoints. Indeed, pertaining to the focus of this particular research, increasing interest in academic spheres in understanding public attitude formation around novel technologies is evident (Fell et al., 2009; Gupta et al., 2011).

Focus groups have traditionally been a popular method of interacting with citizens, with the purpose of establishing perspectives on a particular issue (Krueger, 1988). This qualitative data collection technique, which involves a moderator, is concerned with maintaining a diversity of expressed opinions within a group interaction (Kitzinger, 1994; Lunt & Livingstone, 1996), and is not concerned with reaching a particular conclusion. Focus groups involve bringing together selected participants who are often grouped together due to shared characteristics, for example people with a specific health concern such as diabetes. This approach has previously been applied to explore citizens’ attitudes towards various NFTs, particularly GM foods (e.g. Kuznesof & Ritson, 1996; Grove-White et al., 1997; Shaw, 2002) and functional foods (e.g. Lampila et al., 2009). Interestingly, the objective of focus groups is to establish attitudes as they are, rather than observing how attitudes might evolve with the provision of information. Their goal is not, therefore, to facilitate a particular outcome. A weakness of focus groups is that they are subject to the eventuality of a participant(s) dominating the discussion, in turn influencing the attitudes and views of others in the group (Morgan, 1997), i.e. individuals’ views may be impacted by ‘groupthink’ (Janis 1972; Chioncel et al., 2003).

In light of the evolution of perspectives on methods of interacting with lay citizens, more upstream methods of establishing public views, which extend beyond simply gauging attitudes to exploring the underlying principles guiding their perspectives, including those on scientific and technological issues, have been applied in recent decades (Rowe & Frewer, 2000). Citizens’ juries and consensus conferences are two such methods of interest. Both of these approaches facilitate the provision of information, which participants are asked to question and subsequently form opinions on (Einsiedel & Eastlick, 2000). In addition to being methods of establishing perspectives on issues, these approaches are considered effective means of engaging in public participation about specific topics.

Citizens' juries draw on the premise and several practices of a legal trial by jury. These juries involve a panel of 12-20 lay citizens questioning expert witnesses that have been chosen by a stakeholder panel. Citizens' juries are generally open to the wider public, and conclusions of the 'jury' are typically made through the publication of a report or a press conference (Rowe & Frewer, 2000). If appropriate to do so, a minority view may be reported.

Originally developed by the Danish Board of Technology in 1987, the aim of a consensus conference is to provide lay citizens with a voice, *vis-á-vis* decision making about scientific and technological developments (Powell & Kleinman, 2008; Kleinman et al., 2011). These conferences involve a small group of 10-16 citizens, who partake in a learning process concerning a specific technological issue (Kleinman et al., 2007). Participants extensively deliberate about the topic, engage with relevant experts, and then provide a group assessment of the key issues they consider to be critical within the context of the topic discussed (Einsiedel & Eastlick, 2000). This assessment is then present to relevant policy makers. This approach therefore combines features of a town hall meeting and a citizens' jury (*Ibid*).

The value of citizens' juries and consensus conferences is that they provide immediate insight into the impact of social influences, which, although interesting, is not a focus of this work. In contrast to focus groups, the purpose of these approaches is to facilitate a particular outcome. In turn, these methods predominately focus on achieving a consensus among a group of participants, which may involve influencing the attitudes of some participating lay citizens. A potential weakness of this focus is that differences in participants' opinions may be masked, particularly if these differing opinions are held by less outspoken participants.

Developed by the New Economics Foundation (NEF) in 2002, originally as a tool to discuss stem cell research, DEliberate Meetings Of CitizenS (Democs) are primarily a method of citizen interaction about technological issues involving conversation-based card games (Bruce, 2007). In addition to being an engagement tool, this approach provides useful insight into public views regarding particular issues (Bruce, 2010). Through the Democs game, which involves 6-8 lay citizen 'players', information is provided and revealed through the distribution of different types of (story, information and issue) cards, to stimulate discussion among participants (Bruce, 2007). Presenting information in this iterative manner enables the group to understand and discuss the issue, which they subsequently provide a (potentially divergent) vote on (NEF, 2005). Democs have been applied across Europe through PlayDecide[40], which is a web-based project where games on science topics are available to download. Several games have been devised and 'played' by the general public on various topics, including GM foods (Democs were a participation method used in the UK GM Nation Debate in 2003), nanobiotechnology (as part of the EC FP6 NanoBio-Raise project) and synthetic biology (Bruce, 2007, 2010). They have also been used as a learning tool for schools in the areas of GM foods, animal experiments, climate change and stem-cell research (NEF, 2005, 2006).

Unlike other engagement methods such as consensus conferences, the aim of Democs is not to achieve a consensus. Although Democs apply some features of focus groups, most obvious being group participation, they extend beyond conventional focus groups through the provision of information (the game cards) (Bruce, 2007). The Democs approach is considered a more open and wide reaching method of citizen participation than the aforementioned traditional methods (Bruce, 2010). The key advantages of Democs, over other engagement methods, are accessibility and flexibility. The games do not require the presence of external experts or facilitators, and can be played by a group of willing participants at any location and time (Bruce, 2007). Democs thereby require less formal planning/ co-ordination, in comparison to more traditional methods of citizen interaction (*Ibid*).

40 http://www.playdecide.org

These points withstanding, the lack of an expert or facilitator may also be perceived as a potential weakness of this interactive approach, since information provided is limited to and framed solely by what is written on the cards. This presents challenges, particularly if the subject matter is unfamiliar to participants (Bruce, 2007). Indeed, sole reliance on the card information places pressure on the card authors and reviewers to ensure the presentation of balanced, unbiased, yet concise, arguments. Subsequently, Bruce (2010) argues that for complex unfamiliar issues, the presence of someone who is knowledgeable about the subject matter could improve the 'playing' of Democs games. Another potential weakness, which extends to the previous methods outlined, is that voluntary participation potentially results in over-representation of particular interest groups (Bruce, 2007).

This Appendix has presented an overview of research approaches applied to date to establish citizens' attitudes towards specific topics, including NFTs, and the benefits and drawbacks of each, which are summarised in Table 4.3.

Appendix 4.2: Standard Operating Procedures for Data Collection

There will be three interactions with each citizen: completion of the pre-discourse interviewer-led questionnaire (PDILQ), the deliberative discourse and in-depth post-discourse interview (PDI).

Technologies to be included in the discourses

- Selected technologies and centres responsible for undertaking the discourse on each technology are outlined in the Table 4.1A.

Table 4.1A: *List of Technologies and Centre Responsible for Data Collection*

Technology	Technology Group	Research Centre
Genetic Modification	**Emotive & Contentious Group (ECG)**	UCC
Nanotechnology		UCC
Food Irradiation		UCC
Nutrigenomics and PNPs	**Product & Service Orientated Group (PSOG)**	UCC
Functional Foods		UCC and Teagasc Food Research Centre, Ashtown
Thermal Technologies	**Benign & Non-contentious Group (BNG)**	Teagasc
Non-thermal Technologies		Teagasc

The pilot discourses

- Two pilot discourses will be undertaken (one through each centre; i.e. UCC and Teagasc Food Research Centre, Ashtown) before commencing the actual discourses. The objective of both centres undertaking pilot discourses is to gain adequate feedback for the actual discourse process.
- Teagasc Food Research Centre, Ashtown will undertake a pilot on nanotechnology and UCC will undertake a pilot on functional foods.
- The pilots should fully replicate the actual discourses in so far as possible. In doing so, this will provide valuable feedback for the actual discourses.

Steps to be taken in preparation and undertaking of pilot discourse

- Circulate the technology summary sheets (see Appendix 1.2) and any other appropriate documents (e.g. literature on a specific technology) to the scientists via email for review.
- Schedule the pre-discourse meeting with the relevant food scientist participating in each pilot. The actual timing of the pilot discourses will depend on the scientists' availability.

- Amend the PDILQ and PDI guide, depending on the technology being discussed (see Appendix 4.8 and 4.9).
- Undertake pre-discourse consultation meeting with the scientists participating in the pilots (see relevant documents; i.e. the discourse guide included in Appendix 4.3 and the summary sheet).
- Confirm that the scientist approves of the technology summary sheet that will be distributed to citizens.
- Liaise with the scientists to finalise the scenarios to be used in the pilot discourses (see Appendix 4.11).
- Purposefully recruit citizens to participate in the pilot discourses (the relevant screening questionnaire is included in Appendix 4.4)
    - In addition to meeting the screening criteria outlined in the screening questionnaire, the two citizens recruited for the pilot through each centre should also have the following characteristics: male/ female, young/ old, concerned about food/ not concerned about food.
- Schedule pilot discourses at a time that is convenient for the participants.
- Complete the pilot PDILQs and pilot discourses following the steps outlined in turn for the actual discourses.
    - In the days following the discourses, undertake the pilot PDIs with the citizens. During these PDIs, the participants should also be asked if they have any suggestions as to how the interview and discourse process could be improved.
- The audio recordings of the pilot discourse and PDIs should be reviewed by the researchers, who should document any suggested changes:
    - The researchers should summaries the key findings from the pilot PDILQs, discourses and PDIs, and then discuss these findings with the project's Principal Investigators and other research team members. The team can then decide if any amendments are needed to the proposed approach and relevant documentation.

The remaining sections of this Appendix detail the steps to be completed in preparation for, and when undertaking, the actual discourses. *These steps are also relevant to the pilot discourses.*

A: Develop summary sheets for distribution to citizens

- The researchers are to draft and circulate a summary sheet for each technology to the project team for review.
- Project PIs to provide feedback on summary sheets.
- Summary sheets are to be reviewed by a range of individuals from different socio-economic backgrounds to ensure clarity and comprehension.
- Circulate the relevant summary sheets to the scientists via email for their review in advance of the discourses.
- Finalise all summary sheets, once approved by the relevant scientist.

B: Develop the technology scenarios to be presented during the discourse

- The researchers are to draft scenarios for different potential applications of each technology, which should include a variety of different hypothetical benefits, unknowns and risks.
- Project PIs are to provide feedback on the scenarios developed for each technology.
- Following the pre-discourse preparatory meeting with the scientist, liaise with them to develop and finalise the scenarios to be used during the discourses.

C: Recruit citizens to participate

- Suitable citizens will be purposefully recruited to participate in the study through a consumer screening questionnaire in the weeks prior to undertaking the PDILQ and discourse (see relevant PDILQ (Appendix 4.8) and Discourse Guide (Appendix 4.3).
- There will be seven groups of citizens, each discussing a different technology. A minimum of five participants will be recruited for each technology group. Responsibility for participant recruitment and organising and undertaking the discourses will be shared equally between UCC and Teagasc Food Research Centre, Ashtown, on the basis of the technology in question and scientists' location.
- The citizens participating in each discourse group (who will be discussing a specific technology) will be selected based on pre-defined inclusion/ exclusion criteria and quota allocations derived from a screening questionnaire (see Appendix 4.4).
- Citizens will be excluded from the study if:
    - they have participated in a survey/ focus group in the last six months;
    - they are employed within food marketing, research or product development areas, or a scientist by profession;
    - they are not directly involved in the food purchase decisions of their household; and,
    - they score poorly (less than 18) on a measure of how they interact with others.
- Citizens who meet these screening criteria will also have to meet pre-defined quota allocations in order to be invited to participate in the study. These quota allocations are based on the following groups: gender, age and subjective knowledge and concerns about how food is produced. Citizens participating in each technology specific group will also be dispersed across the following variables: with or without children; level of education and occupation. Citizens discussing each technology will display similar characteristics to those discussing other technologies, to allow for some comparative analysis.
- Citizens will be given a monetary incentive of a €50 payment (UCC) or voucher (TFRC, Ashtown) to participate in the study. This incentive will only be distributed to participants who complete all three stages of the

process (the PDILQ, the discourse and the PDI). Citizens will be informed of this monetary incentive/ voucher and the terms and conditions during the distribution of the screening questionnaire, in an effort to incentivise them to participate in the study.

- If the citizen meets the screening criteria and is willing to take part in the discourse, provide them with your contact details and ask them for their contact details.
- The researchers are to liaise with the project PIs to update them of progress and any issues arising during the recruitment stage.

D: Complete PDILQ with Citizen Participants

- Each participating citizen will complete a PDILQ with the researcher prior to participating in the discourse, which should take approximately 10 minutes to complete (see relevant PDILQ in Appendix 4.8).
    - These questionnaires will establish citizens' attitudes towards food in general and specific novel food technologies, prior to their participation in the discourse.
- Participants responses to the open ended questions included as part of the interviewer-led questionnaire should be audio recorded using a dictaphone for transcription purposes.
    - Note: The discourse and PDI with each participant will also be audio recorded (for transcription purposes) by a commercial transcription service provider, if both participants agree to such a method of recording (see relevant consent form in Appendix 4.7).
- The researcher may have to amend the PDILQ depending on the technology being discussed (i.e. the questions on nutrigenomics and PNPs will have to be slightly adapted, given their distance from market at present).
- Before commencing the PDILQ, an Informed Consent Form is to be distributed to the citizen for their review. The researcher should only proceed with administering the PDILQ once the citizen has carefully reviewed and signed this form.
- The citizen will not be informed of the technology that they will be discussing in advance of completing the PDILQ, to control for proactive information seeking about the specific technology.
- The process should take the following format:
    - Thank the citizen for their participation in the project.
    - Briefly outline the purpose of the project.
    - Pose the questions included in the questionnaire and note/ record responses to the open- and close-ended questions included.
    - Briefly outline their role within the discourse. Remind the citizen that the exchange should be a two-way process, and that the scientist has not engaged in this type of interaction before. Reiterative to the citizen that they are not expected to be familiar with the technologies in advance of the discourse.

- At the end of the completion of the interviewer-led questionnaire, give the citizen the brief summary sheet of the specific technology that they will be discussing (the relevant summary sheets are included in Appendix 1.2). The citizen will be given ten minutes to read and reflect on the information provided. They will be given a pen and paper to write down any questions or queries that they may wish to pose to the scientist about the technology.
- Immediately after this review period, the citizen will participate in the discourse.

Check Lists for Completion of PDILQ with Citizens

- The dictaphone (for recording purposes).
- The relevant Consent Form for signing by the participant.
- Two copies of the relevant interviewer-led questionnaire.
- The relevant technology summary sheet.
- A sheet of paper with the researcher's contact details for distribution.

E: Prepare for and complete the Deliberative Discourses

- The deliberative discourse (one-to-one conversation) will involve the scientist and citizen discussing a specific NFT. During the discourse, the scientist will be able to clarify and build on the information presented in the summary sheet. In other words, participants will consider the initial information provided and question the scientist about this information, and then the scientist will add information that the participants will react to and reflect upon.
- The citizens' and scientists' participation in the discourse will be treated in a confidential and anonymous manner.
- The discourse will be audio recorded, if the participants are agreeable, and later transcribed.
- Each discourse will last approx. 1 hour.
- The researcher will attend the discourse in a purely observatory capacity, and should only engage with the participants at the commencement and conclusion of the exchange.

The objectives of the discourses

The overall objective of the discourse process is to form an in-depth understanding of citizens' attitude formation and information processing around the specific technology.

The specific objectives of the discourse are to:

- To explore the factors influencing citizens' attitudes around these technologies.
- Assess how citizens process information about these technologies, and how such information influences their evaluations.

Scheduling the discourses

- Schedule the discourses at a time that is convenient for both the food scientist and citizen:
    - Contact the scientist via phone/ email to confirm when they would be available to participate in the discourses.
    - Contact the relevant citizens via phone to confirm their availability to participate in the discourse on the dates and times during which the scientist is available. Confirm that they are agreeable to the discourse to be audio recorded (they will need to sign the consent form in advance of completing the PDILQ to give their official consent).
    - Revert back to the scientists to confirm which dates the discourses will take place on. Send them the names of the participating citizens and the time that they will meet each citizen at.
- The actual conducting of discourses may depend on the scientist, i.e. some will spread the process over a number of weeks, whereas others may prefer to complete them over a number of days.

Steps to be undertaken during the discourses

- Bring a copy of participants' names, the summary sheet and the scenarios in case the scientist does not bring a copy of these documents for themselves.
- The researcher will set up the room in advance with two chairs at right angles to each other in the middle of the room for the scientist and citizen. The researcher will be seated in the corner of the room for observation purposes.
- Upon arrival, the researcher will welcome the scientist and citizen. Before the discourse commences, the researcher will introduce the scientist and citizen to each other and recap on the purpose of the discourse. Refreshments will be provided.
- Throughout the discourse, the conversation between the scientist and citizen should be a two-way process with both parties initiating discussion, posing questions and reacting to the perspectives expressed.
    - The scientist will have been advised to encourage the citizen to 'open up' and communicate freely during the exchange, as otherwise they may simply listen to the information presented and provide little feedback in terms of their reactions.
- The steps to be taken during the discourse will have been outlined to the scientist within the Discourse Guide (see Appendix 4.3). This guide is designed to ensure a similar structure and context to each discourse to allow for comparative analysis. The steps in the guide are designed to be sequential in nature, but the specific content of each step may vary, depending on citizens' responses and the technology discussed.
- The researcher is to document their observations during the deliberative discourse, particularly their observations of the views, attitudes and

reactions of participants. These observational field notes will be a useful data source for analytic purposes.

- The scientist will commence the discourse by briefly introducing themselves, by presenting the citizen with a brief description of where they work and what their job entails.
- The citizen will then be asked by the scientist to introduce themselves, as part of this brief ‘warm-up’ stage of the discourse.
- The scientist will then outline their research background and its relevance to the specific technology (without going into too much scientific detail).
- The scientist will ask the participant about their current level of awareness and knowledge of the technology, and the sources from which they acquired any such information.
- Building on the information contained in this summary sheet (which the citizen will have a copy of), the scientist will present further details of the technology. This should include a description of what the technology involves, how it originated and a description of how the technological process actually works and the science involved, using language that the citizen can easily relate to.
- The scientist will then present scenarios of different applications of the technology, which include a variety of different benefits, known and unknown negative aspects and possible risks. The scientist should advise the participant that they will be given the opportunity to express their views and ask questions following the presentation of each part of the scenario.
- The scientist should reiterate to the citizen that the scenarios presented are hypothetical and not representative of food products currently for sale on the Irish market.
- The scientist should encourage the citizen to respond to the information presented in terms of: their level of understanding; their attitude towards the technology; and, their evaluations of its applications with the contexts specified.
- The information presented to citizens will vary depending on the technology discussed, as the scope and context of each technology will differ.
- Each participating citizen may broach different topics and issues depending on their personal characteristics, the technology in question and their attitude towards the information.
- Before concluding the discourse, the scientist should encourage the citizen to voice any additional views that they may have, in light of the information presented.
- The discourse will conclude with the researcher thanking both the scientist and citizen for their participation and informing them that the researcher will be in contact to schedule the post-discourse interviews.
- The researchers should update the project Principal Investigators as to how the discourses are progressing and any issues arising.

F: Complete the PDI with citizens

- The researcher should schedule and undertake a PDI with the participating citizens, to take place in the days/ weeks following the discourse (the relevant post-discourse interview guide is included in Appendix 4.9).
    - The purpose of these interviews is to further explore participants' attitudes towards the technology after participating in the discourse. These interviews will also establish citizens' views on engaging in the discourse process, i.e. whether they felt they could comfortably express their opinion to the scientist.
- These interviews should be audio recorded and later transcribed, and should last approx. 30 minutes.
- The researcher may have to amend the PDI guide slightly depending on the technology being discussed.
- This interview may take place at the participant's home or at the relevant research centre.
- The interview should take the following format:
    - Thank the citizen for their participation in the project.
    - Pose the questions included in the citizen PDI guide.
    - Give the participant the monetary incentive (payment or voucher for €50) which is subject to them completing all three stages of data collection. Ask them to sign a form to acknowledge receipt of same.
    - Inform the citizen that the research team may need to contact them again should they have any queries regarding this interview or the discourse they completed.
    - Provide the researcher's contact details, in case the participant has any queries about the project or their involvement in it.

G: Complete data analysis

- Each discourse and interview recording will be transcribed by a transcription company.
- Detailed thematic analysis will be undertaken with the aid of a computer assisted qualitative analytical package (NVivo10).
- Analysis will be undertaken at the technology specific and technology group levels.
- Further details on the analytic approach are presented in Section 4.7.

<u>Appendix 4.3:</u> Discourse Guide for Participating Scientists

The Objectives of the Discourse

The overall objective of the discourse is to form an in-depth understanding of citizens' evaluations of novel food technologies (NFTs).
The specific objectives of the discourse are to:

- Establish citizens' attitudes towards the technology and explore the factors influencing their evaluations of it.
- Assess how citizens process information about NFTs, and how such information influences their evaluations.

How the Discourse will proceed

The researcher will attend the discourse, in an observatory capacity. Each discourse will be audio recorded (subject to your permission) and transcribed. The scientist's participation in the discourse will be treated in a confidential and anonymous manner.

The researcher will set up the room in advance with two chairs at right angles to each other in the middle of the room for the scientist and citizen. The researcher will be seated in the corner of the room for observation purposes. Upon arrival, the researcher will welcome the scientist and citizen. Before the discourse commences, the researcher will introduce the scientist and citizen to each other and recap on the purpose of the discourse. Refreshments will be provided.

The Discourse Guide is designed to ensure a similar structure and context to each discourse, to allow for comparative analysis. The steps in the guide are designed to be sequential in nature, but the specific content of each step may vary, depending on participants' responses and questions posed, and the technology discussed.

Step-by-Step Guide for Scientists during the Discourse

Throughout the discourse, the conversation between the scientist and participant should be a two-way process, with both parties initiating discussion, posing questions and reacting to the viewpoints expressed by the other party. You may wish to reiterate these points before commencing the discourse.

- You may need to encourage the participant to 'open up' and communicate freely in the discussion, as otherwise they may simply listen to the information presented and provide little feedback in terms of their attitudes.

- It may be useful to mention that you have not participated in this type of process either before (to ease any apprehensions they may have about participating in this conversation).
- An objective of this project is to establish participants' attitudes towards the specific technology discussed and the determining factors impacting their attitudes. If participants are not readily communicating their attitudes and reactions to the information presented, you may wish to pose some of the following questions:
    - How do you feel about what I have just said, and what is causing you to feel this way?
    - Do you think there are any issues that I am overlooking?
    - What is your perspective on this matter?
- Commence the discourse by briefly introducing yourself, stating your name and a brief description of where you work and what your job entails.
- Invite the participant to introduce themselves, as part of this brief warm-up discussion. Ensure the participant feels at ease and comfortable to engage in the discourse. To this end, reiterate some of the points highlighted above, if necessary.
- Outline your research background and its relevance to the specific technology (without going into too much scientific detail).
- Ask the participant about their current level of awareness of the technology and the sources from which they acquired any such information.
    - The participant will only be informed of which technology they will be discussing 10 minutes prior to commencing the discourse, so they will not have had time to research the technology in advance.
- The participant will have been provided with the factual summary sheet of the technology for review 10 minutes prior to the discourse. Building on the information contained in this summary sheet, which you will have a copy of, present the participant with further details of the technology.
    - Describe what the technology involves and how it originated.
    - Describe how the technological process actually works and the science involved, using language that the participant can easily relate to. Ask the participant if they understand the process explained. Reiterate the explanation of the technological process if necessary.
- Present the pre-defined scenarios of different applications of the technology, which include a variety of different benefits, known and unknown negative aspects and possible risks. Advise the participant

that they will be given the opportunity to express their views and ask questions following the presentation of each aspect of each scenario. Probe the participant to establish their attitudes towards the different scenarios presented and the factors influencing their attitudes.

- Ensure the participant communicates their attitude towards these scenarios.
  - Ideally, the same scenarios should be presented to the participants that you engage with, to examine whether their attitudes towards them differs.
  - The scenarios presented will build upon each other as part of an iterative process (i.e. starting with a straight-forward definable benefit and building upon this scenario, adding additional benefits, followed by known risks and unknown risks.
  - The participants should be probed at each stage of scenario expansion to record their perspectives and any change in their attitude(s), in light of the additional information.
  - The scenarios will be most effective when they are developed in advance, based on a scenario template. Therefore, if you are in agreement, the researcher will liaise with you, in person or via email, to compose and finalise the scenarios to present during the discourses.
- Reiterate to the citizen that the scenarios presented are hypothetical and may not be representative of current offerings on the Irish market.
- If relevant, outline any outstanding benefits or risks that may relate to different applications of the technology, i.e. which are not included in the scenarios presented.
- Before concluding the discourse, encourage the participant to voice any additional views that they may have on the technology.
- The discourse will conclude with the researcher thanking both the scientist and citizen for their participation.

Key Points of Relevance throughout the Discourse

- At each stage of the discourse, encourage the participant to pose questions and express their views and any concerns that they may have, in light of the information presented.
- Throughout the discourse, please ensure that you use language and terminology that the participant can easily comprehend. You will engage in discourses with citizens who will all have different levels of understanding of scientific and technical language and terminology.
- Each participating citizen may broach different topics and issues depending on their background, experience and attitude towards the information presented.

Information that will be provided to the Scientists in advance of the Discourse:

- The technology summary sheet that will be distributed to citizens prior to participating in the discourse.
- The finalised version of the scenarios to present during the discourse.

Appendix 4.4: Screening Questionnaire for Citizens

Note: Preamble included in this version

I *Grainne Greehy* am currently involved in a research project in UCC, which is examining public acceptance of novel food technologies. We are interested in your attitudes towards food and food processing. As part of this research, I would really appreciate if you would take the time to complete this questionnaire.

The questionnaire is very brief and will only take a few minutes to complete.

Your responses will be treated in a confidential and anonymous manner.

Q1. Have you participated in a consumer survey/focus group in the last six months?

Yes ☐ ***No*** ☐

If respondent answers 'Yes' do not proceed with survey

Q2. Are you employed as a scientist or within food marketing, research or product development areas?

Yes ☐ ***No*** ☐

If respondent answers 'Yes' do not proceed with survey

Q3. With regard to food shopping for the household; are you mainly responsible, jointly responsible with someone else or is someone else responsible[41]?

Mainly Responsible ☐
Jointly Responsible with Someone Else ☐
Someone else is Responsible ☐

If respondent answers 'Someone else is Responsible' do not proceed with survey

41 If you are living in shared accommodation, please indicate your responsibility for your own food shopping.

Q4. The following are a series of statements concerning attitudes towards food production. Please indicate how much you agree or disagree with each statement where (1) is disagree strongly and (7) is agree strongly.

	Disagree Strongly	Disagree Moderately	Disagree Slightly	Neither Disagree nor Agree	Agree Slightly	Agree Moderately	Agree Strongly
I have a good understanding of how food is produced.	1	2	3	4	5	6	7
I worry about how food is produced.	1	2	3	4	5	6	7
I am suspicious of food products that promise additional health benefits.	1	2	3	4	5	6	7
I seek out food products that have natural ingredients.	1	2	3	4	5	6	7
I seek out organic food products.	1	2	3	4	5	6	7

Provide the participant with the relevant Show Card (attached)

Q5. The following are a series of statements concerning how you believe you interact with others. Please indicate how much you agree or disagree with each statement where (1) is disagree strongly and (7) is agree strongly.

	Disagree Strongly	Disagree Moderately	Disagree Slightly	Neither Disagree or Agree	Agree Slightly	Agree Moderately	Agree Strongly
It does not bother me to have to enter a room where other people have already gathered and are talking.	1	2	3	4	5	6	7
When meeting a professional for the first time, my initial reaction is always one of shyness (Reverse Score).	1	2	3	4	5	6	7
When in a group, I very rarely express an opinion (Reverse Score).	1	2	3	4	5	6	7
I am rarely at a loss for words when I am introduced to someone I do not know.	1	2	3	4	5	6	7

Provide the participant with the relevant Show Card (attached)

Proceed with survey if the respondent scores 16 or more overall on Q5

Q6. Please indicate which of the following age categories corresponds to your age group *(Read age categories to the participant).*

18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65+ ☐

Q7. Which of these categories refers to your marital status?
(Read marital status categories to the participant).

Single ☐ Married / Cohabiting ☐ Separated / Divorced ☐ Widowed ☐

Q8. Do you have any children who are under the age of 16 who live with you full-time?

Yes ☐ No ☐

Q9. What is the highest level of education that you have completed to date?
(Tick box based on participant's response).

No Formal Education	☐
Primary Inter / Junior Cert	☐
Leaving Certificate	☐
Third Level Certificate or Diploma	☐
Third Level Degree	☐
Postgraduate Qualification	☐

Q10. What is your current occupational status?

At work	☐	Go to Q11
Not currently in employment	☐	
Retired	☐	
Homemaker	☐	Go to Q12
Student	☐	

Q11 Please state your current occupation or your occupation before becoming unemployed/ retired: ________________

Q12. What is the current occupational status of your spouse (where applicable)?

At work	☐	Go to Q13
Not currently in employment	☐	
Retired	☐	
Homemaker	☐	Go to Q14
Student	☐	

Q13. Please state the current occupation, or occupation before becoming unemployed/ retired, of your spouse/ partner: _________________

Please read the following:

We are interested in establishing people's attitudes towards new food processes. As part of this research, we are inviting citizens to take part in a one-to-one conversation with a food scientist who is researching a specific new food process/ technology. During this conversation, the food scientist will explain the technology to you. You would then be given the opportunity to ask the scientist any questions and queries that you may have about the technology. Participants are not expected to be familiar with the specific technology in advance of participating in the conversation. In most instances, it is expected that they will not be familiar with the technology. However, citizens are expected to take part in a discussion with the scientist by asking questions and reacting to the information relayed by the scientist.

The conversation with the scientist will last approx. one hour. A member of the research team will observe the conversation. Each participant will complete a questionnaire, prior to the conversation with the scientist. In the days/ weeks following the conversation with the food scientist, the researcher will complete a debriefing interview with each participant (lasting 30 minutes). The entire complete process will take under two hours to complete.

Citizens who participate in the study will be given monetary compensation (€50) for their time spent on and participation in this process. This incentive will be given to citizens once they have completed the three stages of the process; i.e. the pre-discourse led questionnaire, the discourse with the food scientist and the post-discourse interview.

Over the next few weeks we will be organising these discourses between citizens and food scientists. We may wish to call upon you to partake in such a conversation. This would take place at UCC (or list other location).

Q14. Are you willing to take part in such an interaction?

Yes □ ***No*** □

If respondent answers 'No' do not review 'second level' screening criteria

If the participant is willing to take part in such an interaction, provide them with your contact details and ask them for the following information:

Name: ______________________ Phone number: _________

Many thanks for completing this questionnaire

<u>Show Card</u>

Show Card for Questions 4 and 5

For the following series of statements that I will read out, please indicate your level of agreement, where (1) is disagree strongly and (7) is agree strongly.

<u>Level of Agreement</u>	**<u>Representative Number</u>**
Disagree Strongly	**1**
Disagree Moderately	**2**
Disagree Slightly	**3**
Neither Disagree nor Agree	**4**
Agree Slightly	**5**
Agree Moderately	**6**
Agree Strongly	**7**

Appendix 4.5: Socio-economic Profile of Participating Citizens

Novel Food Technology and Relevant Group	Code Name for Participant	Gender	Age	Marital Status	Children under the age of 16	Level of Education	Occupational Status	Occupation (currently or before retiring or becoming unemployed)	Occupational Status of Spouse	Occupation of Spouse (currently or before retiring or becoming unemployed)
Genetic Modification (ECG)	**GM1**	Female	18-24	Single	No	3rd Level Degree	At work	Nurse	N/A	N/A
	GM2	Male	35-44	Co-habiting	No	Postgrad Qual.	Not currently in employment	Music Teacher	At work	Social Worker
	GM3	Female	55-64	Married	No	3rd Level Cert or Diploma	At work	Part-time Book Keeper	At work - self employed	Accountant
	GM4	Female	35-44	Separated/ Divorced	Yes	Hairdressing Course (Leaving Cert not completed)	Not currently in employment	Care Assistant Nurse Aid	N/A	N/A
	GM5	Male	25-34	Married	No	Postgrad Qual.	At work	Accountant	At work	Banker
Nanotech (ECG)	**Nano1**	Male	25-34	Single	No	3rd Level Degree	At work	Bar Worker	N/A	N/A
	Nano2	Female	18-24	Single	No	3rd Level Cert or Diploma	Student	N/A	N/A	N/A
	Nano3	Female	55-64	Widowed	No*	Postgrad Qual.	Retired	Senior Management VEC Adult Education	N/A	N/A
	Nano4	Female	35-44	Married	No	Postgrad Qual.	At work	Primary School Teacher	At work	Technician
	Nano5	Male	35-44	Married	Yes	Leaving Cert	At work	Carpenter	At work	Special Needs Assistant
	Nano6	Female	45-54	Married	Yes	3rd Level Degree	Homemaker	Pharmaceuticals	At work	Sales
	Nano7	Female	25-34	Single	No	3rd Level Degree	At work	Leisure attendant (gym)	N/A	N/A
Food Irradiation (ECG)	**Irrad1**	Female	25-34	Co-habiting	No	3rd Level Degree	At work	Care Assistant	At work	Gardner
	Irrad2	Female	45-54	Married	No*	3rd Level Degree	Not currently in employment	Administrator in the Voluntary Sector	At work	HR Manager
	Irrad3	Male	25-34	Single	No	3rd Level Degree	At work	Accountant	N/A	N/A
	Irrad4	Female	55-64	Married	No*	No Formal Secondary Education	Homemaker	Homemaker	At work	Taxi Driver
	Irrad5	Male	35-44	Single	No	Leaving Cert	At work	Off-License Manager	N/A	N/A

Novel Food Technology	Code Name for Participant	Gender	Age	Marital Status	Children under the age of 16	Level of Education	Occupational Status	Occupation (currently or before retiring or becoming unemployed)	Occupational Status of Spouse	Occupation of Spouse (currently or before retiring or becoming unemployed)
Thermal Technologies (BNG)	**Therm1**	Male	25-34	Co-habiting	No	3rd Level Degree	At work	Office Administrator	At work	Social Care Worker
	Therm2	Female	18-24	Single	Yes (1)	Leaving Cert	Student	Part-time Shop Worker	N/A	N/A
	Therm3	Female	35-44	Co-habiting	No	Post Graduate	At work	Gym Manager	At work	Garda
	Therm4	Female	55-64	Married	No	Post Graduate	At work	English Teacher	At work	Scientist
	Therm5	Male	35-44	Married	Yes (1)	3rd Level Degree	Student (Post Grad)	Part-time Assistant in Sports Centre	At work	Sports Centre Worker
Non-Thermal Technologies (BNG)	**Non-Therm1**	Male	25-34	Single	No	3rd Level Degree	At work	Office Administrator	N/A	N/A
	Non-Therm2	Female	45-54	Separated	Yes (1)	Post Graduate	At work	Senior Office Manager	N/A	N/A
	Non-Therm3	Female	55-64	Married	No	Primary	At work (part-time)/ Homemaker	Restaurant Cashier	At work	Charity fundraiser
	Non-Therm4	Male	45-54	Widowed	No	Primary	At work	Bar Manager	N/A	N/A
	Non-Therm5	Female	18-24	Single	No	Leaving Cert	At works (part-time)/ Student	Part-time Bar Worker	N/A	N/A

Novel Food Technology	Code Name for Participant	Gender	Age	Marital Status	Children under the age of 16	Level of Education	Occupational Status	Occupation (currently or before retiring or becoming unemployed)	Occupational Status of Spouse	Occupation of Spouse (currently or before retiring or becoming unemployed)
Functional Foods (PSOG)	**FF1**	Female	35-44	Married	Yes (2)	3rd Level Degree	At work (part-time)/ Homemaker	Accountant	At work	Financial Director
	FF2	Male	45-54	Married	Yes (2)	3rd Level Degree	At work	Civil Servant	At work	Insurance sales
	FF3	Female	55-64	Married	No	3rd Level Degree	At work	Nurse	At work	Civil Servant
	FF4	Female	18-24	Single	No	Leaving Cert	Student	N/A	N/A	N/A
	FF5	Male	18-24	Single	No	Leaving Cert	At work	Retail	N/A	N/A
	FF6	Female	18-24	Single	No	Secondary School	At works (part-time)/ Student	Shop Assistant/ Medicine Student	N/A	N/A
	FF7	Male	65+	Married	No	Inter (Junior) Cert	Retired	Business Man/ Carpenter	At work	B&B owner
	FF8	Female	45-54	Married	No*	3rd Level Cert or Diploma	At work	Special Needs Assistant	At work	Caretaker in a School
	FF9	Male	18-24	Single	No	3rd Level Cert or Diploma	Not currently in employment	Mechanic	N/A	N/A
	FF10	Female	55-64	Married	No	3rd Level Degree	Retired	Teacher	Retired	Teacher
Nutrigenomics & PNPs (PSOG)	**Nut/PNPs1**	Female	35-44	Married	Yes	3rd Level Cert or Diploma	At work	Hairdressing Teacher	Not currently employed	Electrician
	Nut/PNPs2	Female	55-64	Married	No*	3rd Level Cert or Diploma	At work (part-time)/ Homemaker	Part-time Artist	At work	Press Photographer
	Nut/PNPs3	Male	45-54	Married	Yes	Leaving Cert	At work (part-time)	Part-time Bar Worker	Homemaker/ Student	
	Nut4/PNPs4	Male	25-34	Co-habiting	No	3rd Level Degree	At work	Trainee Accountant	At work	Retail/Bar Worker
	Nut5/PNPs5	Female	18-24	Single	No	3rd Level Degree	At work	Nurse	N/A	N/A

** However, they have children over 18 that they food shop and cook for.*

<u>Appendix 4.6:</u> Ethics Application Form to Undertake Research (Submitted to UCC Social Research Ethics Committee)

UCC Social Research Ethics Committee (SREC) Ethics Approval Form

Name of applicant	Gráinne Greehy/ Dr. Mary McCarthy Date	12th February 2010
Department/Unit	Food Business and Development	
Title of project	An in-depth investigation of Irish consumer acceptability of novel food technologies	

		YES	NO
1	Do you consider that this project has significant ethical implications?		X
2	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	X	
3	Will participation be voluntary?	X	
4	Will you obtain informed consent in writing from participants?	X	
5	Will you tell participants that they may withdraw from the research at any time and for any reason, and (where relevant) omit questionnaire items to which they do not wish to respond?	X	
6	Will data be treated with full confidentiality / anonymity (as appropriate)?	X	
7	If results are published, will anonymity be maintained and participants not identified?	X	
8	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	X	
9	Will your project involve deliberately misleading participants in any way?		X
10	Will your participants include schoolchildren (under 18 years of age)?		X
11	Will your participants include people with learning or communication difficulties?		X
12	Will your participants include patients?		X
13	Will your participants include people in custody?		X
14	Will your participants include people engaged in illegal activities (e.g. drug taking; illegal Internet behaviour)?		X
15	Is there a realistic risk of participants experiencing either physical or psychological distress?		X
16	If yes to 15, has a proposed procedure, including the name of a contact person, been given? (see no 23)		

DESCRIPTION OF THE PROJECT

17. Aims of the project

Researchers from University College Cork and Ashtown Food Research Centre, Teagasc are currently undertaking a research project funded by the Department of Agriculture, Fisheries and Food, to examine consumer/ citizen acceptance of novel food technologies.[42] Key issues that this research proposes to investigate include the extent to which: consumer/ citizen acceptance is determined by personal versus societal benefits; consumer/ citizen risk perceptions and risk-benefit trade-offs; the influence of information on acceptance; and, the evolution of consumers'/ citizens' perceptions on and attitudes towards novel food technologies.

A deliberative discourse (one-to-one conversation) approach will be taken, which will involve food scientists and citizens discussing specific novel food technologies (NFTs). Through the discourse we hope to gain a deeper understanding of citizens' attitudes towards NFTs. The specific objectives of the discourse are as follows:

- To establish citizens' attitudes towards NFTs and the determining factors influencing their attitudes.
- To assess the influence of new information on citizen acceptance of NFTs.

18. Brief description and justification of methods and measures to be used (attach copy of questionnaire / interview protocol / discussion guide / etc.)

This qualitative investigation will comprise of a deliberative discourse and in-depth interviews. Detailed thematic analysis will be undertaken on the qualitative data with the aid of a computer assisted qualitative analytical package. The research will involve three interactions with citizens: completion of a pre-discourse interviewer-led questionnaire, the deliberative discourse and post-discourse interviews.

In the weeks prior to commencing the discourse sessions, the food scientists will be consulted to provide training and briefing material (a Discourse Guide included in Appendix 4.3) in advance of participating in the discourse.

---

42 The field researchers from UCC and Teagasc Food Research Centre, Ashtwon are Gráinne Greehy and Dr. Emma Dillon respectively.

Citizens will be recruited to participate in the study through a screening questionnaire (attached). Citizens participating in the discourse will complete a pre-discourse interviewer-led questionnaire (see Appendix 4.8), which will establish citizens' awareness of and attitudes towards specific NFTs, prior to their participation in the discourse. Citizens will be given a brief summary sheet of the specific technology that they will be discussing to read prior to participating in the discourse. Citizens are not expected to be familiar with the technologies in advance of the discourse. They will participate in the discourse immediately after this interview.

The deliberative discourse will involve the food scientist explaining a NFT to the citizen. During the discourse, the citizen will have the opportunity to question the scientist on any aspect of the technology that they have concerns, or are unclear, about. The field researcher will observe the discourse. Each discourse will last approx. one hour. A pilot discourse will be undertaken through each centre (UCC and Teagasc Food Research Centre, Ashtown) before commencing the discourse sessions.

In the weeks following the discourse, the citizens will complete a post-discourse interview; lasting approx. 30 minutes (see Appendix 4.9 for post-discourse interview guide). These interviews will further explore citizens' attitudes towards the specific food technology having participated in the discourse. The post-discourse interviews will be audio recorded and transcribed.

19. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria

Up to seven NFTs will be included in this research project[43]. Seven food scientists (one per technology) will participate and each scientist will engage in a minimum of five discourse sessions with five different citizens. Approximately forty citizens will participate in the study. Responsibility for participant recruitment and organising and undertaking the discourse sessions will be shared equally between UCC and Teagasc Food Research Centre, Ashtown.

43 The seven technologies currently proposed to be included are: Genetic Modification, Nanotechnology, Food Irradiation, Thermal Technologies (Radio Frequency Heating and Ohmic Heating), Non-thermal Technologies, Functional Foods and Nutrigenomics and Personal Nutrition Products.

The five citizens participating in each technology specific group will be selected based on pre-defined inclusion/ exclusion criteria and quota allocations derived from a screening questionnaire (included in Appendix 4.4). Citizens will be excluded from the study if:

- they have participated in a survey/ focus group in the last six months.
- they are employed within food marketing, research or product development areas or as a scientist.
- they are not directly involved in the food purchase decisions of their household.

Citizens who meet these screening criteria will also have to meet pre-defined quota allocations before being invited to participate in the study. These quota allocations are based on the following groups: gender, age and subjective knowledge and concerns about how food is produced. Citizens participating in each technology specific group will also be dispersed across the following variables: with or without children; level of education and occupation. Citizens discussing each technology will display similar characteristics to those discussing other technologies, to allow for some comparative analysis across technologies.

Citizens will be given a monetary incentive (€50) to participate in all aspects of the study. This incentive will only be distributed to citizens who complete the three stages of the process (the pre-discourse interviewer-led questionnaire, the deliberative discourse and the post-discourse interview). Citizens will be informed of this monetary reward and the terms and conditions during the distribution of the screening questionnaire, in an effort to incentivise them to participate in the entire study.

Scientists will be selected based on their expertise in terms of the selected NFTs, their availability and their proximity to the relevant centres.

Each participant will be assigned a unique code and a code sheet will be held in a secure location, to ensure that confidentiality is maintained.

20. Concise statement of ethical issues raised by the project and how you intend to deal with them

No ethical issues are expected to arise during this research. The researcher will be in attendance in an observatory capacity during the discourse between the scientist and citizen, to ensure that participants feel at ease during the process and that no ethical issues arise. The researcher will also describe the discourse process to all participants in advance of the discourse to ensure that they know what to expect. Participants will be asked if they have any concerns in advance of the discourse. Finally, the scientists will be provided with training and briefing material to ensure that they can deal with any issues that might arise during the discourse. The pilot discourse sessions will also confirm that there are no ethical issues arising during the discourse.

21. Arrangements for informing participants about the nature of the study (cf. Question 3)

Citizens will be informed of the purpose of the study at the recruitment stage, during the distribution of the screening questionnaire. The purpose of the study will be reiterated to selected citizens when they are contacted to arrange a time to undertake the discourse. Finally when citizens are completing the pre-discourse interviewer-led questionnaire, the researcher will once again outline the purpose of the study.

Once the appropriate scientists have been selected to participate in the study, the Principal Investigator in the relevant centre (UCC or Teagasc Food Research Centre) will contact the scientist by formal letter to invite them to participate in this research. This letter will outline the purpose of the study. The scientists who agree to participate in the study will meet with the researcher before participating in the discourses, during which time the purpose of the study will be once again outlined.

22. How you will obtain Informed Consent - cf. Question 4 (attach relevant form[s])

Before commencing the pre-discourse interviews, Informed Consent forms will be distributed to the citizens (included in Appendix 4.7). These forms also outline the purpose of the study. The researcher will only proceed with administering the pre-discourse interviewer-led questionnaire once the citizen has carefully reviewed and signed the relevant Informed Consent form.

23. Outline of debriefing process (cf. Question 8). If you answered YES to Question 15, give details here. State what you will advise participants to do if they should experience problems (e.g. who to contact for help).

Each citizen will take part in a post-discourse interview with the researcher. During this interview, participants will be given the opportunity to reflect on the discourse and raise any queries that they may have following the discourse. Participants will be given the researcher's contact details should any further issues arise.

24. Estimated start date and duration of project.

It is proposed to commence recruiting participants for the discourse in March 2010 (subject to ethical approval) and to schedule the discourse sessions for April and May 2010.

Signed ______________________________ Date **___________________**

Signed ______________________________ Date **___________________**

<u>Appendix 4.7:</u> Informed Consent Form Participating Citizens

Information Sheet for Citizens (SIDE A)

Informed consent
You are being asked to participate in a research study. In order to decide whether or not you wish to be part of this study you should understand enough about the study to make an informed decision. This sheet gives detailed information about the research study, which will be discussed with you. Once you understand the study, you will be asked to sign the form on page 2 of this document if you wish to participate.

What is this research concerned with?
This research is part of a nationally funded research project that is investigating Irish consumer/ citizen acceptance of novel (new) food technologies. This part of the research project involves a one-to-one conversation (discourse) between citizens and food scientists about specific novel food technologies. This conversation with the food scientist will provide you with the opportunity to discuss your views and perspectives on food processing and technology. Yours views are important to this study and will be combined with those of other participants.

What will the study involve?
The study will involve completion of a brief interviewer-led questionnaire (which will take approx. 10 minutes). After this, you will be given a brief summary sheet of a novel food technology, which you will not be expected to be familiar with. After reading this summary sheet, you will participate in a conversation (discourse) with the food scientist (lasting approx. one hour) about the technology. You will be asked to participate in a debriefing interview with the researcher in the days/ weeks following the discourse (lasting approx. 30 minutes). The interviews and discourse will be audio recorded and later transcribed.

Do you have to take part?
No, participation is completely voluntary. You can withdraw from the study at any stage. You are free to pass on any questions, take a break, or end the discourse/ interviews at any time. In the two weeks following the debriefing interview, if you wish to withdraw any information, please contact the researcher.

Will your participation in the study be kept confidential?
Yes. Your name or identifying information will not appear on any document relating to this discussion. None of the results from this study will be presented in any way that can be associated with you. All quotations from the research will be entirely anonymous.

What will happen to the information which you give?
All audio-recordings, notes and transcripts will be kept in a secure environment, accessed only by the research team.

What will happen to the results?
The findings will be presented in a research report and thesis. The study may be published in an academic journal.

What are the possible disadvantages of taking part?
No negative consequences of taking part are expected. The researcher will be in attendance in an observatory capacity during the conversation with the food scientist and will ensure that you feel at ease during the process. The researcher will also describe the discourse process to you in detail in advance of participating, to ensure that you know what to expect during the process.

Who has reviewed this study? The UCC Social Research Ethics Committee has given approval for this research study to take place.

Any further queries? If you have any questions or queries relating to this study, please contact Gráinne Greehy in UCC at (021) 4205212.

Information Sheet for Citizens (SIDE B)

Consent Form to Participate in the Interviews with the Project Researcher and Discourse (Conversation) with a Scientist

If you agree to take part in the study, please sign the consent form below.

I……………………………………(BLOCK CAPITALS) agree to participate in the interviews with Gráinne Greehy and the discourse with the food scientist as part of the research project on citizen/consumer acceptance of novel food technologies.

- The purpose and nature of the study has been explained to me in writing and I understand it.
- I am participating voluntarily.
- I give permission for my interviews with the researcher to be audio-recorded.
- I understand that I can withdraw from the study, without repercussions, at any time, whether before it starts or while I am participating.
- I understand that I can withdraw permission to use the data within two weeks of the debriefing interview, in which case the material will be deleted.
- I understand that anonymity will be ensured in the write-up by disguising my identity.
- I understand that disguised extracts from my interview may be quoted in the research report and any subsequent publications if I give permission below:

Please tick one box:
I agree to quotation/ publication of extracts from my interviews/ conversations ☐
I do not agree to quotation/ publication of extracts from my interviews/ conversations ☐

Please tick one box:
I give permission for my conversation with the scientist to be audio-recorded ☐
I give permission for my conversation with the scientist to be audio-recorded only ☐

Signed……………………………………. Date……………….

Appendix 4.8: Pre-discourse Interviewer-led Questionnaire for Participating Citizens

Purpose of Completing the Interviewer-led Questionnaire: To establish consumers'/citizens' attitudes towards food in general and specific NFT, prior to citizens' participation in the discourse and to familiarise participants with the format that the discourse will take and clarify their role in the process, thereby ensuring they are adequately prepared to engage in it. This process will be the first time that citizens will be informed of the technology that they will be discussing during the discourse.

Only proceed with administering the interviewer-led questionnaire once the participant has signed the relevant Informed Consent Form (see Appendix 4.7). The questions posed may have to be modified slightly for each of the technologies.

Preamble: Before we commence, I would like to thank you for agreeing to participate in this research project. During this chat, I am interested in your attitude towards food in general and specific new food technologies prior to your participation in the discourse with the food scientist. As outlined in the Consent Form, confidentiality will be maintained. Your views and perspectives are important and these perspectives will be combined with those of others. Completion of this interviewer-led questionnaire should take about 10 minutes and your responses will be audio-recorded. Your involvement is completely voluntary. Feel free to end the process at any time or pass on a question. I hope you are happy to proceed. (Refreshments will be provided).

Stage 1: Pose the questions (provided on the pages overleaf) to the participant. Insert the name of the specific technology wherever [technology X] is mentioned. Refer to the Show Card when appropriate to do so.

Stage 2: Present the participant with a brief one page summary of the specific technology. Provide the participant with the following instructions: I will now leave the room for 5-10 minutes to give you the opportunity to read and reflect on the information provided. I will give you a pen and paper to write down any questions or queries that you may have and you can pose these questions to the scientist during the discourse if you wish. When I return, I will invite you to participate in the discourse with the food scientist. The discourse will last approx. one hour. I will be in attendance at the discourse in an observatory capacity. Reiterate to the participant that they are not expected to be familiar with the technology and that the conversation with the scientist is a two-way process.

Finishing Up: Thanks the participant. Outline their involvement in the next stage:

- After the discourse, I will be in contact with you to arrange a post-discourse interview with you (which will last approx. 30 minutes). This interview will take place during the days/ weeks following the discourse. Your input will be acknowledged once this final interview is completed by payment of €50 (cash or voucher).

Date:
Time:
Code:
Note: Demographic and socio-economic information, in addition to participants' involvement in their households' food purchasing decisions have already been collected in the screening questionnaire. Questions 1-3 are to be completed by the researcher based on the answers provided by the participant.

Attitude towards Food in General[44]

Q1. Please indicate how important each of the following are when you are making food purchase decisions, where (1) is very important and (5) is very unimportant. *(Complete the table based on participant's responses).*

	Very Important	Important	Neither Important nor Unimportant	Unimportant	Very Unimportant
Price	1	2	3	4	5
Safety	1	2	3	4	5
Taste	1	2	3	4	5
Organic Production	1	2	3	4	5
Fairtrade Production	1	2	3	4	5
Level of Processing	1	2	3	4	5
Produced Locally	1	2	3	4	5
Natural Ingredients	1	2	3	4	5
Health	1	2	3	4	5
Familiar Brand	1	2	3	4	5
Convenience	1	2	3	4	5
Novelty	1	2	3	4	5

Provide the participant with the relevant Show Card (attached)

44 This question was posed in the context of the FIRM project. Responses to this question are not examined within this dissertation, as the importance participants place on different product attributes in their food choice decisions was not a focus of this specific doctoral work.

Awareness and Attitude towards Novel Food Technologies[45]

Q2. Are you aware of the following novel food technologies that are used in food production/ processing? *(Complete the table based on participant's responses).*

	Yes	No
Functional Foods or Ingredients	1	2
Nanotechnology	1	2
Thermal Heating (Radio Frequency Heating and Ohmic Heating)	1	2
Non-Thermal Technologies (High Voltage Pulsed Electric Field and High-Intensity Ultra Sound)	1	2
Irradiation	1	2
Genetic Modification	1	2

Q3. Given your current level of awareness, how likely is it that you would purchase food products that have been produced/ processed using the following technologies, where (1) is very likely and (5) is very unlikely. *(Complete the table based on participant's responses).*

	Very Likely	Likely	Neither Likely nor Unlikely	Unlikely	Very Unlikely
Functional Foods or Ingredients	1	2	3	4	5
Nanotechnology	1	2	3	4	5
Thermal Heating (Radio Frequency Heating and Ohmic Heating)	1	2	3	4	5
Non-Thermal Technologies (High Voltage Pulsed Electric Field and High-Intensity Ultra Sound)	1	2	3	4	5
Irradiation	1	2	3	4	5
Genetic Modification	1	2	3	4	5

Provide the participant with the relevant Show Card (attached)

45 It was not originally within the remit of the associated FIRM project to explore citizens' perspectives towards nutrigenomics and personalised nutrition products. Therefore, awareness of this technology was only measured within this specific discourse group. In addition, likelihood to undergo nutrigenomic testing/ purchase such products was not measured for this specific technology.

Awareness and Attitude towards the Specific Food Technology - Open-ended Questions (Responses Audio Recorded and Transcribed)

Q4. Have you heard of [technology X] *(insert name of specific technology)* and if so, what have you heard about this technology? Are you familiar with any benefits or risks associated with this technology?

Q5. When you think about the word [technology X] *(insert name of specific technology)* what is the first thought or image that comes to mind? Would you say this thought or image is positive, negative, or neutral?

Q6. Given your current level of awareness of this technology, would you avoid purchasing or consuming food products that have applied this technology?

Q7. Have you any concerns in advance of engaging in the conversation with the food scientist about [technology X] *(insert name of specific technology)*?

Show Cards

Questions 1

For the following series of statements that I will read out, please indicate how important each of the following are when you are making food purchase decisions, where (1) is very important and (5) is very unimportant.

Level of Importance	Representative Number
Very Important	1
Important	2
Neither Important nor Unimportant	3
Unimportant	4
Very Unimportant	5

Questions 3

For the following series of statements that I will read out, please indicate how likely it is that you would purchase food products that have been produced/ processed using the following technologies, based on your current awareness of these technologies, where (1) is very likely and (5) is very unlikely.

Likelihoods	Representative Number
Very Likely	1
Likely	2
Neither Likely nor Unlikely	3
Unlikely	4
Very Unlikely	5

Appendix 4.9: Post-discourse Interview Guide for Participating Citizens

Purpose of the Interview: To establish citizens' perspectives on the technology after participating in the discourse and their views on engaging in the discourse process.

The content of this interview guide provides a general guide for the researcher. Questions posed may be modified throughout the interview if appropriate to do so. The questions may have to be adapted for each technology.

Preamble

Before we commence, I would like to thank you, once again, for agreeing to participate in this research project. During this conversation, I am interested in establishing your views on the technology in more detail and also your views on the discourse (conversation) undertaken with the scientist. As outlined in the consent form, confidentiality will be maintained. Your views and perspectives are important, and these will be combined with those of others. This conversation should take about 30 minutes and will be audio-recorded. Your involvement is completely voluntary. Feel free to end the interview at any time or pass on a question. During the interview, if you need to take a break that is fine, just let me know. I hope you are happy to proceed. (Refreshments will be provided if interview takes place at the relevant centre and not the participant's home).

Interview

Pose the interview questions (provided on the pages overleaf) to the participant.
Insert the name of the specific technology wherever [technology X] is mentioned.

Finishing Up

Thank them for their time. Mention that they have given very interesting insight into their perspectives on the technology and discourse undertaken, and you are conscious that you have taken up enough of their time. Inform them that you may need to contact them again, should you have any queries regarding this interview. Outline the next stage of this project.

- Give the participant the monetary incentive (€50 payment/ voucher) at the end of this interview (subject to them completing all three stages of the discourse process). Ask them to sign a form to acknowledge receipt of payment/ voucher.

Inform them that they are free to contact you if they have any queries (provide researcher's contact details).

Post-discourse Citizen Interview Guide

Date:
Time:
Code:

Awareness of Food Related Issues

- Normally, what do you want from food products when making purchase decisions?
- When shopping, do you look for variety in the food products that you purchase?
- When shopping, do you notice different food products? Do you regularly try out these different food products? How do you determine the characteristics of a different food product (i.e. that it contains certain health characteristics)?
- Outside of the shopping environment, do you pay attention to information about food and if yes, what types of communication (i.e. how to prepare food, safety risks etc.)?
- What sources of information do you normally use to inform yourself of food related issues? Have these sources provided you with any information about [technology X] *(insert name of specific technology)*?
- Do you regularly read the information provided on food labels and if so, what are your reasons for doing so?

Awareness of the Specific Food Technology

- Were you aware of [technology X] prior to the discourse? If yes, from what source(s) had you heard about the technology?

Attitude towards the Specific Food Technology

- Having participated in the discourse, how would you describe your general attitude towards [technology X]?

  [Prompt] Would you perceive the technology as:
  - *Benificial / Risky?*
  - *Good / Bad?*
  - *A positive development / negative development?*
  - *Novel and innovative / Not particularly novel or innovative?*

  Why do you think that you hold these views?
- Did your attitude towards the technology change during the course of the conversation with the scientist? If yes, did you become more or less negative in your views? Please elaborate on the reasons why.
- Did the scientist outline specific benefits associated with the technology that you would value?
  - Would these benefits motivate you to seek out food products that use this technology? If yes, please explain why.
  - Would you advocate the wide application of this technology? If yes, please explain why.

- Was there anything about this technology that caused you to become concerned?
    - Would these concerns prevent you from purchasing food products produced/ processed using this technology? If yes, please explain why.
    - Would these concerns result in you preferring that a ban be placed on food applications of this technology? If yes, please explain why.

- In your opinion, do all of the potential benefits of this technology outweigh all of the potential risks?
- Do you think that foods produced/ processed using this technology should be labelled to advise consumers that this technology has been applied?
- How important to you consider the regulation of this technology to be?
- In the time that has lapsed since participating in the discourse:
    - Have you looked for/ gathered more information on the technology? If yes, from what sources? Which sources did you find credible/ trustworthy? Did the information within these sources concur with the information provided during the discourse?
    - Has reflection on the information you received during the discourse (and gathered since) caused you to reconsider your views on the technology, and if so, in what way has the discourse influenced your views?

Interaction with the Scientist

- What was your opinion of the scientist's explanation of the technology? What made the explanation good or bad?
- Did you feel that you were comfortable and confident in openly expressing your views to the scientist during the discourse?
    - How did you feel the scientist reacted to your views?
    - Do you think that the scientist appreciated your views if, at any stage, your views differed from their own?
    - Do you think that the scientist was interested in your views on the technology? Do you think all scientists feel this way?
- In your opinion, what influence, if any, did the relationship between yourself and the food scientist have on the discourse?

The Discourse as a Method of Citizen Interaction

- Having participated in the discourse, has your level of understanding of the technology increased? *[Prompt] On a scale of 1 to 10, to what extent?*
- If the discourse had been a one-way exchange, where you did not have the opportunity to question the scientist about the technology, would you have reacted differently to the information presented? *[Prompt] Do you think that the fact that it was a two-way exchange influenced your attitude towards the technology?*

- In general, are you happy with the current level of information communicated about novel food technologies? Please elaborate on the reasons for your answer.
- Have you any suggestions as to how communication on novel food technologies could be improved/ developed?
    - *[Prompts] Have you any suggestions as to how scientific information regarding novel food technologies and their applications can be more effectively presented to citizens? Who do you believe is the most suitable source to provide citizens with such information? Do you think food scientists have a role in this?*

Have you any additional concluding comments that you would like to make?

<u>Appendix 4.10:</u> Excerpt from a Nanotechnology Discourse Transcript (who was retired and in her late 60s)

Nano Scientist	I'll talk a bit about what…I am doing and I have been doing so far. (…) Then I might ask you just to introduce yourself…what your background is. I'll give you a bit of an introduction on nanotechnology. And then Gráinne prepared four scenarios…imaginary really you know. And we just talk about that…and just want to get your opinion on it and …positive or negative it doesn't…it doesn't really matter to me…I am not advocating nanotechnology.
Nano3	Yes.
Scientist	I just try to inform you about it you know. And maybe pros and cons and…just get your opinion on it, you know. Is that OK with you?
Nano3	That's grand.
(…)	***[The scientist and citizen then each give a brief introduction of their background (where they come from, their occupation etc.) to each other].***
Nano Scientist	Alright, so you read a little bit of the background [summary sheet] of nanotechnology?
Nano3	I did…I read it…yes, yes.
Scientist	Did you hear anything about …what…what is your….knowledge before?
Nano3	Well I was telling Gráinne when I came in first…nanotechnology….I thought it was something to do with computers and with mobile phones. I didn't know what it was after that.
Scientist	Yes…yes…you are not far wrong…of….you know, you are not….
Nano3	I thought…maybe first of all I thought it was a new game…you know. (…) I hate computer games…and all those things. It's like noise….Oh it is another gadget.
Scientist	Yes, yes.
Nano3	And I thought maybe it would be something a child would have now (…) …another gadget you know. But I …that…that was the limit. I would never read anything about it. I wouldn't read a magazine or ….a technical magazine or anything like that.
Scientist	…you haven't heard of nanotechnology in food in one sentence have you?
Nano3	No, I hadn't really no.
Scientist	Yes, yes. Like in principle you are …not far off there. Because in the mainstream media that wouldn't be mentioned in one sentence really. Nanotechnology …as in nano…and the technology really…it comes from the technology background. Nano…do you know what nano is…did you ever hear?
Nano3	It's tiny.
Scientist	Tiny, yes, that's right. (…) I can give you a bit of background there. So a metre…you know what a metre is? Right?
Nano3	Yes, yes.
Scientist	…really a nanometre is one billionth of a metre. And nanotechnology, that's technology as such…or nanoscience, is the science of the small. That means it's nano scale. Anything from nanometre to micrometer….
Nano3	How are you going to see it? What do you see it with?
Scientist	You would see it in microscopy.
(…)	***[Following further discussion about nanotechnology and its potential applications, the scientist presents the four pre-defined hypothetical scenarios to the citizen]***
Scientist	(…)…they [the scenarios] are imaginary, right. They are examples. They could be possible….or couldn't…you know. (…) And I just guide you through them. And the first example… (…) It's a potential application of nanotechnology for food and beverages to reduce unhealthy ingredients right. Unhealthy ingredients such as sugar, salt or fat, right (…) without affecting the taste. (…) Do you like that idea?....

<u>Appendix 4.11:</u> Hypothetical Scenarios Presented 0n the Novel Food Technologies

<u>Appendix 4.11A:</u> Genetic Modification Scenarios

GM Foods Scenario 1: Potential Applications of Genetic Modification in Food Processing: GM Processing Aid in Cheese Production

<u>Scenario 1A</u>

Genetic modification technology is used in hard cheese (e.g. cheddar cheese) production as a 'processing aid'. An enzyme (chymosin), which is found in rennet, is needed to make cheese. Through GM technology, the gene responsible for producing this enzyme is inserted in bacteria which enables it to grow. Only the bacteria are genetically modified, not the enzyme, so the cheese has no GM content because the GM bacteria are not part of the cheese. The traditional alternative to using GM technology in cheese production is to use rennet taken from calves' stomachs. This traditional method does not always produce consistent batches of cheese.

- Based on this information, what is your opinion of using genetic modification in this way to produce cheese?

<u>Scenario 1B</u>

As the GM material is not present in the final product, cheese produced in this way is not labelled as produced using genetic modification. However organic cheese is certified as being free from such GM processing aids.

- What are your views on this additional information?

GM Foods Scenario 2: Potential Applications of Genetic Modification in Agriculture: Genetically Modifying Wheat Crops

Scenario 2A

Crops, such as wheat, can be genetically modified so that they are resistant to certain herbicides (weed killers). Herbicides are used to kill weeds in wheat fields, but they can also affect the growth of wheat. When herbicide is sprayed on the field, it does not affect the growth of the GM wheat. Similarly, genetic modification can reduce the amount of pesticide needed to protect the GM wheat from insect pests, as it can increase resistance to such insect pests. Genetic modification can also give this wheat immunity to plant viruses. The GM crops produced are used as food ingredients/products (e.g. wheat is used to make bread) or are fed to animals. Products such as milk and meat from animals fed on GM animal feed do not have to be labelled. In summary, genetic modification can reduce the impact of herbicides on wheat crops and reduce the need for pesticides.

- Based on this information, are you in favour of using genetic modification in wheat production?
- Would you be in favour of growing GM crops in Ireland?

Scenario 2B

GM wheat can also be modified to increase its ability to grow in extreme weather conditions (e.g. drought), making it suitable to grow in various climates. Genetic modification also results in higher crop yields, increasing wheat supplies.

- Based on this additional information, are you in favour of using genetic modification in wheat production?
- what are your views on the use of GM crops in developing countries?

Scenario 2C

The GM wheat seeds cost more to purchase than traditional seeds. However, less pesticides, herbicides and manpower are needed to successfully grow GM wheat, which should offset the initial higher cost of GM seeds. Therefore, the products from GM wheat (e.g. bread and cereals) would be sold to consumers at the same price as traditional counterparts.

- Based on this additional information, would GM wheat be of interest to you?
- If the GM wheat and the products produced from the wheat (e.g. bread) were cheaper to purchase than the tradition wheat, would this impact your interest in purchasing it?

Scenario 2D

These GM crops may impact the surrounding environment and ecosystem. GM crops may unintentionally cross-pollinate with non-GM crops and other plants. In addition, the companies that produce GM seeds have significant control over these seeds due to licences and patents.

- What are your views on this additional information?
- How important do you consider the labelling of GM products to be?
- This scenario has illustrated how GM crops can cross-pollinate with non-GM crops. Furthermore, in the EU, there is no requirement to label small amounts of approved GM ingredients (below 0.9%) that are accidentally present in a food. How would you feel about consuming a GM-free product if you then discovered there were traces of GM ingredients in it?

GM Foods Scenario 3: Potential Applications of Genetic Modification in Animal Production - Genetically Modifying Pigs

Scenario 3A

Animals, such as pigs, intended for human consumption, can be genetically modified at an early stage of their development to produce pigs with selected traits/ characteristics that would not occur naturally. Through this technology, you will be able to purchase GM bacon and pork that is healthier and leaner than the traditional alternative. Genetic material from spinach could be inserted into pigs to produce healthier GM bacon and pork.

- Based on this information, would you be interested in purchasing and consuming GM bacon and pork?
- Based on this information, are you in favour of GM animals?
- If the healthier GM bacon and pork had been created by inserting the gene(s) of another animal instead of the gene(s) of a vegetable, would this impact on your attitude towards the GM bacon/pork?
- Have you any concerns about this specific application?

Scenario 3B

Pigs can also be genetically modified to consume fewer resources and produce less waste. For example, they can be genetically modified by inserting mouse DNA to produce up to 60% less phosphorus in their manure than conventional pigs. If phosphorus is not handled properly it can cause pollution on the land and water near farms. This will reduce the oxygen concentration in water resulting in the death of fish and increased toxins in the water.

- What are your views on this specific application of genetic modification?

Scenario 3C

Additionally, these pigs can also be genetically modified to increase their resistance to disease by ‘knocking out’, or deactivating, genes that are directly associated with a disease that pigs are susceptible to (e.g. respiratory diseases). This would minimise the need for animal care interventions, including antibiotics and other medicines. However, opponents argue that genetically modifying animals could lead to unknown side-effects for these animals in future years.

- What are your views on this specific application of genetic modification?

Scenario 3D

Furthermore, these pigs can also be genetically modified to enhance their reproductive performance. For example, inserting a specific form of oestrogen receptor gene into a sow’s (female pig’s) embryo could increase the number of piglets it produces[46]. These pigs can also be genetically modified to speed up the growth process. For example, cow genes can be inserted into sows’ embryos to increase their milk production, and a synthetic gene can be added to make milk digestion easier for their piglets, thereby causing them to grow faster. This could result in lower prices for consumers.

- What are your views on this specific application of genetic modification?
- Based on this additional information, are you in favour of GM animals?

46 Biotechnology Industry Organisation (2008). Genetically Engineered Animals and Public Health; Compelling *Benefits for Health Care, Nutrition, the Environment, and Animal Welfare.* Washington D.C.

GM Foods Scenario 4: Potential Applications of Genetic Modification to Enhance Food Products: Genetically Modifying Tomatoes

Scenario 4A

Food products, such as tomatoes, can be genetic modified to provide health benefits to consumers by providing the additional nutrients and stimulating natural defences to better fight diseases. For example, a tomato can be modified to contain antioxidants that help to fight against cancer. Genetic modification can also be used to enhance the functionality of prebiotic and probiotic products (predominately dairy products) to improve gut health.

- Based on this information, are you in favour of GM food products, such as fruits and vegetables and prebiotic and probiotic GM dairy products?
- Based on this information, would you be interested in purchasing and consuming GM tomatoes or prebiotic and probiotic dairy products?
- If the healthier GM tomato had been created by inserting the gene of an animal, would this impact on your attitude towards the GM tomato?
- Have you any concerns about these applications of genetic modification?

Scenario 4B

The tomato can also be genetically modified to enable it to ripen slowly on the vine. This could enhance its flavour so that it tastes better than a non-GM tomato. This modification also increases the tomato's shelf life.

- Based on this additional information, would you be interested in purchasing and consuming GM tomatoes?
- Based on this information, are you in favour of GM food products, such as fruits and vegetables?
- Have you any concerns about this specific application of genetic modification?

Scenario 4C

Food products, including tomatoes, can also be genetically modified to increase the efficiency of processing these foods. For example, tomatoes can be modified so that it is easier to remove their skins, which would be a useful modification for canning purposes. As a result of these increased efficiencies, products produced using GM tomatoes (e.g. tomato purées and sauces) are cheaper to purchase than the non-GM alternatives.

- Would this price reduction influence your decision to purchase GM tomatoes or products produced using GM tomatoes?
- What are your views on this specific application of genetic modification?

Scenario 4D

Opponents argue that genetically modifying tomatoes could alter their allergenic properties, adding allergens from other food products or creating new allergens; potentially causing allergic reactions in a minority of individuals. However, all types of GM tomatoes are thoroughly assessed for allergenicity before being introduced onto the market. Furthermore, tomatoes could be modified to remove naturally occurring allergens, which could enable consumption by individuals who were previously allergic to non-GM tomatoes. Similarly non-allergic peanuts could be produced through genetic modification.

- What are your views on this specific application of genetic modification?

Appendix 4.11B: ***Nanotechnology Scenarios***

Nanotechnology Scenario 1: Potential Applications to Food and Beverages by Reducing Unhealthy Ingredients without Compromising Taste

Scenario 1A

Nanotechnology could be used to develop a low fat butter that tastes the same as full fat 'real butter'. This would involve putting nano-sized water droplets inside fat droplets which are then inside a continuous water phase (a 'water in oil in water' (wow) system). Nanotechnology can also be used to make food products healthier for consumers, by reducing the salt, fat and sugar content without compromising the taste, which would also have societal benefits.

- Based on this information, are you in favour of nanotechnology being used in foods to make them healthier?
- Would you be in favour of such products being available to consumers?

Scenario 1B

In addition to the benefits outlined above, there are some concerns about the use of nanotechnology in food production. As nanotechnology is expensive for industry to employ, there would be a price premium for products made in this way (e.g. a 25% premium).

- Based on this additional information, are you in favour of nanotechnology being used in foods to make them healthier?
- Based on this additional information, would you be willing to pay extra for such a product?
- If nanotechnology were used to 'improve' the nutritional value of 'junk foods' do you think consumers would be happier to purchase them? Would this be a good thing?

Nanotechnology Scenario 2: Potential Applications to Food and Beverages by Adding Ingredients to Improve their Nutritional Value

Scenario 2A

Nanotechnology can be used to add vitamins, nutrients, medicines or supplements to everyday foods and beverages. The general approach is to develop nano-size carriers or materials, in order to improve the absorption of such added materials. For example nanoencapsultaion can be used to add antioxidants from tea to a range of food products.[47] Taste, texture and appearance are unaffected. Nanotechnology in the food sector has the potential to offer wider benefits to society by offering healthier food options.

- Based on this information, would foods and beverages produced using nanotechnology be of interest to you?
- Based on this information, would you be open to the supply of foods and beverages produced using nanotechnology in Ireland?

Scenario 2B

In addition to the benefits highlighted above, the implications for human health of using nanotechnology in any food remain uncertain. In particular, little is known about how the body will react to and break down nano-sized materials. Opponents argue that certain nanomaterials may not break down in the stomach and may have the potential to leave the gut, travel through the body and accumulate in the cells with long-term effects which cannot yet be determined. Therefore a food ingredient that is currently generally recognized as safe could have unintended consequences at the nano-size.[48]

- Based on this additional information, would foods and beverages produced using nanotechnology be of interest to you?
- Do you think that consumers should be informed if food products have been produced using nanotechnology?
- How would you feel about certain individuals who are more vulnerable to the unknown health effects of this technology, due to a particular medical condition (e.g. bowel conditions), consuming such products?

---

47 Chaudhry, Q., Scotter, M., Blackburn, J., Ross, B., Boxall, A., Castle, L., Aitken, R. and Watkins, R. (2008). Applications and implications of nanotechnology for the food sector. *Food Additives & Contaminants*, 25(3), 241-258.

48 Kuzma, J. and VerHage, P. (2006). *Nanotechnology in agriculture and food production: Anticipated Applications.* Project on Emerging Nanotechnology, 4th September.

Nanotechnology Scenario 3: Potential Applications to Food and Beverage Packaging to Improve Food Safety, Shelf Life and Reduce Waste

Scenario 3A

Nanotechnology can be used to produce 'smart packaging'. Specifically, nano-sensors can detect food bacteria and alert consumers to the deterioration of food resulting in more accurate use-by dates. Nanotechnology also enables the use of lighter, stronger and more effective materials resulting in more environmentally friendly products, requiring less packaging, and thereby reducing waste. Such improvements in food processing and safety and reductions in packaging costs would financially benefit producers, distributors and retailers.

- Based on this information, what is your opinion of using nanotechnology in the production of food packaging?
- In your opinion, should the industry adopt such techniques?

Scenario 3B

In addition to the benefits outlined above to consumers and the environment, nanotechnology can be used in 'smart packaging' to make foods and beverages safer and extend shelf life e.g. nanocomposites in anti-microbial packaging can help prevent the growth of bacteria in food by absorbing oxygen.

- Based on this additional information, what is your opinion of using nanotechnology in the production of food packaging?

Scenario 3C

In addition, there are concerns about the potential implications of leaching of nanocomposites from food packaging to food products.[49] In particular, there are concerns about the implications for human health of ingesting some nanomaterials e.g. nanosilver (its potential toxicity and risk of bio-accumulation in the body).[50]

- Based on this additional information, what is your opinion of using nanotechnology in the production of food packaging?
- Based on this information, would the use of such packaging encourage/ discourage you to buy a particular product?

Scenario 3D

Opponents argue that there are some concerns about the antibacterial properties of nanosilver continuing to work when deposited in watercourses or sewage treatment works, posing a threat to healthy (or artificial, in the case of sewage plants) ecosystems. This could have implications for crop production in terms of changes to soil/ water composition. Similarly, increasing the complexity of packaging materials might in turn make such packaging more difficult to recycle, thus actually increasing waste.

- Based on this additional information, what is your opinion of using nanotechnology in the production of food packaging?
- Is there anything about the use of this technology at would concern you?

---

49 Chaudhry, Q., Scotter, M., Blackburn, J., Ross, B., Boxall, A., Castle, et al. …Watkins, R. (2008). Applications and implications of nanotechnology for the food sector. *Food Additives & Contaminants*, 25(3), 241-258.

50 http://www.nanologue.net/custom/user/Downloads/Nanologue_we-need-to-talk.pdf

Nanotechnology Scenario 4: Potential Applications to Food Processing to Improve Food Safety and Efficiency

Scenario 4A

Nanocoatings can be applied to food processing machinery in order to improve food safety. Such machines will need less cleaning, involving less downtime. Reductions in the build-up of deposits on pipes and heat exchangers may result in a more energy efficient process. Consumers may benefit through a price reduction in products processed in this manner.

- Based on this information, what is your opinion of using nanotechnology in food processing to improve food safety and efficiency?
- Would this information entice you to purchase food products produced in this way?

Scenario 4B

In addition to the benefits to industry as outlined above, the need for cleaning agents such as detergents is also minimised, resulting in less environmental pollution. However, the implications of using such nanocoatings for human health or the environment remain unclear.

- Based on this information, what is your opinion of using nanotechnology in this context?
- Do you have any concerns about this particular application of nanotechnology?

<u>Appendix 4.11C:</u> ***Food Irradiation Scenarios***

Food Irradiation Scenario 1: Potential Application of Irradiation to Fresh Fruits and Vegetables to Prolong Shelf-life

<u>Scenario 1.A</u>

Irradiating fruits and vegetable at low doses delays their ripening and maturation. Irradiation also prevents the sprouting and germination of fruits and vegetables, thus extending shelf-life. For example, irradiated strawberries will last two to three weeks in the refrigerator compared to only a few days for non-irradiated berries. It also delays the development of off flavours.

- Based on this information, would you purchase and consume irradiated fruits and vegetables?
- Based on this information, would you be open to the supply of irradiated fruits and vegetables in Ireland?

<u>Scenario 1.B</u>

In addition, by extending the shelf-life of fruits and vegetables, wastage can be reduced and year-round supply of seasonal fruits and vegetables is possible, without having to import them from other countries. This reduces the negative consequences of global food supply on the environment (reduces carbon footprint as less transport is involved).

- Based on this additional information, would you purchase and consume irradiated fruits and vegetables?
- Based on this additional information, would you be open to the supply of irradiated fruits and vegetables in Ireland?
- In turn, how important do you consider the labelling of irradiated fruits and vegetables to be?

<u>Scenario 1.C</u>

In addition to the benefits presented above, there are concerns that the nutritional quality of irradiated fruits and vegetables is affected with lower levels of, for example, vitamins B1, C, A and E in irradiated products compared to non-irradiated products.

- Based on this additional information, would you purchase and consume irradiated fruits and vegetables?

<u>Scenario 1.D</u>

Finally, since the irradiation process involves additional costs for the producer, the consumer will have to pay a small price premium on irradiated fruits and vegetables, compared to non-irradiated products.

- What are your views on this additional information?
- Based on this additional information, would you be willing to pay extra for such irradiated fruits and vegetables?

Food Irradiation Scenario 2: Potential Application of Irradiation to Food Products to Kill Insects and Reduce Micro-organisms and Bacteria

Scenario 2.A

Food products such as grain, flour and spices can be irradiated to disinfest (kill insects and pests), decontaminate (reduce micro-organisms) and reduce or eliminate bacteria from such products, which increases food safety. Irradiation is a viable alternative to chemical fumigants, some of which are banned and considered dangerous to humans and the environment. Spices can get contaminated with bacteria during sun drying (which is the most common drying method) as a result of:

1) deposition of faeces by insects, birds, rodents and other animals,
2) wind-blown dust containing microbes.

- Based on this information, are you in favour of irradiating spices?
- Based on this information, would you purchase and consume irradiated spices?

Scenario 2.B

Irradiation leaves no chemical residues in food and can help to reduce food losses during storage. Irradiation can help countries trading in certain foods to satisfy public health regulations in other markets, which could otherwise be a major trade barrier. Irradiation can help to ensure the availability of foods (such as spices) and prevent the spread of harmful insects and micro-organisms.

- Based on this additional information, are you in favour of irradiating spices?
- Based on this additional information, would you purchase and consume irradiated spices?

Scenario 2.C

In addition to the benefits presented above, there are concerns that irradiation does not provide a 100% guarantee of food safety as poor food handling post-irradiation (i.e. during distribution or in the home) can cause the re-contamination of foods. Re-contamination is also an issue for other food preservation methods.

- What are your views on this additional information?

Food Irradiation Scenario 3: Potential Application of Irradiation to Meat Products to kill Disease causing Micro-organisms (e.g. E-Coli)

Scenario 3.A

Low to medium doses of irradiation can make foods such as meat and poultry safer by reducing the likelihood of food poisoning. Irradiation can eliminate up to 99.9 percent of E-coli, Listeria, and Campylobacter (three of the main causes of food poisoning in Ireland) thus preventing infections, hospitalisations, and deaths from food sources. Multiple outbreaks of E. coli illnesses, principally resulting from consuming burgers, have caused many deaths and permanent illness. A reduction in such outbreaks, through the use of food irradiation, would benefit society by potentially reducing healthcare costs.

- Based on this information, what is your opinion of irradiating meat products to eliminate bacteria, such as E-Coli?
- Based on this information, would you purchase and/ or consume irradiated meat?

Scenario 3.B

Food companies can also benefit by irradiating food products prior to their distribution. Irradiation can help to minimise the need for product recalls and the loss of business reputation and sales associated with unfavourable media attention arising from food scares. Furthermore, it is an efficient mechanism for food companies to render food safe, and is also more versatile than other preservation methods.

- Based on this additional information, what is your opinion of irradiating meat products to eliminate bacteria?
- Have you any concerns about this particular application of food irradiation?

Scenario 3.C

In addition to the information outlined above, there are concerns that certain toxin causing organisms and viruses may not be eliminated at standard doses.

- Based on this additional information, what is your opinion of irradiating meat products to eliminate bacteria?

Food Irradiation Scenario 4: Potential Application of Irradiation to Sterilise Food Products

Scenario 4.A

High doses of irradiation can be used to sterilise food (to kill all living contaminants in food). These sterile foods can be consumed by at-risk consumer groups with severely impaired immune systems, such as patients with cancer or AIDS. The sterilised products can be stored at room temperature almost indefinitely and thus can also benefit the military, outdoor enthusiasts or disaster victims where a long shelf-life at ambient temperatures is required. Irradiation allows such specific consumer groups the option to consume an increased variety of sterile foods in comparison to other sterilisation techniques.

- Based on this information, do you consider the provision of irradiated sterile foods to patients with cancer/AIDS to be a good idea?
- Based on this information, do you consider the provision of irradiated sterile foods to the military be a good idea?
- Do you have any concerns about this particular application of food irradiation?

Scenario 4.B

In addition to the information presented above, foods irradiated at such high doses may not taste very good and it may affect texture (e.g. become tougher)

- Based on this additional information, do you consider the provision of irradiated sterile foods to specific consumer groups outlined to be a good idea?

Scenario 4.C

Furthermore, the nutritional quality of irradiated sterile foods will be lower than non-irradiated foods.

- What are your views on this additional information?

*<u>Appendix 4.11D:</u> **Thermal Technologies (Ohmic Heating and Radio Frequency Heating) Scenario***

Thermal Technologies Scenario 1: Potential Application of Ohmic Heating in Peeling Fruit and Vegetables (e.g. Tomatoes for Sauces)

<u>Scenario 1A</u>

Conventionally, tomatoes are peeled for making sauces either by using steam or by immersion in a chemical solution (lye). Ohmic heating (OH) can be used to peel tomatoes equal in quality to those peeled in a lye solution, yet in a more environmentally friendly manner. OH avoids the environmental problems associated with lye peeling (i.e. treatment of wastewater). Instead of lye, it uses a very low concentration of salt in the OH process.

- Based on this information, are you in favour of using ohmic heating to produce tomato based products. Would such products be of interest to you?
- Would other products produced in this way be of interest to you?

<u>Scenario 1B</u>

In addition, cost savings will be made by industry, due to increased production efficiency and reduced energy consumption. This could result in a cheaper product for consumers.

- Based on this additional information, would you be interested in purchasing tomato based products produced in this way?
- Do you think products produced in this way should be labelled accordingly?

<u>Scenario 1C</u>

With the lye peeling system, lye disintegrates the peel so that it cannot be used. In contrast, using OH, the peel can be retained and processed e.g. mashed and put back into the tomato product to increase, for example, its vitamin content, as the skin of fruit and vegetables is rich in these nutrients. Alternatively, the peel can be retained and used as a separate product or as an ingredient in another product.

- What are your views on this additional information?

Thermal Technologies Scenario 2: Potential Application of Ohmic Heating to Perserve Canned Foods (e.g. Sweet Corn)

Scenario 2A

In conventional canning, the contents of the can (e.g. sweet corn) is not sterilised until the can has been filled and sealed. Heat (steam) is then applied to prevent the growth of dangerous bacteria within the can. The contents at the centre of the can may take longer to heat and, as a result, some of the contents may become overheated, resulting in a loss of flavour and nutrients. Alternatively, OH can be used before canning to heat the sweet corn, by pumping continuously through a tube. The product is then cooled and canned. This a faster method of applying heat than traditional methods, as the entire product is heated at the same time and the sweet corn is therefore less likely to be overcooked. OH is as safe in eliminating bacteria as conventional (steam) methods.

- Based on this information, would sweet corn produced in this way be of interest to you? Would you purchase such a product?

Scenario 2B

In addition, costs savings are made in the longer term by industry due to using a more energy efficient process (although initial capital expenditure is high). However, the price for the product will remain unchanged for the consumer.

- Based on this additional information, would you purchase sweet corn produced in this way?
- Would you purchase other canned products produced in this way?

Scenario 2C

Alternatively, OH can be used to heat food in pouches. Products such as oriental vegetables, prepared pasta and fruit dishes could be processed quickly in this way, resulting in a more fresh-like product with a good colour, flavour, appearance and more nutrients retained. However, special sachets (with metal conductors) would be needed if using OH, which would result in a more expensive product for consumers.

- Based on this additional information, would you purchase food products produced in this way?
- Would you be willing to pay extra for such a product?
- Would you have any reservations about this processing technique being used?

Thermal Technologies Scenario 3: Potential application of Radio Frequency Heating to Dry (Post-Bake) e.g. Biscuits, Crackers and Other Snack Products

Scenario 3A

Radio frequency (RF) heating can be used in the post-bake drying and moisture control of biscuits, crackers and other snack products to make them crisper, i.e. to remove excess moisture that is difficult to remove during conventional baking and drying. RF is a finishing step in the drying process and is used after conventional oven baking. For example, an RF dryer will dry the wettest area of biscuit products without heating the areas that are already dry. Typically, there is greater moisture in the interior of a product (than the exterior) when it is removed from a conventional oven. Therefore, this moist area will absorb more of the RF energy. In addition, RF heating reduces processing times and produces consistent quality products.

- Based on this information, what is your opinion on using radio frequency heating in the post-bake drying of goods?
- Would you purchase biscuits produced in this way? Would you purchase other products produced in this way?

Scenario 3B

In addition, RF systems used in post-bake drying result in reduced surface cracking of the biscuits, due to the uniform drying process. RF systems are generally more energy efficient than conventional heating systems. RF systems are initially more expensive to buy than conventional systems. This cost will be recouped over time, given reduced cooking times, increased labour efficiency and improved yield etc.

- Based on this additional information, what is your opinion of using RF heating in the post-bake drying of goods e.g. biscuits?
- Would you be willing to pay extra for such products?

Thermal Technologies Scenario 4: Potential application of Radio Frequency Heating to Cook Meat

Scenario 4A

Radio frequency heating is a faster way for companies to cook large quantities of meat (for industrial slicing) compared to conventional steam or immersion cooking methods. In RF heating, heat is generated within the product (as opposed to heating from the outside in) which reduces cooking times and leads to a more even heating throughout the food. Research has shown that it can be at least 4-5 times faster and results in a safe product, which does not differ nutritionally from conventionally cooked alternatives. A problem in the conventional cooking of meats is that the centre of the meat does not cook very quickly which in turn leads to long cooking times, and possibly variation in quality.

- Based on this information, what is your opinion on using RF heating to cook meat products on an industrial scale?
- Would you be interested in purchasing meat cooked in this way?

Scenario 4B

In addition, RF may result in reduced cooking losses (loss of weight and product shrinkage during cooking) for certain meat products e.g. deli meats like cooked ham (given the faster cooking time). Its application will subsequently increase profit for food processors.

- Based on this additional information, what is your opinion on using radio frequency heating to cook meat products on an industrial scale?

Scenario 4C

Also RF can be used by industry to quickly thaw out meat, which is to be processed further or has been previously processed (e.g. burgers), for cooking. RF is a faster alternative to conventional air thawing and results in less drip loss (i.e. liquid coming from the defrosted meat) and more nutrients being retained.

- Based on this information, what is your opinion on using RF heating to defrost meat products on an industrial scale?

Appendix 4.11E: ***Non-Thermal Technologies (High voltage Pulsed Electric Field and High-Intensity Ultrasound) Scenarios***

Non-thermal Technologies Scenario 1: Potential Application of Pulsed Electric Field to Extract Juice from Fruit

Scenario 1A

In general, fresh fruit juice is produced by first squeezing the fruit, and then adding commercial enzymes to extract more juice from the fruit pulp (by breaking down the cell walls within the fruit). Pulsed Electric Field (PEF) technology is an alternative method that can also be used to extract juice from fruit (pulp). Fruit juice extracted using PEF processing is more comparable to freshly pressed juice than juice extracted using commercial enzymes.

- Based on this information, what is your opinion of using PEF processing in the production of fruit juice? Would you buy such a product?

Scenario 1B

In addition, PEF results in a more efficient (faster, more continuous) extraction process and higher yields than conventional extraction methods. Furthermore, the technology is available at a reasonable cost, when compared to conventional processes.

- Based on this additional information, would you be willing to purchase fruit juice processed using PEF?
- Do you think products processed in this way should be labelled accordingly?

Scenario 1C

In addition, using PEF to extract juice from fruit causes less damage to the pulp (when compared to commercial enzymes). This pulp can then be re-used as an ingredient in other products (e.g. smoothies and yoghurts) which reduces waste.

- Based on this additional information, what is your opinion of using PEF processing in the production of fruit juice?

Non-thermal Technologies Scenario 2: Potential Application of Pulsed Electric Field (PEF) to Preserve Liquid Foods e.g. Fruit Juice

Scenario 2A

PEF processing can be used as an alternative preservation method to pasteurisation. It uses lower processing temperatures (than pasteurisation) which should result in a more fresh-like product and the retention of more nutrients while fulfilling its main purpose i.e. killing micro-organisms like bacteria to make the product safer and increase shelf life. For example, a fresher more natural tasting fruit juice can be produced through PEF processing compared to conventionally pasteurised fruit juice.

- Based on this information, what is your opinion of using PEF to preserve products such as fruit juice?
- Would you be willing to consume fruit juice or other products processed using PEF?

Scenario 2B

In addition, in order to remain fresh, PEF processed products need to be refrigerated (similar to conventionally pasteurised products). The PEF process is more energy efficient and environmentally friendly. The product may be potentially more expensive for the consumer, due to its enhanced sensory characteristics and increased nutritional content.

- What are your views on this additional information?
- Would you be interested in purchasing products produced in this way?
- Would you be willing to pay extra for fruit juice produced in this way?

Scenario 2C

In addition, there is a very minimal risk that small metal particles from the machinery could be released into the juice during PEF processing. This risk is, however, extremely low when proper safety and quality standards are in place within the factory.

- Based on this additional information, do you have any concerns about the use of PEF processing in juice?
- Based on this additional information, do you think that consumers should be informed if food products have been processed using PEF?

Non-thermal Technologies Scenario 3: Potential Application of High-Intensity Ultrasound to Emulsify and Homogenise Products e.g. a Yoghurt Based Fruit Smoothie

Scenario 3A

High-Intensity Ultrasound (HIU) can be used to successfully homogenise (mix thoroughly) unblendable liquids like water and fat to obtain a suspension or emulsion in products such as a yoghurt based fruit smoothie. Practically all liquid milk sold in Ireland is homogenised to prevent the cream separating from the milk. HIU is more environmentally friendly and energy efficient than conventional homogenisation, since it uses less energy to complete the homogenisation process. HIU could result in a higher quality product (with an improved texture) than homogenisation.

- Based on this information, what is your opinion of the use of HIU processing in yoghurt smoothies?
- Would you consume yoghurt smoothies processed in this way?

Scenario 3B

In addition, HIU equipment costs are high when compared to traditional homogenisation methods and, as a result, the HIU processed yoghurt smoothie may be more expensive for the consumer.

- Based on this additional information, what is your opinion of the use of HIU processing? Would you be willing to pay extra for a smoothie produced in this way?

Scenario 3C

HIU could also possibly be used as a one-step process to homogenise and pasteurise the yoghurt smoothie simultaneously. Conventionally produced smoothies have to be pasteurised (heated to a certain temperature) after homogenisation to ensure the product is safe to consume. The HIU integrated process could be shorter and more efficient. However, it is not yet clear whether such a product would be of comparable quality to that of a product conventionally pasteurised and homogenised separately.

- Based on this additional information, is there anything that would concern you about smoothies processed using HIU?
- Do you think that consumers should be informed if food products have been produced using HIU?

Non-thermal Technologies Scenario 4: Potential Application of HIU to Extract Bioactives from Plant Sources e.g Potato Peel to Use as an Ingredient in a Cereal based Snack Bar

Scenario 4A

HIU is also used to extract beneficial ingredients, known as bioactives from plants.[51] bioactives, naturally occur in plants and can be extracted and added to other foods/ supplements to improve their nutritional value. These foods are sometimes referred to as 'functional foods'. For example, bioactive compounds known as polyphenols can be extracted from potato peel and used as an ingredient in other food products. Polyphenols are thought to have anti-cancer properties and to improve cardiovascular health. HIU is faster than conventional methods (which are slow and mild e.g. infusion in a water and alcohol solution) and results in an increased yield of extracted bioactives, an increased rate of extraction and overall a faster processing time.

- Given this information, what is your opinion of the use of HIU in the production of functional foods?
- Would you be interested in purchasing such products e.g. the cereal based snack bar?

Scenario 4B

In addition, HIU may be relatively less expensive than conventional extraction processes. The technique could be applied to a wide range of products and used to extract bioactives from a wide range of plant sources, such as grains and seeds. However, there is some concern that prolonged use of HIU may result in damage being caused to the bioactive material.

- Given this additional information, would you have any concerns about the use of this technology?

51 For example, polyphenolics, polysaccharides and functional compounds.

__Appendix 4.11F:__ Functional Foods Scenarios

Functional Foods Scenario 1: Addition of a Functional Ingredient to Dairy Products to Enhance (Gut) Health

__Scenario 1A__

Beneficial live probiotic cultures (good bacteria which are also naturally present in the gut) can be added to dairy products, such as fresh cheese, in order to improve gut health for individuals with digestive related problems, possibly caused by a poor diet, lifestyle related activities or taking antibiotics. This can aid digestion, by improving intestinal function and microbial balance.

- Based on this information, are you in favour of functional dairy products to enhance gut health being available to consumers?
- Would you be open to the idea of probiotics being added to other non-dairy foods such as bread? Would you be interested in purchasing such a product?

__Scenario 1B__

Beneficial live probiotic cultures can be added to dairy products to improve gut health and aid digestion for individuals with digestive related problems. However, these probiotics may fail to influence gut health, as the quantity of bacteria delivered may be insufficient or the bacteria may not survive long enough in the digestive system to be beneficial. These probiotic products will only improve gut health and aid digestion when consumed as part of a healthy diet and lifestyle.

- Based on this information, are you in favour of functional dairy products to enhance gut health being available to consumers? Would you purchase such products?
- Would you be open to the idea of probiotics being added to other non-dairy foods? Would you purchase such products?

__Scenario 1C__

In addition to the benefits and risks previously highlighted, additional health benefits could be created in these probiotic products through the use of genetic modification.

- Given this additional information, are you in favour of such functional dairy products, to enhance gut health, being available to consumers?
- Is there anything about this type of additional enhancement that would concern you?

__Scenario 1D__

In addition, prebiotics (which can also improve gut health) have been linked to satiety effects, i.e. maintaining the feeling of fullness for longer. For example, adding such functional ingredients to food products could decrease levels of the hunger-promoting hormones in the body.

- Would you be in favour of such functional products to increase satiety being available to consumers? Would you purchase such products?
- Is there anything about this type of additional enhancement that would concern you?

Functional Foods Scenario 2: Addition of a Functional Ingredient (e.g. Plant Sterols and Stanol Esters) or a Cholerterol Lowering Drug (e.g. Statins) to Food Products (e.g. Fruit Shot) to Prevent or Treat (Cardiovascular) Disease

Scenario 2A

Naturally occurring plant sterols and stanol esters (largely found in vegetables and fruits such as berries) can be added to products, such as fruit shots (drinks), to naturally reduce LDL-cholesterol (bad cholesterol), and in turn decrease the risk of coronary heart disease. Cholesterol lowering products could play a useful role in the overall strategy of maintaining a healthy heart for individuals, which would reduce incidences of heart disease. As a result, healthcare costs for society should also be reduced. These products have a similar taste to other fruit shots on the market.

- Based on this information, are you in favour of functional products to reduce cholesterol being available to consumers? Would you be willing to purchase such products?
- Would you be open to the idea of cholesterol lowering ingredients being added to other food products? Would you be willing to purchase such products?

Scenario 2B

In addition to the benefits highlighted, these products should be consumed as part of a balanced diet. There is a danger that some people will self-diagnose and decide to consume these products (i.e. self-medicate). This may not be in the best interest of their health. In addition, such products may be more effective for some people than others. Finally, these products will be 40% more expensive than conventional fruit shots on the market.

- Given this additional information, are you in favour of functional products to reduce cholesterol being available to consumers?
- Would you be willing to pay the price premium for these type of products?

Scenario 2C

In addition, to ensure that the tastes associated with the stanols and sterol esters are not experienced when consuming the fruit shot, they are micro-encapsulated. This involves surrounding them in a thin film/ coating to create very small capsules within the fruit shot (so small that they are not discernible when consuming the product and do not affect mouthfeel etc.).

- Given this additional information would a fruit shot enhanced in this manner be of interest to you?
- Would you purchase this or other foods enhanced with plant sterols/ stanol esters?
- Is there anything about this type of enhancement that would concern you?

Scenario 2D

Cholesterol lowering drugs known as statins, are prescribed to patients with high levels of cholesterol in their blood stream by their GP. It is also possible to add these drugs to foods like a fruit shot. Such products would have to be highly regulated and only sold in a pharmacy. Consuming the drug through food in this way could be a convenient method through which patients could consume medication on a daily basis. This specialist/ medicinal product should be stored carefully to avoid consumption by those without high cholesterol e.g. children.

- Do you think drugs should be added to food in this way?
- Would you have any concerns about this product being made available?
- How should such products be regulated in your opinion?

Scenario 2E

Furthermore, there is some debate amongst academics that plant stanols and sterol esters may interfere with the body's ability to absorb fat soluble vitamins, such as *beta*-carotene and vitamin E from food. They do not appear to have any impact on other vitamins, for instance Vitamin C. This potential problem can be rectified by eating more fruit and vegetables while eating such functional products.

- What do you think of this additional information?
- Based on this additional information, would you have any concerns about consuming this product?

Functional Foods Scenario 3: The Production of so called 'Cosmeceuticals' or 'Nutricosmetics' i.e. the Addition of Functional Ingredients with 'Beautifying' Benefits (linked to Skin and Hair Health etc.) to Dairy Products e.g. Wheaten Bread

Scenario 3A

The addition of 'functional' ingredients to foods to create so-called 'edible' beauty products is currently being developed. Such ingredients are linked to improved skin, hair and nail health. Functional ingredients, such as vitamins A, C and E and extracts from green tea, olives and grapes, can be added to wheaten bread to add additional beauty benefits. Instead of applying a beauty product to the skin, this bread is consumed and its cosmeceutical ingredients are absorbed into the blood stream and transported from inside the body to the skin, where they exert their beneficial effects.

- Based on this information, what is your opinion of such a product? Would you be willing to purchase this type of bread? Would you be willing to purchase other products produced in this way?
- What kinds of people do you think would be interested in such products?
- Would you have any concerns about this product?
- In terms of labelling, what kind of information would you like to see on such products?

Scenario 3B

In addition, due to the high level of product development required to develop the 'cosmeceutical' bread, it will be 50% more expensive (than regular bread). However, consuming the 'cosmeceutical' bread may result in the consumer spending less money on conventional (non-food) beauty products.

- Based on this price premium, would you be interested in purchasing this type of bread?

Scenario 3C

In addition to the information presented above, there is some concern consumers may unknowingly become over-exposed to certain nutrients, as a result of excessive consumption from several sources. This could potentially result in negative health consequences.

- If you wished to supplement your diet with certain nutrients for health reasons would you prefer to do so from food you already consume, or from a separate supplement? Would this change if you were purchasing a product with beautifying benefits i.e. for skin or hair health?

Functional Foods Scenario 4: Functional Ingredients added to Animal Feed (e.g. cattle) to Produce Healthier Ingredients (e.g. Beef)

Scenario 4A

Conjugated linoleic acid (CLA) is a fatty acid that is beneficial to human health. CLA is naturally occurring in grass fed cattle. CLA has a number of potential health benefits, and has shown properties that are anti-arthritic, cancer preventing and anti-diabetic. The CLA content of beef can be increased by feeding cattle sunflower or linseed oil during the winter, when they are housed in-doors and not grass fed.

- Based on this information, would CLA enriched beef produced in this way be of interest to you? Would you buy such a product?

Scenario 4B

In addition, as production costs (inputs) would be higher for farmers, this beef would be more expensive. Some animals would be naturally better at producing CLA than others for genetic reasons such as their breed. Therefore, the beef from some would have a higher content of CLA than others. However a minimum level of CLA would be guaranteed to the consumer.

- What is your opinion of this additional information? Would you be willing to buy CLA enriched beef produced in this way?
- Would you be willing to pay extra for such a product?
- In terms of labelling, do you think that if beef is CLA enriched it should be stated on the label?
- Do you think other beef products should state on the label how the animal was raised and what it was fed?

Scenario 4C

Alternatively, chitin, found in shellfish can be added to animal feed to increase chitin levels in the beef. Beneficial health properties of chitin include strengthening of individuals' immune systems and improved wound healing.

- What is your opinion of the addition of chitin to animal feed?
- Would you be willing to consume beef produced in this way?
- Would you have any concerns about such a product?

***Appendix 4.11G:** Nutrigenomics and Personalised Nutrition Products (PNPs) Scenarios*

Nutrigenomics and PNPs Scenario 1: Potential Applications of Nutrigenomics: Genetic Testing of Individuals and Provision of Dietary Advice to Reduce/ Prevent Diet related Diseases

Scenario 1A

In the future, nutrigenomics could enable screening of your DNA (genetic testing), which would profile your entire genetic makeup. Based on the genetic information attained from such testing, a specific dietary plan which aligns with your genetic profile could be provided to you. For example, this test could advise you that you are salt sensitive, and that consequently you are recommended to follow a low-salt diet to avoid/ reduce high blood pressure. This evidence-based dietary plan, if followed, could restore health and/ or prevent diet related diseases that your genetic profile suggests you are susceptible to. This could lead to improved health and longer illness-free life.

- Based on this information, would you avail of nutrigenomics (genetic profiling and dietary planning) as part of your food choice planning?
- How interested do you think consumers would be in attaining this type of information? Do you think that the level of interest would vary depending on the type of consumer?
- How do you think that individuals would react to such information?

Scenario 1B

In addition, this profiling and dietary planning could result in substantial cost savings in health care (potentially impacting tax payers), as the numbers presenting with diet related illnesses would be reduced. It could also lead to a decrease in the demand for medications.

- Based on this information, would you approve of the use of nutrigenomics in the Irish health care system?
- Based on this information, would you endorse nutrigenomic testing?

Scenario 1C

In addition, while nutrigenomics promises to provide health benefits, these are not guaranteed. Genetic variation is not the only determinant of individuals' varying responses to diet. Life stage and lifestyle are also important.

- Based on this additional information, would you endorse the use of nutrigenomics?

Scenario 1D

In addition, for the general uptake of nutrigenomics, consultations with medical professionals will be necessary. Swabbing of saliva will have to be completed to obtain an individual's genetic profile, which will provide details on the types of illness and diseases that the individual is predisposed to. This information will be kept on file in a doctor's surgery. Others parties, such as life assurance companies, might have an interest in obtaining, or may even request information, this information, particularly information about any illnesses that individuals may or may not be predisposed to.

- Based on this additional information, would you have any concerns?

Scenario 1E

Finally, nutrigenomics would initially be very expensive, due to the significant costs associated with genetic testing. As a result, this testing may only be feasible for individuals who can afford it privately.

- What are your views regarding this additional information?

Nutrigenomics and PNPs Scenario 2: Potential Applications of Nutrigenomics - Development of Personalised Nutrition Products (PNPs)

Scenario 2A

Nutrigenomics could also lead to the development of PNPs. This could involve segmenting the population based on predisposed illnesses, and developing food products based on these profiles. Based on the information received through nutrigenomic testing, these PNPs could be used by individual consumers to reduce and/ or prevent future health related diseases in a convenient manner (i.e. less organising and managing of diet would be required).

- Based on this information, do you think that society would benefit from these PNPs?
- What impact if any do you think such food products would have on individuals' diets?

Scenario 2B

Some of these food products will be made available to purchase in pharmacies, as they will be categorised as medical food products. Furthermore, some of these medical food products may require a prescription in order to purchase them. These products will be consumed solely by individuals with specific diet related conditions or predisposition to such conditions.

- Are you in favour of the introduction of these products in this manner?
- What are your views on purchasing these products in this way?
- What impact, if any, do you think such products would have on individuals' diets?

Scenario 2C

Other personalised food products will be made available to purchase in supermarkets. These products will be categorised as food products and branded for their particular purposes. They will be sold beside non-personalised food products. Some of these products may taste differently to equivalent non-personalised food products.

- Are you in favour of the introduction of these products in this manner?
- What are your views on purchasing these products in this way?
- What impact, if any, do you think such products would have on individuals' diets?
- Do you believe these particular products would contain the stated benefits?

Scenario 2D

As a result of the additional research and development and product segmentation required to deliver these products, the manufacturer will charge at least 60% more when compared to standard non-personalised products.

- Given this additional information, would these products be of interest to you?

Scenario 2E

To provide specific health benefits for individuals with particular genomes, genetic modification may be used in the production of these products.

- Given this additional information, are you in favour of the introduction of such products?
- Have you any concerns about using GM technology to make such products beneficial for individuals with specific genomes?

<u>Appendix 4.12</u> Overview of Steps involved in the Thematic Analysis

The following steps outlined relate primarily to the inductive analytic stage for the ECG data sub-set.

<u>A. Become familiar with the dataset and identify items of interest</u>

All of the discourse and interview transcripts were checked for accuracy against the audio recordings. This activity was an effective initial step in becoming familiar with the data collected. During this step, major emerging topics were noted in an effort to 'get a sense' of the key issues of pertinence embedded within the data.

The handwritten discourse observational notes were typed into word documents and then reviewed and checked for accuracy, i.e. no contradictions against the content of the discourse transcripts. Reading and reviewing both documents in parallel ensured the observational notes were an accurate and reflective summary of the content of each discourse transcript.

<u>B. Compile and design NVivo database</u>

All of the discourse and interview transcripts were imported into NVivo10, a specialist software package developed to aid qualitative data analysis. These types of computer aided qualitative data analysis software (CAQDAS) programmes are widely recognised as a useful and reputable tool for managing and supporting qualitative analysis (Bringer et al., 2006). Although NVivo is a valuable tool to help organise and see patterns within the data, it *"does not decrease the amount of time needed to read, conceptualize, and analyse data"* (Bringer et al., 2004: 250). Rather, it assists in *"looking at patterns of codes, links between codes, sequencing and co-occurance in a highly systematic fashion, because retrieval of data is made far easier"* (Joffe, 2011: 217).

According to Lyn Richards (1999: 412), who was involved in developing NVivo with Tom Richards (2002), it enables the development and display of *"rich data in dynamic documents"*. The principal benefits of using NVivo, or similar software programmes such as Atlas.ti and MaxQDA, for data coding and analysis are efficiency and transparency. These are achieved through the development of a rigorous database, which clearly demonstrates what data was coded and how it has been coded (Ozkan, 2004).

Pertaining to this research, the use of NVivo (for Stages 2 and 3 of data analysis) made the large dataset easier to manage, and enabled exploration of avenues of inquiry which may not be possible through manual forms of analysis. Its deployment allowed for the automation of many administrative tasks associated with qualitative data analysis and facilitated an evidence-based *"electronic audit trail"* of the analytic process (Bringer et al., 2004: 253). Such an audit trail enables clear documentation of each analytic decision made (Lewis, 2009).

NVivo10, the latest version of this software programme at the time of data compilation, was used. Profile information, including demographic details and the specific technology discussed, were documented in case nodes for each participant, i.e. each discourse transcript. Data was also organised into folder hierarchies by data type (i.e. the discourse transcripts, responses to the PDILQs and the PDI transcripts) and within these grouping, organised by specific technology and technology group. The observational notes on each technology were included as memos in the database, which were linked to the relevant discourse transcripts.

C. Design coding framework and generate initial codes

As a relational database, NVivo facilitates linking relevant data gathered and coded together, thereby making *"relationships between categories more visible"* (Bringer, 2006: 249). Coding involves pattern noting within data and dividing the data into smaller segments, in order to provide greater clarity on its content (Joffe & Yardley, 2003).

> *"Coding is a widely accepted term for categorizing data: taking chunks of text and labelling them as falling into certain categories, in a way that allows for later retrieval and analysis"* (Joffe, 2011: 217).

Coding is a slow and often cumbersome process. To prevent 'getting lost' in the data, a detailed coding strategy was devised and implemented, to ensure analytic credibility and confirmability (Morse et al., 2002; Lincoln & Guba, 1985). This ensured that the coding process was inclusive and systematic, and that the ECG transcripts were coded comprehensively. The strategy involved compiling a ‘coding frame’ or ‘codebook’ (Joffe & Yardley, 2003) for the ECG, which was continually developed and expanded upon. The final version of the codebook contained all codes included across the dataset (Attride-Stirling, 2001).

“A “good code” is one that captures the qualitative richness of the phenomenon” (Boyatzis, 1998: 1). As a starting point of searching for *“codable moment[s]”* (*Ibid*), preliminary codes were identified within the ECG transcripts, using a bottom-up inductive thematic analysis approach that was data-driven. *“An inductive approach is the “purest form” of qualitative analysis”* (Srivastava & Hopwood, 2009: 77). The codes identified for this technology set were therefore strongly linked to the data collected and not a pre-existing coding frame or any preconceptions about what pre-defined themes should emerge (Braun & Clarke, 2006).

NVivo stores data from a source, transcript in the case of this research, in ‘nodes’ which are repositories for codes and themes. Spiggle (1994) proposes coding meaningful data at the word, sentence or paragraph level. Typically, a minimum of one sentence was coded, to give the coded text an element of context. ‘Broad coding’ (participant driven categories) was initially undertaken using ‘free nodes’, which were not assigned to a particular code grouping. Both descriptive (literal) and more subjective and interpretative coding were undertaken. Examples of literal codes include; ‘price’, ‘taste’, ‘regulation’, ‘labelling’ and ‘nature’. Illustrations of more subjective codes include; ‘occupational background influencing attitude’ and ‘risk sensitivity’. The majority of codes related to evaluations of and attitude formation around the specific technology and associated applications/ products. Finally, the PDI transcripts were coded based on the pre-defined questions posed, as the content of the transcripts was influenced by these questions.

In addition, all of the discourse transcripts were coded to indicate the specific stage of the interaction that the coded text related to, i.e. the introduction, explanation of the technology, presentation of the scenarios or discussion thereafter. This enabled the researcher to code the data in the context of the information that had been provided and the stage of the discourse that the conversation related to.

D. Group codes

NVivo assists with establishing patterns and relationships within and across codes (Ozkan, 2004). As part of a data reduction process (Attride-Stirling, 2001), the isolated 'free nodes' were grouped together and placed within hierarchical groupings of relational 'tree nodes'.

In keeping with the three-phased consultative approach adopted (see Section 4.7.2), to strengthen the reflexivity of the process, the grouping and hierarchical ordering of the emerging codes for the ECG were peer reviewed (Creswell & Miller, 2000) and confirmed for consistency and clarity by the primary supervisor, and then discussed more broadly with the other supervisor. As previously outlined, the emerging codebook evolved during the analytic process, in light of active re-coding and re-ordering of codes (nodes), based upon reflection as to where each node 'best fit' and the name that best represented the data coded to each node. Original code groupings were often deconstructed and put into new groups, until further reviewing did not result in additional amendments to these groupings.

Throughout this process, the same sections of text were often coded several times to different nodes. For example, the following extract was coded to 'positive evaluation', 'impact on industry', 'shelf-life' and 'occupational background influencing attitude': *"I suppose from…the suppliers point of view they have a little bit longer to get rid of the stock [by prolonging shelf life through food irradiation] (...) I suppose I am just thinking like an accountant"* (Irrad3, M, 25-34).

As the inductive analytic stage progressed, data interrogation was undertaken to explore the data and emerging codes further. As part of this process, the transcripts for the ECG were cross coded for this technology group to indicate emerging thematic patterns, which subsequently formed the basis for the deductive analysis of the remaining technology clusters.

Several different types of queries were 'run' in NVivo. Text searches (i.e. all occurrences of a word or phrase) and word frequency (i.e. the most frequently occurring words or phrases) queries were run, to explore commonly used words and reaffirm patterns of words and responses within the data. Coding frequency queries were also run to tested emergent patterns in terms of coded data. These searches and queries facilitated further interrogation of the data, thereby strengthening the credibility of the analytic process (Ozkan, 2004).

Once these 'coding cycles' were completed, the search for emerging themes across the ECG became the primal focus. All of the coded data that was relevant to each theme was collated together. Some codes that were not directly relevant to the core research question, e.g. the impact of the current financial climate, were disregarded at this point.

E. 'Search' for themes across the codes

Boyatzis (1998: 161) defines a theme as *"a pattern in the information that at minimum describes and organises the possible observations and at maximum interprets aspects of the phenomenon".* A theme can be considered a specific, coherent and relevant pattern of meaning found within the data that is relevant to the research questions. It may contain *"manifest content"*, which is directly observable and explicitly expressed. Alternatively, it may include more *"latent content"*, i.e. underlying phenomenon which are implicit within the transcripts (Joffe, 2011: 209).

Following deep emersion within the data (Strauss & Corbin, 1998), all codes and potential sub-themes for the ECG were clustered together and reviewed for consistency, variability and emergent patterns (Taylor & Ussher, 2001). These codes were then collated together into broad emerging themes, following an iterative and active process of searching for recurrent patterns in this data sub-set, and subsequent meanings and interpretations of these patterns (Boyatzis, 1998). This iterative process increased the reflexivity of the analytic process (Srivastava & Hopwood, 2009).

The emerging themes and sub-themes for the ECG were peer reviewed at length as part of the consultative process outlined, until no new themes emerged (Strauss & Corbin, 1998). This collaborative review process involved 'moving up' several levels of abstractions, to establish the overarching themes and sub-themes (Spiggle, 1994).

F. Review emerging themes

Adhering once more to the three-phased consultative approach, the emerging themes were reviewed to ensure they 'worked' in relation to the coded extracts for the ECG, i.e. that there was sufficient data to support each theme, and that each was distinct and had a clear central concept, thereby strengthening the credibility of the analysis.

A detailed ‘map’ of the emerging themes and sub-themes concerning the features influencing evaluations of the ECG was developed and is presented in Chapter 6. Development of this map facilitated review and refinement of the hierarchical ordering of the themes and sub-themes, the relationship or networks between them (Attride-Stirling, 2001), and the ‘boundaries’ of each theme/ sub-themes. This review process ensured the emergence of a coherent ‘story’ that addressed the core research question.

Bowen (2008: 149) reiterates that in spite of the coding and analytic process being *“time-consuming and demanding (...) the process of achieving saturation and generating a theory should be rigorous, thorough, and transparent”*. As part of the three-phased review process, thematic and theoretical saturation was confirmed; i.e. that additional analysis and data would not ‘add anything’ in terms of the emerging themes (Hyde, 2003) across each technology group.

G. Define and name overarching themes

This stage of analysis focused on the underlying meanings of each theme and sub-theme, as the emerging themes cut across several topics (Bazeley, 2009). Potential names for the overarching themes and sub-themes for the ECG were discussed at length with the primary supervisor, to ensure the most appropriate and encompassing names were applied. Following the recommendations of Braun and Clarke (2006), the overarching themes were reviewed once more to verify theme saturation, and checked against each other for internally coherency, consistency and distinctiveness.

The third analytic stage involved deductively analysing these emerging themes in the context of their relevance to the remaining technology groups (Patton, 1991). Although this final stage was predominately deductive, these data sub-sets were also examined for unique manifestations of materialising themes and patterns and their features and emphases.

H. Construct and 'write up' of overarching themes

The themes were discussed and re-examined in detail to ensure they worked together to tell a comprehensive story about each data sub-set. Throughout each of the three analytic stages, the data were interpreted and analysed in-depth and not just summated or described.

Fereday and Muir-Cochrane (2006: 82) have outlined how the inclusion of direct quotations from participants can *"strengthen the face validity and credibility of the research"* and *"ensure that data interpretation remains directly linked to the words of the participants".* Within the presentation of the analysis, quotations were selected for inclusion, based on their effectiveness and poignancy in illustrating and supporting analytic claims and emerging themes (Breakwell et al., 2012). In the context of the three analytic stages, the appropriateness of the selected quotations was discussed at length with the primary supervisor, to ensure each quotation clearly illustrated and supported the analysis presented. In addition, a conscious effort was made to ensure an appropriate balance between analytic narrative and illustrative quotations.

The overarching themes were checked against the original dataset, as a final step in ensuring rigour and transparency to the analytic process. This process involved re-reading each transcript, bearing in mind the overarching emerging themes.

Overall, NVivo facilitated useful comparisons of the emergent codes and themes, at the technology specific and group levels (Ozkan, 2004). Following the inductive and deductive phases of analysis, the emerging themes across the technology groupings were compared and contrasted to those reported in previous literature of relevance (Spiggle, 1994).

<u>Appendix 9.1</u> Overview of Cognitive Associations and Types of Responses guiding Evaluations

Building on the analysis presented in Chapters 6-8, this section provides a synopsis of the specific cognitive associations drawn upon in forming attitudes around each technology (Table 9.1A). Word and image associations support the formation of sense-making and attitude formation around each technology. Explicit images conjured include for example: the *"injection of substances into food"* (genetic modification); "*tiny robots"* and computers (nanotechnology); *"radiation"* (food irradiation); *"food that has extra stuff in it that will benefit you"* (functional foods); healthy people (functional foods and PNPs); personalised physical fitness and PNPs; and, *"designer babies"*, conspiracy theories, Aryanism and science fiction (nutrigenomics and PNPs). The images and conceptions generated around nutrigenomics and PNPs are particularly wide-reaching given their futuristic and abstract connotations.

Across the technologies, individuals make comparisons to risks and benefits associated with other technologies, innovations and processes in an effort to place them in context: *"I wonder, is it [nanoparticles leaching into the ecosystem] any more dangerous than the stuff that's in nappies or chemical waste"* (Nano6, F, 45-54). For example, risk comparisons are made: between BSE and genetically modifying animals; between risks now known to be associated with asbestos/ smoking and nanotechnology; and, between risks recognised nowadays as being connected to chemical fumigation/ food colourants/ xrays and food irradiation: *"At one time x-rays were given left right and centre until they realised, 'well…use them sparingly'. (…) So, I would still have that concern of the guidelines or the regulations might change at some point and [we might find out] they have been zapping it [food] with too much [irradiation]"* (Irrad2, F, 45-54, PDI). In contrast, for the BNG and PSOG, positive comparisons are made between, for example: technologies that are already conventionally accepted, i.e. pasteurisation and thermal and non-thermal processing; between adding healthy ingredients when home baking/ cooking and functional foods; and, between allergy/ food intolerance testing and nutrigenomic testing.

It generally, evaluations of the ECG and PSOG are guided by both affect- and cognition-based responses: *"I still have that fear factor [of GM foods]"* (GM3, M, 35-44). In comparison, cognitive responses tend to dominate evaluations of the thermal and non-thermal processing technologies, given their perceived benign characteristics: *"So long as (…) it [the technology] didn't affect the quality of the food and (…) the goodness of the food…then I wouldn't really have a problem with it [being applied]"* (Therm1, M, 25-34).

Table 9.1A: *Overview of Cognitive Associations and Types of Responses guiding Evaluations*

	ECG			**BNG**	**PSOG**	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Cognitive associations (specifically, word and image associations)	*"Injection of substances into food"* to make it bigger, *"huge big tomatoes or square cucumbers",* human intervention and individuals' genetic make-up.	*"Tiny robots",* computers, mobile phones and *"small or compact"* items.	The symbol for 'radiation', radiation factories, cancer treatment and *"zapping with x-rays".* The name 'irradiation' is considered a major barrier to public acceptance.	Some associate ultrasound with its medical usage.	Supplement foods, *"food that has extra stuff in it that will benefit you",* fortified milk, foods consumed by astronauts and soldiers and healthy people.	**Nutrigenomics:** nutrients/cells, other genetic technologies, blood testing, *"designer babies",* space age, conspiracy theories, Aryanism and science fiction. **PNPs:** healthy people and targeted nutrition.
Cognitive associations (specifically, comparisons to other technologies, processes and known risks)	BSE, i.e. how this resulted from interfering with the food chain (negative comparison).	GM technologies and risks now known to be associated with asbestos and smoking; examples of previously unknown risks which are now known (negative comparison).	Risks associated with certain food colourants and chemical fumigation; examples of previously unknown risks which are now known (negative association).	Technologies that are already conventionally accepted, e.g. pasteurisation and microwaving (generally positive comparison).	Individuals adding healthy ingredients when baking and cooking in the home (positive comparison).	**Nutrigenomics:** other genetic technologies and allergy/ food intolerance testing (positive and negative comparisons). **PNPs:** functional foods, personalised physical fitness (positive comparisons).
Main types of responses (i.e. affective reactions versus cognitive responses)	Primarily, affective responses, given the emotive nature of the technology, but also cognitive responses for certain applications	Both affect-based reactions and cognition-based responses.	Both affect-based reactions and cognition-based responses.	Cognition-based responses dominate, based on the presumption that the technologies are generally safe.	Both affect-based reactions and cognition-based responses.	Both affect-based reactions and cognition-based responses.

Appendix 9.2 Overview of Technology Assessments and Conditions of Acceptance

Although measuring explicit technology assessments and conditions of acceptance is not a specific goal of this work, this Appendix presents an overview on each technology, in terms of average likelihood to purchase associated products/ services, and general conditions of acceptance (Table 9.2A).

Overall reactions are heterogeneous, with responses towards certain technologies, such as functional foods, being more positive than others, i.e. genetic modification and food irradiation. Positive reactions towards functional foods and nutrigenomics/ PNPs are guided by perceived associated health benefits and outcomes: *"If I thought I was eating a product and it had extra benefits to it, to me that would be a positive"* (FF1, F, 35-44). Reactions towards the more contentious technologies are more variable and subject to perceived benefit and risk assessments of explicit products and applications, in addition to questioning of their necessity: *"I just think fruit and vegetables are a fresh thing and they are supposed to go off anyway. (...) If I saw two punnets of strawberries on the shelf and one was irradiated and one wasn't, I would probably buy the ones that weren't [irradiated]."* (Irrad2, F, 45-54).

Furthermore, initial average likelihood to purchase associated products (measured prior to information provision about the technologies) is variable, with participants indicating greatest likelihood to purchase functional foods (scoring an average of 2.2) and least likelihood to purchase GM (average of 3.5) and irradiated (average of 3.6) foods.[52&53] In comparison, average likelihood to purchase was slightly greater (3.2) for nano foods. Interestingly, in spite of a low reported likelihood to purchase thermal (averaging

52 Average likelihood to purchase associated products is based on responses from the 42 participants. Likelihood to purchase is based on a scale from 1 to 5, where 1 is very likely, 5 is very unlikely and 3 is neither likely nor unlikely. Therefore a lower score indicates greater likelihood to purchase associated products.

53 As it was not originally within the remit of the associated FIRM project to explore citizens' perspectives on nutrigenomics and PNPs, likelihood to avail of nutrigenomic testing or purchase PNPs were not measured.

3.3) and non-thermal (averaging 3.4) processing related products, reactions towards these technologies are distinctly apathetic following information provision, based on perceptions of their *"harmless"* (Non-Therm2, F, 45-54) qualities.

Deriving from a sense of dread, based on a fear of the unknown, assurances of safety are an important general condition of acceptance for the more contentious technologies. Conversely, assurances of outcomes are a more pressing concern for the PSOG: *"If you had an [health] ailment (…) if this [functional food] was said to improve your health, you would have to…at some stage…get evidence of it or feel better after a number of months"* (FF2, M, 45-54). Additional conditions of acceptance reported include any associated price premiums not being prohibitively expensive and assurances of taste not being compromised: *"Taste would probably be a big issue for some of these functional foods. If it changes the taste, a lot of people aren't going to use it"* (FF6, F, 18-24). Some are unequivocal in noting that price is a prime consideration directing their overall assessments: *"It's all down to money…"* (Nut/PNPs2, F, 55-64). In additional to these broad conditions, technology specific conditions of acceptance are apparent. For instance, assurances of 'genetic privacy' and social equality are imperative in the context of nutrigenomics and PNPs.

Overall reactions and general conditions of acceptance diverge across the technology groups, with reactions towards the BNG seeming to be blasé or indifferent relative to reactions towards the other technologies: *"Once it's perfectly safe and it doesn't affect the quality of food then…it wouldn't bother me. (…) I assume that they [radio frequency heating and ohmic heating] are both perfectly healthy ways of preserving food"* (Therm1, M, 25-34). In contrast, reactions towards the other technologies are more volatile and hinge upon benefit and risnk perceptions of the diverse applications presented.

Table 9.2A: *Overall Reactions and General Conditions of Acceptance*

	ECG			BNG	PSOG	
	Genetic Modification	**Nanotechnology**	**Food Irradiation**	**Non-thermal & Thermal Processing**	**Functional Foods**	**Nutrigenomics & PNPs**
Overall reactions towards the technology	Relatively negative; however this depends on individuals' views regarding perceived benefits and risks of different applications of the technology.	Depends on views regarding perceived benefits and risks of different applications of the technology.	Relatively negative; however, reactions depend on views regarding food safety/ prolonging shelf life and perceptions of the naturalness and necessity of the different applications presented.	Apathetic, based on the perceived benign nature of the technologies and indifferent based on a lack of perceived personal relevance.	Positive, due to the perceived relevance of associated health benefits to individuals, their families and society, and minimal risk associations.	Unclear but potentially positive, due to associated health benefits. However, reactions also depend on how genetic privacy and social equality issues are perceived to be addressed.
Conditions of acceptance for the technology	Assurances of safety and benefits being extended to citizens, and not just to industry.	Assurances of safety, taste not being compromised and benefits being extended to citizens.	Assurances of safety, and quality and taste not being compromised.	Taste and quality not being compromised and the price of products not being higher than their conventional counterparts.	Taste not being compromised, any resultant price premiums not being too high and associated health claims/ outcomes being validated.	Cost of testing and associated products being affordable, genetic privacy and social equality issues being adequately addressed and education being provided. Also, associated health claims/ outcomes being validated.