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The Impact of the Temperament Trait of Sensory Processing Sensitivity and Different Environments on Psychological Wellbeing and Cognition

Study 1: The Effect of Environment on Psychological Outcomes of the Highly Sensitive Person: A Systematic Scoping Review

Study 2: Impact of the Temperament Trait of Sensory Processing Sensitivity and a Virtual Environmental Intervention on Cognition and Affect

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Thesis submitted in partial fulfilment of the requirements

for the degree of Doctor of Clinical Psychology

School of Applied Psychology

University College Cork

Supervisors: Dr Annalisa Setti and Dr Mike Murphy

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May 2022

Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

Signed: 

Date: 05/05/2022

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List of Commonly Used Abbreviations

SPS	Sensory Processing Sensitivity
HSP	Highly Sensitive Person
EOE	Ease of Excitation
LST	Low Sensory Threshold
AES	Aesthetic Sensitivity

Chapter One: Introduction

Context and Overview

Sensory Processing Sensitivity (SPS) is a temperamental trait which involves increased sensitivity of the central nervous system to physical, social, and emotional stimuli, which are more deeply processed than in lower sensitive individuals (Boterberg & Warreyn, 2016). Those with higher levels of the trait are considered to be a highly sensitive person (HSP), a phrase coined in the mid-1990s by the developers of the Highly Sensitive Person Scale (HSPS) Elaine and Arthur Aron (Aron & Aron, 1997). SPS can be categorised into three different categories, those with low SPS, medium levels of SPS, and those with high levels of SPS, also known as a "HSP" (Lionetti et al., 2018). HSP individuals represent a significant minority of the population, with studies suggesting that between 20% and 30% of individuals have high levels of SPS (Aron & Aron, 1997; Lionetti et al., 2018).

Higher levels of SPS can confer both benefits and disadvantages to individuals. They can thrive in certain environments, yet in others can struggle. These individuals display higher levels of empathy and emotionality, but they have also been found to struggle more with mental health issues such as anxiety and depression (Aron et al., 2012; Liss et al., 2005). One possible mechanism behind this is thought to be the cognitive process of rumination (Lionetti et al., 2021; Wyller et al., 2017). In agreement with this idea, those with higher levels of SPS have also been shown to have differences in their cognitive processes, with self-reported higher levels of rumination and with fMRI studies demonstrating that brain activation differs in those with higher levels of SPS (Acevedo et al., 2018; Bas et al., 2021).

Considering the different types of environment, those with higher levels of SPS have noted in previous research a feeling of needing connection with the environment and have higher levels of nature connectedness (Black & Kern, 2020; Setti et al., 2022). However,

there is a dearth of research into the relationship between the trait of SPS and exposure to nature and the environment, though the research around the benefits of nature exposure is widespread, and the benefits well supported in the literature in general (e.g., Coventry et al., 2021; Kotera et al., 2020; Yao et al., 2021).

This thesis explored the relationship between SPS, the environment, and psychological outcomes. Specifically, it explored how the environment and aspects thereof can interact with SPS and impact on the psychological wellbeing, be it cognitive or affective, of individuals with high levels of SPS. This thesis is comprised of two research papers exploring this topic. The first research paper is a systematic scoping review exploring the impact of different environments on the psychological wellbeing of those with higher levels of SPS. Sixty-three studies were synthesised following guidelines for scoping reviews and using thematic analysis. The second research paper is an original empirical study on the impact of a short virtual nature intervention on the affect and cognition of individuals with varying levels of SPS and examining the unique role of SPS in outcomes. This was a mixed methods study, utilising an online survey experiment.

Outline of Chapters

The thesis is structured as follows:

Chapter Two: Systematic Scoping Review

This chapter presents the process and the results of a systematic scoping review on the impact of different environments on the psychological wellbeing of those with high levels of SPS, in the form of a journal article written for *The Journal of Mental Health*. Author guidelines for this journal are provided in Appendix A, and references are presented at the end of the chapter.

Note: How the Systematic Scoping Review Informs the Major Research Project

This section gives a brief overview of how the systematic scoping review informs the major research project, and links between these aspects of the thesis.

Chapter Three: Systematic Scoping Review Extended Methodology

This chapter provides additional information which pertains to the systematic scoping review, including background information on the use of scoping reviews as well as the process of the current review, including information on the search strategy, the criteria used in the review, and on the analysis of results using thematic analysis. Examples of coding are also provided.

Chapter Four: Major Research Project

In this chapter, the major research project is presented, which explored the impact of a short virtual nature intervention on affect and cognition, and how levels of SPS might affect outcomes. This is written in the form of a journal article for *Current Psychology.* Author guidelines for this journal are presented in Appendix B.

Chapter Five: Major Research Project Extended Literature Review

This chapter contains a review of the literature on the relationship between nature and psychological wellbeing, and further explores the research around SPS. Rationale for the major research project, and the aims of the major research project, are also explored.

Chapter Six: Major Research Project Extended Methodology

In this chapter, additional information with regards the methodology for the major research project which was not provided in Chapter Four due to wordcount constraints is provided. This chapter includes information around the theoretical framework of the

methodology, additional information around the tools used, the interventions, and the qualitive process including researcher reflexivity.

Chapter Seven: Major Research Project Extended Data Analysis

In this chapter, further relevant statistical analysis which was not included in the paper but provides context and further information of interest is presented, as well as information around the decisions made in the statistical plan.

Chapter Eight: General Discussion and Conclusions

This chapter summarises the findings from both the systematic scoping review and the major research project. It further discusses the implications of the research and its unique contribution to the literature around SPS and the impact of nature on psychological wellbeing.

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Chapter Two: The Effect of Environment on Psychological Outcomes of the Highly Sensitive Person: A Systematic Scoping Review

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Prepared in accordance with author guidelines for Journal of Mental Health. Author guidelines state that tables and figures containing study characteristics should be uploaded separately which will be published alongside the online version of the article. For ease of examination of the thesis, these tables and figures have been inserted in text.

Abstract

Those high in the temperament trait of Sensory Processing Sensitivity (SPS) tend to be more at risk of mental health issues such as internalising symptoms, anxiety, and depression due to their sensitivity to potentially unfavourable environments. They also thrive in favourable environments. A comprehensive review of the literature on different kinds of environment in relation to SPS and psychological outcome is lacking. We aimed to fill this gap by conducting a systematic scoping review to map existing research on the impact of different environments (physical, psychological, social) on psychological outcomes of those with high levels of SPS. It was conducted following the guidelines of Arksey and O' Malley (2005) and following the PRISMA-ScR checklist. Sixty-three studies were included in the final review. Studies were conducted in mainly WEIRD countries. Thematic analysis indicated that there are a variety of environments studied, including sensory, occupational, and social environments, and particularly parenting and childhood circumstance. SPS conferred both benefits and risks in different environments, with negative psychological outcomes being the most studied, and different aspects of sensitivity explored. This review demonstrates the need for further research systematically examining different kinds of environments in relation to high SPS and in more varied populations.

Keywords: highly sensitive person, highly sensitive child, sensory processing sensitivity, environment, mental health, wellbeing.

Introduction

Background

Mental health is an important public concern, with mental health disorders affecting around 10.7% of people around the world (Ritchie & Roser, 2018). Two of the most common mental health issues are anxiety disorders and depression, affecting 3.6% and 4.4% of the world's population respectively and contributing significantly to global disability (WHO, 2017). Importantly, a recent systematic review on the impact of COVID-19 on mental health suggests the global prevalence of depression and anxiety to have risen to 28% and 26.9% respectively (Nochaiwong et al., 2021). Different models aiming to explain the aetiology of mental health issues, some focusing on specific disorders and others which take a broader focus on mental health, have been proposed. A model which has come to the forefront of research is the biopsychosocial model (Engel, 1977).

The biopsychosocial model posits that health and illness are a result of interactions between biological factors, psychological factors, social factors, and context. Research suggests that the environmental context of an individual has a role, alongside individual factors, in determining their mental health outcomes (Schmidt, 2007).

One research area which examines this interplay between the individual and their environment, and its subsequent effects, is that of Environmental Sensitivity (ES). ES is an umbrella term, covering theories which aim to explain the role of the individual-environment interplay in adjusting to environmental circumstances, as well as a term to reflect the differences in individuals' abilities in the registration and processing of environmental stimuli (Pluess, 2015). Theories and models falling under this umbrella include; the Diathesis-Stress model (Gottesman & Shields, 1967) also known as the dual-risk or transactional model which posits that mental and physical disorders develop from genetic or biological predispositions

combined with stressful conditions; Biological Sensitivity to Context (BSC) theory (Boyce & Ellis, 2005) which suggests that depending on one's psychobiologic reactivity to stress individuals differ in their susceptibility to environmental influence in a "for better or for worse" way; Differential Susceptibility (DS) theory (Belsky & Pluess, 2009) which suggests highly sensitive individuals have greater susceptibility to the environment and assumes an evolutionary point of view, and Vantage Sensitivity (VS) theory (Pluess & Belsky, 2013) which speaks to vantage resistance in positive environments without reference to negative environments. Another theory residing under this umbrella, and the focus of the current review, is that of Sensory Processing Sensitivity (SPS) (Aron & Aron, 1997). SPS specifically defines ES as resulting from a deeper perception and processing of stimuli. It has been extensively studied in relation to mental health outcomes.

SPS refers to an individual trait capturing individual differences in ES. Increased SPS is driven by a greater sensitivity of the central nervous system which in turn is associated with greater levels of sensitivity and responsivity to both social and environmental stimuli, which are processed more deeply (Acevedo et al., 2018). SPS is different from Sensory Processing Disorder (SPD). SPS refers to normal variations in the levels of a temperamental trait, whereas SPD refers to a disorder of sensory processing difficulties which impair an individual's functioning (Miller et al., 2007).

SPS is a continuously distributed trait, existing in individuals at different levels throughout the population (Greven et al., 2019). Those who are high in the trait are known as Highly Sensitive Persons (HSPs) and the Highly Sensitive Person Scale (HSPS; Aron & Aron, 1997) is used to measure the trait. Research on the percentage of HSPs in the population has it ranging between 20% to 30% (Aron et al., 2012; Lionetti et al., 2018; Pluess et al., 2018). HSPs are characterized by high levels of sensitivity to stimulation offered by the

environment and are identifiable by their heightened emotionality, their empathy, and their depth of processing i.e., HSPs are able to absorb more information from their surroundings than others can, and they analyse it more deeply (Aron et al., 2012). While the HSP scale has been designed to capture a unique individual trait, other investigations reported the existence of three components (Smolewska et al., 2006); Ease of excitation (EOE) i.e. feeling overwhelmed by internal and external demands, aesthetic sensitivity (AES) i.e. awareness of aesthetics in one's surroundings, and low sensory threshold (LST) i.e. unpleasant sensory arousal. These factors resulted post-hoc from analysis, but still capture increased sensitivity for both negative and positive stimuli, that is, they are consistent with the higher order construct of SPS. fMRI studies have reported that there is an association between SPS and activation of brain regions associated with social processing, reflective functioning, and empathy (Acevedo et al., 2014, 2017).

Research has found that HSPs tend to struggle more with mental health related issues, such as anxiety and depression, than their non-HSP counterparts, (e.g. Ahadi & Basharpoor, 2010; Benham, 2006; Jagiellowicz et al., 2019; Liss et al., 2005, 2008). Furthermore, SPS has been found to correlate positively with neuroticism in children and adults, and is moderately associated with negative affect in adults (Lionetti et al., 2019), defined by the authors as an amalgamation of anxiety, depression, stress, complaints and negative affect/emotions. Aron (2011) notes that HSPs are overrepresented in clinical practices, suggesting they represent close to 50% of clients in most psychotherapy practices, compared to 20-30% of the general population (Lionetti et al., 2018; Pluess et al., 2018), highlighting the psychological needs of this cohort. One possible link between SPS and poorer psychological outcomes is dysfunctional cognitive responses to environmental stimuli, such as rumination i.e., cognitive reactivity (Wyller et al., 2017). SPS has also been found to impact on cognitive tasks, for

example in Rigby et al. (2020), where EOE was a negative predictor of accuracy in classification of positive scenes in an evaluation of emotional scenes task.

While the possible disadvantages of having high levels of SPS have been discussed thus far, it is important to note that research has also found SPS to be a marker of behavioural plasticity in response to the environment and can, in the right conditions, confer benefits such as better emotional wellbeing and fewer issues with behavioural problems. This has been shown in both intervention studies (e.g., Nocentini et al., 2018; Pluess & Boniwell, 2015) and longitudinal studies (e.g., Slagt et al., 2018). For example, Lionetti et al. (2018) found that those higher in SPS had increased positive affect and were more susceptible to positive mood induction compared with those lower in SPS in a study utilising mood induction video clips.

The term 'environment' differs in meaning across research areas; in the realm of SPS research, the term is used to refer to any salient conditioned or unconditioned stimuli, be they internal or external, including; physical environments, social environments, sensory environments, and internal events both physiological and psychological (Greven et al., 2019). Many of the environments studied in SPS research contain combinations of these elements. Examples of environments studied in SPS to date include; the work environment (e.g., Andresen & Goldmann, 2016; Evers et al., 2008), the parenting environment (e.g., Aron et al., 2019; Slagt et al., 2018; Su et al., 2018), and intervention studies which impact on an individual's environment (e.g., Amemiya et al., 2020; Nocentini et al., 2018).

The environment clearly plays a large role in outcomes for those high in the trait of SPS; thus, identifying the specific environmental variables which could impact on the adjustment and functioning of those high in SPS is crucial, especially considering the sizable minority of the population who have high levels of SPS. While there is interest in the area from media and the public, and the research in the area has grown in recent years, applied scientific

research is lagging behind in some areas (Greven et al., 2019). Research into the area has grown globally, with studies from, for example; Kibe et al. (2020) in Japan, Tillmann et al. (2018) in Germany, Grinapol et al. (2022) in Israel, and Weyn et al., (2019) in Belgium.

The aim of this scoping review is to identify what types of environmental variables have been explored in relation to HSP, the kinds of psychological outcomes found in HSPs, the research design of the studies in the area, and to identify future directions of research. Psychological outcomes include mental health itself, mood state, and cognitive functioning.

Key definitions

Environment: In the context of this review, 'environment' refers to any salient conditioned or unconditioned stimuli; internal or external, including but not limited to: physical environments, social environments, sensory environments, and internal events both physiological and psychological – as per Greven et al. (2019).

Psychological outcomes: In the context of this review, psychological outcomes encapsulate three different constructs, including psychological measures assessing (i) indicators of poor mental health, (ii) indicators of positive mental health/wellbeing, and (iii) cognitive functioning.

Aims and objectives

The overall aim of the scoping review is to both systematically and comprehensively scope the extent, nature, and range of evidence currently available in the area of the impact of environment on the psychological outcomes of those high in SPS. The protocol for this review is pre-registered at https://osf.io/aehbt.

The objectives of the current review are as follows:

- Document the nature (e.g., qualitative, quantitative, paradigms used) of the existing research examining the effect of different environments on the psychological outcomes of HSPs.
- Identify and describe specific environments which have been found to be beneficial for psychological outcomes in those with high levels of SPS, and those which have been found to be detrimental.
- Identify any gaps in the literature with regards the psychological outcomes of HSPs and the relationship of these with the environment.
- Identify the major theoretical frameworks used in the literature in understanding the relationship between HSPs, and the impact of environment on their psychological outcomes.

This review will summarise the existing evidence in the area and map it out systematically. Through this process, gaps in the literature can be identified as areas for possible future research (Arksey & O'Malley, 2005). The scope of this review has been kept deliberately broad to allow for the collection, summarisation, and mapping of all currently available research in the field.

Methodology

Given the diverse nature of the existing literature in the field, a scoping review was selected as the preferred method. Scoping reviews differ from systematic reviews, in that they have a less focused research question, include differing study designs and methods, and attempt to describe the whole literature broadly (Arksey & O'Malley, 2005). The current review is a systematic scoping review, as a systematic approach has been used to identify,

include, and extract data from the literature (Oswald et al., 2020). The scoping review process was guided by the methodology outlined by Arksey & O'Malley (2005), as well as by the PRISMA Scoping Review Checklist (Tricco et al., 2018) to enhance the quality of the methodology and reporting. Thus, the five framework stages of a scoping review as outlined by Arksey & O'Malley (2005) were followed, namely: (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, and (5) collating, summarizing, and reporting the results.

Identifying the research question

Given the diverse nature of research in the area of SPS, and significance of mental health issues globally, the research question which was the focus of the current scoping review is: what evidence is available in the literature around the kinds of effects of environment on the psychological outcomes of those high in SPS, with psychological outcomes including both psychological wellbeing and cognitive functioning.

The research question was purposely kept broad to allow for the mapping of the literature across the many different types of environments and across all age groups.

Identifying relevant studies

The search strategy was developed, and search terms were selected through discussions between all authors, with the first author (EC) conducting literature searches relevant to the research question to aid in identifying key terms. The different terms identified and used in searches can be seen in Table 2.1, with search strategies, with specific terms used, including Boolean operators for each database available in Appendix C.

Table 2.1

Search Terms for Scoping Review

"Highly Sensitive Person" OR "Highly Sensitive Child*" OR "Sensory Processing Sensitivity" OR "Environmental Sensitivity"
AND "Wellbeing" OR "Well-being" OR "well being" OR "Anxi*" OR "Depress*" OR "Mental Health" OR "Cognit*" OR "Psychia*" OR "Psychol*" OR "Happ*" OR "Flourish*" OR "Perception" OR "Processing" OR "Internalising Beh*" OR "Internalising Prob*" OR "Internalizing Beh*" OR "Internalizing Prob*" OR "Externalising Beh*" OR "Externalising Prob*" OR "Externalizing Beh*" OR "Externalizing Prob*" OR "social competence" OR "life satisfaction" OR "satisfaction with life" OR "positive affect" OR "negative affect"

The following six databases were searched from 8th September 2021 to the 16th of September 2021: Scopus, Web of Science, Academic Search Complete, APA PsycInfo, PubMed, and Google Scholar. The first 200 results from Google Scholar were considered as these are likely to be the most relevant to the current review (Bramer et al., 2017). The reference lists of relevant papers were also hand-searched to identify relevant papers which may not have been identified on these scholarly databases i.e., backwards search. The hand-search was completed by examining the reference lists of the identified papers and contacting relevant authors in the field when studies were identified as possibly relevant to the review but could not be accessed. See PRISMA flow diagram below for numbers.

Selecting studies

The titles and abstracts of articles returned by the search engines were screened for relevance by the first author (EC), and those deemed as relevant selected for full text review. EC conducted the primary screening of the full texts, with the fourth author (AS) screening in

cases where there was uncertainty (*n*=48), and screening 10% of all identified articles. In cases where uncertainty remained (*n*=7 studies), the relevant studies were presented to all authors, discussed, and majority decision taken. The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" flow diagram in Figure 2.1. outlines how papers were selected for the review. The inclusion and exclusion criteria can be seen in Table 2.2. They were intentionally kept broad and both peer-reviewed and grey literature were included in the search. As noted previously, study quality was assessed in the current review, however, it was not used as a criterion for inclusion in the review as it aimed to cover the literature as broadly as possible. Quality was assessed in order to allow possible gaps in the literature due to poorer quality of studies in the area to be identified. Zotero and Microsoft Excel were used to assist with the screening process and to remove duplicates.

Table 2.2

Inclusion Criteria

- Articles in English language
- Articles published any time up to 16th September 2021 (this was indicated at 31st of July in OSF but updated.)
- Articles relating to HSPs/HSC and SPS, where there is an environmental factor and psychological outcome

Exclusion Criteria

- Articles in a language other than English

- Articles not in relation to the concepts of HSP or SPS, or concerning other types of sensitivities or SPD
- Articles containing no psychological outcome
- Articles with no environmental factor

Charting the data and collating, summarising, and reporting results

Once exclusion criteria were applied and the final articles for inclusion were identified, the data were charted – see Appendix D. To ensure the data was being systematically mapped, the chart was pre-tested, with EC charting the first five studies and then meeting with AS to ensure there was consistency and accuracy in the charting of data.

Quality of the studies included was also assessed at this stage, using the Mixed Methods Appraisal Tool (MMAT) 2018 version (Hong et al., 2018), which assesses study quality across five different methodological categories; qualitative, quantitative randomised control trials, quantitative non-randomised, quantitative descriptive, and mixed methods. While a scoping review does not require quality appraisal, whether this step should be included remains controversial in the literature, with quality assessment reported to be present in 22.38% of scoping reviews in a scoping review of scoping reviews (Bieber et al., 2019; Pham et al., 2014). The MMAT was utilised as it is both a reliable and practical instrument which can be utilised with studies of various designs (Pace et al., 2012). Results will be reported as per guidance document from the creators (*Reporting the Results of the MMAT*, 2020), such that studies which meet all five criteria receive five stars, four of five criteria receive four stars etc. EC and AS met and discussed the quality review process. The initial quality review

was carried out by EC. AS then reviewed 20% of the studies, including all studies with ratings of 1 and 2 stars. Consensus was reached for these studies, and revisions to the criteria applied when needed.

An optional step for scoping reviews identified by Arksey and O'Malley (2005) is consultation. In the current review, researchers consisted of an interdisciplinary team with a researcher with experience in environment and SPS. Preliminary findings from the scoping review chart were presented to the third author (FL), a researcher working in the area of SPS. An in-press paper was identified and added at this stage.

Data were summarised, collated, and presented in the results section. In line with the first aim of the review, numerical summary analysis was utilised to provide an overview of the literature in the area, looking at the different geographical areas of studies, the characteristics of participants, the range of environments, and the research methodology. The findings from the review are also presented in a descriptive narrative summary form.

The data were analysed using an inductive thematic analysis approach (Braun & Clarke, 2006) in order to summarise findings and identify recurring themes. The aim of the qualitative analysis is to identify and describe patterns in the data, which is an appropriate fit for thematic analysis as per the advice of Braun and Clarke (2021). The data consisted of the results of the charting process. Conducting the thematic analysis was an iterative process, moving between the data and research question. As the data had been extracted from the source material and categorised prior to analysis to make sense of the variety of research, this in turn guided the analysis. The chart can be seen in Appendix D.

At this stage of the scoping review process there was a high level of familiarity with the dataset. The table was scrutinised by the first author and then coded systematically. Following the coding of the initial studies in the dataset, EC consulted with AS to ensure

codes were based on the data, and relevant to the current work, with codes checked by AS for the first five papers. The rest of the dataset was then coded. On the basis of these codes, themes and subthemes were generated in a systematic, iterative process. The fit of the generated themes to the extracted data and assigned codes were then assessed by AS.

Results

The database searches returned a total of 1442 records. Before the screening process was begun, 771 duplicates were removed. 671 titles and abstracts were then reviewed, and 384 were removed as the papers were deemed not relevant to the current review. Full texts were reviewed for 287 records, and irrelevant records removed at this stage. This resulted in 61 records to be included. One record was added based on hand-searching the relevant records' reference lists and one record added through identification by the third author. This resulted in a total of 63 records. During this process, four relevant review articles/posters were identified. These were not included in the main analysis to avoid duplication in the results as they contain many of the records already identified and included in the scoping review. They are Aron et al., 2012; Castellano & Dascalu, 2009; Costa-López et al., 2021; and Greven et al., 2019. A flow diagram of this process is presented in Figure 2.1. A summary of the studies included is presented in Table 2.3.

Figure 2.1

PRISMA Flow Diagram

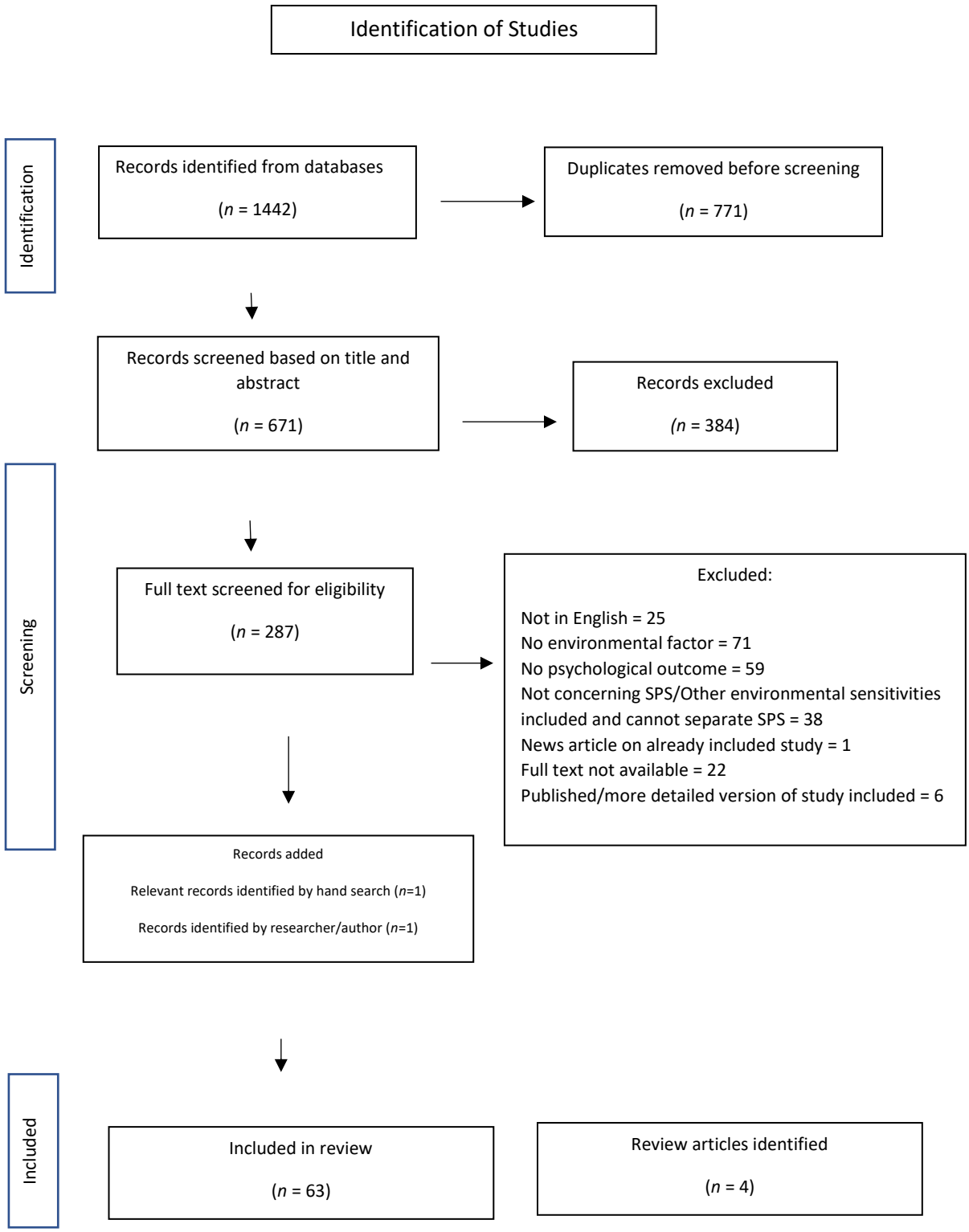


Table 2.3

Characteristics of the included studies

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Aron, E.N. & Aron, A.	1997	USA	Studies 2-4: To assess the extent to which original themes constituted a core pattern, relation of core items to social introversion and emotionality, the existence of subgroups of HSPs, whether sensitivity moderated the relation of family environment to how childhood was experienced.	Multiple	Family environment in childhood	Study 2: When parental environment was optimal, there was little difference between HSPs and non HSPs, but when the parental environment was poor, the highly sensitive scored higher on unhappy childhood. Study ¾: Three-way interaction found with gender, such that when parental environment was optimal, there was little difference between men regardless of sensitivity; when the parental environment was poor, highly sensitive men reported having a much less happy childhood.	SPS	Study 2: ***** Study 3: ***** Study 4: ****
Meyer, B., & Carver, C. S.	2000	USA	To test a model that memories of negative childhood experiences, SPS, and pessimistic expectancies are associated with Avoidant Personality Disorder (APD) features.	Multiple	Childhood Environment	APD features were found to be negatively correlated with optimism, and positively correlated with negative childhood memory valence, and SPS. A significant negative interaction between optimism/pessimism and SPS was found. A significant negative correlation emerged between optimism and APD features among those scoring highly in SPS. The combination of pessimistic expectancies and high levels of SPS yielded higher levels of APD features.	SPS, theories of APD e.g., Beck and colleagues (1990), Carver and Scheier's (1981, 1998) self-regulation theory	**

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Aron, E. N., Aron, A., & Davies, K. M.	2005	USA	Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in turn shyness.	Social	Studies 1-3 Childhood Environments / Study 4. Manipulated negative event i.e. frustrating survey completion	SPS and childhood environment interact predicting adult trait negative affectivity. SPS interacts with a manipulated negative experience to predict greater state negative affect.	SPS	Study 1 - **** Study 2 - **** Study 3 - **** Study 4 - ***
Liss, M., Timmel, L., Baxley, K., & Killingsworth, P.	2005	USA	To explore the relationship between SPS, parenting style, anxiety, and depression. To determine how knowledge of an individual's SPS contributes to predicting if someone is anxious or depressed above parenting style. To look at interaction effects between negative parental environment and negative affect separately in anxiety and depression and looking separately at parental care and overprotection.	Relational	Parenting environment	SPS was strongly related to depression and to anxiety. It contributed unique variance above parenting factors for both depression and anxiety. SPS was particularly strongly related to anxiety. SPS was correlated with parental-overprotection. For depression there was a small but significant interaction between parental care and SPS, such that HSPs were more depressed in the context of low parental care. This interaction was not found for anxiety. No interaction effects found for parental overprotection.	SPS	****
Kemler, D.S.	2006	USA	To investigate how differences between athletes with varying levels of SPS apply self-discrepancies and emotional reactions to competitive sports.	Multiple	Competitive sports event	Participants high in SPS responded to competition with greater anxiety and shame than low SPS counterparts. Participants high in SPS also reported having greater stress related to actual to ideal and actual to ought self-discrepancies than those low SPS.	SPS , Self-discrepancy Theory (Higgins, 1987)	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Evers, A., Rasche, J., & Schabracq, M. J.	2008	Netherlands*	To examine the construct validity of the HSPS, to introduce the concept into the field of work stress, and to adapt the user-friendliness of the HSPS without affecting reliability and validity.	Multiple	Work environment	SPS (and its subscales) are negatively correlated with sense of coherence, comprehensibility, manageability, meaningfulness and self-efficacy. SPS (and its subscales) are positive correlated with negative affectivity, work displeasure and need for recovery.	Organisational Psychology, SPS	****
Jagiellowicz, J., Xu, X., Aron, A., Aron, E., Cao, G., Feng, T., & Weng, X.	2011	China	Investigate the relationship between perceptual and cognitive processes underlying tendency of pausing before acting and SPS.	Sensory/Perceptual	Change detection task using images	No significant associations between accuracy and SPS. Significant correlation between SPS and minor-minus-major difference in response time, such that the higher a participant was on SPS the longer time they spent before responding to minor changes, relative to major changes.	SPS	***
Gerstenberg, F.X.	2012	Germany	To investigate potential differences in SPS with regard to the HSPS subscales, to further investigate whether individuals high in SPS process information more carefully and correctly using a larger sample size, and to use a behavioural task that allowed for differentiation between reaction times and error rates.	Sensory	Visual detection task	SPS was found to predict performance on a visual detection task (both reaction times and error rates) and increased perceived stress. Only the LST subscale led to these results however. Results were independent of Big-5. Individuals high in SPS perceived more stress after taking the test than individuals low in SPS.	SPS	*****
Sobocko, K.	2012	Canada	To assess whether continuous self-regulation among people showing higher levels of sensitivity accelerates states of ego-depletion, in turn explaining poor cognitive and social performances. To show SPS is distinct from yet related to neuroticism and introversion.	Sensory	Exposure to noise similar to that of a busy I or restaurant	No significant difference found between participants in cognitive performance in noise vs control. This indicates the impact of the environmental stimulus was not affected by SPS. Though results null, more sensitive participants showed slowest response time in Stroop task.	SPS	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Gearhart, C.G.	2014	USA	To investigate the multiple effects of SPS on nonverbal decoding. Specifically, on identifying emotions from paralinguistic cues.	Multiple	Audio stimulation	HSPs were found to be no worse or no better at recognizing vocal expressions of emotion than non-HSPs. This was regardless of whether they were exposed to conditions of stimulation or not. When neuroticism was controlled for, HSPs did not report being more distracted by moderate or high intensity audio stimulation than non-HSP counterparts.	SPS, Information processing	****
Booth, C., Standage, H., & Fox, E.	2015	UK	To assess a continuous predictor and outcome variable, that is capable of differentiating positive and negative extremes. Assessing for possible plasticity effects for SPS's three factors. While using a heterogeneous adult community sample. Assess would SPS moderate association between current life satisfaction and childhood experiences.	Social	Childhood experiences with caregiver	Those scoring more highly in SPS were found to be more affected by negative childhood experiences than those scoring lower in terms of adult life satisfaction levels. No differential effects under positive childhood experiences were found for high or low SPS scorers. LST and EOE produced the same significant interaction.	Differential susceptibility	***
Pluess, M., & Boniwell, I.	2015	UK	To investigate whether SPS moderates the efficacy of a school-based intervention aimed towards preventing depression.	Intervention	SPARK Resilience programme	SPS was a significant predictor of treatment response. The intervention was successful in reducing depression in girls scoring highly in SPS, though not effective at all in those scoring lower in SPS.	SPS , Vantage sensitivity framework	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Valojää, A.	2015	Finland	To investigate whether SPS can explain social preference for interacting online, and if the internet should be considered as a beneficial and alternative channel for communication for HSPs.	Multiple	Internet	No difference was found in the psychological wellbeing of those HSPs who preferred online interaction and those who preferred face-to-face interaction. When comparing the psychological wellbeing in the HSPs who belonged to online and Face to face groups, no difference was found. HSPs were found to be somewhat more distressed than non-HSP counterparts.	SPS, Computer mediated communication	***
Jagiellowicz, J., Aron, A., & Aron, E. N.	2016	USA	To examine the greater subjective emotional responses to both negative and positive stimuli which is thought to be characteristic of SPS.	Multiple	IAPS picture presentation/parenting environment from childhood	Those high in SPS tend to rate standard pictorial stimuli, and especially positive ones, as more intensely valanced, perhaps respond more quickly than others, but do not differ in their rating of the level of arousal caused by the pictures. Evidence found for an interaction between SPS with quality of parenting in predicting how they rated arousal, such that those high in SPS with high-quality parenting reported having greater arousal to positive pictures.	SPS	*****
Jaswetz, L.	2016	Netherlands	To answer the question of what are the combined effects and individual effects of SPS and childhood environment on social anxiety.	Multiple	Childhood environment	No significant interaction effect found. Main effect of SPS on social anxiety found.	SPS	***

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Meredith, P. J., Bailey, K. J., Strong, J., & Rappel, G.	2016	Australia	To gain understanding of the interrelation of adult attachment, sensory processing, and distress in healthy adults	Sensory	Cold-pressor pain inducement task used to activate attachment system	Attachment anxiety was related to sensory sensitivity as measured by the HSP-SV. This association was not retained when controlling for stress, indicating the association was largely accounted for by stress. Sensory sensitivity as measured by HSP-SV was positively linked with distress.	Attachment theory	*****
Uljarević, M., Carrington, S., & Leekam, S.	2016	UK	Study aimed to further characterize the nature of the specific Sensory Sensitivity – Intolerance of Uncertainty - anxiety inter-relationship to determine whether the pattern was evident in a sample of adults.	Relational	Parenting child with ASD diagnosis	A three-way inter-relationship between SPS, Intolerance of Uncertainty and anxiety was found. High sensitivity and a susceptibility to being overwhelmed by environmental stimulation may lead to an experience of the world as being highly unpredictable, which in turn could make even simple situations and events uncertain and difficult for the HSP, thus provoking anxiety.	SPS, Intolerance of Uncertainty	***

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Rothenbucher, F. U.	2017	Belgium	Aimed to explore if HSPs and those scoring highly in SPS differ in the manner in which they attend to incoming visual stimuli.	Sensory	Posner exogenous cueing task and cued attention task	A significantly higher levels of attentional engagement was found for the high SPS group for happy cues at the 100ms duration, which indicates a continuous direction of attention at the positive stimuli and deeper processing of this material. High SPS participants had self-reported higher negative affect and lower levels of extraversion. They also diverted attention away from neutral cues at 100ms, possibly to precent sensory overload.	Attentional bias research	*****
Stefan Lindsay, J.	2017	USA	To describe how teachers who may be highly sensitive interpreted professional stressors and cognitively appraised work events to develop successful coping skills, and to make clear successful coping strategies from teachers who may be highly sensitive and have committed to help others who are highly sensitive sustain their profession.	Multiple	Teaching environment	SPS significantly and positively correlated with risk of burnout. However, stress fully mediated this relationship when introduced into this model. At increased risk of presenting with SPS, teachers tended to have a greater risk of burning out due to emotional exhaustion. They also reported experiencing more stress at work. Qualitative results indicated time demands and colleagues as primary sources of stress, and both daily and systematic coping strategies were utilised.	Teacher self-efficacy and cognitive appraisal theory	****
Andresen, M., Goldmann, P., & Volodina, A.	2018	Germany*	To explore the role of resources (such as SPS and social capital) in explaining the perceived stress of expatriates and their turnover intention.	Multiple	Expatriation – working in a foreign country	Perceived stress fully mediated the effects of SPS and bonding social capital on expatriates' turnover intention. 26.4% of expatriates scored highly in SPS. Significant differences were found such that 30.7% of organisational expatriates were highly sensitive compared to 19.3% of external expatriates.	Hobfoll's (1989) conservation-of-resources (COR) theory	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Campbell, T., & Moore, K.	2018	Australia*	To better understand the relationship between SPS and social anxiety through investigating relevant factors thought pertinent to the onset and maintenance of the relationship.	Relational	Parenting environment	Those higher in SPS were found to be more prone to experiencing social anxiety than others. SPS also associated with avoidant coping, irrespective of the quality of parental bond experienced in childhood.	SPS, Differential susceptibility	****
Lionetti, F., Aron, A., Aron, E. N., Burns, G. L., Jagiellowicz, J., & Pluess, M.	2018	USA & UK	Study 2. To investigate whether the detected groups in levels of SPS differ significantly regarding common personality traits and emotional reactivity.	Sensory	Viewing happy and sad video clips	HSP mean score and EOE subscale were positively associated with positive emotional reactivity, and a marginally significant positive association between HSP and EOE subscale and negative emotional reactivity. Difference between three sensitivity groups in positive emotional reactivity approached significance, though groups did not differ significantly regarding negative emotional reactivity.	Environmental Sensitivity	*****
Nocentini, A., Menesini, E., & Pluess, M.	2018	Italy	To test whether individual differences in environmental sensitivity predict treatment response to an antibullying intervention in a large randomised control trial.	Intervention	KiVa antibullying programme	Significant intervention effects on victimisation and internalising symptoms were moderated by Highly Sensitive Child (HSC) scale score and gender. Boys scoring higher on HSC benefitted significantly more than lower scoring counterparts with reduced victimisation and internalising symptoms.	Environmental sensitivity	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Rubaltelli, E., Scrimin, S., Moscardino, U., Priolo, G., & Buodo, G.	2018	Italy	To examine whether exposure to terrorism-related pictures interacted with individual differences in environmental sensitivity and psychophysiological response to stress in explaining people's risk perception.	Sensory	Exposure to terror-related or neutral pictures and Manneheim multi-component stress task	Sensitivity and reactivity were not significantly correlated. Sensitivity and likelihood of attack were correlated such that those scoring higher in HSPS estimated future attacks were more likely. The relationship between HSPS score and experimental condition was not significant. Those scoring higher in HSPS in the terrorism-related pictures condition were more willing to trade off privacy than those in neutral condition.	Risk-perception, environmental sensitivity	***
Scrimin, S., Osler, G., Pozzoli, T., & Moscardino, U.	2018	Italy	To investigate how adversities experienced by families and the supportive resources within the family itself are linked to children's perceptions about a number of factors. Namely: their own health status, their emotional wellbeing, as well as their academic and social performance. Furthermore looked at whether expected associations were moderated by the levels of environmental sensitivity in the children.	Multiple	Early adversities in family environment e.g. death in family, discontent in relations	HSCS score moderated the association between both family adversities and supportive resources provided by families on children's physical comfort and their perceived academic and social performance.	SPS	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Slagt, M., Dubas, J. S., van Aken, M. A., Ellis, B. J., & Deković, M.	2018	Netherlands	To compare SPS and negative emotionality as markers of individual differences in susceptibility to parenting among children.	Relational	Parenting environment	SPS interacted with both changes in negative and positive parenting in predicting externalising, though not prosocial, behaviours. Sensitive children decreased the most in externalising behaviour when negative parenting decreased, but increased in it the most when negative parenting increased. Likewise, sensitive children decreased the most in externalizing behaviour when high levels of positive parenting were maintained, however they increased the most in externalizing behaviour when positive parenting decreased. Sensitive children decreased in externalising behaviours more than less-sensitive counterparts when receiving low levels of negative parenting. Sensitive children had the lowest levels of externalizing behaviour when high levels of positive parenting were maintained, but similar levels when positive parenting decreased.	Differential susceptibility	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Strand, J. F., Brown, V. A., Merchant, M. B., Brown, H. E., & Smith, J.	2018	USA	To evaluate the convergent validity and sensitivity of commonly used measures of Listening effort. To assess how scores on the tasks relate to cognitive and personality variables.	Multiple	A number of lab-based tasks	Those with higher HSPS scores rated the tasks as more difficult and had slower complex dual-task (CDT) latencies. A marginally significant HSPS × Noise interaction was found, indicating that the relationship between HSPS score and CDT latency is stronger in the hard than in the easy condition. Individuals who score higher in SPS showed increased effort as measured by some LE tasks.	Listening Effort, SPS	****
Su, X., Cai, R. Y., & Uljarević, M.	2018	China	To explore the influence of different factors on the mental health of Chinese parents of children diagnosed with autism spectrum disorder (ASD). Namely; Intolerance of uncertainty, sensory sensitivity, broader autism phenotype, and the severity of the child's ASD symptoms and comorbid symptoms.	Multiple	Parenting a child with ASD diagnosis	Higher levels of parental sensory sensitivity were associated with higher DASS-21 total score. Sensory sensitivity had an indirect effect through intolerance of uncertainty on parental mental health.	Intolerance of uncertainty, SPS	***
Tillmann, T., El Matany, K., & Duttweiler, H.	2018	Germany	Study 2: Exploring relationship of newly developed German SPS scale for children with additional school related variables.	Multiple	School environment	The highest positive significant correlation found between negative affect and the SPS sub-facet Overexcitability and the total SPS scale. Significant negative relationships between physical well-being, psychological well-being, functional capacity, and SPS.	SPS, Environmental sensitivity	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Hjordt, L. V., & Stenbæk, D. S.	2019	Denmark	To investigate the cross-seasonal group differences in trait SPS and the association between trait SPS in remitted phase, and depression severity in symptomatic phase in those with Seasonal Affective Disorder (SAD)	Physical	Seasons – summer/winter	Participants with SAD exhibited higher scores on trait SPS compared to healthy controls in both summer and winter. Their scores on trait SPS increase from summer to winter, i.e. individuals with SAD displayed a cross-seasonal pattern of high sensitivity. Higher trait SPS in summer was found to be associated with more severe SAD symptoms in winter.	SPS	****
Holm, S. E. H., Hansen, B., Kvale, G., Eilertsen, T., Hagen, K., & Solem, S.	2019	Norway	To examine whether SPS affects treatment outcome in patients with OCD.	Intervention	Bergen concentrated 4-day exposure treatment (B4DT)	No significant relationship between SPS and treatment outcome was found after controlling for pre-treatment levels of OCD, depression, and anxiety. HSPS scores were significantly reduced after treatment.	SPS, cognitive behavioural therapy	****
Karam, E. G., Fayyad, J. A., Farhat, C., Pluess, M., Haddad, Y. C., Tabet, C. C., ... & Kessler, R. C.	2019	Lebanon	Aimed to evaluate the relative roles of war, childhood adversities and sensitivity in the development of PTSD.	Multiple	Exposure to war environment	While sensitivity was significantly related to PTSD, childhood adversities were the most important variable in predicting PTSD. The effect of war on PTSD was dependent on the interplay between adversities and sensitivity and was most prominent in highly sensitive children with lower adversities levels, and less pronounced in those experiencing high adversities levels.	Ecological framework	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Lionetti, F., Aron, E. N., Aron, A., Klein, D. N., & Pluess, M.	2019	USA	Developing an observational rating system of environmental sensitivity suitable for pre-schoolers and testing whether this predicts individual differences in response to negative and positive parenting aspects.	Relational	Parenting environment	Children who scored highly in the HSC-RS were more affected by the influence of parenting quality compared to those scoring low. Children in the highly sensitive group were found to be more sensitive to negative influences of high levels of permissive parenting when considering externalizing behaviour problems aged three and internalizing behaviour problems aged 3 and 6. They were also more sensitive to positive effects of high levels of authoritative parenting in predicting social competence at aged 3 and 6. Those scoring low in sensitivity were generally less sensitive to the influence of parenting.	Environmental sensitivity	*****
Slagt, M., Dubas, J. S., Ellis, B. J., Van Aken, M. A., & Deković, M.	2019	Netherlands	To investigate whether children who show stronger immediate reactions to their mothers during observed parent–child interactions are those whose development across one year is more strongly predicted by parenting at the beginning of that year.	Multiple	Parenting	SPS was related to neither externalising nor prosocial behaviour. Highly Reactive children did not score more highly on SPS than other children. Authors suggest it may be unlikely for children who are identified as susceptible for better and for worse using SPS to be the same ones who are also reactive for better and for worse within parent–child interactions.	Differential susceptibility	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Tillmann, T.	2019	Germany	To differentiate SPS from other variables of psychological wellbeing. To examine whether highly sensitive teachers perceived characteristics of their professional lives in a different way than non-highly sensitive counterparts, and how SPS relates to perceived stress. Examine how SPS relates to different symptoms of mental disorders. Explore how highly sensitive teachers differ among each other in SPS and other variables, and if an overarching model of teacher stress including SPS be supported.	Multiple	Teaching environment	Highly sensitive teachers, while more attuned to students in need, do not demonstrate enhanced processing in teaching related aspects. SPS can explain the relationship between some work characteristics and perceived stress through coping and cognitive processes. SPS was found to relate to teachers depression, anxiety, and some psychosomatic disorders. Teachers who were highly sensitive benefited more from therapeutic interventions than non-highly sensitive counterparts. SPS can contribute significantly to development of stress in teachers.	SPS	*****
Vander Elst, T., Sercu, M., Van den Broeck, A., Van Hoof, E., Baillien, E., & Godderis, L.	2019	Belgium	Investigate assumptions that those with higher or lower levels of SPS develop differential susceptibility for the work environment, which is characterised by demands of the job and resources.	Multiple	Work environment	EOE and LST were found to amplify the relationship between job demands and emotional exhaustion.	SPS , Job Demands-Resources model (JD-R model; Bakker & Demerouti, 2007)	****
Yano, K., Kase, T., & Oishi, K.	2019	Japan	To investigate the associations of SPS, sense of coherence, and the interaction between these and depressive symptoms in university students.	Multiple	University environment	Strong Sense Of Coherence prevented high-SPS students from experiencing over-arousability and dysfunctional cognition, and consequently decreased the severity of depressive symptoms.	SPS, Sense of coherence	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Amemiya, R., Takahashi, G., Rakwal, R., Kahata, M., Isono, K., & Sakairi, Y.	2020	Japan	To examine the impact of yoga on mood states and attentional control in graduate students with varying levels of SPS in a physical education course setting.	Multiple	Yoga course	Students higher in SPS had lower Attentional Control and higher negative mood states before the course, however, a significant improvement in scores was observed. Differences between the two groups after the yoga course were not statistically significant. A positive correlation was found between SPS and variation in AC, however, a negative correlation was found between variation in AC and mood states.	SPS	**
Baldwin, E. D.	2020	USA	To examine if in college students with high SPS, there is a relationship between watching ASMR videos and change in emotional response.	Sensory	Viewing ASMR videos/non ASMR controls	Negative affectivity was not correlated with high SPS. Increase in positive affect between pre and post-test when viewing no voice control video in high SPS participants. Data did not support the hypothesis of significant improved positive affect after watching ASMR type videos. Decrease in negative affect found after watching ASMR videos and control video in those with higher HSPS score.	SPS,ASMR	**

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Black, B. A., & Kern, M. L.	2020	Australia	To investigate how those high in SPS who live within an extravert-dominant social context conceive of and experience wellbeing.	Multiple	Extravert-dominant social context	HSPs perceived wellbeing arises from harmony across different dimensions. A number of valued practices were noted for wellbeing: self-acceptance, having positive social relationships but this being balanced by times of solitude, connecting with nature, contemplative practices, emotional self-regulation, practicing self-compassion. Emotional experiences were also valued: low-intensity positive emotion, self-awareness, having a sense of meaning, and hope/optimism. Barriers to wellbeing were identified as physical health issues and saying no to others.	Idiographic	*****
Carr, M., Summers, R., Bradshaw, C., Newton, C., Ellis, L., Johnston, E., & Blagrove, M.	2020	UK*	Aimed to contrast predictions of diathesis-stress and differential susceptibility frameworks by assessing nightmare sufferers on a range of questionnaire, dream diary, task and neuroimaging measures.	Sensory	Emotional Picture Viewing	Nightmare sufferers scored more highly on the HSPS than control participants.	Diathesis-stress, Differential susceptibility	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Fikkers, K. M., & Piotrowski, J. T.	2020	Netherlands	To explore individual differences in responses to media through investigating how four theoretically relevant variables (including SPS) affect responses to positively and negatively valanced media entertainment.	Social	Viewing positive and negative media video clips	Results showed that more variation in responses to media was due to differences between the participants rather than difference between stimuli, however SPS did not significantly explain this between-participant variation as a predictor or moderator.	Models of interactions between content and person e.g. Differential Susceptibility to Media effects model	****
Goldberg, A., & Scharf, M.	2020	Israel	To examine parenting practices regarding adolescent children of parents high in SPS. To examine whether attachment insecurity mediated this relationship.	Relational	Parenting environment	Attachment anxiety was positively associated to SPS. Attachment anxiety mediated the relationship between parents' SPS levels and harsh parenting, and partially mediated the relationship between parents' SPS levels and use of psychological intrusiveness.	Attachment theory	****
Iimura, S., & Kibe, C.	2020	Japan	Aims to clarify the mechanism of adolescents' differential adjustments. Investigates the role of SPS using the Japanese version of Highly Sensitive Child Scale for Adolescence (J-HSCS), and tests whether the diathesis-stress model or the differential susceptibility model best describes the socioemotional adjustment of students across the transition to high school.	Multiple	Transition to high school environment	Adolescents higher in SPS reported a greater increase in their well-being after the transition to high school, corresponding to their perceived environmental change, whilst low sensitivity peers did not show such well-being enhancement. Evidence found for vantage sensitivity over diathesis-stress or differential susceptibility models.	Environmental Sensitivity	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Kibe, C., Suzuki, M., Hirano, M., & Boniwell, I.	2020	Japan	To develop a culturally suitable intervention in prevention and evaluate its efficacy, and to investigate moderation effects of SPS and gender of Japanese young people's wellbeing from a diathesis stress perspective.	Intervention	Modified version of the SPARK resilience program	Student scoring higher in SPS, who scored significantly lower in wellbeing than counterparts at baseline, responded more positively to the intervention, and had greater levels of reduction in depression and more promotion of self-esteem.	Differential susceptibility	*****
Meyerson, J., Gelkopf, M., Eli, I., & Uziel, N.	2020	Israel	Analyse the influence of SPS on burnout and professional quality of life in Israeli dentists.	Multiple	Work as dentist in Israel	Found that burnout can be predicted by the three aspects of SPS (ease of excitation, low sensory threshold and aesthetic sensitivity). These also predicted dentists satisfaction at work. Positive correlation between SPS and secondary traumatic stress. EOE and LST but not AES predicted dentists' reactions to patient's stress and trauma.	SPS, Occupational health	****
Onursal Özer, B.	2020	Turkey	To investigate the association between internalizing behaviours and perceived maternal and paternal rejection. To test whether this association is moderated by SPS and further moderated by child's gender.	Relational	Parenting environment	Higher levels of SPS predicted higher levels of internalizing problems when controlling for parental rejection, however this effect was not there when interaction between SPS and gender was included in the model. Highly sensitive girls were more inclined to experience internalizing problems.	Environmental Sensitivity, Parental Acceptance – Rejection Theory (PARTheory, contemporarily called IPARTheory)	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Pernot, L.	2020	Netherlands	To examine if depression can be explained by the amount of mismatch factors i.e., the different way of living in present time compared with ancestral world, and if SPS plays a role in this relationship. To gain more understanding about the onset of student depression, considering SPS and the timeline of mismatch factors.	Multiple	University environment	SPS was found to have a moderating effect on the positive correlation between mismatch factors and depression. SPS was found to correlate with mismatch factors, depression, and neuroticism. In the interviews, HSPs noted their sensitivity to environmental stimuli, feeling different compared to others, and having more difficulty coping with mismatch factors in their daily life.	SPS, Evolutionary mismatch hypothesis	****
Pluess, M., Lionetti, F., Aron, E. N., & Aron, A.	2020	UK	Study 3: To test individual differences in sensitivity to negative experiences. Study 4: To test individual differences in response to positive experiences.	Multiple	Study 3: Teaching environment as a teacher-trainee Study 4: Exposure to mood induction video.	Study 3: HSP-12 was a significant predictor of changes in well-being across 10 months, with teacher trainees who were more sensitive showing a significant decline in well-being followed by a full recovery. Those low in sensitivity appeared unaffected by the experience. Study 4: HSP-12 score significantly moderated short-term effects of positive mood induction using video clip on pre-post changes in positive mood. Change in positive mood was more pronounced in the high sensitivity group.	Environmental sensitivity	Study 3: *** Study 4: *****
Redfearn, R. A., van Ittersum, K. W., & Stenmark, C. K.	2020	USA	To explore major nursing stressors and burnout levels in nurses that are considered highly sensitive by nature compared to their less sensitive peers.	Multiple	Working in nursing currently in the USA	SPS was found to correlate overall with nursing stress, burnout, five nursing subscales of stress, and two subscales of burnout. SPS was shown to be a predictor for overall nursing stress, overall burnout, of two nursing stress subdimensions, and one burnout subdimension.	SPS, Occupational health	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Rigby, S. N., Jakobson, L. S., Pearson, P. M., & Stoesz, B. M.	2020	Canada	Investigate the links between alexithymia and the evaluation of emotional scenes, and whether viewer's evaluations of these scenes were better predicted by specific alexythymic traits or individual differences in SPS.	Sensory	Emotional scenes task	Strong positive correlations were observed between difficulties identifying and describing feelings scores and scores on the EOE subscale of the HSPS. Authors suggest this indicates that problems with emotional appraisal are most evident in those who are easily overwhelmed by busy sensory environments. EOE was a negative predictor of accuracy in classification of positive scenes.	SPS, Alexithymia	****
Bordarie, Jimmy; Aguerre, Colette; Bolteau, Laëtitia	2021	France	Investigate the effects of confinement using a longitudinal reflection framework on quality of life and anxiety/depressive symptoms in individuals with different levels of SPS.	Multiple	Confinement during COVID-19 pandemic	SPS related to levels of anxiety and depression, with depression increasing with higher levels of SPS. For those with average SPS, lockdown had a significant positive effect in reducing anxiety disorders. In terms of quality of life, lockdown appeared to play a positive role for entire sample regardless of SPS level.	SPS	**
Hellwig, S., & Roth, M.	2021	Germany	Study 2: To test if SPS is an ability construct, with regards perceiving and processing environmental stimuli.	Multiple	Geneva Emotion Recognition Test (GERT; Schlegel et al., 2014)	Any potential relation between the factors of SPS and emotional recognition ability can be fully explained by the Big-5 personality traits. Low sensory threshold (LST) was found to be unrelated to emotional recognition ability.	SPS , Big 5 personality framework	***

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Iimura, S.	2021	Japan	Aims to provide new evidence on whether adolescents' SPS moderates the relationship between current life events and current socioemotional well-being and what shape of interaction SPS and current life events exhibit.	Multiple	Current life environment	Adolescents with high SPS were more likely to be affected by both negative and positive life events, which resulted in an increase in their socioemotional well-being. However, their SPS functioned as vulnerability when they experienced many negative life events. Lower SPS adolescents showed resilience regardless of the quality of their life events.	Environmental Sensitivity	*****
Lionetti, F., Klein, D. N., Pastore, M., Aron, E. N., Aron, A., & Pluess, M.	2021	USA	Investigate the interactions between early parenting styles and children's ES on symptoms of rumination and depression in middle childhood and early adolescence.	Multiple	Early parenting environment	Children's sensitivity interacted with permissive parenting to predict rumination at age 9, which in turn predicted higher levels of depression.	Environmental Sensitivity	*****
Lionetti, Spinelli, Moscardino, Ponzetti, Garito, Dellagiulia, Aureli, Fasolo, & Pluess	2021	Italy	Study 2: Explore changes in externalising and internalising behaviours in children during the COVID-19 pandemic.	Relational	Parenting environment during COVID-19 Pandemic	High levels of parent–child closeness was protective for HSCs for internalising and externalising behaviours. HSCs showed overall slightly higher levels of internalizing behaviours before and during the lockdown. Low levels of parent–child closeness was associated with a small increase in internalizing behaviours during the lockdown in both low and highly sensitive children.	Environmental sensitivity	****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
May, A.K. & Pitman, M.M.	2021	South Africa	To examine university adjustment differences between students scoring high and low on SPS, and test whether these effects were independent of the five-factor model of personality, and moderated by early parental care levels.	Multiple	Early parenting experiences/Adjustment to university	Students with high levels of SPS reported significantly worse adjustment to university. Moderating effect for parental care for students low on SPS. Poor adjustment to university was driven by a propensity towards negative affect, but carefully and deeply processing stimulation by those with high SPS levels partially offset adjustment difficulties.	SPS, Big 5 Personality Framework	***
Moscardino, U., Scrimin, S., Lionetti, F., & Pluess, M.	2021	Italy	To investigate behaviourally observed environmental sensitivity in children from low Socio Economic Status families to explore the existence of sensitivity groups. To assess whether the aforementioned groups differ in terms of physiological self-regulation.	Relational	Family support	Three sensitivity groups identified: “Low sensitive” (43%), “Moderately sensitive” (33%), and “Highly sensitive” (24%). No difference between groups at baseline cardiac vagal tone (CVT). At low and average levels of family support, highly sensitive children with higher resting CVT reported better wellbeing than those with low resting CVT, this was not observed in other sensitivity groups.	Socioecological, risk- and resilience-oriented framework (Bronfenbrenner & Morris, 1998; Masten, 2018)	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Pérez-Chacón, M., Chacón, A., Borda-Mas, M., & Avargues-Navarro, M. L.	2021	Spain	This study's objectives were to find out the extent to which both healthcare and educational professionals showed burnout at the beginning of COVID-19 pandemic, to determine if there were differences in SPS, burnout, compassion fatigue/compassion satisfaction depending on sector, and to find out to what extent these variables influenced experience of these syndromes as risk or protective factors.	Multiple	Working in education or healthcare fields at beginning of COVID-19 pandemic	Relationship between emotional exhaustion and SPS were significant in healthcare workers and educators. Relationship between DP and SPS was significant in educators. Increase in EOE would contribute to increasing emotional exhaustion. Being a healthcare worker and scoring high on EOE acted as a risk factor for personal realization. Low sensorial threshold and compassion satisfaction acted as protective factors in this area. EOE and EAS increased compassion fatigue regardless of sector.	SPS, Occupational health	****
Sklar, A. Y., Goldstein, A. Y., Abir, Y., Goldstein, A., Dotsch, R., Todorov, A., & Hassin, R. R.	2021	Israel	Experiment 8: To examine whether differences in non-conscious visual prioritization speed (NVPS) are echoed in individuals' conscious everyday experiences, and to examine correlate of SPS.	Sensory	bCFS task	Significant correlation found between NVPS and self-reported SPS using the HSPS short version.	SPS, Cognitive neuroscience	***

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Weyn, S., Van Leeuwen, K., Pluess, M., Lionetti, F., Goossens, L., Bosmans, G., ... & Bijttebier, P.	2021	Belgium & Netherlands	To improve the HSC scale by including new items, to allow more variation and capture underlying construct. To examine psychometric properties of this scale and run a validity check. Assess whether scores on the HSC scale are a moderator in the relationship between negative and positive environmental factors (in this case negative and positive parenting) and outcomes (here internalizing and externalizing problem behaviours)	Multiple	Parenting environment	Results did not support evidence for HSC Scale as a moderator for relationship between parenting internalising or externalising problems.	Environmental Sensitivity	*****
Yano, K., Kase, T., & Oishi, K.	2021	Japan	To investigate the relationship between life skills and depressive tendencies in Japanese university students, as well as how this relationship may be moderated by individuals' levels of SPS.	Multiple	University environment	Association between SPS and depressive tendencies even when controlling for neuroticism. Emotional coping skills were found to be negatively associated with depressive tendencies only when SPS was high. Decision-making skills were found to be negatively associated with depressive tendencies only when SPS was low. Interpersonal relationship skills were negatively associated with depressive tendencies, without SPS interaction.	Life-skills training, SPS	*****

Authors	Year	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Environment Type	Specific Environment	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Iimura, S.	2022	Japan	To examine how SPS and resilience in those aged 18-24 relate to COVID-19 induced distress.	Multiple	COVID-19 pandemic in Japan	Higher levels of SPS were associated with higher levels of COVID-19 stress. Resilience buffered the negative association between SPS and COVID-19 stress.	Environmental sensitivity	*****

*Note. * indicates that the country listed was the listed country of first author*

The majority of records were from peer reviewed journal articles (*n* = 52), followed by college theses/dissertations (*n* = 8). Most studies were quantitative (*n* = 66), cross-sectional (*n* = 52), and observational (i.e., the independent variable not manipulated) (*n* = 48). Most studies included only adults (*n* = 31), and participants of both sexes/genders (*n* = 61). Most environment types contained multiple facets (*n* = 35). The methodological characteristics of the different articles included are summarized in Table 2.4.

Table 2.4
Methodological Characteristics of the included articles

Characteristics	Categories	*N*
Source	Peer reviewed journal article	52
	Preprint journal article	2
	College thesis/Dissertation	8
	Poster presentation	1
Country Study was Conducted In/ Or Lead Author Affiliated	Australia	3
	Belgium	3
	Canada	2
	China	2
	Denmark	1
	Finland	1
	France	1
	Germany	5
	Israel	3
	Italy	5
	Japan	7
	Lebanon	1
	Netherlands	7
	Norway	1
	South Africa	1
	Spain	1
	Turkey	1
	UK	6
	USA	14
Study Type	Observational	48
	Experimental	15
	Quasi-experimental	4
	Outcome Research	1

	Two-cohort treatment/control design	1
	Randomised-control design	1
Study Design	Cross-sectional	52
	Longitudinal	13
	Longitudinal seasonally counter-balanced design	1
	Initial measures of longer study	1
	Pre-post design	2
Methodological Approach	Quantitative	66
	Qualitative	1
	Mixed-Methods	1
	Explanatory sequential mixed methods	1
Environment type	Intervention	4
	Multiple	35
	Physical	1
	Sensory	11
	Social	3
	Relational	9
	Sensory/Perceptual	1
Participants Gender/Sex	Males only	0
	Females only	2
	Males and Females	61
Participants Age Group	Adults (18+)	31
	Children (0-17)	8
	Adults and Children	14
	Not specified	10
Theoretical Framework/Area of study	Alexithymia	1
	ASMR	1
	Attachment theory	2
	Attentional bias research	1
	Big 5 Personality Framework	2
	Cognitive appraisal theory	1
	Cognitive behavioural therapy	1
	Cognitive neuroscience	1
	Diathesis-stress	1

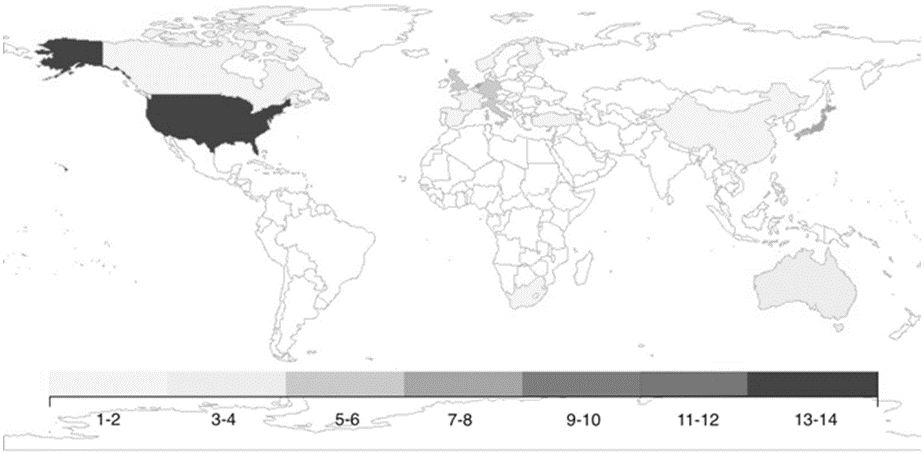
Differential susceptibility	6
Ecological framework	1
Environmental sensitivity	13
Evolutionary mismatch hypothesis	1
Theories of APD e.g., Beck and Freeman (1990), Carver and Scheier (1981, 1998) self-regulation theory	1
Hobfoll's (1989) conservation-of-resources (COR) theory	1
Idiographic	1
Information processing	1
Job Demands-Resources model (JD-R model; Bakker & Demerouti, 2007)	1
Life-skills training	1
Listening Effort	1
Occupational health	3
Organisational Psychology	1
Parental Acceptance – Rejection Theory (PARTheory, contemporarily called IPARTheory)	1
Risk-perception	1
Self-discrepancy Theory (Higgins, 1987)	1
Sense of coherence	1
Socioecological, risk- and resilience-oriented framework (Bronfenbrenner & Morris, 1998; Masten, 2018)	1
SPS	37
Teacher self-efficacy	1
Vantage sensitivity framework	1

Note: Some studies applied multiple study designs or were carried out across several countries. Thus, it is possible that the sum of the categories exceeds the number of included articles. Children were defined as participants up to and including 17 years old.

Most studies were conducted in, or if that data was not available had a first author from, the USA (*n* = 14), Japan (*n* = 7), the Netherlands (*n* = 7), the UK (*n* = 6), and Germany (*n* = 5). See Figure 2.2 for a visual representation of this. Map was created using R with package rworldmap v. 1.3–6 (South, 2011).

Figure 2.2

Countries where included research was conducted



Note. Created with worldmap v. 1.3–6 (South, 2011)

Theoretical frameworks/areas of study

It was noted during the process of identifying theoretical frameworks in the included studies that very few papers explicitly stated the theoretical framework they were using; thus, for some studies where this was not clear it was decided to add in the area of study, as this too would provide useful information in terms of the studies' background.

As can be seen in Table 2.4, we could identify a number of different theoretical frameworks and areas of study across the included studies, the most prevalent being SPS.

A number of sensitivity models were identified in the theoretical discussions of the studies: vantage sensitivity, diathesis-stress, and differential susceptibility.

The area of Occupational Health also appeared in a number of papers, while other papers focused more on specific theories, e.g., Hobfoll's (1989) conservation-of-resources (COR) theory, Interpersonal Acceptance-Rejection Theory (IPARTheory; Rohner, 2014).

Quality assessment

A detailed presentation of the ratings of each of the included studies, across the five criteria, is available in Table 2.3. MMAT resulted in the identification 4 studies meeting two of the criteria, and 12 studies meeting three of the criteria. The majority of studies complied with the quality criteria with 24 studies meeting all five criteria and 29 studies meeting four of five criteria. As noted previously, this assessment was not an inclusion or exclusion criterion, and all studies are included in the analysis regardless of their MMAT quality. See Appendix E for more information.

Themes identified

Three primary themes were identified through the analysis: 1) Studied environments, 2) Outcomes for SPS in environments, and 3) Different aspects of sensitivity and SPS. A summary of the included studies is presented in Table 2.3, and a table with a detailed description and coding, and a coding table can be found in Appendix F.

Studied Environments. The theme of "studied environments" included the subthemes of "early years for child and caregiver", "the senses, perception, and cognitive modification", "occupational environment", and "multi-faceted environment".

The area of childhood and the effects of the parenting environment appeared frequently in the literature, including areas such as parenting a child with additional needs (e.g., ASD).

Other environmental areas included the use of different sensory and cognitive tasks, manipulating the visual or auditory input, presenting different kinds of emotional stimuli, and attention tasks. A number of longer-term intervention environments were also identified

ranging from those targeted towards mental health, to yoga courses, and school-based interventions.

Occupational environments also appeared frequently. This included working environments such as in healthcare and teaching, as well as school and university environments i.e., the occupation of younger people.

Finally, the subtheme of multifaceted environments comprised of those environments which contained a multitude of different features; for example, the environment of war, the COVID-19 pandemic, and competitive sporting environments.

Outcomes for SPS in environments. The larger of the three overarching themes, this contained the subthemes of "Mental Health and Wellbeing", "Cognition", and "Relationships with Other Internal and External Factors".

In terms of mental health and wellbeing, a number of different facets were studied in the literature, with some having a positive impact, others negative, and some null findings.

Benefits appeared in areas such as emotional and social wellbeing, decreases in negative affect, and increases in self-esteem. In general, high levels of SPS appeared to be beneficial in intervention studies, with reductions in depression and greater changes in positive mood noted in different studies. However, higher levels of SPS were also associated with higher levels of distress, negative affect, work displeasure, declines in wellbeing, higher negative affect, anxiety, psychosomatic disorders, and rumination. In different environments, SPS can confer both vulnerabilities and more positive opportunities in this area.

In the area of cognition, outcomes pertaining to processing, affect, and behaviour were examined. High levels of SPS were related to difficulties in emotional identification, reduced comprehensibility i.e., comprehension of internal and external stimuli as

understandable, a negative impact on CDT latencies, difficulties with emotional description, a negative relationship with functional capacity, and lower Stroop response times. However, other studies found faster reaction times for rating positive valence of images, greater attention engagement, more attunement to students' needs, using coping strategies, and deeper processing of material were related to higher levels of SPS. Self-perception such as in the areas of academia and socially, and perception of the external world, such as in work and safety, also appear to be related to individuals' levels of SPS.

Relationships between SPS and other factors, both internal and external, appear to relate to the connections between SPS and outcomes. Factors such as coping styles, intolerance of uncertainty, optimism/pessimism, sense of coherence, parenting quality, and lockdown, amongst others, all appear to interact with environments and SPS in creating the aforementioned outcomes.

Different aspects of sensitivity and SPS. The final theme, "Different aspects of sensitivity and SPS", was the least represented of the three themes, and contained the subthemes of "SPS Groupings" and "Other sensitivities".

SPS groupings captured the finding that SPS tends to be broken down into either two or three groupings in the literature, that is low, and highly sensitive or low, medium, and highly sensitive. Furthermore, individual factors of SPS are often used in analysis in the literature. These factors of EOE, AES, and LST are used in some, but not all studies.

Other sensitivities appeared alongside SPS in research papers. Theories such as vantage sensitivity, diathesis-stress, and differential susceptibility are all linked with SPS, and in the research in the area.

Discussion

This systematic scoping review examined the current research on environmental variables explored in relation to HSP, the types of psychological outcomes investigated, the impact of these environments on psychological outcomes of HSP, and the methodological approaches adopted. The overall trend of the literature included in the scoping review suggests that the relationships between SPS, the environments, and psychological outcomes are complex, and vary regarding specific population types and levels of exposure. A wide variety was found amongst the studies in terms of the types of environments investigated and methodologies used in research.

Having extracted descriptive characteristics and key results of the included studies, a thematic analysis approach was applied as per the guidelines of Braun and Clarke (2006) to identify patterns in the data. This resulted in three overarching themes; Studied environments, Outcomes for SPS in environments, and Different aspects of sensitivity and SPS. Numerical analysis was also applied to identify key descriptive trends.

The descriptive analysis of the study characteristics found that most studies applied a cross-sectional design. Most studies were carried out in Western countries, with adult populations. However, there were a number of studies carried out in Asia. As can be seen in Figure 2.2, this highlights a gap in the research into this area in areas such as Africa, South America, and South Asia. As noted by Black and Kern (2020), Western Educated Industrialised Rich and Democratic (WEIRD) countries have been found in research to differ from non-WEIRD countries across different behavioural and cognitive indices. Thus, investigating the trait of SPS in non-WEIRD populations is a necessity when considering generalisability of the construct and findings from SPS research worldwide. However, as can

be seen from the dates of the included studies, this is an area of research which is rapidly expanding, with 50 of the 63 included papers being published in the last 5 years.

Considering the first overarching theme found in this review, it appears that research in SPS has taken place across a multitude of different environments. One area which is widely researched is that of the family environment, specifically parenting (e.g., Lionetti et al., 2019; Moscardino et al., 2021; Onursal Özer, 2020; Slagt et al., 2018; Uljarević et al., 2016). Research into the impact of parenting took place both at the time of child/parent interactions in the present (e.g., Lionetti et al., 2021), or in the participants' past (e.g., Liss et al., 2005).

A number of different sensory environments were researched, with participants exposed to different audio stimuli (e.g. Hellwig & Roth, 2021; Strand et al., 2018), visual stimuli (e.g. Jagiellowicz et al., 2016; Sklar et al., 2021), and cognitive tasks (e.g. Gerstenberg, 2012; Rigby et al., 2020). Environmental manipulations through interventions were also popular in the literature, with a number of school-based interventions identified (e.g. Nocentini et al., 2018; Pluess & Boniwell, 2015). The interaction between the working environment, SPS, and psychological outcomes has been investigated in a number of working environments, from healthcare (Redfearn et al., 2020), to teaching (Tillmann et al., 2018), and working as an expatriate (Andresen et al., 2018). Throughout the qualitative analysis, it became apparent that there were a number of multi-faceted environments which resulted in the construction of the subtheme of the same name. Environments like the seasons changing (Hjordt & Stenbæk, 2019), and competitive sports (Kemler, 2006), contain a multitude of factors which make them complex.

Areas that could be of relevance for SPS but are not directly investigated are natural environments and social relationships, such as friendships and romantic relationships. This is surprising given the growth in this research area over the past decade, and the fact that HSPs note nature to be an important enabler of wellbeing (Black & Kern, 2020). Furthermore, research around social environments in relation to SPS was limited to specific areas e.g., work, parenting, and did not include the areas of friendships or romantic relationships. Given the importance of relationships in the area of psychological wellbeing, and the growing evidence for the role of nature, these could possibly be important areas for research in the area going forward.

Regarding the second theme, "Outcomes for SPS in environments", and the results of the charting process, the findings suggest that the picture of what environments benefit those with high levels of SPS, and the environments that are disadvantageous in terms of their psychological outcomes for this cohort, is complex. Considering cognitive tasks, in some situations SPS can confer benefits, such as a deeper processing of material in a Posner exogenous cueing task and cued attention task (Rothenbücher, 2017), and faster reaction times in responding to pictorial emotional stimuli (Jagiellowicz et al., 2016). However, it was also found to have a negative impact on Stroop performance (Sobocko, 2012), and a negative impact on complex dual-task (CDT) latencies. In terms of mental health and wellbeing in the school environment, the two available interventions had a positive effect for those higher in SPS, with greater benefits from school-based interventions in reducing internalising symptoms and victimisation for boys (Nocentini et al., 2018), and reductions in depression in girls (Pluess & Boniwell, 2015).

The work environment presents some difficulties for the HSP in terms of burnout (Meyerson et al., 2020; Redfearn et al., 2020; Stefan Lindsay, 2018), and aspects such as

manageability i.e., extent of belief that necessary resources to cope with problems are available, comprehensivity i.e., extent of belief that problem being faced is clear, and meaningfulness i.e., the extent of belief that one wishes to cope with the problem (Evers et al., 2008). The parenting environment appeared to have an impact on the HSP's psychological outcomes, dependent on the quality of the parenting, with positive parenting predicting better outcomes and lower quality parenting having a negative impact (e.g., Lionetti et al., 2019; Liss et al., 2005). This is in line with the parenting research in the general population and in research regarding parenting a child with a learning disability (Lawrence et al., 2019; Tabak & Zawadzka, 2017). Areas of psychological outcomes investigated were diverse, though few focused on the area of mental health disorders. Given the noted prevalence of those higher in SPS in therapy (Aron, 2011), it is surprising that the impact of the environment on this cohort and on these disorders is not as prevalent in the current review. Future studies might examine the relationship between SPS and mental health disorders, as opposed to symptoms alone.

As identified in the theme "Different aspects of sensitivity and SPS", the use of different conceptualisations of SPS and sensitivity in the literature is widespread. This is in line with the literature, as while initial analysis suggested SPS was a unitary factor (Aron & Aron, 1997), later research suggested it contains a bifactor solution including the three constructs of EOE, LST, and AES and a general SPS factor (Lionetti et al., 2018). In terms of measurement, as can been seen in Appendix D, all studies used some form of SPS scale based on Aron and Aron's (1997) original HSP scale. Most scales were in a written format, apart from the HSC scale developed for pre-schoolers which is based on observation (Lionetti et al., 2019). This allows for comparison across studies; however, as the scales are generally self-report, apart from studies in which parents report for children, there is likely to be some self-reporting bias. As noted by Greven et al. (2019), more objective assessment procedures

could be a beneficial addition to the research in this area. Furthermore, the HSP/HSC scales were at times used in studies as a measure of SPS, though at times noted to be measuring ES. It could be helpful for future research in the area to be careful to clarify the concepts of sensitivity they are utilising, what the sensitivity scale one is using has been designed to measure, and place results within the greater sensitivity literature framework – for example the framework suggested in Greven et al. (2019).

Indeed, the theoretical framework of ES was popular across studies, as can be seen in Table 2.3. As noted in the results, many studies did not note the theoretical framework from which they were working in their articles. From examining those noted and the general areas of research, there appears to be a plethora of different theories and research areas, from cognitive to social and mental health-based research. However, given the relative spread and the high levels of speciality of the studies, it suggests that SPS is a concept which at times gets included in studies rather than being the main focus. Thus, building a foundation of research into different common environments, e.g., nature, home environment, educational, could be beneficial in terms of identifying the areas which are more likely to impact on the mental health of those high in SPS alongside the examination of the more niche areas which have been examined already in the literature.

Strengths and Limitations of the Current Scoping Review

This is the first scoping review summarising the available research in the area of the impact of different environments on the psychological outcomes of those high in SPS. Indeed, it would appear to be the first scoping review in the area of SPS. However, there are a number of limitations which need to be considered in relation to this review. Only articles published in English were included in the review, thus relevant studies published in other languages were not included. As can be seen in Figure 2.1, 25 studies identified were not

published in English which is a substantial number. Thus, the countries and cultures of these papers were not included in the analysis leading to a WEIRD-leaning review.

Another limitation is that due to the heterogeneity of the studies, there were difficulties in summarising the findings, and in turn difficulty in drawing conclusions. Future reviews may overcome such difficulties by focusing on more discrete aspects of the SPS research rather than the broader approach taken in the current systematic scoping review.

This review also has some strengths. A large number of theses completed around the area of SPS were identified throughout the process of the review, with the majority of these not appearing in published form. This speaks to a possible "file drawer" problem in the area. As much of this research may not be returned in traditional searches, it is a strength of this review to include the results of such studies. Furthermore, the definitions of environment and psychological outcomes were kept broad in order to include as much research as possible to allow it to be mapped. The study also included quality review, which adds to the descriptions of the studies, and aids in identifying what areas may need further investigation.

Conclusions

SPS is a trait which interacts with a wide variety of environments, which can have an impact, for better or for worse, on an individual's psychological outcomes. The field of research into sensitivity is burgeoning in recent years and is being carried out in many regions of the world. This review synthesised the available evidence regarding the relationship of SPS with the environment on psychological outcomes. In sum, the interactions between SPS and the environment are complex, and research differs in the outcomes of having this trait. In addition, research gaps were identified in terms of non-WEIRD populations, research into mental health disorders interacting with SPS and environments, and nature environments. Beyond these identified gaps, future research should apply

longitudinal designs to investigate psychological outcomes for those high in SPS, and follow-up to investigate possible long-term associations. Further intervention studies should also be considered, especially in the area of mental health.

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Chapter Three: Systematic Scoping Review Extended Methodology

Methodological Framework

Scoping Reviews

A field of evidence synthesis which has emerged in recent times is that of scoping reviews (Munn et al., 2018). Scoping reviews are described by Arksey and O'Malley (2005) as a way of mapping the range, extent, and the nature of research available on a topic, which can aid in identifying gaps in the literature, provide summaries of available evidence to researchers and others stakeholders in the particular field, and also assist in identifying if a full systematic review is warranted in the area. They have also been defined as "exploratory projects that systematically map the literature available on a topic, identifying key concepts, theories, sources of evidence and gaps in the research" (Government of Canada, 2010, p.34). A description of the steps of completing a scoping review in general as set out by Arksey and O'Malley (2005), and as applied in the current scoping review, can be found in Chapter Two.

In 2009, it was one of the 14 different types of literature reviews identified by Grant and Booth (2009). A number of strengths and limitations have been identified for this form of evidence synthesis. Strengths include: they can aid in informing whether a full systematic review is needed; the fact that they are systematic, transparent and replicable; that they include both published and un-published literature; its usefulness as a tool in mapping broad and diverse topics; and its focus on the state rather than quality of research activity in an area (Grant & Booth, 2009; O'Brien et al., 2016). Weaknesses have also been identified, namely; the difficulties in establishing boundaries with such a broad scope, the lack of clarity in interpreting scoping evidence with the lack of quality appraisal which can make it difficult to use scoping reviews in informing policy, the variability in the field around definitions and

terminology, and the resources required to complete such reviews due to their iterative process (Grant & Booth, 2009; O'Brien et al., 2016).

Rationale for Scoping Review

A scoping review was selected as a method of synthesising the literature in the area of SPS and the impact of different environments on psychological outcomes for a number of reasons. Firstly, their utility in examining emerging evidence when it is unclear what other more specific questions can be posed and addressed using the more precise tool of systematic review, due to the heterogeneity of the specific empirical questions in the literature to date (Armstrong et al., 2011). There have been some reviews of the literature conducted in the area covering different specific areas, from brain circuitry to associations with personality and evidence from evolutionary biology (e.g., Acevedo et al., 2018; Aron et al., 2012; Greven & Homberg, 2020; Lionetti et al., 2019). However, these do not focus solely on the important relationship of SPS with the environment. To the best of our knowledge, this is the first scoping review summarising the available evidence between SPS, different environments, and psychological outcomes.

Secondly, given the breath of the literature in this area, mapping the available evidence was identified as something which could benefit research in this area going forward. As can be seen in Chapter Two, the range of studies in SPS and psychological outcomes covers areas as diverse as work settings (e.g., Andresen et al., 2018; Evers et al., 2008), floatation baths (e.g., Jonsson et al., 2014), parenting (e.g., Aron et al., 2019; Slagt et al., 2018) etc. Thus, having this evidence synthesised and summarised in one scoping review will be beneficial for future researchers, as gaps have been identified for future research and summaries provided for what is currently known in the literature.

In sum, our rationale for using scoping review methodology was that it would allow us to map the diverse range of knowledge that is available in the area of SPS at present, but also identify what is needed to help in progressing this growing field of research.

Identifying Studies for Inclusion

Search Strategy

As described in Chapter Two, the search strategy for the scoping review was developed through discussion between the authors and informed by an initial search of the literature by the first author. Search terms were piloted to confirm that the search returned relevant studies of which I was already aware.

Due to the differing nature of the databases, search strategies differed. For example, there is a character limit on Google Scholar, such that all identified search terms could not be included. Thus, discussions between authors took place to identify which terms to include in the context of restricted character count to ensure the results reflected best what was being searched for. A number of variations were trialled by the first author, and an appropriate search string identified and agreed upon. See Appendix C for all search strings.

Development of Inclusion and Exclusion Criteria

As noted by Arksey and O'Malley (2005) a mechanism is needed in order to help us eliminate studies that do not address the central research question when conducting a scoping review. Furthermore, it is a convention of systematic review methods to develop inclusion and exclusion criteria at the outset of projects to ensure consistency in decision making. The scoping review in Chapter Two used inclusion and exclusion criteria to aid with this, but also clear definitions of the areas being examined. Definitions used in the current scoping review can be found in Chapter Two.

As noted by Peters et al. (2015), while deviations from a review protocol in a traditional systematic review are rare, given the iterative nature of a scoping review, changes may be necessary in the process, though clear details and justifications for these are needed in the "Methods" section of the scoping review report if and when they occur. In the current review, following discussion with authors, it was decided to include relevant studies identified during the search process which were published following the original 31st of July 2021 cut off as specified in the Inclusion/Exclusion criteria. Due to their time consuming nature to complete, scoping reviews are at risk of becoming out of date quite quickly (O'Brien et al., 2016). Thus, to aid with this pitfall, it was decided to accept studies which were relevant, and appeared in the original search in September 2021 that were outside of these guidelines. From this experience, it became apparent that due to the increasing speed with which research is published in journals, and pre-published online, that perhaps having a date cut off does not work as well in scoping review methodology as it does in other methods of synthesising research.

Pre-registering Scoping Review Protocol

The idea of protocol registration in systematic reviews was first noted in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement in 2009 (Liberati et al., 2009). Protocol registration has been noted to be of benefit when completing a systematic review. Sideri et al. (2018) found that when orthodontic systematic reviews were registered a priori in the international prospective register of systematic reviews (PROSPERO), they had increased review quality. However, while protocol registration is also noted in the PRISMA-ScR (Tricco et al., 2018), PROSPERO do not accept scoping review protocols at present (National Institute for Health Research, 2021). Thus, the current

scoping review protocol was published on OSF.io (i.e., Open Science Framework website) which allows for preregistration of reviews and studies of many kinds.

Quality Appraisal

Scoping reviews provide an overview of the existing evidence base regardless of study quality, thus formal assessment of methodological quality of the included studies is generally not performed (Arksey & O'Malley, 2005; Peters et al., 2015). However, this lack of quality analysis can interfere with the main purposes of carrying out a scoping review. As noted by Levac et al. (2010), when considering whether a scoping review has identified gaps in the literature, one may end up coming to false conclusions around the nature of the gaps or the extent when quality of the available evidence is not assessed. Daudt et al., (2013) echo this sentiment, and recommend scoping reviews assess for quality and this step be added to the framework, suggesting the use of validated instruments. Despite these reservations around the lack of quality assessment, appraisal of the evidence is noted as only an optional item in the PRISMA-ScR (Tricco et al., 2018), though a rationale is noted to be necessary as to why it was included.

Quality appraisal of the studies included was carried out in the current scoping review in order to fully elucidate the gaps in the literature. As this scoping review included non-peer reviewed work and grey literature, it was decided that such a step would be beneficial in highlighting areas where more research, or indeed more rigorous research, is needed. Following from the suggestions of Daudt et al. (2013), a validated instrument was utilised, the MMAT (Hong et al., 2018). This is a critical appraisal tool, designed and used in the appraisal stage of a systematic review of mixed studies. It was chosen for its validity and for the fact that it is designed for appraising the most common types of study design and

methodology. See Chapter Two for details on how this tool was applied in the current systematic scoping review.

Synthesising Studies

Following the charting of the data, as described in Chapter Two, data was analysed and synthesised using quantitative and qualitative methods.

Arksey and O'Malley (2005) note that scoping reviews need a thematic construction to present a narrative account of the existing literature. In order to do this in a systematic way, a thematic analysis approach was utilised to summarise our findings and identify recurring themes. The guidelines proposed by Braun and Clarke (2006) were utilised. These guidelines consist of six steps; reading and familiarization, coding, searching for themes, reviewing themes, defining and naming themes, and finalizing the analysis (Braun & Clarke, 2006). It was decided to take an inductive approach to the data, meaning the coding was not driven by existing literature in the area, rather by the data itself. The data was looked at for its semantic meaning rather than latent. These decisions were made based on the nature of the data and the research question. The use of the thematic analysis as described by Braun and Clarke (2006) is common in scoping review analysis (e.g., Huschke et al., 2020; Ng et al., 2020; Nigg et al., 2021; Sherborne et al., 2020; Thompson et al., 2017).

As described in Chapter Two, coding was conducted on the results of the charting process, as per Huschke et al. (2020) and Nigg et al. (2021). However, if more information was needed for a better understanding, additional information was obtained from the article. Coding was conducted based on the columns Environment type, Specific Environment and Relevant Key findings. For an example of how this was coded please see Figure 3.1 below.

Figure 3.1

Initial coding example

Authors	Year	Title	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Carr, M., Summers, R., Bradshaw, C., Newton, C., Ellis, L., Johnston, E., & Blagrove, M.	2020	Frontal Brain Activity and Subjective Arousal During Emotional Picture Viewing in Nightmare Sufferers	Sensory	Emotional Picture Viewing	Nightmare sufferers scored more highly on the HSPS than control participants.	Sensory environment/ Viewing emotional material environment/ Nightmare sufferers higher in SPS/ Differences in SPS levels identified
Redfearn, R. A., van Ittersum, K. W., & Stenmark, C. K.	2020	The Impact of Sensory Processing Sensitivity on Stress and Burnout in Nurses	Multiple	Working in nursing currently in the USA	SPS was found to correlate overall with nursing stress, burnout, five nursing subscales of stress, and two subscales of burnout. SPS was shown to be a predictor for overall nursing stress, overall burnout, of two nursing stress subdimensions, and one burnout subdimension.	Multiple environmental aspects/ Nursing environment/ Healthcare environment/ SPS relationship with nursing stress/ Burnout association/ SPS predictor for negative wellbeing/

The iterative nature of Braun and Clarke's (2006) thematic analysis reflects the iterative nature of scoping review methodology itself and is useful in the exploration and search for themes which fit the data. In the current study, while the first author conducted the coding and construction of themes, another author was included at the different steps to ensure that the analysis was remaining data-driven rather than introducing bias. Once the initial coding process was completed, themes were developed based on these codes, namely: 1) Studied environments, 2) Outcomes for SPS in environments, and 3) Different aspects of sensitivity and SPS. The first author organized the initial codes into thematic categories in a systematic, repetitive process. Themes were not mutually exclusive, and an article's content could be mapped into multiple themes. The first author revisited and reviewed the categorization from the coding often throughout the process to ensure themes were

representative of the data they contained, and codes properly housed during the coding and categorisation process.

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Note: How the Systematic Scoping Review Informs the Major Research Project

The results of the systematic scoping review suggest that while the trait of Sensory Processing Sensitivity (SPS) has been researched in many domains, one area in which it remains under-researched is that of the physical environment, more specifically greenspace and bluespace environments. Greenspace refers to areas that is at least partly covered by vegetation such as forests, parks, and fields. Bluespaces are areas such as the seaside, rivers, and lakes, where there are bodies of water.

The findings of Black and Kern (2020) suggest that those higher in SPS report that nature is an enabler of their wellbeing, thus it is surprising that this avenue has not been explored in the literature at a theoretical level, or in terms of intervention. A recent study from Setti et al. (2022), demonstrated that those with higher levels of SPS showed greater nature connectedness, that is a sense of being connected to the natural world and being a part of the natural world. Considering these studies together, it is possible to hypothesise that nature plays a role in the wellbeing of those with higher levels of SPS, but also is something for which they feel an affinity. As will be discussed in Chapter Four and Chapter Five, there is a wide body of research which demonstrates the benefits of nature on mental health, mood, and cognition.

Given the sensitivity of those with higher levels of SPS to their environments, and the dearth of research in the area, the following major research project aimed to explore this area. It does this through using a pre-post intervention study on the effects of a virtual nature intervention, and control virtual urban intervention, on the affect and cognition of individuals with varying levels of SPS and examining the relationship of SPS with the outcomes. This study also contains a smaller qualitative component to support this work, which looks at the

participants' experience of the intervention they received, and their experience of nature in day-to-day life, to add context to the quantitative results.

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Chapter Four: Major Research Project

Impact of the Temperament Trait of Sensory Processing Sensitivity and Virtual Environmental Intervention on Cognition and Affect

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Abstract

Sensory Processing Sensitivity (SPS) is linked with a variety of mental health issues, including rumination. The positive impact of nature-based interventions, and virtual nature interventions, on affect and cognition, particularly executive functions, are well established. The purpose of the current pre-post intervention study was to evaluate the impact of a virtual nature intervention on affect, rumination, and cognition in individuals with varying levels of SPS. Using a survey experiment method, 147 participants (53.1% female; $M_{age} = 48.07$) completed measures at T1 including Highly Sensitive Person Scale, Depression Anxiety Stress Scales-21, Positive and Negative Affect Schedule, Brief State Rumination Inventory, and online Stroop Task, watched a nature scenes video or urban scenes video, completed T2 measures and Stroop Task, and then answered two open ended questions on their experience of the intervention and of nature in their lives. Pre-post intervention analysis showed significant decreases in negative affect and rumination following the nature intervention, and significant decreases in positive affect and rumination following the urban intervention. Multiple regressions showed that the model was significant for predicting changes in positive affect, negative affect and rumination, while the model was not significant for the Stroop Task. Changes in positive affect were found to be significantly predicted by the interaction between SPS and the virtual environment viewed. Conventional Content Analysis (CCA) explored participants' experience of the intervention and of nature in day-to-day life, and suggested that many participants had positive associations with the urban environment as well as nature. A brief virtual nature intervention may be a feasible way of reducing negative affectivity and rumination.

Keywords: Sensory Processing Sensitivity; Highly Sensitive Person; Nature Intervention; Virtual Nature Intervention; Rumination; Psychological Wellbeing

Introduction

Depression and anxiety are two of the most common mental health issues globally, with depression being ranked by the WHO as the single largest contributor to global disability, while anxiety ranked sixth (WHO, 2017). A group of people who are particularly at risk for mental health issues such as these are Highly Sensitive Persons (HSPs; Aron & Aron, 1997).

HSP individuals are defined by their high levels of the temperamental trait known as Sensory Processing Sensitivity (SPS), and are thought to make up a significant minority of the population, approximately 20-35% (Greven et al., 2019). SPS involves increased sensitivity of the central nervous system to stimulation offered by the environment. Recent research suggests that SPS is a continuum, but with three broad categories i.e., low, medium, and highly sensitive individuals (Lionetti et al., 2018). More recent conceptualisations of SPS integrate it into the theory of Environmental Sensitivity (ES; Greven et al., 2019) which refers to an ability to register, process, and then respond to an external stimuli. There is evidence to suggest that SPS changes with age. In a study from Ueno et al. (2019), it was found that some aspects of SPS decrease with age (low sensory threshold and ease of excitation) while others increase (aesthetic sensitivity).

HSPs are identifiable by their heightened emotionality, empathy, and depth of processing, however this trait goes beyond processing of sensory inputs and also comprises a deep sense of beauty in the world and one's environment, and great empathy towards the suffering of others (Greven et al., 2019).The mechanisms behind these differences in processing have been explored in the neuroscience literature. Using fMRI and a change

detection task with natural scenes, Jagiellowicz et al. (2011) demonstrated that SPS was associated with greater activation in brain areas for higher-order visual processing, which would suggest there are not only differences observable at the social level, but also in terms of brain activation. An fMRI study of Acevedo et al. (2014) demonstrated that HSP scores were associated with individuals showing stronger activation in brain regions operating in self-other processing, awareness, and also in empathy. The authors note the findings demonstrate how the highly sensitive brain processes information about those close to themselves and positive emotions more thoroughly, perhaps as an evolutionary tool for conservation of resources. In a study from Aron et al. (2010) it was found that individuals high in SPS were less influenced by cultural differences in tasks evaluating context dependency, which suggests that HSPs can focus on tasks themselves, independent of other factors. Furthermore, Acevedo et al. (2017) showed an interaction between participants' ratings of the quality of childhood parenting received and SPS, such that the interaction was positively associated with brain regions with a relationship to depth of processing, memory, and also physiological regulation when faced with emotional stimuli. Here it was noted that positive parenting environments could provide benefits in terms of adaptive responsivity to stimuli which are evocative. From the research in the area to date, it would appear that there are differences in brain activation in the highly sensitive person, which results in these observable differences in processing and in social skills.

Having high levels of the trait SPS can confer benefits and strengths for individuals. For example, they have been found to benefit more from interventions. In studies from Nocentini et al. (2018) and Pluess and Boniwell (2015), it was found that those higher in SPS benefited more from school-based intervention programmes in terms of psychological benefits.

While SPS is associated with benefits, it is also a risk factor. There is a growing body of research suggesting that high levels of SPS are a risk factor for mental health issues such as anxiety and depression (Liss et al., 2005, 2008), and for higher levels of psychopathology related traits and traits of autism spectrum disorder and alexithymia (Liss et al., 2008). While showing higher levels of anxiety in general, HSPs also show greater levels of negative affect when in experimentally manipulated negative experiences, for example completing an extremely difficult task (Aron et al., 2005).

The usefulness of considering SPS a transdiagnostic trait has been raised in the literature given its observability in humans and animals, heritability, and its association with traits of mental disorders (Greven et al., 2019). Theories around why SPS is associated with these outcomes include viewing the vicious circles of interaction between an aversive stimulus, SPS, strong emotions, and cognitive reactivity (Wyller et al., 2017) . Wyller et al. (2017), who applied a model of recurrent depression to the relationship between SPS and psychological distress, suggested that rather than sensory stimuli or negative emotions themselves being the cause of the ongoing distress, it may be the secondary dysfunctional cognitive responses to the negative environmental stimuli or negative emotions fostered by rumination, mediating that relationship (Wyller et al., 2017). This leads to self-perpetuating vicious circles. Evidence in support of this theory comes from Brindle et al. (2015), who demonstrated that difficulties in emotional regulation partially mediate the relationship between depression and SPS.

Rumination is a maladaptive method for emotional regulation in which individuals focus on their negative self-referencing thoughts rather than engaging in more positive coping strategies, and can be both a state and a trait (Marchetti et al., 2018). The link between SPS,

rumination, and psychological distress has been explored in the literature, with Lionetti et al., (2021) demonstrating that children's levels of sensitivity interacted with permissive parenting environments to predict rumination, which in turn was associated with depressive symptoms. Furthermore, in a qualitative study of adults with high levels of SPS, participants noted they worried and ruminated more than others about private events and events in society (Bas et al., 2021). While the deeper processing of those with higher levels of SPS can be a strength under certain positive conditions (e.g., Acevedo et al., 2017), given their propensity to ruminate, this could suggest that if an individual with high levels of SPS focuses on negative thoughts it may be more difficult for them to interrupt them due to their greater focus on them.

Considering the work of Acevedo et al. (2017), Lionetti et al. (2021), and Aron et al., (2005) it would appear the quality of an individual's environment e.g., the parenting environment or childhood environment, plays a role in the relationship between mental health and the trait of SPS, acting as a mediator between the trait and distress. However, while the social world of the HSP has been explored in the literature, from parenting, to schooling, and work, the physical world of the HSP has not been as thoroughly researched. This is especially true of the relationship between SPS and nature. This is an important area in the study of SPS, as HSPs by their very definition are more sensitive to their environment, they express a need for connectedness to nature (Black & Kern, 2020) and show greater nature connectedness (Setti et al., 2022).

In recent years, there has been significant growth in research around the benefits of interacting with natural environments for mental health. These are also known as greenspaces (e.g., forests, parks, fields) and bluespaces (e.g., the seaside, rivers, lakes) in the literature. In a meta-analysis from Roberts et al (2019) it was demonstrated that a significant reduction in depressive mood is found following nature exposure, while nature interventions have also

been shown to aid anxiety (e.g., Reynolds et al., 2018). It has also been shown to impact on the transdiagnostic process of rumination. In a study from Bratman et al. (2015), it was found that a walk in nature for ninety minutes decreased both self-reported rumination and activity in the subgenual prefrontal cortex (sgPFC). This is a brain area which is associated with self-focused behavioural withdrawal, and it has been linked to rumination in individuals both with and without depression. Similar results were found by Lopes et al. (2020), who demonstrated that walking in an urban park for 30 minutes reduced ruminative thinking significantly in participants, whereas a 30 minute walk along a part of the city devoid of nature did not. Walking in nature and viewing pictures of nature, have also been found to aid in improving executive functioning (Berman et al., 2008)

Virtual nature interventions have also been found to be beneficial in aiding mental health. In a recent systematic review from Browning et al. (2021), it was found that in approximately 100 experiments, mood improvements were demonstrated, while in approximately 50 experiments, improved attention or cognition, stress reductions, increased pain tolerance, or perceived restoration was found. This systematic review looked at virtual nature of many kinds: slideshows, pictures, videos on different kinds of media devices. It is thought in the literature that the more immersive the experience the more effective. For example, in a study from Annerstedt et al. (2013), the inclusion of combined audio and visual nature elements showed greater stress recovery than visual alone. The time for such improvements would also appear to be minimal, with a study exploring 360 videos of nature finding five minutes was sufficient to lower negative affect in students with high exam anxiety (O'Meara et al., 2020). Similarly, other research using virtual nature interventions have found ten minutes of virtual nature to be effective in seeing results (Reynolds et al., 2018). In a randomised cross-over pilot study of a virtual nature intervention, consisting of looking at pictures of natural scenes, sustained attention was found to improve following the

intervention (Jung et al., 2017). This study utilised the Stroop task amongst other neuropsychological tests in creating a composite sustained attention score.

Thus, virtual nature can confer similar improvements to mental health and cognition as in vivo experiences of nature. This is important given the COVID-19 pandemic and regional lockdowns, there is a greater awareness that such events can limit the access of individuals to spaces which people can use to support both their physical and mental health. Virtual nature can also be used as an alternative to real nature in specific situations which make access to nature more difficult e.g., in hospital or prison settings. It has also been found to promote curiosity to explore real natural environments (Calogiuri et al., 2022).

There are a number of theories as to why contact with nature improves mental health and cognition. Considering the Attention Restoration Theory framework of Kaplan and Kaplan (1989), it proposes that nature renews our attentional and cognitive capacities. Bratman et al. (2021) would suggest that it is possible that rumination is affected by the restoration of directed attention, possible reductions in attentional fatigue, or improvement in cognitive control. This is pertinent given the impact of deeper processing on the attentional energies of the HSP. Egner et al.'s (2020) Conditioned Restoration Theory (CRT) suggests that restoration provided by nature can be accounted for by a process of conditioning and associative learning, in which people learn to associate nature with something relaxing and then subsequently find that nature by itself triggers relaxation. The authors note that non-natural environments can also trigger restoration. Given the deeper processing of stimuli by those with higher levels of SPS, it is possible that they would form stronger associations in such circumstances than others.

Those with higher levels of SPS show a greater depth of processing information, both social and environmental, and are noted to struggle with issues of mental health and the

process of rumination. Nature interventions are noted in the literature to improve both cognition and affect. This raises the question of how effective nature interventions may be for this cohort in reducing rumination, and improving affect and executive functioning. Thus, investigating protective and risk factors for this cohort could have implications for clinical and applied research, as well as practice in terms of prevention and intervention. This is especially pertinent given that this population appears to benefit more from intervention and makes up a significant proportion of those attending psychotherapy practices, as noted previously. Given its ubiquity and cost-effectiveness, nature interventions could provide a much-needed avenue of intervention for this population if they are at risk of mental health issues or are struggling with such issues.

The present study aims to explore the beneficial role of natural environments in decreasing maladaptive cognitive strategies that have been linked with anxiety and depression i.e., rumination, as well as increasing levels of positive affect. This study will look specifically at virtual nature environments as there are many situations in which it is not possible for individuals to access nature, such as when one lives in an urban area without greenspaces, hospitals, nursing homes, and prisons, amongst many more. Furthermore, as noted above virtual nature can promote curiosity to explore real nature (Calogiuri et al., 2022). This is also an important area of study in the current global pandemic which at times can restrict an individual's access to nature due to regional restrictions.

It is hypothesized that individuals will show improvements in executive functioning, improved affect i.e., increased positive affect and decreased negative affect, and decreased rumination from a short virtual nature-based intervention, and that those higher in SPS will show greater benefit than those with lower levels of the trait. The Stroop Task (Stroop, 1935) will be utilised as a measure of executive functioning. The Stroop has been found to be

affected by the tendency to ruminate due to greater difficulty in ignoring irrelevant information (Philippot & Brutoux, 2008). We will also control for the impact of general distress i.e., depression, anxiety, and stress, as this is likely to have an impact on results, considering the higher levels of psychological distress in HSPs. Exposure to natural environments will be compared with a control condition where participants are exposed to an urban environment, in line with the paradigms utilised in the literature in this area. Participants will also be asked open-ended questions on the intervention and their relationship with nature to provide context.

Methodology

Participants

The sample consisted of 147 individuals (53.1% female), with a mean age of 48.07 years (*SD* = 16.44 years, range 20 to 80 years). Participants were recruited through social media, student email, and snowball sampling. Informed consent was given prior to beginning the study, and participants confirmed that they were at least 18 years old at the time of study completion. Participants completed the study on the Qualtrics survey site which complies with GDPR regulations and is approved by University College Cork. Ethical approval for the study was received from the Clinical Psychology Research Ethics Committee of University College Cork. Participants provided informed consent by reading the information sheet provided and clicking "Yes" to consenting to take part in the study.

Measures and Materials

Sensory Processing Sensitivity. The Highly Sensitive Person Scale (HSPS)(Aron & Aron, 1997) was used to measure SPS. The scale consists of 27 items and was found to have a Cronbach's α of 0.87 by Aron and Aron (1997). In this scale, participants are presented with a series of statements - e.g. "I seem to be aware of subtleties in my environment", "I

have a rich, complex inner life", "I am deeply moved by the arts or music" and are instructed to answer each according to how they feel on a seven-point Likert scale. A rating of 1 indicates "Not at all", 4 "Moderately", and 7 "Extremely". In the current study SPS was used as a continuous variable in the multiple regression analysis. Cronbach's α in the current study was .90.

Trait Negative Affectivity. In order to allow for the examination of trait negative affectivity, a three-item measure from Aron and Aron (1997) was utilised. This is due to many of the HSPS items involving negative affect and negatively worded questions. The items are; "Are you a tense or worried person by nature," "Are you prone to fears?" and "Are you prone to depression?".

Depression and Anxiety. The Depression, Anxiety and Stress Scale (DASS-21) (Lovibond & Lovibond, 1995) consists of 21 items. It is a set of three self-report scales designed to measure the emotional states of depression, anxiety, and stress. The DASS-21 is a well-established instrument for measuring symptoms of depression, anxiety, and stress which has shown to be reliable and valid in both clinical and non-clinical samples of adults (Beaufort et al., 2017). In order to compare results with DASS norms, the scores from the DASS-21 are doubled (Beaufort et al., 2017). In the current study, the total DASS-21 score doubled was utilized as a measure of distress. Cronbach's α in the current study was 0.92.

State Rumination. The Brief State Rumination Inventory (BSRI; Marchetti et al., 2018) was used to measure state rumination. This is a short self-report scale which assesses the state of ruminative self-focus. It consists of 8 items, with these items being evaluated on a visual analogue scale (VAS) ranging from completely disagree to completely agree on a scale of 0 to 100. Items include; ". Right now, I wonder why I react the way I do" and ". Right now, I wonder why I can't respond in a better way". The scores are then summed such that

higher scores indicate greater depressive rumination i.e., minimum of 0 and maximum of 800. The scale has been shown to be reliable and have good convergent and discriminant validity and sensitivity to experimental manipulation of rumination when tested by Marchetti et al. (2018). Cronbach's α in the current study was 0.90 at T1 and .91 at T2.

Positive and Negative Affect. The Positive and Negative Affect Scale (Watson et al., 1988) consists of two 10-item scales that measure positive and negative affect. Items are rated on a 5-point Likert scale of 1 (not at all) to 5 (very much). In the literature, this is a widely used tool in both clinical and non-clinical populations. Cronbach's αs in the current study were 0.91 and 0.95 for the PANAS Positive Affect scale at T1 and T2 respectively, and 0.89 and 0.86 for the PANAS Negative Affect scale at T1 and T2 respectively.

Executive Functioning. The Stroop Colour and Word Test (SCWT) (Stroop, 1935) is a neuropsychological test used for both experimental and clinical purposes to measure cognitive control, selective attention, and processing speed. The task shows that participants are slower and/or make more mistakes naming the ink of a printed colour word when the ink name and the printed word are incongruent (e.g., the word green printed in blue) than when they are congruent (e.g., the word blue printed in blue). The current study utilised an online version of the Stroop Task based on the work of Puccioni and Vallesi (2012). The task included four colours (red, blue, green, and yellow). There were two states in the task, congruent and incongruent. A practice section of 16 trials which included corrective feedback was first completed. If participants did not reach 10 correct answers within the allotted time per item a second practice was completed. If this was failed the participants moved on to the next part of the study, if not they moved onto the main Stroop task which consisted of 128 trials, with one quarter being congruent trials. No corrective feedback was given in the main task. The task was coded such that the colour of the word would not be the same more than

twice in a row, as this can cause bias in terms of manual response. A question was included following each Stroop task asking, “Did you encounter any specific difficulties while completing the previous task? For example; technical difficulties or having trouble distinguishing the different colours from one another etc.” to inform the results.

Resemblance Effect Question. In order to ascertain if the participants’ personal relationship with the landscapes presented could be impacting on the restoration effect, a single Likert style question was asked; “Did the place you saw in the video resemble a place you have good or bad memories of?” and the answer options were as follows; “It resembled a place I have very good memories of, It resembled a place I have somewhat good memories of, It resembled a place I have neutral memories of, It resembled a place I have somewhat bad memories of, It resembled a place I have very bad memories of, It did not resemble a place I have any memories of”.

Qualitative Questions. Two questions were asked to assess the participants’ experiences of watching the video clip, and their relationship with nature in everyday life. These were: “In the middle of the study, you were presented with a video clip showing an outdoor scene. What was your experience of watching this clip? How did you feel while watching it? Please be as descriptive as possible in your answer” and “What is your relationship with nature like in your daily life? Describe this relationship in terms of the amount of time you spend in nature and how you find the experience of being in nature. Please be as descriptive as possible in your answer”.

Video of Nature and Urban Scenes. The videos used in the study consisted of 6-minute clips of nature scenes and urban scenes. The nature scenes included the beach, rivers, flowers, forestry, and foliage. The urban scenes included traffic, trains, buses, and industrial estates. The nature video was made available via link at the end of the study for all

participants such that those who had viewed the urban video would also have the opportunity to experience the nature scene. In total, 70 (48%) participants viewed the nature intervention video, and 77 (52%) viewed the urban intervention video. The videos are available from the following links:

Urban: https://ucc.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=e9fe87bf-8b93-4786-acd9-add400caa1ec

Nature: https://ucc.cloud.panopto.eu/Panopto/Pages/Viewer.aspx?id=4c7a6618-9d33-4cf2-887a-add400caa1aa

Procedure

Participants received a link to complete the study on Qualtrics. On clicking the link participants viewed the information sheet, and gave consent to take part. Participants completed questions on demographics, the HSP scale, the three item trait negative affect scale, and the DASS-21. T1 measures were then completed i.e., the PANAS, the BSRI, and the Stroop task, in this order. Participants then viewed either the nature or urban video, this was randomised between participants such that approximately half would see each video. Participants then completed the T2 measures i.e., the PANAS, the BSRI, and the Stroop task again. Following this they answered the two qualitative questions. Participants were presented with a closing screen which explained more about the study and offered a link to watch the nature video should they so wish.

Data Analysis

Wilcoxon Signed Ranks tests were used to determine if there were significant differences in outcomes between T1 and T2. Multiple regression analysis tested factors which were hypothesised to influence the changes in outcome scores between T1 and T2. Outcome scores

were operationalised as delta change scores, calculated by subtracting the T1 score from the T2 score. The participants to predictors ratio was found to be adequate for multiple regression analysis using a G*power analysis (Faul et al., 2009) and the guidelines of Tabachnick and Fidell (2013). Tests of assumptions were carried out in order to check if data met the necessary criteria for parametric testing, in certain cases where data did not meet assumptions of normality, non-parametric tests were used. Missing data analysis was carried out on the scales used in the study using Little's MCAR test (Little, 1988), which indicated that data was missing completely at random (MCAR) for all scales, except for the BSRI at T1. Separate variance t-tests were utilised to assess if BSRI T1 missing data was related to other variables. All t-tests with BSRI T1 were non-significant at $p<.05$, which suggests it was not systematically related to the other variables and thus missing at random (MAR) can be inferred (Tabachnick & Fidell, 2013). All scale data was thus imputed in SPSS using Expectation Maximisation (EM) at a subscale level for the DASS and PANAS, and at scale level for the HSP scale and BSRI. Intervention type was coded as a dummy variable, such that 0 = urban video and 1 = nature video. Unless otherwise stated, the minimum *p*-value level of $p < .05$ was set for detecting significant differences for all statistical analyses. Data was analysed using IBM SPSS V.28.

Qualitative analysis was carried out using qualitative conventional content analysis as described by Hsieh and Shannon (2005). This is a form of content analysis which is used in studies where the existence of theoretical literature on the phenomenon is more limited, and so inductive logic can be utilised to avoid imposing any categorical system of data interpretation. Data was analysed at a semantic rather than latent level, and aims to describe the experiences of participants as they present them. The steps described by Hsieh and Shannon (2005) were followed by the first author (Cadogan); first reading through each of the participants' answers to get a sense of the whole phenomenon. Next, re-reading them,

making notes on first impressions and thoughts, and developing initial codes for each unit of meaning identified at the phrase level. Codes were examined and codes with similar meanings merged. Codes were then grouped into clusters of related meanings and developed into categories and subcategories. These were then defined and written up, including quotations from the participants to illustrate the phenomena being described. A known weakness of conventional content analysis is the potential for insufficiently capturing the context of the phenomena and thus not capturing important codes (Hsieh & Shannon, 2005). Thus, to aid with threats to validity, verification strategies were incorporated, as per Creswell (2013), namely, researcher reflexivity and maintaining a paper trail of analysis. For an example of coding, please see Appendix G.

Results

Quantitative Results

A total of 150 participants completed the study, however data for 3 participants were removed as they noted they had not been exposed to the intervention due to issues with internet connectivity and internet browser type. The data of 9 participants were removed for the Stroop Reaction Time (RT) at T1 and T2 as they noted being distracted during the task, had a type of colour-blindness which affected their performance, or had a score greater than 3 SDs outside the mean for the Stroop Task. For information on demographics see Table 4.1 in Appendix H.

Means for the outcome variables at T1 and T2 by intervention condition are presented in Table 4.2.

Table 4.2

Means of Outcome Variables by Intervention Condition

Outcome	Nature Intervention Group		Urban Intervention Group	
	T1 Mean	T2 Mean	T1 Mean	T2 Mean
PANAS PA	31.49	30.62	30.63	26.92
PANAS NA	13.10	11.56	13.02	12.23
BSRI	212.80	152.98	197.02	131.78
Stroop RT Congruent	1135.09	1037.96	1115.02	1037.69
Stroop RT Incongruent	1237.63	1146.94	1241.87	1150.21
Stroop RT Difference	102.54	108.98	126.85	112.51

Note. Nature Intervention: $N = 70$ for all bar Stroop RT Difference where $N = 56$

Urban Intervention: $N = 77$ for all bar Stroop RT Difference where $N = 72$

Wilcoxon Signed Ranks tests were used to assess the differences between outcomes at T1 and T2 based on which intervention the participant had been exposed to, i.e., the nature video or urban video. A Bonferroni adjustment was used to adjust the minimum p value to $p < .0125$ as multiple tests were being run. For those exposed to the nature video, results indicated there was not a statistically significant change in the Stroop RT Difference (i.e., mean of incongruent trials RT minus mean of congruent trials RT) ($Z = -0.71$, $p = .478$), or in the PANAS PA scale ($Z = -1.49$, $p = .135$) between T1 and T2. However, there was a statistically significant change in the PANAS NA scale ($Z = -3.25$, $p=.001$) with a T1 mean of 13.10, and T2 mean of 11.56, and a statistically significant change in BSRI score ($Z = -4.35$, $p<.001$) with a T1 mean of 212.80 and a T2 mean of 152.98.

For those exposed to the urban video, results indicated there was not a statistically significant change in the Stroop RT Difference ($Z = -1.55$, $p = .121$), or in the PANAS NA scale ($Z = -2.10$, $p = .036$) between T1 and T2. However, there was a statistically significant

change in the PANAS PA scale (Z = -4.96, p< .001) with a T1 mean of 30.63, and T2 mean of 26.92, and a statistically significant change in BSRI score (Z = -5.49, p<.001) with a T1 mean of 197.02 and a T2 mean of 131.78.

The data for the resemblance question for those who noted the environment in the video did not resemble a place they had any memories of (N=5) was not included in the following analyses, as it was not in line with the rest of the Likert scale, i.e., ranging from very good memories to very bad memories. However, as pairwise deletion was utilised, the rest of their data is included in the following analyses. A series of Spearman correlations were run to assess the relationships between the variables of interest. HSP score centered was found to be significantly correlated with Negative Affectivity and the DASS Total score, which themselves were also significantly correlated. See Table 4.3.

Table 4.3

Spearman's Correlations between Variables of Interest

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. HSP Score Centered	-									
2. DASS Total	.51**	-								
3. Negative Affect Total	.60**	.70**	-							
4. Resemblance Question	.06	.21*	.09	-						
5. Intervention	.07	.01	.07	-.60**	-					
6. HSP X Intervention Interaction Effect	.67**	.34**	.39**	-.04	.08	-				
7. PANAS PA Delta	-.02	-.09	.03	-.34**	.21*	.08	-			
8. PANAS NA Delta	-.11	-.34**	-.22**	.09	-.09	-.19*	-.04	-		
9. BSRI Delta	-.23**	-.34**	-.22**	-.15	.07	-.19*	.11	.18*	-	
10. Stroop RT Difference Delta	.05	-.05	.02	-.24**	.14	-.04	.17	-.01	-.10	-

Note. *p<.05, **p<.01. Correlations involving intervention are point-biserial correlations.

While there were not strong correlations between some of the outcome variables and independent variables of interest, it was decided to include all variables of interest in the analyses based on our a priori hypotheses (see also Feng et al. (2016)).

A series of four standard multiple regression analyses were run in order to examine the predictive power of HSP score, DASS Total score, Resemblance to an area with good or bad memories, the intervention received (i.e., urban or rural video), and the interaction between HSP score and intervention received, on the outcomes. Given the inclusion of an interaction effect in the model, centering was utilised for HSP score to clarify the regression coefficients, see Iacobucci et al. (2017). Pairwise deletion of data was utilised. As the residuals for two outcome variables were found to be non-normally distributed, 95% bias corrected and accelerated (BCA) bootstrapping was utilised, using 2000 bootstrap samples. In the current study, bootstrap corrected B values, confidence intervals, and p-values are reported and non-bootstrapped regression weights (β) are reported. See Table 4.4 for the results.

The model for prediction of PANAS PA delta (N = 142) was found to be significant, $F(5, 136) = 4.72$, $p<.001$, and explained 15% of the variance ($R = .38$, $R^2 = .15$, adj. $R^2 = .12$). This had an effect size of Cohens $f^2 = .18$, i.e., a medium effect size (Cohen, 1988). The question on the resemblance of the video environment to an area with good or bad memories ($\beta = -.24$) was found to be significantly predictive, as was the HSP by Intervention interaction effect ($\beta = .26$) (see Figure 4.1). As HSP score centered increases, PANAS PA delta decreases for those in the urban intervention, and increases for those in the nature intervention.

Figure 4.1

Scatterplot with Fit Line at Subgroups of PANAS PA Delta and HSP Score Centered by Intervention received



The model for prediction of PANAS NA delta (N = 142) was also found to be significant $F(5, 136) = 6.47$, $p<.001$, and explained 19% of the variance ($R = .44$, $R^2 = .19$, adj. $R^2 = .16$). This had an effect size of Cohens $f^2 = .23$, i.e., a medium effect size (Cohen, 1988). The question on the resemblance of the video environment to an area with good or bad memories (β = .26) was found to be significantly predictive, as were the HSP score centered ($\beta = .27$), and the DASS Total ($\beta = -.47$).

The model for prediction of BSRI delta (N = 142) was also significant $F(5, 136) = 4.31$, $p=.001$, and explained 14% of the variance ($R = .37$, $R^2 = .14$, adj. $R^2 = .11$). This had an effect size of Cohens $f^2 = .16$, i.e., a medium effect size (Cohen, 1988). The DASS Total ($\beta = -.31$) was found to be a significant predictor.

The model for prediction of the Stroop RT Difference delta (N = 123) was not found to be significant, $F(5, 117) = 1.93$, p=.094, explaining only 8% of the variance (R = .28, R^2 = .08, adj. R^2 = .04). This had an effect size of Cohens f^2 = .09 i.e., a small effect size (Cohen, 1988).

Table 4.4

Standard Multiple Regressions Assessing Predictive Role of Variables on Outcomes

Outcome	Predictor	*N*	*T*	*p*	*B*	Std. Err.	*β*
PANAS PA	HSP Centered	142	-1.27	.206	-.04	0.03	-.16
	DASS Total		-0.87	.388	-.03	0.03	-.08
	Resemblance		-2.28	.024	-1.52	0.66	-.24
	Intervention		0.94	.350	1.14	1.21	.10
	HSP X Intervention Interaction		2.19	.030	0.09	0.04	.26
PANAS NA [a]	HSP Centered	142		.042	0.05	0.02	.27
					[0.01, 0.09] [b]		
	DASS Total			.002	-0.11	0.03	-.47
					[-0.17, -0.04] [b]		
	Resemblance			.040	1.16	0.56	.26
					[0.15, 2.18] [b]		
	Intervention			.440	0.66	0.84	.08
					[-0.82, 2.29] [b]		
	HSP X Intervention Interaction			.226	-0.04	0.03	-.15
					[-0.10, 0.02] [b]		
BSRI [a]	HSP Centered	142		.759	0.17	0.55	.04
					[-0.90, 1.19] [b]		
	DASS Total			.004	-1.65	0.57	-.31
					[-2.77, -0.50] [b]		
	Resemblance			.888	-1.43	10.56	-.01
					[-22.69, 18.76] [b]		
	Intervention			.708	6.36	17.57	.03
					[-27.48, 39.98] [b]		
	HSP X Intervention Interaction			.289	-0.82	0.76	-.14
					[-2.33, 0.49] [b]		
Stroop RT	HSP Centered	123	1.04	.300	0.51	0.49	.15
Difference	DASS Total		0.59	.559	0.27	0.47	.06
Delta	Resemblance		-2.56	.012	-26.10	10.21	-.30
	Intervention		-0.51	.613	-9.46	18.64	-.06
	HSP X Intervention Interaction		-1.45	.149	-0.93	0.64	-.19

Note. [a] Indicates 95% BCA bootstrapping used, [b] 95% BCA confidence intervals

Qualitative Results

The conventional content analysis of the open-ended question on the participants' experience of the intervention (i.e., "In the middle of the study, you were presented with a video clip showing an outdoor scene. What was your experience of watching this clip? How did you feel while watching it? Please be as descriptive as possible in your answer") resulted in three distinct categories, and eleven subcategories. These are presented in Table 4.5. Please note quotes have been corrected for capitals and punctuation.

Table 4.5

Categories and Subcategories

Category	Subcategory
Experience of Intervention	
Feelings and Emotions Arise…or don't	Positive Emotions and Feelings
	Negative Emotions and Feelings
	Nothing Evoked, or Neutrality
Cognitive Aspects of Experience	Memories
	Familiarity
	Processes
	Inspiring Thought and Actions
Quality of Video and Study environment	Audio Component
	Visual Component
	Relative Magnetism of Scenes
	Expectations
Daily Experiences of Nature	
What nature does for us and what we do for nature.	Nature Aids Affect and Wellbeing

	Nature is Restorative
	Relationship
What is done in nature.	Activities in Nature
	Nature-Based Activities
	Enjoyed Facets of Nature
	Being in Solitude or with Others
Time spent in nature and things which impact on this.	Time and States
	Perspective from Where You are Based

Feelings and Emotions Arise…or don't. For some participants, there was an experience of positive emotions or feelings as a result of the video intervention, both the urban and nature video. Participants noted feeling happy, relaxed, curious, and many other positive feelings. For one participant who viewed the nature view they noted, "*It was very pleasant and calming. It felt comfortable*.". However, for some participants, more negative emotions arose. Participants noted feeling bored, impatient, frustrated and other negative feelings. One participant who viewed the nature video noted, "*I felt pretty bored and wanted it to be over as soon as possible*". Other participants did not experience any positive or negative emotions, and noted a more neutral experience of the intervention, for example, a participant who viewed the urban video remarked, "*The clip did not really trigger any emotions on my behalf, despite me being familiar with the locations*.".

Cognitive Aspects of Experience. Different cognitive aspects of the experience were noted by the participants. One particular aspect which came up for many of the participants was memories being sparked of visiting similar places to those in the video, memories of their youth, pleasant life memories, memories linked with nature and sounds, and memories of tasks that needed to be completed. One participant who viewed the urban video noted,

"*happy of memories of train station, bus station reminded me as a child. DIY stores reminded me of jobs I have to do at home*", while another who viewed the nature video related, "*The plants and animals reminded me of warm, carefree summers when I was young*." Familiarity with the area presented also appeared to factor into the participants' experience, with some participants noting their familiarity with the area in the video, and others noting their attempts to recognise it. One participant noted it was "*Very relaxing and reminded me of places I have visited…*", while another related, "*I wondered where the location was…*". A number of other cognitive processes appeared to be sparked also, including reflecting, processes of attention, as well as focus. For some they found themselves focusing, for example "*I was concentrating on the details*", while others noted having difficulty concentrating, "*hard to concentrate while watching it*". The videos also appeared to spark some thoughts and intentions towards action in the participants, with some noting they wished to engage in activities in the areas of the video, "*It made me think that I would love to be at that beach now going for a swim*".

Quality of Video and Study Environment. A number of different aspects of the video and study environment were commented on by the participants. One aspect of the videos often noted by participants was the audio component. Participants who viewed the nature video and those who viewed the urban video had positive and negative things to say about the audio component. Some had pleasant experiences, with the sounds of the water often being noted by those who viewed the nature video, "*The sounds of waves, of running water and especially of the insects and birds had a calming effect on me*." Though some disliked this, "*a bit of annoyance towards the sound of the water*". For some who viewed the urban scenes, the noise was noted to be overwhelming at times, "*I didn't like all the noise*". The visual component of the scenes was also commented on, with participants commenting on the sights they recognised, the beauty of the scenery, and the busyness of the scenes. Participants also commented on the magnetism of the videos themselves, and how they found

them repetitive, e.g., "*It wasn't very facinating to watch and the same places being repeatedly shown*", and interesting or indeed not interesting, "*I didn't feel any pleasure in watching it. It was boring, noisy and uninteresting*." Another aspect brought up by several participants was an expectation that they would be quizzed on the scenes contents. Participants noted paying close attention, for example; "*I was anticipating being asked series of random questions on details of the video*". The fact that this was part of a psychology experiment appears to have impacted on the experiences of some of the participants, "*given this was some sort of experiment, I was too focused on why this video clip was being shown and I thought that there was going to be questions on the video afterwards so I was way too focused on the detail of the video*".

The conventional content analysis of the open-ended question on the participants' experience of nature in their day to day lives (i.e., "What is your relationship with nature like in your daily life? Describe this relationship in terms of the amount of time you spend in nature and how you find the experience of being in nature? Please be as descriptive as possible in your answer") resulted in three distinct categories, and nine subcategories. These are also presented in Table 4.5.

What nature does for us and what we do for nature. The benefits which nature provides in terms of participants' daily lives were often raised. Participants noted the benefits nature provides in terms of mental health and in inducing positive emotions, as well as being an opportunity for escapism and positive experiences. One participant noted that "*when I do spend time in nature I do feel quite peaceful within myself as it is a form of escapism from life*." Many participants also related that they find nature to be a restorative factor in their life, as being "*refreshing"* and as "*relaxing and rejuvenating"*. Some participants noted having a strong and positive relationship with nature, with one describing themselves as *"intertwined"* with nature. This relationship with nature was noted to be symbiotic for some, giving back to

nature and animals. For example, one participant described keeping "*the bird tables in the garden filled with nuts to feed the various species including the squirrels."* However, other participants noted they did not have a strong relationship with nature, *"I have limited relationship with nature, being indoors most of the time."*

What is done in nature. Participants also discussed the various activities they do in nature in their daily lives. Some of these activities were general activities based in nature, such as going for a walk or run, or exercising. Others were nature-based activities such as gardening, hiking, playing with animals, watching wildlife including birdwatching. Participants also related the various aspects of nature that they enjoy, including scenery and sensory aspects of nature, such as smell and sound. For example, one participant described how they "*enjoy the scenery around me, it makes me thankful for what I have and where I live, I can often lose myself in an horizon"*, while another shared that they "*go walking on a daily basis and enjoy the surrounding noises from wild life and animals in the fields and smells".* Nature was also described as something which could be enjoyed in solitude or with others, with differences noted between these by some, for example, "*I sometimes go with a friend and I enjoy that but I feel completely different when I go on my own, I seem to get more out of it."*

Time spent in nature and things which impact on this. Participants also described the amount of time they spend in nature generally. Some participants noted spending time in nature daily, for example, *"I try to spend time in nature at least once a day, it helps to ground me and helps me gain perspective when I'm feeling stressed".* Others related that they had more limited exposure to nature in their lives, for example, "*I have limited time in my daily life with nature but I do prefer to run 5km a week on the road than attend boring gym classes."* Some participants reported that they would like to spend more time in nature, but the impact of the demands of daily life prevent this, for example *"I would love to see more*

nature but I live too close to the city centre and don't have a car" and *"I love nature, but time does not allow me to spend time there being a professional and a working mother"*. Other participants did not express such wishes, for example, *"I only spend time in nature sporadically and I am not a big lover, I much enjoy cities".* A number of factors appear to impact on nature exposure, such as being based in an urban area, the time of the year and day, and where one works. Some participants described viewing nature from indoors as a result of their environments, for example,*"I work in an office so I dont have much interaction with nature except when I look out the window at the river in the distance."*

Discussion

This study examined the impact of virtual nature and urban interventions on the cognition and affect of individuals with varying levels of SPS, the participants' experience of this intervention, and of nature in their day-to-day lives.

The results from the quantitative analysis showed that there were changes in most outcomes between T1 and T2 in both the virtual urban and virtual nature interventions, however an interaction effect between SPS and the intervention received was only found for one outcome, changes in positive affect. There are a number of reasons why the hypotheses were only partially supported, which will be explored throughout this discussion. In the nature intervention group, participants showed a decrease in negative affect and in rumination, while in the urban intervention group participants showed a decrease in positive affect and in rumination. No change was found in Stroop RT Difference score in either intervention group.

The findings on changes in rumination and negative affect are in line with our hypothesis that a short virtual nature intervention would reduce levels of these. These findings are in line with the work of O'Meara et al. (2020), who found similar decreases in

negative affect following a virtual reality nature intervention, and Bratman et al. (2015) and Lopes et al., (2020) who demonstrated that in vivo nature exposure decreased rumination.

Considering the qualitative results, this would appear to be in line with the experiences of participants where many noted the virtual nature intervention was calming and relaxing. This is in line with the ART (Kaplan & Kaplan, 1989), which would suggest that the nature scene offered participants an opportunity for effortless attention and so was relaxing for them. Participants often discussed the facets of nature which they could see and hear in the video, such as the scenery or the sounds of nature. When discussing their experiences of nature in their lives, some participants related their feeling of connection with nature, where nature was noted to provide benefits to participants, and some participants noted their contribution to nature, such as feeding the birds. This would speak to a biophilia, that is, an innate human instinct to connect with living things and with nature. A number of participants related their experience of feeling a familiarity with the place shown in the video they viewed, and others noted that it had sparked memories, often pleasant, of trips to the beach or being in similar natural environments. This would be in line with CRT (Egner et al., 2020) where nature has become a conditioned stimulus which leads to a conditioned response of restoration. In discussion, the experience of nature in day-to-day life, many participants noted the activities which they complete in nature. Several activities completed in nature were specific to some environments e.g., sea-swimming, while others were activities which more generally related to natural environment e.g., walking. This highlights the associations between leisure activities, nature, and restoration, in line with CRT. While some participants described having an increase in positive emotions or negative emotions as a result of watching the nature video, these were not reflected in the quantitative results.

The change in rumination score following the urban intervention was not expected. Findings from previous studies comparing exposure to nature and urban environments in the

literature have found that the urban environment did not show positive impacts on outcomes in rumination (Bratman et al., 2015; Lopes et al., 2020). There are a number of possible reasons for this finding. It is possible that the participants found the urban environment to be restorative in some way. It is also possible that the urban video acted as a distraction, taking the participants' minds off their ruminations.

Considering the positive comments of participants about their experience of the virtual urban environment, their familiarity with it and the pleasant memories it aroused, it is possible that the urban environment is a conditioned stimulus, with the virtual urban environment being a generalised conditioned stimulus, resulting in a conditioned response of restoration in line with CRT (Egner et al., 2020). Adding further credence to this explanation, participants often listed the activities they completed in urban environments which they found enjoyable or brought back pleasant memories. However, it is also possible that the urban video acted a distractor for the participants, disrupting the ruminative thoughts which they were experiencing by having them focus on another task rather than acting as a restorative intervention. Given the decrease in positive affect for those in the virtual urban condition, this would also appear to be a possibility.

That both the six-minute videos had an impact at a cognitive and affective level is an important finding which could have clinical implications. While longer videos have been used in the past in the literature (Reynolds et al., 2018), that such a short amount of time spent watching an outdoor scene can lower negative affect and rumination is relevant given the relationship between negative affect, rumination and mental health issues. The results point to the potential for short nature videos as an intervention for reduction of negative affect and rumination within a short time span, and as something which is both portable and not dependent on factors such as weather or availability, as is real nature access. While there was also a decrease in rumination in the urban intervention group, which is a positive finding

in terms of the possible benefits, it is important to note the accompanying decrease in positive affect, which would speak to the benefits of virtual nature in comparison.

The predictive models were significant for outcomes except for the Stroop RT Difference Delta. Whether the place in the video resembled a place the participant had good or bad memories of was predictive of outcomes for both the positive and negative affect outcomes. Given that delta scores were utilised, and the scale for resemblance went from positive to negative memories, this means that more positive memories of the environment resembled predicted higher levels of positive affect, and lower levels of negative affect. Considering CRT, it is possible that videos of familiar environments with positive connotations acted as a generalised conditioned stimulus, which resulted in the conditioned response of restoration of affect (Egner et al., 2020).

Levels of general distress also related to results in both the negative affect outcome and the rumination outcome, such that for those with higher distress scores, there were greater decreases in negative affect and rumination. This is an interesting result when considered from a clinical perspective, as it suggests that those with greater levels of distress could expect to benefit more from virtual environmental interventions.

The interaction between SPS and intervention type was found to be a predictor for positive affect, such that higher levels of SPS predicted greater benefits in terms of positive affect from the nature intervention. This is pertinent given the relationship between SPS and mental health outcomes (e.g., Liss et al., 2005). This information could be used in the formation of future interventions for this group, as it suggests that those high in SPS would benefit more from a virtual nature intervention when trying to increase positive affect. Furthermore, as SPS increased, positive affect decreased for those viewing the urban

environment, which would suggest such environments may be more aversive for those with higher levels of the trait.

These findings are in line with the literature, as those with higher levels of SPS are also found to struggle more with their mental health and also benefit more from interventions (e.g., Nocentini et al., 2018; Pluess & Boniwell, 2015). SPS by itself was also found to be predictive of changes in negative affect, such that SPS predicted increases in negative affect when considering both interventions together. No significant interaction effect was found between SPS and the intervention type for negative affect, which was not in line with the literature. Considering the positive qualitative response of many participants to the urban intervention, this could account for the lack of significance in intervention type in predicting changes in negative affect.

These results have an applied significance. It suggests that ensuring person – intervention fit for what is needed from an intervention is of great importance for this population. Those with higher levels of SPS benefited more from a nature intervention in terms of increasing positive affect. This could be in part due to their higher levels of nature connectedness (Setti et al., 2022), or the type of sensory input from this environment may be more suitable than that of the urban environment, which they may find more overwhelming due to their sensory sensitivity (Aron & Aron, 1997).

It is important to note also, the mean scores for SPS from the current participants were not as high as those reported in other studies (e.g., Lionetti et al., 2018). SPS was used as a continuous variable in the analyses presented here, and results are correlational, and so it is the relationship explored rather than definitive categories. The population were mainly Irish in the present study, a population who are under-researched in the area of SPS. It is possible that cultural differences play a role here, as the participants were mainly Irish. There have not

been norms for the HSP scale completed for the Irish population. It is possible the wording of the questions, and their negative valence, may have led participants to answer as though they were less sensitive due to potential cultural stigmas associated with sensitivity. However, further research would be needed in order to explore this. Furthermore, the participants' mean age was in middle age. Considering the results of Ueno et al. (2019) it is possible that SPS was lower due to the generally older age of the participants in this study compared with others with university students samples. It is possible that the older participants influenced the mean, reducing it. This decline in SPS based on age may be for a number of reasons, for example, changes in sensory ability such as hearing and sight or changes in environment as one ages. More research is needed in this area. However, it is important to note the pattern in terms of correlation with negative affect and distress was as expected from this population i.e., SPS showed a strong correlation with negative affect as measured by the three-item scale, and with distress as measured by the DASS.

The lack of impact on executive functioning was unexpected, given the literature in the area (e.g., Berman et al., 2008, Jung et al., 2017). It is possible that the type of executive functioning measured in the present study differed from these papers, and was not as affected by the restorative effect of the virtual nature intervention. Indeed, in Jung et al. (2017), the Stroop was one of several neuropsychological tests utilised in the composite score for sustained attention, which may account for the differences in findings. Another possible reason for this lack of replication, order effects, is explored in the limitations. It is also possible that a six-minute intervention does not offer enough time for participants' executive functioning to feel the effects of restoration and given the proximity of both Stroop tasks.

The finding from the qualitative results that several participants were expecting to be quizzed on the contents of the video was unexpected. However, it serves to highlight the possible confounder of the experimental environment itself. As these participants were

focusing in detail on the aspects of the video rather than engaging in the effortless attention as predicted by Kaplan and Kaplan's (1989) ART, this suggests that there was more effortful attention in effect here, which in turn could have impacted on the restorative potential of the videos. While there was no indication given to participants that there would be questions based on the video presented, it is possible the mere fact of knowingly engaging in a psychological study impacted their expectations and thus their experience. It is not clear whether this effect would also be found in an in vivo exposure intervention, or whether the virtual aspect of the study contributed to this effect. It does raise an important question for future virtual interventions around participant expectations, their possible impacts, and how to control for these.

The participants in the current study showed lower levels of SPS overall than in previous studies when considering the mean. However, SPS did appear to act as a predictor in terms of changes in negative affect and in conjunction with the intervention in predicting changes in positive affect post intervention. While the results in the current study are suggestive of some impact of SPS on the restorative impact of a virtual environmental intervention, further research is needed to elucidate the intricacies of this relationship. However, the present study does illustrate that there is some role for SPS in predicting affective outcomes from virtual environmental interventions.

Limitations and Future Directions for Research

Limitations of the current study must also be considered when interpreting the outcomes. Firstly, there is a possibility that the lack of significant results found for the Stroop task is in part due to order effects. Participants were presented with the scales in the same order, which may have impacted on the results, as the PANAS and BSRI have words with negative connotations which could have impacted on participants' mood and their

performance on the Stroop task. However, should this be the case, it would call into question the relative strength of the intervention's effects. Future research could consider randomising the order of the outcome measures and assessing the relative impact on the results.

While the HSP scale is a reliable and validated measure, it has been recently criticised for its lack of negatively or reversed phrased items, which can lead to dissent and acquiescence response sets (May et al., 2022). Furthermore, it has been noted that the valence of wording for most of the questions in the currently used scale is negative (Ueno et al., 2019). This means the scale may not sufficiently take into account the many benefits associated with the trait, and so may contribute to biasing studies on HSPs towards the negative attributes of the trait (Bas et al., 2021). This in turn can influence the progression of research in this area, as high levels of SPS is considered more of a risk factor. Thus, it may be important in future, should the scale be updated, to assess different populations in terms of their SPS levels, and in turn their associations with negative and positive outcomes.

Another limitation of the current study is the wide breadth of ages covered by the study, which could impact on the generalisability of these results, as participants were at very different life-stages. Furthermore, while participants completing the study in their own environments adds some ecological validity for how such interventions could be used in the future, it also means there is less control over the environment, and things which could impact on the results. Future research should consider completing such work again in a standardised laboratory setting to account for this, as this would allow for greater manipulation of other aspects of the nature experience, e.g., smell, and also to allow for follow up questions on participants' qualitative responses which might add further information and clarity around their intervention experiences. A further limitation is that participants were not directly asked were they distracted during the Stroop task, though some offered this information when asked if they had specific difficulties during the Stroop task.

Thus it is possible some were distracted but did not include this as a specific difficulty. Future research might consider including this as a separate question.

The impact of having good or bad memories associated with the intervention video is also something which could be of interest for future research, using both quantitative and qualitative methods. Given the anonymity of the study, it was not possible to follow up with participants about their experiences of the intervention and nature in general. Future research could consider exploring the relationship between levels of SPS and nature through interview or focus group methods to explore this area further.

Future research must also consider the limitations, clinical utility, and ethical implications of using videos of nature, and virtual nature interventions in general. While we emphasise here the importance of using such means of accessing nature when it is not available, that is not to say that this should be used in lieu of real nature, or temper the effort to include real nature in built environments, especially given the literature is still not clear whether virtual nature serves as a true substitute (Browning et al., 2020). The field of virtual nature interventions thus must consider how this research is used to benefit individuals, and not in support of removing natural spaces from individuals' lives. Virtual environments and virtual reality are fields which has many possible implications for political and social misuse, and so must be heavily monitored by those researching in this area so research is not misemployed leading to harm at a human or environmental level (O' Brolcháin et al., 2015; Ramirez & LaBarge, 2018).

Conclusion

Research into the area of SPS and physical environments, especially nature, is limited. The current study explored this relationship using a virtual nature intervention. There were significant reductions in rumination and negative affect in participants following a virtual

nature intervention. This intervention lasted just 6 minutes, indicating that changes in these outcomes can be brought about quickly using virtual nature. Exposure to a virtual urban intervention resulted in decreased rumination, but also decreased positive affect. Thus, it appears that virtual nature interventions would be preferable. Results suggest that SPS is associated with affective outcomes, with SPS interacting with exposure to a virtual environment, nature and urban, in predicting positive affect outcomes. This suggests that those higher in SPS benefit more in terms of their positive affect when exposed to a nature video, but not so when exposed to an urban video. Participants reported having positive experiences of both the virtual urban and nature conditions, noting the features of nature, activities they complete in the areas, and the familiarity and memories which the videos evoked. CRT is one possible basis for these results. Future research to explore the relationship between levels of SPS and the natural environment, and mechanisms surrounding this is recommended.

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Chapter Five: Major Research Project Extended Literature Review

The Importance of Nature

Natural environments are a crucial resource for humans. They provide us with food and shelter, compounds which can be used medicinally when we are sick, and may hold cultural meanings or symbolic significance (Institute of Medicine (US) Roundtable on Environmental Health Sciences et al., 2002; Reese et al., 2021; Scannell & Gifford, 2010). Natural environments have also been shown to have a health and wellbeing promoting effect, with a growing body of research since the 1980s evidencing this (Bratman et al., 2012; Hartig et al., 2014; Nukarinen et al., 2022). Research tends to focus on greenspaces, i.e. areas of trees, grass, or other vegetation in the countryside or spaces managed in urban environments (Natural England, 2010; Taylor & Hochuli, 2017), and bluespaces, i.e. aquatic environments such as rivers, lakes, and the coast (White et al., 2020).

More than 55% of the world's population lives in urban cities at present, with this proportion expected to reach 68% by 2050 (UN DESA, 2018). Thus, research into how nature can be utilised therapeutically in populations who do not have easy access is important at this time.

Theories of Nature Restoration

In terms of theoretical frameworks which aim at explaining why nature offers benefits to health and wellbeing, the restorative potential of nature has often been considered (Kaplan, 1995). Restoration refers to renewing of diminished functional capacities and resources (Hartig & Staats, 2003). Three of the major theories in this area include the biophilia hypothesis (Kellert & Wilson, 1993), Attention Restoration Theory (ART; Kaplan & Kaplan, 1989) and Stress Reduction Theory (SRT; Ulrich, 1983). While both ART and SRT share an evolutionary approach rooted in the biophilia hypothesis, ART claims recovery from directed

attention fatigue is the central process (Kaplan & Kaplan, 1989), while SRT postulates it is the recovery from psychophysiological stress.

The biophilia hypothesis suggests that our ancestors were dependent on connecting with nature for their wellbeing and ultimate survival through finding food, providing shelter, navigating etc. (Kellert & Wilson, 1993). Humans living in urbanised areas is a relatively recent phenomenon in the grand scheme of human history, and thus the need to connect with nature remains innate to us. While evolutionary concepts have been noted to be difficult to test (Capaldi et al., 2015), there is evidence which suggestively supports this hypothesis, such as research that shows humans' preference for natural scenes more than built up environments (e.g., Dopko et al., 2014; Kaplan & Kaplan, 1989), and the fact that attraction to nature can be seen in diverse cultures (e.g., Newell, 1997). In sum, the biophilia hypothesis would suggest that given our evolutionary history, connection with nature is an innate need of humans.

Another similar theory, though more specific, as to why nature confers these benefits is ART (Kaplan & Kaplan, 1989). This theory posits that nature has the ability to renew our attention and cognitive capacities after we exert mental energy, as it allows us a space for involuntary attention. Involuntary attention refers to attention which is effortless yet engaging, and contrasts with directed attention which involves our executive functions and involves more focus and effort. An example of the effortless involuntary attention is watching the clouds float across the sky. Directed attention is a limited resource and can become fatigued over time, leading to negative emotional states, while the effortless attention one uses in natural environments with their varied and rich stimuli have been found to have a restorative effect, as they capture attention without being demanding of executive functions. This may be as it allows us to act without needing to constantly monitor our behaviours (Kaplan & Kaplan, 1989). One area which shows benefits from this is rumination; that is,

thinking which is negative about one's own self and emotions, or about personal concerns or previous upsetting experiences (Watkins, 2008). Indeed, a study from Bratman et al. (2015) showed that a 90 minute walk in nature decreased both self-reported rumination and activity in the subgenual prefrontal cortex (sgPFC), a brain area which is associated with self-focused behavioural withdrawal linked to rumination in individuals both with and without depression.

Finally, SRT (Ulrich, 1983) posits that stress recovery is promoted by nature (Ulrich et al., 1991). Based on evolution, it is thought that positive physiological reactions to non-threatening natural settings are rooted into our genetic make-up, such that following stressful situations, exposure to an unthreatening nature setting has a physiological calming effect which is spontaneous, unconscious, and associated with increases in positive affect and reduction in physiological arousal (Ulrich et al., 1991). Evidence for this theory has been found in studies such as Ulrich's seminal study showing a positive effect on speed of recovery from surgery when patients had visual contact with nature (Ulrich, 1984), and promotion of psychophysiological stress recovery when attentional abilities are fatigued (Hartig et al., 2003). In sum, SRT suggests there are benefits of nature for mood and stress due to a physiological relaxation, which is grounded in the biophilic attitude of humans.

In recent years, there have been a number of theories developed both in contradiction to, and growing from, these major theories. For example, in a critique of the evolutionary assumptions of restoration, Joye and Van den Berg (2011) suggest a perceptual fluency hypothesis of restoration, in which it is implied that the information from natural environments is processed more effectively than that of urban environments which in turn has a restorative effect. Two recent theories which extend the restoration narrative into the social realm are relational restoration theory and collective restoration theory (Hartig, 2021). These theories were built on the argument that restoration does not occur in a social vacuum. While relational restoration theory posits that a dyad or small group's social resources may be

depleted and restored by spending time in nature, collective restoration theory suggests the depletion and restoration can be at a collective level. For example, a simultaneous summer break time for a specific population could correlate with increases in wellbeing for that group during that time.

A recent theory which is pertinent to the present study is the Conditioned Restoration Theory (CRT) which has been proposed by Egner et al. (2020), building on the classical condition paradigm. It suggests that positive affective responses are partially conditioned responses to natural environments, with nature often associated with leisure and play activities, leading to a restorative conditioning. This occurs in two steps, initially with restorative conditioning, where one experiences restoration while engaging in leisure activities in nature, which is followed by conditioned restoration, where the natural environment is the conditioned stimulus and results in the conditioned response of restoration. The final step is the generalisation of the stimulus, such that cues associated with the environment result in the conditioned restorative experience. This is pertinent in the present study, as participants are not exposed to nature in vivo, rather a video of images and associated sounds recorded in real-time of nature. Egner et al. (2020) note that nature is more detached from everyday life than any other environment, which allows for conditioning of positive stimuli in the absence of negative stimuli.

Benefits of Nature Exposure

While the exact mechanisms behind the benefits associated with nature remain debated, the benefits of exposure to natural environments are numerous and varied and have been the subject of numerous review articles.

The impact of nature on mental wellbeing and relaxation have been well established in the literature. A systematic review of the impact of greenspace on the mental wellbeing of

adults was carried out by Houlden et al. (2018). This review examined both access to local greenspace, views of greenspace, greenspace accessibility, and visits to greenspace using both cross-sectional and longitudinal studies. It showed that the amount of local greenspace had positive associations with mental wellbeing, particularly hedonic wellbeing, though there was limited evidence for associations between mental wellbeing and visits to greenspace, accessibility to greenspace, and types of greenspaces. There was inadequate evidence found for wellbeing associations with views of nature or nature connectedness. The authors note further studies were needed based on the dynamic measures of greenspace. Bluespaces have also been investigated in the literature in terms of their impact on psychological wellbeing and health. In a narrative review of the impact of exposure to bluespaces on health and wellbeing, it was shown that bluespaces offer many of the same benefits as greenspaces in helping people to de-stress, calm, and restore (White et al., 2020). The authors note the difficulties in disentangling green and bluespaces, as they often overlap and co-occur.

Similar results have been found in younger populations. In a systematic review examining the benefits of interacting with nature in children and adolescents consisting of 35 papers, support was found for the argument that nature positively influences mental health in this age-group (Tillmann et al., 2018). However, the authors note that additional research with more rigorous study designs are needed in the area, and the evidence is limited due to the cross-sectional nature of most of the papers.

Nature has been investigated in relation to stress also, with exposure to nature, both virtual and real, being found to decrease levels of perceived stress and physiological stress in a recent systematic review from Shuda et al. (2020). The authors conclude that removal from natural environments could be detrimental to public health.

The cognitive impact of nature exposure is also well documented, with exposure to natural environments being shown to improve working memory performance, cognitive-flexibility, and attentional-control tasks (Schertz & Berman, 2019). A study from Bailey et al. (2018) demonstrated that participants did significantly better on a Stroop task after walking, and walking in an outdoor environment had an additional positive influence on these results.

One of the areas which is highlighted in the literature around the benefits of nature is that of nature connectedness. Nature connectedness refers to the trait-like individual difference, which is stable across time, in how subjectively connected an individual feels towards the environment. In research, consistent evidence has been found for differences in individuals who strongly identify as being connected to the natural world compared to those who do not, in areas such as personality, attitude, behaviour, and wellbeing (Capaldi et al., 2014). In five questionnaire studies examining the links between connectedness with nature and different aspects of wellbeing, consisting of 547 participants, it was found that psychological wellbeing, meaningfulness, and vitality all had robust correlations with connectedness to nature (Cervinka et al., 2012). Furthermore, in a study of a representative sample of the adult population of England, with 4,960 participants, it was found that nature connectedness acts as a moderator for key relationships between nature contact, wellbeing, and pro-environmental behaviours (Martin et al., 2020). Thus, one's personal relationship with nature would appear to have an influence on the benefits one can get from nature in terms of wellbeing.

Virtual Nature

While the benefits of interaction with natural environments have been demonstrated in numerous research studies, in some environments real-life contact with nature is limited or indeed impossible e.g., in prison, nursing homes, or urban areas with no greenspace. In

addition to this, virtual nature may be more readily available to individuals when time is limited or they are travelling, as it can be accessed on mobile devices such as mobile phones and tablets. Virtual nature, such as viewing videos or images, can also be used as a memory aid to spark one's own memories of experiences of and in nature. Furthermore, considering the lockdown policies of governments across the globe in response to the COVID-19 pandemic, it is clear that access to nature for those, especially in urban environments, is not always a guarantee.

One way in which to mitigate the effects of not having access to natural environments is through what has been termed vicarious nature experiences (VNEs; Kahn & Kellert, 2002). VNEs refers to contact with natural environments in the absence of physical contact with such environments through different means e.g., watching videos of nature, listening to recordings of nature such as bird songs, looking at magazines about natural history (Nadkarni et al., 2021). Research in this area has used a variety of mediums to provide VNEs, for example slides of nature images (Brown et al., 2013), videos of nature both including and excluding sound, olfactory mediums such as air freshener and oils (Serrano et al., 2016; Valtchanov et al., 2010), and haptics such as thermal stimuli and tactile (Anderson et al., 2017; Serrano et al., 2016; Valtchanov et al., 2010). In recent years with advances in technology, this has grown to include immersive virtual reality (IVR). Immersive virtual environments (IVEs) are the result of synthesising sensory information which provides a surrounding and continuous flow of stimuli which creates a perceived illusion of being encompassed in an authentic environment (Calogiuri et al., 2018).

The benefits of exposure to different types of virtual nature environments have been demonstrated in the literature. In the seminal work of Berto (2005) it was found that university students who viewed photos of nature before completing a sustained attention task scored better than the students who viewed image of geometric patterns or of an urban

landscape, thus demonstrating that virtual nature possesses restorative qualities akin to real life nature. However, in a recent replication of this study, there was a failure to replicate the results of Berto (2005), with the authors noting they had failed to support Berto's findings across multiple unpublished studies in their laboratory (Neilson et al., 2021). In a study from O'Meara et al. (2020) it was found that exposure to virtual reality nature, using virtual reality technology, for high anxiety students led to a significant reduction in negative affect. In a study from Hedblom et al. (2019), it was found that exposure to a virtual park or forest using virtual reality equipment, and other congruent multisensory factors of smell and sound, reduced stress responses over that of exposure to an urban environment. Similarly, Valtchanov et al. (2010) showed that immersion in a constructed virtual nature environment using VR has similar beneficial effects to when one is exposed to surrogate nature, such as photographs and colour videos.

However, while exposure to various different types of virtual nature has been shown to have benefits, there are a number of important factors which can have an effect on this field of research. For example, a recent systematic review examining roles of methodological choices in the effects of exposure to simulated nature landscapes on health and cognitive outcomes, it was noted that rigorous study design is the most important predictor for unbiased experimental findings in studies which utilise simulations of natural landscapes (Browning et al., 2021). As found in the research of de Kort et al. (2006), the importance of simulation quality is very important, with research showing a significant impact of screen size manipulation, i.e. immersion, on physiological measures of restoration. The authors concluded that immersion enhances the restorative potential of mediated natural environments. However, it is important to note that significant effects were not found for self-reported affect (de Kort, et al., 2006). Furthermore, audio of nature has been found to play a role in the facilitation of stress recovery (Annerstedt et al., 2013). In a study from Annerstedt

et al. (2013) it was found that the addition of sounds of nature to a virtual green environment in a laboratory setting had a facilitative effect on stress recovery. Thus, the immersive nature, both visually and for other senses would appear to be important factors when considering a virtual nature intervention.

Virtual Nature VS In Vivo Nature

While the emerging evidence suggests that exposure to virtual nature environments using technology are more beneficial than the absence of any human-nature interaction, or interaction with virtual urban environments, they do not offer the same levels of benefit as afforded by real nature exposure (Frumkin et al., 2017; Kjellgren & Buhrkall, 2010; Litleskare et al., 2020; Olafsdottir et al., 2017). In a systematic review looking at green exercise, authors reported there was inconclusive evidence around the ability of virtual green exercise to provide the physical and psychological benefits of real green exercise (Lahart et al., 2019).

However, despite the shortcomings of virtual nature exposure compared with actual nature-based experiences, virtual nature offers a compromise for those who do not have access to nature for many reasons; lockdowns, where they live, disabilities which prevent them accessing nature areas. Furthermore, virtual nature has the potential to evoke memories of times in natural environments with immediate availability, as access to technology has become more ubiquitous.

Relevance of Nature to Clinical Psychology

Given the clear benefits in terms of psychological health and wellbeing of natural experiences and exposure to virtual nature environments, it is important to consider the implications for clinical practice.

The uncertainty surrounding therapy provision indoors during the COVID-19 pandemic has been noted in the literature, with restrictions leading to some switching from face-to-face therapy to virtual therapy provision (Lutz et al., 2021), and in an effort to ensure adequate ventilation during therapy and allow for therapy to continue face-to-face, another workaround has been the provision of therapy outdoors. In 2020 the BPS issued guidance around the provision of outdoor therapies (Cooley & Robertson, 2020). In this it was noted working outdoors is an evidence-based approach which allows for clients to experience more shared ownership around their therapeutic space, and that it gives clients support in psychological flexibility, tapping into the benefits of being out in nature. However, virtual therapies have potential benefits, with many noting in the literature that it is here to stay (Prescott, 2022). Furthermore, given the increase in popularity and research of using therapies outdoors (James et al., 2021), these would appear to be continued going forward also.

Indeed, certain therapies already take place outside, and often in natural environments. The number and type of outdoor based therapies has grown significantly in recent times (Moeller et al., 2018) and it now encompasses diverse practices such as nature-based therapy, wilderness therapy, adventure therapy, horticultural therapy, and forest therapy (Harper et al., 2021). In a recent meta-synthesis, 38 articles over the past 25 years were examined which had an outdoor therapy context (Cooley et al., 2020). Here it was found that therapy outdoors was effective both in connecting clients with the natural world and enriching the therapeutic encounter itself. It was also noted that the benefits of having therapy outdoors was not exclusive to particular client groups, thus could be considered on a client by client basis considering an individual's formulation (Cooley et al., 2020).

Summary

Theories around the mechanisms behind the effects of nature exposure, in vivo and virtual, on wellbeing are numerous and vary. The restorative impact of nature on wellbeing, including affect and cognition, would appear to be a strong theme across the literature. These benefits of being in nature, in reality or through virtual means, are reported consistently in the literature. However, individual differences would appear to have an impact on this, for example nature connectedness. The impact of the trait of SPS on the relationship between nature and wellbeing remains under-researched, however.

In the second part of this chapter, I will explore this trait and what is known about it in terms of benefits, disadvantages, and what is already known about its relationship to nature.

The Highly Sensitive Person

The concept of the Highly Sensitive Person (HSP; Aron & Aron, 1997) is still relatively new to the psychological literature. First described in the seminal paper of Aron and Aron (1997), it refers to individuals who are high in the personality trait known as Sensory Processing Sensitivity (SPS). The HSP, as would be suggested by their very name, is found to be more sensitive than their non-HSP peers to the environment, be they social, emotional, or physical (Aron & Aron, 1997). While this area is discussed in more detail in Chapter Four, I will add additional pertinent background information in this chapter to provide more context and elaboration.

It is important to distinguish what SPS is from what it is not, as it can at times become confused in the literature with other similarly named concepts. SPS refers to the trait level individual differences in sensitivity to negative and positive environments, which can be inherited genetically but is also influenced by environmental factors (Greven et al., 2019).

SPS is a trait which involves deeper cognitive processing of stimuli that is driven by higher levels of emotional reactivity (Aron et al., 2012). In this sense, deeper processing is considered as per the model of Craik and Lockhart (1972), that is "the meaningfulness extracted from the stimulus rather than in terms of the number of analyses performed upon it" (Craik, 1973, p.48). It is distinct from Sensory Processing Disorder (SPD) which refers to individuals who have atypical responses to sensory input (Miller et al., 2009).

Background

Different animal species have been observed to show individual differences in their sensitivity to react to their environment, with animals using one of two different strategies; higher reactivity or lower reactivity (Aron et al., 2012). While it has been observed that the majority of any population will use the lower reactivity strategy, which results in more risk taking, the minority will utilise the strategy of high reactivity, which can be seen in a precise and reduced selection of activities undertaken (Wilson et al., 1993). These two strategies are also believed to be used by humans, with higher levels of SPS representing the strategy of high reactivity in humans.

SPS is also associated with high inhibitory functioning, or pausing before acting (Hoffmann et al., 2022). This is another evolutionary strategy, which offers a way of stalling responses to the environment, allowing for more time to process stimuli more deeply. In a recent study from Hoffmann et al. (2022), they examined whether SPS was related to better information processing in an behavioural inhibitory control task. They demonstrated that SPS was related to faster processing speed on an emotional antisaccade paradigm, but not on the classical version of this paradigm. The authors note that this provides evidence for higher SPS individuals showing better inhibitory abilities, especially for emotional stimuli (Hoffmann et al., 2022).

SPS is part of a collection of theoretical frameworks that explain individual differences in ability to register and process stimuli from the environment, known as Environmental Sensitivity (ES; Greven et al., 2019). While the other facets of ES are discussed in Chapter Two, SPS is a unique addition to ES, in that it proposes there is an underlying temperament trait that can be characterised by the greater depth of processing, the increased emotional reactivity, awareness of the subtleties in the environment, and overstimulation (Aron et al., 2012; Greven et al., 2019).

Higher levels of SPS can be beneficial in some situations and yet pose a threat to wellbeing in others. As described in Chapters Two and Four, there have been numerous studies on the links between SPS and mental health issues such as depression and anxiety (Ahadi & Basharpoor, 2010; Booth et al., 2015; Liss et al., 2005, 2008; Yano & Oishi, 2018), as well as showing higher levels of psychopathology related traits such as internalising problems (Boterberg & Warreyn, 2016). Those with higher levels of SPS have also been found to be more sensitive to somatic symptoms that may go unnoticed by others, and have a higher rate of somatic issues such as headaches, chronic fatigue, migraines, and chronic pain (Jonsson et al., 2014).

The mechanism behind this relationship has been the topic of some consideration in the literature. A recent study from Eşkisu et al. (2021) suggested that dysfunctional beliefs and emotional regulation skills used by those higher in SPS play a role in this relationship. They note higher levels of SPS create a cognitive and emotional burden, which in turn leads to suppression of dysfunctional beliefs and emotions, which increase psychological problems in this cohort (Eşkisu et al., 2021). Wyller et al. (2017) proposes that cognitive reactivity, which is dysfunctional thought content and maladaptive thought processes, may be a link between SPS and psychological distress. One of the thought processes named by Wyller et al. (2017) is the transdiagnostic factor of rumination. Indeed, in a recent longitudinal study from

Lionetti et al. (2021) it was found that children's levels of environmental sensitivity interacted with a permissive parenting style in predicting their levels of rumination, with rumination in turn being associated with depressive symptoms at nine years of age. The authors note that rumination is an important cognitive risk factor in developing depression in this cohort.

SPS and Nature

The association between SPS and the environment is intrinsically linked, however the relationship between it and nature have not been the subject of many studies. In a recent study from Setti et al. (2022), it was found that SPS predicted higher levels of nature connectedness, i.e. the sense of being connected to and a part of the natural world. This suggests that those higher in SPS may benefit more from interventions which focus on contact with nature, such as walks in nature or even just viewing nature scenes. In a qualitative study from Black and Kern (2020), it was found that for highly sensitive people, nature and being connected with nature are important contributors to wellbeing, in the participants' own view.

There are a number of possible reasons for this link. As described above, those high in SPS are characterised by an aesthetic sensitivity, which may make them more aware of and affected by the beauty which nature has to offer (Lionetti et al., 2018), which would be in line with the biophilia hypothesis. It is also possible that the restorative effects of nature and the relief from cognitive processes such as rumination create a positive association with nature in the minds of those with higher levels of SPS, more in line with ART or CRT.

While the exact mechanism behind the relationship is not fully elucidated to date, the benefits of experiencing nature have been found repeatedly in the literature, as described

earlier in the chapter. Empirical evidence for the benefits of nature in the highly sensitive person cohort remains to be examined to date, however.

The Clinical Importance of SPS

The importance of transdiagnostic factors in the world of mental health has been highlighted in recent years (Rodriguez-Seijas et al., 2015). As noted by Greven et al. (2019), it may be useful for SPS to be considered as a transdiagnostic trait itself in research, given its observability in both humans and other animals, its heritability, and its association with mental ill-health and psychological distress. Given that transdiagnostic factors can be thought of as an intersection between personality and psychopathology, their relevance to clinical work is clear to be seen (Rodriguez-Seijas et al., 2015). Thus, studying SPS and its relationship with psychological factors is not only relevant to the literature in terms of expanding our knowledge, but also has relevance to the practice of clinical psychology. This is even more important given that higher levels of SPS are reported in around 20-35% of children and adolescents (Pluess et al., 2017) and 30% of adults (Lionetti et al., 2018).

As discussed in Chapter Four, having higher levels of SPS has been found to be associated with a number of mental health issues such as anxiety and depression (e.g. Booth et al., 2015; Liss et al., 2005). Given the impact SPS can have on an individuals' mental health in terms of the risks it confers, some authors suggest that screening for SPS can confer benefits for clients (Smith et al., 2019). For example, Smith et al. (2019) suggest that screening for SPS can provide a mental health practitioner with different paths to consider for interventions with the population, in terms of both selection of intervention and approach taken within interventions, as well as highlighting the possibility of different coping skills being more helpful in this cohort.

Similarly, Eşkisu et al. (2021) note that due to the different characteristics of those high in SPS, there may be a necessity for psychological interventions which specifically target this population. There is research to suggest that highly sensitive persons can benefit more from intervention than the less sensitive. For example, in a study from Nocentini et al. (2018), it was found that boys scoring higher on sensitivity benefited more from a school based intervention looking at reducing victimisation and internalising symptoms. Kibe et al. (2020) demonstrated that highly sensitive adolescents, who scored lower than their counterparts at baseline, responded more positively to a culturally modified resilience education programme, and had greater reductions in their levels of depression and had greater promotion of their self-esteem.

Those high in SPS would appear to be a population who struggle more with difficulties with their mental health due to cognitive factors associated with the trait, though the trait confers abilities which allow them to benefit more from interventions to aid these difficulties.

The Present Study

Rationale for the Present Study

To the researcher's knowledge, no existing research has carried out an exploration of the impact of nature or urban environments on HSP individuals' psychological wellbeing, mental health, and cognitive functioning. Existing research into this cohort and its relationship with the environment and psychological factors has focused on childhood environments, the school environment, or specific task environments - as noted in the completed systematic scoping review in Chapter Two. Those high in SPS represent a population at risk in terms of their mental health and wellbeing, and represent a sizable minority of the population. The benefits of nature in terms of mental health and wellbeing are

well founded in the literature, however, the temperament trait of SPS has not been examined in this arena. This leads to the present study.

Aims of the Present Study

In light of the aforementioned gaps in the existing literature in the area, the clinical importance of transdiagnostic factors and the possibility of high levels of SPS being a transdiagnostic factor in mental health difficulties, the tendency of high SPS individuals to ruminate which is also a clinically-relevant transdiagnostic factor, and the growing evidence for the benefits of nature in mental health, the aim of the present study was to explore the impact of a virtual nature intervention on psychological factors in HSP individuals. The study aimed to examine the impact of exposure to virtual nature environments, as opposed to virtual urban environments, in those with varying levels of SPS in order to ascertain how this impact on affect, rumination, and executive functions in the general population. This study offers an original contribution to the HSP literature and the literature around nature and its impact on psychological functioning. This research has both basic and applied relevance, especially in the realm of clinical psychology practice.

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Chapter Six: Major Research Project Extended Methodology

Research Design

Study Design and Methodology

The current study utilised a mixed-methods design. Mixed methods is commonly defined as integrating qualitative and quantitative data, collected and analysed, into a unified study (Tashakkori & Creswell, 2007), and has been defined by Creswell (2003) as research which uses:

Strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problems. The data collection also involves gathering both numeric information (e.g., on instruments) as well as text information (e.g., on interviews) so that the final database represents both quantitative and qualitative information. (p.20).

Many different designs of mixed methods studies have been identified, which are differentiated generally in the timing of data collection and analyses (Creswell & Clark, 2017). The current study would fall under the category of concurrent, as the qualitative and quantitative data is collected at the same time. The current research has a quantitative focus. The qualitative component was included in order to allow for the quantitative results to be interpreted in the light of the participants' experiences, as per their answers to the open-ended questions. This may also aid in elucidating the underlying mechanisms of the quantitative findings.

It has been noted that when they are used in combination in a study, qualitative and quantitative methods complement each other, and can allow for a more complete analysis of a research area (Greene et al., 1989). However, it is not without controversy in the literature, as the question of paradigm-method fit issue and "best" paradigm issue have been the centre of much debate in the literature (Migiro & Magangi, 2011). In more recent times, pragmatism

has emerged as a popular paradigm for mixed-methods research (Migiro & Magangi, 2011). This would posit that it is the research question itself that should be of primary importance (Teddlie & Tashakkori, 2009). Pragmatism as a philosophy supports the use of different research methods and a cycle of using induction, deduction, and abduction where appropriate in the production of useful knowledge and rigorous research (Mitchell, 2018).

In terms of the quantitative component of the current study, it employs a cross-sectional pre-post design, using randomisation of participants to one of two conditions i.e., either watching a video of nature scenes, or a video of urban scenes. Due to COVID-19 restrictions, bringing participants into the laboratory for testing was noted as a possible issue. Thus, it was decided that online survey experiment methodology would be utilised. This also allowed for the collection of qualitative data, as participants were able to answer the questions through writing their responses into the survey itself.

Survey methods have been ubiquitous in psychological research, and are used across psychological disciplines in examining relationships between different psychological constructs using scales, and testing hypothesis in this area also (Ponto, 2015). One form of survey which has grown in popularity is that of the survey experiment. As noted by Barabas and Jerit (2010), researchers in the social sciences aim to establish causal relationships that are generalizable, trying to maximise internal and external validity. Survey experiments refer to the inclusion of an experiment in a survey. That is the case in the current research, as participants are randomly assigned to one of two conditions, that is one of our independent variables, which video they see.

The current study was delivered online. Given the COVID-19 pandemic, and regional restrictions, being able to collect data remotely was a draw of the online survey. During the course of the pandemic, there has been a noted increase in online data collection by social

scientists (Peyton et al., 2020). As noted by Evans and Mathur (2018), online survey research has come into its own in recent years, and changed substantially with evolving technology over the past fifteen years. There are a number of benefits to using online survey technology; its convenience for participants, its speed and timeliness, the great flexibility of modern survey platforms, and the possibility of reaching a wide and diverse population (Evans & Mathur, 2018). However, there are also drawbacks. One of the major drawbacks is low response rates. One meta-analysis found that the average response rate for online surveys was just 11% (Manfreda et al., 2008) while a recent systematic review concluded that web-based data collection shows lower response rates to alternative data collection methods (Blumenberg & Barros, 2018).

Many online surveys utilised a forced answering (FA) formatting, in which a participant must answer each question in order to proceed through the questionnaire. This is a practice used to avoid missing data, and reduce item non-response rates, which are an indicator of data quality (Sischka et al., 2022). Recent research in the area proposes that FA can increase state reactance, i.e., a combination of anger and negative cognitions, questionnaire dropout, and reduce answer length in open-ended questions (Sischka et al., 2022). Given the impact that FA can have on data quality it was decided to not use this formatting in the current study. Furthermore, it was decided it would be more ethical to allow participants to not respond to questions they do not wish to answer. The three initial questions around consent and confirming the participant was over 18 required a response, but all other questions did not.

Rationale for Methodology

The decision to use mixed methods was made for a number of reasons. One of the main reasons was for comprehensiveness. Given the complexities of the area being studied,

and the relative lack of research in the population of interest, mixed methods afforded us a lens to look at our research question in a more comprehensive way than any one method alone. For example, it would allow for the interpretation of the potential benefits of the nature video in terms of memory or the pleasantness of the visual scene, as participants would be able to name this in the open-ended questions. Conversely, if there were aspects of the video which participants found off-putting, or impacted on the restorative effect of the video, the textual responses would aid us in interpreting why the video was not as effective as expected.

The current study utilised quantitative data collection in order to create reliable and replicable results which can be measured and generalised. The quantitative results give an insight, in a replicable manner, into the possible benefits of exposure to a virtual nature intervention and other factors which influence this, which addresses the research questions. In order to capture the experiences of the participants in viewing the nature or urban scene, and to explore their relationship with nature in their day-to-day life, it was decided that a qualitative approach would be best. The qualitative component of this study was included such that the experience of participants with nature in general, and with the experimental environment they saw, could be captured in their own words, and so give context to the quantitative findings. It allows for a greater understanding of where the participants are coming from in terms of their relationship with nature, and can elucidate aspects of the intervention which were positive or negative for participants. The combination of quantitative and qualitative analysis allows for a richer discussion of the findings, as they inform one another.

Participants gave answers in the form of text during the completion of the survey. It was decided to use conventional content analysis (CCA; Hsieh & Shannon, 2005) to analyse the data. CCA was deemed as an appropriate choice as we were exploring a phenomenon where the research on the phenomenon is limited. Furthermore, given the method of data

collection for the qualitative findings, the responses were expected to be limited in length which is still suitable for content analysis. In this way, when using CCA the researcher utilises inductive logic, and avoids imposing any categorical system of data interpretation (Hsieh & Shannon, 2005). It also offers the opportunity for researchers to give findings a theoretical cohesion, which can in turn inform the direction of future research and substantiate possible future findings (Fox et al., 2015).

Sampling and Recruitment

The sample for the study consisted of a community sample of the general adult population i.e., adults aged 18 years old and older. This was a convenience sample, which comes with issues around generalizability (Mullinix et al., 2015). Thus, a number of different strands of recruitment were utilised to allow for as broad a representation of the population to take part in the study. These strands targeted students and the adult population at large.

A number of recruitment techniques were used; a call for participants using the university email system, use of social media to share information around the study and the link to the study, and snowball sampling. Snowball sampling refers to the method of sampling where those who have taken part in a study recommends it to another.

A priori power analysis was utilised to assess the number of participants needed in order to meet sufficient power. Using a priori power analysis, carried out on G*Power version 3.1 (Faul et al., 2009) for linear multiple regression, an estimate of a sample size of 107 is required to detect a moderate effect size f^2=0.15 with a power level >.95 and an alpha of 0.05. This would indicate 54 participants are needed in each condition. This was in line with Tabachnick and Fidell's (2013) formula of N > 50+8m, where m is number of independent variables i.e., N > 50 +8(5) = N> 90.

This resulted in a sample of 147 participants. In terms of power this exceeded the required amount of participants as per the G*power analysis and the formula of Tabachnick and Fidell (2013).

Data Collection

For a comprehensive look at the procedure of the study, please see Chapter Four.

Qualtrics

Data was collected via the online survey platform, Qualtrics. This platform was chosen for a number of reasons. It is a reputable website which has been vetted for GDPR by UCC, and UCC has a licence for this platform. Furthermore, the Qualtrics platform allows for tests such as the Stroop test to be included without asking the participant to shift between platforms, and allows for accurate measurement of reaction times, which was crucial in the current study. Qualtrics also allows for branch logic, and randomisation was used to allocate participants to either the nature scenes video condition or the urban scenes video condition. Considering all of this, Qualtrics appeared to be a good fit for the current study.

Information on Scales Used

As can been seen in Chapter Four, a number of different scales were utilised. The content of each scale can be seen as a part of Appendix J, the ethics application for the research. The scales will now be discussed in more detail.

Highly Sensitive Person Scale (HSPS; Aron & Aron, 1997). This 27-item scale was developed by Aron and Aron (1997) to identify people with the highly sensitive trait. Research has consistently reported Cronbach's alphas greater than .80, which would indicate adequate levels of internal consistency and reliability (Aron & Aron, 2013). While the original design showed a unidimensional SPS structure, later studies have suggested possible

multidimensionality of the HSPS. For example, Smolewska et al. (2006) suggested a three factor structure; aesthetic sensitivity (AES) – which is an aesthetic awareness of one's setting, low sensory threshold (LST) – which is unpleasant sensory excitation, and ease of excitation (EOE) – which is a feeling of being overwhelmed by internal and external stimuli. This structure has been replicated by others (Booth et al., 2015; Lionetti et al., 2018; Sobocko & Zelenski, 2015). In a study from Lionetti et al. (2018), the scale was found to have a Cronbach's alpha of 0.89, i.e. high.

Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a scale used to measure levels of depression, anxiety, and stress symptoms in the general population, and has been used worldwide (Scholten et al., 2017). While it is based on the tripartite model of psychopathology, the scale assumes that the three components comprise a general distress construct, but also have their own distinct characteristics (Zanon et al., 2021). In a recent study from Zanon et al., (2021), findings suggested that in a number of countries, including Canada, Romania, Taiwan, and the United States, that the DASS-21 would be useful as a score of general distress. In a recent Irish study utilising the DASS-21, it found the depression scale (0.81) anxiety scale (0.89) had good Cronbach's alpha values, while the stress scale (0.78) was considered fair. In a study which examined the total DASS-21 score, it was found to have a reliability of 0.93 in a non-clinical sample (Henry & Crawford, 2005). Therefore, it was deemed suitable for this study.

Brief State Rumination Inventory (BSRI; Marchetti et al., 2018). The BSRI is a an 8-item scale which utilizes a visual analogue scale (VAS) ranging from "completely disagree" (i.e., 0) to "completely agree" (i.e., 100). Participants are presented with 8 statements regarding how they are experiencing repetitive negative thinking at the time of answering the questions. For example, item 5 states "Right now, I am rehashing in my mind recent things I've said or done". The visual analogue scale was kept in the present study.

Scores were calculated as a sum of the responses for all eight items. It was found to have a Cronbach's Alpha of 0.83 in a recent study from Mollaahmetoglu et al. (2021).

Positive and Negative Affect Scale (Watson et al., 1988). The PANAS is made up of two ten item scales which presents participants with mood related adjective words describing feelings or emotions, to which participants respond on a 5-point Likert scale of 1 (not at all) to 5 (very much). The scale can be used with different timeframes, with the timeframe for the current study being right at the present moment. Given its brevity and good psychometric properties, the scale has been used in many studies across the psychological field (Wedderhoff et al., 2021). It assesses both Positive affect (PA), which is associated with engaging in the environment with pleasure, and Negative Affect (NA), which reflects aspects of general distress. Both scales were used in analysis in the current study. Cronbach's Alpha's from Watson et al. (1988) were between 0.86 and 0.90 for the PA scale, and 0.84 to 0.87 for the NA scale.

The Stroop Test

The Stroop Test (Stroop, 1935) is a classic neuropsychological paradigm to study controlled processing. In the classic Stroop Colour and Word Test (SCWT), a coloured word, which itself refers to a colour (e.g., RED) is presented to the participant, and they are required to ignore the word itself, which is a distractor, and respond to the colour of the ink, i.e., the target. Thus, participants are performing a less automated task, naming ink colours, while inhibiting interference from a more automated task, that is, reading the word (Ivnik et al., 1996; MacLeod & Dunbar, 1988). On the occasions where the word and the ink colour are the same (e.g., RED printed in red), the trial is known as a congruent trial, and in those were the word and the ink colour it is printed in are different (e.g., RED printed in green) it is known as an incongruent trial. Responses have been found to usually be more accurate and

have faster reaction times when the trial is congruent as opposed to incongruent. In the literature, this is referred to as the Stroop effect, and is likely due to the processing conflict between the target colour and the distractor word (Puccioni & Vallesi, 2012).

While it is widely used to measure ability in inhibiting cognitive interference, literature also reports its application in measuring other cognitive functions such as attention, processing speed, cognitive flexibility, and working memory (Jensen & Rohwer, 1966; Kane & Engle, 2003). The Stroop test as it is now known is a selective attention task, and one of cognitive control (Parris et al., 2021).

The Stroop task is considered the "gold standard" in attentional measures (MacLeod, 1992). It has been widely used in basic, applied, and clinical research (Matern et al., 2020). While the original version of the task was carried out on paper card, in recent times and with the advancing of technology, computerised versions of the Stroop task have become more popular. Two key reasons why is that computerised versions of the Stroop task allow for more accurate recording of reaction times, and that experimenter expectancy effects are eliminated (Davidson & Wright, 2002). Furthermore, it allows for colour-naming speeds at individual trial level, which would be extremely difficult in the classical administration. However, to date there is no solid standardised computerised version of the Stroop task in terms of materials included, administration, or scoring methods.

The Stroop task used in the current study was created using JavaScript, and was largely based on the computerised Stroop task described by Puccioni and Vallesi (2012). However, modifications were made to their task to account for differences in the what the study was focusing on, as their study focused mainly on congruency effects. I will now describe the composition of the Stroop task used in the current study.

This was a classical Stroop task in which participants were required to identify the ink colour of the word and ignore the word itself by pressing one out of four keys on their keyboard. Keys were R for red ink, B for blue ink, Y for yellow ink, and G for green ink. This is the same key pattern used in the PsyToolkit version of the Stroop task (Stoet, 2020). Participants were shown an image with accompanying text explaining a helpful way to position their hands in the Stroop task, so they could easily reach the Y, G, R, and B keys which they would be using. While the original Stroop included a word-reading section, as it would not be possible to assess this without voice recognition, it was decided to instead include a screen including the four words to be used in the task in white on a black screen, i.e., RED, BLUE, GREEN, and YELLOW, and as participants to respond whether they could read the words using the Y key for yes and the N key for no. Should participants indicate they could not read the word for whatever reason, they moved on to the next part of the Qualtrics survey and did not complete the Stroop task.

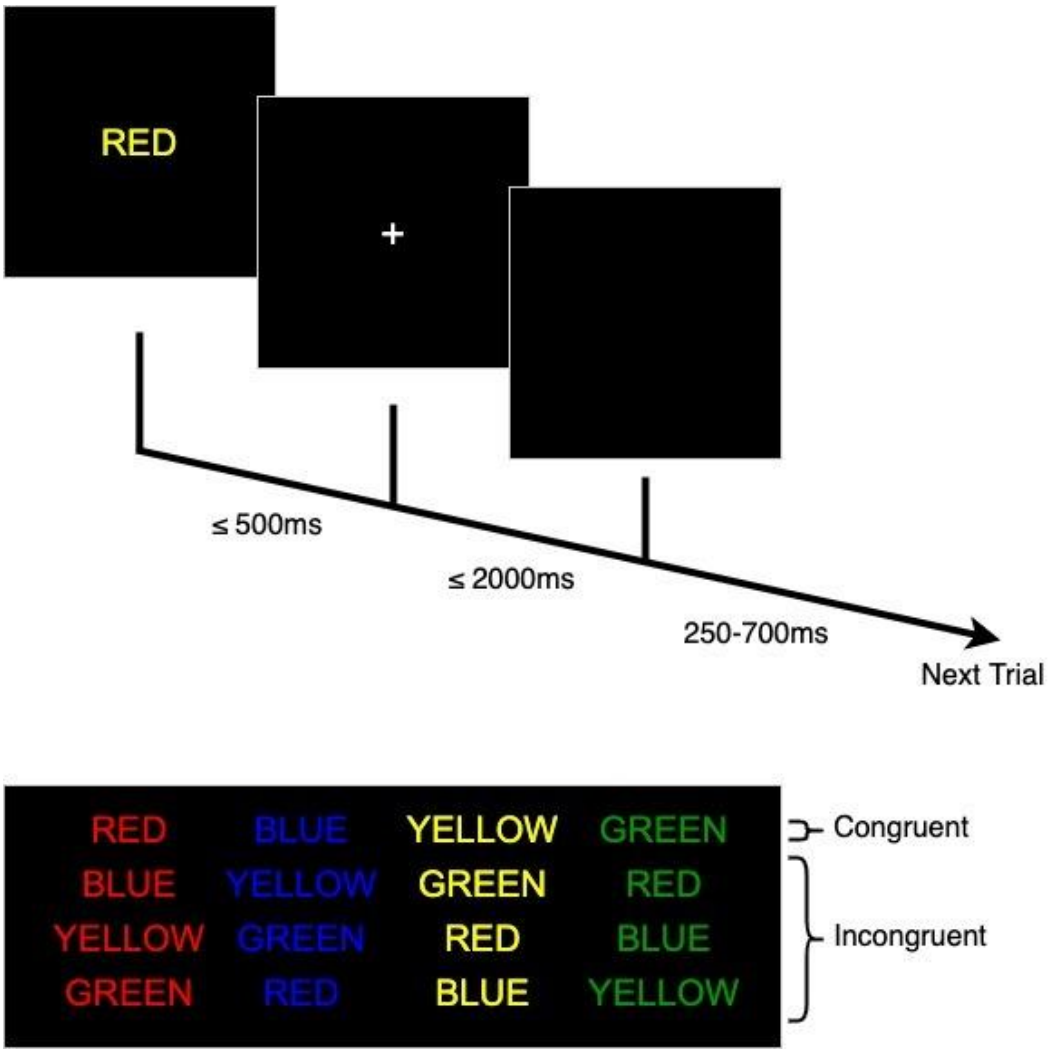
For those who answered yes, they were brought onto a set of instructions and a training phase to make sure they understood and were familiarised with the task. The task had defined font sizes that were variable depending on the screen size the participant was completing the task on. This was to reduce potential issues whereby statically sized text can appear smaller on higher resolution screens, and bigger on lower resolution screens. The words appeared in the middle of a black screen, in a size that is equivalent to a traditional 74pt at screen width of 1696px, in Arial font. The training phase included 16 trials with all possible word-colour combinations, i.e., four congruent and 12 incongruent trials. Each stimulus appeared in the centre of the screen for 500ms, followed by a white fixation cross until the trial was answered or the response deadline of 30,000ms. On a response, feedback about accuracy and speed appeared. If the response was correct and within 2,000 ms from trial onset, the feedback message was “Good!”. Whenever the response was incorrect, or

correct but occurred later than 2,000 ms from stimulus onset, the feedback messages was ‘‘Wrong’’ or ‘‘Correct, but try to be faster…’’, respectively. After an inter-trials interval (ITI) of 500 ms the next stimulus appeared. The training phase was repeated if the participant did not reach the proportion of 10 correct trials out of 16. On not reaching the proportion on the second training phase participants were moved onto the next part of the Qualtrics survey without completing the main task.

The test phase was divided into two blocks of 64 stimuli, arranged such that there were sixteen repetitions per colour, and four repetitions per condition i.e., YELLOW in yellow, in blue, in green, and in red, BLUE in yellow, in blue, etc. This resulted in sixteen congruent conditions. While many tasks use a 50:50 ration of congruent to incongruent trials, this is problematic as it introduces contingency learning confounds (Schmidt & Besner, 2008; Schmidt & De Houwer, 2011). The presentation of trials was pseudo-randomised such that no target colour would appear more than twice in a row consecutively to avoid consecutive trials eliciting the same manual response more than twice in a row (Dresler et al., 2009). However, given that a certain number of trials in each condition had to be included, it is possible that some repetition occurred for a small number of participants at the end of a block. Given the randomization procedure and the number of participants, the effect of the repetition is negligible. No corrective feedback was given in the main task. For each trial the stimulus appeared in the centre of the screen for 500ms, followed by a white fixation cross for 2,000ms whose offset marked the response deadline of 2,500ms. An extra blank screen varying randomly and continuously between 250ms and 700ms was presented before the onset of the next trial. However, a participant could answer at any time once the stimulus appeared. After 64 trials there was a ten second comfort break for participants which was on a timer. Following this, the remaining 64 trials were presented. For a timeline of a trial from the main task, and examples of congruent and incongruent stimuli please see Figure 6.1.

Figure 6.1

Example of Stroop Trial and Congruent and Incongruent Stimuli



For the text included in the training and main task instructions, and the advice given on hand placement please see Appendix I.

Data captured in this process included the reaction time, and the answer chosen.

Videos of Nature and Urban Scenes

The videos included in the study consisted of a nature scene and an urban scene. In line with the research in the area the videos had different aspects of greenspaces and bluespaces included. The videos were filmed in urban and rural areas of the Southwest of Ireland. All videos were filmed on similarly temperate days, with no rain and little to no cloud cover, so as to prevent the weather introducing a potential bias in participants. The duration for both videos was 6 minutes. Videos included the sounds present in the environment at the time of recording. For still images from the videos see Figure 6.2.

Figure 6.2

Still Images from the Nature and Urban Videos

Nature Images





Urban Images









Data Analysis

Quantitative Analysis

Quantitative analysis was carried out using SPSS (V.28). For a full explanation of all quantitative analysis used, please refer to Chapters Four and Seven, where this is discussed in detail.

Qualitative Analysis

As noted above, CCA was used in analysing the qualitative data. This is also discussed in more detail in Chapter Four.

Ethical Considerations

Ethical Approval

The study received ethical approval from the UCC Clinical Psychology Research Ethics Committee. See Appendix J for the ethics application including amendments, and for the letter and subsequent emails from the ethics committee confirming ethical approval.

Informed Consent

Participants were provided with a copy of the information sheet on clicking the Qualtrics link to the survey. See Appendix K for the text of this. Participants gave their consent by clicking "Yes" in response to questions asking if they had read and understood the information sheet on the study, and giving their consent to take part.

Anonymity

Participants' anonymity was assured by not collecting any identifying information, and through not collecting IP Addresses through Qualtrics. While no identifying information

was requested, should participants have provided this in their qualitative answers, this was anonymised to disguise any information which could potentially identify participants.

Participant Wellbeing

While no harm was expected to come to participants in the course of completing this study, email addresses for myself and my two supervisors were provided to participants at the start of the study should they have any questions about taking part, or should they want to make contact around any aspect of the study. At the end of the study, on the ending page which debriefed participants, a link was provided to the nature scene video, to allow participants to view this again if they were in the nature condition, or for the first time if they were in the urban condition, if they so wished. This was included specially to provide those who had experienced the control urban condition access to the nature scene video, as we hypothesised this would provide participants with greater benefits than the urban scene video.

Qualitative Component: Validity and Quality Assurance

One of the noted weakness of CCA is the potential for the context of the phenomena under investigation to be insufficiently captured, which can lead to important codes not being captured in the analysis phase (Hsieh & Shannon, 2005). To mitigate such threats to validity, Creswell (2013) recommends all qualitative research include at least two forms of verification strategies in its methodology. In the present study, different strategies were used, namely researcher reflexivity, maintaining a paper trail of analysis, and consultation with my supervisor. In order to assure the quality of the analysis, one of my supervisors reviewed my coding of answers from participants and categories. This was not completed with a view to calculating inter-rater reliability, rather, to ensure my coding was credible and plausible to the data collected.

The importance of reflexivity in qualitative research has been to the forefront of the literature in recent times. Reflexivity is generally understood to be an awareness of the influence of the researcher on the people or topic being studied, while at the same time recognising the impact of the research experience on the researcher (Gilgun, 2008). Awareness of one's own subjectivity develops through an internal process, but is supported by external activities (Probst & Berenson, 2014). While some suggest that through reflexivity one can "bracket" off their own subjectivity and in doing so eliminate or reduce their bias, other usages would consider it a means of exposing false claims of objectivity (Lynch, 2000). In the current research, subjectivity was considered as per Bradbury-Jones (2007), that is, akin to a "garment that cannot be removed and is always present in both our research and non-research life" (p.292). I have provided below a reflexivity statement as a way of being transparent about my own relationship to the research, and my own personal experiences, values, and traits that are relevant to the research conducted.

Reflexivity Statement

I conducted this research as a twenty-eight-year-old, Irish, white, female, trainee clinical psychologist. I have been many years in education and have an Honours Bachelor of Arts Degree and a Masters Degree in Applied Psychology. I am from a rural community and have had exposure to nature throughout my life. Many of my relatives come from farming backgrounds, so I have an understanding of the importance of nature in providing work, food, and other benefits. I have found the benefits of engaging in nature in my own life and would have a preference for spending time in nature as opposed to city or urban environments.

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Chapter Seven: Extended Data Analysis

In order to further explore the data presented in Chapter Four, this chapter will present more information around the data, data analysis methods, and decisions around same.

Sample Characteristics

150 participants completed the full study. However, 3 participants were removed from the dataset as they had not been exposed to the intervention video due to internet connectivity and internet browser issues. Thus, the sample consisted of 147 participants, with 70 (48%) participants viewing the nature intervention video, and 77 (52%) viewing the urban intervention video. For demographic information about the remaining sample, please see Table 4.1 in Appendix H.

As can be seen in Table 4.1, the majority of participants were Irish, and the majority of participants were resident in Ireland at the time of the study. The sex composition of the participants was quite balanced, with one participant noting their preference for not giving this information. The age range of participants was quite wide, with participants aged between 20 and 80 years of age. The majority of participants had college experience at some level. A large minority of the participants were living in a rural area at time of study completion.

Missing Data

There was some missing data in the present study. The percentage of missing items by scales which had missing data was as follows; HSP Scale (0.5%), DASS-21 (0.13%), PANAS T1 (0.2%), BSRI T1 (13.95%), PANAS T2 (0.24%), and BSRI T2 (16.1%). As noted by Dong and Peng (2013), the impact of missing data on quantitative research can be serious and must be properly handled.

In order to assess whether data was missing completely at random (MCAR), Little's MCAR test (Little, 1988) was utilised. Findings for all scales were non-significant, indicating data was MCAR, apart from the BSRI T1 which was significant, X^2 (110) = 136.94, p = .042.

Separate variance t-tests were thus run on the BSRI T1 data in order to assess if the data was systematically related to other variables, and would thus be missing not at random (MNAR). Results showed that missingness on BSRI T1 was not systematically related to other variables, thus missing at random (MAR) can be inferred. It is interesting that there were different patterns in terms of missingness between the BSRI T1 results and BSRI T2 results. This would indicate that some who did not answer at T1 did at T2, and vice versa. However, tests such as Little's MCAR and utilising separate variance t-tests have been criticised by some, and they cannot be interpreted as providing definitive evidence of the data missingness mechanism, and can only guide our decision making process in handling missing data (Dong & Peng, 2013; Schafer & Graham, 2002).

It was decided to utilise Expectation-Maximisation (EM) to handle the missing data. EM is a principled, maximum likelihood based missing data method (Dong and Peng, 2013). It is considered to be unbiased and efficient when data is MAR, as it is in the present study (Graham, 2003), it is also considered to be stable (Couvreur, 1997). Data was imputed at a subscale level for the DASS and PANAS, and at the scale level for the HSP scale and the BSRI. This was done to improve the quality of the imputations. This was not used for the Stroop Experimental data, and analysis was run pairwise to ensure those who did not complete the Stroop Task were still included in other tests. Data for 9 participants' Stroop tasks was also removed following initial screening, for a number of reasons; participants who were colourblind, participants who noted considerable environmental distractions during testing, and participants whose scores were more than 3 *SD*s away from the mean. This was done to ensure greater integrity of the Stroop results. This resulted in a total of 147

participants for most analysis, and 128 for analysis using the Stroop. This compares with totals ranging between 87 and 123 when using complete case analysis.

Two further data sets were also created, and the main analyses run on these. One in which data was deleted listwise, and another in which individual mean imputation was utilised. In the data set where mean imputation was used, given the larger percentage of missing data in the BSRI, mean imputation was utilised in cases where participants had at least 75% of the scale data, in line with guidance from Wu et al. (2021). These results are presented in Appendix L and will be discussed further later in the chapter.

The analysis described in this chapter, and in Chapter Four, refer to data using the EM missing data method on a final sample of 147 participants.

Scale Descriptions

The Cronbach's alpha, mean and standard deviation of each scale are illustrated in Table 7.1.

Table 7.1
Reliability, Mean, and Standard Deviation for scales

Scale	Cronbach's α	*M*	*SD*
HSP Scale	0.90	98.04	23.18
DASS-21 (Total)	0.92	10.11*	9.44*
DASS-21 (Anxiety)	0.81	2.23*	3.06*
DASS-21 (Stress)	0.86	5.07*	4.28*
DASS-21 (Depression)	0.83	2.81*	3.40*
Negative Affect Items	0.80	8.92	4.15
PANAS T1 Positive Affect	0.91	31.04	8.47
PANAS T1 Negative Affect	0.89	13.06	4.74
PANAS T2 Positive Affect	0.95	28.68	10.23
PANAS T2 Negative Affect	0.86	11.91	3.69
BSRI T1	0.90	204.53	179.02
BSRI T2	0.91	141.88	147.92

Note. * This is for the 21-item version, Mean (SD) when multiplied by two as follows; DASS Total = 20.21 (18.88), DASS Anxiety = 4.45 (6.13), DASS Stress = 10.14 (8.55), DASS Depression = 5.62 (6.79).

As can be seen in Table 7.1, it is clear that the scales had satisfactory internal consistency scores, with all being over the generally recommended cut off of a Cronbach's alpha of 0.7 (Nunnally, 1978). Furthermore, the results lie within the acceptable range without being too high, as noted by Hair et al. (2019), where Cronbach's alphas over .95 indicate there are items in the scale which are redundant.

Sensory Processing Sensitivity (SPS)

Comparing to Norms

In order to compare levels of SPS in the current sample to normed samples, mean effect size calculation was used. The mean total and standard deviation in the present study were compared to the mean total and standard deviation from Smith et al. (2019), who aggregated the scores for the HSP scale from 13 studies across 11 articles, resulting in a

sample of 2,451. Hedges' *g* was utilised due to the differences in number of participants between the studies, which is taken into account in the Hedges' *g* formula, but not Cohen's *d*.

When comparing the mean of the total HSP scale score for participants, and associated standard deviation, from Smith et al (2019) (M = 105.57, SD = 20.84) to that of the current sample, Hedges' g = 0.36. Considering the effect size guidance from Cohen (1992), this would fall in between a small (0.20) and medium (.50) effect size, though is closer to small. This demonstrates that the current sample show a small difference compared to this normed sample, with the current sample having lower levels of SPS.

Differences in SPS by Age and Sex in the Current Sample

In the table of correlations below, it is clear that age and sex appear to have a relationship to level of SPS.

Table 7.2

Spearman's Correlations Between Participant Characteristics and HSP Score

Variable	1.	2.	3.
1. Sex	-		
2. Age	-.23**	-	
3. HSP Score	.31**	-.27**	-

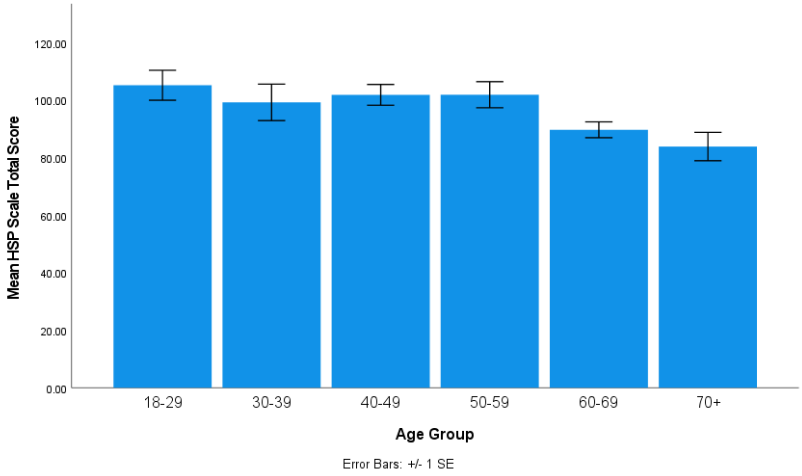
Note. * p<.05, ** p<.01

To assess whether there were significant differences between the age-groups in levels of SPS, a one-way ANOVA was used. As Levene's test was found to be significant (F = 2.88, p = .017), homogeneity of variances cannot be assumed. Considering the outcomes of the Welch Test - $F(5, 56.60) = 3.60$, p = .007 - and the Brown-Forsythe test – $F(5, 109.25) = 2.80$, p = .020 - there would appear to be a significant effect of age group on HSP scale scores. The effect size, omega squared = .06, which would meet the criteria for a medium effect size as

proposed by Kirk (1996) i.e., .06. Post-Hoc analysis using Tukey's HSD indicated that HSP scores were higher in the youngest age group compared to the oldest age group (p = .049), with an effect size of Cohen's d = .90 i.e., a large effect size (Cohen, 1988). There were no other significant findings. See Figure 7.1 below for a graph of this data.

Figure 7.1

Simple Mean Bar Chart of HSP Total Score by Age Group



This is in line with a recent study from Ueno et al. (2019), which showed a negative correlation between SPS and age.

Considering differences in sex in levels of SPS, an independent t-test was utilised to compare HSP scores in men and women. As only one participant noted they would prefer not to state their sex and considering the small sample size, they were excluded from the following analysis.

As Levene's test was significant (F = 4.26, p = .041), homogeneity of variance could not be assumed. The results of the t-test (equal variances not assumed) were found to be significant, t(143.39) = -4.09, p<.001, with the mean score for females (M = 105.02, SD = 24.05), being significantly higher than that of males (M = 90.25, SD = 19.61), with an effect

size of Cohen's *d* = .67, i.e., a medium effect size (Cohen, 1988). This is in line with other studies in the area (e.g., Aron & Aron, 1997; Benham, 2006).

Comparing Sensitivity Groups

Considering whether there were significant differences in the outcome measures depending on one's level of SPS, a number of statistical tests were completed. Participants were divided into groups based on the findings of Lionetti et al. (2018) that 29% of the population fall into a low sensitivity group, 40% into a medium sensitivity group, and 31% into a high sensitivity group. Participants were ranked according to their mean HSP score, and percentile cut-offs found from which participants could be placed into the appropriate grouping for their score. The following analyses should be interpreted with caution, as the mean HSP score for the current sample is lower than that of Lionetti et al. (2018). Therefore, for example, an individual classified as highly sensitive in the current study may only be considered to have medium levels of sensitivity in Lionetti et al. (2018). This is a limitation in terms of drawing conclusions across studies when the groupings are utilised. However it is important to note that when the scale is used as a continuous variable the associations are established based on increasing score in the scale not on a cut-off score itself.

The number of participants in each group, and the means and standard deviations of the HSP scale score for the three groups were as follows:

Table 7.3

Table of Participant numbers, Percentages of Participants, Mean HSP Total score and Standard Deviation for Different SPS Groupings

	Number in group	% Total Participants	Mean	SD
Low Sensitivity	42	28.57%	71.22	9.89
Medium Sensitivity	59	40.14%	96.03	7.20
High Sensitivity	46	31.30%	125.11	12.73

As can be seen in Table 7.3, the percentage in each group is close to aligning to that of Lionetti et al. (2018), however due to the number of participants exactly matching was not possible.

A series of Kruskal-Wallis Tests were completed to assess whether there were differences between the three sensitivity groups at T1, i.e., at baseline. The results are presented in Table 7.4. Effect sizes are considered using the benchmarks provided by Cohen (1988).

Table 7.4

Kruskal-Wallis Tests Comparing Dependent Variables at Baseline Across Sensitivity Groups

Variable	Group	*N*	Mean Rank	Kruskal-Wallis *H*	*p*	Eta Squared
PANAS PA T1	Low Sensitivity	42	83.44			
	Medium Sensitivity	59	81.86	12.96	.002	0.08
	High Sensitivity	46	55.30			i.e., medium
PANAS NA T1	Low Sensitivity	42	60.96			
	Medium Sensitivity	59	72.24	9.83	.007	0.05
	High Sensitivity	46	88.16			i.e., small
BSRI T1	Low Sensitivity	42	56.89			
	Medium Sensitivity	59	71.33	16.22	<.001	0.10
	High Sensitivity	46	93.04			i.e., medium
Stroop RT Difference T1	Low Sensitivity	37	65.14			
	Medium Sensitivity	50	65.40	0.12	.940	N/A
	High Sensitivity	41	62.83			

The Kruskal-Wallis tests suggest there were significant differences between the groups at T1. Further post-hoc analysis using pairwise comparisons and the Bonferroni adjustment showed that in the PANAS PA scale, those in the high sensitivity group (Mean = 27.25, *SD* = 8.62) had significantly different scores than those in the medium sensitivity (Mean = 32.73, *SD* = 7.86) (p = .005) and low sensitivity (Mean = 32.81, *SD* = 7.93) (p = .006) groups. Considering the PANAS NA scale, those in the high sensitivity group (Mean = 14.39, *SD* = 5.71) had significantly different scores than those in the low sensitivity group (Mean = 11.65, *SD* = 3.03) (p = .006). In the BSRI scale, those in the high sensitivity group (Mean = 283.65, *SD* = 191.53) had significantly different scores to those in the low sensitivity group (Mean = 139.34, *SD* = 153.76) (p < .001).

Impact of Intervention by Sensitivity Group

A series of Wilcoxon-Signed Rank tests were completed to assess differences between T1 and T2 outcomes, by level of SPS independently from the type of video. The analysis was completed using the Bonferroni adjustment, meaning an p value level of less than .0125 must be reached for significance rather than .05 for the tests. The effect sizes reported are those calculated using the formula provided by Pallant (2007) for r, and have a criteria of .1 is small, .3 is medium, and .5 is a large effect size, as per Cohen (1988).

The results of this showed that for the low sensitivity group, there was a statistically significant change in the PANAS Positive Affect (PA) Scale (Z = =2.56, p = .010, r = 0.28 i.e., medium effect size) and the BSRI score (Z = -2.93, p = .003, r = 0.32 i.e., medium effect size) following the intervention video. There appeared to be a decrease in the PANAS PA scale score (T1 Mean = 32.81, T2 Mean = 30.59), and a decrease in the BSRI scale score (T1 Mean = 139.34, T2 Mean = 105.53). There was no statistically significant difference for the

PANAS Negative Affect (NA) Scale (Z = -0.06, p = .955) and for the Stroop RT Difference (Z = -0.08, p = .934).

For the medium sensitivity group there was a statistically significant change in the PANAS PA Scale (Z = -3.16, p = .002, r = 0.29 i.e., medium effect size), the PANAS NA Scale (Z = -4.27 , p < .001, r = .39 i.e., medium effect size), and the BSRI Score (Z = -3.99 , p < .001, r = 0.37 i.e., medium effect size). There was a decrease in the PANAS PA Scale (T1 Mean = 32.73, T2 Mean = 30.50) and the PANAS NA Scale (T1 Mean = 13.02, T2 Mean = 11.36), as well as the BSRI score (T1 Mean = 189.25, T2 Mean = 140.93). There was no statistically significant change in the Stroop RT Difference (Z = -1.48, p = .138).

In the high sensitivity group, there as a statistically significant change in the BSRI score (Z = -5.04, p < .001, r = .53 i.e., a large effect size). There was a decrease in the mean following the intervention video (T1 Mean = 283.65, T2 Mean = 176.27). There was no statistically significant change in the PANAS PA Scale (Z = -2.33, p = .020), the PANAS NA Scale (Z = =2.08, p = .037) or the Stroop RT Difference (Z = -0.91, p = .361).

For a visual representation of the above, please see Figure 7.2 through Figure 7.5 below. Figures which represent significant results have an asterisk (i.e., *) above the T1 – T2 dyad.

Figure 7.2

Clustered Bar Graphs of Differences in Means of PANAS PA Scale at T1 and T2 by Sensitivity group

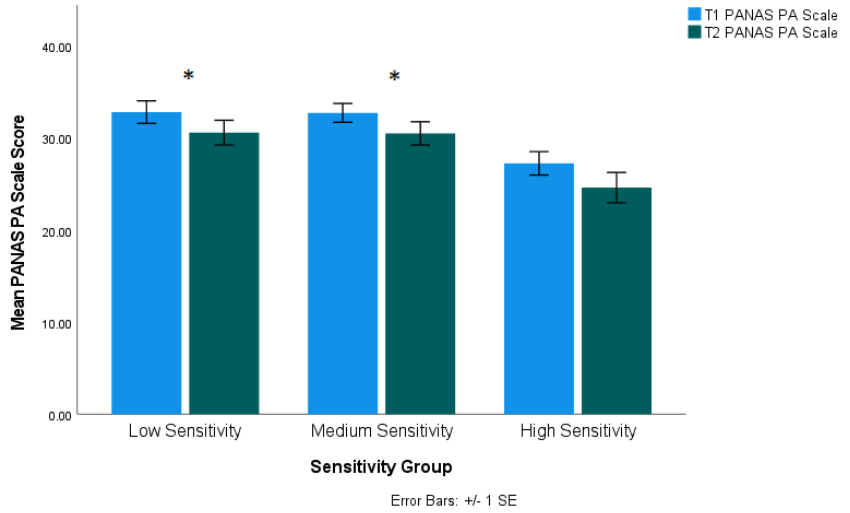


Figure 7.3

Clustered Bar Graphs of Differences in Means of PANAS NA Scale at T1 and T2 by Sensitivity group

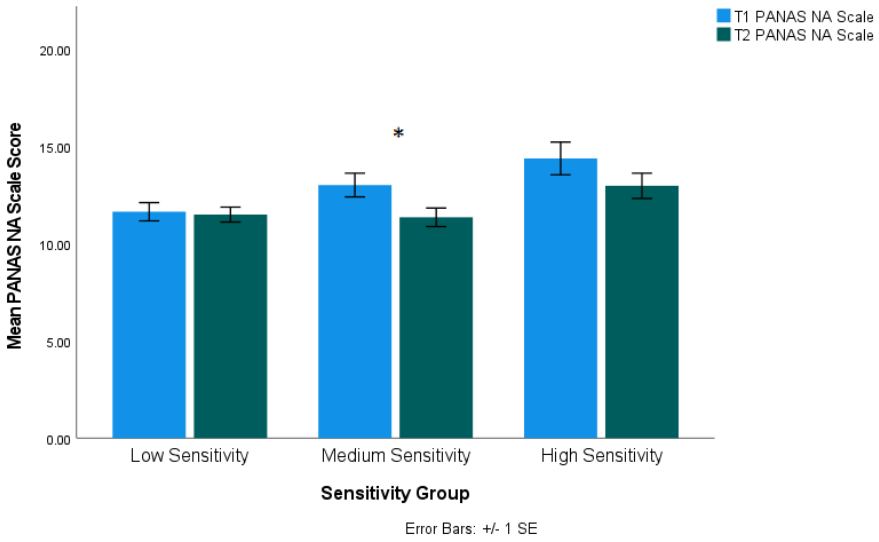


Figure 7.4

Clustered Bar Graphs of Differences in Means of BSRI Scale at T1 and T2 by Sensitivity group

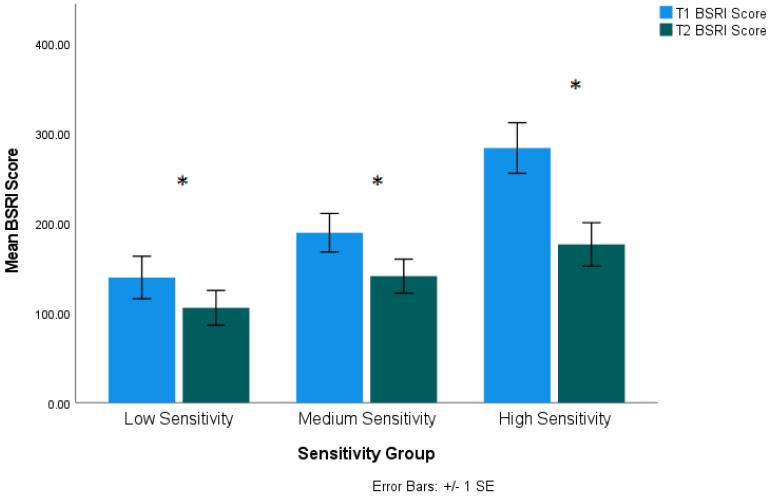
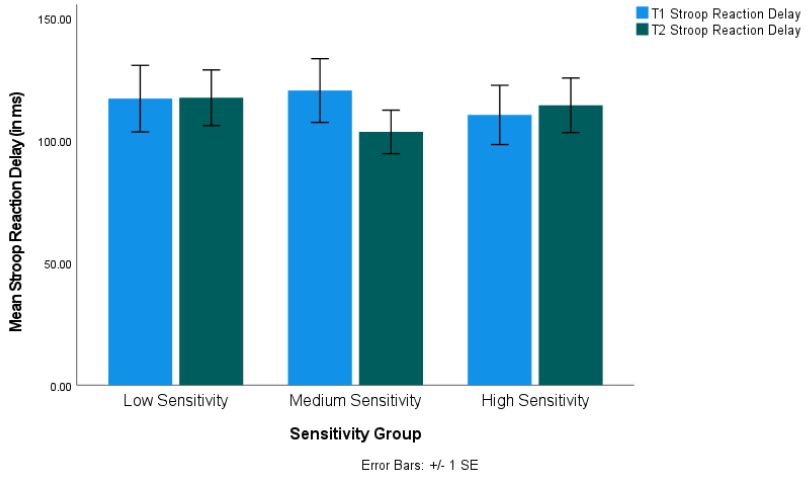


Figure 7.5

Clustered Bar Graphs of Differences in Means of Stroop RT Difference at T1 and T2 by Sensitivity group



Levels of Distress in the Sample

Distress Caseness

Considering the levels of distress as measured by the DASS-21 in the current sample cut off scores were considered. The DASS has a cut off of greater than or equal to 60 when considering the total score (Beaufort et al., 2017; Lovibond & Lovibond, 1995). Using this cut off, 6 participants (4.1%) reached this cut off. Considering caseness by each subscale, the results are presented in Table 7.5 below.

Table 7.5

DASS Caseness by Number of Participants and Percentage of Total Sample

	DASS Depression	DASS Anxiety	DASS Stress
Normal	112 (76.19%)	112 (76.19%)	112 (76.19%)
Mild	13 (8.84%)	9 (6.12%)	7 (4.76%)
Moderate	14 (9.52%)	14 (9.52%)	19 (12.93%)
Severe	7 (4.76%)	6 (4.08%)	8 (5.44%)
Extremely Severe	1 (0.68%)	6 (4.08%)	1 (0.68%)

Note. Number of participants presented with percentage of total participants in brackets

As Table 7.5 shows, the majority of participants fell within the normal range for Depression, Anxiety, and Stress.

Comparison to Norms

Considering the DASS-21 scores doubled, the mean and standard deviations were higher than UK norms for a non-clinical population reported by Henry and Crawford (2005) for all scales except the DASS Depression scale which was lower. Comparing these populations using Hedge's *g*, the following was found;

Table 7.6
Comparison of DASS-21 Doubled scores to Norms

	Hedge's g
DASS-21 doubled	
Depression	0.01
Anxiety	0.12
Stress	0.08
Total	0.07

As can be seen in Table 7.6, values for all effect size differences are smaller than the criteria set by Cohen (1992) for a small effect size i.e. 0.20. This would indicate that the means were comparable in the current sample and the UK normed sample. Hedges' *g* was utilised due to the differences in participant numbers between the studies, which is taken into account in the Hedges' *g* formula, but not Cohen's *d*.

Stroop Analysis

While the Stroop RT Difference was utilised in the current study as the dependent variable, it was decided to also analyse differences between the number of correctly answered trials.

Differences between the number of correctly answered trials between T1 and T2 by intervention group were assessed using Wilcoxon Signed Ranks tests. The results of this showed that for those who viewed the urban intervention video, there was a statistically significant change in the number of correctly answered Stroop trials (Z = -2.71, p = .007, r = 0.22 i.e., small effect size). There was an increase in the number answered correctly (T1 Mean = 119.74, T2 Mean = 122.45). Similarly, for those who viewed the nature intervention video, there was a statistically significant change in the number of correctly answered Stroop trials (Z = -2.73, p = .006, r = 0.24 i.e., small effect size). There was an increase in the number answered correctly (T1 Mean = 119.54, T2 Mean = 120.78). It is possible that participants traded off speed for accuracy, however, given the lack of difference between

Stroop RT differences at T1 and T2 as noted previously in the chapter would indicate that this was likely not the case here.

Multiple Regressions

Delta Values

Delta values were utilised in the present study and represent the difference between the outcome variables at T1 and T2. In the present study, Delta was calculated by subtracting the T1 score from the T2 score.

Centering of Predictors in Interactions

As both HSP Scale score and intervention type were going to be utilised in the Multiple Regression analysis, mean centering was utilised as a way of aiding the likely multicollinearity this would cause. As noted by Iacobucci et al. (2017), mean centering predictors when the interaction of said predictors are also included in analysis can clarify the regression coefficients, while allowing the overall model fit of R^2 to remain undisturbed. As the intervention type had only 2 levels, this was not centered, however the HSP Total score was centered prior to computing the product term as suggested by (Iacobucci et al., 2016).

Regression Analyses

The results of the correlations between variables and main regression analyses can be seen in Chapter Four.

Bias corrected and accelerated bootstrapping (BCA) was utilised in cases where data did not meet the assumptions for Multiple Regression as the residuals were not normally distributed. The current study utilised 2000 random re-samples. This is a computationally intensive methodology which corrects for bias associated with non-normal predictor and

dependent variable residual distributions, and generates more accurate confidence limits and *p*-values (Chernick, 2007; DiCiccio & Efron, 1996).

Pairwise deletion was utilised for the EM data regressions and the Mean Imputed data regressions as per Pallant (2007), and listwise deletion was utilised in the complete case analysis. Comparing the results of the Multiple Regressions using the EM data, complete case analysis, and Mean Imputation, there are some differences in the outcomes.

Comparing the EM data and the complete case analysis, while there are no significant differences in the regression relating to BSRI delta, in the regression for PANAS PA delta, the interaction between HSP centered and the intervention environment is no longer a significant predictor in the complete case analysis, and in the regression for PANAS NA delta, the question on resemblance and memories is no longer a significant predictor in the complete case analysis. Furthermore, the model is significant for predicting the Stroop RT Difference delta in the complete case analysis. Given the nature of the missing data, there are fewer participants in the complete case analysis compared to the EM data, meaning reduced power. Complete case analysis also results in bias compared to using other imputation techniques such as EM (Newman, 2014). Thus, in the current study, the results from the EM data are utilised.

Comparing results from the EM data to that of the Mean Imputed data, the results are identical in terms of significance.

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Chapter Eight: General Discussion and Conclusions

Summary of Findings

The overall aim of this thesis was to explore the impact of the temperament trait of Sensory Processing Sensitivity (SPS) in different environments in the area of psychological wellbeing and cognition. The systematic scoping review in Chapter Two aimed to examine the breadth of the literature available at present in the area. Sixty-three studies were synthesised using thematic analysis and qualitative means.

This review found that studies were mainly carried out in Western, Educated, Industrialised, Rich, and Democratic (WEIRD) countries and covered a wide range of theoretical backgrounds. The thematic analysis resulted in the formation of three themes; 1) Studied environments, 2) Outcomes for SPS in environments, and 3) Different aspects of sensitivity and SPS.

The studied environments were diverse, including the parenting environment, the work environment, the school environment, some sensory environments, and some intervention environments. While the areas covered were diverse, the research in the area appears to be sparse in certain environments. SPS was found to confer both benefits in some environments and risks in others, speaking to the complex nature of the trait. The third theme, the different ways in which SPS is characterised, was an interesting finding. The links between SPS and Environmental Sensitivity (ES) research appears to be well established in some papers, while not present in others. Furthermore, the view of SPS as a unitary, or multi-faceted, trait would appear to be viewed differently by researchers across the literature.

Considering the dates of the published studies, it is clear that this is a burgeoning area of research in recent years. In light of the scope of the literature in the review, SPS would

appear to be a trait which has wide-reaching implications in a variety of areas in both the world of psychology and beyond.

The major research project aimed to explore the impact of a virtual nature intervention on both cognition and affect, looking at the contribution of varying levels of SPS in the outcomes. Other possible contributors were also included, such as level of distress and whether the area in the video resembled a place of which the participant had good or bad memories. This work was supported by a qualitative component, which explored the participants' experiences of the intervention they received and their experience of nature in their day-to-day lives to add context to the quantitative results.

An online experiment was carried out, with participants randomised to either the virtual nature video condition or an active control virtual urban video condition. Overall, there was a significant reduction in rumination following both the virtual urban video condition and the virtual nature condition groups. Those in the virtual nature condition also showed a significant decrease in negative affect, while those in the virtual urban condition showed a significant decrease in positive affect. SPS was found to be predictive of changes in negative affect, such that as SPS increased negative affect increased, which was not expected. SPS was found to interact with the intervention area in predicting positive affect, such that participants in the virtual nature video condition benefitted more in terms of changes in positive affect and showed less improvement in positive affect in the virtual urban video condition than those with lower levels of SPS.

Considering the extended data analysis presented in Chapter Seven, the total HSP scale scores were different than those from a normed sample, with a small to medium effect size. Participants in the current study had lower levels of SPS than those in the normed sample. One possible reason for this is the age of the participants in the current sample.

Facets of SPS, namely ease of excitation and low sensory threshold, have been shown to reduce with age, and in the current sample there was a significant difference in levels of SPS between the youngest and oldest age groups. It is possible that in the current sample, as they were leaning to older age, had lower levels of SPS due to this phenomenon. There was also a significant difference found between the sexes, with females showing higher levels of SPS than males.

Upon examining the differences between the three sensitivity groups – low, medium, and high – it was found that there were significant differences between the three groups in terms of positive affect, negative affect, and rumination, but not Stroop score. This was such that those in the high SPS group had higher levels of negative affect and rumination, and lower scores in positive affect. Differences between the groups were also found in terms of how the interventions impacted on their scores, independently of which video they watched. Here it was found that those in the high SPS group had a significant decrease in their levels of rumination, but not in the other outcome areas. Considering the previously discussed interaction effect, this may be as a result of the interplay between the intervention type and level of SPS when considering positive affect.

The number of correctly answered items in the Stroop was also analysed, with participants showing an increase in the number answered correctly in both the urban intervention and nature intervention groups. It is possible that this result is down to practice effects, with participants having become familiar with the task at T1 and so being better able to answer correctly at T2. Considering the lack of significant change in reaction times, this would suggest that there was not a speed-accuracy trade off occurring.

When the results of the multiple regression using the EM data and the complete case analysis are compared, there are some differences. The model for the Stroop RT Difference

Delta is significant when considering the complete case analysis, and the question around memories is a significant predictor. Furthermore, the interaction between HSP score and the intervention is not significant. The numbers of participants included in analysis are lower in the complete case analysis, as would be expected, and so the power behind the statistical tests is lower. As complete case analysis can introduce significant bias (Dong & Peng, 2013), it was decided to present the results of the EM data. However, through showing the difference between the three datasets, it demonstrates that one's choices in terms of statistical analysis can impact on one's findings.

The results of the qualitative analysis found participants felt that there was an impact of the intervention on their affect for many, with some feeling it induced positive emotions and relaxation, while others found more negative emotions arose. Others noted it had no impact on their mood. The videos also appeared to impact somewhat on the cognitions of participants, with some relating it sparked memories in participants of familiar places and times spent in areas such as those they viewed. The videos themselves seemed to have an impact in that the auditory experience and visual experience was commented on by participants. Surprisingly, some participants related that as they were aware that this was a psychological study, they thought they would be asked questions on what they saw, and so focused on the details and trying to remember these. Participants' experience of nature in their day-to-day lives varied, with some having daily contact and others less. The relationship between participants and nature was clear in terms of what nature offered with regards restoration and activities.

The results from the qualitative analysis were helpful in interpreting the results of the quantitative analysis. For example, the findings that many participants had positive associations with the urban scene presented and recalled memories of activities and leisure time gave support to the Conditioned Restoration Theory (CRT). Without this information, it

would not have been possible to know that the urban environment presented had these positive associations which likely impacted on the quantitative results. Furthermore, the information on the participants' relationship with nature in their day-to-day life, in terms of the activities they complete and the benefits which they feel they receive, speaks to the biophilia hypothesis, as well as CRT. The nature intervention participants spoke to the audio and visual aspects of nature which impacted upon them and brought them calm. The comments on the views were in line with what would be expected from the Attention Restoration Theory. Some participants' experiences were different than others, for example few found the nature intervention induced more of a negative mood and caused frustration. This speaks to the individual differences which could not be captured in the quantitative analysis.

Limitations

There are several limitations of this thesis, which will be explored here. The systematic scoping review in Chapter Two aimed to examine the scope of the literature available at present, however, some papers which could possibly have been relevant were not available, even after attempting to follow up with the authors. Furthermore, by the nature of the publication of research, in the time that has passed since the review has come out it is likely there are more relevant pieces of research which are not included. While this is an issue which cannot be helped in the creation of scoping reviews, it is pertinent in that they have a limited amount of time in which they are relevant, though can still be of use in gaining a greater understanding of the literature.

The major research project also had several limitations. Given the online nature of the study, participants were not administered the intervention in a standardised environment which could have possibly impacted on the results. There is also a possibility that order

effects impacted on the results, as participants are exposed to negative wording in some of the scales which could have an impact on affect and possibly their executive functioning as a result. Future research might consider randomising the order of administration of the scales and tasks to overcome this and assess if there are indeed order effects here. The wide age range of participants is also a limitation, as it covers a span of 60 years. While it is positive that participants of many ages were able to take part, it impacts on the generalisability of the results as there is a lack of homogeneity between the participants in terms of age. Given the answers from some participants in the qualitative aspect of the study, it is a limitation in one sense that we could not go back and elucidate some of their experiences and explore them further, however, it does point to a possible future avenue for research and raise the question about the impact of the intervention environment itself when participants are aware they are taking part in a psychological study. The priming of doing a psychological study can itself impact on the experience and expectations of participants.

Contribution of the Research

The systematic scoping review makes an original contribution to the existing literature around SPS, as it is the first to synthesise studies around the impact of different environments on the psychological wellbeing of those with higher levels of SPS, which should make the findings of the primary research included in the review more accessible to clinicians and policy makers. The use of thematic analysis allowed for the generation of themes which captured aspects of all the studies as a whole, rather than at an individual level. The review highlighted the heterogeneity of the results, the fact that most research was carried out in WEIRD countries, and the growth in research in the area in recent years. It also highlighted the need for more research in non-WEIRD countries, and in the physical world's impact on those with higher levels of SPS, particularly nature.

The review also has some clinical implications. It highlighted the impact of the parenting environment on those with higher levels of SPS, and how this can impact on mental health in later life. Good quality parenting would appear to be important for those with higher levels of SPS. This is pertinent for psychologists working with family systems, as if a child would appear to have higher levels of SPS it may influence the type of parenting strategies which they would suggest to the parents. It could also be important in terms of formulation with adult clients, as parenting could be a predisposing factor in terms of their mental health difficulties. Furthermore, it highlighted that the work environment can impact on the psychological wellbeing of those higher in SPS. Findings in this area could impact on strategies clinicians suggest for clients in the work environment and how to manage such difficulties.

Indeed, in general the findings suggest that SPS is an aspect of one's temperament which should be considered in the formulation process, as it can act as a predisposing factor in mental health difficulties, but also as a perpetuating factor. This is important in terms of finding the right intervention for the client. It would also be helpful in generating insight into why they might experience the world differently to others they know, and thus have a normalising effect for the client on learning they are not alone in their sensitivity.

The major research project also makes an original contribution to the literature, as it is the first to examine the impact of a virtual nature intervention on the affect and cognition of those with varying levels of SPS while measuring this trait. A strength of this study in terms of what it adds to the extant literature is the fact that it incorporates a qualitative analysis element which adds context to the quantitative findings, allowing for greater understanding of the participants' experience of the intervention and of nature in their day-to-day lives.

This study highlighted the impact which a short video intervention can have on positive affect and rumination. Specifically, it highlights that in as little as six minutes, watching a video of nature scenes can result in significant decreases in negative affect and rumination. This has clinical implications in terms of virtual nature-based interventions. Virtual nature has portability and accessibility which is not possible with real nature. Using mobile phones, tablets, or laptops, one can view and listen to nature videos and experience these benefits, even if one is in an urban environment with no nature access. This has implications for those who are unable to leave environments, such as those in hospital, in nursing homes, in prisons, and those with disabilities which prevent them from accessing nature. Furthermore, those who are geographically restricted but show a biophilia for a distant nature setting, for example those in landlocked areas who have an affinity for the sea, can experience some of these benefits from where they are based.

It also highlighted the role of SPS in this relationship between the virtual environment and psychological wellbeing and cognition. The knowledge that those with higher levels of SPS are likely to benefit more in terms of positive affect is important when clinicians are considering which intervention may aid improvements in certain clients. This speaks to a person-intervention fit, which is important in clinical practice.

Conclusion

The aim of this thesis was to explore the impact of the temperament trait of SPS and different environments on psychological wellbeing and cognition. A systematic scoping review and an original, empirical research project have added to the existing literature on SPS and its relationship with different environments. The findings of these works also have clinical implications for policy makers and clinicians working with individuals that are high in SPS.

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Appendices

Appendix A

Author Guidelines for Journal of Mental Health

About the Journal

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- This result was later contradicted by Becker and Seligman (1996).
- This effect has been widely studied (Abbott, 1991; Barakat et al., 1995; Kelso & Smith, 1998; Medvec et al., 1999).

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- Book Sapolsky, R. M. (2017). *Behave: The biology of humans at our best and worst*. Penguin Books.
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- Online document Fagan, J. (2019, March 25). *Nursing clinical brain*. OER Commons. Retrieved January 7, 2020, from https://www.oercommons.org/authoring/53029-nursing-clinical-brain/view

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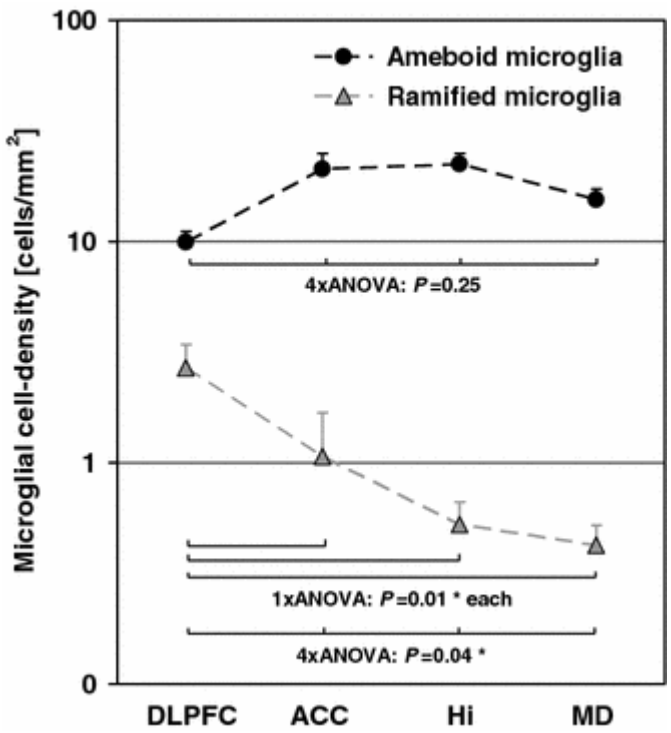
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Artwork and Illustrations Guidelines

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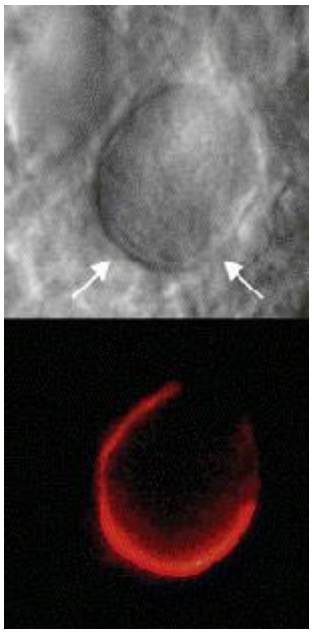
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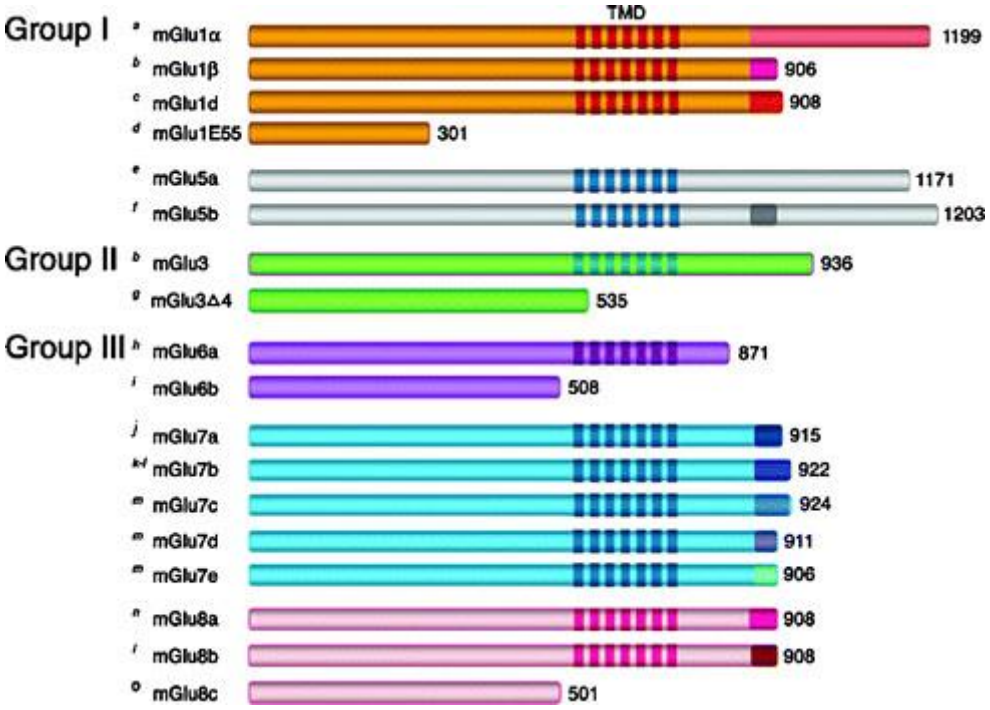
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Although retrospective studies are conducted on already available data or biological material (for which formal consent may not be needed or is difficult to obtain) ethics approval may be required dependent on the law and the national ethical guidelines of a country. Authors should check with their institution to make sure they are complying with the specific requirements of their country.

Ethics approval for case studies

Case reports require ethics approval. Most institutions will have specific policies on this subject. Authors should check with their institution to make sure they are complying with the specific requirements of their institution and seek ethics approval where needed. Authors should be aware to secure informed consent from the individual (or parent or guardian if the participant is a minor or incapable) See also section on **Informed Consent**.

Cell lines

If human cells are used, authors must declare in the manuscript: what cell lines were used by describing the source of the cell line, including when and from where it was obtained, whether the cell line has recently been authenticated and by what method. If cells were bought from a life science company the following need to be given in the manuscript: name of company (that provided the cells), cell type, number of cell line, and batch of cells.

It is recommended that authors check the NCBI database for misidentification and contamination of human cell lines. This step will alert authors to possible problems with the cell line and may save considerable time and effort.

Further information is available from the International Cell Line Authentication Committee (ICLAC).

Authors should include a statement that confirms that an institutional or independent ethics committee (including the name of the ethics committee) approved the study and that informed consent was obtained from the donor or next of kin.

Research Resource Identifiers (RRID)

Research Resource Identifiers (RRID) are persistent unique identifiers (effectively similar to a DOI) for research resources. This journal encourages authors to adopt RRIDs when reporting key biological resources (antibodies, cell lines, model organisms and tools) in their manuscripts.

Examples:

Organism: *Filip1*$^{tm1a(KOMP)Wtsi}$ **RRID:MMRRC_055641-UCD**

Cell Line: RST307 cell line **RRID:CVCL_C321**

Antibody: Luciferase antibody DSHB Cat# LUC-3, **RRID:AB_2722109**

Plasmid: mRuby3 plasmid **RRID:Addgene_104005**

Software: ImageJ Version 1.2.4 **RRID:SCR_003070**

RRIDs are provided by the Resource Identification Portal. Many commonly used research resources already have designated RRIDs. The portal also provides authors links so that they can quickly register a new resource and obtain an RRID.

Clinical Trial Registration

The World Health Organization (WHO) definition of a clinical trial is "any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes". The WHO defines health interventions as “A health intervention is an act performed for, with or on behalf of a person or population whose purpose is to assess, improve, maintain, promote or modify health, functioning or health conditions” and a health-related outcome is generally defined as a change in the health of a person or population as a result of an intervention.

To ensure the integrity of the reporting of patient-centered trials, authors must register prospective clinical trials (phase II to IV trials) in suitable publicly available repositories. For example www.clinicaltrials.gov or any of the primary registries that participate in the WHO International Clinical Trials Registry Platform.

The trial registration number (TRN) and date of registration should be included as the last line of the manuscript abstract.

For clinical trials that have not been registered prospectively, authors are encouraged to register retrospectively to ensure the complete publication of all results. The trial registration number (TRN), date of registration and the words 'retrospectively registered’ should be included as the last line of the manuscript abstract.

Standards of reporting

Springer Nature advocates complete and transparent reporting of biomedical and biological research and research with biological applications. Authors are recommended to adhere to the minimum reporting guidelines hosted by the EQUATOR Network when preparing their manuscript.

Exact requirements may vary depending on the journal; please refer to the journal’s Instructions for Authors.

Checklists are available for a number of study designs, including:

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Observational studies (STROBE)

Systematic reviews and meta-analyses (PRISMA) and protocols (Prisma-P)

Diagnostic/prognostic studies (STARD) and (TRIPOD)

Case reports (CARE)

Clinical practice guidelines (AGREE) and (RIGHT)

Qualitative research (SRQR) and (COREQ)

Animal pre-clinical studies (ARRIVE)

Quality improvement studies (SQUIRE)

Economic evaluations (CHEERS)

Summary of requirements

The above should be summarized in a statement and placed in a 'Declarations' section before the reference list under a heading of 'Ethics approval'.

Examples of statements to be used when ethics approval has been obtained:

• All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Bioethics Committee of the Medical University of A (No. ...).

• This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University B (Date.../No. ...).

• Approval was obtained from the ethics committee of University C. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

• The questionnaire and methodology for this study was approved by the Human Research Ethics committee of the University of D (Ethics approval number: ...).

Examples of statements to be used for a retrospective study:

• Ethical approval was waived by the local Ethics Committee of University A in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

• This research study was conducted retrospectively from data obtained for clinical purposes. We consulted extensively with the IRB of XYZ who determined that our study did not need ethical approval. An IRB official waiver of ethical approval was granted from the IRB of XYZ.

• This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964

Helsinki Declaration and its later amendments or comparable ethical standards. The Human Investigation Committee (IRB) of University B approved this study.

Examples of statements to be used when no ethical approval is required/exemption granted:

• This is an observational study. The XYZ Research Ethics Committee has confirmed that no ethical approval is required.

• The data reproduced from Article X utilized human tissue that was procured via our Biobank AB, which provides de-identified samples. This study was reviewed and deemed exempt by our XYZ Institutional Review Board. The BioBank protocols are in accordance with the ethical standards of our institution and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Authors are responsible for correctness of the statements provided in the manuscript. See also Authorship Principles. The Editor-in-Chief reserves the right to reject submissions that do not meet the guidelines described in this section.

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Informed consent

All individuals have individual rights that are not to be infringed. Individual participants in studies have, for example, the right to decide what happens to the (identifiable) personal data gathered, to what they have said during a study or an interview, as well as to any photograph that was taken. This is especially true concerning images of vulnerable people (e.g. minors, patients, refugees, etc) or the use of images in sensitive contexts. In many instances authors will need to secure written consent before including images.

Identifying details (names, dates of birth, identity numbers, biometrical characteristics (such as facial features, fingerprint, writing style, voice pattern, DNA or other distinguishing characteristic) and other information) of the participants that were studied should not be published in written descriptions, photographs, and genetic profiles unless the information is essential for scholarly purposes and the participant (or parent/guardian if the participant is a minor or incapable or legal representative) gave written informed consent for publication. Complete anonymity is difficult to achieve in some cases. Detailed descriptions of individual participants, whether of their whole bodies or of body sections, may lead to disclosure of their identity. Under certain circumstances consent is not required as long as information is anonymized and the submission does not include images that may identify the person.

Informed consent for publication should be obtained if there is any doubt. For example, masking the eye region in photographs of participants is inadequate protection of anonymity. If identifying characteristics are altered to protect anonymity, such as in genetic profiles, authors should provide assurance that alterations do not distort meaning.

Exceptions where it is not necessary to obtain consent:

• Images such as x rays, laparoscopic images, ultrasound images, brain scans, pathology slides unless there is a concern about identifying information in which case, authors should ensure that consent is obtained.

• Reuse of images: If images are being reused from prior publications, the Publisher will assume that the prior publication obtained the relevant information regarding consent. Authors should provide the appropriate attribution for republished images.

Consent and already available data and/or biologic material

Regardless of whether material is collected from living or dead patients, they (family or guardian if the deceased has not made a pre-mortem decision) must have given prior written consent. The aspect of confidentiality as well as any wishes from the deceased should be respected.

Data protection, confidentiality and privacy

When biological material is donated for or data is generated as part of a research project authors should ensure, as part of the informed consent procedure, that the participants are made aware what kind of (personal) data will be processed, how it will be used and for what purpose. In case of data acquired via a biobank/biorepository, it is possible they apply a broad consent which allows research participants to consent to a broad range of uses of their data and samples which is regarded by research ethics committees as specific enough to be considered "informed". However, authors should always check the specific biobank/biorepository policies or any other type of data provider policies (in case of non-bio research) to be sure that this is the case.

Consent to Participate

For all research involving human subjects, freely-given, informed consent to participate in the study must be obtained from participants (or their parent or legal guardian in the case of children under 16) and a statement to this effect should appear in the manuscript. In the case of articles describing human transplantation studies, authors must include a statement declaring that no organs/tissues were obtained from prisoners and must also name the institution(s)/clinic(s)/department(s) via which organs/tissues were obtained. For manuscripts reporting studies involving vulnerable groups where there is the potential for coercion or where consent may not have been fully informed, extra care will be taken by the editor and may be referred to the Springer Nature Research Integrity Group.

Consent to Publish

Individuals may consent to participate in a study, but object to having their data published in a journal article. Authors should make sure to also seek consent from individuals to publish their data prior to submitting their paper to a journal. This is in particular applicable to case studies. A consent to publish form can be found

here. (Download docx, 36 kB)

Summary of requirements

The above should be summarized in a statement and placed in a 'Declarations' section before the reference list under a heading of 'Consent to participate' and/or 'Consent to publish'. Other declarations include Funding, Competing interests, Ethics approval, Consent, Data and/or Code availability and Authors' contribution statements.

Please see the various examples of wording below and revise/customize the sample statements according to your own needs.

Sample statements for **"Consent to participate"**:

Informed consent was obtained from all individual participants included in the study.

Informed consent was obtained from legal guardians.

Written informed consent was obtained from the parents.

Verbal informed consent was obtained prior to the interview.

Sample statements for **“Consent to publish”**:

The authors affirm that human research participants provided informed consent for publication of the images in Figure(s) 1a, 1b and 1c.

The participant has consented to the submission of the case report to the journal.

Patients signed informed consent regarding publishing their data and photographs.

Sample statements if identifying information about participants is available in the article:

Additional informed consent was obtained from all individual participants for whom identifying information is included in this article.

Authors are responsible for correctness of the statements provided in the manuscript. See also Authorship Principles. The Editor-in-Chief reserves the right to reject submissions that do not meet the guidelines described in this section.

Images will be removed from publication if authors have not obtained informed consent or the paper may be removed and replaced with a notice explaining the reason for removal.

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Data availability

All original research must include a data availability statement. Data availability statements should include information on where data supporting the results reported in the article can be found, if applicable. Statements should include, where applicable, hyperlinks to publicly archived datasets analysed or generated during the study. For the purposes of the data availability statement, “data” is defined as the minimal dataset that would be necessary to interpret, replicate and build upon the findings reported in the article. When it is not possible to share research data publicly, for instance when individual privacy could be compromised, data availability should still be stated in the manuscript along with any conditions for access. Data availability statements can take one of the following forms (or a combination of more than one if required for multiple datasets):

1. The datasets generated during and/or analysed during the current study are available in the [NAME] repository, [PERSISTENT WEB LINK TO DATASETS]

2. The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

3. All data generated or analysed during this study are included in this published article [and its supplementary information files].

4. The datasets generated during and/or analysed during the current study are not publicly available due [REASON(S) WHY DATA ARE NOT PUBLIC] but are available from the corresponding author on reasonable request.].

5. Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

6. The data that support the findings of this study are available from [THIRD PARTY NAME] but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [THIRD PARTY NAME].

More templates for data availability statements, including examples of openly available and restricted access datasets, are available here:

Data availability statements

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Appendix C

Systematic Scoping Review Search Strings

Academic Search Complete on 08/09/2021

155 results

Search Term:

AB (“Highly Sensitive Person” OR “Highly Sensitive Child*” OR “Sensory Processing Sensitivity” OR “Environmental Sensitivity”) AND AB (“Wellbeing” OR “Well-being” OR “well being” OR “Anxi*” OR “Depress*” OR “Mental Health” OR “Cognit*” OR “Psychia*” OR “Psychol*” OR “Happ*” OR “Flourish*” OR “Perception” OR “Processing” OR “Internalising Beh*” OR “Internalising Prob*” OR “Internalizing Beh*” OR “Internalizing Prob*” OR “Externalising Beh*” OR “Externalising Prob*” OR “Externalizing Beh*” OR “Externalizing Prob*” OR “social competence” OR “life satisfaction” OR “satisfaction with life” OR “positive affect” OR “negative affect”)

APAPsychInfo on 09/09/2021

174 results

Search Term

AB (“Highly Sensitive Person” OR “Highly Sensitive Child*” OR “Sensory Processing Sensitivity” OR “Environmental Sensitivity”) AND AB (“Wellbeing” OR “Well-being” OR “well being” OR “Anxi*” OR “Depress*” OR “Mental Health” OR “Cognit*” OR “Psychia*” OR “Psychol*” OR “Happ*” OR “Flourish*” OR “Perception” OR “Processing” OR “Internalising Beh*” OR “Internalising Prob*” OR “Internalizing Beh*” OR “Internalizing Prob*” OR “Externalising Beh*” OR “Externalising Prob*” OR “Externalizing Beh*” OR “Externalizing Prob*” OR “social competence” OR “life satisfaction” OR “satisfaction with life” OR “positive affect” OR “negative affect”)

PubMed on 10/09/2021

158 results

Search Terms:

All Fields

(“Highly Sensitive Person” OR “Highly Sensitive Child*” OR “Sensory Processing Sensitivity” OR “Environmental Sensitivity”) AND (“Wellbeing” OR “Well-being” OR “well being” OR “Anxi*” OR “Depress*” OR “Mental Health” OR “Cognit*” OR “Psychia*” OR “Psychol*” OR “Happ*” OR “Flourish*” OR “Perception” OR “Processing” OR “Internalising Beh*” OR “Internalising Prob*” OR “Internalizing Beh*” OR “Internalizing Prob*” OR “Externalising Beh*” OR “Externalising Prob*” OR “Externalizing

Beh*" OR "Externalizing Prob*" OR "social competence" OR "life satisfaction" OR "satisfaction with life" OR "positive affect" OR "negative affect")

I.E.

("Highly Sensitive Person"[All Fields] OR "highly sensitive child*"[All Fields] OR "Sensory Processing Sensitivity"[All Fields] OR "Environmental Sensitivity"[All Fields]) AND ("Wellbeing"[All Fields] OR "Well-being"[All Fields] OR "Well-being"[All Fields] OR "anxi*"[All Fields] OR "depress*"[All Fields] OR "Mental Health"[All Fields] OR "cognit*"[All Fields] OR "psychia*"[All Fields] OR "psychol*"[All Fields] OR "happ*"[All Fields] OR "flourish*"[All Fields] OR "Perception"[All Fields] OR "Processing"[All Fields] OR "internalising beh*"[All Fields] OR "internalising prob*"[All Fields] OR "internalizing beh*"[All Fields] OR "internalizing prob*"[All Fields] OR "externalising beh*"[All Fields] OR "externalising prob*"[All Fields] OR "externalizing beh*"[All Fields] OR "externalizing prob*"[All Fields] OR "social competence"[All Fields] OR "life satisfaction"[All Fields] OR "satisfaction with life"[All Fields] OR "positive affect"[All Fields] OR "negative affect"[All Fields])

Google Scholar on 13/09/2021

3240 results (Go with first 200 as per plan)

("Highly Sensitive Person" OR "Highly Sensitive Child" OR "Sensory Processing Sensitivity") AND (well-being OR Anxiety OR Depression OR "Mental Health" OR Cognition OR Psychiatry OR Psychology)

Web of Science – Core collection on 16/09/2021

343 results

("Highly Sensitive Person" OR "Highly Sensitive Child*" OR "Sensory Processing Sensitivity" OR "Environmental Sensitivity") AND ("Wellbeing" OR "Well-being" OR "well being" OR "Anxi*" OR "Depress*" OR "Mental Health" OR "Cognit*" OR "Psychia*" OR "Psychol*" OR "Happ*" OR "Flourish*" OR "Perception" OR "Processing" OR "Internalising Beh*" OR "Internalising Prob*" OR "Internalizing Beh*" OR "Internalizing Prob*" OR "Externalising Beh*" OR "Externalising Prob*" OR "Externalizing Beh*" OR "Externalizing Prob*" OR "social competence" OR "life satisfaction" OR "satisfaction with life" OR "positive affect" OR "negative affect") (Topic)

Scopus on 16/09/2021

412 results

(TITLE-ABS-KEY (“Highly Sensitive Person” OR “Highly Sensitive Child*” OR “Sensory Processing Sensitivity” OR “Environmental Sensitivity”) AND TITLE-ABS-KEY (“Wellbeing” OR “Well-being” OR “well being” OR “Anxi*” OR “Depress*” OR “Mental Health” OR “Cognit*” OR “Psychia*” OR “Psychol*” OR “Happ*” OR “Flourish*” OR “Perception” OR “Processing” OR “Internalising Beh*” OR “Internalising Prob*” OR “Internalizing Beh*” OR “Internalizing Prob*” OR “Externalising Beh*” OR “Externalising Prob*” OR “Externalizing Beh*” OR “Externalizing Prob*” OR “social competence” OR “life satisfaction” OR “satisfaction with life” OR “positive affect” OR “negative affect”))

Appendix D

Systematic Scoping Review Charted Data

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Aron, E.N. & Aron, A.	1997	Sensory-Processing Sensitivity and Its Relation to Introversion and Emotionality	Peer reviewed Journal article	Journal of Personality and Social Psychology	USA	Studies 2-4: To assess the extent to which original themes constituted a core pattern, relation of core items to social introversion and emotionality, the existence of subgroups of HSPs, whether sensitivity moderated the relation of family environment to how	Studies 2-4: Observational, Cross-sectional design, quantitative, survey methods	Multiple	Family environment in childhood	Males and Females	Adults (18+)	1. Items from what would become the HSPS (Aron & Aron, 1997) 2. Social introversion novel items 3. Emotionality novel items 4. Two sets of questions on childhood which were novel	Study 2: When parental environment was optimal, there was little difference between HSPs and non HSPs; but when the parental environment was poor, the highly sensitive scored higher on unhappy childhood. Study 3/4: Three way interaction found with gender,	SPS	Study 2: **** Study 3: **** Study 4: ***

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						childhood was experienced.							such that when parental environment was optimal, there was little difference between men regardless of sensitivity; when the parental environment was poor, highly sensitive men reported having a much less happy childhood.		

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Meyer, B., & Carver, C. S.	2000	Negative childhood accounts, sensitivity and pessimism: A study of avoidant personality disorder features in college students	Peer reviewed Journal article	Journal of Personality Disorders	USA	To test a model that memories of negative childhood experiences, SPS, and pessimistic expectancies are associated with Avoidant Personality Disorder (APD) features.	Observational, Cross-sectional design, quantitative, survey methods	Multiple	Childhood Environment	Males and Females	Adults and Children	1. APD criteria set forth in the DSM-IV (American Psychiatric Association, 1994) 2. Childhood Memories: Participants asked to write a paragraph describing their childhood which was then rated by four persons for valence and quality. 3. Highly Sensitive Person Scale (HSPS)(Aron & Aron, 1997) 4. The Life Orientation Test-Revised (LOT-R) (Scheier, Carver, & Bridges, 1994)	APD features were found to be correlated with optimism/ pessimism, childhood memory valence, and SPS. A significant interaction between optimism/ pessimism and SPS was found. A significant negative correlation emerged between optimism and APD features among those scoring highly in SPS. The	SPS, theories of APD e.g. Beck and colleagues (1990), Carver and Scheier s (1981, 1998) self-regulation theory	**

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
												5. Profile of Mood States (POMS; McNair, Lorr, & Droppelman, 1971)	combination of pessimistic expectancies and high levels of SPS yielded higher levels of APD features.		
Aron, E. N., Aron, A., & Davies, K. M.	2005	Adult Shyness: The Interaction of Temperamental Sensitivity and an Adverse Childhood Environment	Peer reviewed Journal article	Personality and Social Psychology Bulletin	USA	Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in	Studies 1,2,3 - Observational, cross-sectional design, quantitative, survey methods Study 4 - Experimental, cross-sectional design, quantitative, survey methods	Social	Childhood Environments / Study 4. Manipulated negative event i.e. frustrating survey completion	Males and Females	Adults (18+)	1. Highly Sensitive Person Scale (Aron & Aron, 1997) 2. Revised Cheek and Buss Shyness Scale (Cheek, 1983) 3. Childhood parental environment was assessed with the six-item measure from Aron and Aron (1997) 4. Negative affectivity	SPS and childhood environment interact predicting adult trait negative affectivity. SPS interacts with a manipulated negative experience to predict greater state negative affect.	SPS	Study 1 - **** Study 2 - **** Study 3 - **** Study 4 - *

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						turn shyness.						was assessed with the three-item measure from Aron and Aron (1997) 5. Social Introversion assessed with two-item measure from Aron and Aron (1997) 6. The Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988) 7. Beck Depression Inventory (Beck, 1978) 8. The average rating on 10 negative moods (distressed, upset, guilty, scared, hostile, irritable,			

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
												ashamed, nervous, jittery, and afraid) for how much participants "generally feel this way." 9. Parental Bonding Instrument (PBI) (Parker, Tupling, & Brown, 1979) 10. Ratings of actual and desired closeness to the mother at ages 5, 9, 13, and 16. 11. State negative affect—feeling "sad," "anxious," and "depressed"			

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Liss, M., Timmel, L., Baxley, K., & Killingsworth, P.	2005	Sensory processing sensitivity and its relation to parental bonding, anxiety, and depression	Peer reviewed Journal article	Personality and Individual Differences	USA	To explore the relationship between SPS, parenting style, anxiety and depression. To determine how knowledge of an individuals SPS contributes to prediction if someone is anxious or depressed above parenting style. To look at interaction effects between negative parental environme	Observational, Cross-sectional design, quantitative, survey methods	Relational	Parenting environment	Males and Females	Not Specified	1. Highly Sensitive Person Scale (HSPS, Aron & Aron, 1997) 2. Parental Bonding Instrument (PBI, Parker, Tupling, & Brown, 1979) 3. Beck Depression Inventory (BDI, Beck & Steer, 1987) 4. State Trait Anxiety Inventory (STAI-2, Spielberger, Gorsuch, & Lushene, 1970)	SPS was strongly related to depression and to anxiety. It contributed unique variance above parenting factors for both depression and anxiety. SPS was particularly strongly related to anxiety. SPS was correlated with parental-overprotection. For depression there was a small but significant interaction between parental care and SPS, such	SPS	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						nt and negative affect separately in anxiety and depression, and looking separately at parental care and overprotection.							that HSPs were more depressed in I context of low parental care. This interaction was not found for anxiety. No interaction effects found for parental overprotection.		
Kemler, D.S.	2006	Sensitivity to sensoriprocessing, self-discrepancy, and emotional reactivity of collegiate athletes	Peer reviewed Journal article	Perceptual and Motor Skills	USA	To investigate how differences between athletes with varying levels of SPS apply self-discrepancies and emotional reactions to	Quasi-experimental, cross-sectional design, quantitative, using survey methods	Multiple	Competitive sports event	Males and Females	Not Specified	1. High Sensitivity Scale (Aron & Aron, 1997) 2. The Selves Questionnaire (Higgins, Bond, Klein, & Straumann, 1986 3. The Goal Congruent and Incongruent	Participants high in SPS responded to competition with greater anxiety and shame than low SPS counterparts. Participants high in SPS also	SPS, Self-discrepancy Theory (Higgins, 1987)	****

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						competitive sports.						Emotion Scale (Lazarus, 1991)	reported having greater stress related to actual to ideal and actual to ought self-discrepancies than those low SPS.		
Evers, A., Rasche, J., & Schabracq, M. J.	2008	High Sensory-Processing Sensitivity at Work	Peer reviewed Journal article	International Journal of Stress Management	Netherlands*	To examine the construct validity of the HSPS, to introduce the concept into the field of work stress, and to adapt the user-friendliness of the HSPS without affecting reliability	Observational, Cross-sectional design, quantitative, survey methods	Multiple	Work environment	Males and Females	Adults (18+)	1. Dutch translation of HSPS (Aron & Aron, 1997) 2. Dutch translation of Antonovsky's Sense of Coherence Questionnaire (Broekmans, 1996) 3. Dutch translation (Broekmans, 1996) of the self-estrangement scale adapted to work domain	SPS (and its subscales) are negatively correlated with sense of coherence, comprehensibility, manageability, meaningfulness and self-efficacy. SPS (and its subscales) are positive correlated	Organisational Psychology, SPS	****

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						and validity.						(Roberts. 1987) 4. Dutch translation (Broekmans, 1996) of the self-efficacy scale of Schwarzer (1993) 5. Dutch translation (Peeters, Ponds, & Vermeeren, 1996) of the Negative Affectivity scale (Watson et al., 1988) 6. summated scales of workload, emotional load, work displeasure, and recovery need of the 'Questionnaire Experience and Evaluation of Labor' (Van	with negative affectivity, work displeasure and need for recovery.		

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												Veldhoven, 1993)			
Jagiellowicz, J., Xu, X., Aron, A., Aron, E., Cao, G., Feng, T., & Weng, X.	2011	The trait of sensory processing sensitivity and neural responses to changes in visual scenes	Peer reviewed Journal article	Social Cognitive and Affective Neuroscience	China	Investigate the relationship between perceptual and cognitive processes underlying tendency of pausing before acting and SPS.	Experimental design, cross-sectional, quantitative, lab-based study using change detection task and questionnaires	Sensory/perceptual	Change detection task using images	Males and Females	Adults (18+)	1. Chinese translation of 26 items from the 27-item HSP Scale (Aron and Aron, 1997) 2. Chinese translation of 50-item short form of the NEO Personality Inventory—	No significant associations between accuracy and SPS. Significant correlation between SPS and minor-minus-major difference in	SPS	***

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												Revised (NEO-PI-R; Costa and McCrae, 1992) 3. Visual change task that was adapted from a change detection task used by Rensink and colleagues (1997)	response time, such that the higher a participant was on SPS the longer time they spent before responding to minor changes, relative to major changes.		
Gerstenberg, F.X.	2012	Sensory-processing sensitivity predicts performance on a visual search task followed by an increase in perceived stress	Peer reviewed Journal article	Personality and Individual Differences	Germany	To investigate potential differences in SPS with regard to the HSPS subscales, to further investigate whether individuals high in SPS process information more carefully	Observational, Cross-sectional design, quantitative, lab-based visual detection task detecting the presence and absence of stimuli, and questionna	Sensory	Visual detection task	Males and Females	Not Specified	1. HSP Scale (Aron & Aron, 1997) 2. German version of the NEO PI-r (Costa & McCrae, 1992; German version, Ostendorf & Angleitner, 2004) 3. Perceived Stress Questionnaire (Levenstein,	SPS was found to predict performance on a visual detection task (both reaction times and error rates) and increased perceived stress. Only the LST subscale led to	SPS	****

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						and correctly using a larger sample size, and to use a behavioural task that allowed for differentiation between reaction times and error rates.	ire completion.					Prantera, Varvo, & Scribano, 1993) using the German version by Fliege, Rose, Arck, Levenstein, and Klapp (2001) 4. Visual detection task was assessed in analogy to a task used by Dukewich and Klein (2009)	these results however. Results were independent of Big-5. Individuals high in SPS perceived more stress after taking the test than individuals low in SPS.		
Sobocko, K.	2012	The relationship between ego-depletion and sensory processing sensitivity	College Thesis/Dissertation	N/A	Canada	To assess whether continuous self-regulation among people showing higher levels of sensitivity accelerates states of ego-depletion , in turn	Experimental, cross-sectional design, quantitative, lab-based questionnaires and ego depletion task consisting of clerical task highlightin	Sensory	Exposure to noise similar to that of a busy I or restaurant	Males and Females	Adults (18+)	1. Demographics 2. BIS/BAS scales (Carver & White, 1994) 3. Amended Eysenck Personality Questionnaire (Eysenck, Eysenck, & Barrett, 1985) 4. Big Five	No significant difference found between participants in cognitive performance in noise vs control. This indicates the impact of the environme	SPS	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						explaining poor cognitive and social performances. To show SPS is distinct from yet related to neuroticism and introversion.	g letters in piece of text with rules as to what can be highlighted with unpredictable soundtrack playing					Inventory (BFI; John & Srivastava, 1999) 5. Highly Sensitive People Scale (HSPS; Aron & Aron, 1997). 6. The computerized Stroop (1935) task 7. Positive Affect Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) 8. e Subjective Vitality Scale (Bostic, Rubio, & Hood, 2000; Ryan & Frederick, 1997) 9. The Effort Scale 4-item	ntal stimulus was not affected by SPS. Though results null, more sensitive participants showed slowest response time in Stroop task.		

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												m (Gallagher et al., 2011)			
Gearhart, C.G.	2014	Sensory-Processing Sensitivity and Nonverbal Decoding: The Effect on Listening Ability and Accuracy	Peer reviewed Journal article	International Journal of Listening	USA	To investigate the multiple effects of SPS on nonverbal decoding. Specifically, on identifying emotions from paralinguistic cues.	Experimental, cross-sectional design, quantitative, online questionnaires and lab-based nonverbal decoding test with follow up questionnaires	Multiple	Audio stimulation	Males and Females	Not Specified	1. HSPS (Aron & Aron, 1997) 2. Neuroticism (versus Emotional Stability) component of the Big Five Inventory (John et al., 1991) 3. Novel 12-item distraction items 4. Adult Paralanguage portion of the Diagnostic Analysis of Non-Verbal Accuracy-2	HSPs were found to be no worse or no better at recognizing vocal expressions of emotion than non-HSPs. This was regardless of whether they were exposed to conditions of stimulation or not. When neuroticism was controlled	SPS,Information processing	****

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												(DANVA-2-AP; Nowicki & Duke, 1994)	for, HSPs did not report being more distracted by moderate or high intensity audio stimulation than non-HSP counterparts.		
Booth, C., Standage, H., & Fox, E.	2015	Sensory-processing sensitivity moderates the association between childhood experiences and adult life satisfaction	Peer reviewed Journal article	Personality and Individual Differences	UK	To assess a continuous predictor and outcome variable, that is capable of differentiating positive and negative extremes. Assessing for possible plasticity effects for	Observational, Cross-sectional design, quantitative, online survey methods	Social	Childhood experiences with caregiver	Males and Females	Adults and Children	1. Satisfaction with Life Scale (SWLS; Diener et al., 1985) 2. HSPS (Aron & Aron, 1997) 3. Risky Families Questionnaire (RF-Q; Taylor et al., 2006)	Those scoring more highly in SPS were found to be more affected by negative childhood experiences than those scoring lowly in terms of adult life satisfaction levels.	Differential susceptibility	***

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						SPS's three factors. While using a heterogeneous adult community sample. Assess would SPS moderate association between current life satisfaction and childhood experiences.							No differential effects under positive childhood experiences were found for high or low SPS scorers. LST and EOE produced the same significant interaction.		
Pluess, M., & Boniwell, I.	2015	Sensory-Processing Sensitivity predicts treatment response to a school-based depression prevention program: Evidence	Peer reviewed Journal article	Personality and Individual Differences	UK	To investigate whether SPS moderates the efficacy of a school-based intervention aimed towards preventing	Experimental, Two-cohort treatment/control design, longitudinal design, quantitative, school-based intervention study using	Intervention	SPARK Resilience programme	Females	Children (0-17)	1. Demographics 2. Center for Epidemiologic Studies Depression scale (CESD) (Radloff, 1977) 3. 12-item child self-report	SPS was a significant predictor of treatment response. The intervention was successful in reducing depression in girls	SPS, Vantage sensitivity framework	****

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		of Vantage Sensitivity				depression.	survey methods					version (Pluess et al., in preparation) of the Highly Sensitive Person scale (HSP) (Aron & Aron, 1997) 4. Positive And Negative Affect Scales (PANAS) (Watson, 1988)	scoring highly in SPS, though not effective at all in those scoring lowly in SPS.		
Valojä ä, A.	2015	The effect of sensory-processing sensitivity on social preference for online interaction and associated outcome on psychological wellbeing	College Thesis/Dissertation	N/A	Finland	To investigate whether SPS can explain social preference for interacting online, and if the internet should be considered as a beneficial and alternative channel	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Internet	Males and Females	Adults and Children	1. Highly Sensitive Person Scale (HSPS) (Aron & Aron, 1997) 2. Shyness and Sociability Scales for Adults (Asendorpf, 1987 ; Asendorpf & Wilpers, 1998) 3. How many hours they spend in	No difference was found in the psychological wellbeing of those HSPs who preferred online interaction and those who preferred face-to-face interaction. When	SPS, Computer mediated communication	***

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						for communication for HSPs.						social interaction on an average day in their free time, both online and in face-to-face situations questions and degree to which preferred relationships are online 4. CORE-10 (Barkham et al., 2012)	comparing the psychological wellbeing in the HSPs who belonged to online and Face to face groups, no difference was found. HSPs were found to be somewhat more distressed than non-HSP counterparts.		

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Jagiellowicz, J., Aron, A., & Aron, E. N.	2016	Relationship between the temperament trait of sensory processing sensitivity and emotional reactivity	Peer reviewed Journal article	Social Behaviour and Personality	USA	To examine the greater subjective emotional responses to both negative and positive stimuli which is thought to be characteristic of SPS.	Experimental, cross-sectional design, quantitative, Lab-based RT task using IAPs pictures and questionnaires	Multiple	IAPS picture presentation /parenting environment from childhood	Males and Females	Not Specified	1. Standard pictorial Self-Assessment Manikin (SAM; Bradley & Lang, 2007) 2. The Highly Sensitive Person scale (HSP; Aron and Aron 1997) 3. Positive and Negative Affectivity Scales (Watson, Clark, & Tellegen, 1988) 4. Modified Life Experience Questionnaire (Canli et al., 2006) 5. 2-item Neuroticism measure 6. 2-item Social Extraversion measure	Those high in SPS tend to rate standard pictorial stimuli, and especially positive ones, as more intensely valanced, perhaps response more quickly than others, but do not differ in their rating of the level of arousal caused by the pictures. Evidence found for an interaction between SPS with quality of	SPS	****

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												7. Care and Overprotection subscales of the Parental Bonding Inventory (PBI: Parker, Tupling, & Brown, 1979) 8. Abuse subscale of the Measure of Parenting Style (Parker et al., 1997) 9. 8-item parenting scale (Aron et al., 2005)	parenting in predicting how they rated arousal, such that those high in SPS with high-quality parenting reported having greater arousal to positive pictures.		
Jaswetz, L.	2016	The Interaction between Sensory Processing Sensitivity and Childhood Environment on Social Anxiety	Peer reviewed Journal article	Student Undergraduate Research E-journal!	Netherlands	To answer the question of what are the combined effects and individual effects of SPS and childhood environment on	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Childhood environment	Males and Females	Not Specified	1. Highly Sensitive Person Scale (HSPS) (Aron & Aron, 1997), 2. Measurement of Parental Style (MOPS) (Parker et	No significant interaction effect found. Main effect of SPS on social anxiety found.	SPS	***

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						social anxiety.						al., 1997) 3. Liebowitz Social Anxiety Scale (LSAS) (Liebowitz, 1987) 4. Positive and Negative Affectivity Schedule (PANAS) (Watson, Clark, & Tellegen, 1988) 5. Social introversion four-item questionnaire devised by Aron and Aron (1997) and Aron et al. (2005)			
Meredith, P. J., Bailey, K. J., Strong, J., & Rappel, G.	2016	Adult Attachment, Sensory Processing, and Distress in Healthy Adults	Peer reviewed Journal article	The American Journal of Occupational Therapy	Australia	To gain understanding about the interrelation of adult attachment, sensory	Observational, Cross-sectional design, quantitative, Lab-based questionna	Sensory	Cold-pressor pain inducement task used to activate attachment system	Males and Females	Adults (18+)	1. Experiences in Close Relationships-Revised Questionnaire (ECR-R; Fraley, Waller, &	Attachment anxiety was related to sensory sensitivity as measured by the	Attachment theory	**** **

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						processing, and distress in healthy adults	ires and pain inducement task					Brennan, 2000) 2. Adolescent/ Adult Sensory Profile (AASP; Brown & Dunn, 2002) 3. Highly Sensitive Person Scale-Shortened Version (HSPS- SV; Aron et al., 2010) 4. Depression Anxiety Stress Scales 21 (DASS-21; Lovibond & Lovibond, 1995a, 1995b)	HSP-SV. This associated was not retained when controlling for stress, indicating the association was largely accounted for by stress. Sensory sensitivity as measured by HSP-SV was positively linked with distress.		

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Uljarević, M., Carrington, S., & Leekam, S.	2016	Brief Report: Effects of Sensory Sensitivity and Intolerance of Uncertainty on Anxiety in Mothers of Children with Autism Spectrum Disorder	Peer reviewed Journal article	Journal of Autism and Developmental Disorders	UK	Study aimed to further characterize the nature of the specific Sensory Sensitivity – Intolerance of Uncertainty-anxiety inter-relationship to determine whether the pattern was evident in a sample of adults.	Observational, Cross-sectional design, quantitative, survey methods	Relational	Parenting child with ASD diagnosis	Females	Adults (18+)	1. Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith 1983) 2. The Intolerance of Uncertainty Scale-12 (IU; Carleton et al. 2007) 3. The Highly Sensitive Person scale (HSP; Aron and Aron 1997)	A three-way inter-relationship between SPS, Intolerance of Uncertainty and anxiety was found. High sensitivity and a susceptibility to being overwhelmed by environmental stimulation may lead to an experience of the world as being highly unpredictable, which in turn could make even simple	SPS, Intolerance of Uncertainty	***

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													situations and events uncertain and difficult for the HSP, thus provoking anxiety.		
Rothenbucher, F. U.	2017	Sensory Processing Sensitivity and Attentional Bias - A Pilot Study	College Thesis/Dissertation	N/A	Belgium	Aimed to explore if HSPs and those scoring highly in SPS differ in the manner in which they attend to incoming visual stimuli.	Experimental, cross-sectional design, quantitative, Lab or home based experimental sessions with online survey	Sensory	Posner exogenous cueing task and cued attention task	Males and Females	Adults (18+)	1. Highly Sensitive Person Scale (HSPS, Aron & Aron, 1997) 2. Adult Temperament Questionnaire (ATQ; Rothbart, Ahadi, & Evans, 2000) 3. Four-Dimensional Symptom Questionnaire (4DSQ;	A significantly higher level so attentional engagement was found for the high SPS group for happy cues at the 100ms duration, which indicates a continuous direction of	Attentional bias research	****

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												Terluin, 1996) 4. Rejection Sensitivity Questionnaire (RSQ, Downey & Feldman, 1996) 5. Utrecht Burnout Scale (UBOS-A, Schaufeli & Dierendonck, 2000) 6. Reaction times in tasks	attention at the positive stimuli ad deeper processing of this material. High SPS participants had self-reported higher negative affect and lower levels of extraversion. They also diverted attention away from neutral cues at 100ms, possibly to precent sensory overload.		

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Stefan Lindsay, J.	2017	The highly sensitive teacher: Sensory-Processing Sensitivity, burnout, and self-efficacy in urban public school teachers	College Thesis/Dissertation	N/A	USA	To describe how teachers who may be highly sensitive interpreted professional stressors and cognitively appraised work events to develop successful coping skills, and to make clear successful coping strategies from teachers who may be highly sensitive and have committed to help others	Observational, cross-sectional design, Explanatory sequential mixed methods design, survey methods and interview and participant journal methods	Multiple	Teaching environment	Males and Females	Adults (18+)	1. Highly Sensitive Person Scale (HSP; 1996) 2. Maslach Burnout Inventory-Educators Survey (MBIES; 1986) 3. Teacher Stress Inventory (TSI; 1984) 4. Teachers' Sense of Efficacy Scale (TSES; 2001) 5. 3-item negative affectivity measure 6. New items targeting the work environment 7. New items targeting school leader support	SPS significantly and positively correlated with risk of burnout. However, stress fully mediated this relationship when introduced into this model. At increased risk of presenting with SPS, teachers tended to have a greater risk of burning out due to emotional exhaustion. They also reported experiencing more stress at work. Qualitative	Teacher self-efficacy and cognitive appraisal theory	****

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						who are highly sensitive sustain their profession.							results indicated time demands and colleagues as primary sources of stress, and both daily and systematic coping strategies were utilised.		
Andresen, M., Goldmann, P., & Volodina, A.	2018	Do Overwhelmed Expatriates Intend to Leave? The Effects of Sensory Processing Sensitivity, Stress, and Social Capital on Expatriates' Turnover Intention	Peer reviewed Journal article	European Management Review	Germany*	To explore the role of resources (such as SPS and social capital) in explaining the perceived stress of expatriates and their turnover intention.	Observational, Cross-sectional design, quantitative, online-survey methods	Multiple	Expatriation - working in a foreign country	Males and Females	Adults (18+)	1. HSP short form (11 questions)(Aron et al., 2010) 2. 3-itemscale of the Michigan Organizational Assessment Package (Nadler et al., 1975) 3. PSS-10 (Cohen and Williamson, 1988) 4. Adapted version of	Perceived stress fully mediated the effects of SPS and bonding social capital on expatriates' turnover intention. 26.4% of expatriates scored highly in SPS. Significant differences were found such	Hobfoll's (1989) conservation-of-resources (COR) theory	****

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												Bonding Social Capital subscale (Williams, 2006) 5. Neuroticism 3 item short scale (Aron & Aron, 1997) 6. Cultural distance measured according to the approach of Kogut and Singh (1988) using Hofstede et al.'s (2010) dimension scores	that 30.7% of organisational expatriates were highly sensitive compared to 19.3% of external expatriates.		
Campbell, T., & Moore, K.	2018	Sensory-processing sensitivity: A model to predict social anxiety	Poster Presentation	N/A	Australia*	To better understand the relationship between SPS and social anxiety through investigating relevant	Observational, Cross-sectional design, quantitative, online survey methods	Relational	Parenting environment	Males and Females	Adults (18+)	1. Highly sensitive person scale (Aron & Aron, 1997) 2. Deakin coping scale: avoidance subscale (Moore, 2003) 3. Parental	Those higher in SPS were found to be more prone to experiencing social anxiety than others. SPS also	SPS, Differential susceptibility	****

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						factors thought pertinent to the onset and maintenance of the relationship.						bonding instrument (Parker, Tupling, & Brown, 1979) 4. Social Phobia inventory (Moore & Gee, 2003)	associated with avoidant coping, irrespective of the quality of parental bond experienced in childhood.		
Lionetti, F., Aron, A., Aron, E. N., Burns, G. L., Jagiellowicz, J., & Pluess, M.	2018	Dandelions, tulips and orchids: evidence for the existence of low-sensitive, medium sensitive and high-sensitive individuals	Peer reviewed Journal article	Translational Psychiatry	USA & UK	<u>Study 2.</u> to investigate whether the detected groups in levels of SPS differ significantly regarding common personality traits and emotional reactivity.	Experimental (within-subjects design), cross-sectional, quantitative, using experimental mood induction task of happy and sad video clip and rating of mood pre and post	Sensory	Viewing happy and sad video clips	Males and Females	Adults (18+)	1. 12-item version of HSP scale (Pluess, 2013) 2. 50 items from international personality item pool (Goldberg, 1999) 3. Self-rated negative and positive emotional reactivity scores (0-100)	HSP mean score and EOE subscale were positively associated with positive emotional reactivity, and a marginally significant positive association between HSP and EOE subscale and negative emotional reactivity.	Environmental Sensitivity	****

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													Difference between three sensitivity groups in positive emotional reactivity approached significance, though groups did not differ significantly regarding negative emotional reactivity.		
Nocentini, A., Menesini, E., & Pluess, M.	2018	The Personality Trait of Environmental Sensitivity Predicts Children's Positive Response to School-Based Antibullying Intervention	Peer reviewed Journal article	Clinical Psychological Science	Italy	To test whether individual differences in environmental sensitivity predict treatment response to an antibullying intervention in a	Experimental, randomised-control design, longitudinal design, quantitative, school-based intervention study using survey methods	Intervention	KiVa antibullying programme	Males and Females	Children (0-17)	1. Florence Bullying-Victimization scales (Palladino, Nocentini, & Menesini, 2016) 2. HSC scale (Pluess et al., 2018) 3. Youth Self-Report (Achenbach, 1991)	Significant intervention effects on victimisation and internalising symptoms were moderated by HSC score and gender. Boys scoring	Environmental sensitivity	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						large, randomised control trial.							higher on HSC benefitted significantly more than lower scoring counterparts with reduced victimisation and internalising symptoms.		
Rubaltelli, E., Scrimin, S., Moscardino, U., Priolo, G., & Buodo, G.	2018	Media exposure to terrorism and people's risk perception: The role of environmental sensitivity and psychophysiological response to stress	Peer reviewed Journal article	British Journal of Psychology	Italy	To examine whether exposure to terrorism-related pictures interacted with individual differences in environmental sensitivity and psychophysiological response to stress in	Experimental, Cross-sectional design, quantitative, Lab based session where participants randomly assigned to terror-related or neutral pictures conditions	Sensory	Exposure to terror-related or neutral pictures and Manneheim multi-component stress task	Males and Females	Adults (18+)	1. Novel Perceived likelihood of terrorist attack questions 2. Novel trade off of privacy for security questions 3. PANAS (Watson, Clark, & Tellegen, 1988) 4. HRV 5. 12-item version of the HSPS (Aron &	Sensitivity and reactivity were not significantly correlated. Sensitivity and likelihood of attack were correlated such that those scoring higher in HSPS estimated future attacks	Risk-perception, environmental sensitivity	***

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						explaining people's risk perception.						Aron, 1997; Pluess, 2013)	were more likely. The relationship between HSPS score and experimental condition was not significant. Those scoring higher in HSPS in the terrorism-related pictures condition were more willing to trade off privacy than those in neutral condition.		
Scrimin, S., Osler, G., Pozzoli, T., & Moscardino, U.	2018	Early adversities, family support, and child well-being: The moderatin	Peer reviewed Journal article	Child: care, health and development	Italy	To investigate how adversities experienced by families and the supportive	Observational, Cross-sectional design, quantitative, Interview methods	Multiple	Early adversities in family environment e.g. death in family, discontent in relations	Males and Females	Adults and Children	1. Sociodemographic information 2. Stressful events checklist 3. Child Health and	HSCS score moderated the association between both family adversities	SPS	****

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		g role of environmental sensitivity				resources within the family itself are linked to children's perceptions about a number of factors. Namely; their own health status, their emotional wellbeing, as well as their academic and social performance. Furthermore looked at whether expected associations were moderated by the levels of environmental sensitivity						Illness Profile—Child Edition (CHIP-CE; Riley et al., 2004) 4. 12-item Highly Sensitive Child Scale (HSCS)(Pluess et al., 2018)	and supportive resources provided by families on children's physical comfort and their perceived academic and social performance.		

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						in the children.									
Slagt, M., Dubas, J. S., van Aken, M. A., Ellis, B. J., & Dekovi ́, M.	2018	Sensory processing sensitivity as a marker of differential susceptibility to parenting	Peer reviewed Journal article	Developmental Psychology	Netherlands	To compare SPS and negative emotionality as markers of individual differences in susceptibility to parenting among children.	Observational, Longitudinal design, quantitative, survey methods	Relational	Parenting environment	Males and Females	Adults and Children	1. Dutch version of the Strengths and Difficulties Questionnaire (Goodman, 2001; van Widenfelt, Goedhart, Treffers, & Goodman, 2003) 2. Over reactivity scale from the Parenting Scale (Prinzie, Onghena, & Hellinckx, 2007) 3. Power assertion scale from the Parenting Dimensions Inventory	SPS interacted with both changes in negative and positive parenting in predicting externalising, though not prosocial, behaviours. Sensitive children decreased the most in externalising behaviour when negative parenting decreased, but increased	Differential susceptibility	****

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												(Power, 1993) 4. Ignoring scale from the Nijmegen Parenting Questionnaire (Gerrits, Deković, Groenedaal, & Noom, 1996) 5. Inconsistent discipline from the Parenting Dimensions Inventory (Power, 1993) 6. Responsiveness scale from the Nijmegen Parenting Questionnaire (Gerrits et al., 1996) 7. Autonomy granting scale from the	in it the most when negative parenting increased. Likewise, sensitive children decreased the most in externalizing behaviour when high levels of positive parenting were maintained, however they increased the most in externalizing behaviour when positive parenting decreased. When receiving low levels of negative parenting,		

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
												Nijmegen Parenting Questionnaire (Gerrits et al., 1996) 8. Positive interactions scale from the Parenting Practices Scale (Strayhorn & Weidman, 1988) 9. Positive parenting scale from the Alabama Parenting Questionnaire (Essau, Sasagawa, & Frick, 2006) 10. Inductive discipline scale from the Parenting Dimensions Inventory (Power, 1993) 11. Dutch version of the Children's Behavior	sensitive children decreased in externalising behaviours more than less-sensitive counterparts. sensitive children had the lowest levels of externalizing behaviour when high levels of positive parenting were maintained, but similar levels when positive parenting decreased.		

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												Questionnaire—Short From (Putnam & Rothbart, 2006; Rothbart, Ahadi, Hershey, & Fisher, 2001) 12. Dutch parent-report version of the HSC (adapted from Pluess et al., 2017; Pluess & Boniwell, 2015)			

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Strand, J. F., Brown, V. A., Merchant, M. B., Brown, H. E., & Smith, J.	2018	Measuring Listening Effort: Convergent Validity, Sensitivity, and Links With Cognitive and Personality Measures	Peer reviewed Journal article	Journal of Speech, Language, and Hearing Research	USA	To evaluate the convergent validity and sensitivity of commonly used measures of Listening effort. To assess how scores on the tasks relate to cognitive and personality variables.	Observational, Cross-sectional, quantitative, Lab-based tasks measuring listening effort and cognitive ability, and questionnaires	Multiple	A number of lab-based tasks	Males and Females	Adults (18+)	1. Four questions from the original NASA-TLX 2. "how often did you give up on trying to perceive the speech?" on a 21-point scale 3. CDT 4. SDT 5. RM task was based on the methods of McCoy et al. (2005) 6. LS 7. CSCT based on the procedures used by Mishra et al. (2013a, 2013b) 8. NASA-TLX measures of LE 9. Pupillometry 10. Audiogram	Those with higher HSPS scores rated the tasks as more difficult and had slower CDT latencies. A marginally significant HSPS × Noise interaction was found, indicating that the relationship between HSPS score and CDT latency is stronger in the hard than in the easy condition. Individuals who score	Listening Effort, SPS	****

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												11. Rspan task (Conway et al., 2005; Daneman & Carpenter, 1980; Foo, Rudner, Rönnberg, & Lunner, 2007) 12. LM task used by Mishra et al. (2013a, 2013b; adapted from Miyake et al., 2000; Morris & Jones, 1990) 13. LDT based on Picou et al. (2013) 14. TRT test (Besser et al., 2013; Besser, Zekveld, Kramer, Rönnberg, & Festen, 2012; Mishra et al., 2013a, 2013b;	higher in SPS showed increased effort as measured by some LE tasks.		

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												Zekveld et al., 2007) 15. Simon task based on Mishra et al. (2013a, 2013b) 16. BFI-2 (Soto & John, 2017) 17. HSPS (Aron & Aron, 1997)			

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Su, X., Cai, R. Y., & Uljarević, M.	2018	Predictors of Mental Health in Chinese Parents of Children with Autism Spectrum Disorder (ASD)	Peer reviewed Journal article	Journal of Autism and Developmental Disorders	China	To explore the influence of different factors on the mental health of Chinese parents of children diagnosed with autism spectrum disorder (ASD). Namely; Intolerance of uncertainty, sensory sensitivity, broader autism phenotype, and the severity of the child's ASD symptoms and comorbid symptoms.	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Parenting a child with ASD diagnosis	Males and Females	Adults (18+)	1. The Depression Anxiety and Stress Scale (DASS-21; Lovibond and Lovibond 1995; Moussa et al. 2001) 2. The Autism Spectrum Quotient-Child 10 item version (AQ-10C; Allison et al. 2012) 3. Autism Spectrum Quotient-Adult 10 item version (AQ-10A; Alison et al. 2012) 4. The Strengths and difficulties questionnaire (SDQ; Goodman et al. 1998; Lai	Higher levels of parental sensory sensitivity were associated with higher DASS-21 total score. Sensory sensitivity had an indirect effect through intolerance of uncertainty on parental mental health.	Intolerance of uncertainty, SPS	***

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												et al. 2010) 5. The Intolerance of Uncertainty Scale-12 (IU; Carleton et al. 2007) 6. The Highly Sensitive Person scale (HSP; Aron and Aron 1997)			
Tillmann, T., El Matany, K., & Duttweiler, H.	2018	Measuring Environmental Sensitivity in Educational Contexts: A Validation Study With German-Speaking Students	Peer reviewed Journal article	Journal of Educational and Developmental Psychology	Germany	Study 2: Exploring relationship of newly developed German SPS scale for children with additional school related variables.	Observational, Cross-sectional design, quantitative, survey methods	Multiple	School environment	Males and Females	Children (0-17)	1. Novel 14-item measure of SPS 2. German scales on the Big Five personality traits openness, neuroticism, and extraversion –introversion (Rammstedt, 1997; English original: John, Donahue, & Kentle, 1991)	The highest positive significant correlation found between negative affect and the SPS sub-facet Overexcitability and the total SPS scale. Significant negative relationships between physical	SPS, Environmental sensitivity	****

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												3. Intrinsic interest in school (Steinmayr & Spinath, 2010) 4. Scientific interest (Hiesel & Lück, 1974) 5. School-related self-efficacy (Jerusalem & Satow, 1999) 6. Frequency of positive and negative affect during the last four weeks (Diener et al., 2010) 7. psychological well-being, physical well-being, and functional capacity in school (Ravens-Sieberer & Bullinger, 1998, 2000)	well-being, psychological well-being, functional capacity, and SPS.		

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												8. Report card grades			
Hjordt, L. V., & Stenbæk, D. S.	2019	Sensory processing sensitivity and its association with seasonal affective disorder	Peer reviewed Journal article	Psychiatry research	Denmark	To investigate the cross-seasonal group differences in trait SPS and the association between trait SPS in remitted phase, and depression	Quasi-experimental, Longitudinal seasonally counter-balanced design, quantitative, survey methods	Physical	Seasons - summer/winter	Males and Females	Adults (18+)	1. HSP Scale (Aron and Aron, 1997) 2. Major Depression Inventory (MDI; Bech et al., 2001) 3. Seasonal Pattern Affective Questionnaire (Rosenthal et al., 1987)	Participants with SAD exhibited higher scores on trait SPS compared to healthy controls in both summer and winter. Their scores on trait SPS	SPS	****

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						severity in symptomatic phase in those with Season.al Affective Disorder (SAD)							increase from summer to winter, i.e., individuals with SAD displayed a cross-seasonal pattern of high sensitivity. Higher trait SPS in summer was found to be associated with more severe SAD symptoms in winter.		
Holm, S. E. H., Hansen, B., Kvale, G., Eilertsen, T., Hagen, K., &	2019	Is sensory processing sensitivity related to treatment outcome in concentrated exposure and response	Peer reviewed Journal article	Journal of Obsessive-Compulsive and Related Disorders	Norway	To examine whether SPS affects treatment outcome in patients with OCD.	Outcome research, quantitative, Data from medical quality registry	Intervention	Bergen concentrated 4-day exposure treatment (B4DT)	Males and Females	Adults (18+)	1. Obsessive-Compulsive Inventory – Revised (OCI-R; Foa et al., 2002) 2. Yale–Brown Obsessive Compulsive Scale	No significant relationship between SPS and treatment outcome was found after controlling for pre-treatment	SPS, cognitive behavioural therapy	****

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Solem, S.		prevention treatment for obsessive-compulsive disorder?										(Goodman et al., 1989a; Goodman et al., 1989b) 3. Highly Sensitive Person Scale (HSPS; Aron & Aron, 1997) 4. Patient Health Questionnaire PHQ-9; (Spitzer, Kroenke, & Williams, 1999) 5. Generalized Anxiety Disorder 7-item scale GAD-7; (Spitzer, Kroenke, Williams, & Löwe, 2006)	levels of OCD, depression, and anxiety. HSPS scores were significantly reduced after treatment.		

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Karam, E. G., Fayyad, J. A., Farhat, C., Pluess, M., Haddad, Y. C., Tabet, C. C., ... & Kessler, R. C.	2019	Role of childhood adversities and environmental sensitivity in the development of post-traumatic stress disorder in war-exposed Syrian refugee children and adolescents	Peer reviewed Journal article	British Journal of Psychiatry	Lebanon	Aimed to evaluate the relative roles of war, childhood adversities and sensitivity in the development of PTSD.	Observational, Cross-sectional design, quantitative, survey methods	Multiple	Exposure to war environment	Males and Females	Children (0-17)	1. PTSD Reaction Index (PTSD-RI) for DSM-IV (Pynoos et al., 1998) 2. War exposure measured with checklist of 25-items 3. ISPCAN Child Abuse Screening Tools (ICAST) (17 items)(Runyan et al., 2009) 3. Novel adversities measure 4. Highly Sensitive Child Questionnaire (HSC)(Pluess et al., 2018)	While sensitivity was significantly related to PTSD, childhood adversities were the most important variable in predicting PTSD. The effect of war on PTSD was dependent on the interplay between adversities and sensitivity, and was most prominent in highly sensitive children with lower adversities levels, and less pronounced in those	Ecological framework	****

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													experiencing high adversities levels.		

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Lionetti, F., Aron, E. N., Aron, A., Klein, D. N., & Pluess, M.	2019	Observer-rated environmental sensitivity moderates children's response to parenting quality in early childhood	Peer reviewed Journal article	Developmental Psychology	USA	Developing an observational rating system of environmental sensitivity suitable for pre-schoolers, and testing whether this predicts individual differences in response to negative and positive parenting aspects.	Longitudinal design, quantitative, based on data from Stony Brook Temperament study	Relational	Parenting environment	Males and Females	Childr en (0-17)	1. adapted version of the Laboratory Temperament Assessment Battery (Lab-TAB) (Goldsmith et al., 1999) 2. Parenting Styles and Dimensions Questionnaire (PSDQ) (Robinson, Mandleco, Olsen, & Hart, 2001) 3. Child Behavior Checklist (CBCL) 1½−5/4-18 (Achenbach, 2009) 4. Vineland Adaptive Behavior Screener socialization subscale (Sparrow, Balla, Cicchetti, Harrison, &	Children who scored highly in the HSC-RS were more affected by the influence of parenting quality compared to those scoring low. Children in the high sensitive group were found to be more sensitive to negative influences of high levels of permissive parenting when considering externalizing	Environmental sensitivity	**** **

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												Doll, 1984) 5. children's social competence measured using a 7-item questionnaire developed by Eisenberg and associates (1993) 6. Novel Highly Sensitive Child Rating-System (HSC-RS)	behaviour problems aged three and internalizing behaviour problems aged 3 and 6. The were also more sensitive to positive effects of high levels of authoritative parenting in predicting social competence at aged 3 and 6 . Those scoring low in sensitivity were generally less sensitive to the influence		

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													of parenting.		

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Slagt, M., Dubas, J. S., Ellis, B. J., Van Aken, M. A., & Deković, M.	2019	Linking emotional reactivity "for better and for worse" to differential susceptibility to parenting among kindergartners	Peer reviewed Journal article	Development and psychopathology	Netherlands	To investigate whether children who show stronger immediate reactions to their mothers during observed parent–child interactions are those whose development across one year is more strongly predicted by parenting at the beginning of that year.	Observational, Longitudinal design, quantitative, observation and survey methods	Multiple	Parenting	Males and Females	Adults and Children	1. Two 5-min situations were coded using the Relationship Affect Coding System (Peterson, Winter, Jabson, & Dishion, 2008) 2. Dutch version of the Strengths and Difficulties Questionnaire (Goodman, 2001; van Widenfelt, Goedhart, Treffers, & Goodman, 2003) 3. Over reactivity scale from the Parenting Scale (Prinzie, Onghena, & Hellinckx, 2007)	SPS was related to neither externalising nor prosocial behaviour. Highly Reactive children did not score more highly on SPS than other children. Authors suggest it may be unlikely for children who are identified as susceptible for better and for worse using SPS to be the same ones who are also reactive for better	Differential susceptibility	****

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												4. The Power assertion scale from the Parenting Dimensions Inventory (Power, 1993) 5. The Ignoring scale from the Nijmegen Parenting Questionnaire (Gerrits, Dekovic´, Groenedaal, & Noom, 1996) 6. Inconsistent discipline from the Parenting Dimensions Inventory (Power, 1993) 7. The Responsiveness scale from the Nijmegen Parenting Questionnair	and for worse within parent–child interactions.		

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												e (Gerrits et al., 1996) 8. The Autonomy granting scale from the Nijmegen Parenting Questionnaire (Gerrits et al., 1996) 9. The Positive interactions scale from the Parenting Practices Scale (Strayhorn & Weidman, 1988) 10. The Positive parenting scale from the Alabama Parenting Questionnaire (Essau, Sasagawa, & Frick, 2006) 11. Inductive discipline scale from the Parenting			

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
												Dimensions Inventory (Power, 1993) 12. Dutch version of the Children's Behavior Questionnaire—Short Form (Putnam & Rothbart, 2006; Rothbart, Ahadi, Hershey, & Fisher, 2001) 13. Dutch 12-item parent-report version (adapted from Pluess & Boniwell, 2015; Pluess et al., 2018)			

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Tillmann, T.	2019	Sensory-processing sensitivity in the context of the teaching profession and its demands	College Thesis/Dissertation	N/A	Germany	To differentiate SPS from other variables of psychological wellbeing. To examine whether highly sensitive teachers perceived characteristics of their professional lives in a different way than non-highly sensitive counterparts, and how SPS relates to perceived stress. Examine how SPS relates to different	Observational, Cross-sectional design, quantitative, using in person and online questionnaires	Multiple	Teaching environment	Males and Females	Adults (18+)	1. German HSPS (based on Aron & Aron, 1997) 2. German scale measuring general self-efficacy, (Jerusalem & Schwarzer, 1999) 3. Novel dysfunctional cognitions scale 4. Coping Strategies scale (Lehr et al., 2008) 5. German version of the Depression Anxiety and Stress Scale (DASS-21; Nilges & Essau, 2015) 6. Beck Depression Inventory II (Beck, Steer, & Brown,	Highly sensitive teachers, while more attuned to students in need, do not demonstrate enhanced processing in teaching related aspects. SPS can explain the relationship between some work characteristics and perceived stress through coping and cognitive processes. SPS was found to relate to teachers depression, anxiety, and some	SPS	****

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						symptoms of mental disorders. Explore how highly sensitive teachers differ among each other in SPS and other variables, and if an overarching model of teacher stress including SPS be supported.						1996) 7. Trierer Kurzskala zur Messung von work-life-balance (English translation: The Trier Short Scale for Measuring Work-Life-Balance; Syrek et al., 2011) 8. Measurement of teacher collaboration developed by Fussangel and colleagues (e.g., Fussangel, 2008; Fussangel & Gräsel, 2012) 9. Characteristics of the teaching profession (T. Tillmann,	psychosomatic disorders. Teachers who were highly sensitive benefited more from therapeutic interventions than non-highly sensitive counterparts. SPS can contribute significantly to development of stress in teachers.		

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												Weiß, Hillert, & Kiel, 2019) 10. Novel scale with nine items measuring teachers' perceptions of other peoples' expectations toward themselves in their everyday work life 11. Novel scale measuring teachers' perceived performance in their professional work life 12. Two novel subscales of SPS relating to Attunement to students and Deeper processing 13.German			

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												translation of the PHQ (Löwe, Spitzer, Zipfel, & Herzog, 2002) 14. Global Assessment of Functioning (GAF) 15. Clinical Global Impression (CGI; Guy, 1976) 16. Brief Symptom Inventory (Franke, 2000) 17. Additional clinical data 18.			
Vander Elst, T., Sercu, M., Van den Broeck, A., Van	2019	Who is more susceptible to job stressors and resources? Sensory-processing sensitivity	Peer reviewed Journal article	PloS one	Belgium	Investigate assumptions that those with higher or lower levels of SPS develop	Observational, Cross-sectional, quantitative, survey methods	Multiple	Work environment	Males and Females	Not Specified	1. Scales from the Short Inventory to Monitor Psychosocial Hazards (SIMPH; Notelaers et al., 2007)	EOE and LST were found to amplify the relationship between job demands and	SPS, Job Demands - Resources model (JD-R model; Bakker &	****

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Hoof, E., Baillien, E., & Godderis, L.		as a personal resource and vulnerability factor				differential susceptibility for the work environment, which is characterised by demands of the job and resources.						2. Task autonomy measured using four items from Baillien et al. (2011) 3. Five-item subscale of the Utrecht Burnout Scale (UBOS-A; Schaufeli & Van Dierendonck, 2000) 4. Helping behaviour measured by the seven-item subscale (Podsakoff et al., 1997) 5. 23 items from the Highly Sensitive Person Scale (Aron & Aron, 1997) 6. Demographics	emotional exhaustion.	Demerouti, 2007)	

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Yano, K., Kase, T., & Oishi, K.	2019	The effects of sensory-processing sensitivity and sense of coherence on depressive symptoms in university students	Peer reviewed Journal article	Health psychology open	Japan	To investigate the associations of SPS, sense of coherence, and the interaction between these and depressive symptoms in university students.	Observational, Cross-sectional design, quantitative, survey methods	Multiple	University environment	Males and Females	Not Specified	1. HSPS (Takahashi, 2016) 2. 13-item Sense of Coherence Scale (SOC-13;Yamazaki, 1999) 3. Japanese version of Center for Epidemiologic Studies Depression Scale (CES-D; Shima et al., 1985) 4. Japanese version of Ten Item Personality Inventory (TIPI-J; Oshio et al., 2012)	Strong Sense Of Coherence prevented high-SPS students from experiencing over-arousability and dysfunctional cognition, and consequently decreased the severity of depressive symptoms.	SPS, Sense of coherence	****
Amemiya, R., Takahashi, G., Rakwal, R., Kahata, M., Isono, K., &	2020	Effects of yoga in a physical education course on attention control and mental health	Peer reviewed Journal article	Cogent Psychology	Japan	To examine the impact of yoga on mood states and attentional control in graduate students	Quasi experimental, Pre-post design, longitudinal design, quantitative, using	Multiple	Yoga course	Males and Females	Adults (18+)	1. Japanese version of the Highly Sensitive Person Scale-19 (HSPS-J19; Takahashi, 2016) 2. Japanese	Students higher in SPS had lower Attentional Control and higher negative mood states	SPS	**

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Sakairi, Y.		among graduate students with high sensory processing sensitivity				with varying levels of SPS in a physical education course setting.	group survey methods					version of the Effortful Control Scale for Adults (Yamagata et al., 2005) 3. Profile of Mood States, 2nd Edition, short form (POMS2) (Heuchert & McNair, 2012)	before the course, however, a significant improvement in scores was observed. Differences between the two groups after the yoga course were not statistically significant. A positive correlation was found between SPS and variation in AC, however, a negative correlation was found between variation in AC and mood states.		

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Baldwin, E. D.	2020	The Relationship Between Viewing ASMR Videos and Affect in College Students with Sensory Sensitivity	College Thesis/Dissertation	N/A	USA	To examine if in college students with high SPS, there is a relationship between watching ASMR videos and change in emotional response.	Quasi-Experimental design, Pre-post test, quantitative, online study	Sensory	Viewing ASMR videos/non ASMR controls	Males and Females	Adults (18+)	1. Demographics 2. The Highly Sensitive Person Scale (HSPS) (Aron & Aron, 1997) 3. The Multi-Affect Indicator (MAI) (Warr, 2014	Negative affectivity was not correlated with high SPS. Increase in positive affect between pre and post test when viewing no voice control video in high SPS participants. Data did not support the hypothesis of significant improved positive affect after watching ASMR type videos. Decrease in negative affect	SPS,ASMR	**

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													found after watching ASMR videos and control video.		
Black, B. A., & Kern, M. L.	2020	A qualitative exploration of individual differences in wellbeing for highly sensitive individuals	Peer reviewed Journal article	Palgrave Communications	Australia	To investigate how those high in SPS who live within an extravert-dominant social context conceive of and experience wellbeing.	Observational, cross-sectional, Qualitative, interview methods	Multiple	Extravert-dominant social context	Males and Females	Adults (18+)	1. Highly Sensitive Person Scale (HSPS; Aron and Aron, 1997) 2. PERMA-Profiler (Butler and Kern, 2016) 3. Self-acceptance, autonomy, and personal growth sub-scales from the Psychological Wellbeing scales (PWB; Ryff and Singer, 1996) 4. Semi-structured questionnair	HSPs perceive wellbeing arises from harmony across different dimensions. A number of valued practices were noted for wellbeing; self-acceptance, having positive social relationships but this being balanced by times	Idiographic	**** **

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												e with 13 prompts	of solitude, connecting with nature, contemplative practices, emotional self-regulation, practicing self-compassion. Emotional experiences were also valued; low-intensity positive emotion, self-awareness, having a sense of meaning, and hope/optimism. Barriers to wellbeing were identified as physical		

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													health issues and saying no to others.		

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Carr, M., Summers, R., Bradshaw, C., Newton, C., Ellis, L., Johnston, E., & Blagrove, M.	2020	Frontal Brain Activity and Subjective Arousal During Emotional Picture Viewing in Nightmare Sufferers	Peer reviewed Journal article	Frontiers in Neuroscience	UK*	Aimed to contrast predictions of diathesis-stress and differential susceptibility frameworks by assessing nightmare sufferers on a range of questionnaire, dream diary, task and neuroimaging measures.	Observational, initial measures of longer intervention study, quantitative, Lab-based task and physiological measures, questionnaires and home-based dream diary	Sensory	Emotional Picture Viewing	Males and Females	Adults (18+)	1. Near-Infrared Spectroscopy data 2. Image Task: the Nencki Affective Picture System (NAPS) database of emotional imagery (Marchewka et al., 2013) 3. Warwick-Edinburgh Mental Well-being Scale (StewartBrown and Janmohamed, 2008) 4. Dream Lucidity Questionnaire (DLQ; Stumbrys et al., 2013) 5. Mannheim Dream Questionnaire (MADRE; Schredl et al., 2014)	Nightmare sufferers scored more highly on the HSPS than control participants.	Diathesis-stress, Differential susceptibility	****

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												6. Interpersonal Reactivity Index (IRI; Davis, 1980) 7. Highly Sensitive Person Scale (HSPS; Aron and Aron, 1997) 8. Dream Diary			

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Fikkers, K. M., & Piotrowski, J. T.	2020	Content and person effects in media research: Studying differences in cognitive, emotional, and arousal responses to media content	Peer reviewed Journal article	Media Psychology	Netherlands	To explore individual differences in responses to media through investigating how four theoretically relevant variables (including SPS) affect responses t positively and negatively valanced media entertainment.	Experimental (within-subjects design), cross-sectional design, quantitative, child watches video-clips and answers questions, physiological measurements taken/parent completes questionnaire on child	Social	Viewing positive and negative media video clips	Males and Females	Adults and Children	1. Self reported cognitive responses to clips based on Solomon (1984) 2. Valence dimension of the Self-Assessment Manikin (Bradley & Lang, 1994) 3. 5 items from the PANAS (PANAS, Ebesutani et al., 2012; Watson, Clark, & Tellegen, 1988) 4. Self report arousal levels from Arousal dimension of the Self-Assessment Manikin (Bradley & Lang, 1994) 5. Children's tonic heart	Results showed that more variation in responses to media was due to differences between the participants rather than difference between stimuli, however SPS did not significantly explain this between-participant variation as a predictor or moderator.	Models of interactions between content and person e.g. Differential Susceptibility to Media effects model	****

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												rate and skin conductance level 6. Need for cognition scale (Preckel, 2014; Zarouali, Walrave, Poels, Ponnet, & Vanwesenbeeck, 2016) 7. Surgency subscale from Dutch parent-report Early Adolescent Temperament Questionnaire-Revised (Hartman & Rothbart, 2001) 8. Sympathy subscale of Adolescent Measure of Empathy and Sympathy (Vossen et al., 2015) 9. Parent-			

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												report version of the Highly Sensitive Person Scale - short form (Pluess & Boniwell, 2015) 10. Demographics 11. Familiarity with the media 12. Parent-reported general and violent TV exposure of child			
Goldberg, A., & Scharf, M.	2020	How do highly sensitive persons parent their adolescent	Peer reviewed Journal article	Journal of Social and Personal Relationships	Israel	To examine parenting practices regarding adolescent children	Observational, Cross-sectional design, quantitative,	Relational	Parenting environment	Males and Females	Adults and Children	1. Demographics and background information 2. The HSPS (Aron &	Attachment anxiety was postiviely associated to SPS. Attachmen	Attachment theory	****

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		children? The role of sensory processing sensitivity in parenting practices				of parents high in SPS. To examine whether attachment insecurity mediated this relationship.	using survey methods					Aron, 1997) 3. Experiences in Close Relationships Scale (ECRS) (Brennan et al., 1998) 4. Weinberger Parenting Inventory (WPI) (Weinberger et al., 1989)	t anxiety mediated the relationship between parents' SPS levels and harsh parenting, and partially mediated the relationship between parents' SPS levels and use of psychological intrusiveness.		
Iimura, S., & Kibe, C.	2020	Highly sensitive adolescent benefits in positive school transitions: Evidence for vantage sensitivity in Japanese	Peer reviewed Journal article	Developmental Psychology	Japan	Aims to clarify the mechanism of adolescents' differential adjustments. Investigates the role of SPS using the	Observational, Longitudinal design, quantitative, survey methods	Multiple	Transition to high school environment	Males and Females	Children (0-17)	1. J-HSCS (Kibe & Hirano, 2019) 2. Japanese version of the Positive and Negative Affect Schedule (PANAS-J; Sato & Yasuda, 2001)	Adolescents higher in SPS reported a greater increase in their well-being after the transition to high school, corresponding to their	Environmental Sensitivity	****

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		high-schoolers				Japanese version of Highly Sensitive Child Scale for Adolescence (J-HSCS), and tests whether the diathesis-stress model or the differential susceptibility model best describes the socioemotional adjustment of students across the transition to high school.						3. Japanese version of the BIS/BAS scales (Takahashi et al., 2007) 4. Perceived Change in School Environment scale (PCSE) 5. Japanese version of the World Health Organization's Five Well-Being Index (WHO-5-J; Awata et al., 2007)	perceived environmental change, whilst low sensitivity peers did not show such well-being enhancement. Evidence found for vantage sensitivity over diathesis-stress or differential susceptibility models.		

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Kibe, C., Suzuki, M., Hirano, M., & Boniwell, I.	2020	Sensory processing sensitivity and culturally modified resilience education: Differential susceptibility in Japanese adolescents	Peer reviewed Journal article	PloS one	Japan	To develop a culturally suitable intervention in prevention and evaluate it's efficacy, and to investigate moderation effects of SPS and gender of Japanese young people's wellbeing from a diathesis stress perspective.	Experimental, cross-sectional/longitudinal design, quantitative, intervention programme with pre and post surveys	Intervention	Modified version of the SPARK resilience program	Males and Females	Children (0-17)	1. Rosenberg Self-Esteem Scale (Rosenberg, 1965; Sakurai, 2000) 2. General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995; Ito et al., 2005) 3. Bidimensional Resilience Scale (Hirano, 2010) 4. Birleson Depression Self-Rating Scale for Children (Birleson, 1981) 5. Japanese version of the Highly Sensitive Child Scale for Adolescence (J-HSCS)	Student scoring higher in SPS, who scored significantly lower in wellbeing than counterparts at baseline, responded more positively to the intervention, and had greater levels of reduction in depression and more promotion of self-esteem.	Differential susceptibility	*****

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												(Kibe & Hirano, 2019)			
Meyerson, J., Gelkopf, M., Eli, I., & Uziel, N.	2020	Burnout and professional quality of life among Israeli dentists: the role of sensory processing sensitivity	Peer reviewed Journal article	International Dental Journal	Israel	Analyse the influence of SPS on burnout and professional quality of life in Israeli dentists.	Observational, Cross-sectional design, quantitative, survey methods	Multiple	Work as dentist in Israel	Males and Females	Adults (18+)	1. Demographic data and professional profile questionnaire 2. Hebrew version of the ProQOL-5 questionnaire (Stamm, 2010) 3. Highly Sensitive Person (HSP) scale (Aron & Aron, 1997)	Found that burnout can be predicted by the three aspects of SPS (ease of excitation, low sensory threshold and aesthetic sensitivity). These also predicted dentists satisfaction at work. Positive correlation between	SPS, Occupational health	****

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													SPS and secondary traumatic stress. EOE and LST but not AES predicted dentists' reactions to patient's stress and trauma.		
Onursal Özer, B.	2020	The relationship between perceived parental rejection and internalizing behaviours: moderating role of sensory processing sensitivity and gender	College Thesis/Dissertation	N/A	Turkey	To investigate the association between internalizing behaviours and perceived maternal and paternal rejection. To test whether this association is moderated by SPS and further	Observational, Cross-sectional design, quantitative, survey methods	Relational	Parenting environment	Males and Females	Adults and Children	1. Parental Acceptance/ Rejection Scale (Child Report) (Rohmer & Khaleque, 2005) 2. Turkish version of Highly Sensitive Child Scale (Mother Report) developed by Aron (2002) 3. Revised version of Child Behavior Checklist developed by	Higher levels of SPS predicted higher levels of internalizing problems when controlling for parental rejection, however this effect was not there when interaction between SPS and gender	Environmental Sensitivity, Parental Acceptance – Rejection Theory (PARTheory, contemporarily called IPARTheory)	****

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						moderated by child's gender.						Achenbach (1991) and adapted to Turkish by Dümenci et al. (2004) 4. Demographics	was included in the model. highly sensitive girls were more inclined to experience internalizing problems.		
Pernot, L.	2020	The evolution of depression among students: Evidence for the mismatch hypothesis and the influence of sensory processing sensitivity	College Thesis/Dissertation	N/A	Netherlands	To examine if depression can be explained by the amount of mismatch factors and if SPS plays a role in this relationship. To gain more understanding about the onset of student depression, considering SPS and	Observational, Cross-sectional design, Mixed-methods, survey methods and interview methods	Multiple	University environment	Males and Females	Adults and Children	1. Dutch translated version of the University Student Depression Inventory (USDI; Khawaja & Bryden, 2006) 2. Novel mismatch questionnaire 3. Dutch translation of the Highly Sensitive Person Scale (HSPS, Aron & Aron,	SPS was found to have a moderating effect on the positive correlation between mismatch factors and depression. SPS was found to correlate with mismatch factors, depression, and neuroticism. In the interviews,	SPS, Evolutionary mismatch hypothesis	****

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						the timeline of mismatch factors.						1997) 4. Quick Big Five (QBF; Vermulst & Gerris, 2005) 5. Questions around level of education 6. Questions around health status	HSPs noted their sensitivity to environmental stimuli, feeling different compared to others, and having more difficulty coping with mismatch factors in their daily life.		
Pluess, M., Lionetti, F., Aron, E. N., & Aron, A.	2020	People Differ in their Sensitivity to the Environment: An Integrated Theory and Empirical Evidence	Preprint Journal Article	PsyArXiv	UK	Study 3: To test individual differences in sensitivity to negative experiences. Study 4: To test individual differences in response	Study 3: Experimental, longitudinal design, quantitative, online survey methods Study 4: Experimental, cross-sectional design, quantitative, lab-	Multiple	Study 3: Teaching environment as a teacher-trainee Study 4: Exposure to mood induction video.	Males and Females	Adults (18+)	Study 3: 1. Novel HSP-12 2. Mental Health Continuum Short Form (MHC-SF) (Keyes, 2002) Study 4: 1. Novel HSP-12 2. Positive mood measured	Study 3: HSP-12 was a significant predictor of changes in well-being across 10 months, with teacher trainees who were more sensitive	Environmental sensitivity	Study 3: *** Study 4: ****

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						to positive experiences.	based surveys and tasks including mood induction experiment					using Visual Analogue Scale	showing a significant decline in well-being followed by a full recover. Those low in sensitivity appeared unaffected by the experience. Study 4: HSP-12 score significantly moderated short-term effects of positive mood induction using video clip on pre-post changes in positive mood. Change in positive mood was		

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													more pronounced in the high sensitivity group.		
Redfearn, R. A., van Ittersum, K. W., & Stenmark, C. K.	2020	The Impact of Sensory Processing Sensitivity on Stress and Burnout in Nurses	Peer reviewed Journal article	International Journal of Stress Management	USA	To explore major nursing stressors and burnout levels in nurses that are considered highly sensitive by nature compared to their less sensitive peers.	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Working in nursing currently in the USA	Males and Females	Adults (18+)	1. Demographics 2. BFI-2-S (Soto & John, 2017) 3. Shortened version of the HSPS 4. Nursing Stress Scale (Gray-Toft & Anderson, 1981) 5. Maslach Burnout Inventory for Medical Personnel Survey (MBI-HSS)	SPS was found to correlate overall with nursing stress, burnout, five nursing subscales of stress, and two subscales of burnout. SPS was shown to be a predictor for overall nursing stress, overall burnout, of	SPS, Occupational health	****

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													two nursing stress subdimensions, and one burnout subdimension.		
Rigby, S. N., Jakobson, L. S., Pearson, P. M., & Stoesz, B. M.	2020	Alexithymia and the Evaluation of Emotionally Valenced Scenes	Peer reviewed Journal article	Frontiers in Psychology	Canada	Investigate the links between alexithymia and the evaluation of emotional scenes, and whether viewer's evaluations of these scenes were better predicted by specific alexythymic traits or individual differences in SPS.	Observational, Cross-sectional design, quantitative, Lab-based experimental emotional scenes task where participants make speeded judgments of whether photographs obtained from the IAPS pleasant or unpleasant, and complete	Sensory	Emotional scenes task	Males and Females	Adults (18+)	1. Positive and Negative Affect Schedule – Short Form (PANAS; Thompson, 2007) 2. Edinburgh Handedness Inventory (Oldfield, 1971) 3. TAS-20 (Bagby et al., 1994) 4. HSPS (Aron & Aron, 1997) 5. Rating IAPS photographs are pleasant/unpleasant	Strong positive correlations were observed between difficulties identifying and describing feelings scores and scores on the EOE subscale of the HSPS. Authors suggest this indicates that problems with emotional appraisal	SPS, Alexithymia	****

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							questionnaires						are most evident in those who are easily overwhelmed by busy sensory environments. EOE was a negative predictor of accuracy in classification of positive scenes.		
Bordarie, Jimmy; Aguerre, Colette; Bolteau, Laëtitia	2021	A longitudinal approach of lockdown effects on quality of life and the expression of anxiety-depressive disorders according	Peer reviewed Journal article	Psychology, Health & Medicine	France	Investigate the effects of confinement using a longitudinal reflection framework on quality of life and anxiety/depressive symptoms in	Observational, Longitudinal design, quantitative, online survey methods	Multiple	Confinement during COVID-19 pandemic	Males and Females	Adults (18+)	1. French version of the Highly Sensitive Person Scale (HSPS-FR) (Bordarie, Aguerre & Bolteau, coming) 2. French version of the WHOQOL-BREF 3. Hospital	SPS related to levels of anxiety and depression, with depression increasing with higher levels of SPS. For those with average SPS,	SPS	**

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		to sensory processing sensitivity				individuals with different levels of SPS.						Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983)	lockdown had a significant positive effect in reducing anxiety disorders. In terms of quality of life, lockdown appeared to play a positive role for entire sample regardless of SPS level.		
Hellwig, S., & Roth, M.	2021	Conceptual ambiguities and measurement issues in sensory processing sensitivity	Peer reviewed Journal article	Journal of Research in Personality	Germany	Study 2: To test if SPS is an ability to process sensory information.	Observational, Cross-sectional design, quantitative, lab-based survey and emotion recognition test consisting of audio-video clips	Multiple	Geneva Emotion Recognition Test (GERT; Schlegel et al., 2014)	Males and Females	Adults and Children	1. HSPS (Konrad & Herzberg, 2019) 2. NEO-FFI (Borkenau & Ostendorf, 2008) 3. Geneva Emotion Recognition Test (GERT; Schlegel et al., 2014)	Any potential relation between the factors of SPS and emotional recognition ability can be fully explained by the Big-5 personality	SPS, Big 5 personality framework	***

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							of an actor expressing a particular emotion while uttering a pseudo linguistic sentence						traits. LST was found to be unrelated to emotional recognition ability.		
Iimura, S.	2021	Highly sensitive adolescents: The relationship between weekly life events and weekly socioemotional well-being	Peer reviewed Journal article	British Journal of Psychology	Japan	Aims to to provide new evidence on whether adolescent's SPS moderates the relationship between current life events and current socioemotional well-being and what shape of interaction SPS and current life events exhibits.	Observational, Longitudinal design, quantitative, survey methods	Multiple	Current life environment	Males and Females	Not Specified	1. Japanese version of the Highly Sensitive Child Scale for adolescence (J-HSCS)(Kibe & Hirano, 2019) 2. Based on Pluess et al. (2010), students were asked to answer questions about two striking events they had experienced during the past week; their two most	Adolescents with high SPS were more likely to be affected by both negative and positive life events, which resulted in an increase in their socioemotional well-being. However, their SPS functioned as vulnerability when they	Environmental Sensitivity	****

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												memorable events, and the subjective positive or negative impact of these events 3. 5-item Japanese version of the World Health Organization ’s five-item Well-Being Index (WHO-5; Awata et al., 2007)	experienced many negative life events. Lower SPS adolescents showed resilience regardless of the quality of their life events.		
Lionetti, F., Klein, D. N., Pastore, M., Aron, E. N., Aron, A., & Pluess, M.	2021	The role of environmental sensitivity in the development of rumination and depressive symptoms in childhood: a	Peer reviewed Journal article	European Child & Adolescent Psychiatry	USA	Investigate the interactions between early parenting styles and children's ES on symptoms of rumination and depression in middle childhood	Observational, Longitudinal design, quantitative, data from stony brook temperament study	Multiple	Early parenting environment	Males and Females	Adults and Childrden	1. Highly sensitive child-rating system (HSC-RS; Lionetti et al., 2019) 2. Parenting styles and dimensions questionnaire (PSDQ; Robinson et al., 2001) 3. Ruminative	Children's sensitivity interacted with permissive parenting to predict rumination at age 9, which in turn predicted higher levels of depression.	Environmental Sensitivity	****

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		longitudinal study				and early adolescence.						response subscale from the child response styles questionnaire (CRSQ-Rumination; Abela et al., 2002) 4. Children's depression inventory (CDI; Kovacs, 1992)			
Lionetti, Spinelli, Moscardino, Ponzetti, Garito, Dellagiulia, Aureli, Fasolo, & Pluess	2021	The interplay between parenting and environmental sensitivity in the prediction of children's externalizing and internalizing behaviours during	Preprint Journal Article	Development and psychopathology	Italy	Study 2: Explore changes in externalising and internalising behaviours in children during the COVID-19 pandemic.	Study 2: Observational, longitudinal design, quantitative part of ongoing project using survey methods	Relational	Parenting environment during COVID-19 Pandemic	Males and Females	Adults and Children	1. 12-item HSC scale (Pluess et al., 2018) 2. Brief version of the PSC was used (Gardner et al., 1999) 3. Closeness subscale of the Parent–child Relationship Scale (Pianta, 1992),	High levels of parent–child closeness was protective for HSCs for internalising and externalising behaviours. HSCs showed overall slightly higher	Environmental sensitivity	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
		COVID-19										Italian version (Settanni et al., 2015)	levels of internalizing behaviours before and during the lockdown. Low levels of parent–child closeness was associated with a small increase in internalizing behaviours during the lockdown in both low and highly sensitive children.		

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May, A.K. & Pitman, M.M.	2021	The association between sensory processing sensitivity, the five-factor model and university adjustment amongst South African university students	Peer reviewed Journal article	Current Psychology	South Africa	To examine university adjustment differences between students scoring high and low on SPS, and test whether these effects were independent of the five-factor model of personality, and moderated by early parental care levels.	Observational, Cross-sectional design, quantitative, online-survey methods	Multiple	Early parenting experiences/ Adjustment to university	Males and Females	Adults (18+)	1. Highly Sensitive Person Scale (HSPS)(Aron & Aron, 1997) 2. Student Adjustment to College Questionnaire - Modified (Baker & Siryk, 1984) 3. Measure of Parental Style (MOPS; Parker et al., 1997)/Parental Bonding Instrument (PBI; Parker et al., 1979) 4. The Big Five Inventory (BFI; John et al., 1991) 5. Resistance to Peer Influence (RPI) scale (Steinberg & Monahan, 2007)	Students with high levels of SPS reported significantly worse adjustment to university. Moderating effect for parental care for students low on SPS. Poor adjustment to university was driven by a propensity towards negative affect, but carefully and deeply processing stimulation by those with high SPS levels partially offset adjustment	SPS, Big 5 Personality Framework	***

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
													difficulties.		
Moscardino, U., Scrimin, S., Lionetti, F., & Pluess, M.	2021	Environmental sensitivity and cardiac vagal tone as moderators of the relationship between family support and well-being in low SES children: An exploratory study	Peer reviewed Journal article	Journal of Social and Personal Relationships	Italy	To investigate behaviourally observed Environmental sensitivity in children from low Socio Economic Status families to explore the existence of sensitivity groups. To assess whether the	Observational, Cross-sectional design, quantitative, school-based behavioural tasks and physiological measures	Relational	Family support	Males and Females	Children (0-17)	1. Emotional and Physical comfort subscales of Child Health and Illness Profile–Child Edition (CHIP–CE) (Riley et al., 2004) 2. Family support subscale, standardized set of five questions derived from the Child Health and Illness Profile–Child Edition	Three sensitivity groups identified; "Low sensitive" (43%), "Moderately sensitive" (33%), and "Highly sensitive" (24%). No difference between groups in baseline CVT. At low and average levels of family support, highly	Socioecological, risk- and resilience-oriented framework (Bronfenbrenner & Morris, 1998; Masten, 2018)	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						aforementioned groups differ in terms of physiological self-regulation.						(CHIP–CE) (Riley et al., 2004) 3. Lab-based phenotypic tasks based on HSC scale (Pluess et al., 2018) 4. Cardiac Vagal Tone (CVT)	sensitive children with higher resting CVT reported better wellbeing than those with low resting CVT, this was not observed in other sensitivity groups.		
Pérez-Chacón, M., Chacón, A., Borda-Mas, M., & Avargues-Navarro, M. L.	2021	Sensory Processing Sensitivity and Compassion Satisfaction as Risk/Protective Factors from Burnout and Compassion Fatigue in	Peer reviewed Journal article	International journal of environmental research and public health	Spain	This study's objectives were to find out the extent to which both healthcare and educational professionals showed burnout at the beginning	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Working in education or healthcare fields at beginning of COVID-19 pandemic	Males and Females	Adults (18+)	1. Novel sociodemographic and occupational questionnaire 2. Highly sensitive person scale (HSPS)(Smolewska et al., 2006; Chancon & Perez-Chacon, 2020). 3. Spanish Adaptation	Relationship between emotional exhaustion and SPS were significant in healthcare workers and educators. Relationship between DP and SPS was significant in	SPS, Occupational health	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
		Healthcare and Education Professionals				of COVID-19 pandemic, to determine if there were differences in SPS, burnout, compassion fatigue/compassion satisfaction depending on sector, and to find out to what extent these variables influenced experience of these syndromes as risk or protective factors.						of the Maslach burnout inventory (MBI)(Maslach et al., 1986;Seisdedos, 1997) 4. Spanish Adaptation of the Professional Quality of Life Scale (ProQOL-vIV)(Stamm, 1997;Morante-Benadero, N.D.)	educators. Increase in EOE would contribute to increasing emotional exhaustion. Being a healthcare worker and scoring high on EOE acted as a risk factor for personal realization. Low sensorial threshold and compassion satisfaction acted as protective factors in this area. EOE and EAS increased compassion fatigue		

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
													regardless of sector.		
Sklar, A. Y., Goldstein, A. Y., Abir, Y., Goldstein, A., Dotsch, R., Todorov, A., & Hassin, R. R.	2021	Did you see it? Robust individual differences in the speed with which meaningful visual stimuli break suppression	Peer reviewed Journal article	Cognition	Israel	Experiment 8: To examine wither differences in non-conscious visual prioritization speed (NVPS) are echoed in individual's conscious everyday experiences, and to	Experimental, Cross-sectional design, quantitative, Lab based breaking continuous flash suppression (bCFS) task and telephone questionnaire	Sensory	bCFS task	Males and Females	Adults (18+)	1. HSP short form (6 questions)(Aron, Aron, & Jagiellowicz, 2012) 2. bCFS results (Tsuchiya & Koch, 2005)	Significant correlation found between NVPS and self-reported SPS.	SPS, Cognitive neuroscience	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						examine correlate of SPS.									
Weyn, S., Van Leeuwen, K., Pluess, M., Lionetti, F., Goossens, L., Bosmans, G., ... & Bijttebier, P.	2021	Improving the Measurement of Environmental Sensitivity in Children and Adolescents: The Highly Sensitive Child Scale–21 Item Version	Peer reviewed Journal article	Assessment	Belgium & Netherlands	To improve the HSC scale by including new items, to allow more variation and capture underlying construct. To examine psychometric properties of this scale and run a validity check. Assess whether scores on the HSC	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	Parenting environment	Males and Females	Adults and Childr en	1. Novel HSC scale (38 items) based on the original HSC scale (Pluess et al., 2018) 2. Hierarchical Personality Inventory for Children (HiPIC; Mervielde et al., 2009) 3. Short version of the Adult Temperament Questionnaire (ATQ)(Evans & Rothbart, 2007) 4. Parental Support subscale of	Results did not support evidence for HSC Scale as a moderator for relationship between parenting internalising or externalising problems.	Environmental Sensitivity	*****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						scale are a moderator in the relationship between negative and positive environmental factors (in this case negative and positive parenting) and outcomes (here internalizing and externalizing problem behaviours)						the short version of the Parental Behaviour Scale (PBS-S; Van Leeuwen et al., 2018) 5. Externalizing Problem scale of the Child Behaviour Checklist (CBCL; Achenbach, 1991)/Study 2 mean of the subscales Conduct Problems and Hyperactivity/Attentional problems of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) 6. Internalizing Problem			

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
												scale of the CBCL (Achenbach, 1991)			
Yano, K., Kase, T., & Oishi, K.	2021	Sensory Processing Sensitivity Moderates the Relationships Between Life Skills and Depressive Tendencies in University Students	Peer reviewed Journal article	Japanese Psychological Research	Japan	To investigate the relationship between life skills and depressive tendencies in Japanese university students, as well as how this relationship may be	Observational, Cross-sectional design, quantitative, survey methods	Multiple	University environment	Males and Females	Not Specified	1. Japanese version of the Highly Sensitive Person Scale (HSPS-J19; Takahashi, 2016) 2. Life Skills Scale for Adolescents and Adults (LSSAA; Kase, Iimura, Bannai, &	Association between SPS and depressive tendencies even when controlling for neuroticism. Emotional coping skills were found to be negatively associated	Life-skills training, SPS	****

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
						moderated by individuals' levels of SPS.						Oishi, 2016) 3. Japanese version of the Center for Epidemiologic Studies Depression Scale (CES-D; Shima, Shikano, Kitamura, & Asai, 1985) 4. Neuroticism subscale of Japanese Big Five Scale (Namikawa et al., 2012)	with depressive tendencies only when SPS was high. Decision-making skills were found to be negatively associated with depressive tendencies only when SPS was low. Interpersonal relationship skills were negatively associated with depressive tendencies, without SPS interaction.		

Authors	Year	Title	Content Type (Peer reviewed article, conference proceedings etc.)	Journal (if applicable)	Country Study was Conducted In/ Or Lead Author Affiliated	Objectives of the Study	Research Design	Environment Type	Specific Environment	Participants Gender/ Sex	Participants Age group	Measures Used	Relevant Key Findings	Theoretical Framework/Area of study	MMAT Result
Iimura, Shuhei	2022	Sensory-processing sensitivity and COVID-19 stress in a young population: The mediating role of resilience	Peer reviewed Journal article	Personality and Individual Differences	Japan	To examine how SPS and resilience in those aged 18-24 relate to COVID-19 induced distress.	Observational, Cross-sectional design, quantitative, online survey methods	Multiple	COVID-19 pandemic in Japan	Males and Females	Adults (18+)	1. 10-item Japanese version of the Highly Sensitive Person Scale (Iimura et al., 2021) 2. Japanese version of the Brief Resilience Scale (Iimura & Taku, 2018; Tokuyoshi & Moriya, 2014) 3. Japanese version of the COVID Stress Scale (Muta et al., 2020)	Higher levels of SPS were associated with higher levels of COVID-19 stress. Resilience buffered the negative association between SPS, and COVID-19 stress.	Environmental sensitivity	****

Appendix E

Systematic Scoping Review MMAT Results

Title	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5	Comments
Studies	**Criteria from the Mixed Methods Appraisal Tool**																									
Adult Attachment, Sensory Processing, and Distress in Healthy Adults											1	1	1	1	1											
Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in turn shyness. Study 1:																1	1	1	?	1						4. *Not enough information
Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in																1	1	1	?	1						4. Not enough information

turn shyness. Study 2:																									
Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in turn shyness. Study 3:																1	1	1	?	1					4. Not enough information
Examining the relationship between adult shyness and SPS. Positing new model where the interaction of sensitivity and adverse childhood environments lead to negative affectivity and in turn shyness. Study 4:						?	1	1	?	1															1./4. Not enough information
Alexithymia and the Evaluation of Emotionally Valenced Scenes											1	1	1	0	1										4. Did not account for confounders e.g. neuroticism

Brief Report: Effects of Sensory Sensitivity and Intolerance of Uncertainty on Anxiety in Mothers of Children with Autism Spectrum Disorder																1	0	1	0	1						2. Mothers only took part when initially wanted both parents 4. Fathers invited did not take part
Burnout and professional quality of life among Israeli dentists: the role of sensory processing sensitivity																1	1	1	0	1						4. 49% response rate.
Content and person effects in media research: Studying differences in cognitive, emotional, and arousal responses to media content											0	1	1	1	1											1. Participants from museum - sampling bias?
Dandelions, tulips and orchids: evidence for the existence of low-sensitive, medium-sensitive and high-sensitive individuals											1	1	1	1	1											
Did you see it? Robust individual differences in the speed with which											1	1	0	1	1											3. Only 60.5% completed follow up

meaningful visual stimuli break suppression																								
Do Overwhelmed Expatriates Intend to Leave? The Effects of Sensory Processing Sensitivity, Stress, and Social Capital on Expatriates' Turnover Intention																1	1	1	?	1						4. Not enough information RE missing data
Early adversities, family support, and child well-being: The moderating role of environmental sensitivity																1	1	1	1	1						
Environmental sensitivity and cardiac vagal tone as moderators of the relationship between family support and well-being in low SES children: An exploratory study																1	1	1	1	1						
The association between sensory processing sensitivity, the five-factor model and university adjustment amongst South																1	1	0	0	1						3. Parental measure queried weak 4. Large percentage non-completed data

African university students																									
Frontal Brain Activity and Subjective Arousal During Emotional Picture Viewing in Nightmare Sufferers																1	1	1	1	1					
High Sensory-Processing Sensitivity at Work																1	0	1	1	1					2. Snowball approach of asking friends of author and restricted timeframe possible impact on representativeness?
Highly sensitive adolescent benefits in positive school transitions: Evidence for vantage sensitivity in Japanese high-schoolers											1	1	1	1	1										
Highly sensitive adolescents: The relationship between weekly life events and weekly																1	1	1	1	1					

socioemotional well-being																									
Improving the Measurement of Environmental Sensitivity in Children and Adolescents: The Highly Sensitive Child Scale–21 Item Version																1	1	1	1	1					
Is sensory processing sensitivity related to treatment outcome in concentrated exposure and response prevention treatment for obsessive-compulsive disorder?										1	1	1	1	?											5. Not enough information
Linking emotional reactivity “for better and for worse” to differential susceptibility to parenting among kindergartners																1	1	1	1	1					
Measuring Environmental Sensitivity in Educational Contexts:																1	1	1	1	1					

A Validation Study With German-Speaking Students																								
Measuring Listening Effort: Convergent Validity, Sensitivity, and Links With Cognitive and Personality Measures																1	0	1	1	1					2. Small, younger age range, impact on cogntive test results?
Media exposure to terrorism and people's risk perception: The role of environmental sensitivity and psychophysiological response to stress						?	1	1	?	1															1./4. Not enough information
Negative childhood accounts, sensitivity and pessimism: A study of avoidant personality disorder features in college students																0	0	1	?	1					1./2. Undergraduate rather than clinical sample 4. Not enough information
Observer-rated environmental sensitivity moderates children’s response to parenting																1	1	1	1	1					

quality in early childhood																									
People Differ in their Sensitivity to the Environment: An Integrated Theory and Empirical Evidence: Study 3											1	1	0	0	1										3. High amount of missing data 4. Confounders not measured
People Differ in their Sensitivity to the Environment: An Integrated Theory and Empirical Evidence: Study 4											1	1	1	1	1										
Predictors of Mental Health in Chinese Parents of Children with Autism Spectrum Disorder (ASD)																1	0	1	?	1					2. Sample from those who had attended workshop - could this not include those unable to attend such events due to work etc? 4. Not enough information
Relationship between the temperament trait of sensory processing sensitivity and emotional reactivity											1	1	1	1	1										

Role of childhood adversities and environmental sensitivity in the development of post-traumatic stress disorder in war-exposed Syrian refugee children and adolescents																1	1	1	?	1						4. Not enough information
Sensory Processing Sensitivity and Attentional Bias - A Pilot Study											1	1	1	1	1											
Sensory Processing Sensitivity and Compassion Satisfaction as Risk/Protective Factors from Burnout and Compassion Fatigue in Healthcare and Education Professionals																1	1	1	?	1						4. Not enough information
Sensory processing sensitivity and culturally modified resilience education: Differential susceptibility in Japanese adolescents											1	1	1	1	1											

Sensory processing sensitivity and its relation to parental bonding, anxiety, and depression																1	1	1	?	1						4. Not enough information
A qualitative exploration of individual differences in wellbeing for highly sensitive individuals	1	1	1	1	1																				
Sensory processing sensitivity as a marker of differential susceptibility to parenting																1	0	1	1	1						2. Low SES not represented, one province in Netherlands only
Sensory Processing Sensitivity Moderates the Relationships Between Life Skills and Depressive Tendencies in University Students																1	1	1	1	1						
The Impact of Sensory Processing Sensitivity on Stress and Burnout in Nurses																1	1	1	?	1						4. Not enough information
Sensory-Processing Sensitivity and Its																1	1	1	1	1						

Relation to Introversion and Emotionality: Study 2																								
Sensory-Processing Sensitivity and Its Relation to Introversion and Emotionality: Study 3																1	1	1	1	1					
Sensory-Processing Sensitivity and Its Relation to Introversion and Emotionality: Study 4																1	1	1	0	1					4. Low response rate impact?
Sensory-Processing Sensitivity and Nonverbal Decoding: The Effect on Listening Ability and Accuracy																1	1	1	0	1					4. Not enough information
Sensory-processing sensitivity in the context of the teaching profession and its demands																1	1	1	1	1					
Sensory-processing sensitivity moderates the association																1	0	1	0	1					2. not representative sample 4.

between childhood experiences and adult life satisfaction																									
Sensory-processing sensitivity predicts performance on a visual search task followed by an increase in perceived stress											1	1	1	1	1										
The effect of sensory-processing sensitivity on social preference for online interaction and associated outcome on psychological wellbeing																1	?	1	?	1					3. Not enough information RE removing 44 year olds up 4. Not enough information
The effects of sensory-processing sensitivity and sense of coherence on depressive symptoms in university students																?	1	1	1	1					1. Not enough information
The evolution of depression among students: Evidence for the mismatch hypothesis and the influence of sensory processing sensitivity	1	1	1	1	1											1	1	1	?	1	1	1	1	1	4.4 Not enough information

The highly sensitive teacher: Sensory-Processing Sensitivity, burnout, and self-efficacy in urban public school teachers	1	1	1	1	1											1	1	1	0	1	1	1	1	1	1	4.4. Very low response rate
The Interaction between Sensory Processing Sensitivity and Childhood Environment on Social Anxiety																1	0	1	?	1						2. Not representative sample - large gender imbalance 4. Not enough information
The relationship between ego-depletion and sensory processing sensitivity																1	1	1	1	1						
The relationship between perceived parental rejection and internalizing behaviours: moderating role of sensory processing sensitivity and gender																1	1	1	?	1						4. Not enough information
The Relationship Between Viewing ASMR Videos and Affect in College Students with Sensory Sensitivity											0	1	?	0	1											1. Not representative sample 3. Not enough information 4. Confounders not controlled e.g.

																									negative affectivity, neuroticism etc.
The role of environmental sensitivity in the development of rumination and depressive symptoms in childhood: a longitudinal study																1	1	1	1	1					
The trait of sensory processing sensitivity and neural responses to changes in visual scenes											0	1	0	1	1										1. One culture looked at when cultural differences may be an issue 3. Data missing for 4/16 participants in task
Who is more susceptible to job stressors and resources? Sensory-processing sensitivity as a personal resource and vulnerability factor																1	1	1	?	1					4. Not enough information
Sensory-processing sensitivity: A model to predict social anxiety																1	1	1	?	1					4. Not enough information

Sensory processing sensitivity and its association with seasonal affective disorder											1	1	1	0	1										4. Confounders e.g. neuroticism, not included
Sensory-Processing Sensitivity predicts treatment response to a school-based depression prevention program: Evidence of Vantage Sensitivity											1	1	0	1	1										3. High levels of participants not completeing the 12 month follow up - over 30%.
The Personality Trait of Environmental Sensitivity Predicts Children's Positive Response to School-Based Antibullying Intervention						1	1	1	1	1															1. Not enough information
Effects of yoga in a physical education course on attention control and mental health among graduate students with high sensory processing sensitivity											0	1	?	0	1										1. Small, specific sample not representative 3. Not enough information 4. Confounders e.g. neuroticism not included.
How do highly sensitive persons parent their adolescent																1	1	1	0	1					4. Number of drop outs - no explanation?

children? The role of sensory processing sensitivity in parenting practices																									
Sensitivity to sensoriprocessing, self-discrepancy, and emotional reactivity of collegiate athletes											1	1	1	0	1										4. Confounders e.g. neuroticism, post game feedback, not included
A longitudinal approach of lockdown effects on quality of life and the expression of anxiety-depressive disorders according to sensory processing sensitivity																?	0	1	?	1					1. Not enough information 2. Non-representative sample 4. Not enough information
Sensory-processing sensitivity and COVID-19 stress in a young population: The mediating role of resilience																1	1	1	1	1					
Conceptual ambiguities and measurement issues in sensory processing sensitivity																1	0	1	0	1					2. Higher numbers of university population, not

																									balanced with others
The interplay between parenting and environmental sensitivity in the prediction of children's externalizing and internalizing behaviors during COVID-19																1	1	1	?	1					4. Not enough information

*_Note_. The numbers included in comments row refer to the number of the subitem of methodological criteria being addressed in the MMAT. See MMAT Tool (Hong et al., 2018) for details of to what each subitem pertains.

Appendix F

Coding and Coding Tables

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Aron, E.N. & Aron, A.	1997	Multiple	Family environment in childhood	Study 2: When parental environment was optimal, there was little difference between HSPs and non HSPs; but when the parental environment was poor, the highly sensitive scored higher on unhappy childhood. Study 3/4: Three way interaction found with gender, such that when parental environment was optimal, there was little difference between men regardless of sensitivity; when the parental environment was poor, highly sensitive men reported having a much less happy childhood.	Multiple environmental aspects/ Family environment in childhood/ optimal parenting environment no difference in happiness by SPS level/ Poor parental environment - unhappy childhood for HSP/ Optimal parenting environment little difference for men/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Meyer, B., & Carver, C. S.	2000	Multiple	Childhood Environment	APD features were found to be correlated with optimism/pessimism, childhood memory valence, and SPS. A significant interaction between optimism/pessimism and SPS was found. A significant negative correlation emerged between optimism and APD features among those scoring highly in SPS. The combination of pessimistic expectancies and high levels of SPS yielded higher levels of APD features.	Multiple environmental aspects/ childhood environment/ avoidant personality disorder features relationship/ interaction with optimism and pessimism/ optimism and APD features negatively correlated for high SPS/ pessimistic features and high SPS - high APD features/ SPS interaction with environment/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Aron, E. N., Aron, A., & Davies, K. M.	2005	Social	Childhood Environments / Study 4. Manipulated negative event i.e., frustrating survey completion	SPS and childhood environment interact predicting adult trait negative affectivity. SPS interacts with a manipulated negative experience to predict greater state negative affect.	Environment of childhood/ Manipulated environment/ create frustration in present/ Childhood environment affects HSPs/ Impact of negative experiences/ SPS interacts with environments/ creating state negative affect / creating trait negative affect

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Liss, M., Timmel, L., Baxley, K., & Killingsworth, P.	2005	Relational	Parenting environment	SPS was strongly related to depression and to anxiety. It contributed unique variance above parenting factors for both depression and anxiety. SPS was particularly strongly related to anxiety. SPS was correlated with parental overprotection. For depression there was a small but significant interaction between parental care and SPS, such that HSPs were more depressed in the context of low parental care. This interaction was not found for anxiety. No interaction effects found for parental overprotection.	Parenting environment/ Childhood environment/ Relationship with depression/ Relationship with anxiety/ Correlation with parental overprotection/ Interaction effect for depression, between parental care and SPS/
Kemler, D.S.	2006	Multiple	Competitive sports event	Participants high in SPS responded to competition with greater anxiety and shame than low SPS counterparts. Participants high in SPS also reported having greater stress related to actual to ideal and actual to ought self-discrepancies than those low SPS.	Multiple environmental aspects/ Competitive sporting environment/ High SPS respond to competition with more shame and anxiety/ Greater stress to aspects self-discrepancies for high SPS

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Evers, A., Rasche, J., & Schabracq, M. J.	2008	Multiple	Work environment	SPS (and its subscales) are negatively correlated with sense of coherence, comprehensibility, manageability, meaningfulness and self-efficacy. SPS (and its subscales) are positive correlated with negative affectivity, work displeasure and need for recovery.	Multiple environmental aspects/ Working environment/ SPS impacts on psychological work factors/ Reduced sense of coherence/ reduced comprehension of internal and external stimuli as rationally understandable/ reduced perception of manageability in work/ decreased finding meaningfulness/ associations with negative affect/ associations with work displeasure/ Associations with need for recovery/ SPS associated with negative outcomes

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Jagiellowicz, J., Xu, X., Aron, A., Aron, E., Cao, G., Feng, T., & Weng, X.	2011	Sensory/perceptual	Change detection task using images	No significant associations between accuracy and SPS. Significant correlation between SPS and minor-minus-major difference in response time, such that the higher a participant was on SPS the longer time they spent before responding to minor changes, relative to major changes.	Sensory environment/perceptual environment/ Visual task/ No association with accuracy and SPS in visual task/ Significant relationship with minor-minus-major difference/
Gerstenberg, F.X.	2012	Sensory	Visual detection task	SPS was found to predict performance on a visual detection task (both reaction times and error rates) and increased perceived stress. Only the LST subscale led to these results, however. Results were independent of Big-5. Individuals high in SPS perceived more stress after taking the test than individuals low in SPS.	Sensory environment/ Visual task/ Predicts performance in RT and error in visual search task/ Predicts increased perceived stress/ Differences in SPS levels identified

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Sobocko, K.	2012	Sensory	Exposure to noise similar to that of a busy cafe or restaurant	No significant difference found between participants in cognitive performance in noise vs control. This indicates the impact of the environmental stimulus was not affected by SPS. Though results null, more sensitive participants showed slowest response time in Stroop task.	Sensory environment/ Exposure to noise environment/ No significant difference in cognitive performance/ Environmental stimulus not affected/ Lowest Stroop response time
Gearhart, C.G.	2014	Multiple	Audio stimulation	HSPs were found to be no worse or no better at recognizing vocal expressions of emotion than non-HSPs. This was regardless of whether they were exposed to conditions of stimulation or not. When neuroticism was controlled for, HSPs did not report being more distracted by moderate or high intensity audio stimulation than non-HSP counterparts.	Multiple environmental aspects/ Audio stimulatory environment/ Sensory environment/ No difference in recognising vocal expressions of emotion/ HSPs not more distracted when controlling neuroticism

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Booth, C., Standage, H., & Fox, E.	2015	Social	Childhood experiences with caregiver	Those scoring more highly in SPS were found to be more affected by negative childhood experiences than those scoring lowly in terms of adult life satisfaction levels. No differential effects under positive childhood experiences were found for high or low SPS scorers. LST and EOE produced the same significant interaction.	Social environment/ Childhood environment/ Interaction childhood experiences, SPS, wellbeing/ Lower levels life satisfaction/ No effects of positive childhood experiences/ Individual factors of SPS predict interaction
Pluess, M., & Boniwell, I.	2015	Intervention	SPARK Resilience programme	SPS was a significant predictor of treatment response. The intervention was successful in reducing depression in girls scoring highly in SPS, though not effective at all in those scoring lowly in SPS.	Intervention environment/ Resilience programme environment/ School environment/ SPS predictor of treatment response/ Effective reducing depression in high SPS girls not low SPS/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Valojää, A.	2015	Multiple	Internet	No difference was found in the psychological wellbeing of those HSPs who preferred online interaction and those who preferred face-to-face interaction. When comparing the psychological wellbeing in the HSPs who belonged to online and Face to face groups, no difference was found. HSPs were found to be somewhat more distressed than non-HSP counterparts.	Multiple environmental aspects/ Internet environment/ No significant difference in wellbeing/ HSPS somewhat more distressed
Jagiellowicz, J., Aron, A., & Aron, E. N.	2016	Multiple	IAPS picture presentation/parenting environment from childhood	Those high in SPS tend to rate standard pictorial stimuli, and especially positive ones, as more intensely valanced, perhaps response more quickly than others, but do not differ in their rating of the level of arousal caused by the pictures. Evidence found for an interaction between SPS with quality of parenting in predicting how they rated arousal, such that those high in SPS with high-quality parenting reported having greater arousal to positive pictures.	Multiple environmental aspects/ Visual task/ parenting environment/ Childhood environment/ Visual task/ Faster RT for rating positive valence/ Interaction with quality of parenting/ high-quality parenting interacts with SPS and impacts response to stimuli / greater arousal levels to positive stimuli

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Jaswetz, L.	2016	Multiple	Childhood environment	No significant interaction effect found. Main effect of SPS on social anxiety found.	Multiple environmental aspects/ Childhood environment/ No interaction effect found childhood environment, SPS, anxiety/ Main effect on social anxiety
Meredith, P. J., Bailey, K. J., Strong, J., & Rappel, G.	2016	Sensory	Cold-pressor pain inducement task used to activate attachment system	Attachment anxiety was related to sensory sensitivity as measured by the HSP-SV. This associated was not retained when controlling for stress, indicating the association was largely accounted for by stress. Sensory sensitivity as measured by HSP-SV was positively linked with distress.	Sensory environment/ Pain inducement task environment/ Activating attachment system/ Attachment anxiety has a relationship with SPS/ stress accounts for attachment anxiety-SPS relationship / Stress impacts on HSP/ Higher levels of SPS - Higher levels of distress/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Uljarević, M., Carrington, S., & Leekam, S.	2016	Relational	Parenting child with ASD diagnosis	A three-way inter-relationship between SPS, Intolerance of Uncertainty and anxiety was found. High sensitivity and a susceptibility to being overwhelmed by environmental stimulation may lead to an experience of the world as being highly unpredictable, which in turn could make even simple situations and events uncertain and difficult for the HSP, thus provoking anxiety.	Parenting environment/ Parenting child with additional needs/ SPS links with intolerance of uncertainty/ High SPS and unpredictability leads to anxiety/ Unpredictability impacts negatively on HSP/ Simple things more difficult for HSP

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Rothenbucher, F. U.	2017	Sensory	Posner exogenous cueing task and cued attention task	A significantly higher level so attentional engagement was found for the high SPS group for happy cues at the 100ms duration, which indicates a continuous direction of attention at the positive stimuli ad deeper processing of this material. High SPS participants had self-reported higher negative affect and lower levels of extraversion. They also diverted attention away from neutral cues at 100ms, possibly to precent sensory overload.	Sensory environment/ Attention task/ greater attention engagement/ deeper processing of material/ higher negative affect/ divert attention from neutral/ diverts attention to prevent sensory overload/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Stefan Lindsay, J.	2017	Multiple	Teaching environment	SPS significantly and positively correlated with risk of burnout. However, stress fully mediated this relationship when introduced into this model. At increased risk of presenting with SPS, teachers tended to have a greater risk of burning out due to emotional exhaustion. They also reported experiencing more stress at work. Qualitative results indicated time demands and colleagues as primary sources of stress, and both daily and systematic coping strategies were utilised.	Multiple environmental aspects/ Teaching environment/ Risk of burnout correlation - Stress mediated relationship/ Greater risk of burnout due to emotional exhaustion/ More stress at work/ Demands as sources of stress/ Coping strategies utilised
Andresen, M., Goldmann, P., & Volodina, A.	2018	Multiple	Expatriation - working in a foreign country	Perceived stress fully mediated the effects of SPS and bonding social capital on expatriates' turnover intention. 26.4% of expatriates scored highly in SPS. Significant differences were found such that 30.7% of organisational expatriates were highly sensitive compared to 19.3% of external expatriates.	Multiple environmental aspects/ Work environment/ Foreign environment/ Stress mediated relationship/ approximately one third of organisational expatriates were highly sensitive/ Approximately one quarter expatriates high in SPS

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Campbell, T., & Moore, K.	2018	Relational	Parenting environment	Those higher in SPS were found to be more prone to experiencing social anxiety than others. SPS also associated with avoidant coping, irrespective of the quality of parental bond experienced in childhood.	Parenting environment/ Higher social anxiety/ Association with avoidant coping irrespective of parenting environment
Lionetti, F., Aron, A., Aron, E. N., Burns, G. L., Jagiellowicz, J., & Pluess, M.	2018	Sensory	Viewing happy and sad video clips	HSP mean score and EOE subscale were positively associated with positive emotional reactivity, and a marginally significant positive association between HSP and EOE subscale and negative emotional reactivity. Difference between three sensitivity groups in positive emotional reactivity approached significance, though groups did not differ significantly regarding negative emotional reactivity.	Sensory environment/ Viewing media/ Viewing positive and negative video clips/ Positive relationship SPS and positive emotional reactivity/ Positive relationship SPS and negative emotional reactivity/ Three sensitivity groups identified/ Similarities between three sensitivity groups for negative emotional reactivity

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Nocentini, A., Menesini, E., & Pluess, M.	2018	Intervention	KiVa antibullying programme	Significant intervention effects on victimisation and internalising symptoms were moderated by HSC score and gender. Boys scoring higher on HSC benefitted significantly more than lower scoring counterparts with reduced victimisation and internalising symptoms.	Intervention environment/ Anti-bullying programme environment/ School environment/ HSC boys benefited more reduction in victimisation/ HSC boys benefited more reduction in internalising symptoms
Rubaltelli, E., Scrimin, S., Moscardino, U., Priolo, G., & Buodo, G.	2018	Sensory	Exposure to terror-related or neutral pictures and Manneheim multi-component stress task	Sensitivity and reactivity were not significantly correlated. Sensitivity and likelihood of attack were correlated such that those scoring higher in HSPS estimated future attacks were more likely. The relationship between HSPS score and experimental condition was not significant. Those scoring higher in HSPS in the terrorism-related pictures condition were more willing to trade off privacy than those in neutral condition.	Sensory environment/ Terror-related media exposure environment/ stress task environment/ no correlation with reactivity/ sensitivity associated with perception/ likelihood of terrorist attack perception higher/ impact of terror content on privacy wants/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Scrimin, S., Osler, G., Pozzoli, T., & Moscardino, U.	2018	Multiple	Early adversities in family environment e.g., death in family, discontent in relations	HSCS score moderated the association between both family adversities and supportive resources provided by families on children's physical comfort and their perceived academic and social performance.	Multiple environmental aspects/ early childhood environment/ difficult early childhood/ HSC moderates' relationship between adversities and resources on wellbeing/ environmental impact on physical and psychological outcomes/ worse physical comfort emphasised/ self-perception academically moderated for better and worse/ self-perception socially moderated for better and worse

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Slagt, M., Dubas, J. S., van Aken, M. A., Ellis, B. J., & Deković, M.	2018	Relational	Parenting environment	SPS interacted with both changes in negative and positive parenting in predicting externalising, though not prosocial, behaviours. Sensitive children decreased the most in externalising behaviour when negative parenting decreased but increased in it the most when negative parenting increased. Likewise, sensitive children decreased the most in externalizing behaviour when high levels of positive parenting were maintained, however they increased the most in externalizing behaviour when positive parenting decreased. When receiving low levels of negative parenting, sensitive children decreased in externalising behaviours more than less-sensitive counterparts. sensitive children had the lowest levels of externalizing behaviour when high levels of positive parenting were maintained, but similar levels when positive parenting decreased.	Parenting environment/ SPS interaction with parenting in predicting behaviour/ High SPS Decrease in externalising behaviour parenting dependent/ High SPS Increases in externalising behaviour parenting dependent/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Strand, J. F., Brown, V. A., Merchant, M. B., Brown, H. E., & Smith, J.	2018	Multiple	A number of lab-based tasks	Those with higher HSPS scores rated the tasks as more difficult and had slower CDT latencies. A marginally significant HSPS × Noise interaction was found, indicating that the relationship between HSPS score and CDT latency is stronger in the hard than in the easy condition. Individuals who score higher in SPS showed increased effort as measured by some LE tasks.	Multiple environmental aspects/ Listening Tasks/ perception of listening tasks as difficult/ Negative impact on CDT latencies/ Interaction with noise environment/ results varied by environment type/ Increased listening effort/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Su, X., Cai, R. Y., & Uljarević, M.	2018	Multiple	Parenting a child with ASD diagnosis	Higher levels of parental sensory sensitivity were associated with higher DASS-21 total score. Sensory sensitivity had an indirect effect through intolerance of uncertainty on parental mental health.	Multiple environmental aspects/ Parenting environment/ Parenting child with additional needs/ Parenting child with ASD/ Association with negative psychological outcomes/ SPS links with intolerance of uncertainty/ indirect impact on parental mental health
Tillmann, T., El Matany, K., & Duttweiler, H.	2018	Multiple	School environment	The highest positive significant correlation found between negative affect and the SPS sub-facet Overexcitability and the total SPS scale. Significant negative relationships between physical well-being, psychological well-being, functional capacity, and SPS.	Multiple environmental aspects/ school environment/ Association with negative affect/ SPS sub-facets relationship negative affect/ negative relationship with physical wellbeing/ negative relationship with psychological wellbeing/ negative relationship with functional capacity

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Hjordt, L. V., & Stenbæk, D. S.	2019	Physical	Seasons - summer/winter	Participants with SAD exhibited higher scores on trait SPS compared to healthy controls in both summer and winter. Their scores on trait SPS increase from summer to winter, i.e., individuals with SAD displayed a cross-seasonal pattern of high sensitivity. Higher trait SPS in summer was found to be associated with more severe SAD symptoms in winter.	Physical environment/ Seasonal environment/ Scores on SPS increased by season for SAD participants/ High SPS summer more severe depression winter
Holm, S. E. H., Hansen, B., Kvale, G., Eilertsen, T., Hagen, K., & Solem, S.	2019	Intervention	Bergen concentrated 4-day exposure treatment (B4DT)	No significant relationship between SPS and treatment outcome was found after controlling for pre-treatment levels of OCD, depression, and anxiety. HSPS scores were significantly reduced after treatment.	Intervention environment/ OCD treatment environment/ exposure therapy environment/ no significant relationship with OCD treatment outcome when controlling pre-treatment factors/ reduced HSPS scores post-OCD intervention

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Karam, E. G., Fayyad, J. A., Farhat, C., Pluess, M., Haddad, Y. C., Tabet, C. C., ... & Kessler, R. C.	2019	Multiple	Exposure to war environment	While sensitivity was significantly related to PTSD, childhood adversities were the most important variable in predicting PTSD. The effect of war on PTSD was dependent on the interplay between adversities and sensitivity and was most prominent in highly sensitive children with lower adversities levels, and less pronounced in those experiencing high adversities levels.	Multiple environmental aspects/ war environment/ related to PTSD/ relationship with adversity and sensitivity/ highly sensitive children with low adversities PTSD most impacted by war/ negative impact on mental health/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Lionetti, F., Aron, E. N., Aron, A., Klein, D. N., & Pluess, M.	2019	Relational	Parenting environment	Children who scored highly in the HSC-RS were more affected by the influence of parenting quality compared to those scoring low. Children in the high sensitive group were found to be more sensitive to negative influences of high levels of permissive parenting when considering externalizing behaviour problems aged three and internalizing behaviour problems aged 3 and 6. They were also more sensitive to positive effects of high levels of authoritative parenting in predicting social competence at aged 3 and 6. Those scoring low in sensitivity were generally less sensitive to the influence of parenting.	Parenting environment/ Childhood environment/ impact of environment type parenting quality/ affected by parenting quality/ negative impact on externalising behaviour/ negative impact on internalising behaviour/ sensitivity to permissive parenting/ parenting style interaction/ benefits of authoritative parenting/ positive impact on social competence/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Slagt, M., Dubas, J. S., Ellis, B. J., Van Aken, M. A., & Deković, M.	2019	Multiple	Parenting	SPS was related to neither externalising nor prosocial behaviour. Highly Reactive children did not score more highly on SPS than other children. Authors suggest it may be unlikely for children who are identified as susceptible for better and for worse using SPS to be the same ones who are also reactive for better and for worse within parent–child interactions.	Multiple environmental aspects/ Parenting environment/ childhood environment/ SPS not linked to externalising behaviour/ SPS not linked to prosocial behaviour/ No relationship for SPS with high reactivity/ Differences between SPS and reactivity/ for better and for worse are different for SPS and reactivity

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Tillmann, T.	2019	Multiple	Teaching environment	Highly sensitive teachers, while more attuned to students in need, do not demonstrate enhanced processing in teaching related aspects. SPS can explain the relationship between some work characteristics and perceived stress through coping and cognitive processes. SPS was found to relate to teachers' depression, anxiety, and some psychosomatic disorders. Teachers who were highly sensitive benefited more from therapeutic interventions than non-highly sensitive counterparts. SPS can contribute significantly to development of stress in teachers.	Multiple environmental aspects/ Teaching environment/ More attunement to student need/ No enhanced processing in teaching/ Part of relationship with stress, work, and coping/ Relationship with depression/ Relationship with anxiety/ Relationship with psychosomatic disorders/ More benefit from therapeutic intervention for high SPS/ Higher stress levels

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Vander Elst, T., Sercu, M., Van den Broeck, A., Van Hoof, E., Baillien, E., & Godderis, L.	2019	Multiple	Work environment	EOE and LST were found to amplify the relationship between job demands and emotional exhaustion.	Multiple environmental aspects/ Work environment/ Aspects of SPS amplify negative outcomes/ Aspects of SPS amplify job demands - emotional exhaustion relationship
Yano, K., Kase, T., & Oishi, K.	2019	Multiple	University environment	Strong Sense of Coherence prevented high-SPS students from experiencing over-arousability and dysfunctional cognition, and consequently decreased the severity of depressive symptoms.	Multiple environmental aspects/ Education environment/ Strong sense of coherence protective/ Strong SOC decrease depression severity for high HSP

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Amemiya, R., Takahashi, G., Rakwal, R., Kahata, M., Isono, K., & Sakairi, Y.	2020	Multiple	Yoga course	Students higher in SPS had lower Attentional Control and higher negative mood states before the course, however, a significant improvement in scores was observed. Differences between the two groups after the yoga course were not statistically significant. A positive correlation was found between SPS and variation in AC, however, a negative correlation was found between variation in AC and mood states.	Multiple environmental aspects/ Yoga course environment/ Intervention environment/ Improvement in attentional control/ Differences not significant post-course/ Positive correlation with SPS and variation in attentional control
Baldwin, E. D.	2020	Sensory	Viewing ASMR videos/non ASMR controls	Negative affectivity was not correlated with high SPS. Increase in positive affect between pre and post-test when viewing no voice control video in high SPS participants. Data did not support the hypothesis of significant improved positive affect after watching ASMR type videos. Decrease in negative affect found after watching ASMR videos and control videos.	Sensory environment/ Viewing ASMR environment/ Increase in positive affect for high SPS/ hypothesis not supported RE ASMR/ Decrease in negative affect following all videos for HSP

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Black, B. A., & Kern, M. L.	2020	Multiple	Extravert-dominant social context	HSPs perceive wellbeing arises from harmony across different dimensions. A number of valued practices were noted for wellbeing; self-acceptance, having positive social relationships but this being balanced by times of solitude, connecting with nature, contemplative practices, emotional self-regulation, practicing self-compassion. Emotional experiences were also valued; low-intensity positive emotion, self-awareness, having a sense of meaning, and hope/optimism. Barriers to wellbeing were identified as physical health issues and saying no to others.	Multiple environmental aspects/ Extraverted environment/ Social environment/ Perception of wellbeing coming from harmony of different areas/ Engage in different practices to cultivate wellbeing/ Different emotional experiences valued for wellbeing/ Poor physical health and saying no are barriers to wellbeing

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Carr, M., Summers, R., Bradshaw, C., Newton, C., Ellis, L., Johnston, E., & Blagrove, M.	2020	Sensory	Emotional Picture Viewing	Nightmare sufferers scored more highly on the HSPS than control participants.	Sensory environment/ Viewing emotional material environment/ Nightmare sufferers higher in SPS/ Differences in SPS levels identified
Fikkers, K. M., & Piotrowski, J. T.	2020	Social	Viewing positive and negative media video clips	Results showed that more variation in responses to media was due to differences between the participants rather than difference between stimuli, however SPS did not significantly explain this between-participant variation as a predictor or moderator.	Social environment/ Viewing positive and negative video clips/ SPS not predictive of response to media/ SPS not moderative of response to media/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Goldberg, A., & Scharf, M.	2020	Relational	Parenting environment	Attachment anxiety was postiviely associated to SPS. Attachment anxiety mediated the relationship between parents' SPS levels and harsh parenting, and partially mediated the relationship between parents' SPS levels and use of psychological intrusiveness.	Parenting environment/ Attachment anxiety has a relationship with SPS/ Attachment anxiety mediated relationships/ Attachment anxiety role in parenting styles at different levels of SPS
Iimura, S., & Kibe, C.	2020	Multiple	Transition to high school environment	Adolescents higher in SPS reported a greater increase in their well-being after the transition to high school, corresponding to their perceived environmental change, whilst low sensitivity peers did not show such well-being enhancement. Evidence found for vantage sensitivity over diathesis-stress or differential susceptibility models.	Multiple environmental aspects/ school environment/ transition to high school environment/ SPS associated with wellbeing/ bigger increase in wellbeing/ vantage sensitivity supported/ diathesis-stress not supported/ differential susceptibility not supported

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Kibe, C., Suzuki, M., Hirano, M., & Boniwell, I.	2020	Intervention	Modified version of the SPARK resilience program	Student scoring higher in SPS, who scored significantly lower in wellbeing than counterparts at baseline, responded more positively to the intervention, and had greater levels of reduction in depression and more promotion of self-esteem.	Intervention environment/ School-based intervention/ School environment/ Increase in wellbeing post intervention/ reduction in depression/ increasing self-esteem/ greater impact of intervention for higher SPS
Meyerson, J., Gelkopf, M., Eli, I., & Uziel, N.	2020	Multiple	Work as dentist in Israel	Found that burnout can be predicted by the three aspects of SPS (ease of excitation, low sensory threshold and aesthetic sensitivity). These also predicted dentists' satisfaction at work. Positive correlation between SPS and secondary traumatic stress. EOE and LST but not AES predicted dentists' reactions to patient's stress and trauma.	Multiple environmental aspects/ Work environment/ Dentistry/ Burnout can be predicted by SPS/ Work satisfaction impacted by SPS/ SPS positive correlation with secondary traumatic stress/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Onursal Özer, B.	2020	Relational	Parenting environment	Higher levels of SPS predicted higher levels of internalizing problems when controlling for parental rejection, however this effect was not there when interaction between SPS and gender was included in the model. highly sensitive girls were more inclined to experience internalizing problems.	Parenting environment/ Childhood environment/ Higher levels of internalising problems controlling for parental rejection/ No prediction when gender interaction included/
Pernot, L.	2020	Multiple	University environment	SPS was found to have a moderating effect on the positive correlation between mismatch factors and depression. SPS was found to correlate with mismatch factors, depression, and neuroticism. In the interviews, HSPs noted their sensitivity to environmental stimuli, feeling different compared to others, and having more difficulty coping with mismatch factors in their daily life.	Multiple environmental aspects/ University environment/ Moderating effect of SPS on mismatch and depression/ Correlate with mismatch/ Relationship with depression/ SPS Correlates with neuroticism/ Feeling different to others/ Difficulty coping with mismatch factors

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Pluess, M., Lionetti, F., Aron, E. N., & Aron, A.	2020	Multiple	Study 3: Teaching environment as a teacher-trainee Study 4: Exposure to mood induction video.	Study 3: HSP-12 was a significant predictor of changes in well-being across 10 months, with teacher trainees who were more sensitive showing a significant decline in well-being followed by a full recover. Those low in sensitivity appeared unaffected by the experience. Study 4: HSP-12 score significantly moderated short-term effects of positive mood induction using video clip on pre-post changes in positive mood. Change in positive mood was more pronounced in the high sensitivity group.	Multiple environmental aspects/ Teaching environment/ Viewing positive video clip/ mood induction/ Decline in wellbeing/ more pronounced effects - greater change in positive mood
Redfearn, R. A., van Ittersum, K. W., & Stenmark, C. K.	2020	Multiple	Working in nursing currently in the USA	SPS was found to correlate overall with nursing stress, burnout, five nursing subscales of stress, and two subscales of burnout. SPS was shown to be a predictor for overall nursing stress, overall burnout, of two nursing stress subdimensions, and one burnout subdimension.	Multiple environmental aspects/ Nursing environment/ Healthcare environment/ SPS relationship with nursing stress/ Burnout association/ SPS predictor for negative wellbeing/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Rigby, S. N., Jakobson, L. S., Pearson, P. M., & Stoesz, B. M.	2020	Sensory	Emotional scenes task	Strong positive correlations were observed between difficulties identifying and describing feelings scores and scores on the EOE subscale of the HSPS. Authors suggest this indicates that problems with emotional appraisal are most evident in those who are easily overwhelmed by busy sensory environments. EOE was a negative predictor of accuracy in classification of positive scenes.	Sensory environment/ Evaluation of emotional material/ difficulties with emotional identification/ difficulties with emotional description/ accuracy in classifying positive scenes impacted
Bordarie, Jimmy; Aguerre, Colette; Bolteau, Laëtitia	2021	Multiple	Confinement during COVID-19 pandemic	SPS related to levels of anxiety and depression, with depression increasing with higher levels of SPS. For those with average SPS, lockdown had a significant positive effect in reducing anxiety disorders. In terms of quality of life, lockdown appeared to play a positive role for entire sample regardless of SPS level.	Multiple environmental aspects/ Lockdown environment/ COVID-19 pandemic environment/ Relationship with anxiety/ Relationship with depression/ Depression increasing with SPS/ Positive effect of lockdown for average SPS on anxiety/ Lockdown reducing anxiety disorders/ Positive effect of lockdown on QOL regardless of SPS

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Hellwig, S., & Roth, M.	2021	Multiple	Geneva Emotion Recognition Test (GERT; Schlegel et al., 2014)	Any potential relation between the factors of SPS and emotional recognition ability can be fully explained by the Big-5 personality traits. LST was found to be unrelated to emotional recognition ability.	Multiple environmental aspects/ Emotional recognition test environment/ Relationship between SPS and emotional recognition ability explained by Big-5/
Iimura, S.	2021	Multiple	Current life environment	Adolescents with high SPS were more likely to be affected by both negative and positive life events, which resulted in an increase in their socioemotional well-being. However, their SPS functioned as vulnerability when they experienced many negative life events. Lower SPS adolescents showed resilience regardless of the quality of their life events.	Multiple environmental aspects/ Current life environment/ High SPS/ increased wellbeing/ increased social wellbeing/ increased emotional wellbeing/ SPS as vulnerability factor/ negative life environment impact/ Low SPS associations with resilience any environment/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Lionetti, F., Klein, D. N., Pastore, M., Aron, E. N., Aron, A., & Pluess, M.	2021	Multiple	Early parenting environment	Children's sensitivity interacted with permissive parenting to predict rumination at age 9, which in turn predicted higher levels of depression.	Multiple environmental aspects/ Early parenting environment/ Childhood environment/ Interaction between parenting and sensitivity/ Predicting rumination/
Lionetti, Spinelli, Moscardino, Ponzetti, Garito, Dellagiulia, Aureli, Fasolo, & Pluess	2021	Relational	Parenting environment during COVID-19 Pandemic	High levels of parent–child closeness was protective for HSCs for internalising and externalising behaviours. HSCs showed overall slightly higher levels of internalizing behaviors before and during the lockdown. Low levels of parent–child closeness was associated with a small increase in internalizing behaviors during the lockdown in both low and highly sensitive children.	Parenting environment**/** COVID-19 pandemic environment/ Parent-child closeness protective for HSC in internalising and externalising behaviour/ HSC showed higher levels of internalising behaviour/ Low levels parent-child closeness associated with increase in internalising behaviours regardless of SPS

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
May, A.K. & Pitman, M.M.	2021	Multiple	Early parenting experiences/ Adjustment to university	Students with high levels of SPS reported significantly worse adjustment to university. Moderating effect for parental care for students low on SPS. Poor adjustment to university was driven by a propensity towards negative affect, but carefully and deeply processing stimulation by those with high SPS levels partially offset adjustment difficulties.	Multiple environmental aspects/ early childhood environment/ early parenting environment/ adjusting to university environment/ relationship SPS and adjustment/ adjustment difficulties/ moderating effect of parental care/ poor adjustment driven by negative affect/ helped offset adjustment difficulties
Moscardino, U., Scrimin, S., Lionetti, F., & Pluess, M.	2021	Relational	Family support	Three sensitivity groups identified: “Low sensitive” (43%), “Moderately sensitive” (33%), and “Highly sensitive” (24%). No difference between groups in baseline CVT. At low and average levels of family support, highly sensitive children with higher resting CVT reported better wellbeing than those with low resting CVT, this was not observed in other sensitivity groups.	family support environment/ Three sensitivity groups identified/ relationship between HSC, CVT, family support, and wellbeing/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Pérez-Chacón, M., Chacón, A., Borda-Mas, M., & Avargues-Navarro, M. L.	2021	Multiple	Working in education or healthcare fields at beginning of COVID-19 pandemic	Relationship between emotional exhaustion and SPS were significant in healthcare workers and educators. Relationship between DP and SPS was significant in educators. Increase in EOE would contribute to increasing emotional exhaustion. Being a healthcare worker and scoring high on EOE acted as a risk factor for personal realization. Low sensorial threshold and compassion satisfaction acted as protective factors in this area. EOE and EAS increased compassion fatigue regardless of sector.	Multiple environmental aspects/ Education environment/ Teaching environment/ healthcare environment/ COVID-19 pandemic environment/ relationship with emotional exhaustion/ increase ease of excitation negative impact/ risk factor for personal realization/ increased compassion fatigue/ different impacts by environment
Sklar, A. Y., Goldstein, A. Y., Abir, Y., Goldstein, A., Dotsch, R., Todorov, A., & Hassin, R. R.	2021	Sensory	Breaking continuous flash suppression (bCFS) task	Significant correlation found between NVPS and self-reported SPS.	Sensory environment/ Visual task/ Negative correlation between NVPS and SPS/

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Weyn, S., Van Leeuwen, K., Pluess, M., Lionetti, F., Goossens, L., Bosmans, G., ... & Bijttebier, P.	2021	Multiple	Parenting environment	Results did not support evidence for HSC Scale as a moderator for relationship between parenting internalising or externalising problems.	Multiple environmental aspects/ parenting environment/ childhood environment/ No evidence for HSC as moderating parenting and behaviour/
Yano, K., Kase, T., & Oishi, K.	2021	Multiple	University environment	Association between SPS and depressive tendencies even when controlling for neuroticism. Emotional coping skills were found to be negatively associated with depressive tendencies only when SPS was high. Decision-making skills were found to be negatively associated with depressive tendencies only when SPS was low. Interpersonal relationship skills were negatively associated with depressive tendencies, without SPS interaction.	Multiple environmental aspects/ Education environment/ SPS association with depressive tendencies/ High SPS emotional coping skills negative association with depressive tendencies/ Low SPS decision-making skills negative association with depressive tendencies/ SPS No interaction with interpersonal relationship skills and depressive tendencies

Authors	Year	Environment Type	Specific Environment	Relevant Key Findings	Initial Coding
Iimura, Shuhei	2022	Multiple	COVID-19 pandemic in Japan	Higher levels of SPS were associated with higher levels of COVID-19 stress. Resilience buffered the negative association between SPS, and COVID-19 stress.	Multiple environmental aspects/ COVID-19 pandemic environment/ Higher SPS - Higher levels of COVID-19 related stress/ Resilience buffers negative associations

Studied Environments			
Early Years For Child and Caregiver	**The senses, perception, and cognitive modification**	**Occupational environment**	**Multi-faceted environment**
Parenting • Parenting environment • Parenting child with additional needs • Family support environment • Early parenting environment • Parenting child with ASD **Childhood** • Environment of childhood • Early childhood environment • Difficult early childhood • Childhood environment • Family environment in childhood	**Task** *Sensory Task* • Pain inducement task environment • Visual task • Listening Tasks *Cognitive Task* • Stress task environment • Emotional recognition test environment • Attention Task • Evaluation of emotional material **Exposure** *Activation of emotions/systems* • Manipulated environment • Create frustration in present • Activating attachment system • Viewing positive and negative video clips • Viewing positive video clip • Mood induction Terror-related media exposure environment *Impact on senses* • Sensory environment • Perceptual environment	**Working environment** • Work environment • Dentistry • Working environment • Teaching environment • Healthcare environment • Nursing environment **Educational environment** • Adjusting to university environment • School environment • Transition to high school environment • Education environment • University environment	• Social environment • Multiple environmental aspects • Current life environment • War environment • COVID-19 pandemic environment • Extraverted environment • Internet environment • Physical environment • Seasonal environment • Lockdown environment • Competitive sporting environment • Foreign environment

	• Audio stimulatory environment • Exposure to noise environment • Viewing ASMR environment **<u>Intervening in the environment</u>** • Intervention environment • OCD treatment environment • Exposure therapy environment • School-based intervention • Resilience programme environment • Anti-bullying programme environment • Yoga course environment		

Outcomes for SPS in environments		
Mental Health and Wellbeing	**Cognition**	**Relationships with Other Internal and External Factors**
<u>Impacted areas:</u> *Positively impact* • Positive relationship SPS and positive emotional reactivity • SPS associated with wellbeing • Bigger increase in wellbeing • Increased wellbeing • Increased social wellbeing • Increased emotional wellbeing • Low SPS associations with resilience any environment • More pronounced effects - greater change in positive mood • Effective reducing depression in high SPS girls not low SPS • HSC boys benefited more reduction in victimisation • HSC boys benefited more reduction in internalising symptoms • Lockdown reducing anxiety disorders • Increase in positive affect for high SPS • Decrease in negative affect following all videos for HSP • Increase in wellbeing post intervention • Reduction in depression • Increasing self-esteem • Greater arousal levels to positive stimuli • Parent-child closeness protective for HSC in internalising and externalising behaviour *Negatively impact* • Attachment anxiety has a relationship with SPS	**<u>Abilities:</u>** *Processing* • Difficulties with emotional identification • Accuracy in classifying positive scenes impacted • Negative correlation between NVPS and SPS • Reduced comprehension of internal and external stimuli as rationally understandable • Negative impact on CDT latencies • Increased listening effort • Faster RT for rating positive valence • Deeper processing of material • Improvement in attentional control • Positive correlation with SPS and variation in attentional control • Greater attention engagement • HSPs not more distracted when controlling neuroticism • No enhanced processing in teaching • No significant difference in cognitive performance • Lowest Stroop response time • No association with accuracy and SPS in visual task • Significant relationship with minor-minus-major difference • Predicts performance in RT and error in visual search task • No difference in recognising vocal expressions of emotion *Affective*	*Internal Factors* • Stress accounts for attachment anxiety-SPS relationship • Stress impacts on HSP • SPS links with intolerance of uncertainty • Stress mediated relationship • Relationship SPS and adjustment • Poor adjustment driven by negative affect • Helped offset adjustment difficulties • Nightmare sufferers higher in SPS • SPS as vulnerability factor • No significant relationship with OCD treatment outcome when controlling pre-treatment factors • No relationship for SPS with high reactivity • Differences between SPS and reactivity • Interaction with optimism and pessimism • Attachment anxiety mediated relationships • Association with avoidant coping irrespective of parenting environment • No prediction when gender interaction included • Resilience buffers negative associations • Relationship between SPS and emotional recognition ability explained by Big-5 • Strong sense of coherence protective • Strong SOC decrease depression severity for high HSP • Moderating effect of SPS on mismatch and depression • Correlate with mismatch • SPS Correlates with neuroticism • Risk of burnout correlation - Stress mediated relationship • High SPS emotional coping skills negative association with depressive tendencies

• Higher levels of SPS - Higher levels of distress • Creating state negative affect • Creating trait negative affect • High SPS and unpredictability leads to anxiety • Burnout can be predicted by SPS • Work satisfaction impacted by SPS • SPS positive correlation with secondary traumatic stress • Positive relationship SPS and negative emotional reactivity • worse physical comfort emphasised • Adjustment difficulties • SPS impacts on psychological work factors • Associations with negative affect • associations with work displeasure • Associations with need for recovery • SPS associated with negative outcomes • SPS sub-facets relationship negative affect • Negative relationship with physical wellbeing • Negative relationship with psychological wellbeing • Avoidant personality disorder features relationship • Optimism and APD features negatively correlated for high SPS • Pessimistic features and high SPS - high APD features • Negative impact on externalising behaviour • Negative impact on internalising behaviour • Decline in wellbeing • Association with negative psychological outcomes • Indirect impact on parental mental health • Related to PTSD • Relationship with adversity and sensitivity	• Difficulties with emotional description • Reduced sense of coherence • More attunement to student need *Behavioural* • Simple things more difficult for HSP • Decreased finding meaningfulness • Negative relationship with functional capacity • Positive impact on social competence • Engage in different practices to cultivate wellbeing • Coping strategies utilised • Diverts attention to Prevent sensory overload **<u>Perception:</u>** *Self-perceiving* • Self-perception academically moderated for better and worse • Self-perception socially moderated for better and worse • Different emotional experiences valued for wellbeing • Feeling different to others *External world* • Perception of listening tasks as difficult • Sensitivity associated with perception • Likelihood of terrorist attack perception higher • Perception of wellbeing coming from harmony of different areas • Reduced perception of manageability in work	• Low SPS decision-making skills negative association with depressive tendencies *External Factors* • Childhood environment affects HSPs • Impact of negative experiences • SPS interacts with environments • Unpredictability impacts negatively on HSP • Approximately one third of organisational expatriates were highly sensitive • Approximately one quarter expatriates high in SPS • HSC moderates relationship between adversities and resources on wellbeing • environmental impact on physical and psychological outcomes • relationship between HSC, CVT, family support, and wellbeing • Moderating effect of parental care • Negative life environment impact • No evidence for HSC as moderating parenting and behaviour • Interaction with noise environment • Results varied by environment type • Impact of terror content on privacy wants • SPS interaction with environment • Impact of environment type parenting quality • affected by parenting quality • Sensitivity to permissive parenting • Parenting style interaction • Benefits of authoritative parenting • Interaction with quality of parenting • High-quality parenting interacts with SPS and impacts response to stimuli • Highly sensitive children with low adversities PTSD most impacted by war • Greater impact of intervention for higher SPS

• Negative impact on mental health • Higher negative affect • Relationship with emotional exhaustion • Increase ease of excitation negative impact • Risk factor for personal realization • Increased compassion fatigue • Relationship with depression • Relationship with anxiety • SPS association with depressive tendencies • SPS relationship with nursing stress • Burnout association • SPS predictor for negative wellbeing • Relationship with psychosomatic disorders • Higher stress levels • Lower levels life satisfaction • Higher SPS - Higher levels of COVID-19 related stress • Predicts increased perceived stress • HSPS somewhat more distressed • Difficulty coping with mismatch factors • Greater risk of burnout due to emotional exhaustion • More stress at work • Main effect on social anxiety • Higher levels of internalising problems controlling for parental rejection • Predicting rumination • Aspects of SPS amplify negative outcomes • Aspects of SPS amplify job demands - emotional exhaustion relationship • Higher social anxiety • High SPS respond to competition with more shame and anxiety • Greater stress to aspects self-discrepancies for high SPS • Depression increasing with SPS		• Correlation with parental overprotection • Interaction effect for depression, between parental care and SPS • Poor physical health and saying no are barriers to wellbeing • SPS interaction with parenting in predicting behaviour • High SPS Decrease in externalising behaviour parenting dependent • High SPS Increases in externalising behaviour parenting dependent • Optimal parenting environment no difference in happiness by SPS level • Optimal parenting environment little difference for men • Part of relationship with stress, work, and coping • More benefit from therapeutic intervention for high SPS • Interaction childhood experiences, SPS, wellbeing • No effects of positive childhood experiences • Demands as sources of stress • Environmental stimulus not affected • Interaction between parenting and sensitivity • Positive effect of lockdown for average SPS on anxiety • Positive effect of lockdown on QOL regardless of SPS • Attachment anxiety role in parenting styles at different levels of SPS • Scores on SPS increased by season for SAD participants • SPS predictor of treatment response • Reduced HSPS scores post- OCD intervention • Low levels parent-child closeness associated with increase in internalising behaviours regardless of SPS

• High SPS summer more severe depression winter • Poor parental environment - unhappy childhood for HSP • HSC showed higher levels of internalising behaviour **<u>Null findings:</u>** • SPS not linked to externalising behaviour • SPS not linked to prosocial behaviour • SPS not predictive of response to media • SPS not moderative of response to media • No correlation with reactivity • Differences not significant post-course • SPS no interaction with interpersonal relationship skills and depressive tendencies • No significant difference in wellbeing • No interaction effect found childhood environment, SPS, anxiety • Hypothesis not supported RE ASMR		

Different aspects of Sensitivity and SPS
SPS Groupings • Three sensitivity groups identified • Similarities between three sensitivity groups for negative emotional reactivity • Different sensitivity groups • Differences in SPS levels identified • Individual factors of SPS predict interaction **Other sensitivities** • Vantage sensitivity supported • Diathesis-stress not supported • Differential susceptibility not supported • For better and for worse are different for SPS and reactivity

Appendix G

Examples of Coding of Qualitative Data From MRP

Question 1: “”

Table G.1
Coding example for Qualitative Question 1

Participant’s Answer	Codes
I felt interested to see what would happen in the everyday seen. I watched the trains, buses and cars waiting to see if people would appear in the scene. I felt interested and alert during the clip, paying attention to the details of the scene and imagining in my head who might appear on the scene (e.g., a commuter going to work on the train). I also felt a little bit of nostalgia as I have used both the train station and post office depot previously. This stirred up some memories of times I have been waiting for the bus at that station and collecting parcels from the depot as a teenager. I also thought of my own car as my model of car passed in the video. For me, the video scenes were familiar and interesting, as a local.	Curiosity/ Focus on details/ Interested/Feeling alert/ Imagination sparked/ Feeling nostalgia/Familiarity with area/ Memories of place/ Familiarity with area/ Interested
it was a very relaxing video of nature scenes. I was trying to see if I recognised the beach. It made me think that I would love to be at that beach now going for a swim. The scenes of the woods were peaceful also and made me think about going for a walk today. Around the middle of the video I started getting a bit bored and distracted wondering how much longer it would be despite finding the footage to be pleasant	Relaxed/ Attempts to recognise the area/Wish to change own surrounds/ Want to engage in outdoor activity/Bored/ Pleasant video/

Table G.2
Coding example for Qualitative Question 2

Participant’s Answer	Codes
I spend time in nature almost everyday as I live in a rural area and close to a woodland where I take my dog for walks. I find spending time in nature very relaxing and rejuvenating and notice that I also feel better and have more energy after going outside. In warmer months I go to the beach most weekend for a swim in the sea and a walk along the headlands and it has become part of my routine since the pandemic.	frequent nature exposure/living in rural area/walking dog in nature/nature brings relaxation/nature brings rejuvination/nature brings energy/impact of weather on nature experience/swimming/walking in nature
I enjoy going for walks in the countryside and also enjoy the sound of running water like rivers and the sound of waves on the beach	Walking in nature/ enjoys auditory aspects of nature/enjoys bluespaces

Appendix H

Table of Demographic Information of MRP Participants

Table 4.1
Demographic Information of Participants

Information	*n*	*%**
Age Group		
18-29	29	19.70
30-39	18	12.20
40-49	26	17.70
50-59	30	20.40
60-69	27	18.40
70+	14	9.50
Sex		
Male	68	46.30
Female	78	53.10
Prefer not to say	1	0.70
Nationality		
Irish	136	92.60
British	4	2.70
British/Irish	2	1.40
Asian	1	0.70
French	1	0.70
Spanish	1	0.70
Turkish	1	0.70
United States	1	0.70
Highest Educational Level		
Primary Education	1	0.70
Upper Secondary School e.g. Leaving Certificate, LCA	27	18.40
Third Level non degree e.g. Diploma	29	19.70
Third level degree	41	27.90
Postgraduate degree	49	33.30
Area Lived in Currently		
Rural	66	44.90
Urban	41	27.90
Suburban	40	27.20
Country of Current Residence		
Ireland	139	94.60
United Kingdom	5	3.50
Australia	2	1.40
United States	1	0.70

* Including missing data

Appendix I

Stroop Advice on Hand placement and Stroop Script

On the following screen you will be completing a task using several keys on your keyboard - namely R, G, B, and Y.

Here is an image of how we would recommend putting your fingers on the keyboard for this task.



Press the arrow on the bottom right of your screen to continue.

Before you begin, can you read these words?

YELLOW RED

GREEN BLUE

YES => Press Y NO => Press N

Practice STROOP Task Instructions

In this task you will see colour names

(YELLOW, BLUE, RED, GREEN)

each printed in a different colour, followed by a white cross in the centre of the screen

Your task is to respond to the print colour of the word.

So, for example, if you see

GREEN

You need to respond with the printed colour, (i.e., red).

You respond using the keys on your keyboard.

R (red) B (blue)

Y (Yellow) G (green)

Try to ignore the meaning of the word, and look at the printed colour

You can still answer when the white cross is on the screen.

You will now have a practice round to try this out before completing the task.

Press the SPACE BAR to begin.

Main Task Instructions

In the main task, again you will see the same colour name, each printed in a different colour.

You will NO LONGER RECEIVE FEEDBACK on your answers,

Your task is to respond to the print colour of the word.

So, for example, if you see

GREEN

You need to respond with the printed colour, (i.e., red).

You respond using the keys on your keyboard.

R (red) B (blue)

Y (Yellow) G (green)

Try to ignore the meaning of the word, and look at the printed colour

You can still answer when the white cross is on the screen.

Press the SPACE BAR to begin.

Appendix J

Ethics Application with Amendments, and Letter of Ethical Approval and Follow Up Emails Following Amendments

University College Cork

School of Applied Psychology

Doctor of Clinical Psychology

Feedback Form - Major Research Project Proposal

Trainee:	Eimer Cadogan 112329751
Supervisor:	Dr Annalisa Setti, Dr Mike Murphy
Project Title:	Impact of nature intervention on rumination in the highly sensitive person

Research Panel Decision

Please circle ONE of the following decisions:

Pass unconditionally

Pass conditional on required revisions

Currently not passable; revise and resubmit

Not competent / passable; a different project proposal is required

Feedback and any revisions required:

Major Research Project Proposal for:

Impact of nature intervention on rumination in the highly sensitive person



Name: Eimer Cadogan

Student ID: 112329751

Academic Supervisors: Dr Annalisa Setti, Dr Mike Murphy

Date: ~~8th January 2021~~ ~~26th October 2021~~ 20th November 2021

Wordcount for Proposal: ~~3255~~ 3527

Declaration of Academic Honesty: I declare that the content of this assignment is all my own work. It has not been submitted in respect of any other course/module. Where I have used the work of others it is acknowledged and referenced accordingly.

Background and Rationale

Two of the most common mental health issues globally are depression and anxiety, with depression being ranked by the WHO as the single largest contributor to global disability and anxiety ranked 6th (WHO, 2017). A group of people who are particularly at risk for this are Highly Sensitive Persons (HSPs). The HSP construct was popularized in self-help literature, though it is in fact a well characterized scientific construct though it remains understudied in Ireland.

The trait that defines HSPs is known as Sensory Processing Sensitivity (SPS), it is a genetically based trait, which has been found to be associated with greater levels of sensitivity and responsivity to social and environmental stimuli (Acevedo et al., ~~Aron, Pospos, & Jessen,~~ 2018). It is distinct from introversion and sensory processing disorder. The trait is characterized by high levels of sensitivity to stimulation offered by the environment and HSPs are identifiable by their heightened emotionality, empathy, and depth of processing (Aron et al., ~~Aron, & Jagiellowicz,~~ 2012). At present, the literature would suggest considering SPS as a continuum with three broad categories i.e. indicating there are low, medium, and highly sensitive individuals (Lionetti et al., 2018). However, this trait goes beyond processing of sensory inputs, and also comprises a deep sense of beauty, as well as empathy towards others' suffering (Greven et al., 2019). HSPs are thought to represent a significant minority of the population, 20-35% approximately (Greven et al., 2019).

Although the trait would appear to confer benefits, those who have it, due to their sensitivity, are more vulnerable to unfavourable environments yet have the ability to thrive in more suitable environments. For example, research would suggest that SPS is a risk factor for the mental health issues of anxiety and depression (Booth et al., ~~Standage, & Fox,~~ 2015; Liss et al., ~~Timmel, Baxley, Killingsworth,~~ 2005) particularly when HSP children grow up in chaotic environments. One recent review hypothesized that it is dysfunctional cognitive responses to environmental stimuli (e.g. rumination) mediating the relationship between SPS and psychological distress (Wyller et al., 2017).

Indeed, rumination is a process common in cognitive theories of both depression and anxiety in general.

However, the SPS trait can confer strengths in terms of cognition, e.g. attention, with a study from Jagiellowicz et al. (2011) showing that those with greater levels of SPS showed stronger activation in brain regions for visual and attention processing when asked to notice subtle differences in photographs. Similarly, a study from Aron et al., (2010) found that individuals high in SPS to be less influenced by cultural differences in tasks evaluating context dependency. This finding would suggest that HSPs can focus on tasks themselves independent of other factors. This is interesting, as research has shown that impaired attentional control, particularly narrow and inflexible attentional focus, could increase risk of depression through the promotion of ruminative thinking (DeJong et al., ~~Fox, & Stein,~~ 2019). Therefore, if an HSP individual focuses on negative thoughts it may be more difficult for them to interrupt them. However, HSPs are also more susceptible to distraction due to overwhelm from external factors and strong stimuli, e.g. bright lights, loud noises, which is a feature of the trait (Aron & Aron, 1997).

Considering the biopsychosocial model of mental health, the environment has a large role to play in determining mental health outcomes and more so for HSPs (e.g. Liss et al, 2005). Here environment refers not only to the psychological and social world, but also the physical environment. In recent years, there has been significant growth in research around the benefits of interacting with natural environments, also known as green spaces (e.g. parks, fields) and blue spaces (e.g. the seaside). These benefits include improvements in cognition, in mental and emotional health (Bratman et al., 2019). For example, a recent meta-analysis from Roberts et al (2019) showed a significant reduction in depressive mood is found following nature exposure. Nature interventions have also been shown to aid anxiety (e.g. Reynolds et al., 2018). This is pertinent, as HSPs by their very definition are more sensitive to their environment and show a need for connectedness to nature (Black & Kern, 2020).

One theory as to why nature confers these benefits is called the Attention Restoration Theory (ART) (Kaplan & Kaplan, 1989). This theory posits that nature has the ability to renew our attention and cognitive capacities after we exert mental energy, as it allows us a space for effortless attention, e.g. watching the clouds float across the sky, rather than the directed attention that most tasks demand. Indeed, a study from Bratman et al., (2015) showed that a 90 minute walk in nature decreased both self-reported rumination and activity in the subgenual prefrontal cortex (sgPFC), a brain area which is associated with self-focused behavioral withdrawal linked to rumination in individuals both with and without depression.

As HSPs show measurable differences in aspects of their cognitive functioning and are likely impacted on by the cognitive process of rumination, and the literature would suggest that nature based interventions have the capacity to improve cognitive functioning, including ruminative thinking, this raises the question of how effective would such an intervention be for HSPs. Investigating protective and risk factors associated with an increased vulnerability to depressive and anxiety symptoms in HSPs, and their relationship with cognitive processing which can have potential regulatory functions, can have clinical and applied implications for informing both intervention and prevention programs. This is especially important, given that while HSPs represent 20 - 35% of the general population, they represent closer to 50% of clients in most psychotherapy practices (Aron, 2011).

Importantly, HSP may benefit more from such interventions due to their sensitivity to the natural environment and their disposition to benefit from interventions. In fact, along with their high reactivity, HSPs have the ability to capture subtlety in the surrounding environment making highly sensitive individuals more susceptible to intervention programs (Nocentini et al., ~~Menesini, & Pluess,~~ 2018; Pluess & Boniwell, 2015), which would suggest that should environmental interventions prove to be beneficial to HSPs, it could have big implications for mental health provision in general due to their ubiquity in mental health services. Nature potentially presents a readily available and cost-

effective way to provide cognitive restoration, i.e. decrease in ruminative thinking and increase in attentional capacities, which are related to depression and anxiety. In addition nature, as expressed by the Stress Relief Theory (Ulrich et al., 1991) can have a direct positive impact on mood and relief from stress, which is also related to anxiety and depression. Thus, the present project proposes to explore the beneficial role of natural environments in decreasing maladaptive cognitive strategies linked with anxiety and depression, i.e. rumination, in HSPs as well as increasing positive affect. ~~We will be investigating solely greenspaces as opposed to bluespaces, which is generally considered separately to greenspace in the literature (Houlden et al., 2018).~~

The current study will utilise virtual nature experiences. With the current COVID-19 crisis, and the possibility of regional lockdowns, access to nature may not be guaranteed for those living in urban areas. Thus, in the present study, we will be assessing the impact of a virtual nature intervention on cognition, and rumination and affect. Studies have shown that viewing video or photographic images of nature reduces stress, improves mood, and also reduces negative affect (e.g., Brown et al., ~~Barton, & Gladwell,~~ 2013; de Kort et al., 2006), with the inclusion of nature sounds with video shown to aid in stress recovery (Annerstedt et al., 2013). In a recent study, exploring 360 videos of nature for five minutes was sufficient to lower negative affect in student with high exam anxiety (O'Meara et al., ~~accepted~~ 2020).

It is hypothesized that individuals high in HSP will show higher benefit in cognition and affect, as well as decreased rumination copying strategies, from a nature-based intervention. It is expected the effect of this manipulation to be greater particularly if they also show higher levels of depressive and anxiety symptoms, due to HSPs' heightened environmental sensitivity and likely higher levels of rumination, as well as their sense of beauty and higher levels of nature connectedness. Exposure to natural environments will be compared with a control condition where participants are exposed to an urban environment, in line with the paradigms utilised in the literature on Attention Restoration and Stress Relief.

Following the intervention, participants will also be presented with a number of open ended questions, which will be analysed using content analysis to aid us in gaining insight into their experience of their particular intervention, as well as their own experiences of nature as way to restore cognition and promote positive affect in real life.

This study has important implications for informing intervention and prevention programs for supporting the wellbeing of people at risk of depressive or anxiety symptoms, as well as expanding the literature on SPS in Ireland. The qualitative element of the study will aid in refining such interventions going forward, and in capturing the experiences of nature of HSPs. This is of particular relevance in the Irish context, as no published studies on HSP so far have been based in Ireland.

For a summary of the theory underpinning the project, please see Figure 1 below;

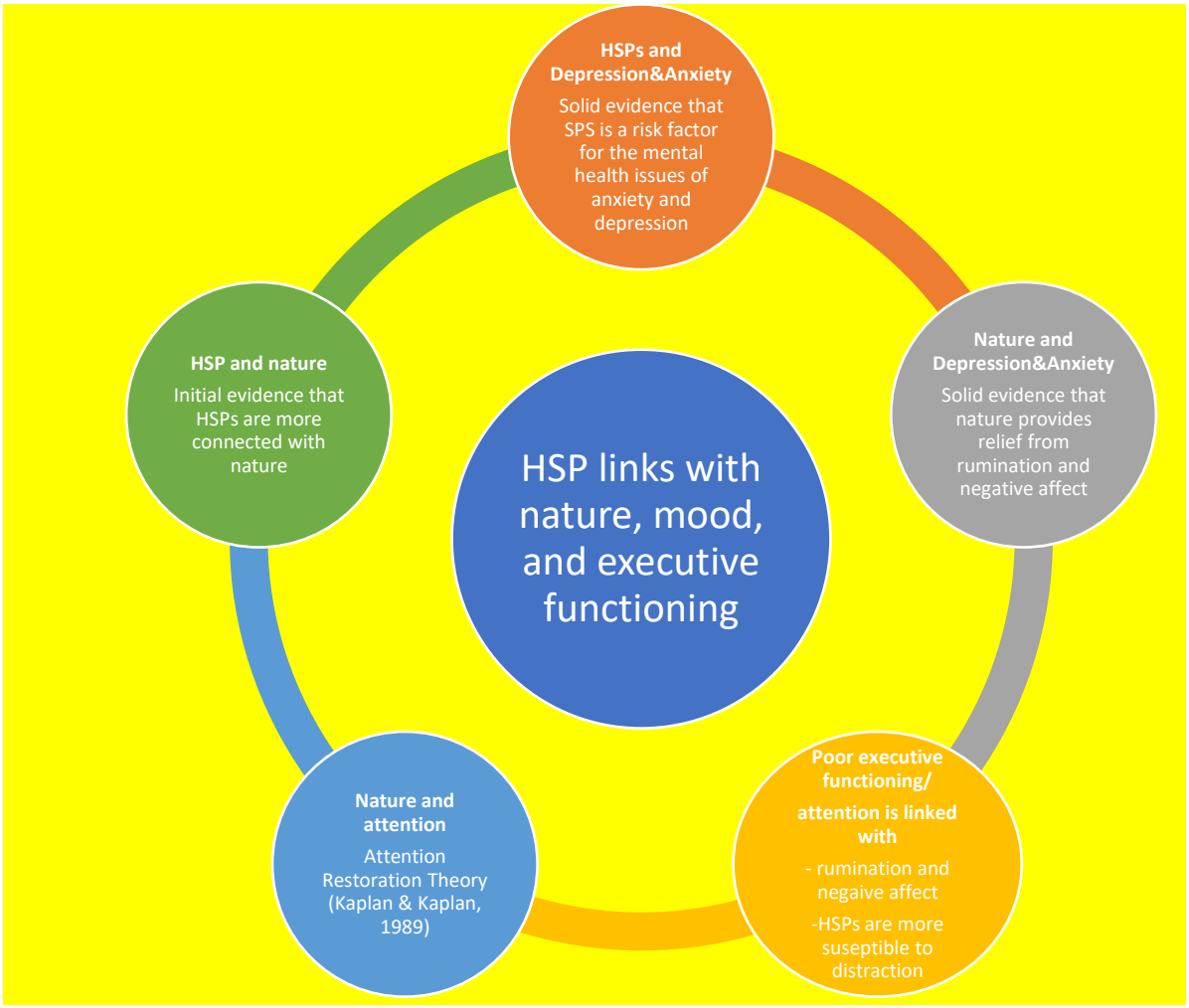


Fig.1 Summary of theoretical background to project

Methodology

Brief Description of Study

A pre/post-test study investigating the impact of a virtual nature intervention and virtual urban intervention on rumination, cognition, and affect in adults with varying levels of sensory processing sensitivity (SPS), depression and anxiety. The study also has a qualitative component, in

which participants will be asked about their experiences of the intervention, and their relationship with nature in their daily lives.

Research Questions

Pre/Post test study

1. ~~Do all participants~~ Do participants, irrespective of their HSP score, show greater improvements in cognition (attention/inhibition) and affect, as well as decreased rumination coping strategies, following the virtual nature-based intervention compared to the urban intervention? Is this moderated by levels of depression and anxiety?
2. Do HSPs show greater improvements in cognition and affect, as well as decreased rumination coping strategies, compared to non-HSPs following the virtual nature-based intervention? Is this moderated by levels of depression and anxiety?

Qualitative aspect of the study

1. What are the experiences of participants completing the different interventions?
2. What are the experiences of participants of nature in their daily lives?

Design

A pre/post-test experimental design, with random assignment to conditions i.e. virtual nature or urban intervention. Qualitative component examining the experiences of participants.

Participants

Participants will include a community sample. Participants will be of all genders, and will be required to be at least 18 years old with no upper age limit.

Recruitment will be conducted through a call for participants using student email, as well as by word of mouth and snowball sampling. As this is a doctoral level project, the reach from this

email will be wider within UCC than if it were for an undergraduate project. Social media sites such as Twitter and Facebook will be utilised in recruitment. The researchers will share links to the study from their pages, ask the Applied Psychology UCC Twitter account to retweet, and encourage others to share and retweet the posts. Websites which allow one to post links to studies will also be contacted and the link to the study shared. As this may result in participants from other countries, a question on where one resides will be included with demographics.

Using *a priori* power analysis, carried out on G*Power version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009) for linear multiple regression, an estimate of a sample size of 107 is required to detect a moderate effect size f^2=0.15 with a power level >.95 and an alpha of 0.05. This would indicate 54 participants are needed in each condition. This would be in line with Tabachnick and Fidell's (2007) formula of N > 50+8m, where m is number of independent variables i.e. N> 90. See ~~below~~ Appendix A for screenshot of calculation.

Data Collection

Data will be collected through the online survey platform, Qualtrics.

Measures

Highly Sensitive Person Scale (HSP)(Aron & Aron, 1997) Scale measuring SPS, consisting of 27 items. Cronbach's α of 0.87 in Aron & Aron (1997). Participants are presented with a series of statements - e.g. "I seem to be aware of subtleties in my environment", "I have a rich, complex inner life", "I am deeply moved by the arts or music"- and are instructed to answer each according to how they feel. A seven point Likert scale is employed, with 1 indicating "Not at all", 4 "Moderately", and 7 "Extremely". HSPs and non-HSPs will be classified using the scale results, such that those with a mean item score of 4 or above will be classified as HSP and those with a score below will be classified as non-HSP. However depending on the mean and median of the sample, I will consider HSP the highest quartile of the distribution. HSP will be also as continuous variable, as HSP is a

personality trait that can be present in different degrees in the population and there are no established clinical cut-offs across populations.

Measure of Trait Negative Affectivity (Aron & Aron, 1997) In order to allow for the controlling of trait negative affectivity a three-item measure from Aron and Aron (1997) is suggested by Aron and Aron (2018). They suggest partialling this out as many of the HSP Scale (Aron & Aron, 1997) items involve negative affect and negatively worded questions. The items are; "Are you a tense or worried person by nature," "Are you prone to fears?" and "Are you prone to depression?".

The Depression, Anxiety and Stress Scale (DASS-21) (Antony et al., 1998) consists of 21 Items. It is a set of three self-report scales designed to measure the emotional states of depression, anxiety, and stress. Each of DASS-21 scales contains 7 items, divided into subscales which contain similar content. Research has shown it to be reliable and valid worldwide, thus demonstrating the DASS-21 is a well-established instrument for measuring symptoms of depression, anxiety, and stress in both clinical and non-clinical samples of adults (Beaufort et al, 2017).

Brief State Rumination Inventory (BSRI; Marchetti, Mor, Chiorri, & Koster, 2018) This is a short self-report scale which assesses the state of ruminative self-focus. It consists of 8 items, with these items being evaluated on a 100-mm visual analogue scale (VAS) ranging from completely disagree to completely agree. The scores are then summed such that higher scores indicate greater depressive rumination i.e. minimum of 0 maximum of 800. The scale has shown to be reliable, as well has having good convergent and discriminant validity and sensitivity to experimental manipulation of rumination when tested by Marchetti et al. (2018). Their experimental manipulation in this lasted approximately 11 minutes, with a similar manipulation from Altan-Atalay, Kaya KiziLoz, Donger, and Demiray (2020) lasting approximately 7 minutes. While these studies also utilised 5 minutes of neutral videos to neutralise the participants mood state prior to the manipulation, this will not be utilised in the current study to maintain ecological validity to how individuals experience

nature in their day to day lives. Cronbach's alpha in a recent study ranged from α = .91 to α = .93 (Dondzilo, Rieger, Shao, & Bell, 2020).

PANAS (Watson, Clark, & Tellegan, 1988): This is a self-report questionnaire consisting of two 10-item scales that measure positive and negative affect. Items are rated on a 5-point Likert scale of 1 (not at all) to 5 (very much). The tool is validated and used in both clinical and non-clinical populations (Crawford & Henry, 2004).

The Stroop Colour and Word Test (SCWT) (Stroop, 1935) is a neuropsychological test used for both experimental and clinical purposes to measure cognitive control, selective attention, and processing speed. The task shows that participants are slower and/or make more mistakes naming the ink of a printed colour word when the ink name and the printed word are incongruent (e.g., the word green printed in blue) than when they are congruent (e.g., the word blue printed in blue). The Stroop has been found to be affected by the tendency to ruminate in a previous study, due to greater difficulty to ignore irrelevant information (Philippot & Brutoux, 2008). A question will be added following the Stroop both times it is presented to ensure there were not any difficulties which prevented the participants from completing the task that may result in their data needing to be excluded from analysis. The question is as follows; " Did you encounter any specific difficulties while completing the previous task? For example; technical difficulties or having trouble distinguishing the different colours from one another etc. "

Demographic and technological information: Participants were asked for their age, sex, nationality, highest level of education achieved and what kind of area they live in (i.e. rural, urban, suburban etc.), and what country they live in. Information regarding the device they are completing the study on will also be sought to allow for analysis of the effects of screen on immersion.

Restoration effect question: In order to ascertain if the participants' personal relationship with the landscapes presented could be impacting on the restoration effect, a single Likert style question will be asked; "Did the place you saw in the video resemble a place you have good or bad

memories of?" and the answer options, "It resembled a place I have very good memories of, It resembled a place I have somewhat good memories of, It resembled a place I have neutral memories of, It resembled a place I have somewhat bad memories of, It resembled a place I have very bad memories of, It did not resemble a place I have any memories of".

Open-ended questions around experience: Questions will be asked around participant's experience of the intervention, and around their experience of nature in daily life. See Appendix ~~III~~B for questions.

Interventions

Interventions will consist of a video with related audio of either a nature scene or an urban scene. The use of these two contrasting conditions, nature and urban settings, is characteristic of the research in this area (e.g. Berman et al., 2012; Bratman et al., 2015). These will be of ~~an Irish~~ a nature and urban setting, and will be reviewed by the researcher, supervisors, and other researchers with an interest in the field to ensure they capture the elements of greenspace and urban scenes respectively. Weather will be consistent in both interventions (i.e. no precipitation, light cloud cover to clear skies) to ensure this does not confound results. A greenspace with biodiversity will be chosen for the nature intervention, as research suggests that wellbeing shows a positive relationship with the perceived richness of the greenspace by the individual (Dallimer et al., 2012).

The intervention length of approximately 10 minutes has been chosen based on the literature in the area. For example, in a study from Barton and Pretty (2010) it was found that dose responses for both intensity and duration of nature interventions showed large benefits from short engagements in green exercise, and then diminishing but still positive returns, with a short dose being 5 minutes. ~~Furthermore,~~ More pertinently, other research using virtual nature interventions have utilised a 10 minute intervention and found this length of time to be effective (e.g. Reynolds et al., 2020; Brown et al., 2013; Reynolds, Rodiek, Lininger, & McCulley, 2018).

Procedure

Participants will be emailed and provided with a link outlining the study and asking for their participation or they will access the link directly from social media or websites hosting the link. Participants will be randomly assigned to different conditions. Random assignment will be carried out by using this option on the Qualtrics survey site using the "Evenly Present Elements" option so approximately 50% of participants will be in each condition. They will be asked to complete the initial questionnaires and T1 measures. The intervention will be embedded into the middle of the survey. This will consist of a video depicting a nature scene with nature sounds, or an urban scene with related urban sounds. T2 measures will then be completed, as well as the open-ended questions for qualitative analysis.

Data Analysis

Data will be analysed using IBM's SPSS. Descriptive statistics will be run to show the mean and frequency of different personal data e.g. age, gender etc. Scale descriptive statistics will be run to assert the level of reliability of the different scales used in this study. Multiple regression analyses and post hoc analyses will be run in order to ascertain the relative impact of each intervention, and the SPS construct and the moderators on affect and cognition and rumination.

Qualitative data will then be analysed using conventional content analysis (Hsieh & Shannon, 2005), which allows for categories and names for them to flow from the data itself. Given the limited research into this area with HSPs, using such an open approach will allow for insight into their experiences without imposing theoretical framework which may not match their experiences. This form of qualitative analysis was chosen as the aim of the work is to describe the phenomenon, and not to develop a theory around it as is the aim of other qualitative methods e.g. grounded theory.

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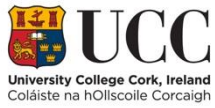
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ETHICS APPROVAL FORM

Clinical Psychology Research Ethics Committee (CPREC)

✉ nhennessy@ucc.ie

Introduction

UCC Clinical Psychology doctoral students who are seeking ethical approval for research should complete this approval form. CPREC, as a component of the ethical oversight structures of the School of Applied Psychology, reports to the Social Research Ethics Committee (SREC)[1].

CPREC approval is required where the methodology is not clinical or therapeutic in nature and proposes to involve:

- direct interaction with human participants for the purpose of data collection using research methods such as questionnaires, interviews, observations, focus groups etc.;
- indirect observation with human participants for example using observation, web surveys etc.;
- access to, or utilisation of, anonymised datasets;
- access to, or utilisation of, data or case files/records concerning identifiable individuals

OR where

- therapeutic engagement with patients/clients is clearly psychological in nature, and
- there is no gathering of biological samples.

CPREC considers itself an enabling committee, working as a part of SREC in promoting strong research ethics amongst UCC's community of staff and student researchers. We seek to support applicants in conducting their research, and all feedback is provided in such a spirit.

Application Checklist

This checklist includes all of the items that are required for an application to be deemed complete. In the event that any of these are not present, the application will be returned to the applicant ***without*** having been sent for review. Please ensure that your application includes all of these prior to submission. Thank you and best of luck with your research.

All relevant files are combined into one PDF file (CPREC application form, consent/assent forms, information sheets, data collection instruments, permission letters, etc.)	Yes
Completed CPREC Application Form	Yes
Information Sheet(s) / Information Statement (i.e. at the beginning of an electronic survey) included	Yes

Consent Sheet(s) / Consent Statement (i.e. at the beginning of an electronic survey) included	Yes
Data Collection Instrument: Psychometric Instruments / Interview Guide / Focus Group Schedule / Survey Questionnaire / etc. included	Yes
Copy of permission letters to undertake research from relevant agencies/services included (if available)	Yes
Your supervisor(s) have approved the wording of and co-signed this application prior to submission	Yes
If this is a resubmission, all the revised and new text is highlighted in yellow	YES

APPLICANT(S) DETAILS

Name of applicant(s)	Eimer Cadogan	**Date**	08/01/2021
Email Address	112329751@umail.ucc.ie	**Contact No.**	087 2717005
Correspondence Address	Gogginshill, Ballinhassig, Co. Cork T12 E2FV	**Name(s) of supervisor(s)**	Dr Annalisa Setti Dr Mike Murphy
Is this a resubmission?	No	SREC Log No. (if known):	

Obtaining ethical approval from CPREC does not free you from securing permissions and approvals from other institutional decision-makers and agency ethical review bodies. These bodies may accept the SREC approval, but researchers are responsible for ensuring they are compliant in advance of collecting data.

Project working title	Impact of nature intervention on rumination in the highly sensitive person

If this is a collaborative project / community-based participatory research project / *joint* application with another agency, please complete this additional section:

Names of research partners / civil society organisations collaborating on this project (this section must be completed for	

participatory / community-based participatory research studies)	
Agency contact person and position	
Agency address	
Details of the partnership (roles, type of partnership, etc.)	

ETHICAL APPROVAL SELF-EVALUATION

If your answer falls into any of the shaded boxes below, please address each point later on in the application form

		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/questions to which they do not wish to respond?	X	
6	Will data be treated with full confidentiality/anonymity (as appropriate)? Does your project require you to carry out a Data Protection Impact Assessment (DPIA) in compliance with UCC Data Protection Policy?	X	~~X~~
7	Will data be securely held for a minimum period of ten years after the completion of a research project, in line with the University's *Code of Research Conduct* (2016)?	X	
8	If results are published, will anonymity be maintained and participants not identified? (see Q. 30 below regarding open data considerations, if relevant)	X	
9	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	X	
10	Will your project involve deliberately misleading participants in any way?		X
11	Will your participants include children / young persons (under 18 years of age)?		X
12	If yes to question 11, is your research in compliance with the UCC *Child Safeguarding Statement* which sets out the legal requirements under the Children First Act 2015? (see: https://www.ucc.ie/en/media/support/ocla/policies/UCC_Child_Protection_Policy_5April2018-Final.pdf)		
13	Will your project require you to carry out "relevant work" as defined in the National Vetting Bureau (Children and Vulnerable Persons) Acts 2012 to 2016?[1]		X
14	Do you require official Garda Vetting through UCC before collecting data from children or vulnerable adults? (Please note that having a Garda Vetting through another body is not sufficient; a separate UCC Garda Vetting is always required.)		X
15	Will your participants include people with learning or communication difficulties?		X
16	Will your participants include patients / service users / clients?		X
17	Will your participants include people in custody?		X
18	Will your participants include people engaged in illegal activities (e.g. drug taking, illegal Internet behaviour, crime, etc.)?		X
19a	Is there a realistic risk of participants experiencing either physical or psychological distress?		X

19b	Is there a realistic risk of the researcher experiencing either physical or psychological distress?		X
20	If yes to question 19a, has a proposed procedure for linking the participants to an appropriate support, including the name of a contact person, been given? (see Q. 33)		
21	If yes to question 19b, has a proposed procedure/support structure been identified?		
22	Are your research participants students with whom you have some current/previous connection?		X
23	Will your study participants receive payment / gifts / voucher / etc. for participating in this study?		X

DESCRIPTION OF THE PROJECT

*Ethical review requires that you **reflect** and seek to **anticipate** ethical issues that may arise,*

rather than reproduce copious text from existing research proposals into these boxes.

*Entries should be **concise** and relevant to the point / question.*

25. Very brief description of your study (15-25 words max.)
[e.g. This is a qualitative study of primary school teachers' attitudes towards religious teaching using focus groups to collect original data]

Study investigating the impact of a nature vs urban intervention on rumination, cognition, and mood in adults with varying levels of sensory processing sensitivity (SPS), depression and anxiety.

26. What is your study about? (100-200 words max.)

Two of the most common mental health issues globally at present are depression and anxiety. A group of people who are particularly at risk for this are Highly Sensitive Persons (HSPs). The HSP trait is characterized by high levels of sensitivity to stimulation offered by the environment. According to the biopsychosocial model of mental health, the environment has a significant role to play in determining mental health outcomes. In recent years, there has been significant growth in research around the benefits of interacting with natural environments, also known as green spaces and blue spaces. These benefits include improvements in cognition, and in different outcomes related to mental health. This is pertinent, as HSPs by their very definition are more sensitive to their environments. Thus, the present project proposes to explore the beneficial role of natural environments in decreasing the maladaptive cognitive strategy of rumination in HSPs, which is linked with anxiety and depression, as well as attention/inhibition, which is linked with rumination. We will also investigate affect, as it is known that nature has beneficial effects on diminishing negative affect and promoting positive affect. This research will have clinical and applied implications for informing both intervention and prevention programs. This is especially important, given that HSPs represent 20-35% of the general population, and they may represent closer to 50% of clients in most psychotherapy practices.

27. What are your research questions?[1]

Pre/Post-test study

1. ~~Do all participants~~ Do participants, irrespective of their HSP score, show greater improvements in cognition and affect, as well as decreased rumination coping strategies, following the virtual nature-based intervention compared to the urban intervention? Is this moderated by levels of depression and anxiety?
2. Do HSPs show greater improvements in cognition and affect, as well as decreased rumination coping strategies, compared to non-HSPs following the virtual nature-based intervention? Is this moderated by levels of depression and anxiety?

Qualitative study

1. What are the experiences of participants completing the different interventions?
2. What are the experiences of participants of nature in their daily lives?

28. Who are the participants in your study? (recruitment methods, number, age, gender, exclusion/inclusion criteria, detail permissions to be sought / secured already)

Participants will include a community sample. Participants will be of all genders, and will be required to be at least 18 years old with no upper age limit.
Recruitment will be conducted through a call for participants using student email, as well as by word of mouth and snowball sampling. As this is a doctoral level project, the reach from this email will be wider within UCC than if it were for an undergraduate project. Social media sites such as Twitter and Facebook will be utilised in recruitment. The researchers will share links to the study from their pages, ask the Applied Psychology UCC Twitter account to retweet, and encourage others to share and retweet the posts. Websites which allow one to post links to studies will also be contacted and the link to the study shared. As this may result in participants from other countries, a question on where one resides will be included with demographics.

29. Concise statement of *anticipated* ethical issues raised by your project. How do you intend to deal with them? Please address *all* items where your answers fell into a shaded box in the self-evaluation above. (350 words max.)

Research to date would suggest the efficacy of nature over urban intervention in stress reduction, thus those participants who are randomised to the urban condition will not have access to these benefits in the study. Links will be provided following the study to allow them to trial the nature intervention should they so wish and information on the benefits of nature.

30. Data.

(a) How will you collect your data? Brief description and justification of methods and data collection measures to be used.

(b) What type of data will you be storing?

(c) How and where will you store your data? [1,2] (provide details for both physical *and* electronic documents).

(d) For how long will you store the data? (A minimum storage period of 10 years is required)

(e) Who will you share the data with? (*Sample* prompts: If you plan to make your raw research dataset available publicly as part of the open data movement, or if you are required to do so as part of funding/journal requirements, please address your protocol here (make explicit links to Q. 32 below and show that you have addressed this in your consent form and information sheet). For collaborative/community-based participatory research, please address issues such as shared ownership of data, publication of findings, etc. If your funder contractually requires you to give them access to the 'raw' dataset, examine relevant implications, including appropriate anonymisation, protocols for secure access to the dataset, etc.).

(f) If you are planning to analyse an existing dataset, please outline how the original consent process allows for your data analysis.

(g) If you are planning to request access to health/case files/personal records that were not created for research purposes, please address Data Protection considerations, provide a strong rationale and comprehensively address associated ethical issues.

(h) If you ticked yes to Q.6 above, have you submitted your DPIA?

(a) We will be using a pre-post design, data will be collected using the survey platform Qualtrics. No in person testing is required. This is to allow for the possibility of future lockdowns as a result of the current pandemic and to limit the possibility of participants or researchers coming into contact with the virus. As noted above, the benefits and applicability of virtual nature interventions have been noted in the literature.

(b) Anonymised data will be stored consisting of answers to the different measures, the cognitive task, open-ended answers, and socio-demographic information collected. This will be stored as an Excel and SPSS database in the UCC OneDrive as per UCC guidelines. Qualitative data will be also anonymised if needed and stored in the same way. It is important to note that qualitative data are gathered through Qualtrics and therefore there is no transcription needed.

(c) The anonymous data file will be stored on a password protected encrypted computer to allow for data analysis, with anonymous data files made available to supervisors and advisor (Dr Francesca Lionetti, G. d'Annunzio University of Chieti-Pescara, Italy) through Microsoft Teams. An anonymised file will be also made available to UCC School of Applied Psychology for storage for at least 10 years in line with policy. Participants will be asked for permission to make their data available in anonymised form for future studies in line with the Open science framework

(d) The anonymised copy in UCC School of Applied Psychology will be stored for 10 years.

(e) Data will only be shared with supervisors and advisor while the analysis is ongoing. It will then be added to a data repository.

(f) N/A

(g) N/A

(h) N/A

31. Arrangements for informing participants about the nature of the study (e.g. information sheets, letters of invitation, social media information, participant recruitment, focus group welcome/schedule etc.)

Participants will be informed about the study through the call to participate which will contain some information around the nature of the study. The information sheet (See Appendix ǂ C) available when one clicks through to the study will contain more information on the study and what participation entails. Finally, once participation is completed, information on what is being investigated will be provided. An email address of the researcher and supervisors will be provided for participants who have further questions or queries.

32. How you will ensure that participants provide informed consent? (cf. Question 4 - attach relevant form(s); address special considerations in terms of children / young people / vulnerable persons / adults who have difficulty in making decisions unaided)

Informed consent will be ensured through providing participants with information on the study in our information sheet, and through asking participants to confirm they understand the nature of the study and what taking part involves (See Appendix ǂ D). We will also be providing contact information if potential participants have any queries about their possible participation.

33. Outline of debriefing process at the end of the data collection process (cf. Question 9)**. If you answered Yes to Questions 19a or 19b, give details here. State what you will advise participants to do if they should experience problems (e.g. who to contact for help).**

Participants will be thanked for their participation, and informed of the specific nature of the study and what was being examined. Email address for researcher and supervisors will be provided to contact with questions and queries (see Appendix ǂ C). Participants will be directed to resources on the benefits of nature

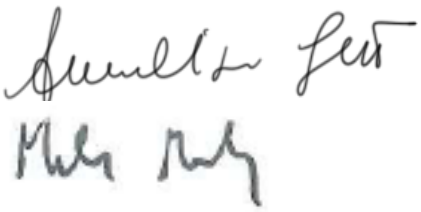
34. Estimated start date and duration of project

Estimated start date for data collection is February 2021, with the full project being completed by June 2022.

35. Additional information of relevance to your application

N/A

36. Declarations	
I/we agree that should there be unexpected ethical issues arising during the course of this study, that I/we will utilise my/our professional/disciplinary code of ethics, and/or notify UCC CPREC, where appropriate.	Yes
I/we have consulted the UCC *Code of Research Conduct* (2016) and believe my/our proposal is in line with its requirements.	Yes
I/we have consulted the UCC *Child Protection Policy* and believe my/our proposal is in line with its requirements.	N/A
I/we have consulted the UCC GDPR guidelines and declare that our project is GDPR compliant. Where required under the UCC GDPR Guidelines, I have submitted a DPIA.	Yes N/A
I/we have consulted the UCC Garda Vetting Guidelines, and where appropriate, researchers on this project have valid Garda vetting through UCC (having a valid Garda Vetting through another body is insufficient).	NA

37. Signatures	
UCC Applicant(s)	**Academic Supervisor(s)**
	
Date: ~~20/10/2020~~ 05/01/2021	Date: 22/10/20

1. Please submit a *signed* copy this form and all relevant attachments **as one PDF file to** nhennessy@ucc.ie . No hard copies are required.
2. CPREC is not primarily concerned with methodological issues but may comment on such issues in so far as they have ethical implications.

Website links and helpful resources

UCC *Code of Research Conduct*	https://www.ucc.ie/en/media/research/researchatucc/documents/UCCCodeofResearchConduct.pdf
UCC *Child Protection Policy*	https://www.ucc.ie/en/media/support/ocla/policies/UCCChildProtectionPolicyFINAL.pdf
Garda Vetting of UCC Staff	https://www.ucc.ie/en/hr/gardavetting/
UCC Student Garda Vetting Policy	https://www.ucc.ie/en/media/studyatucc/undergrads/downloadabledocumentssection/StudentVettingPolicyandProcedure.pdf Students for whom Garda Vetting is required should contact studentgardavetting@ucc.ie.
UCC Data Protection Impact Assessment (DPIA) policy and templates	https://www.ucc.ie/en/gdpr/procedures/
UCC GDPR UCC website	https://www.ucc.ie/en/gdpr/
IT Support for UCC Researchers	http://www.ucc.ie/en/it/services/research/
EU Commission, Responsible Research and Innovation & H2020 **RRI Tools Website**	https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation http://www.rri-tools.eu /
Irish Qualitative Data Archive (IQDA)	https://www.maynoothuniversity.ie/social-sciences-institute/research/iqda
Irish Social Science Data Archive (quantitative datasets)	http://www.ucd.ie/issda/
Data Protection Commissioner's Guidelines on Research in the Health Sector	https://www.dataprotection.ie/documents/guidance/Health_research.pdf
Health Service Executive National Consent Policy	http://www.tusla.ie/uploads/content/National-Consent-Policy-August-2017.pdf

Electronic data storage

UCC Research Data Store and UCC Cloud Storage	https://www.ucc.ie/en/it/services/datastore/ http://www.ucc.ie/en/it/services/networkfilestorenas/	UCC IT recommendations on data storage options: If data is confidential then IT recommendation is to use **Research Data Store OR Departments/Schools own local secure storage (if this exists). If applicants store data on local personal storage devices (laptops etc), the devises must be encrypted and must consider how to maintain safe storage of their data beyond the life of the personal storage

		devices to meet the 10 year requirement in the UCC Code of Research Conduct. It is essential that personal devices (laptops, phones, tablets etc.) are not used to store or access research data. If confidential data has been anonymised or if you have public or non-sensitive data, then OneDrive for Business or Google Drive supplied by UCC, can be used for data storage. ****Research Data Store** provides a network based shared data storage facility for the UCC Research community. It is for active research projects and is not an archive service. A Principal Investigator or Head of Department can request storage (maximum 1TB) for a research project. Research Groups will have access to 1TB of storage and folders can be shared with researchers in either the central or student domains. **This service can be requested by a PI or by a Head of Department on behalf of members of a research team / students.** To make a request to use Research Data Store, visit http://Servicedesk.ucc.ie and select option 4 (Data Storage and NAS Access).
UCC Device Encryption Service	http://www.ucc.ie/en/it/services/encryptionlaptop/	--
UCC Staff IT Services	http://www.ucc.ie/en/it/services/staff/	List of all UCC staff IT services.
HEAnet FileSender	http://www.heanet.ie/services/hosting/filesender	HEAnet FileSender is a way to share large files. It works through your web browser to send a file to any email address. FileSender can send files up to 500 GB and there is an option to encrypt your files.

[1] CPREC reports to SREC, a subcommittee of the University Ethics Committee. If you are unsure which University ethics committee you should apply to, please consult this resource: https://www.ucc.ie/en/research/ethics/. Acknowledgement: This form is adapted from the SREC ethics application form.

[1] Relevant work constitutes any work or activity which is carried out by a person, a necessary and regular part of which consists mainly of the person having access to, or contact with, children or vulnerable adults.

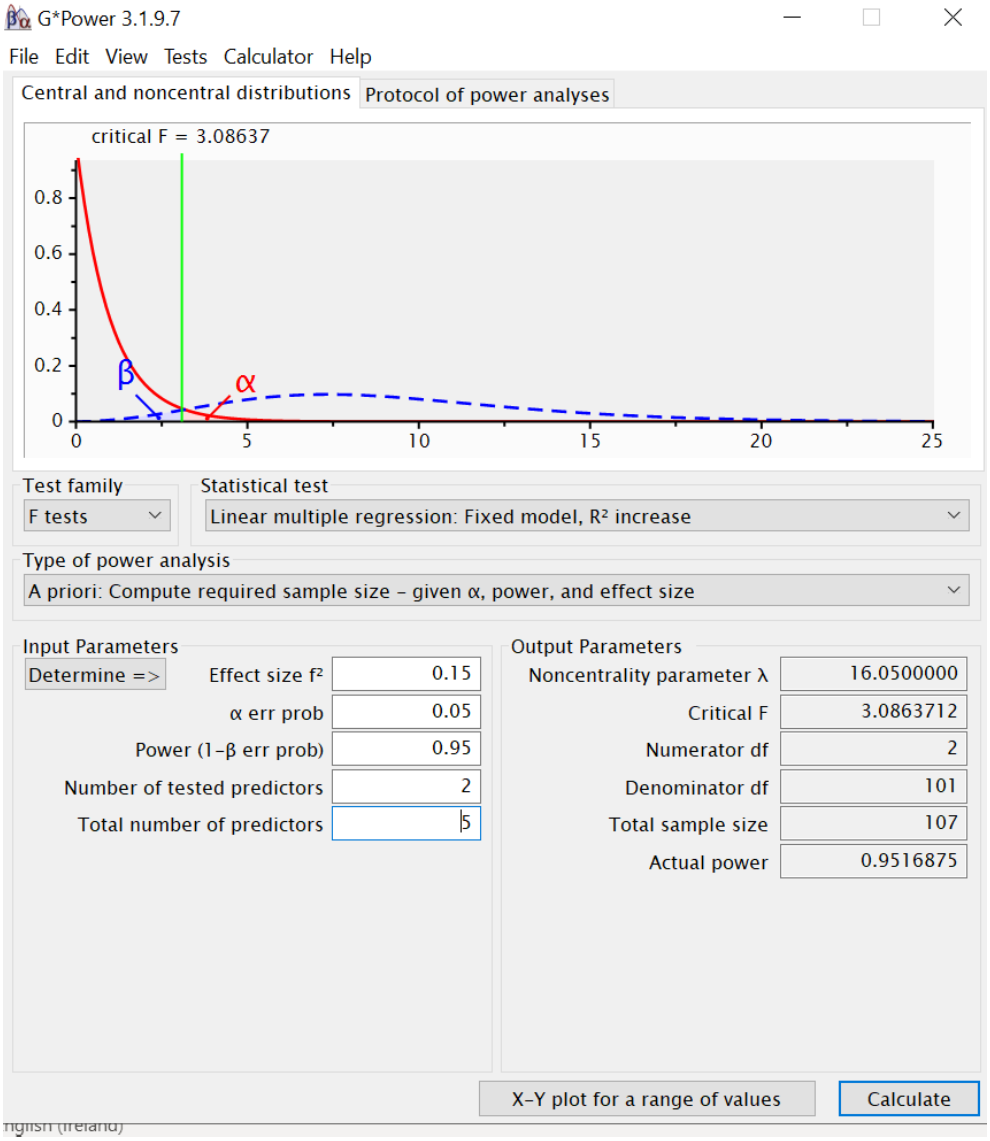
[1] If your study approach does not normally require that research questions are set in advance, please provide a rationale in Q. 28.

[1] Data management should follow the FAIR guiding principles (Findability, Accessibility, Interoperability & Reusability). See, for example, Wilkinson, M. D. *et al*. (2016) *The FAIR Guiding Principles for Scientific Data Management and Stewardship*. Full text: http://www.nature.com/articles/sdata201618.

[1] It is required that all staff and student researchers store those data which are required to replicate research findings, and the information required to enable re-use of data. Details of the UCC policy on research data storage can be found in section 8 of the *Code of Research Conduct* (2016): https://www.ucc.ie/en/media/research/researchatucc/documents/UCCCodeofResearchConduct.pdf. SREC advises against storing research data on non UCC approved cloud-based storage services.

Appendix A

G*Power Analysis







Cadogan, E. M. 2022. The impact of the temperament trait of sensory processing sensitivity and different environments on psychological wellbeing and cognition. DClinPsych Thesis, University College Cork.

Please note that Appendix B (pp. 459-463) is unavailable due to a request by the author.

CORA Cork Open Research Archive http://cora.ucc.ie

Open-ended questions for qualitative analysis

1. In the middle of the study, you were presented with a video clip showing an outdoor scene. What was your experience of watching this clip? How did you feel while watching it? Please be as descriptive as possible in your answer.

2. What is your relationship with nature like in your daily life? Describe this relationship in terms of the amount of time you spend in nature and how you find the experience of being in nature~~?~~. Please be as descriptive as possible in your answer.

Question around relationship with the landscape; restoration effect:

Q. Did the place you saw in the video resemble a place you have good or bad memories of?

1. It resembled a place I have very good memories of
2. It resembled a place I have somewhat good memories of
3. It resembled a place I have neutral memories of
4. It resembled a place I have somewhat bad memories of
5. It resembled a place I have very bad memories of
6. It did not resemble a place I have any memories of

Appendix ~~II~~ C

Information Sheet and Debrief Sheet

Information Sheet

What is this research about?

Researchers from the School of Applied Psychology in UCC ~~are seeking individuals~~ would like you to take part in a study to explore how aspects of our personality can impact on how we experience different environments.

Why is this research taking place?

Research has shown that our personalities and how we interact with the world can impact on our mental health. It is hoped that the results from this study will provide evidence to aid in the creation of bespoke interventions which might aid people with different personality traits.

Where and how do I take part?

The study happens online, you are not asked to meet the researcher in person and can complete the study on your ~~phone or your~~ computer or laptop. It is not possible to complete the study on a mobile phone or tablet. The duration is about 40 minutes, we appreciate your time and we are grateful that you can help us to answer these important questions. We would appreciate if you could set this time aside to complete the study. As there will be an audio component, we would ask that you complete the study in a quiet place or use headphones.

What will I be asked to do?

You will be asked to complete a survey that ask questions about you (age, gender, education) and your life (e.g. are you sensitive to loud noises?) and how do you feel in a particular moment (are you relaxed? Do you dwell on negative thoughts?). You will then complete a short task, the task will require you to decide the color of words, it is a test of attention which has been done by many people in other studies. Following this you will be asked to view a brief video. You will then complete the task one more time and answer some more questions similar to those that you answered before. Finally we will ask your opinion on the study and explain what this is about.

What are my rights in relation to participating in this research?

Your participation in this research is voluntary. You can opt not to participate if you wish. If you decide to participate, you maintain the right to ~~withdraw~~ stop participating in ~~from~~ the study at any stage~~.~~, ~~H~~however~~,~~ once you completed the study, your data will be collected from the beginning of the study, and at this point it will be collated with that of other participants and can no longer be retracted. Your responses will be anonymous, and we seek no identifying details and do not gather IP addresses. Your participation in this research is confidential.

What will happen to the data that is collected?

A specific, anonymized, electronic data file for this research will be available to the researchers for the purposes of this research. The anonymous data will be stored on an encrypted laptop and subsequently on the UCC server. The data will be stored for ten years and will be made available to other researchers in anonymous format for other studies in line with the Open Science framework. If you have a concern about how we have handled your personal data, you are entitled to this raise this with the Data Protection Commission.

https://www.dataprotection.ie/

What are the risks associated with this research?

The researchers anticipate that there are no risks involved in your participation in this research. However, if you have concerns about any aspect of this research you are welcome to contact Eimer Cadogan via email at e.cadogan@umail.ucc.ie or Dr. Annalisa Setti (a.setti@ucc.ie) and Dr. Mike Murphy (mike.murphy@ucc.ie) who supervise the study.

What happens following the research?

This research will be presented as part of a doctoral thesis for the Doctorate in Clinical Psychology in UCC as part of the programme requirements. The anonymized information you provide may also contribute to research publications and/or conference presentations.

How can I complete this survey online?

Please go to ** LINK HERE ** and follow the instructions to complete this study online.

Who do I contact if I have any more questions about this research?

You can contact Eimer Cadogan via email at e.cadogan@umail.ucc.ie or Dr. Annalisa Setti a.setti@ucc.ie and Dr. Mike Murphy mike.murphy@ucc.ie who supervise the study.

This study has obtained ethical approval from the UCC School of Applied Psychology Ethics Committee.

If you have a concern about how we have handled your personal data, you are entitled to this raise this with the Data Protection Commission.

https://www.dataprotection.ie/

If you have a complaint about how this research was conducted please contact in writing:

The Ethics Committee,

School of Applied Psychology,

University College Cork,

Cork

Debrief Sheet

Thank you for taking part in this study!

~~This study aims to explore how the personality trait of sensory processing sensitivity, also known as SPS, impacts on our experience of being in nature.~~ With this study we want to see whether viewing nature decreases negative thoughts and increases attention in people with different levels of sensory processing sensitivity. Sensory processing sensitivity is a personality trait present at different levels in the population. Being in nature has been shown to bring us many benefits, emotionally and to our cognitive abilities. One process which is noted to improve in nature is rumination. Rumination is when we continuously think about

the same thoughts, and the thoughts are sad or distressing. Rumination has been linked with a number of mental health difficulties, including anxiety and depression.

Virtual experiences of nature have been noted to give similar benefits. This is important, as not everyone has access to nature on their doorstep.

In this study you will have viewed a nature scene or an urban scene. If you would like to experience the nature scene, it is available to view at the following link.

Thank you again for your participation.

If you want to know more about nature benefits you can find some references here:
https://www.rte.ie/brainstorm/2020/1012/1171028-spending-time-outdoors-nature-walking-woodlands-mood-attention/

Gratefully,

Eimer Cadogan

Appendix ~~I~~D

Consent Question from Online Questionnaire

1. Please confirm that you have read the information sheet and have considered your consent to participate in this study before proceeding further by choosing "yes" or "no" in relation to the following statements:

* I confirm that I am presently aged 18 or over.

* ◯ Yes
  ◯ No

* I confirm that I have read and understand the information provided above for this research.

◯ Yes

◯ No

* I consent to taking part in this study.

* ◯ Yes
  ◯ No

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Coláiste na nEalaíon, an Léinn Cheiltigh agus na nEolaíochtaí Sóisialta
College of Arts, Celtic Studies and Social Sciences

Scoil an Síceolaíochta Feidhmí
School of Applied Psychology

University College Cork,
Cork, Ireland.

T +353 (0)21 490 4551 / 4552
E infoapsych@ucc.ie
http://www.ucc.ie/en/apsych/

22nd January 2021

Clinical Psychology Research and Ethics

Dear Eimer,

Impact of nature intervention on rumination in the highly sensitive person

Eimer Cadogan

Thank you for your ethics application and subsequent changes. Your application has been approved by the Clinical Psychology Research and Ethics Committee and you have full ethical approval for the above named project.

Yours sincerely,



Dr Mike Murphy
Chair Clinical Psychology Research and Ethics Panel

Dr Carol Linehan
Head of School of Applied Psychology

Ollscoil na hÉireann, Corcaigh
National University of Ireland, Cork

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Eimer Cadogan <112329751@umail.ucc.ie>

Ethics Amendments

Hennessy, Nora <nhennessy@ucc.ie> Mon, Nov 8, 2021 at 1:34 PM
To: Eimer Cadogan <e.cadogan@umail.ucc.ie>

Dear Eimer,

Thank you for your recent ethics amendment submission. This has been approved.

Kind regards,

Nora

Nora Hennessy |DCLIN Programme Administrator | School of Applied Psychology |Top Floor, Distillery House | UCC | 021 490 4512 | nhennessy@ucc.ie

From: Eimer Cadogan <e.cadogan@umail.ucc.ie>
Date: Tuesday 26 October 2021 at 15:55
To: "Hennessy, Nora" <NHennessy@ucc.ie>
Subject: Ethics Amendments

[Quoted text hidden]

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Eimer Cadogan <112329751@umail.ucc.ie>

Ethics Amendment

Hennessy, Nora <nhennessy@ucc.ie> Fri, Nov 26, 2021 at 12:12 PM
To: Eimer Cadogan <e.cadogan@umail.ucc.ie>

Hi Eimer,

Thanks for sending this in. It has now been approved.

All the best,

Nora

Nora Hennessy | Programme Administrator, DCLIN Psychology| School of Applied Psychology| Distillery House, North Mall Campus |UCC ||Ph: (021) 490 4512| nhennessy@ucc.ie

[Quoted text hidden]

Appendix K

Information Sheet

Information Sheet

What is this research about?

Researchers from the School of Applied Psychology in UCC would like you to take part in a study to explore how aspects of our personality can impact on how we experience different environments.

Why is this research taking place?

Research has shown that our personalities and how we interact with the world can impact on our mental health. It is hoped that the results from this study will provide evidence to aid in the creation of bespoke interventions which might aid people with different personality traits.

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The study happens online, you are not asked to meet the researcher in person and can complete the study on your computer or laptop. It is not possible to complete the study on a mobile phone or tablet. The duration is about 40 minutes, we appreciate your time and we are grateful that you can help us to answer these important questions. We would appreciate if you could set this time aside to complete the study. As there will be an audio component, we would ask that you complete the study in a quiet place or use headphones.

What will I be asked to do?

You will be asked to complete a survey that ask questions about you (age, education) and your life (e.g. are you sensitive to loud noises?) and how do you feel in a particular moment (are you relaxed? Do you dwell on negative thoughts?). You will then complete a short task, the task will require you to decide the color of words, it is a test of attention which has been done by many people in other studies. Following this you will be asked to view a brief video. You will then complete the task one more time and answer some more questions similar to those that you answered before. Finally we will ask your opinion on the study and explain what this is about.

What are my rights in relation to participating in this research?

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this point it will be collated with that of other participants and can no longer be retracted. Your responses will be anonymous, and we seek no identifying details and do not gather IP addresses. Your participation in this research is confidential.

What will happen to the data that is collected?
A specific, anonymized, electronic data file for this research will be available to the researchers for the purposes of this research. The anonymous data will be stored on an encrypted laptop and subsequently on the UCC server. The data will be stored for ten years and will be made available to other researchers in anonymous format for other studies in line with the Open Science framework. If you have a concern about how we have handled your personal data, you are entitled to raise this with the Data Protection Commission.
https://www.dataprotection.ie/

What are the risks associated with this research?
The researchers anticipate that there are no risks involved in your participation in this research. However, if you have concerns about any aspect of this research you are welcome to contact Eimer Cadogan via email at e.cadogan@umail.ucc.ie or Dr. Annalisa Setti (a.setti@ucc.ie) and Dr. Mike Murphy (mike.murphy@ucc.ie) who supervise the study.

What happens following the research?
This research will be presented as part of a doctoral thesis for the Doctorate in Clinical Psychology in UCC as part of the programme requirements. The anonymized information you provide may also contribute to research publications and/or conference presentations.

Who do I contact if I have any more questions about this research?
You can contact Eimer Cadogan via email at e.cadogan@umail.ucc.ie or Dr. Annalisa Setti a.setti@ucc.ie and Dr. Mike Murphy mike.murphy@ucc.ie who supervise the study.

This study has obtained ethical approval from the UCC Clinical Psychology Research and Ethics Committee.

If you have a concern about how we have handled your personal data, you are entitled to raise this with the Data Protection Commission.
https://www.dataprotection.ie/

If you have a complaint about how this research was conducted please

contact in writing:
UCC Clinical Psychology Research and Ethics Committee,
School of Applied Psychology,
University College Cork,
Cork

Appendix L

Additional Multiple Regressions

Table 7.7

Standard Multiple Regressions Assessing Predictive Role of Variables on Outcomes using Listwise Deletion

Outcome	Predictor	*N*	*t*	*P*	*B*	Std. Err.	*β*	*F*	*df*	*p*	*Adj* R^2
PANAS PA	Overall model	122						3.29	5, 121	.008	.09
	HSP Centered		-0.87	.388	-0.3	0.03	-.12				
	DASS Total		0.66	.510	0.02	0.03	0.07				
	Resemblance		-2.72	.008	-1.91	0.70	-.32				
	Intervention		-0.03	.977	-0.04	1.29	-.00				
	HSP X Intervention Interaction		1.40	.165	0.06	0.04	.18				
PANAS NA [a]	Overall Model	123						5.649	5, 117	<.001	.16
	HSP Centered			.004	.06 [0.03, 0.09] [b]	0.02	.37				
	DASS Total			.002	-0.09 [-0.15, -0.04] [b]	0.03	-.46				
	Resemblance			.377	0.45 [-0.39, 1.37] [b]	0.48	.12				
	Intervention			.908	0.09 [-1.31, 1.75] [b]	0.81	.01				
	HSP X Intervention Interaction			.053	-0.05 [-0.11, -0.01] [b]	0.03	-.24				
BSRI [a]	Overall Model	87						4.874	5, 86	<.001	.18
	HSP Centered			.464	.364 [-0.66, 1.39] [b]	0.55	.09				
	DASS Total			<.001	-2.46 [-3.97, -1.12] [b]	0.70	-.51				

	Resemblance			.576	7.30 [-18.75, 34.98] [b]	13.31	.07			
	Intervention			.291	23.15 [-18.14, 66.65] [b]	21.42	.12			
	HSP X Intervention Interaction			.722	-0.37 [-2.50, 1.21] [b]	1.03	-.06			
Stroop RT	Overall Model	111						3.037	5, 110	.013	.09
Difference	HSP Centered		1.14	.259	0.52	0.46	.16				
	DASS Total		0.10	.921	0.05	0.48	.01				
	Resemblance		-2.80	.006	-28.46	10.18	-.36				
	Intervention		0.04	.969	0.72	18.62	.01				
	HSP X Intervention Interaction		-0.98	.329	-0.60	0.61	-.13				

Note. [a] Indicates 95% BCA bootstrapping used, [b] 95% BCA confidence intervals

Table 7.8

Standard Multiple Regressions Assessing Predictive Role of Variables on Outcomes using Individual Mean Imputation

Outcome	Predictor	*N*	*t*	*P*	*B*	Std. Err.	*β*	*F*	*df*	*p*	*Adj* R^2
PANAS PA	Overall model	142						4.74	5, 141	<.001	.12
	HSP Centered		-1.26	.211	-0.04	0.03	-.16				
	DASS Total		-0.88	.380	-0.03	0.03	-.09				
	Resemblance		-2.30	.023	-1.53	0.66	-.24				
	Intervention		0.93	.353	1.13	1.21	.10				
	HSP X Intervention Interaction		2.18	.031	0.09	0.04	.25				
PANAS NA [a]	Overall Model	142						6.45	5, 141	<.001	.16
	HSP Centered			.041	.05 [0.01, 0.09] [b]	0.02	.27				
	DASS Total			.002	-0.10 [-0.17, -0.04] [b]	0.03	-.47				
	Resemblance			.040	1.16 [0.19, 2.14] [b]	0.55	.26				
	Intervention			.461	0.65 [-0.77, 2.14] [b]	0.83	.08				
	HSP X Intervention Interaction			.224	-0.04 [-0.10, 0.02] [b]	0.03	-.15				
BSRI [a]	Overall Model	107						3.99	5, 106	.002	.12
	HSP Centered			.568	0.38 [-0.85, 1.54] [b]	0.66	.09				
	DASS Total			<.001	-1.92 [-3.12, -0.64] [b]	0.60	-.39				
	Resemblance			.899	1.50 [-23.93, 25.03] [b]	12.43	.02				
	Intervention			.381	16.34	18.57	.08				

	HSP X Intervention Interaction			.431	[-23.04, 56.04] [b]	0.98	-.12				
					-0.77 [-2.74, -0.92] [b]						
Stroop RT	Overall Model	123						1.94	5, 122	.093	.04
Difference	HSP Centered		1.03	.305	0.50	0.49	.14				
	DASS Total		0.62	.540	0.29	0.47	.07				
	Resemblance		-2.56	.012	-26.15	10.21	-.30				
	Intervention		-0.51	.611	-9.51	18.64	-.06				
	HSP X Intervention Interaction		-1.45	.149	-0.92	0.64	-.19				

Note. [a] Indicates 95% BCA bootstrapping used, [b] 95% BCA confidence intervals