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# Working out the best deal: the role of consumer numerical skills within a grocery shop

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## Abstract

**Purpose** – Price promotions are a common tool used by retailers to increase sales. This study aims to investigate the effect of consumer's numerical skills and other demographic characteristics on their ability to determine the best deal when conducting a grocery shop (referred to as deal competency).

**Design/methodology/approach** – A consumer survey ($n$ = 308) was conducted online, collecting information about respondent's demographics and grocery shopping behaviours, numerical literacy using the subjective numeracy scale (SNS), and deal competency (a novel measure). Multiple regression analysis and Pearson's correlations were conducted using SPSSv26.

**Findings** – Overall, the mean SNS score for the total sample was 31.47 (SD = 8.27), and the mean sample deal competency score was 13.5 (SD = 2.3). Spearman's correlation analysis identified a moderate significant positive relationship between numerical skills and deal competency, $r_s(303) = 0.360$, $p < 0.001$. Regression analysis found significant positive relationships between numerical skills and being male, and with mathematical achievement; and between deal competency and age, mathematical achievement and educational achievement. Regarding buying behaviour, correlation analyses identified only one significant relationship between numerical skills (SNS score) and deal competency and variables relating to buying behaviour, namely a negative relationship between deal competency and amount spent on promotional food items in top up grocery shops.

**Originality/value** – This study contributes to the gap in literature regarding consumer ability to work out the best deal on promotions, presents a novel scale for describing consumer deal competency, and considers the comparative usefulness of using objective and subjective scales in similar studies.

**Keywords** Promotions, Retail, Consumer, Numerical skills, Subjective numeracy scale, Deal competency

**Paper type** Research paper

## Introduction

Price is an important factor for consumers when choosing groceries, and price promotions are a common tool used by retailers to increase sales (Carlson and Kukar-Kinney, 2020; Zorbas

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*et al.*, 2020). In the context of this research, "promotions" refers to a temporary reduction in price of an item (Hollywood *et al.*, 2016). Promotions can take a variety of forms, such as bulk discounts (e.g. buy one get one free), price reduction (e.g. save 50%), standalone offer (e.g. marked as "only £1"), multi buys (e.g. any 3 for £5), mix and match (e.g. 3 for 2 – cheapest free), extra free (e.g. 33% extra free, 150 ml extra free) and meal deals with choice (e.g. main, side and dessert for £10) (Bogomolova *et al.*, 2015; Hollywood *et al.*, 2016). These strategies can be useful for retailers and brands to stimulate sales as they increase a consumers' perception of value (Choi and Coulter, 2012). However, calculating cost savings requires numerical skills, and can cause some difficulty in accurately determining the cost savings (Chen and Rao, 2007; DelVecchio *et al.*, 2007; Tan and Bogomolova, 2016; Gordon-Hecker *et al.*, 2020).

Numerical skills aid consumers in understanding, processing and comparing differences in prices between different product options (Tan and Bogomolova, 2016; Zorbas *et al.*, 2020) allowing them to make a more informed decision, and these skills are a particularly important consideration for consumers on low budgets (Tan and Bogomolova, 2016). However, there is wide variation in consumers' numeracy skills, and this can impact upon judgement and decision making (Weller *et al.*, 2013). If consumers cannot process information effectively, they are less informed and have reduced agency when responding to marketing communications, for example, when responding to point-of-sale promotional offers (Harrison-Walker, 1995) and mistakenly choosing the least valuable deal (Jae and Delvecchio, 2004). Generally, price promotions have been suggested to be potentially misleading or confusing, thus it is assumed that this confusion will be greater for those with low numerical skills (Tan and Bogomolova, 2016). From the retail management perspective, certain promotional strategies may be more effective in reducing the amount of time consumers spend considering the value of the promotional offer, thereby potentially maximising sales (Gordon-Hecker *et al.*, 2020). Although various studies have considered the impact of numerical skills on decision making generally (e.g. Peters, 2012; Sinayev and Peters, 2015), consumer decision making in retail environments (e.g. Graffeo *et al.*, 2015; Tan and Bogomolova, 2016), or literacy of promotions or products in the retail environments (e.g. Gau and Viswanathan, 2008; Tan and Bogomolova, 2016), there are limited studies specifically relating to consumers numerical skills and the grocery shop. This study therefore examines the influence of consumers numerical skills on their ability to determine the best deal (best value) on grocery products. Considering the grocery shop is of particular interest as this type of activity is often faster paced and more impulsive, requiring more decisions to be made during one shop (due to the number of items typically being purchased). In addition, more items are likely to be on promotional offer due to the sheer volume of SKUs in any one store compared to purchases in another type of store (e.g. electronics). This time pressure combined with the increased number of decisions to be made (and number of alternative options) may increase the likelihood of consumers incorrectly calculating the best deal (c.f. Caviola *et al.*, 2017 on broader mathematical processing under time pressure). Therefore, this study considers consumers ability to work out the best deal (deal competency) alongside numerical skills and related consumer behaviour and demographics.

## Background

There has been a large influx of promotional offers within the grocery sector, with various promotions being viewed as misleading, making it difficult for the consumer to determine the best deal (Babin *et al.*, 2004; Garaus *et al.*, 2015; Competition and Markets Authority, 2015). The nature of the promotion type and the related complexity of the calculation needed to evaluate the value of the promotion can impact consumers' ability to determine the best deal, for example, percentage-off discounts have been identified as potentially more difficult for consumers to compute, and more prone to error (Chen and Rao, 2007; DelVecchio *et al.*, 2007; Gordon-Hecker *et al.*, 2020).

Consumers may find it difficult to determine the best grocery deal for various circumstantial and demographic reasons, such as financial and time constraints, product availability and cognitive differences regarding numerical skills (Choi and Mattila, 2014; Lee *et al.*, 2015). Consumer ability to correctly calculate and appraise deals is particularly important for grocery (food and drink) items as these are necessary products which are bought in high volume and thus represent an ongoing significant proportion of the household budget. Budgetary constraints may be of heightened relevance to certain consumers, influencing the amount and types of food (and drink) they are able to buy, i.e. influencing the adequacy and the healthiness of their shopping basket.

In response to concerns about misleading grocery prices, in 2015 the Competition and Markets Authority (CMA) introduced unit pricing to stores in the United Kingdom (UK) to allow consumers to compare prices of groceries (CMA, 2015). Unit pricing refers to the display of the cost of products per unit of weight, or volume, to allow consumers to compare product costing (Bogomolova *et al.*, 2020), i.e. unit pricing enables consumers to look past the promotional offer and see how much the product costs per (e.g.) 100 g, so that they can confirm the value offering of the product in comparison to alternatives. Unit pricing is useful for consumers as it can allow them to more quickly make a value related decision to complete their shopping task. For retailers, unit pricing can potentially increase customer satisfaction and improve store image (Yao and Oppewal, 2016). Unit pricing is widely used globally, but while mandated in some regions, such as the UK, the European Union, Australia and some states in the United States, it is not mandatory in all regions where it is used (Sefcik and Hockert, 2014; EUR-lex, 2020; ACCC, 2020).

While unit pricing offers consumers the opportunity to draw meaningful pricing comparisons between products, the UK government highlighted specific concerns relating to the inconsistent reporting of unit pricing, specifically in relation to, "*the legibility of unit prices, inconsistencies for units of similar products and missing unit prices when there is a promotion*" (Competition and Markets Authority, 2015, p. 10). These concerns not only cause unnecessary confusion for consumers when making comparisons between different products, irrespective of brand, size, and any ongoing promotional activity but highlight the need for consumers to possess the appropriate numerical proficiency when information is missing, and pricing inconsistencies arise during a grocery shop. Therefore, to determine the best grocery deals, consumers also need to obtain positive proficiency skills such as numeracy and problem solving. Numeracy and mental calculation skills can be viewed as important life skills for consumers to uphold, allowing consumers to compare prices regarding products and services (Sauble, 1955; Tan and Bogomolova, 2016). However, these skills can largely fluctuate amongst consumers in terms of age, gender and educational status (OECD, 2012). Within the UK, the most recent government research survey on adult skills (*Skills for Life Survey: A Survey of Literacy, Numeracy and ICT Levels in England*) found that between 2003 and 2011, numeracy skills displayed a decline and that it is most noticeable in the oldest generation. Further results revealed that numerical skills were lower amongst women (Department for Business, Innovation and Skills, 2012). The OECD (2012) also reported a high proportion of adults scoring at or below Level 1 in numeracy across England and Northern Ireland (NI), meaning that they can only perform basic mathematical processes in common concrete contexts (OECD, 2012).

Research has found that higher levels of numerical skills predict a more thorough decision-making process in a retail setting, and thereby influence the quality of the purchase decision (Graffeo *et al.*, 2015). On the other hand, having a low level of numerical skills can result in various negative outcomes in a retail setting. Difficulties locating prices on products and in accurately reading and computing numerical information can result in consumers reducing their product choices, making product choice decisions based on one attribute, in spending unusually long periods of time making product decisions, and in choosing the

option that offers least value (Gau and Viswanathan, 2008). Lower levels of numerical skills and related difficulties in the retail store can also result in negative affective outcomes such as feelings of frustration and hopelessness and can lead to implementation of various coping strategies such as choosing stores with fewer choices and depending on others to help (Gau and Viswanathan, 2008).

Those with lower educational qualifications are likely to have lower numerical skills (Department for Business, Innovation and Skills, 2012). This is problematic due to the link between lower education and lower income (Stryzhak, 2020), as complex promotional calculations which are misjudged by consumers could result in some spending more than they anticipated. This suggestion is justified by study findings which demonstrate that consumers will make more purchases and generate more revenue/profit for retailers when more complex promotional pricing strategies are used, such as sequential percentage discounts as opposed to single percentage discounts (Chen and Rao, 2007; Competition and Markets Authority, 2015; Amor, 2016). Difficulty calculating the best "deal" or best value option may be particularly problematic for those who are shopping within a particular specified budget for a household.

Zorbas *et al.* (2020) conducted a study on household purchasing patterns of price promoted and generic branded foods and found that a significantly greater proportion of purchases made by low- and middle-income households were price promoted and generic branded compared to high-income households, a pattern generally observed across food categories. Although Zorbas *et al.* (2020) did not use education as a mediating variable in their study, nor did they examine numerical skills, it could be considered that those in higher income households could have had higher education/numerical skills, and perhaps made calculated judgements regarding whether promotional items were a better offer than buying at the usual unit price. Tan and Bogomolova (2016) examined ability to comprehend numeric price promotions and found both age and income to be significant factors impacting on comprehension, indicating that young consumers with low-income were most likely to have difficulty accurately computing promotional offers. Although it has been indicated that numerical skills are differentiated by gender (Department for Business, Innovation and Skills (2012), Tan and Bogomolova (2016) found no significant difference in gender and ability to calculate price promotions. The link between gender and numerical skills/ability to calculate price promotions is of interest to further examine, considering that despite indication females have lower numerical skills than males (Department for Business, Innovation and Skills, 2012), and despite maths and numerical skills often being viewed as a "males subject", with 71% of men describing themselves as good/excellent at numeracy compared to 59% of women (Stanford, 2012), in many households females still carry the role of the main household shopper, with recent research finding that 77% of women (in a UK adult sample) carry out this task (Maynard, 2021). Therefore, it is of interest to compare how numerical skills and ability to work out the best deal on promotion is potentially differentiated by gender.

The overall aim of this study is to investigate the effect of consumer's numerical skills on their deal competency, and how both these variables relate to the demographic variables of education, age and gender. For the purposes of this study, "numerical skills" refers to the subjective appraisal of consumers quantitative ability, measured using an existing validated scale, the subjective numeracy scale (SNS) (Fagerlin *et al.*, 2007). "Deal competency" for the purposes of this study refers to the ability of consumers to work out the best deal, measured using a novel measure which was informed by Hollywood *et al.* (2016). To the best of our knowledge, there has been no study conducted on consumers' numerical literacy which has focused exclusively on the purchase of grocery items. There further exists a gap relating to how numerical skills and deal competency vary according to various demographic characteristics. Considering previous findings regarding how numerical skills can affect shopping behaviour, it is also of interest to examine if a significant relationship exists

between numerical skills and deal competency and various consumer shopping behaviours such as amount and time spent in store, and behaviour relating to promotions. Specific research questions therefore are as follows:

*RQ1.* What is the relationship, if any, between numerical skills, deal competency and the demographic characteristics of gender, age and education?

*RQ2.* Is there a significant relationship between numerical skills and deal competency?

*RQ3.* Is there a significant relationship between numerical skills, deal competency and consumer grocery shop buying behaviour (amount of money spent, amount of time spent and behaviour relating to promotions)?

## Methods

An online survey was used to collect data from consumers. The survey was administered through the software program Qualtrics, and a convenience sample was used whereby the survey link was disseminated via email to undergraduate students within one university department and via social media (Twitter and Facebook) by members of the research team. This survey was further endorsed by the Consumer Council for NI who shared the survey web link to their consumer panel and across their social media channels. A total of 308 people completed the survey. The only screening criteria for this survey was that respondents should be 18 years or older. As the survey was disseminated online and as the scope of the study was interested in consumers generally rather than a specific respondent profile, there was no constraint on geographic location of respondents.

### *Survey design and measures*

The survey consisted of four sections: demographic information, grocery shopping behaviour, numerical literacy evaluation (as measured by the SNS (Fagerlin *et al.*, 2007)) and questions examining consumer ability to work out the best deal on promotion (deal competency) (as measured using a novel scale – see further elaboration below). Regarding demographics, this survey wanted to explore if there were consumer group differences (i.e. between genders, age groups and educational achievement) and numerical ability. The second section focused on self-reported grocery shopping behaviour to examine the level of the respondent's responsibility for grocery shopping in the household; how long they spend on a shop and their purchase intentions/attitudes towards promotions. Thirdly, the survey measured consumers numerical literacy using the *SNS* (Fagerlin *et al.*, 2007), a validated eight-item scale constructed to subjectively measure consumers quantitative ability. The scale has eight-items: four relating to cognitive ability, for example "*How good are you at working with fractions*?"; and the other four items relate to preference for display of numeric information, for example "*When reading the newspaper, how helpful do you find tables and graphs that are parts of a story*?". Each of the responses eight-item SNS scale questions was scored on a six-point Likert scale, with higher scores indicating higher numerical ability (apart from one question which was reverse ranked). The reverse ranked question was reverse coded to create a new variable for use in analysis. All eight SNS items were computed to create a total SNS score ranging from a minimum of eight, to a maximum of 48, with the higher scores indicating higher numerical skills. The SNS was chosen for use in this study as it has been found to correlate well with objective measures of numerical skills, but is quicker and easier to administer, thereby reducing respondent burden and making it more likely they will finish completing the survey (Fagerlin *et al.*, 2007). The fourth section examined consumer's *deal competency* regarding food and drink promotion using a novel exploratory scale measure constructed for the purposes of this study. This measure involved an experimental task that required respondents to assess (without using a calculator) which of

the two options presented in each question was the better deal. The measure consisted of 16 questions, divided into four categories corresponding with the types of promotional offers most commonly used by grocery retailers, as identified by Hollywood *et al.* (2016). These included: price reductions, standalone offers, multi buys and mix and match deals. Each of the 16 questions relating to ability to discern the best promotional offer had two question responses: the correct answer (coded "1") and the incorrect answer (coded as "0"). Participant answers were then totalled to calculate "deal competency", with possible scores ranging from 0 to 16, with the higher scores indicating better deal competency. The authors recognise further testing for the reliability and validity of this scale is required using a representative sample. However, the development of this experimental scale is useful in providing some exploratory insight into people's ability to work out the best deal.

*Data analysis*

Data were analysed using SPSSv26. Following checks that the relevant assumptions were met, multiple regression analysis was used to examine the relationship between numerical skills and the demographic variables of gender, age and education (two education variables were included–highest educational achievement and highest mathematical achievement). A Poisson regression was used to assess the relationship between deal competency and the same demographic variables. Correlations (both Pearson and Spearman, as appropriate) were used to examine the relationship between numerical skills and ability to discern the best promotional offer on grocery products (deal competency), and other grocery shopping behaviours. Adjustments for multiple comparisons were made using Bonferroni corrections.

*Ethics*

Ethical approval was granted from the Ulster University Ethics Committee. No individuals under the age of 18 were obliged to complete this survey and this was clearly outlined in the survey guidelines. All information remained strictly confidential as no names or contact details were provided on the questionnaire.

## Results

*Respondent demographics*

A total of 308 respondents (Table 1) completed the survey. The majority of the sample (82%) was from NI, 10.4% were from the Republic of Ireland, 6.5% were from regions in the UK other than NI, and a smaller number of participants were from Europe ($n = 3$) and Canada ($n = 1$). Over two-thirds of the sample (69%) was female, and regarding age, 57% were in the younger age groups, aged between 18 and 34. Almost half (47%) of respondents were in full time employment, while 30% were employed part time. There were a greater proportion of single individuals (59%) in the sample versus married (29%), and over half of respondents (57%) of respondents had no dependents living in their household. There was representation of respondents across social grades, with 56% of respondents categorised as ABC1 consumers (i.e. consumers from one of the three higher social and economic groups), therefore social/economic representation in this survey was fairly comparable to the UK as a whole which categorises 57% of consumers as ABC1 (Smith, 2019). Regarding mathematical achievement, 71% of participants achieved GCSE level maths or equivalent, and in terms of educational achievement, 40% of participants had attained a bachelor's degree while for 25% their highest educational achievement was secondary level.

*Respondent buying behaviour*

A total of 42% of respondents indicated that they were the principal household shopper, with a further 22% classifying this as a shared responsibility. Results showed that 67% of

| | Percentage |
|---|---|
| *Age* | |
| 18–24 | 44% |
| 25–34 | 23% |
| 35–44 | 14% |
| 45–54 | 15% |
| 55–64 | 4% |
| *Gender* | |
| Male | 31% |
| Female | 69% |
| *Location* | |
| United Kingdom | 89% |
| Republic of Ireland | 10% |
| *Occupation* | |
| Student | 34% |
| Unemployed | 2% |
| Homemaker/Retired/Carer | 6% |
| Part time employment (up to 29 h) | 12% |
| Full time employment (30+ hours per week) | 47% |
| *Marital status* | |
| Single | 59.11% |
| Married/Cohabiting | 38% |
| Divorced/separated/widowed | 3% |
| *No. of dependents in the household* | |
| 0 | 58% |
| 1 | 13% |
| 2 | 15% |
| 3+ | 15% |
| *Highest level of mathematical achievement* | |
| Key stage 3 maths | 3% |
| Maths GCSE (or equivalent) | 71% |
| Maths AS level | 2% |
| Maths A level | 16% |
| University degree | 7% |
| Career related to mathematics | 2% |
| *Highest level of educational achievement* | |
| Primary school | 1% |
| Secondary school | 25% |
| Apprenticeship/NVQ level 2 or 3 | 11% |
| Bachelor degree | 40% |
| Postgraduate degree (e.g. PGCE, Masters or PhD) | 19% |
| *Social grade** | |
| A–high managerial, administrative or professional | 8% |
| B–Intermediate managerial, administrative or professional | 34% |
| C1 - Supervisory, clerical and junior managerial, administrative or professional | 14% |
| C2 - Skilled manual workers | 13% |
| D–Semi and unskilled manual workers | 27% |
| E–state pensioners, casual or lowest grade workers and unemployed with state benefits only | 5% |

**Note(s):** *Occupations cited by respondents were categorised according to the six main social grades (NRC, 2021)

**Table 1.** Respondent demographics

respondents spent £100 or less on their main weekly grocery shop, with approximately £65 being spent per week on the main grocery shop, and approximately £18 being spent per week on a top-up shop (Table 2). Regarding duration of the grocery shop, 46% of participants reported spending on average between 11 and 30 min carrying out the main grocery shop (Table 3), with 24% spending between 11 and 20 min on carrying out a top-up shop (Table 4). Most respondents (93%) stated they purchased promotional food items during a grocery shop. Overall, the mean SNS score for the total sample was 31.37 (SD = 8.27), and mean sample deal competency score was 13.49 (SD = 2.34) (Table 2).

*Relationship between numerical skills and demographic variables*

A multiple linear regression was conducted with predictor variables of gender, age, highest level of mathematical achievement and highest level of educational achievement (Table 5). The model was a significant fit ($F(4) = 7.77, p < 0.001$) and explained 9.4% of the variance in

**Table 2.** Summary descriptive statistics

| | Mean (SD) | Min | Max |
|---|---|---|---|
| Subjective numeracy scale score | 31.37 (8.27) | 8 | 48 |
| Deal competency score | 13.49 (2.34) | 6 | 16 |
| Average spend on main grocery shop per week (£) | 64.93 (40.10) | 0 | 250 |
| Average spend on promotional food items in main grocery shop per week (£) | 19.22 (20.19) | 0 | 203 |
| Average spend on top-up shop per week (£) | 17.72 (14.17) | 0 | 100 |
| Average spend on promotional food items in top-up grocery shop per week (£) | 7.78 (20.04) | 0 | 202 |

**Table 3.** Frequency of responses to "On average, how long did you spend on your last grocery shop?"

| | *N* (%) |
|---|---|
| 5–10 min | 37 (12.0) |
| 11–30 min | 142 (46.1) |
| 31–60 min | 114 (37.0) |
| More than 60 min | 15 (4.9) |

**Table 4.** Frequency of responses to "On average, how long did you spend on your last top-up grocery shop?"

| | *N* (%) |
|---|---|
| Less than 5 min | 83 (26.9) |
| 6–10 min | 133 (43.2) |
| 11–20 min | 75 (24.4) |
| More than 20 min | 17 (5.5) |

**Table 5.** Linear regression predicting numerical skills

| Adjusted $R^2$ | 0.082** | |
|---|---|---|
| Predictors | Unstandardised *B* | *t* |
| Age | 1.37 | 0.17 |
| Gender | 0.149* | 2.70 |
| Highest level of mathematical attainment | 3.19* | 0.002 |
| Highest level of educational attainment | 2.46 | 0.014 |

**Note(s):** ** < 0.001; * < 0.05

numerical skills as measured by the SNS (adjusted $R^2 = 0.082$). Numerical skills were positively associated with being male ($B = 2.67$; $t = 2.70$; $p = 0.007$), and with highest level of mathematical achievement ($B = 1.33$; $t = 3.19$; $p = 0.002$). Age and highest educational achievement were not significant unique predictors of numerical skills.

*Relationship between deal competency and demographic variables*

A Poisson regression was conducted with predictor variables of gender, age, highest level of mathematical achievement and highest level of educational achievement and outcome variable of deal competency score. Goodness of fit statistics indicated that model fit was poor (deviance, value/df = 0.369). Omnibus results indicated that the model was not statistically significant ($p = 0.084$). Therefore, further interpretation of the model was not possible. Chi squared analyses indicated that there was no significant association between deal competency and gender, $X^2(10, N = 273) = 11.47$, $p = 0.322$, or with age, $X^2(50, N = 273) = 50.38$, $p = 0.458$. However, there were significant positive associations between highest level of education and deal competency score, $X^2(50, N = 273) = 72.31$, $p = 0.021$ and between highest level of mathematical achievement and deal competency score, $X^2(50, N = 273) = 70.65$, $p = 0.029$.

*Numerical skills and deal competency*

A Spearman's correlation analysis identified a moderate significant positive relationship between numerical skills and deal competency, $r_s(303) = 0.360$, $p < 0.001$ (Table 6). A scatterplot (Figure 1) was used to further examine the relationship between both variables, indicating that higher numerical skills were associated with higher deal competency scores.

| | | Deal competency score | Average spend on main grocery shop per week | Average spend on promotional food items in main grocery shop per week | Average spend on top-up shop per week | Average spend on promotional food items in top-up grocery shop per week |
|---|---|---|---|---|---|---|
| SNS score | *r* | 0.360[a] | −0.011 | −0.068 | 0.044 | 0.014 |
| | *p* | <0.001* | 0.868 | 0.276 | 0.527 | 0.841 |
| | *N* | 271 | 249 | 256 | 211 | 210 |
| Deal competency score | Rho | | 0.050[a] | 0.007[a] | 0.022[a] | −0.195[a] |
| | *p* | | 0.429 | 0.912 | 0.749 | 0.005 |
| | *N* | | 250 | 257 | 211 | 210 |
| Average grocery shop spend per week | *r* | | – | 0.545 | 0.526 | 0.268 |
| | *p* | | | <0.001* | <0.001* | <0.001* |
| | *N* | | | 247 | 205 | 204 |
| Average spend on promotional food items in main grocery shop per week | *r* | | – | – | 0.399 | 0.526 |
| | *p* | | | | <0.001* | <0.001* |
| | *N* | | | | 207 | 208 |
| Average spend on top-up shop per week | *r* | | – | – | – | 0.581 |
| | *p* | | | | | <0.001* |
| | *N* | | | | | 205 |

**Note(s):** [a]Spearman correlations, all other correlations are Pearson; * Remains significant after correction for multiple comparisons

**Table 6.** Correlations between numerical skills, deal competency and average spend per week

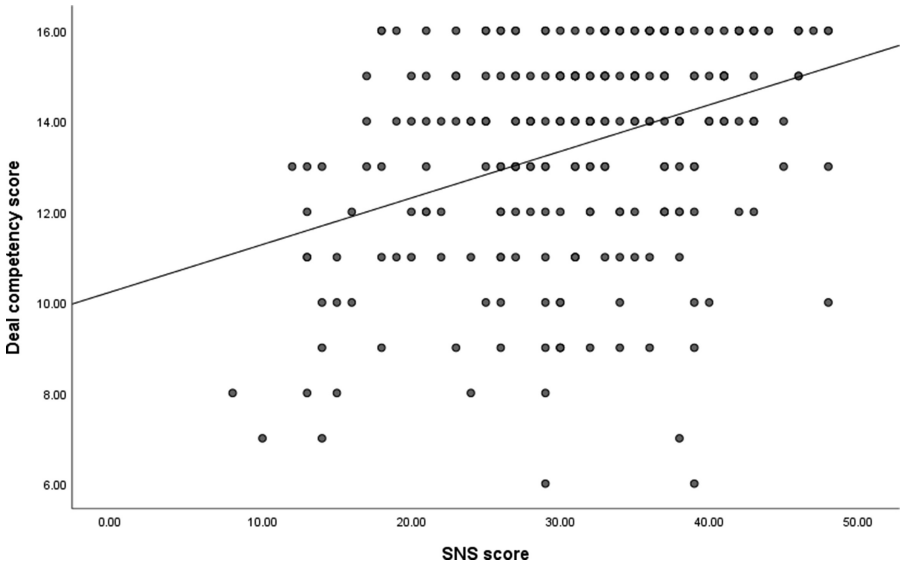



**Figure 1.**
Scatterplot of relationship between deal competency score and numerical skills

*Numerical skills, deal competency and consumer buying behaviour*

Correlation analyses (both Pearson and Spearman, used as appropriate) did not, on the main, identify significant correlations between numerical skills (SNS) and deal competency scores and average spend on grocery and top up shops (Table 6). Lower deal competency scores were significantly associated with increased average spend on promotional food items in top-up grocery shop, $r_s(208) = -0.195$, $p = 0.005$ Pearson correlation analyses identified significant correlations ($p < 0.001$) between variables relating to average consumer spend on grocery and top up shops (Table 6).

Results of Spearman correlation analyses indicated no significant relationships (after correction for multiple comparisons) between numerical skills, deal competency and variables relating to time consumers spend on grocery and top up shops (Table 7). Regarding the relationship between times spent and money spent when shopping, analyses indicated that there were significant relationships between time spent on main and grocery shops, and average amount spent on these shops (Table 7). However, there was no significant relationship between time spent on main and grocery shops and average spend specifically on promotional food items (Table 7).

An independent samples *t*-test indicated that there was no significant difference between people who do and do not purchase foods on promotion both in terms of numerical skills ($p = 0.072$) and deal competency score ($p = 0.148$). Further correlation analysis (both Pearson and Spearman as appropriate) indicated no significant relationships between numerical skills and deal competency and variables relating to consumer buying behaviour and promotions after correcting for multiple comparisons (Table 8). Spearman correlation analyses established that the majority of variables relating to consumer buying behaviour and promotions were correlated with each other (Table 8).

## Discussion

There was a moderate, significant correlation between numerical skills and deal competency. Being male and having a higher level of mathematical achievement were

| | | Time spent on main grocery shop | Time spent on top-up grocery shop |
|---|---|---|---|
| SNS score | Rho | 0.033 | 0.031 |
| | *p* | 0.571 | 0.585 |
| | *N* | 305 | 305 |
| Deal competency score | Rho | 0.120 | 0.023 |
| | *p* | 0.047 | 0.699 |
| | *N* | 273 | 273 |
| Average grocery shop spend per week | Rho | 0.277 | 0.059 |
| | *p* | <0.001* | 0.349 |
| | *N* | 252 | 252 |
| Average spend on promotional food items in main grocery shop per week | Rho | 0.054 | −0.130 |
| | *p* | 0.383 | 0.037 |
| | *N* | 259 | 259 |
| Average spend on top-up shop per week | Rho | 0.173 | 0.213 |
| | *p* | 0.011 | 0.002* |
| | *N* | 213 | 213 |
| Average spend on promotional food items in top-up grocery shop per week | Rho | −0.038 | −0.018 |
| | *p* | 0.579 | 0.793 |
| | *N* | 212 | 212 |
| Time spent on main grocery shop | Rho | – | 0.370 |
| | *p* | | <0.001* |
| | *N* | | 308 |

**Note(s):** *Remains significant after correction for multiple comparisons

**Table 7.** Spearman correlations between numerical skills, deal competency score and time spent shopping

identified as significant predictors of numerical skills, while we could not identify significant predictors of deal competency. The finding that being male was a significant predictor of numerical skills appears to accord with previous findings that males have a greater level of numerical skills (Department for Business, Innovation and Skills, 2012). Further study should therefore assess group (gender) differences to confirm (or disconfirm) this finding. Males' greater numerical skills did not however translate through to deal competency, as findings indicated that there is no significant difference in the accuracy of how males and females compute information relating to promotions. As the numerical skills measurement was subjective, and the deal competency measurement objective, it is possible that males may have overestimated their numerical capabilities on the subjective measure, thereby perhaps explaining why the finding that males had a greater level of numerical skills did not translate through to deal competency. Therefore, future studies should examine numerical skills using both subjective and objective measures. As females have been identified as often being the household primary shopper (Mintel, 2014; Maynard, 2021), it is possible that they have a greater aptitude for working out promotions, having more experience making similar calculations in a grocery environment, thus perhaps contributing towards explaining the finding that there was no significant difference between males and females deal competency scores, despite males being found to have greater numerical skills. Findings also suggest that older participants are more adept at working out promotions (indicated by deal competency score). Therefore perhaps it can also be hypothesised that older consumers have more experience with grocery shopping and are more accustomed to working out promotions than those in the youngest age category (18–24) who may live in a household where someone else is responsible for the grocery shopping (e.g. a parent), or if they are buying for themselves (i.e. a single household) they may be less likely to frequently be choosing bulk buying promotional items as they are buying a lower volume of goods.

| | | Deal competency score | I shop around for special offers | I check newspapers and fliers for the best offers | I shop at a number of supermarkets for their best offers | Number of items in main grocery shop on promotion per week | Number of items in top-up grocery shop on promotion per week |
|---|---|---|---|---|---|---|---|
| SNS score | Rho | 0.360 | −0.011 | −0.052 | −0.009 | −0.047[a] | −0.014[a] |
| | *p* | <0.001* | 0.845 | 0.366 | 0.872 | 0.449 | 0.829 |
| | *N* | 271 | 305 | 305 | 305 | 259 | 255 |
| Deal competency score | Rho | – | −0.101 | −0.095 | 0.003 | −0.039 | −0.123 |
| | *p* | | 0.097 | 0.118 | 0.960 | 0.532 | 0.050 |
| | *N* | | 273 | 273 | 273 | 260 | 256 |
| I shop around for special offers | Rho | – | – | 0.326 | 0.644 | 0.243 | 0.178 |
| | *p* | | | <0.001* | <0.001* | <0.001* | 0.004 |
| | *N* | | | 308 | 308 | 262 | 258 |
| I check newspapers and fliers for the best offers | Rho | – | – | – | 0.422 | 0.208 | 0.135 |
| | *p* | | | | <0.001 | 0.001 | 0.030 |
| | *N* | | | | 308 | 262 | 258 |
| I shop at a number of supermarkets for their best offers | Rho | – | – | – | – | 0.207 | 0.212 |
| | *p* | | | | | 0.001* | 0.001* |
| | *N* | | | | | 262 | 258 |
| Number of items in main grocery shop on promotion per week | *r* | | | | | | 0.760[a] |
| | *p* | | | | | | <0.001* |
| | *N* | | | | | | 253 |

**Note(s):** [a]Pearson correlations, all other correlations are Spearman; *Remains significant after correction for multiple comparisons

**Table 8.**
Correlations between numerical skills, deal competency and shopping behaviour

Regarding education, the finding that mathematical achievement was related to numerical skills accorded with previous research (Department for Business, Innovation and Skills, 2012). The relationship between mathematical achievement and deal competency logically indicates that those with higher mathematical achievement will be better equipped to make accurate decisions about promotions. However, as a substantial number of the population have below average numerical skills (OECD, 2012), it is important that retailers are conscious to implement promotions which are as clear as possible for consumers, minimising risk of confusion, especially for those who may struggle to calculate the best deal (Competition and Markets Authority, 2015). Complex pricing strategies can be viewed negatively by consumers (Amor, 2016). Therefore, clarity around pricing and clear promotions can positively affect how consumers view a retailer and simplify their shopping decisions improving customer satisfaction and increasing repeat store visits.

Although there were no significant relationships between numerical skills and consumer buying behaviour, or between deal competency and consumer buying behaviour, it is acknowledged that one limitation of this experimental study is a relatively small sample size, and therefore in a larger sample significant effects may be observed. Although no significant relationships between deal competency and consumer buying behaviour were identified, as the scale is novel and has not been validated we cannot conclusively state that deal competency does not impact on consumer behaviour, and instead recommend further

refining of the scale, i.e. more clearly defining and operationalising "deal competency" in an updated measure, and further testing to assess validity and reliability.

Regarding the implications of this study, awareness of how consumers differ in their numerical skills levels can incentivise retailers to be socially responsible and to empower consumers to make the best choice by providing clearer messaging around price promotion savings. This agenda however competes with retailers' understandable corresponding goal of making profit. If consumers are misled by promotions or choose options offering less value this will be more profitable for the retailer. However, legislation on unit pricing and other recommendations by the Competition and Markets Authority (2015) following a complaint by consumer advocacy body "Which?" which encourages retailers to empower consumers by acting responsibly regarding pricing and promotional strategies. The study findings that consumers do differ in their level of numerical skills and in their ability to calculate the best deal contributes to the rationale for the use of mandatory unit pricing, however some limitations have been identified with unit pricing, such as legibility of unit prices, inconsistency of unit pricing, missing unit prices for promotional items and infrequent use of unit pricing by consumers (Competition and Markets Authority, 2015). Addressing these issues with unit pricing and raising consumer awareness of unit prices and their benefits can assist consumers in working out the best deal. The research also suggests some implications for consumer education, particularly amongst younger consumers. It may be advantageous to include teaching and evaluation of skills related to calculating promotions on the curriculum for all students, as budgeting and money skills are an important life skill. Students who study home economics and maths will learn these skills but those who do not pursue these subjects beyond basic required levels at school may be less equipped and have lower consumer efficacy in the future. Equipping consumers with the ability to make the best decisions as relate to value when purchasing food grocery items, can be considered to further accord with Cullen's (2015) conceptualisation of "food literacy" as the positive relationship built through social, cultural and environmental experiences with food enabling people to make decisions that support health, if ability to purchase the best deal on promotion facilitates making healthier food choices. Increasing consumer numerical skills and applying this knowledge to grocery shopping decision making therefore has potential to remove barriers to more healthful grocery shopping (Hollywood *et al.*, 2013). Several studies have found price to be a primary influencing factor when grocery shopping (Glanz *et al.*, 1998; Maillot *et al.*, 2007; Waterlander *et al.*, 2019), and that this attribute is particularly important for low-income consumers who may be less concerned about the healthiness of food (Jetter and Cassady, 2006; Drewnowski *et al.*, 2007; Maillot *et al.*, 2007). As price promotions have potential to influence population health through influencing consumption of certain food categories (Hollywood *et al.*, 2016; Furey *et al.*, 2019), consumer comprehension of promotions, and related influence of numerical skills is a research topic of interest not only from retail management, pricing strategy and consumer education perspectives, but also from a population health perspective. Further consideration is therefore recommended with regards to how best to educate consumers and provide them with the agency and skills to choose the best deal when grocery shopping, in accordance with their needs and budget, particularly for those consumers with lower levels of numerical skills (and literacy) who have been identified as being underrepresented in research, and with experiencing greater challenges and reliance on coping strategies when making purchase decisions in the retail environment (Gau and Viswanathan, 2008).

## Conclusion

This study identified a positive relationship between numerical skills and deal competency, indicating that those with greater numerical skills will be more adept at working out the best deal in store. Those with lower numerical skills are therefore at a disadvantage in the retail

environment with regards to making an informed decision. Although retailers have competing priorities with regards to maximising sales and increasing profits, it is nonetheless recommended that standardised unit pricing and clear promotional strategies should be used by retailers to empower consumers and build store trust; and thereby increasing store repeat visits and sales. Although this study did not find numerical skills and deal competency to have any significant relationship with consumer buying behaviour variables considered, findings regarding demographic differences with regards to numerical skills and deal competency accord with the above recommendation, and further rationalise the suggestion for increasing consumer education around making the most informed decision in store with regards to cost savings, for example related education in schools. Educating consumers and empowering them with the skills and knowledge to make informed choices in a grocery shopping environment is useful to aid consumers shopping on a budget, particularly low-income consumers, and has the potential to encourage more healthful grocery shopping, if price is a perceived barrier to making healthy choices, thereby consumer education with regards to numerical skills and deal competency can further contribute towards public health agendas for the population.

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