Assessing Hypersensitivity to Difference in Autistic and Non-Autistic Adults

Sophia Christophi

Submitted to the University of Hertfordshire in partial fulfilment of the requirement of the degree of PhD

October 2023

Contents

Abstract **5**
CHAPTER ONE – Introduction **6**
Overview 6
1:1 Background 6
1.2 Autism and Perception 8
1:2:1 Visual Search Tasks 10
1:2:2 Change Blindness 13
1:3 Autism and Attention 15
1:4 Categorisation and Autism 16
1:5 Core Traits 18
1:5:1 Autism and Anxiety 18
1:5:2 Intolerance of Uncertainty 20
1:5:3 Acute Sensory Experiences 21
1:5:4 Insistence on Sameness 22
1:6 One Explanation or Many? 23
1:7 Similarity and Difference 24
1:8 The Model 25
1:9 Scripts, Schema, and Context 27
1:10 Conclusion 30
CHAPTER TWO – Typicality Ratings & Change Blindness **32**
2:1 Pilot Study – Introduction **34**
2:2 Methods 34
2:2:1 Participants 34
2:2:2 Design 35
2:2:3 Materials 35
2:2:4 Procedure 35
2:3 Results 35
2:4 Discussion 41
2:5 Experiment 1 – Introduction **42**
2:6 Methods 42
2:6:1 Participants 42
2:6:2 Design 44
2:6:3 Materials 44
2:6:4 Procedure 47

2:7 Results ... 48
2:8 Discussion ... 56
CHAPTER THREE – Rating Similarity & Difference ... 60
3:1 Experiment 2 – Introduction ... 60
3:2 Methods ... 63
3:2:1 Participants ... 63
3:2:2 Design ... 64
3:2:3 Materials ... 64
3:2:4 Procedure ... 65
3:3 Results ... 66
3:3:1 Strategy and Method ... 74
3:3:2 Protocol Analysis ... 76
3:3:3 Additional Analysis ... 81
3:4 Discussion ... 90
3:5 Experiment 3 – Introduction ... 94
3:6 Methods ... 94
3:6:1 Participants ... 94
3:6:2 Design ... 95
3:6:3 Materials ... 95
3:6:4 Procedure ... 96
3:7 Results ... 96
3:8 Discussion ... 102
CHAPTER FOUR – Card Sort ... 105
4:1 Experiment 4 – Introduction ... 105
4:2 Methods ... 107
4:2:1 Participants ... 107
4:2:2 Design ... 108
4:2:3 Materials ... 108
4:2:4 Procedure ... 109
4:3 Results ... 110
4:4 Discussion ... 114
CHAPTER FIVE – Virtual Reality Technology ... 117
5:1 Experiment 5 – Introduction ... 117
5:2 Methods ... 117
5:2:1 Participants ... 117
5:2:2 Design ... 118

5:2:3 Materials ... 119
5:2:4 Procedure ... 122
5:3 Results ... 123
5:4 Discussion ... 127
CHAPTER SIX – Discussion ... 129
Overview ... 129
6:1 Change Blindness Task ... 129
6:1:1 Methodological Inconsistencies and Co-occurring Conditions ... 130
6:2 Rating Similarity and Difference ... 131
6:2:1 Protocols and Ratings ... 133
6:2:2 Subgroups & Age of Diagnosis ... 134
6:3 Card-sorting Tasks ... 136
6:4 Virtual Reality Technology ... 137
6:4:1 Difficulties Accessing a Sample ... 139
6:5 The Importance of Participatory Research ... 140
6:6 Hypersensitivity to Difference, Anxiety, & Sensory Experiences ... 140
6:7 General Summary ... 142
6:7:1 Evidence for the Hypersensitivity to Difference Model ... 144
6:7:2 What Has Been Learned? ... 147
6:7:3 Future Work ... 149
6:8 Conclusion ... 149
References ... 151
Appendices ... 168
Appendix A – Base bathroom, bedroom, living room, kitchen, and office images ... 168
Appendix B – Congruent changes ... 169
Appendix C – Detail changes ... 170
Appendix D – Incongruent changes ... 171
Appendix E – Position changes ... 172
Appendix F – Protocols and codes ... 173
Appendix G – Autistic subgroup protocols and ratings ... 241
Appendix H – Sample of autistic participants' protocols and ratings ... 245
Appendix I – Category label names and number of autistic and control participants who used that category name ... 250
Appendix J – Words used in lexical decision-making task ... 252
Appendix K – Interview transcripts ... 253

Abstract

Current literature on autism has tended to examine individual traits and characteristics, or the link between two or three traits. This thesis will outline previous literature on the cognitive and perceptual theories of autism, as well as research on anxiety, sensory processing, intolerance of uncertainty and the need for predictability, and schema development in this group; a model is presented that proposes hypersensitivity to difference as a central unifying trait from which these autistic traits flow. A change-blindness task (Chapter 2) did not prove to be a useful measure of hypersensitivity to difference. It appeared to provide evidence that autistic participants were not affected by context; however, this was not conclusive, given that non-autistic participants performed in a similar way. Ratings of similarity and difference (Chapter 3) by autistic and non-autistic participants revealed a subgroup of autistic participants who made very low similarity ratings for pairs of items that only shared a thematic relationship, which highlighted a reduced use of context in this group. Protocols showed that autistic participants made more reference to difference compared to non-autistic participants, although this was not reflected in the difference ratings. A card-sorting task (Chapter 4) showed that autistic participants performed similarly to non-autistic participants in creating more taxonomic categories over thematic ones. The performance of autistic participants demonstrated that they were able to form categories based on featural similarities. A second sorting task using novel stimuli showed that both sets of participants made a comparable number of categories, but autistic participants generated more unique labels, possibly suggesting narrow, more specific categories. A small-scale pilot study (Chapter 5), using virtual reality technology to increase the ecological validity of a change detection task, raised interesting questions about the potential usefulness of this with autistic participants. Overall, there was sufficient evidence to suggest that the model is worth further exploration.

CHAPTER ONE – Introduction

Language: Throughout this thesis, the term 'autistic people' will be used instead of 'people with autism'. This is to reflect the preference of the autistic community for the use of identity-first language (autistic person) as opposed to person-first language (person with autism). A study has shown that 87% of autistic adults preferred to use identify-first language (Taboas et al., 2023). Many autistic people, including myself, view autism as an integral part of our identity, and therefore, it is something that we are (e.g., Sophia is autistic) rather than something we have (e.g., Sophia has autism). In reporting the experimental work, for the purposes of clarity, the non-autistic group will be referred to as the control group or simply as controls.

Recruitment of Participants: It should be noted that the data reported in Chapters 2-4 were collected online. This was necessitated by the restrictions on face-to-face testing during the pandemic, which were introduced by the university in 2020 and continued until 2022. This prevented the collection of data from participants pertaining to IQ. Attempts to collect such data were made in Experiment 1 in the form of the National Adult Reading Test (NART); however, as this had to be conducted in a separate online session (due to the length of the main experimental task), it was found that there was a reduction in the number of participants attending the follow-up. Only the data in Chapter 5 was collected face-to-face once restrictions were lifted, but as this was a very small sample of postgraduate psychology students, average to above-average IQ was assumed.

Overview

In light of the vast and ever-increasing literature pertaining to autism, this chapter will provide a background summary of selected work that has been deemed to be most relevant to the thesis. This has been drawn from well-rehearsed theories of autism, more recent theoretical perspectives, and research that has documented differences in performance between autistic and non-autistic participants on perceptual and conceptual tasks. This is followed by the presentation of a theoretical model that proposes a spontaneous hypersensitivity to difference as a central trait from which other autistic traits flow.

1:1 Background

Autism is a complex neurodevelopmental condition first described in a paper by Kanner (1943). Having observed a small number of children, Kanner had recognised that they shared some common traits. For example, he noted that the children seemed to prefer their own company and had a strong need for routines, which resulted in distress when things unexpectedly changed. In addition, they demonstrated repetitive behaviours, sensory sensitivities, and difficulty with language (for example, the children often repeated other people's words and phrases to communicate). Asperger (1944) further identified similar characteristics in the children he had observed, though there were some differences; in particular, the children Asperger observed did not demonstrate any language difficulties and instead seemed to have very advanced vocabularies. As a result of these differences, subcategories of autism began to emerge, including 'classic autism', 'Asperger's syndrome', and 'pervasive developmental disorder – not otherwise specified'. However, due to changes in the understanding of autism over time, the recent change to the Diagnostic and Statistical Manual of Mental Disorders (5^{th} ed; American Psychiatric Association, 2013) has resulted in the introduction of 'Autism Spectrum Disorder' as a diagnosis. Autism Spectrum Disorder has replaced all previous diagnostic labels, as autism is now thought of as a spectrum condition in which individuals share core traits that can be present to varying degrees. Alongside grouping individuals into the different 'types' of autism, early attempts to classify the behavioural characteristics of autism led to traits being categorised into what became known as the 'Triad of Impairments' (Wing & Gould, 1979). It was thought that autistic people were 'impaired' in three key domains: social communication, social interaction, and social imagination.

Early theories that sought to explain the traits linked to social contexts famously included Theory of Mind (ToM), most notably endorsed by Baron-Cohen (1995). ToM is thought to be a cognitive facility whereby an individual can make inferences about another person's mental state in relation to their thoughts, feelings, intentions, and emotions (Leslie, 1987). It has been suggested that some of the social and communication differences noted in autistic people may be due to a lack of theory of mind. An attempt to assess theory of mind in autism led to the development of the Sally-Anne task. The Sally-Anne task is a type of false belief task to assess whether an individual is aware that others may hold beliefs that are different from reality. During this task, an experimenter introduces two puppets, 'Sally' and 'Anne'. Sally leaves the scene, and Anne takes a marble out of Sally's basket and places it into her box. The participant is asked where Sally will look for the marble once she has returned. To 'pass' the test, the participant needs to recognise that Sally will hold the false belief that the marble is still in her basket. Using this task, Baron-Cohen et al. (1985) found that 85% of typically developing children and 86% of children with Down's syndrome passed the test, whereas only 20% of autistic children answered correctly. This finding seemed to suggest the autistic children were relying on their knowledge of the situation rather than viewing it from the perspective of Sally, who would not have known the marble had been moved. Baron-Cohen (1995) concluded that autistic people experienced 'mindblindness' due to an underdeveloped theory of mind, resulting in an inability to place themselves in another person's shoes. He argued that this 'cognitive deficit' underpinned the 'social impairments' of autistic people and supported the notion of a Triad of Impairments as proposed by Wing and Gould (1979). However, this theory did not account for why some autistic individuals pass false belief tasks (Happe, 1995), nor did it seem to address any of the non-social autistic traits, such as differences in perceptual skills. Boucher (2012) acknowledged that the theory had helpfully directed attention to other paths of research, such as possible 'impairments' in dyadic interaction, but concluded that an 'impairment' of Theory of Mind in its initial conception had "*limited power to explain the full set of socio-emotional communicative anomalies associated with ASD"* (Boucher, 2012, p.238).

An alternative theory that has, in some forms, exerted greater influence is the Weak Central Coherence theory that was proposed by Frith (1989). This theory moved away from a focus on 'deficits' in autism to a broader consideration of a 'cognitive style' that exerts an increased focus on detail compared to non-autistic individuals, resulting in autistic individuals being less likely to 'see the bigger picture'. By focusing on details, as opposed to the whole, it may be that autistic individuals tend not to benefit from integrating all available information in a range of experimental and real-life situations. For example, difficulty drawing together different pieces of information could better explain some social differences due to missing the overall meaning of a conversation. However, it could also explain some of the strengths of autistic people, particularly in perceptual skills. For example, studies have shown that autistic people perform particularly well on visuospatial tasks such as the Block Design Task (Shah & Frith, 1993) and Embedded Figures Test (Jolliffe & Baron-Cohen, 1997). Such tasks require the individual to utilise a 'local' over 'global' processing system, that is, to focus on individual components instead of perceiving the stimulus in its entirety. Therefore, it seems that Frith's (1989) theory is the first to explain differences noted in autism that span perceptual, attentional, and social processes and suggests that, in situations where one needs to perceive the parts rather than the whole, autistic individuals are likely to excel.

1.2 Autism and Perception

In 1977, Navon introduced a task that led to the general conclusion that people are faster at identifying features at a global level than at a local level, with the stimuli taking the form of large letters (for example, the letter H) made up of smaller letters (for example S) (see Figure 1.1).

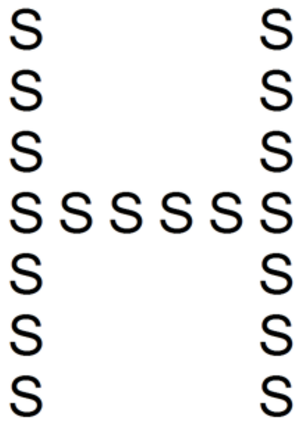


Figure 1.1 Example stimuli used in the Navon task

In line with the Enhanced Perceptual Functioning model, a study by Plaisted et al. (1999) found that autistic participants made fewer errors on this task compared to the non-autistic group when the target appeared at a local level, that is, the individual features which make up the whole shape. However, in a condition where participants were instructed to look at either the local or global level, there was no difference in response times to the global target compared to the local target between the two groups. This suggested that there was a tendency toward local processing in autistic participants but that global processing was intact. Furthermore, when autistic participants took part in a task where they had to match a target face to a whole face or a face feature, there was evidence of holistic processing, but only when they were given a cue (participants were told which feature to look at) relating to the face feature to be matched (Lopez et al., 2004). These findings demonstrated that autistic individuals can perform global and holistic processing if they are cued to do so. In everyday life, where cues are not provided, autistic individuals may well focus more on local details than non-autistic individuals and miss broader ‘context’ that may affect how those details are interpreted.

The Enhanced Perceptual Functioning model (Mottron et al., 2006) argued that autistic people do not experience a global processing ‘deficit’ as suggested by the Weak Central Coherence theory (Frith, 1989). They also move away from the language of deficit in global processing to claim that the *“default setting of autistic perception is more locally oriented than that of non-autistics”* (Mottron et al., 2006, p.30). Amongst the conclusions of Mottron et al. (2006) is the interesting proposition that for non-autistic individuals, the activation of ‘higher order control’ over perception is not a matter of choice, but in autistic individuals, it can be activated. However, it will not be activated if it *“interferes with performance of tasks that can be more economically processed locally or using a low-level processing mode”* (Mottron et al., 2006, p.35). This perspective predicts superior local processing in autistics but also that they may be at a disadvantage in tasks where the broader ‘context’ is of value, whilst the automatic global processing of non-autistics slows their processing of local detail.

The role of context is an important aspect of perception and cognition that has arguably only been discussed in relation to autism relatively recently. Vermeulen (2015) proposed that autistic people experience ‘context-blindness’ in which they either experience reduced sensitivity to contextual information or an inability to incorporate contextual information to extract the overall meaning. This is likely to influence a wide range of cognitive processes and is supported by the studies above, which demonstrate a visual-perceptual advantage, as well as change blindness studies in which autistic participants can identify contextually congruent and incongruent objects equally well compared to non-autistic participants who are quicker to identify incongruent scene changes (Fletcher-Watson et al., 2006; Loth et al., 2008). Reduced sensitivity to context could mean that it is difficult for autistic people to determine the most important stimuli to attend to; as a result, they are more likely to notice changes which may seem irrelevant to non-autistic individuals. If autistic individuals are constantly noticing differences in the environment, this may make it difficult to generalise across situations or to categorise information effectively as there is a reduced perception of similarity and therefore, information is not viewed as being sufficiently similar to ‘group together’ (Plaisted, 2001). The implications of this will be discussed later in this chapter under ‘Scripts, Schema, and Context’.

1:2:1 Visual Search Tasks

Another way in which the perceptual skills of autistic people have been assessed is by using visual search tasks. A visual search task requires a participant to identify a particular visual stimulus amongst other distractor visual stimuli, for example, to identify a black circle in a display of black squares. The earliest study to demonstrate a visual search advantage in autism was conducted by Plaisted et al. (1998). Autistic and non-autistic children aged between six and ten completed two visual search tasks. The first task required participants to find a red letter ‘S’ (target) among a display of red letter ‘T’ and a green letter ‘X’ distractors. This is known as a feature search in which the target letter shares a colour with one set of the distractor letters. In the second task, known as conjunctive search, the target letter shared a colour with one of the distractors and shape with the other distractor (e.g., the target letter grey ‘X’ amongst grey ‘Ts’ and black ‘Xs’). See Figure 1.2.

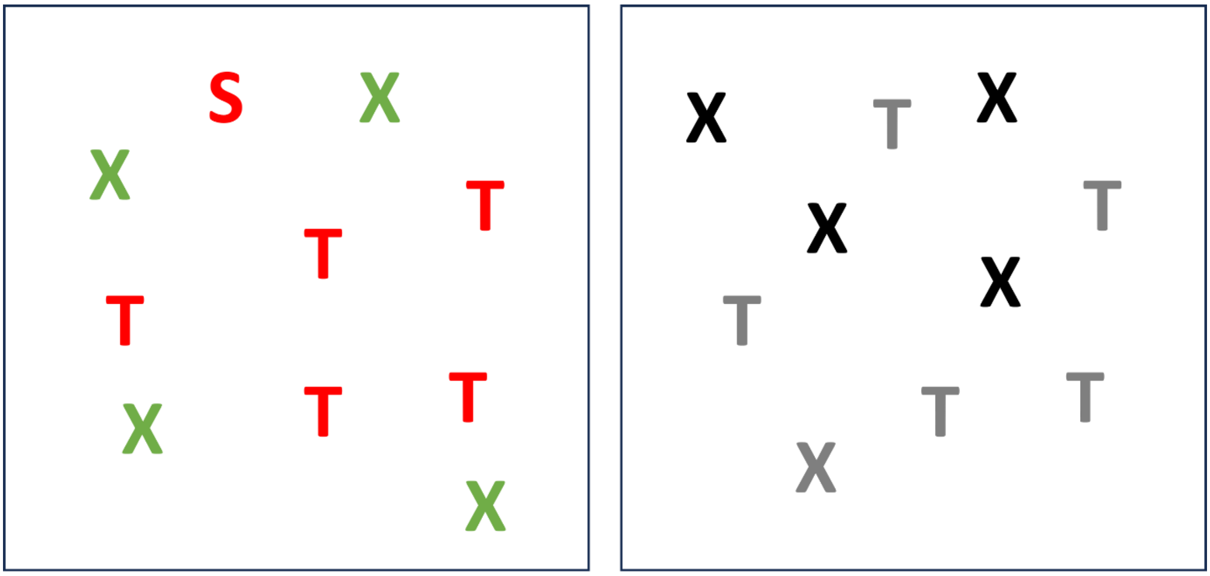


Figure 1.2. Left – feature search – red target 'S' amongst red distractor 'Ts' and green 'Xs' (shared colour). Right – conjunctive search – grey target 'X' amongst grey distractor 'Ts' and black 'Xs' (shared colour and shape).

The results showed that overall search times were quicker for the feature condition, but autistic children were significantly faster, compared to non-autistic children, in the conjunctive condition. Furthermore, autistic children made fewer errors overall. Since then, several other studies have supported the visual search advantage in autism, which seems to be present across age, 'symptom severity' and task difficulty (Kaldy et al., 2011). For example, autistic children as young as 2.5 years old showed enhanced visual search abilities using an eye-tracking paradigm compared to non-autistic toddlers (Kaldy et al., 2011), suggesting that this ability develops early on and continues into adulthood (O'Riordan, 2004). What is less clear is the underlying mechanisms involved in this advantage, such as whether it is due to differences in perceptual or attentional functions.

One suggestion is that autistic people have an enhanced ability to discriminate between multiple objects (O'Riordan & Plaisted, 2001), perhaps because they are less likely to take context into account (Vermeulen, 2015). In the first experiment by O'Riordan and Plaisted (2001), three conjunctive search tasks were used. In the first task, the target had two distinguishing stimulus features – colour and orientation (known as a double conjunctive). In tasks two and three, the target had three distinguishing stimulus features (triple conjunctive) – colour, size, and orientation. When comparing task one and task two, each distractor differed from the target by one and two features, respectively (target-distractor similarity). As predicted, overall, task one (high target-distractor similarity) was more difficult than task two (low target-distractor similarity), but autistic children were still significantly faster in task one compared to the control group. This supports the visual search advantage in autism as detection times for the second task should be faster given that it is easier to discriminate the target from the distractor. Comparison between task two and task three directly examined discrimination ability as only the number of features differed between the tasks (e.g., both tasks were triple conjunctive, but in task two, each distractor differed from the target by two features but only by one feature in task three). Interestingly, although performance in task two was better than task three, autistic children were not slowed to the same extent as the control group, showing that despite target and distractor items being more similar, they were still able to discriminate effectively. In a second experiment, the focus was only on increasing target-distractor similarity using four conjunctive search tasks. In each task, participants had to identify a target amongst distractors that were increasingly less distinguishable from the target e.g., finding a red ‘X’ hidden among green ‘Xs’ and red ‘C’ distractors vs finding a red ‘F’ among pink ‘Fs’ and red ‘Es’. Despite reaction times being slower for both groups, the more similar the target to the distractor, the autistic group remained significantly faster than the control group in the remaining tasks. This could also explain findings of superior performance by autistic people in tasks such as the Block Design Task (Shah & Frith, 1993) and Embedded Figures Test (Jolliffe & Baron-Cohen, 1997), both of which require the ability to home in on ‘hidden’ features.

Evidence for enhanced stimulus discriminability has been supported by studies using eye-tracking data (Kemner et al., 2008). Participants with Pervasive Development Disorder (PDD), a type of autism spectrum condition, and a control group completed the search tasks used in Experiment 2 of O’Riordan and Plaisted (2001). It was found that the PDD group were significantly faster than the control group on both easy and difficult search tasks, which is in line with previous findings relating to a visual search advantage in autism. Furthermore, the PDD group made significantly fewer eye movements and fixations compared to the control group. A lack of rapid eye movements during these tasks suggests that participants did not need to ‘search’ for the target but were able to effectively discriminate between target and distractor stimulus just by glancing. Interestingly, some studies have shown that autistic individuals demonstrate significantly better visual acuity than control groups (Ashwin et al., 2009; Brosnan et al., 2012), and therefore, better performance on visual search tasks cannot be simply attributed to a different cognitive style in this group, as suggested by the Weak Central Coherence theory, but should also consider differences at a perceptual level. There is evidence to suggest that there is a neurological basis to the perceptual experiences of autistic individuals, with differences in brain structure. For example, it has been found that in autistic people, there is an increase in grey matter in parts of the brain which process auditory and visual information (Hyde et al., 2010) as well as atypical activity and connectivity in the visual cortex (Chung & Son, 2020).

1:2:2 Change Blindness

An alternative task that investigates visual processing abilities uses the change blindness paradigm. Change blindness refers to the perceptual phenomenon that individuals can fail to detect large changes to a visual stimulus when there is a visual disruption. For example, the effect can be produced during a saccade, such as a rapid eye movement (Grimes, 1996), when people are shown an image that flickers rapidly and is interspersed with a mask (Rensink et al., 1997) or using ‘mudsplashes’, e.g., small black and white textured shapes over parts of an image (O’Regan et al., 1999). Given the research that has demonstrated an autistic advantage in visual perceptual skills, particularly tasks requiring a focus on detail, such as the Block Design Task (Shah & Frith, 1993) and Embedded Figures Test (Jolliffe & Baron-Cohen, 1997) and the widespread anecdotal evidence relating to the ability of autistic people to detect very small changes in their environment, it may be expected that autistic people show a similar advantage here, with reduced change blindness. However, using the change blindness paradigm with this group has demonstrated mixed results, with some studies showing that autistic people are better at detecting changes compared to a control group (Ashwin et al., 2017; Fletcher-Watson et al., 2012; Smith & Milne, 2009) and others showing no significant differences between autistic and non-autistic participants (Fletcher-Watson et al., 2006; Burack et al., 2009; Hochhauser et al., 2018; Loth et al., 2008).

Fletcher-Watson et al. (2006) were interested in whether autistic people direct their attention in the same way as non-autistic people and if the use of context played a role in this perceptual process. In the first part of their study, autistic and non-autistic adolescents were asked to take part in a series of change blindness tasks using a modification to the ‘flicker’ paradigm in which the original and changed image alternate rapidly with a blank ‘mask’ between them. Participants were able to manually induce the flicker by pressing the SPACE bar. There were 18 trials, in nine of which the stimuli had a central change and the remaining nine a marginal change. The results showed that both groups took longer to detect marginal changes; however, the mean difference in response time between marginal and central changes for the autistic group was significantly larger. This suggested that although it appeared that the focus of attention between both groups (e.g., central changes) was similar for autistic and non-autistic participants, the autistic group could not switch their attention to marginal changes as quickly. In the second study, the stimuli were adapted so that the change to the stimuli was either contextually appropriate or contextually inappropriate to the scene. Considering the evidence available at that time that autistic people demonstrate a local over global processing style and a reduced proclivity towards context, it was predicted that the autistic group would be less likely to consider the context. However, it was found that for both the autistic and non-autistic groups, the contextually inappropriate changes were found faster than contextually appropriate ones. In contrast to this, Loth et al. (2008) did report that autistic participants were not affected by the context – that is, they performed equally across the various context conditions (e.g., scene related vs scene unrelated changes) compared to the typically developing group who, as predicted, were better at detecting scene unrelated changes. In other words, they did not demonstrate an advantage for contextually inappropriate changes in the same way as the non-autistic group.

To address a limitation of the ‘flicker’ paradigm, Smith and Milne (2009) were interested in whether autistic participants performed differently compared to non-autistic participants when shown short clips with continuity errors that had been deliberately introduced. In real-world settings, autistic people who can detect small changes in their environment are not looking at static images that are rapidly alternating, and therefore, this study offers a dynamic component. Participants were shown 20 clips, 16 of which had changes (8 ‘social’, e.g., related to the actor in the clip and 8 ‘non-social’, e.g., an object change). The remaining four clips had no change. After watching a clip, the participant was asked whether they had noticed any changes and, if so, to describe the change. Overall, autistic participants were more likely to detect changes in both central and marginal conditions compared to the non-autistic group, though there was no difference between the groups in terms of social vs non-social changes. In some cases, participants correctly identified a change; however, the change reported was incorrect. The autistic group had a 1.6% false-positive rate compared to 10.4% for the non-autistic group. This suggests that the autistic group were more confident in their answers and less likely to guess, and that they demonstrated better performance when the task reflected more closely a real-life experience.

There may be several reasons for the conflicting results. Given that the aforementioned studies used different stimuli, the discrepancy in the results may be better explained by the *type* of change being important to autistic individuals (e.g., the size, location, or colour). A further consideration is the variability in the samples, with some studies recruiting autistic children and others having an autistic adult sample, as well as the amount of control participants had over the flicker of the images. In some studies, the change blindness paradigm elicited a similar performance between autistic and non-autistic individuals, which is contradictory to findings from studies using alternative visual perceptual tasks, suggesting that visual search and change blindness tasks are not directly comparable and may not be using the same underlying mechanisms. It should also be noted that in many of these tasks, participants are told there will be a change, and therefore, these tasks are not able to capture what the individual spontaneously attends to. Furthermore, there are no consequences to not detecting the changes and, therefore, may not provoke the same anxiety response experienced by autistic people when faced with real-life changes. The need for tasks to have high ecological validity is a theme that emerges strongly through the work reported in this thesis.

1:3 Autism and Attention

One's ability to consciously focus on all incoming stimuli is limited, and therefore, it is necessary to select specific stimuli to focus on while simultaneously ignoring irrelevant or distracting information (selective attention). Several models of attention have been proposed to explain how individuals select what information to attend to. According to Broadbent's (1958) filter theory, we can receive an unlimited amount of sensory information, but we are limited in the amount of information we can process; therefore, we filter information based on physical characteristics (early selection) in order to stop the information processing system from being overloaded. Once the information has passed through the filter, meaning can then be assigned. However, this theory suggests that we do not process any information that we are not attending to and contradicts the findings of the Cocktail Party Effect (Cherry, 1953), in which an individual can detect their name being called despite being amongst a crowd or immersed in conversation.

In contrast to Broadbent's theory (1958), Deutsch and Deutsch (1963) proposed an alternative model which postulates that we process all incoming information (including 'unattended' information) and then the most salient stimuli are 'selected' for additional processing (late selection). This would suggest that when using dichotic listening tasks in which an individual listens to two different messages simultaneously, participants should be able to attend equally well to both messages. However, Cherry (1953) found that unless the auditory inputs differed in physical characteristics (e.g., male voice vs female voice), it was very difficult for participants to focus on two different messages. Although participants could distinguish differences between the physical characteristics of the messages, they were unable to extract the meaning of the 'unattended' message, suggesting that this information does not undergo deeper processing. To bridge the gap between early and late selection theories, Treisman (1964) argued that unattended messages are not ignored completely but are instead attenuated. This means that some meaningful information for unattended messages can be processed but less thoroughly than attended messages unless the information is salient. After this, Treisman and Gelade (1980) introduced their Feature Integration Theory to suggest that when processing visual stimuli, the individual features are perceived first and that attention is required in order to 'bind' this information together to process it as a whole. Lavie (1995) added to this with the concept of perceptual load, which stipulates that attention is affected by whether there is a high or low amount of task-relevant information present during a task. Autistic people tend to perceive details that many other people do not, and in line with previous findings relating to visual perceptual advantages in autism, this has led to an interest in how attentional abilities differ in this group, with research suggesting that autistic people may have an unusually broad attentional spotlight (Burack, 1994) making it difficult for them to filter out irrelevant information. The role of attention may play a role in explaining the visual search advantage noted in autistic participants.

To examine the effect of perceptual load on selective attention in autism, Remington et al. (2009) conducted a study in which autistic and non-autistic participants completed a selective attention task which varied in perceptual load. Participants were presented with the letter 'N' or 'X' amongst distractor non-target stimuli and asked to press either 'N' or 'X' depending on which letter was present. In some trials, the perceptual load was low (e.g., the letter 'N' or 'X' was presented with one other letter or small circle dots), and in others, the perceptual load was high (e.g., the letter 'N' or 'X' was presented amongst various letters with similar appearance such as 'K, H, Y, V'). Although there was no significant difference between the autistic and control group in terms of reaction time (both groups were slower to respond in trials with higher perceptual load), the autistic participants needed a higher level of perceptual load to stop processing the distractor stimuli suggesting that they have a larger capacity for perceptual information. Attentional differences can be linked with the sensory experiences of autistic (Liss et al., 2006), with studies showing that autistic people have an increased perceptual capacity for both visual information (hence the ability to process a larger number of distractor stimuli as described above; Remington et al., 2009) as well as auditory and olfactory information (Ashwin et al., 2014; Remington & Fairnie, 2017). As already mentioned, one early possible explanation for this was that autistic people have an unusually broad attentional spotlight (Burack, 1994). However, Ronconi et al. (2013) later found when showing visual targets at different distances to autistic and non-autistic children and looking at response latencies, the non-autistic children were able to 'zoom in and out' efficiently, whereas autistic children struggled with 'zooming out' to see the bigger picture which is likely to be linked with their performance on perceptual tasks.

1:4 Categorisation and Autism

The term schema refers broadly to a cognitive framework which serves to organise and categorise knowledge (Bartlett, 1932). New information can then be compared to an existing schema to process new stimuli. Prototype formation refers to a general representation of an object that allows for the classification of future encountered similar stimuli. This is done through a process of comparison to a learned prototype. Due to the implicit nature of prototype formation, tasks frequently involve showing participants various distortions of artificial objects or dot patterns, as this allows for the manipulation of the variability between exemplars of the prototype that the participant is expected to learn through feedback on each trial. The prototype takes the form of the most repeated aspect of the varying exemplars that receive positive feedback (i.e., the most 'typical' member of a category). One of the earliest studies to look at prototype formation was conducted by Posner and Keele (1968). Participants were shown a variety of random dot patterns that served as category prototypes, followed by distortions of each prototype, and learned to categorise the 'exemplars' with feedback. Categorisation accuracy was tested for previously seen distortions, new distortions, new distortions that are highly distorted from the prototype and the prototypes themselves (which were unseen during the training phase). It was found that participants were able to accurately categorise the old distortions and the prototypes equally well but showed poorer performance for new distortions, suggesting that participants were abstracting the prototypes, as they had created a general representation of the variation of patterns seen during the training phase.

Given the cognitive, perceptual, and attentional differences observed in autistic people, research has looked at whether the categorisation process follows a different trajectory in autism. Using a similar task to that of Posner and Keele (1968), Church et al. (2010) conducted a study in which a randomly generated prototype was created, followed by 40 distortions of that prototype (ranging from low distortion to high distortion) and 45 arbitrary patterns that were not part of the initial prototype. Autistic and non-autistic children were asked to find the shapes that belonged to a category and received feedback based on their answers. There was a significant difference in the performance between the two groups, with autistic participants being less likely to make 'family resemblance comparisons'; that is, they were less likely to focus on the overall similarity between patterns, a process that is crucial to the creation and recognition of categories. Similarly, a study by Klinger and Dawson (2001) found that both autistic children and children with Down's syndrome had difficulty with prototype formation; however, this was not evident when participants were given 'rules' for category formation, suggesting that in some studies, where feedback is provided, a rule-based approach, as opposed to implicit learning, is being utilised. It is important to note that both the autistic and Down's syndrome groups had mental age scores that were lower than their chronological age compared to the control group. A study by Molesworth et al. (2008) found that when the autistic participants' chronological age matched their verbal mental age, the majority demonstrated a prototype effect, suggesting that age and cognitive abilities are important factors in the role of prototype formation.

To address the methodological issues in which participants, in particular autistic participants, may be using a 'rule-based' approach to identifying the category members that all share a particular feature, a study by Froehlich et al. (2012) looked at the categorisation abilities of random dot patterns without any clearly definable features or the use of corrective feedback. They found that the autistic participants demonstrated intact prototype formation; however, when patterns were more highly distorted, accuracy levels were significantly reduced. It was therefore concluded that it is not that autistic participants cannot abstract prototypes, but instead, there is a difficulty with generalising what has been learned about a category to new stimuli. This could be because autistic participants are distracted by differences between the learned patterns and new patterns. The study by Church et al. (2010) supports the idea that autistic people tend to form 'hyper-specific representations' resulting in difficulty in noticing similarity and is endorsed by cognitive theories such as Weak Central Coherence theory (Frith, 1989) and Enhanced Perceptual Functioning (Mottron et al., 2006), and supported by studies demonstrating an advantage in visual perceptual skills, particularly tasks requiring a focus on detail.

Mercado et al. (2020) reviewed findings in perceptual categorisation tasks performed by autistic participants and found that, overall, autistic participants demonstrated difficulties in the learning of prototypes. The impact of atypical category learning was discussed in terms of how it may affect autistic people in relation to social interaction, restricted interests, and repetitive behaviour. It was concluded that the implications of atypical category acquisition are sufficiently wide-ranging to warrant further study and understanding. More recently, Wimmer et al. (2023) conducted a meta-analysis of 50 studies which investigated autistic performance on categorisation tasks. The paper raised a number of interesting points relating to methodological diversity amongst the studies but concluded that *"autistic persons on average were found not to reach the level of category learning typically achieved by nonautistic individuals"* (p. 21). Unlike the review by Mercado et al. (2020), Wimmer et al. (2023) did not limit their analysis to perceptual categories; therefore, categorisation difficulties appear to span different category types.

1:5 Core Traits

Anxiety, intolerance of uncertainty, and sensory sensitivity have all been identified as common traits in autism. Over many years, each has been documented separately or, in some cases, linked to one or more other traits, but increasingly, research has moved towards the reporting of links between these three. The next section will discuss this work and will start to explain the potential for a variance in the innate facility for the creation of similarity, from an environment full of differences, as a factor from which these traits arise.

1:5:1 Autism and Anxiety

Whilst not all traits associated with autism are experienced by all those diagnosed as autistic, research has shown that the prevalence of anxiety in autistic people is significantly higher than that of control groups (Bellini, 2004), with anxiety disorders estimated to affect between 42% and 84% of individuals (Muris et al., 1998; Simonoff et al., 2008). One study found that approximately 55.3% of autistic people meet the criteria for at least one anxiety disorder (de Bruin et al., 2007). Anxiety is prevalent among autistic children, adolescents, and adults (Rodgers et al., 2020; Trembath et al., 2012; White et al., 2009). Nimmo-Smith et al. (2020) reported that in a study with a sample of 221,694 adults aged 18 to 27 years old, of which 4049 were diagnosed with Autistic Spectrum Disorder, approximately 20% of the autistic adults had also been diagnosed with an anxiety disorder, whereas this figure was nearer to 9% for the non-autistic adults in the sample. The most common classification of the disorder was not a named disorder but a general ‘stress-related’ or ‘non-specific disorder’, with OCD and phobic anxiety (including social phobia) being notable amongst the other named disorders. Less seems to have been discussed in terms of anxiety in autistic adults in the absence of a diagnosed co-occurring anxiety disorder.

In a cross-sectional study of autistic individuals, Davis et al. (2011) examined anxiety in four age groups: 18-36 months, 3-16 years, 20-48 years, and 49-64 years. The five items that were identified as being common measures of anxiety across these different age groups were:

- Sudden, rapid, repetitive movements not associated with a physical disability
- Persistent or reoccurring impulses that interfere with activities
- Irritable mood
- Easily upset
- Avoiding specific objects, persons, or situations causing interference with normal routine

Endorsement of these was used as the key dependent measure by Davis et al. (2011), and a combined measure across these five characteristics showed a pattern across the life span of anxiety rising from infants/toddlers (18-36 months) to childhood (3-16 years) then decreasing in young adulthood (20-48 years) and rising again in the older adult group aged 49-65. The authors were aware of the limitations of the study, but the findings were suggestive of anxiety being present for autistic individuals throughout their lives to varying degrees. It is also interesting to note that repetitive movements and avoidance of interference in normal routines (need for sameness) feature amongst the five items used as a measure of anxiety in this study. It is unclear, however, whether the experience of anxiety is, for some, a ‘symptom’ of being autistic or a co-occurring condition (Kerns & Kendall, 2012). Much research in this area has understandably focused on interventions aimed at reducing anxiety (Rodgers & Ofield, 2018). However, to better understand the origins of anxiety experienced by this group, some researchers have attempted to develop cognitive models of anxiety in autism by considering the roles that factors such as intolerance of uncertainty and sensory sensitivity may play.

1:5:2 Intolerance of Uncertainty

Intolerance of uncertainty relates to the negative thoughts and behaviours that are triggered by uncertain situations (Buhr & Dugas, 2009) and has been strongly associated with various anxiety disorders in 'typically developing' groups (Carleton et al., 2012; Holaway et al., 2006). A study by Boulter et al. (2014) aimed to investigate levels of anxiety in autistic children and to examine whether the relationship to intolerance of uncertainty is comparable to that of a control group. Two-hundred and twenty-four children and adolescents (autistic and non-autistic) and their parents completed the Intolerance of Uncertainty Scale – Child and Parent Versions (Comer et al., 2009), Spence Children's Anxiety Scale – Child and Parent Versions (SCAS-C, Spence, 1998; SCAS-P, Nauta et al., 2004), and a Social Responsiveness Scale (SRS, Constantino, 2002). The results showed that for both self-report and parent-report, the autistic participants had significantly higher levels of anxiety and intolerance of uncertainty. Interestingly, levels of anxiety between the two groups were not statistically significant when the effects of intolerance of uncertainty were controlled for, suggesting that intolerance of uncertainty is a mediator between autism and anxiety and that this could account for the higher levels of anxiety in this group. Given that the relationship between anxiety and intolerance of uncertainty was similar across both groups, it seems that there is a similar underlying process at play, although it is possible that they are directly related as autistic people may be particularly sensitive to the effects of intolerance of uncertainty, resulting in higher anxiety levels.

Stark et al. (2021) entered Intolerance of uncertainty into a model alongside attenuated predictions and black-and-white thinking, which may interact and lead to anxiety in autistic people. They argue that of the following dimensions of uncertainty, including a) the desire for predictability, b) becoming paralysed by uncertainty, c) responding to uncertainty with distress, and d) inflexible beliefs about uncertainty (Berenbaum et al., 2008), it is making decisions under ambiguity that is most problematic for autistic people. Therefore, if autistic people struggle to anticipate what may happen, particularly in social situations, which include many unwritten rules that are not easy to predict, this may lead to a greater need for predictability as a response to such prediction difficulties. However, Bervoets et al. (2021) suggest intolerance of uncertainty does not fit well within a predictive processing model. Predictive processing models suggest that brains are wired to try to reduce uncertainty while considering that each person has a different set of 'priors' or expectations, which may change according to the situation. Although intolerance of uncertainty may describe how people react to uncertainty, it doesn't consider, in the same way that predictive processing models do, that uncertainty is subjective. As such, it is thought that the underlying mechanism of anxiety is the same in autistic and non-autistic people, but what triggers the uncertainty that leads to anxiety is different. In response to this, Stark et al. (2021) clarified their position by explaining that they believe intolerance of uncertainty is multifaceted and that there are aspects of intolerance of uncertainty, namely feeling 'stuck' in uncertain situations that could still explain anxiety. One suggestion is that improvements in measures of intolerance of uncertainty are required. The work of Stark et al. (2021) is in line with the research discussed in the previous paragraph, which highlights a link between anxiety and intolerance of uncertainty. In the model that will later be outlined in this thesis, intolerance of uncertainty could be explained by a hypersensitivity to difference in autistic people, leading to an interference in the perception of similarity and, as such, difficulty making predictions, which leads to anxiety.

1:5:3 Acute Sensory Experiences

Unusual sensory experiences are common across both autistic children and adults, spanning several sensory domains, including sight, touch, taste, smell, and the vestibular and proprioception senses (Crane et al., 2009; Leekman et al., 2007). Research has shown that there is a significant difference between autistic people and non-autistic people relating to the presence and frequency of such sensory experiences (Ben-Sasson et al., 2009). A link has been established between sensory sensitivity and autistic traits in the general population (Robertson & Simmons, 2013), suggesting that the sensory experiences of autistic people are on a continuum which appears to be experienced more acutely. It is thought that there are three subtypes of sensory processing difficulties: sensory sensitivity/over-responsivity, sensory under-responsivity, and sensory seeking. Sensory over-responsivity is positively correlated with autistic traits in adults (Tavassoli et al., 2014) and can often lead to feelings of 'sensory overload'. In autistic children, intolerance of uncertainty has been found to mediate the relationship between autism and sensory sensitivity (Neil et al., 2016). Interestingly, intolerance of uncertainty is thought to be present across both familiar *and* unfamiliar situations for autistic people (Hodgsons et al., 2017), which may also link to sensory sensitivity and anxiety in that, if autistic people are prone to noticing details, even a 'familiar' environment is not exactly the same each time and therefore can also become a source of anxiety.

One possible explanation for the sensory experiences of autistic people is that there is difficulty in using 'prior knowledge' to separate relevant and irrelevant information (Pellicano & Burr, 2012). This is likely to be connected to the reduced use of context in this group as it is the context which helps, at any given moment, to focus attention on what is important to the individual's current goals. As a result, autistic individuals may be prone to developing sensory overload due to prediction errors (Van de Cruys et al., 2014). For example, it may be that there is a mismatch between what is predicted by the autistic brain and what is being experienced. If, for autistic people, the ability to predict sensory information is less accurate, this may impact the ability to filter sensory information appropriately and therefore, sensory information can quickly become overwhelming. This has been supported by the finding that autistic individuals have a 'deficit' in invariance detection (the ability to attend to stable patterns in changing stimuli), which allows typically developing individuals to predict and anticipate information (Hellendoorn et al., 2015). This difference in predictive processing may also explain the perceptual advantage noted, as an inefficient filtering system leads to enhanced attention for detail.

1:5:4 Insistence on Sameness

"Pathological insistence on sameness" was identified by Kanner (1943) as one of the 'classic' features of autism in infants. Since that time, this has continued to be recognised as a common behavioural characteristic associated with autism but is most usually addressed in conjunction with repetitive behaviours. Repetitive behaviours in autism include 'stimming' or self-stimulatory behaviours such as repetitive movements and vocalisations, as well as ritualistic behaviours such as arranging and lining up objects. Such behaviours may be a way of managing high levels of anxiety by using repetitive actions, initiated under the control of the individual, as a means of establishing some predictability. It has been found that autistic children with high levels of anxiety displayed more repetitive behaviours than those with lower levels of anxiety (Rodgers et al., 2012). Furthermore, sensory differences have been significantly associated with repetitive behaviours and insistence on sameness, which are mediated by anxiety and intolerance of uncertainty (Wigham et al., 2015). Therefore, it suggests that insistence on sameness and the use of repetitive behaviours, which appear to be measured separately in the literature, may both act as coping strategies. Insistence on sameness and repetitive behaviours can offer a sense of predictability for autistic people in ever-changing environments that provoke anxiety, which stems from intolerance of uncertainty and over-responsivity to sensory information. One potential explanation for the 'success' in the use of robots to encourage 'social skills learning' with autistic children is that they provide predictability. It is possible for the robot to be programmed so that it behaves in the same way every time. It was found that autistic children paid less visual attention when the predictability of the robot varied (Schadenberg et al., 2021), further highlighting the need for predictability in this group. More recent research looking at Insistence on Sameness has begun to examine whether there are subdomains to this construct. According to Spackman et al. (2023), Insistence on Sameness can be subdivided into Insistence on Sameness

Ritualistic/Sameness (such as insisting that objects are arranged in a particular way), Insistence on Sameness Routines (e.g., behaviours that are performed in the same order), and Insistence on Sameness Other (insisting that other people follow their routines).

1:6 One Explanation or Many?

There is a move in the field of autism research from individual traits and characteristics to how such traits may be linked. One theory that has been proposed as a central underlying trait is monotropism (Murray et al., 2005). This theory suggests that autistic people have a cognitive processing style in which they can focus intensely on a limited number of interests or stimuli at any one time and that this central trait could explain other traits such as anxiety, enhanced perceptual processing and repetitive behaviours. Although this theory proposes a different central trait, monotropism shares the aim of this thesis in trying to identify a unifying factor. The link between monotropism and the model presented in this thesis will be discussed in Chapter 6.

As referred to earlier, Hellendoorn et al. (2015) suggest that autistic people have a 'deficit' that interferes with the ability to detect invariant structures. Not being able to detect such structures is likely to cause uncertainty and unpredictability for autistic people. Attention is also likely to have a role here, given that attending to meaningful patterns of repeated experiences is what allows those experiences to be organised in memory. This helps individuals make 'best guess' predictions about items, peoples, and events that are yet to be encountered, which helps to reduce uncertainty. The recognition of repeated patterns of experience depends upon the salience of similarity (e.g., what the individual patterns have in common with each other). Support for this theory comes from a study by Northrup et al. (2017), who reported that 10-month-old babies who were at 'high-risk' of autism (due to a familial link) did not show the same level of learning arising from prior experience as 'low-risk' babies.

Plaisted (2001) has specifically identified the role of similarity in explaining autistic traits in that *"individuals with autism are unable to draw pieces of information together because of an inability to recognize similarities between stimuli or situations"* (p. 3) and recognises the continuity of findings from the research on autistic perceptual capacities and their conceptual processing. Under this view, the superior performance of autistic participants in visual search tasks such as those reported in an earlier section (Autism and Perception) stem from a reduced influence of the similarity between the target and the distractors. It is this same diminished impact of similarity that can lead to difficulties for autistic participants when forming prototypes, which requires noticing the ways in which stimuli are similar to one another.

1:7 Similarity and Difference

The reduced perception of similarity that is inferred from the work of the authors described above would account for experimental findings from both perceptual and conceptual studies of autistic participants. The starting point of the model proposes that interference with the awareness of similarity in autism is due to a heightened perception of difference. If this is the case, could this also explain various other autistic traits and behaviours? This possibility has also been raised by O'Riordan and Plaisted (2001), who suggested that autistic people have an augmented perception of difference. The earliest model of the way in which judgements of similarity are made was proposed by Tversky (1977), who suggested that similarity increases to the extent that common features are shared and decreases to the extent that features differ. Although similarity and difference are related, they are not necessarily complementary, and this will be discussed further in Chapter 3. A heightened awareness of difference is expressed in this model as a hypersensitivity but could also be described as a heightened salience of difference or even, to borrow a term from Stark et al. (2021), an increased 'attunement' to difference. Regardless of how it is described, the model is not just claiming that difference is more frequently noticed, but that the differences that are usually overlooked when noticing similarity remain highly salient in autism. It should be emphasised that this enhanced salience of difference is involuntary.

The role of similarity in facilitating this generalisation of knowledge to form 'best guess' predictions of how to act and interact with a novel item has long been implicated in inductive reasoning (Osherson et al., 1990; Sloman et al., 2003), learning from previous examples (Ross & Kennedy, 1990) and the use of analogical reasoning[1] (Holyoak et al., 1984; Vosniadou & Ortony, 1989). Similarity also underlies the understanding and use of metaphors (Gentner & Wolff, 1997; Gibbs, 1992; Marks et al., 1987;) which may explain why autistic individuals are taken to have a literal understanding of language (Hobson, 2012). Given the broad influence of similarity, interference or differences in that process will impact many other cognitive processes that guide one's interaction with the world.

[1] Research has shown that analogical reasoning is intact in autism (Green et al., 2014; Morsanyi & Holyoak, 2010).

1:8 The Model

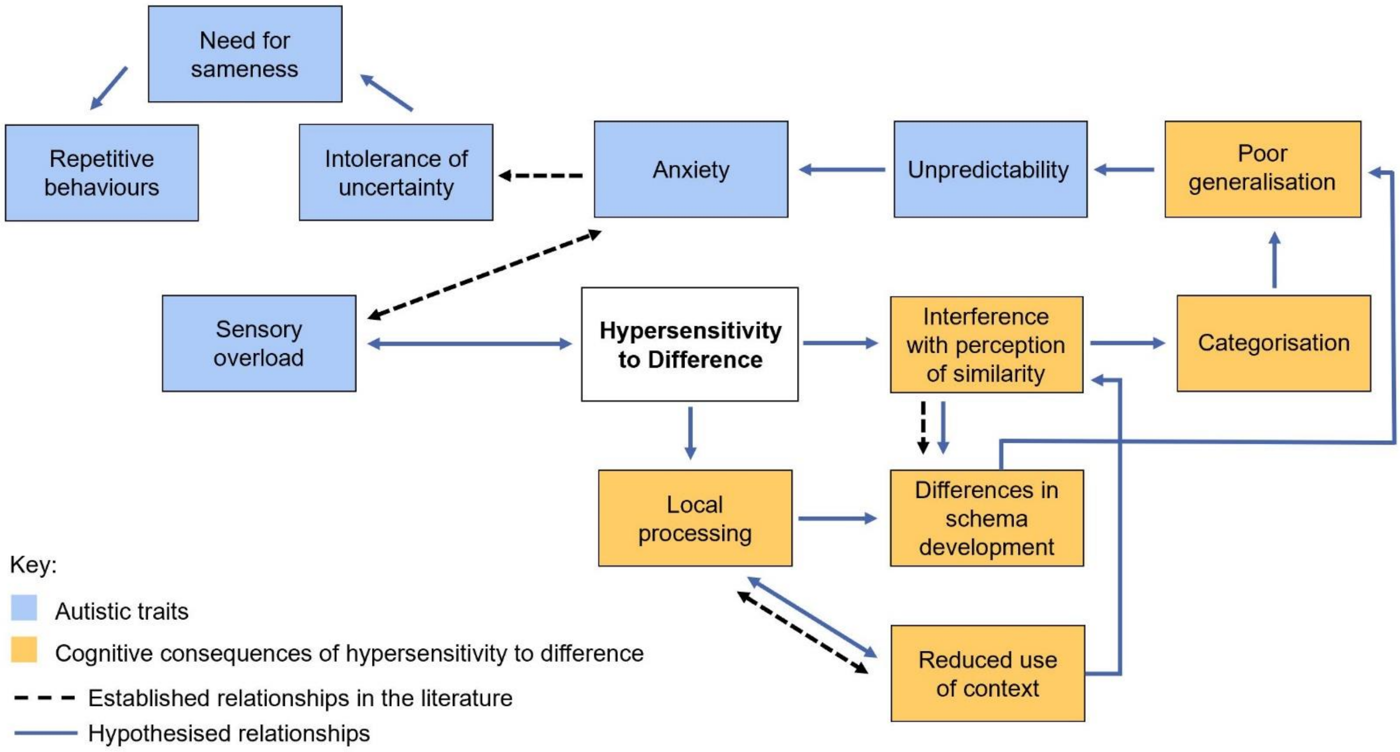


Figure 1.3. Cognitive model proposing that hypersensitivity to difference is a core central trait from which other autistic traits flow.

The primary aim of the empirical work was to establish a task that would serve to strongly demonstrate that autistic individuals, when compared to controls, spontaneously experience a greater sensitivity to differences in their environment both from one point in time and another (visiting the same restaurant on two different occasions) and between two sensory experiences items/situations/people that are often perceived as being ‘the same’ (e.g., looking at two seemingly identical cups – where the autistic person may notice a very small difference between the two, a non-autistic person would say they are the same).

In Experiment 1, the change blindness task was used for this purpose, and if successful, a ‘flat’ performance for only the autistic participants in the noticing of congruent and incongruent differences, would indicate a link between this hypersensitivity and local processing of objects. This would lead to a reduced use of context (the rooms) that interferes with the processing of similarity that underpins the formation of schema. If this were to be found, it would be expected to be associated with higher levels of anxiety, intolerance of uncertainty and sensory sensitivity.

In Experiments 2 and 3, the use of a direct, scaled measure of similarity and difference between everyday items was expected to show that autistic participants would give higher difference ratings than controls, particularly when items were related primarily through context and possibly lower similarity ratings, which would support the link between the enhanced perception of difference and local processing/reduced use of context. The notion of interference with the perception of similarity that the model proposes would be supported by a significant reduction in similarity ratings compared to controls. This would have implications for forming categories that depend upon similarity between category members and difference to members of other categories.

In Experiment 4, the link between hypersensitivity to difference and categorisation was tested using a free card-sort task of familiar and unfamiliar stimuli; this was expected to demonstrate hypersensitivity to difference among autistic participants by the formation of a larger number of smaller categories with fewer items in each, demonstrating a propensity to use difference as a discriminating heuristic in a task (in which no rule for sorting was provided) to a greater extent than controls.

The final experiment (Experiment 5) was intended to resemble a real-life experience of an environment more closely. The use of virtual reality technology allowed the creation of a scene that was both more complex and dynamic, compared to the change blindness paradigm, to increase the ecological validity of a task designed to assess hypersensitivity to difference.

Assuming there is a **spontaneous hypersensitivity to difference** (see Figure 1.3) for autistic people in all aspects of the environment, it would mean that an autistic child or adult experiences a much wider variance amongst objects, people, situations, communication, language, and sensory experiences. More variance means it is harder to identify invariance, and thus, the mental organisation of prior experience in memory does not create a strong basis for anticipating future experiences (other than to expect more difference). As such, life and the world seem unpredictable and overwhelming. A heightened sense of **unpredictability** means more **uncertainty** and higher **anxiety**. To control and counter these feelings, autistic people may engage in behaviours that increase predictability by **creating sameness,** for example, through repeated routines, **repetitive** verbal and motor routines (stimming), insisting on certain foods, always wearing the same types of clothes on certain days, sitting in the same seat etc. Focusing on special interests may also be a strategy which serves to limit attention to difference and increase familiarity. In this way, a number of traits and behaviours that are often associated with autism can be seen to arise. ‘Local processing' may not be due to an 'impairment' in global processing but rather a strategy for blocking out additional sources of difference that may be found in the 'bigger picture'.

Using this model, the enhanced visual abilities in autism that were reported in the previous section arise from the tendency for autistic participants to focus on the differences between target and distractor stimuli, compared to non-autistic participants. As a result, they remain unaffected by the confusion that occurs for non-autistic participants for whom similarity is more salient than difference. Similarly, in the learning of prototypes from artificial stimuli, it is the shared patterns within the stimuli that allow a perception of similarity to arise, creating a single 'prototypical pattern', which requires that the differences between the exemplars are 'overlooked' in order to match the commonalities. This appears to be more challenging for autistic participants compared to non-autistic participants.

1:9 Scripts, Schema, and Context

Specialist schemas for objects and people are referred to as 'categories' or 'concepts', whereas the term schema is usually used in relation to events and everyday situations. Both are formed through repeated experiences, which help to form predictions about the future. For example, over time, an individual may encounter several different types of cups, such that when they encounter a new example of that object, they are able to make a 'best guess' prediction on what that object is and how it may be used. In this case, it may be that the shape, size, and handle on the side suggest that the item is a cup. Therefore, the individual has used the ways in which the new item is sufficiently similar to all the other encountered items of that type to add it to their category knowledge of 'cups'. For autistic people who are hypersensitive to difference, this interference in the perception of similarity is likely to result in the creation of many more categories with different category boundaries (Gastgeb et al., 2012) or categories being formed more slowly (Bott et al., 2006; Soulières et al., 2011). This is not to say that autistic people cannot notice similarity at all, as this would mean that, when encountering a new example of a known object (e.g., a different type of cup), they would be unable to recognise that it is a cup. However, once an autistic person has recognised that the new item is, in fact, a cup, they may then struggle to overlook the differences between the new cup and their prior knowledge of cups. As a result, they may have a category of cups which is subdivided into several other categories based on colour, shape, size, and design, leading to more narrowly defined categories. To use an analogy, if knowledge in memory were stored in filing cabinets, autistic people would have many more files that are separated based on the ways in which they differ. How an individual deals with new information may be dependent on their goals. For example, such featural differences in cups may not be important for non-autistic people if their primary goal is to have a drink. In this case, any object with cup-like properties would serve this purpose. For autistic people, however, who struggle to overlook differences, it is harder to integrate this new example of a cup into existing knowledge.

Widmayer (2002) proposes that when presented with new information, there are three ways it can be added to a schema: 1) new information is added to an existing schema, and no overall changes to that schema are made (assimilate), 2) an existing schema is modified to include the new information (tuning), or 3) the existing schema cannot be modified and so a new schema is formed to resolve the differences between the new information and the old schema (restructuring). For autistic individuals, it may be that schemas are not tuned to include new information as the new information is considered to be too different to be added to an existing schema. This may lead to the creation of many separate schemas encompassing all possible situations. For example, when visiting a restaurant, non-autistic people may have 'menus' in their schema of that experience. However, for autistic people, there could be several schemas for each of the different types of menus they have previously encountered (paper, laminated, single-sided, double-sided, etc.). This may explain why, when investigating the event schemas of autistic people, it was found that they provided more detail about slot fillers and stronger beliefs that 'optional acts' would always occur compared to non-autistic participants (Loth et al., 2008). If autistic people have multiple schemas that capture details and cannot be integrated, through similarity, into a broader event schema, such as going to a restaurant, then the ability to make predictions is compromised due to the amount of variance considered between situations and even within situations. Arguably, event schema is likely to be more disrupted compared to category knowledge as there is only so much variance in objects compared to situations involving people. Since situations capture the varying contexts in which objects, people and activities occur, differences in experimental tasks that implicate the use of schema would be expected to be informative about context.

Several studies have been conducted investigating event schema in autistic people. For example, in a study by Volden and Johnston (1993), autistic children (separated into 'high' and 'low' developmental levels based on language age) and non-autistic children were asked to provide narratives of a given situation. It was found that autistic children included fewer 'core elements' (e.g., the things that are nearly always true for that situation) compared to non-autistic children. They were, however, equally able to predict the next 'core element' when watching a video of the same situation in their second task, and they could identify violations to the script[2] in a third task. The high developmental group were able to correctly identify elements that were inappropriate in a similar way to non-autistic participants, whereas the low developmental group were significantly less accurate. This suggests that autistic participants had a basic script knowledge, but there was a greater difficulty in producing the content in a verbal narrative compared to the non-autistic participants. In another study by Lopez and Leekham (2003), using an adapted version of Palmer's (1975) original method,[3] it was found that both autistic and non-autistic children were faster at identifying objects following a scene in which the objects would normally be expected to be found, compared to a neutral or incongruent contextual scene. This suggests that autistic children showed the same influence of context as non-autistic children when identifying objects. However, the use of a further homograph test (Frith & Snowling, 1983) reported in the same paper showed that autistic children were overall more likely to give the most frequent pronunciation of a word regardless of whether the meaning fitted the context of the sentence. In a later study, Loth et al. (2008) found that whilst non-autistic adult participants were better at identifying scene incongruent changes, autistic participants performed at the same level for changes that were congruent or incongruent with the context presented by the scene (they showed no condition effect). This would suggest that the autistic participants were not influenced by top-down schematic knowledge in this task in the same way as the non-autistic participants. A later study found greater recall of context-relevant objects for non-autistic participants compared to autistic participants (Loth et al., 2011). One suggestion for this discrepancy in performance between autistic and non-autistic participants is that the processing of multiple sources of information may be more difficult for autistic participants, whereas for single items, autistic participants perform in a similar way to non-autistic participants.

Vermeulen (2015) summarises evidence from previous literature to conclude that there is a lack of 'contextual sensitivity' in autism and that this has implications for communication, executive functioning, systemising, sensory problems, and theory of mind. Interestingly, in Vermeulen's (2015) section on 'sensory problems' he states that *"poor contextual sensitivity and the consequent lack of top-down modulation of incoming stimuli could lead to all*

---

[2] Schank and Abelson (1975), using what had been learned in researching the understanding of language, first introduced the term 'script' to describe a 'predetermined' mental structure that organises knowledge of an appropriate sequence of events and actions within 'well-known' situations. This organisation is now commonly referred to as a schema whilst script is often reserved to describe the predicted narratives that can be drawn from this organisation of knowledge in memory.

[3] Palmer's (1975) study showed situational context playing a role in enhancing the probability of correct identification of an item.

incoming stimuli being processed as unexpected, resulting in increased sensitivity and sensory overload" (p. 6).

1:10 Conclusion

The approach taken is this model is not the first to suggest that an altered perception of difference may underly various cognitive processes (O'Riordan & Plaisted, 2011), though it is the first to place a spontaneous hypersensitivity to difference as a central trait from which several other traits flow. The model also suggests that there are cognitive aspects in autism that are not 'impaired' but perhaps do not occur automatically in the way they might for non-autistic people. For example, Lewis and Boucher (1988) noted that although autistic children did not, of their own accord, engage in pretend play to the same extent as the non-autistic children, when prompted, this difference 'disappeared'. Furthermore, it was found that 'joint reference' could be established with autistic children if prompted, and that global processing was possible if participants were cued. Interference with the perception of similarity does not suggest that it is not used at all in the organisation of knowledge for autistic people, but it seems that the 'default' setting for the autistic person is to see differences over similarities.

Caveat: There are numerous references in autism research to the heterogeneity within autistic individuals. Charman et al. (2011) state that "heterogeneity seems to exist at all levels in ASDs: biological, cognitive and behavioural" (p. 14). Not all autistic people experience the same traits, and when they do, the degree to which they are experienced by the individual can vary. This ought to be considered when making comparisons between participants grouped together as autistic and those grouped as non-autistic. Therefore, it is important that autistic participants are similar to each other in important aspects (relevant to the research questions under investigation) and different to non-autistic control groups. The way in which the autistic group is similar may be too broad to reveal the differences that are being investigated (e.g., all participants have a formal diagnosis of autism, or all perform similarly on the chosen measure of IQ). The broadness of the autistic group may explain some of the inconsistencies in findings from experimental methods, such as the change blindness studies that were discussed previously. Empirical evidence of cognitive subgroups in autism remains limited. Thus, the core central trait of hypersensitivity to difference in the model may not apply to all autistic people but could serve to explain a range of traits in a subgroup of autistic people, given that hypersensitivity to difference, like other autistic traits, is likely to vary among individuals.

Thesis Structure

The following chapters will report the findings of several experimental methodologies used with the aim of demonstrating hypersensitivity to difference in autistic adults:

- Chapter 2 explores the use of the change-blindness paradigm as a potential measure of hypersensitivity to difference.
- Chapter 3 uses rating tasks to assess how autistic and non-autistic adults rate similarity and difference between pairs of items.
- Chapter 4 investigates how autistic and non-autistic adults form categories through two card-sorting tasks.
- Chapter 5 considers the role of virtual reality technology in increasing the ecological validity of tasks.

The final chapter (Chapter 6) will summarise and discuss the findings from this programme of work, including its contribution to knowledge, limitations, implications, and future research directions.

CHAPTER TWO – Typicality Ratings & Change Blindness

As referred to in the opening chapter, some studies have demonstrated that autistic participants are better able to detect changes compared to a control group, particularly when the changes are marginal rather than central to a scene (Ashwin et al., 2017; Fletcher-Watson et al., 2012; Smith & Milne, 2009) supporting previous findings that autistic people have a proclivity towards local over global processing (Frith, 1989; Mottron et al., 2006; Plaisted, 2001). In other studies, no difference has been reported between autistic and control participants when detecting change (Fletcher-Watson et al., 2006). Interestingly, in a study whereby one of the change blindness conditions involved inverting the scene (presenting the scene upside down), the autistic groups' performance was not affected in the same way as the control group, who experienced a decrease in performance and were slower to detect changes (Vanmarcke et al., 2018), suggesting that the autistic group are less impacted by context and is in line with theories suggesting that autistic people experience either a reduced sensitivity to contextual information or perhaps a difference in the way in which contextual information is incorporated (Vermeulen, 2015). When including social stimuli, it has been found that although autistic participants detected social and object changes equally fast, control participants were faster at detecting changes to a face (Kikuchi et al., 2009). A review of studies using eye-tracking with autistic children and toddlers has found that they spend less time looking at people and faces in both screen-based simulations (Falck-Ytter et al., 2013) and face-to-face communication (Falck-Ytter, 2015), suggesting that differences in social communication noted in autistic people may stem from that fact that more attention is paid to the environment and object-based information than to social information.

Currently, there is not an established measure of hypersensitivity to difference, and therefore, the aim of Experiment 1 was to build upon a paper by Loth et al. (2008) to examine the limits of attention to detail in autistic participants, and to determine whether performance on the change-blindness paradigm can be considered a reliable indicator of hypersensitivity to difference in this group. Previous studies have not taken into account that certain objects may be more typically associated with a schema than others and that chance differences in the typicality of the items in each room may affect responses. Following the results from the typicality rating study, participants were presented with a base scene, e.g., an office scene, followed by four individual object changes. 1) the change was incongruent to the scene (e.g., a hairdryer was added to a pile of books), 2) a congruent scene change (e.g., a laptop was replaced with a ring binder folder which would still be relevant to the scene), 3) the same target object was moved to a different position (e.g., the telephone on the desk was moved from one side of the scene to the other), or 4) a detail change (e.g., the colour on the desk drawer handle was changed). The congruent and incongruent scene changes were included from the paper by Loth et al. (2008) for replication purposes, and the remaining two conditions of change type (detail change and position change) extended that study. In the study by Loth et al. (2008) participants were presented with images of naturalistic scenes that had three different types of change: 1) an object was replaced with an object unrelated to the scene (e.g., in a living room replacing chair with a washing machine), 2) an object was replaced with an object that could be found in that scene (e.g., in a kitchen replacing microwave with a toaster) and 3) replacing an object with another object of the same type (e.g., in a bedroom changing a lamp with a different type of lamp). It was found that autistic participants were slower and less accurate for scene-unrelated changes compared to the control group; however, there was no significant differences between the two groups on the other two change types. This suggests that autistic participants were not influenced by the context in the same way as control participants and implies that the control participants were focused on the general gist of the scene (e.g., they were utilising prior schematic knowledge). By incorporating the use of everyday scenes, it was suggested that the change-blindness paradigm would provide a more realistic experience of environments than has been used previously. It is predicted that overall, the autistic group would detect more changes than the control group. However, in one condition, namely the incongruent change, it was expected that the control group would detect more changes, and at a faster rate, as it was anticipated that this group were more likely to be incorporating the context. The autistic group would be faster and more accurate with position, congruent, and detail changes, as it was theorised that they would not be relying on schematic knowledge to the same degree as the control comparison group. To assess whether hypersensitivity to difference is related to other autistic traits such as high levels of anxiety (de Bruin et al., 2007), sensory differences (O'Neill & Jones, 1997), and intolerance of uncertainty (Boulter et al., 2014) measures of these traits were included. It was predicted that autistic participants would have significantly higher levels of anxiety, sensory sensitivity, and intolerance of uncertainty and that these measures would be related to a hypersensitivity to difference, as demonstrated through an enhanced ability to detect the differences between the repeated scenes.

2:1 Pilot Study – Introduction

Categorisation relates to separating objects, people, and ideas into different groups. Our mental representations of categories are known as concepts. When categorising objects, a range of information, such as shape, size, and function, can be used. Given that objects can belong to more than one category, categories are thought to be ordered hierarchically. Basic-level categorisation (Rosch et al., 1976) provides a general description of an object (e.g., 'car') and is thought to be easiest for children to learn during language development due to its 'concrete' nature (Brown, 1958). Next, the superordinate level encompasses the basic-level category to provide a broader category (e.g., 'vehicle'). Finally, the most specific of the levels is the subordinate level, which provides distinguishing details (e.g., 'sports car').

Typicality refers to the notion that some objects are a 'better fit' even within a category. Similarity and frequency are two important factors related to typicality (Nosofsky, 1988). The family resemblance model proposes that something is typical if it shares features that are frequent in one category but different from those in another (Rosch & Mervis, 1975). For example, a robin might be considered a 'better' example of a bird compared to a penguin because robins share many of the properties noted in other birds, whereas a penguin also shares some properties with another category, such as fish. This can lead to faster categorisation of new stimuli that are similar to an exemplar (Smith & Medin, 1999). In terms of frequency, something may be typical if we encounter it more in one setting or situation than another. Typicality can be thought of as being on a scale in which there is a variation on how typical an object is based on the context. For example, a saucepan should be rated as having high typicality in a kitchen but low typicality in an office. The current study aimed to collect typicality ratings from the general population on what objects they typically expected to see in five scenes: kitchen, bathroom, living room, office, and bedroom. The findings were used to develop the stimuli for the next experiment in which a change blindness task is employed.

2:2 Methods

2:2:1 Participants

A total of 76 participants took part in the typicality ratings study. The data of five participants who answered 'Yes' to having been formally diagnosed with an Autism Spectrum Condition (ASC) were removed on the basis that autistic individuals differ in how they categorise information (Church et al., 2010).

Of the remaining 71 participants, there were 64 females and five males. Two participants selected 'Prefer not to say'. The age of participants ranged from 18-53 (*M* = 23.27, *SD* =

7.71). Participants were recruited online via the University of Hertfordshire Psychology SONA System. This study and the subsequent studies reported in this thesis received ethical approval.

2:2:2 Design

The study used a within-subjects design. The dependent variable was the typicality ratings for objects given on a 10-point scale on how likely it was expected that they would be found in particular scenes (1 – highly likely; 10 – highly unlikely).

2:2:3 Materials

For each scene, a series of objects were chosen by the research team to be both typical and atypical to the context. By collecting typicality ratings for the objects, it was possible to ascertain which objects the general population rated as being typical and atypical to the scenes.

2:2:4 Procedure

The study was conducted online using Qualtrics. Before beginning the study, participants were provided with an information sheet and consent form. To collect typicality ratings, participants were asked to imagine a typical scene (e.g., a kitchen). On the following page, they were shown a list of eleven objects (different objects for each scene) and asked to rate on a 10-point scale (1 – highly likely; 10 – highly unlikely) how likely they thought it was that they would find each object in that scene. There were five scenes in total: kitchen, bathroom, living room, office, and bedroom. At the end of the study, participants were asked to generate an anonymity code (under which their data would be stored) and complete demographic information on age, gender, and whether they had been formally diagnosed with Autism Spectrum Condition.

2:3 Results

The next study used the change-blindness paradigm with four types of change: detail change, position change, congruent change, and incongruent change. When selecting objects for this subsequent research, it was decided that objects with a mean rating higher than seven would be considered to have high typicality, whereas objects with a mean rating lower than two would be considered to have low typicality (see Tables 2.1 to 2.5). This was particularly important for the congruent and incongruent changes, and therefore, the items for each scene were chosen following the criteria set out above.

Table 2.1.

Mean typicality ratings (SD) given for each object in the kitchen scene.

Kitchen	**Typicality Ratings**
Cooker	9.89 (.65)
Cup	9.83 (.51)
Kettle	9.83 (.56)
Saucepan	9.73 (.74)
Toaster	9.67 (.99)
Grater	9.06 (1.61)
Washing Machine	8.30 (2.06)
Broom	7.25 (2.22)
Watering Can	3.11 (2.53)
Drum	1.27 (1.03)
Hockey Stick	1.20 (.55)

Table 2.2.

Mean typicality ratings (SD) given for each object in the bathroom scene.

Bathroom	**Typicality Ratings**
Towels	9.75 (.60)
Shampoo	9.69 (.84)
Toothbrush	9.69 (1.05)
Toilet	9.65 (1.28)
Bath Mat	9.25 (1.43)
Shower Curtain	8.87 (1.81)
Radiator	7.96 (2.06)
Hairbrush	7.85 (1.99)
Wooden Spoon	1.13 (.38)
Ketchup	1.04 (.36)
Carrot	1.00 (.00)

Table 2.3.

Mean typicality ratings (SD) given for each object in the living room scene.

Living Room	**Typicality Ratings**
Sofa	9.87 (.56)
TV	9.55 (1.23)
Cushions	9.38 (1.50)
Coffee Table	9.00 (1.18)
Rug	8.70 (1.55)
Ornaments	8.41 (1.55)
Candles	7.74 (1.95)
Mirror	7.17 (2.33)
Sink	1.40 (1.29)
Bicycle Wheel	1.23 (.57)
Hose	1.19 (1.11)

Table 2.4.

Mean typicality ratings (SD) given for each object in the office scene.

Office	**Typicality Ratings**
Desk	9.94 (.29)
Telephone	9.76 (.60)
Printer	9.49 (1.04)
Stapler	9.44 (1.12)
Filing Cabinet	9.39 (1.46)
Laptop	9.34 (1.03)
Shelf	9.30 (1.14)
Books	8.89 (1.31)
Musical Keyboard	1.91 (1.54)
Hairdryer	1.33 (.85)
Disposable BBQ	1.13 (.76)

Table 2.5.

Mean typicality ratings (SD) given for each object in the bedroom scene.

Bedroom	**Typicality Ratings**
Bed	9.92 (.60)
Wardrobe	9.60 (1.03)
Lamp	9.01 (1.35)
Side Table	8.61 (1.54)
Alarm Clock	8.55 (1.65)
Framed Picture	8.18 (1.62)
Chair	7.75 (1.95)
Radio	6.52 (2.30)
Armbands	2.88 (2.36)
Road Sign	1.63 (1.54)
Butter	1.33 (1.34)

Table 2.6 shows the objects that were used in each scene (with mean typicality ratings) and for each type of change. Objects were chosen so that they were similar to the object being replaced in terms of size and shape, e.g., for the kitchen scene, the saucepan was replaced by a drum.

Table 2.6.

Objects to be used in change blindness task (objects that will be replaced) and their mean typicality ratings.

	Scene				
	Kitchen	Bathroom	Living Room	Office	Bedroom
Change					
Detail	Cooker (*M* = 9.89)	Toilet (*M* = 9.65)	TV (*M* = 9.55)	Desk (*M* = 9.94)	Wardrobe (*M* = 9.60)
Position	Cup (*M* = 9.83)	Towels *(M* = 9.75)	Cushions (*M* = 9.38)	Telephone (*M* = 9.76)	Lamp (*M* = 9.01)
Incongruent	Drum (*M* = 1.27) *(Saucepan)* (*M* = 9.73)	Carrot (*M* = 1.00) *(Hairbrush)* (*M* = 7.85)	Bicycle wheel (*M* = 1.23) *(Ornament)* (*M* = 8.41)	Hairdryer (*M* = 1.33) *(Books)* (*M* = 8.89)	Butter (*M* = 1.33) *(Alarm Clock)* (*M* = 8.55)
Congruent	Toaster (*M* = 9.67) *(Kettle)* (*M* = 9.83)	Shampoo (*M* = 9.69) *(Toothbrush)* (*M* = 9.69)	Candles (*M* = 7.74) *(Ornament)* (*M* = 8.41)	Printer (*M* = 9.49) *(Laptop)* (*M* = 9.34)	Chair (*M* = 7.75) *(Side Table)* (*M* = 8.61)

One-way repeated-measures ANOVAs were conducted to compare the typicality rating means by change types.

Detail

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated χ^2 (9) = 149.66, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, *F*(2.05, 141.16) = 3.152, *p* = .045. Pairwise comparisons with a Bonferroni adjustment showed that there is a statistically significant difference between 1. Cooker and TV (*M* = 9.89, 9.54; *p* = .006) 2. TV and Desk (*M* = 9.54, 9.94; *p* = .02) and 3. Desk and Wardrobe (*M* = 9.94, 9.60; *p* = .02).

Position

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (9) = 102.20, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, *F*(2.65, 182.65) = 11.892, *p* <.001. Pairwise comparisons with a Bonferroni adjustment showed that there is a statistically significant difference between 1. Cup and Lamp (*M* = 9.83, 9.01; *p* <.001) 2. Towels and Lamp (*M* = 9.74, 9.01; *p* <.001) and 3. Telephone and Lamp (*M* = 9.76, 9.01; *p* <.001).

Incongruent

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (9) = 81.45, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed that there was no significant effect of object on typicality rating, *F(*2.58, 175.36) = 1.927, *p* = .14. Pairwise comparisons with a Bonferroni adjustment showed that there is a statistically significant difference between 1. Carrot and Bicycle Wheel (*M* = 1.00, 1.23; *p* = .01) and 2. Carrot and Hairdryer (*M* = 1.00, 1.33; *p* = .02).

Congruent

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (9) = 74.95, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, *F*(2.84, 193.25) = 51.771, *p* <.001. Pairwise comparisons with a Bonferroni adjustment showed that there is a statistically significant difference between 1. Toaster and Candles (*M* = 9.67, 7.71; *p* <.001) 2. Toaster and Chair (*M* = 9.67, 7.68; *p* <.001) 3. Shampoo and Candles (*M* = 9.68, 7.71; *p* <.001) 4. Shampoo and Chair (*M* = 9.68, 7.68; *p* <.001) 5. Candles and Printer (*M* = 7.71, 9.48; *p* <.001) and 6. Printer and Chair (*M* = 9.48, 7.68; *p* <.001).

One-way repeated-measures ANOVAs were then conducted to compare the typicality rating means by scene types. This was to ensure that within each scene, incongruent objects were, in fact, less typical than congruent objects.

Kitchen

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 98.54, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, *F*(1.62, 120.16) = 2554.68, *p* < .001. Pairwise comparisons with a Bonferroni adjustment showed a statistically significant difference (*p* <.001) between the incongruent object (Drum; *M* = 1.28) and congruent object (Toaster; *M* = 9.65) in the kitchen scene.

Bathroom

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 46.45, *p* <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, *F*(2.15, 159.19)

= 2666.03, p <.001. Pairwise comparisons with a Bonferroni adjustment showed a statistically significant difference (p <.001) between the incongruent object (Carrot; M = 1.03) and congruent object (Shampoo, M = 9.65) in the bathroom scene.

Living Room

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 34.44, p <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, F(2.38, 173.87) = 632.65, p <.001. Pairwise comparisons with a Bonferroni adjustment showed a statistically significant difference (p <.001) between the incongruent object (Bicycle Wheel; M = 1.37) and congruent object (Candles; M = 7.65) in the living room scene.

Office

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 93.87, p <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, F(1.76, 128.42) = 1907.37, p <.001. Pairwise comparisons with a Bonferroni adjustment showed a statistically significant difference (p <.001) between the incongruent object (Hairdryer; M = 1.39) and the congruent object (Printer; M = 9.45) in the office scene.

Bedroom

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, χ^2 (5) = 40.36, p <.001, therefore degrees of freedom were corrected using Greenhouse-Geisser. The results showed a significant effect of object on typicality rating, F(2.56, 164.60) = 457.90, p <.001. Pairwise comparisons with a Bonferroni adjustment showed a statistically significant difference (p <.001) between the incongruent object (Butter; M = 1.42) and the congruent object (Chair; M = 7.62) in the bedroom scene.

2:4 Discussion

This study aimed to obtain from the general population typicality ratings of objects they would typically expect to find in five different everyday scenes. These ratings were made on a 10-point scale, and objects with a mean rating of 7 or more were considered highly typical of a scene; a mean rating of 2 or less indicated low typicality. The participants' results showed that a cooker was considered highly typical for the kitchen scene, whereas a hockey stick had low typicality. For the bathroom scene, towels were considered highly typical, and carrots had low typicality. In the living room scene, sofa received the highest typicality rating and hose the lowest. For office, desk was rated as highly typical and disposable BBQ as least typical. Lastly, in the bedroom scene, bed received the highest typicality rating and butter the lowest.

In order to develop the incongruent condition for the change blindness study, it was necessary to replace the object in the base image with an object that one would not expect to find in a particular scene. To do this, the three lowest-rated objects from each scene were considered incongruent; therefore, one of the objects could be matched with an object of similar size. For example, drum received a low typicality rating in the kitchen scene and replaced the saucepan matching the shape and size. The same process was conducted for the remaining four scenes (bathroom, living room, office, and bedroom). In all scenes, the three lowest-rated objects from each scene were statistically significantly different from the remaining objects (p <.001). The results from this study enabled the development of stimuli for use in the following experiment using the change-blindness paradigm.

2:5 Experiment 1 – Introduction

Following the results from the typicality rating study, participants were presented with five different scenes (bathroom, bedroom, living room, kitchen, and office) using the change blindness paradigm. Within each scene, there were four different change types: 1) a position change, 2) a detail change, 3) an incongruent change and 4) a congruent change. On the basis of the literature, it was expected that overall, the autistic participants would detect more changes than the control group. It was expected that the autistic participants would be faster and more accurate with position, congruent and detail changes but that they would be slower and detect fewer changes in the incongruent condition compared to the control group, as they are less sensitive to contextual information. It was predicted that there would be significant differences between the autistic and control participants on all measures (anxiety, sensory sensitivity, and intolerance of uncertainty).

2:6 Methods

2:6:1 Participants

Eighty-eight participants (M = 28.84, SD = 11.11, range = 18-64) took part in the study. Forty-eight participants had a formal diagnosis of Autism Spectrum Condition or were self-diagnosed/awaiting assessment (N = 7). Of the autistic group, 18 identified as male, 24 as female, and six as ‘other’ (e.g., non-binary). The remaining forty participants formed the control group consisting of 12 males and 28 females. The autistic group was recruited via Autistica and social media (Twitter), and the control group from the Psychology student population through the University of Hertfordshire’s Psychology Research Participation System (see Table 2.7 for descriptive statistics).

Using G*Power, an a-priori power analysis was conducted (f = .25, α = .05, 1 – β = .8), which calculated a minimum required sample size of 82 participants. In the paper by Loth et al. (2008), significant interactions ranged from small to large effect sizes. Given this, a sample size was calculate based on a moderate effect size.

Table 2.7.

Descriptive statistics relating to autistic and control participants.

	Autistic (*N* = 48)	**Control (*N* = 40)**
Mean age *(SD)*	35.50 *(11.06)*	20.85 *(2.81)*
Gender split		
Male	18	12
Female	24	28
Other	6	-
Mean AQ-10 score *(SD)*	7.20 *(2.55)*	4.43 *(1.14)*

<u>*Measures*</u>

The mean scores for the autistic and control groups for the different measures are reported in Tables 2.8 and 2.9. The mean Generalized Anxiety Disorder (GAD-7) score for the autistic group was 9.54 (*SD* = 4.57) and 6.91 (*SD* = 5.04) for the control group. An independent samples t-test found that the difference in mean GAD score between the groups was statistically significant, $t(68) = 2.29$, $p = .013$, $d = .56$, one-tailed. Therefore, the autistic group experienced higher self-reported levels of generalised anxiety.

The mean Intolerance of Uncertainty (IUS-12) score for the autistic group was 45.06 (*SD* = 8.75) and 31.11 (*SD* = 10.54) for the control group. An independent samples t-test found that the difference between the groups was statistically significant, $t(68) = 6.02$, $p < .001$, $d = 1.46$, one-tailed. Therefore, the autistic group experienced higher self-reported levels of intolerance of uncertainty.

The mean Sensory Hypersensitivity Scale (SHS) score for the autistic group was 3.56 (*SD* = .65) and 2.93 (*SD* = .47) for the control group. An independent samples t-test found that the difference between the groups was statistically significant: $t(68) = 4.61$, $p < .001$, $d = 1.12$, one-tailed. Therefore, the autistic group experienced higher self-reported levels of sensory hypersensitivity.

The mean AQ-10 score for the autistic group was 7.20 (*SD* = 2.55) and 4.43 (*SD* = 1.14) for the control group. An independent samples t-test showed the difference between the groups was statistically significant, *t*(47.15) = 5.86, *p* <.001, *d* = 1.71, one-tailed. Therefore, as predicted, the autistic group scored higher on a measure of autistic traits.

Of the participants, twenty-one autistic participants and twenty control participants completed the NART. The mean NART score for the autistic group was 117.24 (*SD* = 7.09) and 112.38 (*SD* = 4.59) for the control group. An independent samples t-test showed this difference to be statistically significant, *t*(39) = 3.59, *p* = .013, *d* =1.15, two-tailed. Therefore, the autistic group had a higher estimated verbal IQ score.

Table 2.8.

Mean scores on measures of Generalized Anxiety Disorder (GAD), Intolerance of Uncertainty (IUS), Sensory Hypersensitivity Scale (SHS), and AQ10 (a measure of autistic traits) (SD).

	Autistic (*N* = 35)	**Control (*N* = 35)**
GAD	9.54 (*SD* = 4.57)	6.91 (*SD* = 5.04)
IUS	45.06 (*SD* = 8.75)	31.11 (*SD* = 10.54)
SHS	3.56 (*SD* = .65)	2.93 (*SD* = .47)
AQ10	7.20 (*SD* = 2.55)	4.43 (*SD* = 1.14)

Table 2.9.

Mean score on the National Adult Reading Test (SD)

	Autistic (*N* = 21)	**Control (*N* = 20)**
NART	117.24 (*SD* = 7.09)	112.38 (*SD* = 4.59)

2:6:2 Design

The study used a mixed design with the independent variables being the status of participants in terms of autism, i.e., autistic group vs control group and change type (detail, position, congruent, and incongruent) and the dependent variables being the reaction time (ms) and the proportion of correct responses on the change-blindness task.

2:6:3 Materials

All participants completed a change-blindness task, which consisted of twenty images of different scenes (bathroom, bedroom, living room, kitchen, and office – see Figure 2.1 for an example using bathroom scene). The remaining base images and subsequent changes can be seen in Appendix A-E. For each scene, there were four types of object changes: (1) an object position change, (2) an object detail change, (3) a congruent change (where an object is replaced by another object that is still relevant to the scene – e.g., replacing a kettle with a toaster in the kitchen) and (4) an incongruent change (replacing an object with another object not typically found in the scene – e.g., replacing a hairbrush with a carrot in the bathroom). In the previous pilot study, typicality ratings were collected from the general population to determine which objects people typically expected to find within the five scenes**.** Images were in colour and were edited using Adobe Photoshop to reduce the possibility of any unintentional differences occurring when moving objects. On every trial, each image had a spatial resolution of 2084 x 1191 pixels.

Figure 2.1. (Left to right) Bathroom base image, congruent change (toothbrush replaced with shampoo bottle), detail change (colour change on toilet lid), incongruent change (hairbrush replaced with carrot), and position change (towel moved from right to left).

Participants also completed the Generalised Anxiety Disorder 7-Item Scale (GAD-7; Spitzer et al., 2006), Sensory Hypersensitivity Scale (SHS; Dixon et al., 2016), Intolerance of Uncertainty Short Form Scale (IUS-12; Carleton et al., 2007), and the Autism Quotient 10 (AQ-10; Allison et al., 2012) to allow for assessment of the homogeneity of the autistic sample.

The GAD-7 is a seven-item self-report measure that assesses levels of general anxiety. Participants respond to each statement by selecting ‘not at all’, ‘several days’, ‘more than half the days’, or ‘nearly every day’. Scores between 0-4 indicate minimal anxiety, 5-9 mild anxiety, 10-14, moderate anxiety, and scores greater than 15 are indicative of severe anxiety.

The IUS-12 is a self-report measure which has 12 items. Participants rate how characteristic each item is of them on a 5-point Likert scale (1 – ‘not at all characteristic of me’ to 5 – ‘very characteristic of me’). The higher the score, the higher the level of intolerance of uncertainty.

The SHS is a 25-item self-report measure of sensory sensitivity. Participants rate the degree to which they agree or disagree with each statement on a 5-point Likert scale (1 – ‘strongly disagree’ to 5 – ‘strongly agree’). The higher the score, the higher the level of sensory sensitivity.

The AQ-10 is a self-report measure which has 10 items. Participants indicate the extent to which they agree with each statement by selecting ‘definitely agree’, ‘slightly agree’, ‘slightly disagree’ or ‘definitely disagree’. The scoring of the AQ-10 ranges from 0-10. A score of 6 or more is indicative of the presence of autistic traits.

To obtain an estimated full-scale IQ score, participants completed the National Adult Reading Test (NART; Nelson & Willison, 1991).[4] The NART consists of 50 irregular words which are presented individually to the participant who is required to read the word out loud. An estimated full-scale IQ score is calculated as follows: 127.8 - .78 x (NART errors).

2:6:4 Procedure

Participants completed the study online using Gorilla. Before each image was displayed, participants saw a fixation cross for 5000ms. For the last 3000ms, participants saw a display countdown in preparation for the image to appear. The original image was presented for 300ms, followed by a grey mask for 300ms, and then the appearance of the image with the change for a further 300ms (see Figure 2.2).[5] Participants were asked to click on the change using the mouse as soon as they noticed it; however, if participants did not click on the image to indicate a change, the page auto-advanced to the next screen after 30,000ms.

[4] Due to the pandemic, the NART was carried out as a separate study which some participants did not attend. Of the participants, 41 completed the NART (autistic N = 21, control N = 20).

[5] It was noticed that when using the timings for the change blindness task used by Loth et al. (2008) the grey mask was very short making the changes too easy to detect. As there is no consensus for the duration and mask timings used in change blindness tasks, based on a small pilot study, a 300ms duration and 300ms mask was used instead.

Both the order of the scenes and the type of change were randomised. Following this, participants completed the GAD-7, SHS, IUS-12, and AQ-10.

2:7 Results

The initial data set consisted of 48 autistic participants and 40 control participants. It was determined that one complete cycle of the change blindness paradigm equated to 1200ms – image one was presented for 300ms, followed by a grey mask for 300ms, then image two for 300ms, followed by a grey mask for 300ms and back to the initial image. It was therefore decided that where participants had a response time (RT) of <1200ms they had responded too quickly, and in cases where more than 25% of responses were <1200 (five or more out of 20 trials), their data was removed completely. As a result, of the autistic group, 10 participants had all their data removed. No participant data was removed from the control group. During the task, if participants did not click on the image, the screen was set to auto-advance after 30,000ms; therefore, participants with a response time of 30,000 on all trials were assumed to have not taken part, and so removed from the data set. Three participants were removed from the autistic group and five from the control group. The number of participants included in the final analysis was 35 in the autistic group and 35 in the control group.

There were three parts to the analysis of the data. Firstly, all the data were analysed, including where participants had missing response times replaced with a maximum response time of 30,000ms. This was followed by only analysing the data where participants had attempted a trial. Lastly, the data of those who had both attempted the trial and made a correct response was analysed. The response times were compared against the image types.

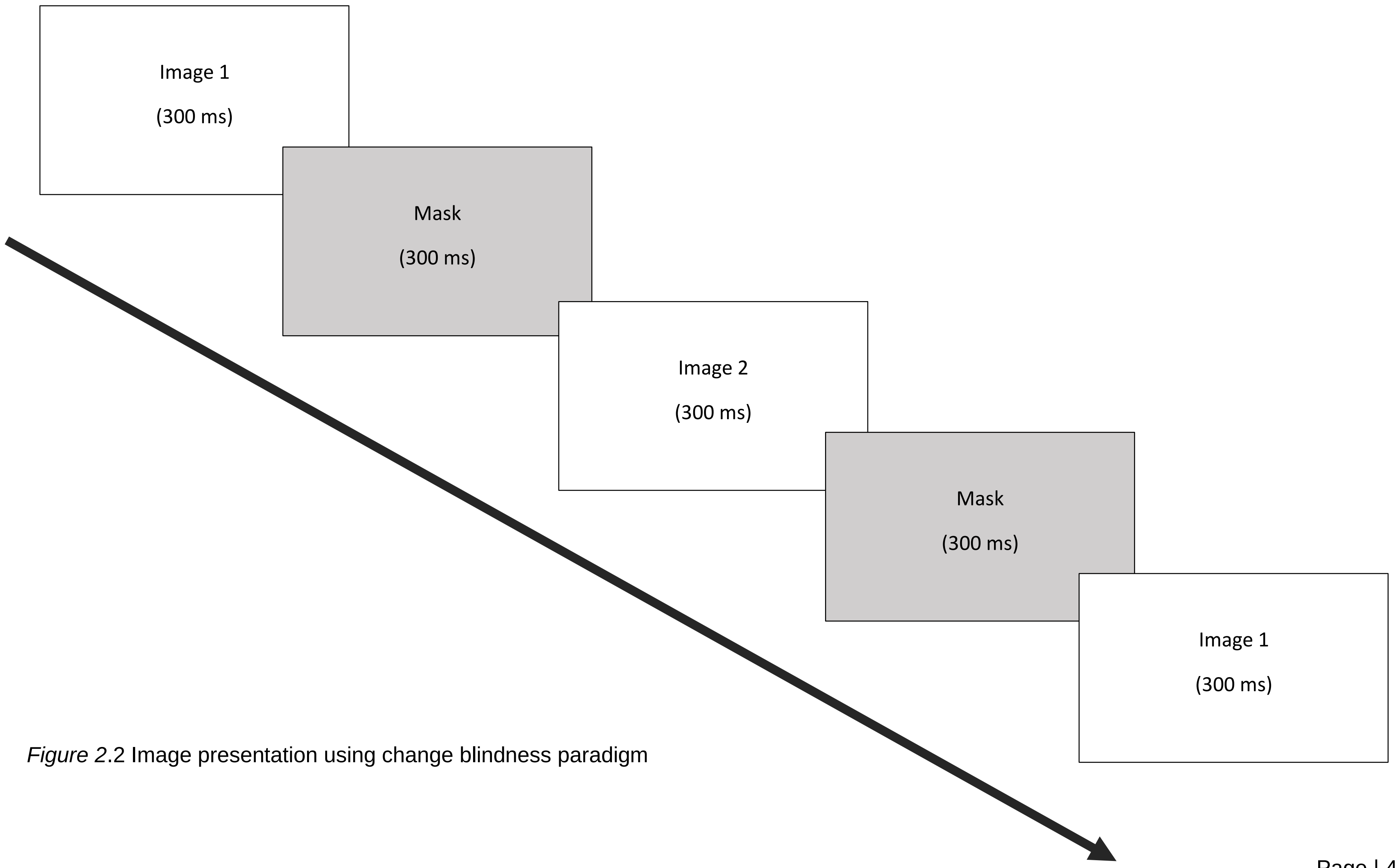


*Figure 2.*2 Image presentation using change blindness paradigm

Overall RT (with 30,000 included)

The mean response times for the autistic and control groups to complete the change blindness task by change type are reported in Table 2.10. A 2x4 mixed ANOVA was conducted using change type (congruent, detail, incongruent, position) as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was not significant (p = .07), and sphericity was assumed. The main effect of change type was significant, $F(3,204) = 100.00$, $p < .001$, $\eta_p^2 = .60$, indicating that the type of change had a significant effect on reaction times. Overall, participants were faster in the incongruent (M = 10,368.93) and position (M = 10,784.88) conditions compared to congruent (M = 12,229.40) and detail (M = 20,487.87). Pairwise comparisons showed a significant difference between the congruent and detail condition ($p < .001$) and the congruent and incongruent condition ($p < .02$). There was a significant main effect of autism on reaction times, $F(1,68) = 13.27$, $p = .001$, $\eta_p^2 = .16$, with the control group (M = 11,881.26) displaying faster overall reaction times compared to the autistic group (M = 15,054.28). There was a significant interaction between change type and autism on reaction times, $F(3,204) = 7.21$, $p < .001$, $\eta_p^2 = .10$. Pairwise comparisons showed a significant difference between the autistic and control group on the detail change ($p < .001$) with the autistic group performing slower (M = 23,971.91) than the control group (M = 17,003.83). The mean differences between the autistic and control groups on the remaining change types (congruent, incongruent, and position) were not significant ($p > .05$).

Table 2.10.

Mean reaction time in milliseconds to complete change blindness task by change type (SD) with 30,000 included.

	Autistic (*N* = 35)	**Control (*N* = 35)**
Congruent	12,999.36 (*SD* = 5591.03)	11,459.43 (*SD* = 4294.33)
Detail	23,971.91 (*SD* = 4665.96)	17,003.83 (*SD* = 5904.31)
Incongruent	11,519.96 (*SD* = 5220.22)	9217.91 (*SD* = 4491.26)
Position	11,725.88 (*SD* = 5273.62)	9843.88 (*SD* = 4390.53)

The mean reaction times for the autistic and control groups to complete the change blindness task by room type are reported in Table 2.11. This was done to assess whether there were any general differences across the contexts. A 2x5 repeated measures mixed ANOVA was conducted using room type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was not significant (p =

.29), and therefore sphericity can be assumed. There was a significant main effect of room type, $F(4,272) = 10.75$, $p < .001$, $\eta_p^2 = .14$, with estimates of marginal means showing reaction times to be fastest for bedroom (*M* = 11,605.90) and slowest for kitchen (*M* = 15,408.84). Pairwise comparisons showed a significant difference between the bathroom and bedroom (*p* <.002). There was a significant main effect of autism on reaction times, $F(1,68) = 13.42$, $p < .001$, $\eta_p^2 = .16$, with the control group (*M* = 11,885.53) displaying faster overall reaction times compared to the autistic group (*M* = 15,090.50). The interaction between autism and room type was not significant, $F(4,272) = 1.15$, $p = .33$, $\eta_p^2 = .02$.

Table 2.11.

Mean reaction time in milliseconds to complete change blindness task by room type (SD) with 30,000 included.

	Autistic (*N* = 35)	**Control (*N* = 35)**
Bathroom	16,487.53 (*SD* = 5466.75)	11,700.98 (*SD* = 4949.26)
Bedroom	13,545.85 (*SD* = 4968.15)	9665.94 (*SD* = 5306.10)
Kitchen	16,679.76 (*SD* = 5856.51)	14,137.91 (*SD* = 5413.94)
Living room	15,664.63 (*SD* = 4009.61)	13,163.31 (*SD* = 5843.16)
Office	13,074.71 (*SD* = 5432.28)	10,759.50 (*SD* = 5059.68)

Attempted

For the next stage of the analysis, only the data of participants who had attempted the task were included (any participant who did not spot the change within the full 30 seconds was excluded here). As a result, across all room types, 16.29% of the data was removed from the congruent change type condition, 43.14% from the detail change type, 10.29% from the incongruent change type, and 11.14% from the position change type.

The mean reaction times for the autistic and control groups to complete the change blindness task for attempted trials by change type are reported in Table 2.12. A 2x4 repeated measures mixed ANOVA was conducted using change type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was significant (*p* = .004), and therefore, sphericity cannot be assumed; thus, the Greenhouse-Geisser adjustment is reported. The main effect of change type was significant, $F(2.485,154.085) = 45.02$, $p <.001$, $\eta_p^2 = .42$, indicating that the type of change (congruent, detail, incongruent, position) had a significant effect on reaction times. Overall, participants were significantly slower (*p* <.001) in the detail condition (*M* = 13,960.93) compared to congruent (*M* = 8705.757), incongruent (*M* = 8040.39), and position (*M* = 8145.35) conditions. There was a significant main effect of autism on reaction times $F(1,62) = 8.82$, $p = .004$, $\eta_p^2 = .13$, with the control group ($M = 8805.61$) displaying faster overall reaction times compared to the autistic group ($M = 10,620.60$). The interaction between change type and autism was not significant, $F(2.485,154.085) = 1.23$, $p = .30$, $\eta_p^2 = .02$.

Table 2.12.

Mean reaction time in milliseconds to complete change blindness task by change type (SD) on attempted trials.

	Autistic (*N* = 29)	**Control (*N* = 35)**
Congruent	9837.63 (*SD* = 4237.02)	7573.88 (*SD* = 2165.60)
Detail	15,390.25 (*SD* = 5391.94)	12,531.62 (*SD* = 4881.20)
Incongruent	8752.60 (*SD* = 3541.43)	7328.19 (*SD* = 2728.06)
Position	8501.93 (*SD* = 3621.75)	7788.77 (*SD* = 3138.94)

The mean reaction times for the autistic and control groups to complete the change blindness task for attempted trials by room type are reported in Table 2.13. A 2x5 repeated measures mixed ANOVA was conducted using room type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was not significant ($p = .19$), and therefore, sphericity can be assumed. The main effect of room type was significant, $F(4,248) = 5.81$, $p <.001$, $\eta_p^2 = .09$. Reaction times for bathroom and kitchen ($M_{bathroom} = 10,213.76$, $M_{kitchen} = 10,119.38$) were slower than for bedroom ($M = 8867.62$), living room ($M = 7984.61$), and office ($M = 8358.67$). Pairwise comparisons showed a significant difference between bathroom and living room ($p = .004$), bathroom and office ($p = .05$), and kitchen and living room ($p = .006$). The main effect of autism was not significant, $F(1,62) = 3.08$, $p = .08$, $\eta_p^2 = .05$, and there was no significant interaction between autism and room type, $F < 1$.

Table 2.13.

Mean reaction time in milliseconds to complete change blindness task by room type (SD) on attempted trials.

	Autistic (*N* = 31)	**Control (*N* = 33)**
Bathroom	10,550.01 (*SD* = 4473)	9877.51 (*SD* = 3737.31)
Bedroom	9577.26 (*SD* = 3877.28)	8157.98 (*SD* = 3659.93)
Kitchen	10,885.29 (*SD* = 4028.52)	9353.48 (*SD* = 3756.55)
Living Room	8722.87 (*SD* = 3615.08)	7246.35 (*SD* = 3055.22)
Office	8329.87 (*SD* = 3697.40)	8387.47 (*SD* = 3887.94)

Correct only

For the final stage of the analysis, only the data of participants who had attempted the task and were correct were included. As a result, across all room types, 32.29% of the data was removed from the congruent change type condition, 58.86% from the detail change type, 22.57% from the incongruent change type, and 24.86% from the position change type.

The mean reaction times for the autistic and control groups to complete the change blindness task for correct trials by change type are reported in Table 2.14. A 2x4 repeated measures mixed ANOVA was conducted using change type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was significant (p = <.001), and therefore, sphericity cannot be assumed; thus, the Greenhouse-Geisser adjustment is reported. The main effect of change type was significant, $F(2.316,120.432) = 35.96$, $p < .001$, $\eta_p^2 = .41$. Overall, reaction times for the detail change (M = 13,924.07) were significantly slower (p <.001) than for the congruent (M = 8568.34), incongruent (M = 7855.44), and position change (M = 7895.47). There was a significant main effect of autism, $F(1,52) = 8.66$, $p = .005$, $\eta_p^2 = .14$, with the autistic group performing significantly slower than the control group ($M_{autistic}$ = 10,412.12, $M_{control}$ = 8709.54). The interaction between autism and change type was not significant, $F(2.316,120.432) = 1.19$, $p = .31$, $\eta_p^2 = .02$.

Table 2.14.

Mean reaction time in milliseconds to complete change blindness task by change type (SD) on correct trials.

	Autistic (*N* = 24)	**Control (*N* = 30)**
Congruent	9786.34 (*SD* = 4075.29)	7350.35 (*SD* = 2257.85)
Detail	15,319.40 (*SD* = 6031.81)	12,528 (*SD* = 4430.11)
Incongruent	8297.70 (*SD* = 3592.12)	7413.18 (*SD* = 2424.11)
Position	8245.05 (*SD* = 3632.50)	7545.89 (*SD* = 2657.74)

The mean reaction times for the autistic and control groups to complete the change blindness task for correct trials by room type are reported in Table 2.15. A 2x5 repeated measures mixed ANOVA was conducted using room type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was not significant (p = .06), and therefore sphericity can be assumed. The main effect of room type was significant, F(4,216) = 5.24, p < .001, η_p^2 = .09. Reaction times were fastest for office (M = 7520.44) and living room (M = 7684.99) compared to bedroom (M = 9169.52), bathroom (M = 9503.05), and kitchen (M = 10,008.79). Pairwise comparisons showed a significant difference between kitchen and living room (p = .01) and kitchen and office (p = .02). There was no main effect of autism, F(1,54) = 3.49, p = .07, η_p^2 = .06, and the interaction between autism and room type was not significant, F < 1.

Table 2.15.

Mean reaction time in milliseconds to complete change blindness task by room type (SD) on correct trials.

	Autistic (*N* = 29)	**Control (*N* = 37)**
Bathroom	9524.32 (*SD* = 4725.56)	9481.78 (*SD* = 2960.67)
Bedroom	9709.45 (*SD* = 3846.49)	8629.59 (*SD* = 4415.11)
Kitchen	10,358.26 (*SD* = 4631.87)	9659.31 (*SD* = 3763.49)
Living room	8513.86 (*SD* = 3420.11)	6856.13 (*SD* = 2717.37)
Office	8218.53 (*SD* = 3838.58)	6822.35 (*SD* = 2904.30)

Efficiency scores

To calculate inverse efficiency scores (Townsend & Ashby, 1978, 1983), the participants' response time, where they had attempted a trial, was divided by their proportion of correct answers where lower scores indicate better performance.

The mean efficiency scores for the autistic and control groups on the change blindness task by change type are reported in Table 2.16. A 2x4 repeated measures mixed ANOVA was conducted using the efficiency scores for change type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was significant (p = <.001), and therefore, sphericity cannot be assumed; thus, the Greenhouse-Geisser adjustment is reported. The main effect of change type efficiency score was significant, $F(1.178, 60.073) = 40.07$, $p < .001$, $\eta_p^2 = .44$. Participants were most efficient with the position change (M = 9959.70) and least efficient with the detail change (M = 38,552.12). There was a significant main effect of autism, $F(1,51) = 10.75$, $p = .002$, $\eta_p^2 = .17$, with the control group performing more efficiently than the autistic group ($M_{control}$ = 13,998.30, $M_{autistic}$ = 21,898.69). The interaction between change type efficiency scores and autism was significant, $F(1.178,60.073) = 8.56$, $p = .003$, $\eta_p^2 = .14$. Pairwise comparisons showed a significant difference in efficiency scores between the autistic and control group on the detail change condition (p = .002) with the autistic group performing less efficiently (M = 51,980.58) compared to the control group (M = 25,123.66).

Table 2.16.

Mean efficiency scores on change blindness task by change type (SD) on correct trials.

	Autistic (*N* = 24)	**Control (*N* = 29)**
Congruent	14,058.58 (*SD* = 10,512.59)	10,453.79 (*SD* = 3314.80)
Detail	51,980.58 (*SD* = 40,104.70)	25,123.66 (*SD* = 19,556.07)
Incongruent	11,099.97 (*SD* =6267.98)	10,951.97 (*SD* = 6482.95)
Position	10,455.63 (*SD* = 4785.74)	9,463.77 (*SD* = 3818.48)

The mean efficiency scores for the autistic and control groups on the change blindness task by room type are reported in Table 2.17. A 2x5 repeated measures mixed ANOVA was conducted using the efficiency scores for room type as the within-subjects factor and autism (autistic vs control) as the between-subjects factor. Mauchly's test of sphericity was not significant (p = .21), and therefore sphericity can be assumed. The main effect of room type efficiency score was significant, $F(4,216) = 6.49$, $p < .001$, $\eta_p^2 = .12$. Participants were most efficient on the office room type (M = 9443.76) compared to bedroom (M = 13,023.96), living room (*M* = 13,758.16), bathroom (*M* = 15,242.38) and kitchen (*M* = 15,791.88). Pairwise comparisons showed a significant difference between bathroom and office (p <.001), bedroom and office (p = .02), kitchen and office (p <.001), and living room and office (p = .02). There was a significant main effect of autism, $F(1,54) = 6.39$, $p = .014$, $\eta_p^2 = .11$, with the control group performing more efficiently than the autistic group ($M_{control}$ = 11,900.73, $M_{autistic}$ = 15,003.33). The interaction between room type efficiency scores and autism was not significant, $F < 1$.

Table 2.17.

Mean efficiency scores on change blindness task by room type (SD) on correct trials.

	Autistic (*N* = 29)	**Control (*N* = 27)**
Bathroom	17,494.52 (*SD* = 10,171.36)	12,990.24 (*SD* = 6515.23)
Bedroom	14,252.46 (*SD* = 7382.21)	11,795.45 (*SD* = 7935.74)
Kitchen	16,815.81 (*SD* = 9608.77)	14,767.95 (*SD* = 8363.711)
Living Room	15,808.65 (*SD* = 10,832.19)	11,707.67 (*SD* = 7554.46)
Office	10,645.19 (*SD* = 5171.58)	8242.34 (*SD* = 3047.41)

Correlations

For the autistic participants, there was a significant negative correlation between AQ-10 scores and reaction time for correct responses on the detail condition, $r(22) = -.50$, $p = .01$. The higher the AQ-10 score, the slower the reaction time in the detail condition.

For autistic participants, there was a significant negative correlation between AQ-10 scores and efficiency scores for the detail condition, $r(22) = -.60$, $p = .002$. The higher the AQ-10 score, the lower the efficiency score (lower scores indicate better performance).

2:8 Discussion

The aim of the study was to investigate whether the change-blindness paradigm would be a suitable measure of hypersensitivity to difference in autistic people. The analysis was broken down into three sections – overall reaction time (where missing responses were replaced with a maximum response time of 30,000ms), analysis of the data from participants who had attempted a trial, and finally, from participants who attempted a trial *and* made a correct response.

Of the change types, it was found that reaction times were fastest (when taking into account missing response times) for the incongruent and position changes compared to congruent and detail changes. Contrary to previous findings, the control group displayed faster reaction times than the autistic group, particularly in the detail condition.

The analysis of the results of participants who attempted all trials within the task, revealed that the detail change condition had the largest amount of data removed, with only 56.86% of participants attempting the task. This suggests that the detail changes were perhaps too difficult, resulting in a floor effect. Overall, all participants were slower in the detail condition compared to congruent, incongruent, and position changes and, again, the autistic participants' reaction time was slower overall compared to the autistic group. This could be informative for future studies.

For the analysis of the results from the participants who had attempted the trial *and* correctly identified the change, again, the largest removal of data was in the detail change condition, with only 41.14% of participants correctly identifying the change. Overall, reaction times for the detail change condition were slower than for the congruent, incongruent, and position changes. The autistic group were significantly slower than the control group.

To consider whether there may have been a speed-accuracy trade-off, efficiency scores were calculated for participants' performance, with a low score indicating better performance. Overall, participants were most efficient with position changes and least efficient with detail changes. The control group performed more efficiently than the autistic group, particularly on the detail change condition. Given that there was a correlation between AQ-10 scores and reaction time for the autistic participants in the detail condition (higher autistic traits correlated with slower reaction time), one possible explanation is that autistic participants are more likely to persevere in the finding of detailed differences resulting in slower performance.

As predicted, compared to the control group, autistic participants had higher self-reported levels of generalised anxiety, intolerance of uncertainty, and sensory hypersensitivity. Autistic participants also had a higher estimated verbal IQ score.

The findings from this study were not as expected since both groups detected a similar number of changes, and this finding was also not in line with previous research that had reported an autistic advantage for detecting changes using a change-blindness task (Smith & Milne, 2009; Fletcher-Watson et al., 2012; Ashwin et al., 2017). This may be connected to changes in the stimuli to more realistic settings. Using these settings, it was found that participants were more efficient at spotting change in some rooms than others, suggesting that the choice of stimuli is an important consideration in this type of study.

The research on which this study was based (Loth et al., 2008) found that control participants were better at detecting changes that were incongruent to a scene than congruent changes, whereas autistic participants did not show a condition effect with performance being stable across the change types (Loth et al., 2008). This study, like Loth et al. (2008), also demonstrated that the performance of the autistic participants was the same when detecting both incongruent and congruent changes. This strengthens the evidence for contextual insensitivity in autistic participants, however, unlike in Loth et al. (2008) this was also the case for the non-autistic participants in this study. It is possible that this discrepancy arises from the marginally significant nature of Loth et al's (2008) findings for the control participants.

A potential limitation to the use of the change-blindness paradigm is that the methodology used across studies is not consistent with studies varying the duration, mask, and how participants are expected to respond. When looking at previous research using the change blindness paradigm, the duration of image presentation ranged from 240ms to 3000ms, with the mask ranging from 80ms to 300ms (Ashwin et al., 2017; Fletcher-Watson et al., 2006; Hochhauser et al., 2018; Kikuchi et al., 2009; Loth et al., 2008; Vanmarcke et al., 2018). Typically, the change-blindness paradigm flickers automatically; however, in one study, this was modified so that participants were able to 'self-pace' the mask (Fletcher-Watson et al., 2006). After being shown the initial image, participants could press the SPACE bar to trigger the flicker as many times as needed. It was found that both groups found it easier to detect central changes over marginal changes. Interestingly, the autistic participants made significantly more 'switches' during the marginal changes and were slower to shift attentional focus from central to marginal changes, suggesting that this group is more likely to persevere in the search for changes. In the second part of Fletcher-Watson et al.'s experiment, which incorporated the use of context by including congruent and incongruent changes, it was found that both the autistic and control participants were better at detecting contextually inappropriate changes. This suggests two things – firstly, autistic participants perform similarly to control participants using the change-blindness paradigm; secondly, in contrast to previous findings such as those from Loth et al. (2008), autistic participants are paying attention to context.

One possible explanation for the slower reaction time to detail changes by the autistic participants in this study is that they spent longer looking for changes as there were no consequences to not detecting the change in this task. In this experiment, participants were told that there would be several changes to be detected across various scenes. Therefore, the change-blindness paradigm cannot capture what participants may spontaneously attend to. Unlike a real-life scenario in which aspects of an autistic person's environment can change unexpectedly, the consequence of not detecting the changes in the task is minimal. However, in the environment, such changes may lead to heightened anxiety and an inability to screen out irrelevant information. This is likely to lead to feelings of sensory overload and further anxiety at the inability to predict the environment. Therefore, it may be that a task involving the change-blindness paradigm is not a suitable measure of hypersensitivity to difference. Alternatively, given that the final sample was less than the required 82 participants, it may be that the findings lacked statistical power. The findings of this study, in particular, do not support previous experimental results and anecdotal evidence from autistic people. A further consideration is that perhaps the disparity between the visual search advantage noted in autistic participants and the mixed findings when using the change-blindness task suggests that there are different underlying mechanisms at play. Given the additional methodological consideration taken in preparing this study (e.g., the typicality of items within the scenes), there is reason to accept that the findings here should be viewed as informative, in that not only is the change-blindness paradigm not useful as a measure of hypersensitivity to difference, but also it is not a reliable task for investigating differences between autistic and control participants in the use of schema.

To address the mixed findings, an experiment reported later in this programme of work (Chapter 5) was designed using virtual reality technology and real-time anxiety measures to offer a more realistic setting for investigating hypersensitivity to difference.

CHAPTER THREE – Rating Similarity & Difference

3:1 Experiment 2 – Introduction

Given that the methods based on the visual perception of differences used in Experiment 1 failed to produce convincing evidence of hypersensitivity to difference in an autistic sample, it was felt that a different type of task was required. This chapter reports two experiments that used a different task in which autistic and control participants gave ratings of similarity OR difference for pairs of familiar items (Experiment 2) and both similarity AND difference ratings for the same items in Experiment 3.

Wisnewski and Bassok (1999) were amongst the first to challenge the previously accepted model of similarity as solely a feature-matching process. In the first of two experiments, participants were presented with pairs and asked to rate how similar the two pairs were. In one condition, participants were asked to write down an explanation for their rating, and in the other condition, no explanation was required. Pairs were either highly alignable (items that are alignable belong to one or more categories from the same taxonomy) and thematically related (A+T+), highly alignable but not thematically related (A+T-), had low alignability but were thematically related (A-T+) or low alignability and thematically unrelated (A-T-). According to the alignment model of similarity, similarity between objects is based on the degree to which there is a matching of features such as shape or structure (Smith & Medin, 1981). Therefore, objects that are highly alignable are perceived as being more similar. Wisnewski and Bassok (1999) found that the way in which similarity judgements were made depended on how compatible stimuli were. For example, when pairs were taxonomically related and highly alignable, they were rated as being more similar than when they were just taxonomically related. This suggests that thematic relatedness enhanced similarity ratings and proposes that there is a dual process including both features and context in such ratings, as opposed to just features as suggested by the alignment model. In Experiment 2, participants were asked to list similarities and differences, in terms of features, between the pairs used in the first experiment. As expected, when pairs were highly alignable but did not have a thematic relationship (A+T-), participants made comparisons as per the instructions. However, interestingly, where pairs were low on alignability but had a thematic relationship (A-T+), participants integrated the pairs based on context, which further supported the findings from Experiment 1 that similarity judgements are affected by both feature and contextual comparisons, irrespective of task instructions.

Lin and Murphy (2001) additionally reported the use by adults of thematic relations between items in a series of studies in which adult participants chose matches to a target in several triad tasks. They demonstrated that when forming categories, individuals may use a taxonomic approach in which they focus on shared features; for example, a cat and dog are both four-legged animals with fur, or they may draw on thematic relations which focus on how well things ‘go together’, and rate ‘dog’ and ‘lead’ as being similar because you typically walk a dog on a lead.

Since then, interest has steadily increased in the role of thematic relations in cognitive processes, a topic that had previously only been researched in relation to the development of semantic organisation in children (Smiley & Brown, 1979). The acceptance of two influential organisations of conceptual knowledge, one based on shared features (taxonomic) and one organised around the situational setting of items as they are regularly encountered (thematic), has become common. For example, Mirman and Graziano (2012) found using eye-tracking data that both ‘systems’ (taxonomic and thematic) were activated during single word processing and that the degree of this activation was related to an individual’s preference for taxonomic or thematic relations. Further support of two distinct systems comes from research looking into neuroanatomical evidence, which has shown that the anterior temporal lobes seem to be particularly important for taxonomic relations, whereas the temporoparietal cortex has a greater role in thematic relations, suggesting there is also a neural dissociation (Mirman et al., 2017).

Since thematic relations between items arise from integrating them into the same situation rather than making a detailed comparison of their features, the potential use of such relationships by autistic individuals who reported to attend to detail and less to context (Frith, 1989; Vermeulen, 2015) is of interest. Furthermore, it is difficult to think about similarity without considering difference, but this relationship is not straightforward. Tversky’s (1977) seminal work proposed that assessing similarity was the result of a process of feature matching and mismatching such that similarity between two items was increased by common features and decreased by differences. However, subsequent work challenged this claim with the finding that similarity and difference are not inversely related, in that pairs that are rated as being very similar can also be rated as very different (Medin et al., 1990) and that when asked to list commonalities and differences between highly similar and highly dissimilar word pairs, participants can list as many similarities as differences for the same pair of items (Markman & Getner, 1993). It is important to note that these findings were published before the work of Wisniewski and Bassok (1999), and so assumed a feature comparison model of similarity.

These two areas came together in an exploration of the effect of thematic relations on similarity and difference judgments. According to Simmons and Estes (2008), there are individual differences in the perceived importance of thematic relations, with thematic relations affecting similarity judgements more than difference judgements; however, it has since been found that this may be influenced by task instructions (Mirman & Graziano, 2012). For example, a thematic bias may only be present when participants are specifically asked about 'association' as opposed to 'similarity' (Honke & Kurtz, 2019).

In the study by Golonka and Estes (2009) on which this experiment is based, participants were asked to rate similarity or difference between pairs of items that varied on whether they were alignable and thematically related, alignable but not thematically related, not alignable but thematically related, or neither alignable nor thematically related. They concluded that thematic relatedness affected similarity judgements more than difference judgements because thematic relations increase the 'weight' of commonalities between items, resulting in a noninversion effect (Golonka & Estes, 2009). The noninversion effect demonstrates that similarity is not always the inverse of difference, and therefore, items that are rated as having high similarity are not necessarily given low ratings when rating difference.

Experiment 2 was based on the reasoning that if autistic individuals are hypersensitive to difference, it is reasonable to conclude that this is likely to impact the direct ratings of similarity and difference judgements. Considering the high level of attention to detail noted in this group, it may be that autistic people are more likely to favour taxonomic relations, which rely on shared features, over thematic relations. Furthermore, given that thematic relations arise between items that are encountered together in time and space, i.e., in the same context, and context is not thought to be used by autistic individuals to the same extent as by controls, it could be expected that thematic relations may not influence ratings at all for the autistic group. In Experiment 2, participants were presented with 40 pairs of items and simply asked to rate on a scale of 1-7 how similar the items are (1 – not at all similar; 7 – extremely similar) *or* how different they are (1 – not at all different; 7 – extremely different). The stimuli used in the study drew on those used by Wisniewski and Bassok (1999) with modifications for a non-American sample of participants. For each trial set, the base was paired with an item that was both taxonomically and thematically related (A+T+; e.g., milk and coffee), taxonomically related but not thematically related (A+T-; e.g., milk and lemonade), thematically related but not taxonomically related (A-T+; e.g., milk and cow) and neither taxonomically related or thematically related (A-T-; e.g., milk and horse). For one pair from each of the pair types (A+T+, A+T-, A-T+, A-T-), participants were also asked to write what they were thinking about *after* they made the rating (e.g., "Please write what you were thinking about when you made your rating for CHAIR and TABLE"). If autistic participants show hypersensitivity to difference, the autistic group would give higher ratings of difference compared to the control group. In terms of similarity ratings, it was expected that autistic participants would give lower ratings for thematically related pairs, and higher similarity ratings for taxonomically related pairs (if following the alignability model with high level of attention to detail of features), compared to control participants. However, if the perception of similarity on this task is reduced for autistic participants compared to controls, then lower ratings of similarity would also be expected from this group.

3:2 Methods

3:2:1 Participants

A total of 225 participants (*M* = 32.24, *SD* = 10.90, range = 18-64) took part in the study. Eighty-three participants had a formal diagnosis of Autism Spectrum Condition, 26 participants stated they were self-diagnosed/awaiting assessment, and 115 participants indicated they were not autistic. One participant selected 'prefer not to say'. Of the autistic group (including self-diagnosed/awaiting assessment), 42 identified as male, 60 identified as female, six as 'other' and one participant selected 'prefer not to say'. The remaining 115 participants (excluding the one participant who did not indicate their autism status) formed the control group consisting of 19 males, 95 females, and one participant who selected 'other' for gender. The autistic and control participants were recruited via a combination of Prolific Academic and the University of Hertfordshire's Psychology Research Participation System (see Table 3.1 for descriptive statistics).

Table 3.1.

Descriptive statistics relating to autistic and control participants.

	Autistic (*N* = 109)	**Control (*N* = 115)**
Mean age *(SD)*	33.73 *(10.46)*	30.82 *(11.20)*
Gender split		
Male	42	19
Female	60	95
Other	6	1
Prefer not to say	1	-
Mean AQ-10 score *(SD)*	7.51 *(2.24)*	2.99 *(1.90)*
Mean RAADS-14 score *(SD)*	31.65 *(8.73)*	11.76 *(9.98)*

Using G*Power, an a-priori power analysis was conducted based on a 2 x 2 x 2 x 2 mixed design (f = .1, α = .05, 1 – β = .8) which calculated a total minimum sample size of 200 participants. In the paper by Golonka and Estes (2008), significant interactions had medium to large effect sizes. However, their effects were based on a 2 x 2 interaction. It was unclear how strong the effect size would be over four variables and how this interacts with the group variable.

3:2:2 Design

The study used a mixed design with group status (autistic vs control) and ratings (similarity vs difference) as the independent, between-subjects variables. There were four groups: autistic similarity rating, autistic difference rating, control similarity rating and control difference rating. The within-subjects factors were taxonomic relatedness (taxonomically related vs not taxonomically related) and thematic relatedness (thematically related vs not thematically related). The dependent variables were the mean ratings given on a 7-point scale of similarity or difference.

3:2:3 Materials

The stimuli used in the study were adapted from that used by Wisniewski and Bassok (1999)[6]. For each trial set, the base was paired with an item that was both taxonomically and thematically related (A+T+; e.g., milk and coffee), taxonomically related but not thematically related (A+T-; e.g., milk and lemonade), thematically related but not taxonomically related (A-T+; e.g., milk and cow) and neither taxonomically related or thematically related (A-T-; e.g., milk and horse). For a complete list of the stimuli used, see Table 3.2.

Participants completed the Autism Quotient 10 (AQ-10; Allison et al., 2012) and Ritvo Autism & Asperger Diagnostic Scale (RAADS-14; Eriksson et al., 2013) to allow for assessment of the homogeneity of the autistic sample. It was decided to include the RAADS-14, in addition to the AQ-10, to ensure that any potential gender biases arising from the AQ-10 items were reduced and a broader approach to identifying autistic traits was implemented.

The RAADS-14 is a self-report measure which has 14 items. Participants respond by selecting the option (‘true now and when I was young’, ‘true only now’, ‘true only when I was younger than 16’, or ‘never true’) which most accurately describes how each items applies to them. Scores range from 0-42. A score of 14 or more is indicative of the presence of autistic traits.

[6] Some stimuli were changed to provide an English (UK) alternative – e.g., ‘Jello’ was replaced with ‘Cheesecake’.

Table 3.2.

A full list of the stimuli used.

Base	**A+T+**	**A+T-**	**A-T+**	**A-T-**
Cod	Haddock	Goldfish	Plate	Bowl
Milk	Coffee	Lemonade	Cow	Horse
Ship	Lifeboat	Canoe	Sailor	Soldier
Car	Caravan	Taxi	Mechanic	Plumber
Chair	Table	Stool	Carpenter	Electrician
Dog	Cat	Hamster	Veterinarian	Optician
Mug	Kettle	Glass	Tea	Champagne
Spider	Fly	Beetle	Web	Net
Knife	Fork	Saw	Cake	Soup
Apple pie	Ice cream	Cheesecake	Baker	Model

3:2:4 Procedure

Participants completed the study online using Qualtrics. There were 40 word pairs to be rated on a 7-point scale. Participants (autistic and control) were randomly allocated to either the similarity (1 = not at all similar, 7 = extremely similar) *or* difference condition (1 = not at all different, 7 = extremely different). All pairs were presented randomly in both conditions. For one pair from each of the pair types (A+T+, A+T-, A-T+, A-T-), participants were asked to write what they were thinking about when they made the rating (e.g., “Please write what you were thinking about when you made your rating for CHAIR and TABLE”). This instruction appeared *after* the participant made their rating. At the end of the rating task, participants were asked to pick a statement that best reflected how they chose the number on the rating scale. In the similarity condition, participants had the following options: a) “In my mind, I started from the top of the scale (7) then thought about the ways in which the items were different to each other; the more differences I found between them, the lower the rating that I gave. In other words, I went down the scale, the more differences that I found.” b) “In my mind, I started from the bottom of the scale (1) then thought about the things the items had in common and the more things that I thought they had in common, the higher the rating that I gave. In other words, I worked up the scale as I thought about the things they had in common.” c) “I just went with a feeling of similarity and picked a number on the scale that reflected that feeling”.

In the difference condition, participants had the following options: a) “In my mind, I started from the bottom of the scale (1) then thought about the ways in which the items were different to each other; the more difference that I found between them, the higher the rating that I gave. In other words, I went up the scale, the more difference that I found." b) "In my mind, I started from the top of the scale (7), then I thought about the things that they had in common and, the more things I thought they had in common, the lower the rating that I gave. In other words, I worked down the scale as I thought about the things they had in common." c) "I just went with a feeling of difference and picked a number on the scale that reflected that feeling". There was an 'other' option with a textbox for both supplementary questions. Participants were then asked to indicate whether they used the selected method 'most of the time' or whether it 'changed depending on which pairs of items were being rated'. All participants completed the AQ-10 and RAADS-14.

3:3 Results

The initial data set consisted of 225 participants. The data from one participant who did not indicate their autism status was removed as comparisons were made between the autistic and control groups. Data from two further participants were removed as more than 50% of their rating data across the total 40 word pairs was missing. There were 10 word pairs to be rated within the four pair types (A+T+, A+T-, A-T+, A-T-). Of the remaining 222 participants, 11 participants had one data point missing out of 10 word pairs for only one pair type (e.g., A+T+), and therefore an average rating was obtained using the remaining nine ratings. Two participants were missing one data point (out of 10 word pairs) in two pair types (e.g., A+T+ *and* A+T-), and again, an average rating was obtained using the remaining nine ratings for each pair type.

The following data analysis was conducted on the remaining data from the 222 participants (83 autistic, 26 self-diagnosed/awaiting assessment, 113 control). A one-way ANOVA was conducted to compare the mean AQ-10 scores between the autistic group, self-diagnosed group and the control group, $F(2, 221) = 138.83$, $p < .001$, $\eta^2 = .56$, and was followed by pairwise comparisons using a Bonferroni adjustment which showed higher AQ-10 scores from the autistic group ($M = 7.19$) than the control group ($M = 3.01$) ($p < .001$) and higher scores for the self-diagnosed group ($M = 8.54$) than both the control group ($p < .001$) and the autistic group ($M = 7.19$) ($p = 0.01$).

A further one-way ANOVA on the RAADS-14 scores also showed significant differences between groups, $F(2, 221) = 123.81$, $p < .001$, $\eta^2 = .53$. Post-hoc pairwise comparisons showed significantly higher scores ($p < .001$) from the autistic group ($M = 30.96$) than the control group ($M = 11.91$). The difference between the self-diagnosed group ($M = 33.85$) and the control group was also significant ($p < .001$). However, the difference in scores between the self-diagnosed group and autistic group was not statistically significant ($p = .52$). Given that the self-diagnosed group scored higher on the AQ-10 than the autistic group and those who self-diagnosed were not statistically different on this measure from each other, with both groups significantly different from the control group, it was decided that the data from self-diagnosed group (*N* = 26) would be combined with that of the autistic group (*N* = 83) for the purposes of the following two-group analyses.

An independent samples t-test confirmed significantly higher mean RAADS-14 scores (higher scores indicate high autistic traits) for the autistic (N = 119, *M* = 31.65, *SD* = 8.73) than for the control group (*M* = 11.91, *SD* = 9.99), *t*(217.87) = 15.68, *p* <.001, *d* = 2.10, one-tailed (equal variances not assumed). An independent samples t-test similarly confirmed that the difference in mean AQ-10 scores between the autistic (*M* = 7.51, *SD* = 2.24) and the control participants (*M* = 3.01, *SD* = 1.91) was also statistically significant, *t*(220) = 16.13, *p* <.001, *d* = 2.16, one-tailed, thus establishing a meaningful difference between the two groups in self-reported levels of autistic traits as measured by both the AQ10 and the RAADS-14 scores.

Main effects

The mean similarity and difference ratings for autistic and control participants across the four pair types are reported in Table 3.3. The difference ratings were reverse-scored to enable comparison with similarity ratings and to be in line with the data analysis method used by Golonka and Estes (2009). A 2 (Group Status: Autistic vs Control) x 2 (Ratings: Similarity vs Difference) x 2 (Taxonomic: Related vs Unrelated) x 2 (Thematic: Related vs Unrelated) mixed ANOVA was conducted using Taxonomic Relatedness and Thematic Relatedness as within-subjects factors and Group Status and Ratings as the between-subjects factors. The main effect of taxonomic relatedness was statistically significant, *F*(1, 218) = 843.08, *p* <.001, η_p^2 = .80, with estimates of marginal means showing higher mean ratings when pairs are taxonomically related (*M* = 4.71) compared to not taxonomically related (*M* = 2.58). The main effect of thematic relatedness was also statistically significant, *F*(1, 218) = 167.04, *p* <.001, η_p^2 = .43, with estimates of marginal means showing higher mean ratings when pairs are thematically related (*M* = 4.02) compared to not thematically related (*M* = 3.27). The main effect of autism was on the borderline of statistical significance, *F*(1,218) = 3.89, *p* = .05, η_p^2 = .02, with autistic participants having a marginally lower overall mean rating (*M* = 3.52) compared to control participants (*M* = 3.77). Given that the effect is weak, this has been treated as non-significant. The main effect of ratings was not statistically significant, *F*(1, 218) = 2.86, *p* = .09, η_p^2 = .01.[7]

[7] The main effect findings are reported here for completeness, but as the findings are collapsed across the variables of interest, they are not informative in terms of the expectations.

Table 3.3.

Mean similarity and difference ratings for autistic and control participants across the four pair types.

		A+T+	**A+T-**	**A-T+**	**A-T-**
Autistic	Similarity	4.58	4.75	3.31	1.59
(*N* = 109)	(*N* = 57)	(*SD* = 1.12)	(*SD* = 1.05)	(*SD* =1.65)	(*SD* = .79)
	Difference	4.47	4.78	3.08	1.63
	(*N* = 52)	(*SD* = 1.13)	(*SD* = .99)	(*SD* = 1.55)	(*SD* = .68)
Control	Similarity	4.94	4.95	4.13	1.75
(*N* = 113)	(*N* = 55)	(*SD* = 1.16)	(*SD* = 1.12)	(*SD* = 1.56)	(*SD* = .72)
	Difference	4.40	4.81	3.28	1.89
	(*N* = 58)	(*SD* = 1.12)	(*SD* = .98)	(*SD* = 1.61)	(*SD* = 1.12)

Interactions (significant)

The two-way interaction between taxonomic relatedness and thematic relatedness was significant, *F* = 730.23, *p* <.001. There was a significant three-way interaction between ratings, taxonomic relatedness, and thematic relatedness (see Figure 3.1), *F*(1,218) = 6.41, *p* = .01, η_p^2 = .03. Pairwise comparisons showed a significant difference (*p* = .04) between taxonomic relatedness in the similarity and difference conditions. Taxonomic relatedness was rated higher when rating similarity (*M* = 4.76) compared to rating difference (*M* = 4.44). There was also a significant difference (*p* = .01) between thematic relatedness in the similarity and difference conditions. Thematic relatedness was rated higher when rating similarity (*M* = 3.72) compared to rating difference (*M* = 3.18).

Pairwise comparisons showed significant differences (*p* <.001) in the similarity condition between A+T+ (*M* = 4.76) and A-T+ (*M* = 3.72), and A+T- (*M* = 4.85) and A-T- (*M* = 1.67). In the difference condition there were significant differences (*p* <.001) between A+T+ (*M* = 4.44) and A-T+ (*M* = 3.18), and A+T- (*M* = 4.79) and A-T- (*M* = 1.76).

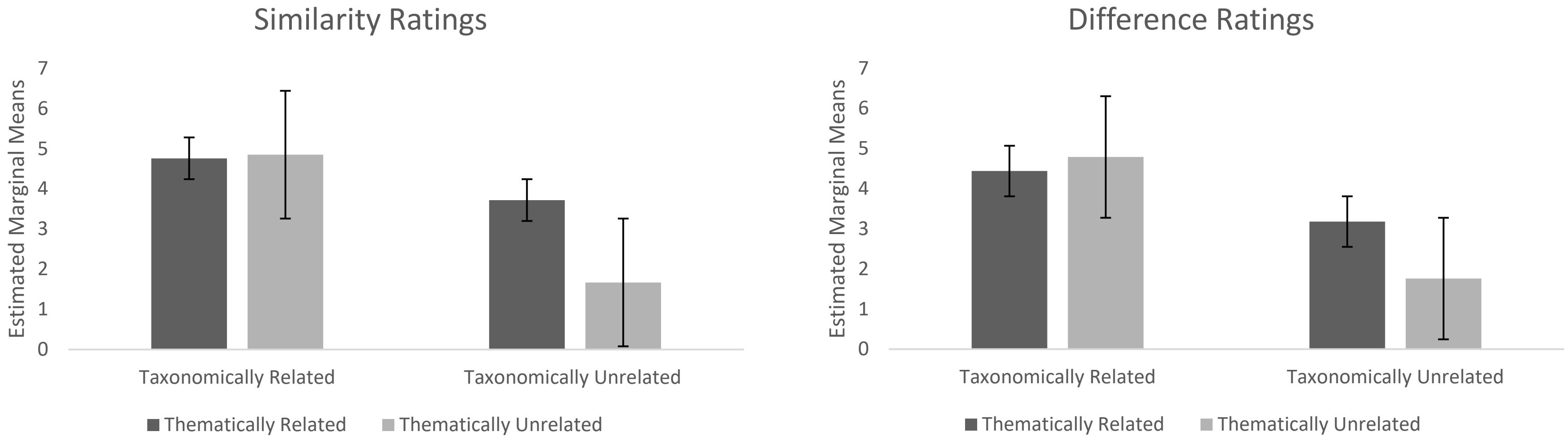


Figure 3.1 Estimated marginal means for all pair types across the similarity and difference conditions.

The two-way interaction between ratings and thematic relatedness was significant, *F* = 14.59, *p* <.001. There was a significant three-way interaction between autism, ratings, and thematic relatedness (see Figure 3.2), *F*(1,218) = 4.42, *p* = .04, η_p^2 = .02. Pairwise comparisons showed a significant difference in similarity ratings for thematic relatedness between autistic and control participants (*p* = .01) with autistic participants rating thematic similarity lower (*M* = 3.95) than control participants (*M* = 4.54). There was no significant difference between similarity ratings for the A+T+ pair type between the autistic participants (*M* = 4.58) and control participants (*M* = 4.94), however, there was a significant difference on the A-T+ pair type between autistic (*M* = 3.31) and control participants (*M* = 4.13) (*p* = .007).

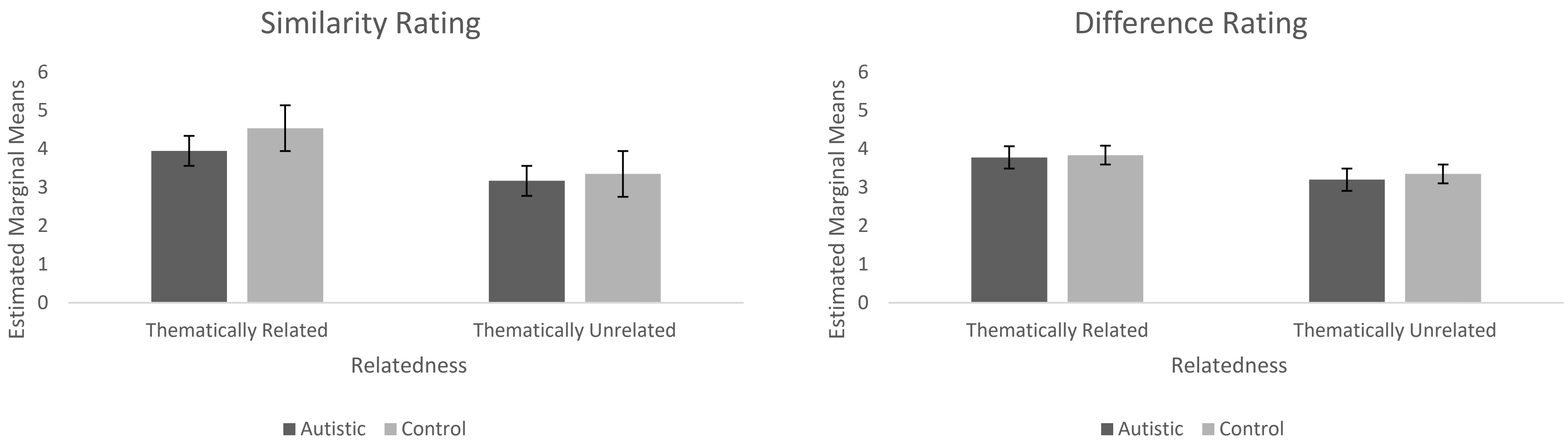


Figure 3.2. Estimated marginal means between the autistic and control participant across the similarity and difference ratings conditions for thematic relatedness.

No other two- or three-way interactions were significant.

Correlations

Correlation analyses were conducted to see whether AQ-10 and RAADS-14 scores correlated with participants' performance.

There is a significant positive correlation between AQ-10 and RAADS-14 scores, $r(220) = .84$, $p < .001$. See Figure 3.3.

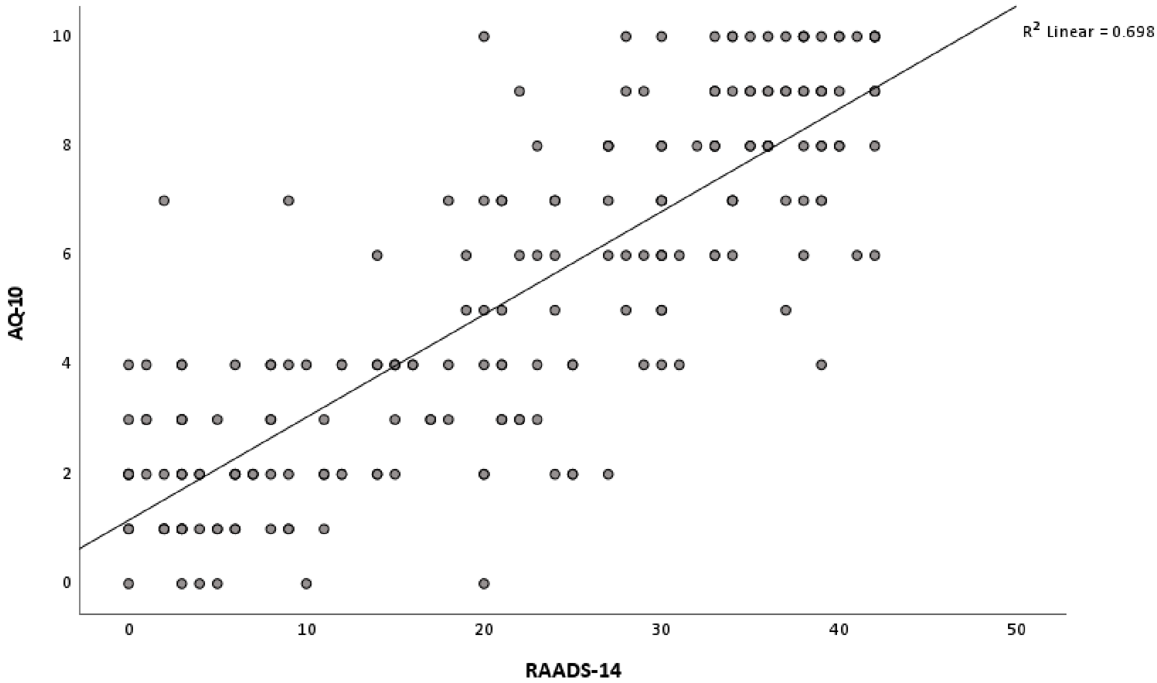


Figure 3.3. Significant positive correlation between AQ-10 scores and RAADS-14 scores.

<u>Similarity ratings</u>

There is a significant negative correlation between AQ-10 scores and similarity ratings for the A-T+ pair type, $r(110) = -.19$, $p = .05$. See Figure 3.4.

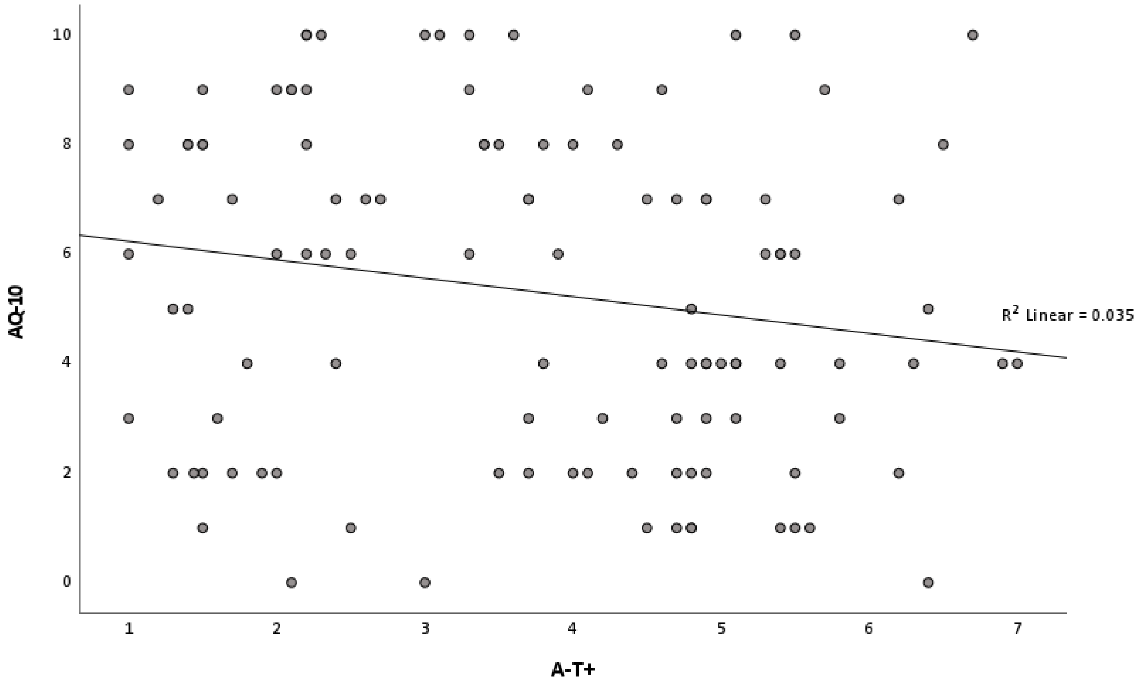


Figure 3.4. Significant negative correlation between AQ-10 scores and A-T+ similarity ratings. The higher the AQ-10 score, the lower the similarity rating for the A-T+ pair type.

There is a significant negative correlation between AQ-10 scores and similarity ratings for the A-T- pair type, $r(110) = -.21$, $p = .03$. See Figure 3.5.

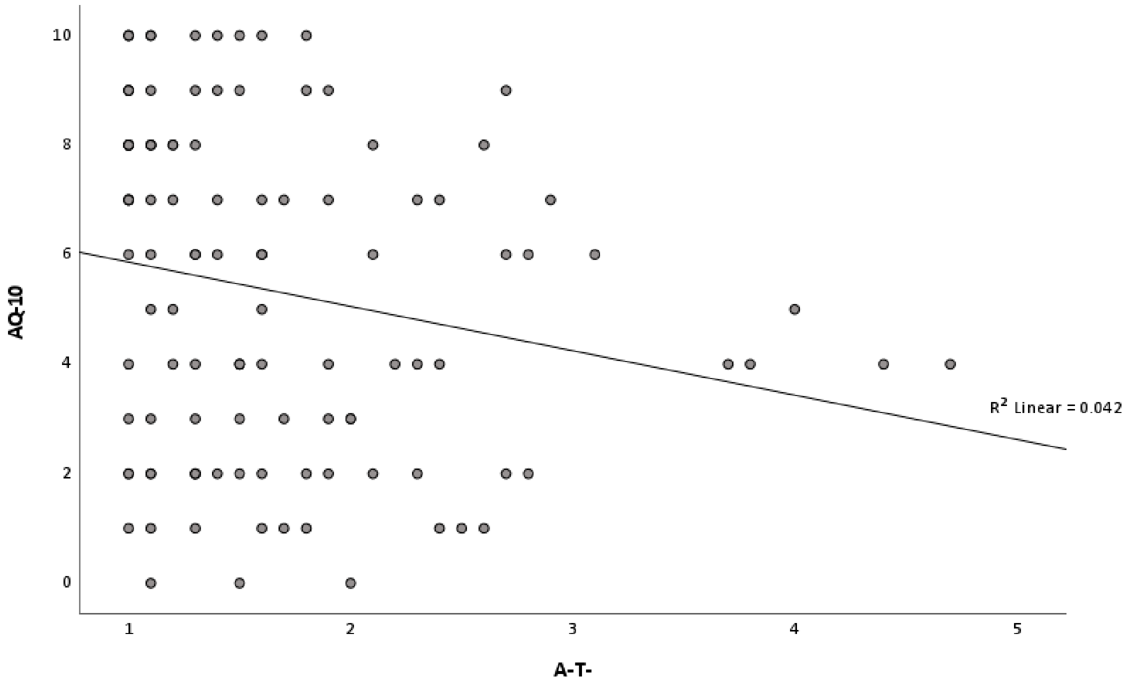


Figure 3.5. Significant negative correlation between AQ-10 scores and A-T- similarity ratings. The higher the AQ-10 score, the lower the similarity rating for the A-T- pair type.

There were no significant correlations between AQ-10 or RAADS-14 scores with participants' performance for difference ratings.

3:3:1 Strategy and Method

Similarity

Participants were asked to pick a statement that best reflected how they chose the number on the rating scale and to indicate how often they used the selected method. Tables 3.4 and 3.5 show the number of autistic and control participants using each strategy and method for similarity ratings. The strategy options for the similarity condition were as follows:

Strategy 1 = "In my mind, I started from the top of the scale (7) then thought about the ways in which the items were different to each other; the more differences that I found between them, the lower the rating that I gave. In other words, I went down the scale, the more differences that I found."

Strategy 2 = "In my mind, I started from the bottom of the scale (1) then thought about the things that the items had in common and the more things that I thought they had in common, the higher the rating that I gave. In other words, I worked up the scale, as I thought about the things they had in common."

Strategy 3 = "I just went with a feeling of similarity and picked a number on the scale that reflected that feeling."

Strategy 4 = "None of the above."

Method 1 meant participants used the selected method 'most of the time', and Method 2 was selected by participants who stated that their method 'changed depending on which pairs of items were being rated'.

Chi-square tests revealed no relationship between autism and the strategy or method used when rating similarity (p > .05).

Table 3.4.

Number of autistic and control participants using each of the four strategies for similarity ratings.

	Strategy 1	**Strategy 2**	**Strategy 3**	**Strategy 4**
Autistic (N = 57)	11	13	26	7
Control (N = 55)	7	12	34	2

Table 3.5.

Number of autistic and control participants using either Method 1 or Method 2 for similarity ratings.

	Method 1	**Method 2**
Autistic (*N* = 57)	39	18
Control (*N* = 55)	34	21

Difference

Tables 3.6 and 3.7 show the number of autistic and control participants using each strategy and method for difference ratings. The strategy options for the difference condition were as follows:

Strategy 1 = "In my mind, I started from the bottom of the scale (1) then thought about the ways in which the items were different to each other; the more differences that I found between them, the higher the rating that I gave. In other words, I went up the scale, the more differences that I found."

Strategy 2 = "In my mind, I started from the top of the scale (7) then I thought about the things that they had in common and, the more things that I thought they had in common, the lower the rating that I gave. In other words, I worked down the scale as I thought about the things they had in common."

Strategy 3 = "I just went with a feeling of difference and picked a number on the scale that reflected that feeling."

Strategy 4 = "None of the above."

Participants were then asked to indicate whether they used the selected strategy 'most of the time' or whether it 'changed depending on which pairs of items were being rated'.

Method 1 meant participants used the selected method 'most of the time', and Method 2 was selected by participants who stated that their method 'changed depending on which pairs of items were being rated'.

Chi-square tests revealed no relationship between autism and the strategy or method used when rating difference ($p > .05$).

Table 3.6.

Number of autistic and control participants using each of the four strategies for difference ratings.

	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Autistic (N = 52)	11	8	28	5
Control (N = 58)	11	15	31	1

Table 3.7.

Number of autistic and control participants using either Method 1, Method 2, or Method 3 for difference ratings.

	Method 1	Method 2	Method 3 (Other)
Autistic (N = 51)	27	24	0
Control (N = 58)	37	20	1

3:3:2 Protocol Analysis

All participants were asked to give a typed description of what they were thinking about when they made a similarity or difference rating for one pair from each pair type. The pair type for A+T+ was 'Chair and Table'; for A+T- it was 'Knife and Saw'; for A-T+ it was 'Dog and Veterinarian'; and for A-T- it was 'Mug and Champagne'.

The protocols were examined by two coders; it was soon apparent that participants often expressed more than one explanation of what they were thinking when making their rating, so the protocols were divided into part protocols, with each part expressing one 'thought'. It was initially thought that protocols could be simply divided into the codes 'Taxonomic' and 'Thematic'; however, following bottom-up analysis of a sample, several finer codes emerged. These were labelled SIMTAX, SIMTHEM, DIFFTAX, DIFFTHEM, GENDIFF and NI. See Table 3.8 for a description and example of each code. A sample was first coded together to establish a shared understanding of the codes, and then the remainder were coded independently. Of the total of 1522 part protocols, there were only 12 where there was disagreement or uncertainty between the coders. A third independent coder was consulted on these, and changes were made by the third coder to four of them, for which there was a final decision agreed between all three coders. (See Appendix F for tables of protocols and their codes).

Table 3.8.

Codes, descriptions and examples used in the qualitative analysis.

Codes	**Description**	**Example**
SIMTAX	A similarity related to feature or function or a shared category	"They are both implements for cutting things with" – (knife and saw)
SIMTHEM	Associated, 'go together', or occurring in the same context	"A vet would treat a dog" – (dog and veterinarian)
DIFFTAX	A difference related to feature or function	"They have different functions" – (chair and table)
DIFFTHEM[8]	Occurring in different contexts, *or* recognising that whilst two items may be associated that doesn't necessarily make them similar	"Different contexts" – (mug and champagne) "A vet will work with a dog but I don't identify them as being similar" – (dog and veterinarian)
GENDIFF	A general difference with no specific detail	"They are different" – (chair and table)
NI	Non-informative	"I wasn't thinking specifically about anything" – (chair and table)

The number of each code (and the percentage of the total) used for the similarity ratings between the autistic and control participants was compared (see Tables 3.9 and 3.10). For all the pair types in the similarity rating condition, the autistic group had a larger number of part protocols, suggesting that they were providing much more detailed responses. However, they only provided more detailed responses in two of the four pair types for difference ratings (A+T- and A-T+).

There was a total of 748 part protocols from the participants giving similarity ratings. The autistic participants generated 424 part protocols, and the control participants generated 324 for their similarity ratings. Amongst the 774 part protocols from the participants giving difference ratings, 383 were generated by the autistic participants and 391 by the control participants.

[8] DIFFTHEM (total *N* = 48) made up of occurring in different contexts (*N* = 39) and associated but not similar (*N* = 9).

Table 3.9.

Number of part protocols (%) made per code type for each pair type (rating similarity) by autistic and control participants.

	A+T+ Chair & Table		A+T- Knife & Saw		A-T+ Dog & Vet		A-T- Mug & Champagne	
	Autistic	**Control**	**Autistic**	**Control**	**Autistic**	**Control**	**Autistic**	**Control**
SIMTAX	46 (39.66)	39 (41.49)	74 (59.68)	55 (58.51)	14 (14)	2 (3.13)	8 (9.52)	9 (12.5)
SIMTHEM	31 (26.72)	30 (31.91)	0 (0)	3 (3.19)	32 (32)	27 (42.18)	1 (1.19)	2 (2.78)
DIFFTAX	18 (15.52)	10 (10.64)	31 (25)	13 (13.83)	34 (34)	11 (17.19)	46 (54.76)	21 (29.17)
DIFFTHEM	0 (0)	0 (0)	3 (2.42)	7 (7.45)	3 (3)	6 (9.38)	4 (4.76)	5 (6.94)
GENDIFF	5 (4.31)	4 (4.62)	1 (0.81)	3 (3.19)	3 (3.03)	1 (1.56)	3 (3.57)	1 (1.39)
NI	16 (13.79)	11 (11.70)	15 (12.10)	13 (13.83)	14 (14)	17 (26.56)	22 (26.19)	34 (47.22)
Total N	*116*	*94*	*124*	*94*	*100*	*64*	*84*	*72*

Table 3.10.

Number of part protocols (%) made per code type for each pair type (rating difference) by autistic and control participants.

	A+T+ Chair & Table		A+T- Knife & Saw		A-T+ Dog & Vet		A-T- Mug & Champagne	
	Autistic	**Control**	**Autistic**	**Control**	**Autistic**	**Control**	**Autistic**	**Control**
SIMTAX	44 (45.83)	38 (35.51)	63 (54.31)	61 (55.45)	7 (7.61)	11 (12.22)	8 (10.13)	14 (16.67)
SIMTHEM	23 (23.96)	35 (32.71)	1 (0.86)	2 (1.82)	28 (30.43)	29 (32.22)	2 (2.53)	2 (2.38)
DIFFTAX	20 (20.83)	22 (20.56)	31 (26.72)	21 (19.09)	36 (39.13)	28 (31.11)	43 (54.43)	36 (42.86)
DIFFTHEM	1 (1.04)	1 (0.93)	6 (5.17)	7 (6.36)	0 (0)	0 (0)	3 (3.80)	2 (2.38)
GENDIFF	0 (0)	6 (5.61)	2 (1.72)	6 (5.45)	6 (6.52)	7 (7.78)	4 (5.06)	5 (5.95)
NI	8 (8.33)	5 (4.67)	13 (11.20)	13 (11.82)	15 (16.30)	15 (16.67)	19 (24.05)	25 (29.76)
Total	*96*	*107*	*116*	*110*	*92*	*90*	*79*	*84*

Protocols derived from similarity ratings showed that for the pair type A+T+ (‘Chair & Table’) in which the items share both a thematic and taxonomic relationship, both autistic and control participants had a larger proportion of ‘SIMTAX’ comments compared to any other code type (39.66% and 41.49%, respectively). This suggests that where pairs share a taxonomic and thematic relationship, there was a propensity for taxonomic-related similarity comments for both groups. The next largest proportion of codes related to SIMTHEM, with 26.72% of autistic protocols and 31.91% of control protocols referencing a thematic similarity. Interestingly, autistic participants appeared more likely to make a comment relating to taxonomic difference even when asked to rate similarity, compared to control participants (15.52% and 10.64%, respectively).

When rating a pair that had a taxonomic relationship but not a thematic relationship (A+T-; ‘Knife & Saw’), both the autistic and control participants had the largest proportion of the SIMTAX code (59.68% and 58.51%, respectively). A small proportion of control participants referenced a thematic relationship where there wasn't one (3.19%), but none of the autistic participants made a thematic comment for this pair type. Again, autistic participants were much more likely to allude to taxonomic differences, compared to control participants, despite being asked to make similarity judgements (DIFFTAX; 25% and 13.83%, respectively).

Where a pair did not have a taxonomic relationship but did have a thematic one (A-T+; 'Dog & Vet'), the control participants made a higher number of thematic similarity comments (42.19%) compared to the autistic group (32.32%). This is in line with the above finding from the rating data that thematic relatedness was not as important for similarity ratings in the autistic group as it was in the control group. Interestingly, the autistic participants made a similar proportion of taxonomic difference comments (34.34%) (e.g., "a dog is an animal and a veterinarian is a human") compared to the control group, who made considerably fewer references to this type of difference (17.19%). For the control participants there is a greater emphasis of thematic similarity compared to taxonomic difference (42.19% compared to 17.19%) but this did not seem to be the case for autistic participants.

Finally, when rating similarity between pairs that have no taxonomic or thematic relationship (A-T-; 'Mug & Champagne'), autistic participants had a much higher tendency towards making taxonomic *difference* comments (e.g., "a mug is a hard ceramic container for liquids with a handle on the side. Champagne is a sparkling alcoholic liquid") compared to any other code type than the controls (54.76% vs 29.17%, respectively). This suggests that overall (compared to the control group), and when there was no clear taxonomic or thematic relationship, autistic participants had a propensity towards stating differences.

Protocols derived from difference ratings showed that for the pair type A+T+ ('Chair & Table'), the most common type of coding for both the autistic and control participants was SIMTAX (45.83% and 35.51%, respectively). Interestingly, this suggests that when asked to rate *difference* for a pair type that has a taxonomic and thematic relationship, both groups were more likely to reference the way in which the pair type is *taxonomically similar*. Unlike the similarity ratings, where autistic participants made overall more taxonomic difference judgements, when asked to describe why the difference rating for A+T+ was made, both autistic and control participants made a similar proportion of taxonomic difference comments (20.83% vs 20.56%, respectively).

Where a pair had a taxonomic relationship but not a thematic one (A+T-; 'Knife & Saw') both autistic and control participants made a similar proportion of SIMTAX comments (54.78% vs 55.45%, respectively) which was higher than the proportion of DIFFTAX comments (26.96% vs 19.09%, respectively). Again, despite being asked to rate difference, both groups had a tendency towards making similarity comments, though the autistic group did make more taxonomic difference comments compared to the control group.

For the pair that had a thematic relationship but not a taxonomic one (A-T+; 'Dog & Vet'), both autistic participants and control participants made a similar proportion of thematic similarity comments (30.43% and 32.22%, respectively). However, the autistic participants had a higher proportion of taxonomic difference comments compared to the control group (DIFFTAX; 39.13% vs 31.11%, respectively). This suggests that although the autistic participants can recognise thematic relationships, they are just as likely to also recognise that although an item may have an 'association', their taxonomic differences are salient.

When the pair shared no taxonomic or thematic relationship (A-T-; 'Mug & Champagne'), protocols derived from the difference ratings found that autistic participants had a higher proportion of taxonomic difference comments (54.43%) compared to control participants (42.86%). Unlike above, autistic participants also made fewer taxonomic similarity comments (10.13%) compared to control participants (16.67%). This suggests that where there is no clear relationship between pairs when rating difference, both autistic and control participants are more likely to focus on taxonomic relatedness, with autistic participants providing a higher proportion of taxonomic differences compared to control participants.

The protocols and ratings from the autistic subgroup (N = 16) were identified and examined (see Appendix G). This was compared to 16 randomly selected participants from the remaining autistic sample (see Appendix H). For the autistic subgroup, their ratings were more in line with protocols, particularly for the A-T+ pair type. The autistic subgroup were more likely to comment that although 'Dog & Veterinarian' were related concepts, this did not make them *similar,* resulting in very low A-T+ ratings. Ratings and protocols from the remaining autistic participants were more varied, with some participants rating 'Dog & Veterinarian' as being highly similar on the basis that they are found in the same situation.

In sum, although protocols were taken for only one example of each pair type and therefore, a wider sample of protocols could lead to a different pattern of responses, based on the responses collected for this study, it seems that autistic participants have a particular tendency to focus on taxonomic differences when rating either similarity or difference compared to the control group.

3:3:3 Additional Analysis

Autistic subgroup vs autistic

Following an awareness of the possibility of the model being applicable to a subset of autistic individuals, as referred to in Chapter 1, and given the 3-way interaction between autism, ratings, and thematic relatedness showed a significant difference on the A-T+ pair type for similarity ratings (no significant difference on A+T+), additional analysis of the data was conducted which revealed a subgroup of the autistic participants who gave very low similarity ratings for the A-T+ pair type (≤ 2). This group of participants did not use the thematic aspect of the pair type as a way of increasing the similarity between the pairs. Further analysis was conducted to compare this subgroup's performance (*N* = 16) against the remaining autistic participants (*N* = 41) in the similarity condition and later to the control group (*N* = 55).

The mean similarity ratings for the autistic subgroup and autistic group across the four pair types are reported in Table 3.11. A 2 x 2 x 2 repeated measures mixed ANOVA was conducted using taxonomic relatedness (A+T+, A+T-) and thematic relatedness (A-T+, A-T-) as the within-subjects factors and autism (autistic subgroup vs autistic group) as the between-subjects factor. The main effect of taxonomic relatedness was statistically significant, $F(1, 55) = 220.02$, $p < .001$, $\eta_p^2 = .80$, with estimates of marginal means showing higher mean ratings when pairs are taxonomically related (*M* = 4.50) compared to not taxonomically related (*M* = 2.10). The main effect of thematic relatedness was statistically significant, $F(1,55) = 23.25$, $p < .001$, $\eta_p^2 = .30$, with estimates of marginal means showing higher mean ratings when pairs are thematically related (*M* = 3.54) compared to not thematically related (*M* = 3.06). The main effect of autism was statistically significant, $F(1,55) = 29.46$, $p < .001$, $\eta_p^2 = .35$, with the autistic subgroup having lower overall mean ratings (*M* = 2.72) compared to the remaining autistic participants (*M* = 3.89).

Table 3.11.

Mean similarity ratings for autistic subgroup and autistic participants across the four pair types.

	A+T+	**A+T-**	**A-T+**	**A-T-**
Autistic sub	3.77	4.50	1.48	1.13
(*N* = 16)	(*SD* = 1.29)	(*SD* = 1.43)	(*SD* = .34)	(*SD* = .23)
Autistic	4.90	4.85	4.02	1.77
(*N* = 41)	(*SD* = .88)	(*SD* = .86)	(*SD* = 1.38)	(*SD* = .86)

Interactions (significant)

The interaction between taxonomic and thematic relatedness was significant, $F = 107.02$, $p < .001$. The interaction between taxonomic relatedness and autism was significant (see Figure 3.6), $F(1,55) = 7.01$, $p = .01$, $\eta_p^2 = .11$). Pairwise comparisons showed a significant difference in similarity ratings for taxonomic relatedness (A+T+, A+T-) between the autistic subgroup and autistic group (*p* = .01) with the autistic subgroup giving lower ratings (*M* = 4.13) compared to the autistic group (*M* = 4.87). When pairs are not taxonomically related (A-T+, A-T-), there is a significant difference in ratings between the autistic subgroup and autistic group (*p* <.001), with the autistic subgroup giving lower ratings (*M* = 1.30) compared to the autistic group (*M* = 2.90).

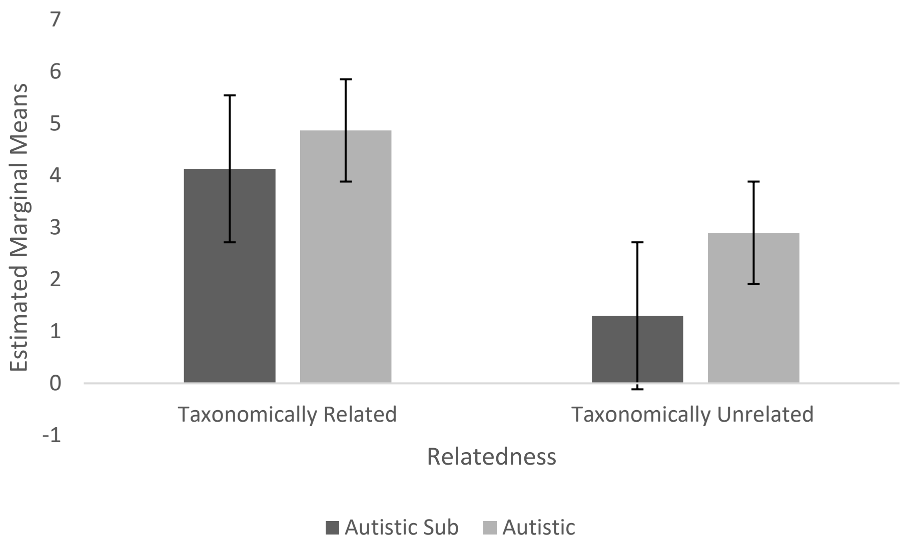


Figure 3.6. Difference between the autistic subgroup and autistic group on taxonomically related and unrelated similarity ratings.

The interaction between thematic relatedness and autism was significant (see Figure 3.7), $F(1,55) = 45.16$, $p < .001$, $\eta_p^2 = .45$). Pairwise comparisons showed a significant difference in similarity ratings for thematic relatedness (A+T+, A-T+) between the autistic subgroup and autistic group (*p* <.001) with the autistic subgroup giving lower ratings (*M* = 2.62) compared to the autistic group (*M* = 4.46). When pairs are not thematically related (A+T-, A-T-), there is a significant difference in ratings between the autistic subgroup and autistic group (*p* = .01), with the autistic subgroup giving lower ratings (*M* = 2.81) compared to the autistic group (*M* = 3.31).

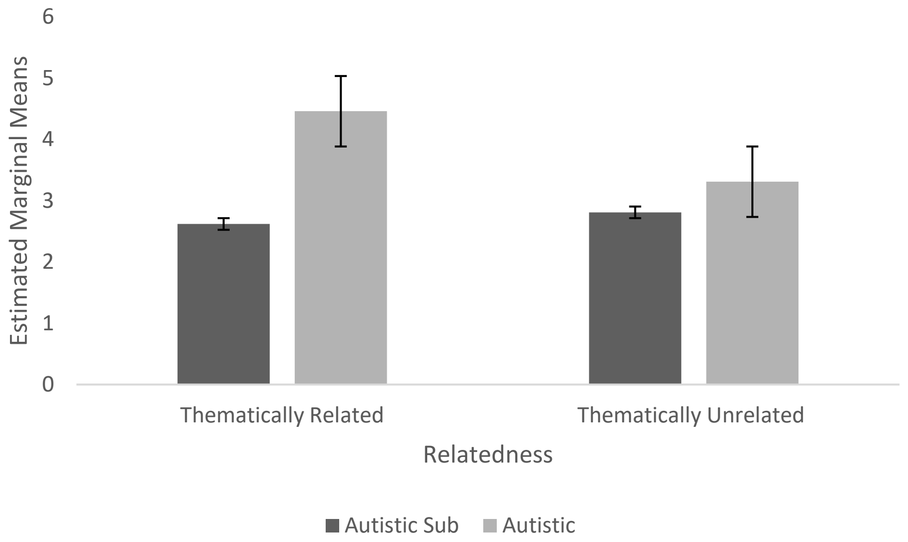


Figure 3.7. Difference between the autistic subgroup and autistic group on thematically related and unrelated similarity ratings.

The interaction between taxonomic relatedness, thematic relatedness, and autism was significant (see Figure 3.8), $F(1,55) = 12.58$, $p = .00$, $\eta_p^2 = .19$. Pairwise comparisons showed significant differences between the ratings by the autistic subgroup and autistic group on A+T+ ($M_{AutSub} = 3.77$, $M_{Autistic} = 4.90$, $p < .001$), A-T+ ($M_{AutSub} = 1.48$, $M_{Autistic} = 4.02$, $p < .001$), and A-T- ($M_{AutSub} = 1.13$, $M_{Autistic} = 1.77$, $p = .005$). The only pair type in which the two groups did not differ significantly was the A+T- pair type, in which pairs only shared a taxonomic relationship.

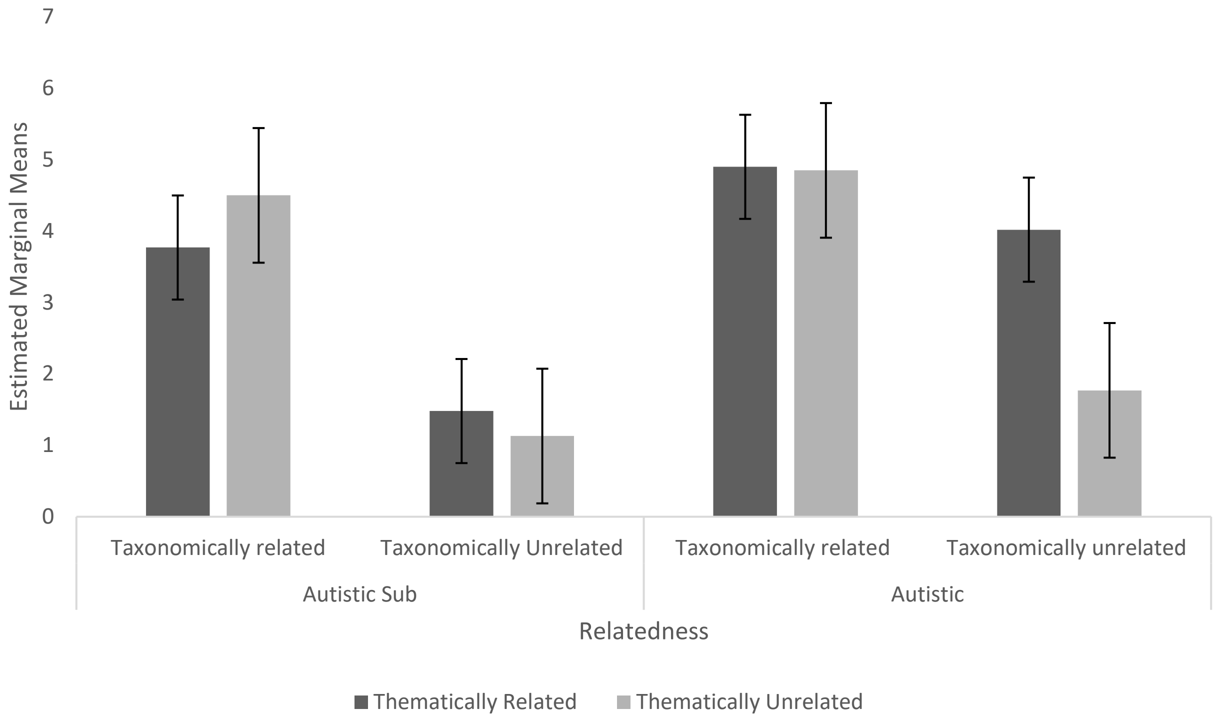


Figure 3.8. Difference in similarity ratings between the autistic subgroup and the autistic group across all four pair types.

Autistic subgroup vs controls

The autistic subgroup was then compared to the control participants (control group) in the similarity rating condition (N = 55). The mean similarity ratings for the autistic subgroup and autistic group across the four pair types are reported in Table 3.12. A 2 x 2 x 2 repeated measures mixed ANOVA was conducted using taxonomic relatedness (A+T+, A+T-) and thematic relatedness (A-T+, A-T-) as the within-subjects factors and autism (autistic subgroup vs control) as the between-subjects factor. The main effect of taxonomic relatedness was statistically significant, $F(1, 69) = 220.85$, $p < .001$, $\eta_p^2 = .76$, with estimates of marginal means showing higher mean similarity ratings when pairs are taxonomically related (M = 4.54) compared to not taxonomically related (M = 2.12). The main effect of thematic relatedness was statistically significant, $F(1,69) = 17.30$, $p < .001$, $\eta_p^2 = .20$, with estimates of marginal means showing higher mean similarity ratings when pairs are thematically related (M = 3.58) compared to not thematically related (M = 3.08). The main effect of autism was statistically significant, $F(1,69) = 25.08$, $p < .001$, $\eta_p^2 = .27$, with the autistic subgroup having lower overall similarity ratings (M = 2.72) compared to control participants (M = 3.94).

Table 3.12.

Mean similarity ratings for autistic subgroup and control participants across the four pair types.

	A+T+	**A+T-**	**A-T+**	**A-T-**
Autistic sub	3.77	4.50	1.48	1.13
(N = 16)	(SD = 1.29)	(SD = 1.43)	(SD = .34)	(SD = .23)
Control	4.94	4.95	4.13	1.75
(N = 55)	(SD = 1.16)	(SD = 1.20)	(SD = 1.56)	(SD = .72)

Interactions (significant)

The interaction between taxonomic and thematic relatedness was significant, $F = 191.38$, $p < .001$. The interaction between taxonomic relatedness and autism was significant (see Figure 3.9), $F(1,69) = 6.57$, $p = .01$, $\eta_p^2 = .09$. Pairwise comparisons showed a significant difference in similarity ratings for taxonomic relatedness (A+T+, A+T-) between the autistic subgroup and control group (p = .02) with the autistic subgroup giving lower ratings (M = 4.13) compared to the control group (M = 4.95). When pairs are not taxonomically related (A-T+, A-T-), there is a significant difference in ratings between the autistic subgroup and control group (p <.001), with the autistic subgroup giving lower mean similarity ratings (M = 1.31) compared to the control group (M = 2.94).

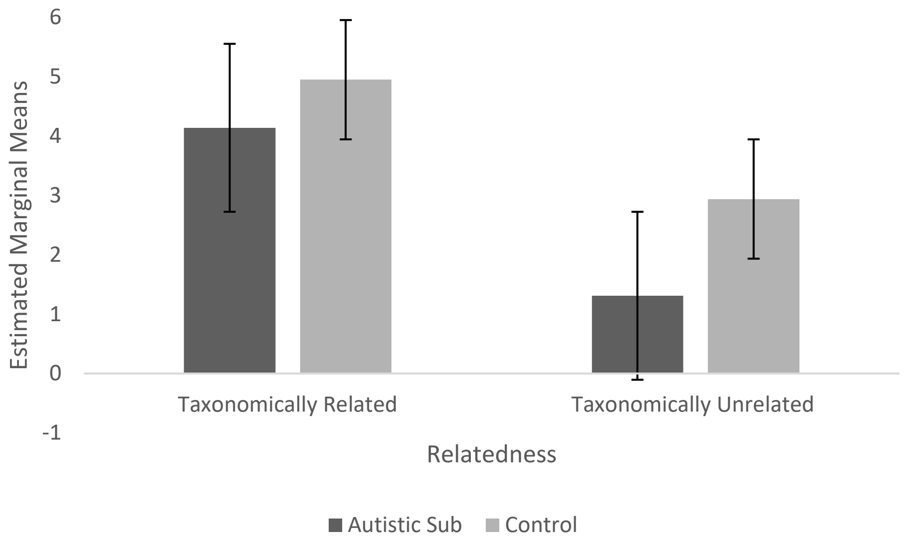


Figure 3.9. Difference between the autistic subgroup and control group on taxonomically related and unrelated similarity ratings.

The interaction between thematic relatedness and autism was significant (see Figure 3.10), $F(1,69) = 32.97$, $p < .001$, $\eta_p^2 = .32$. Pairwise comparisons showed a significant difference in similarity ratings for thematic relatedness (A+T+, A-T+) between the autistic subgroup and control group (p <.001) with the autistic subgroup giving lower ratings (M = 2.63) compared to the control group (M = 4.54). When pairs are not thematically related (A+T-, A-T-), there is a significant difference in ratings between the autistic subgroup and control group (p = .01), with the autistic subgroup giving lower ratings (M = 2.82) compared to the control group (M = 3.35).

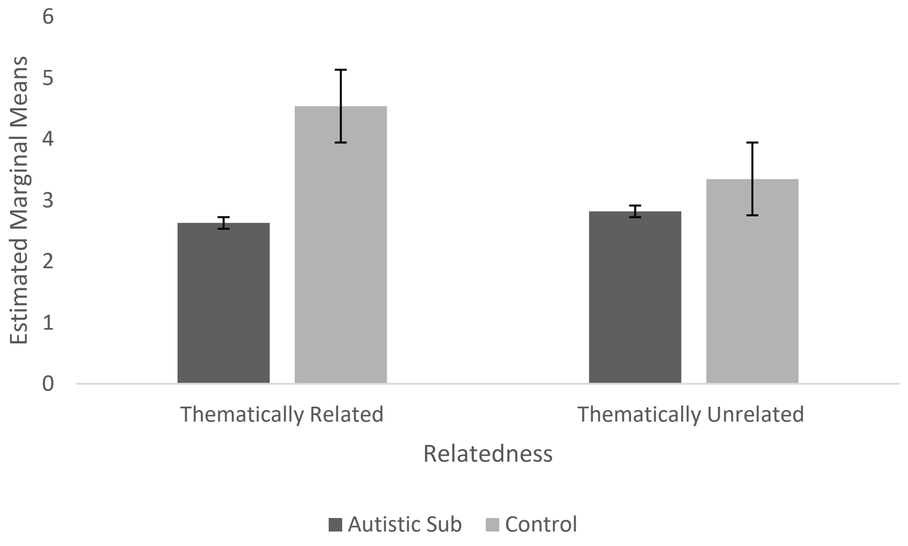


Figure 3.10. Difference between the autistic subgroup and control group on thematically related and unrelated similarity ratings.

The interaction between taxonomic relatedness, thematic relatedness, and autism was significant (see Figure 3.11), $F(1,69) = 27.53$, $p < .001$, $\eta_p^2 = .29$. Pairwise comparisons showed significant differences between the ratings by the autistic and control participants on A+T+ ($M_{AutSub} = 3.77$, $M_{Control} = 4.94$, $p = .00$), A-T+ ($M_{AutSub} = 1.48$, $M_{Control} = 4.13$, $p < .001$), and A-T- ($M_{AutSub} = 1.13$, $M_{Control} = 1.75$, $p = .00$). The only pair type in which the two groups did not differ significantly was the A+T- pair type, in which pairs only shared a taxonomic relationship.

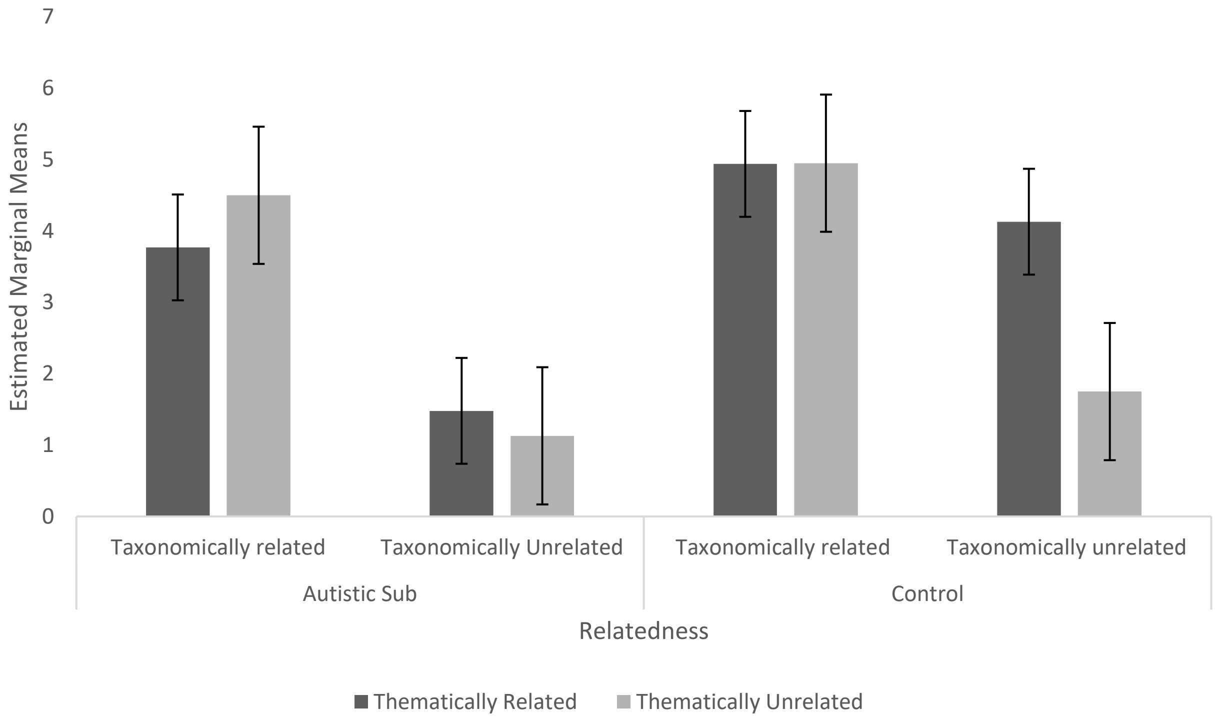


Figure 3.11. Difference in similarity ratings between the autistic subgroup and the control group across all four pair types.

3:4 Discussion

The purpose of this study was to use a simple task to compare how autistic and control participants rated similarity and difference and to consider whether such a task may be a useful measure of potential hypersensitivity to difference in autistic people.

The first notable aspect of the data was that, although the taxonomically related pairs were rated as more similar than the thematically related pairs, as reported by both Wisniewski and Bassok (1999) and Golonka and Estes (2009), there appeared to be no enhancement of the similarity between taxonomically related item pairs when also thematically related (A+T+) compared to the pairs related only taxonomically (A+T-), as found by Wisniewski and Bassok (1999). Given that the 'strength of thematic relations' was not obviously accounted for by those researchers (items were chosen by the researchers and were not tested for typicality), as was also the case when making changes for this study, it is possible that changes in the A+T+ items here led to a reduction in the thematic 'effect' on the taxonomic pairs. Tsagkaridis et al. (2014) explored whether the strength of thematic relations was influenced by other factors, such as shared action. When using a triad task, it was found that items that were thematically related but didn't share an action (e.g., wine bottle and cheese) were chosen less frequently than items that had only a taxonomic relationship (e.g., wine bottle and water bottle). The object chosen with the highest frequency was the object that shared both a thematic relationship and action with the target (e.g., wine bottle and corkscrew). Therefore, it may be that the thematic enhancements in similarity can be further strengthened by shared action.

The result from the initial data analysis that found overall, taxonomically related pairs (A+T+ & A+T-) were rated as more similar than taxonomically unrelated pairs (A-T+, A-T-), was unsurprising given that any thematic enhancement to similarity has never been found to equal the contribution made by items sharing many alignable features. Pairs that were thematically related (A+T+ & A-T+) also received a higher overall mean rating compared to pairs that were not thematically related (A+T- & A-T-). This supported previous findings and theoretical positions that both systems play a part when making similarity judgements between objects.

What was new to this study was the expectation that a general hypersensitivity to difference in the autistic participants would lead that group to give higher ratings of difference overall than those given by the control group. However, no such main effect of autism was found and neither did it enter an interaction with ratings at this level of analysis. There was, however, a three-way interaction between autism, ratings and thematic relatedness which found that thematic relatedness was less important for similarity ratings in the autistic group compared to the control group. In particular, there was a significant difference between these two groups for the A-T+ pair type, which only has a thematic component, supporting the previous evidence that autistic participants are less influenced by contextual information and schema (Vermeulen, 2015), as discussed in Chapter 1.

A 3-way interaction between ratings, taxonomic relatedness and thematic relatedness was also found. Pairs that shared a taxonomic relationship were rated higher when rating similarity compared to when rating difference, suggesting that overall, participants were more likely to focus on shared features between pairs compared to how pairs differed. Similarly, participants were more likely to focus on the shared context between pairs compared to how the context may differ. When pairs were taxonomically and thematically related, they were rated as being less different compared to pairs that only shared a context. Furthermore, pairs that only shared features were rated as less different to pairs that shared neither features nor context.

As was expected, the interaction between ratings and thematic relatedness showed this to be only the case for the similarity ratings. Ratings from the participants in the difference condition were overall unaffected by the presence or absence of thematic relations, suggesting that when pairs are thematically related, this relationship exerts more influence on similarity judgements than on difference judgements, as concluded by Golonka and Estes (2009). More importantly, as also theorised, autism featured in a significant three-way interaction with ratings, and thematic relatedness, which showed that when rating similarity, thematic relatedness was less influential for the autistic group who gave lower mean ratings compared to the controls. This suggests that for autistic participants, sharing a context was less relevant to similarity than for the control participants, which is in line with research which suggests that autistic people may experience a reduced sensitivity towards contextual information (Vermeulen, 2015) and with the model that links interference in the perception of similarity with the formation of schemas. This was further supported by the significant negative correlation between AQ-10 scores and similarity ratings for the A-T+. The higher the measure of the participant's autistic traits, the lower the similarity ratings for pairs that were thematically related but not taxonomically related. There was also a significant negative correlation between AQ-10 scores and similarity ratings for the A-T- pair type; the higher the autistic traits, the lower the rating for pair types that were neither taxonomically nor thematically related, compared to participants with lower autistic traits. There were no significant correlations for difference ratings.

An exploratory analysis was conducted on a subset of autistic participants who provided very low similarity ratings for the A-T+ condition. These participants were of particular interest as they did not seem to be impacted by thematic relatedness in the same way as control participants and were also significantly different from the remaining autistic participants. In fact, the autistic subgroup differed from the autistic group on three of the four pair types (A+T+, A-T+ and A-T-). Only pairs that had a taxonomic-only relationship (A+T-) were given similar similarity ratings by both groups.

Protocol analysis

Although the value of introspective protocols was initially treated with considerable doubt, most famously by Nisbett & Wilson (1977), it has become arguably more common to accept that although these will not be able to reveal subconscious processing in cognitive tasks, the repeated patterns in what participants consciously report under different conditions can be informative (Vallee-Tourangeau et al., 1998; Gilhooly et al., 2007).

Participants were asked, for one stipulated pair of items from each pair type, to write a description of what they were thinking when making their rating. Data from the analysis of these protocols revealed that when asked to give reasons for similarity, autistic participants had a much higher overall proportion of comments than controls relating to how pairs differed taxonomically. Autistic participants also generated a greater number of part protocols for similarity ratings, suggesting that they provided, overall, more detailed responses. This indicates that autistic participants, when asked to explain why pairs are similar, are more likely than control participants to consider the ways in which the pairs differ and, particularly, how they differ in terms of features and functions.

Overall, for the similarity rating protocols, autistic participants made a lower proportion of comments relating to thematic similarity compared to control participants, supporting the proposition that autistic participants are more likely to focus on difference, and due to enhanced attention to detail, these differences are likely to be related to feature and function (taxonomic) compared to context and more general claims of association (thematic). Interestingly, for the pair type which shared a thematic relationship but not a taxonomic one (A-T+; ‘Dog & Vet’), autistic participants provided a similar proportion of comments relating to the association between the pair *and* the taxonomic difference, compared to control participants who were more likely to focus on thematic similarity.

However, when asked to explain difference ratings for one pair from each pair type, both the autistic and control participants were surprisingly more likely to make comments relating to the ways in which pairs were *similar* as opposed to different. For three of the four pair types (A+T-; ‘Knife & Saw’, A-T+; ‘Dog & Vet’, A-T-; ‘Mug & Champagne), autistic participants made a greater proportion of comments relating to taxonomic difference compared to control participants but made a similar proportion of thematic similarity comments. This suggests that autistic participants do recognise the non-taxonomic associations between pairs in a similar way to control participants but also recognise that this does not necessarily make them 'similar' and, therefore, they are also likely to reference the way in which they are different taxonomically.

Interestingly, the most common strategy used by both autistic and control participants for both similarity and difference ratings was Strategy 3: "I just went with a feeling of similarity/difference and picked a number on the scale that reflected that feeling", and for both groups (autistic and controls) the majority of participants used this method "most of the time", as opposed to changing the method depending on the to-be-rated pairs, suggesting that the protocols may have been generated as a way of justifying the ratings as opposed to the ratings emerging as a result of a rule-based, methodical approach.

In conclusion, the findings from research such as Golonka and Estes (2009) that thematic relatedness increased similarity by emphasising shared context was found predominantly in control participants. The same impact of thematic relatedness on similarity ratings was not found in the autistic group, and in particular, a subgroup of autistic participants who provided very low similarity ratings for thematically related items was found. The prediction that autistic participants would give higher difference ratings than controls in this task was not supported; however, the focus on difference was partially demonstrated through the protocol analysis. In fact, surprisingly, when asked to give reasons for difference ratings, both autistic and control participants were more likely to describe the ways in which pairs were *similar*. Whereas, when asked to give reasons for similarity ratings, autistic participants were much more likely to describe the differences between pairs.

Of interest to the researcher was whether, when participants are asked to rate *both* similarity and difference, the autistic participants who give very low similarity ratings would also give very high difference ratings, demonstrating an inversion effect. This was addressed in the next study.

3:5 Experiment 3 – Introduction

As outlined in the previous experiment, the aim of Experiment 2 was to investigate how autistic and control participants make judgments about similarity and difference between items using a simple rating task and a between-subject design for the type of rating. The choice of separate groups to rate similarity and difference followed the practice of Golonka and Estes (2009) and was felt to be a way of avoiding the demand characteristics that could arise if participants started to reason about the meaning of their ratings, i.e. if I have rated X and Y quite highly on the similarity scale then they should be rated as not very different on the difference scale. The resulting reduction of a non-inversion effect was what was found by Simmons and Estes (2008) in Experiment 2(b). However, their participants each made a similarity and difference judgement after each trial, so for Experiment 3, it was decided that all participants should rate *both* similarity and difference using the same 40 pair types repeated twice – one set to be rated for similarity and the same set to be rated for difference. This was done in blocks of each type of rating so that the load on memory was higher than for Simmons and Estes' (2008) participants. Given the identification in the previous experiment in this chapter of a subgroup of autistic participants in the similarity condition who gave very low similarity ratings for the A-T+ pair type, it was expected that a similar group would be found in this study and it would be these participants, who, when rating difference, would also give higher ratings of difference as originally theorised in Experiment 2, therefore demonstrating an inversion effect that could not be attributed to memory or reasoning. In the expectation of identifying such a group showing an increased sensitivity to difference compared both to controls and to other autistic participants, measures of general anxiety, intolerance of uncertainty, and sensory hypersensitivity were included in this study.

3:6 Methods

3:6:1 Participants

A total of 120 participants (M = 27.67, SD = 9.50, range = 18-57) took part in the study. Forty-eight participants had a formal diagnosis of Autism Spectrum Condition, 15 participants stated they were self-diagnosed/awaiting assessment, and 55 participants indicated they were not autistic. One participant selected 'prefer not to say', and one participant did not indicate their autism status. Of the autistic group (including self-diagnosed/awaiting assessment), 31 identified as male, 30 identified as female, and two as 'other'. The remaining 55 participants (excluding the one participant who did not indicate their autism status) formed the control group consisting of six males and 49 females (see Table 3.13 for descriptive statistics). The autistic and control participants were recruited via a combination of Prolific Academic and the University of Hertfordshire's Psychology Research Participation System.

Table 3.13.

Descriptive statistics relating to autistic and control participants.

	Autistic (*N* = 63)	**Control (*N* = 55)**
Mean age *(SD)*	30.10 *(9.11)*	25.04 *(9.40)*
Gender split		
Male	31	6
Female	30	49
Other	2	
Mean AQ-10 score *(SD)*	6.30 *(1.66)*	4.25 *(1.51)*
Mean RAADS-14 score *(SD)*	32.60 *(7.42)*	14.15 *(9.28)*

Using G*Power, an a-prior power analysis based on a 2 x 8 design and following the same technique as the first experiment (3-way interaction and assuming a weak effect), a total minimum sample size of 92 participants was calculated (f = .1, α = .05, 1 – β = .8).

3:6:2 Design

The study used a mixed design with group status (autistic vs control) as the independent, between-subjects variable. The within-subjects factors were ratings (similarity vs difference), taxonomic relatedness (taxonomically related vs not taxonomically related) and thematic relatedness (thematically related vs not thematically related). The dependent variable was the mean rating given on a 7-point scale for similarity and difference.

3:6:3 Materials

The stimuli used in the study were identical to those used in the previous experiment.

Participants completed the Autism Quotient 10 (AQ-10; Allison et al., 2012) and Ritvo Autism & Asperger Diagnostic Scale (RAADS-14; Eriksson et al., 2013) to allow for assessment of the homogeneity of the autistic sample. Participants also completed the Generalised Anxiety Disorder 7-Item Scale (GAD-7; Spitzer et al., 2006), Intolerance of Uncertainty Short Form Scale (IUS-12; Carlton et al., 2007), and Sensory Hypersensitivity Scale (SHS; Dixon et al., 2016).

3:6:4 Procedure

Participants completed the study online using Qualtrics. There were 80 word pairs to be rated on a 7-point scale. The participants (autistic and control) rated 40 word pairs for similarity (1 = not at all similar, 7 = extremely similar) in a block, and the remaining 40 word pairs were then repeated for the purpose of rating difference (1 = not at all different, 7 = extremely different). The order of similarity vs difference ratings and the pairs within those groups were randomly allocated. All participants completed the AQ-10, RAADS-14, GAD, IUS, and SHS.

3:7 Results

The initial data set consisted of 120 participants. The participants' data who did not indicate their autism status, and the participant who selected 'prefer not to say', were removed as comparisons were made between the autistic and control groups. A further nine participants were removed for failure to adhere to task instructions. One participant was removed for having one data point missing from more than two pair types. Of the remaining 108 participants, 13 participants had one data point missing out of 10 word pairs for only one pair type (e.g., A+T+), and therefore an average rating was obtained using the remaining nine ratings. One participant had two data points missing in one pair type (e.g., A+T-), and therefore, an average rating was obtained using the remaining eight ratings. Two participants had one data point missing in two pair types (e.g., A+T+ *and* A+T-), and again, an average rating was obtained using the remaining nine ratings for each pair type.

The final data analysis was conducted on the remaining 108 participants (43 autistic, 14 self-diagnosed/awaiting assessment, and 51 controls). A one-way ANOVA was conducted to compare the mean AQ-10 between the autistic group, the self-diagnosis group, and the control group. There was a significant effect of group on AQ-10 scores, $F(2, 105) = 37.00$, $p < .001$, $\eta^2 = .41$ with a significant difference ($p < .001$) between the mean AQ-10 scores between the autistic group ($M = 6.93$) and control group ($M = 3.67$). The difference between the self-diagnosed group ($M = 8.00$) and the control group was also significant ($p < .001$). The self-diagnosed group was not statistically significant from the autistic group ($p = .33$).

A one-way ANOVA was conducted to compare the mean RAADS-14 scores between the three groups. There was a significant effect of group on RAADS-14 scores, $F(2, 105) = 60.47$, $p < .001$, $\eta^2 = .54$ with a significant difference ($p < .001$) between the mean RAADS-14 scores between the autistic group ($M = 31.65$) and the control group ($M = 14.04$). The difference between the self-diagnosed group ($M = 33.36$) and the control group was also significant ($p < .001$). The self-diagnosed group was not statistically significant from the autistic group ($p = 1.00$). Given that on both measures, the autistic and self-diagnosed group were not statistically different from each other, but both were statistically significant from the control group, it was decided that the self-diagnosed group (N = 14) would be added to the autistic group (N = 43).

An independent samples t-test found that the difference in mean AQ-10 scores between the autistic (M = 7.19) and control group (M = 3.67) was statistically significant, $t(106) = 8.39$, $p < .001$, $d = 1.62$, one-tailed. An independent samples t-test found that the difference in mean RAADS-14 scores between the autistic (M = 32.07) and control group (M = 14.04) was also statistically significant, $t(95.93) = 10.88$, $p < .001$, $d = 2.12$, one-tailed (equal variances not assumed). Therefore, on both measures, the autistic group had higher self-reported levels of autistic traits compared to the control group.

Main effects

The mean similarity and difference ratings for autistic and control participants across the four pair types are reported in Table 3.14. Once again, the similarity ratings for the A+T+ pairs were not significantly different to the A+T- pairs (p = 1), so the additional enhancement of taxonomically related items due to the additional presence of a thematic relationship was not found, contrary to the findings reported by Wisniewski and Bassok (1999).

As with the previous experiment, the difference ratings were reverse-scored to enable comparison with similarity ratings and to be in line with the data analysis method used by Golonka and Estes (2009). A 2 (Group Status: Autistic vs Control) x 2 (Ratings: Similarity vs Difference) x 2 (Taxonomic: Related vs Unrelated) x 2 (Thematic: Related vs Unrelated) mixed ANOVA was conducted using Ratings, Taxonomic Relatedness and Thematic Relatedness as within-subjects factors and Group Status as the between-subjects factors. The same main effects found in the previous study were significant again here; taxonomically related pairs (M = 4.60) were rated higher overall than taxonomically unrelated pairs (M = 3.04) $F(1, 106) = 215.14$, $p < .001$, $\eta_p^2 = .67$ and thematically related (M = 4.19) pairs were rated higher than thematically unrelated (M = 3.45) $F(1, 106) = 118.92$, $p < .001$, $\eta_p^2 = .47$. The main effects of ratings and autism were once again not statistically significant, $F < 1$.[9]

Table 3.14.

Mean similarity and difference ratings for autistic and control participants across the four pair types.

[9] The main effect findings are reported here for completeness, but as the findings are collapsed across the variables of interest, they are not informative in terms of the expectations.

		A+T+	A+T-	A-T+	A-T-
Autistic	Similarity	4.71	4.68	3.76	1.91
(*N* = 57)		(*SD* = 1.18)	(*SD* = 1.13)	(*SD* = 1.56)	(*SD* = 1.08)
	Difference	4.51	4.69	3.44	2.36
		(*SD* = 1.22)	(*SD* = 1.14)	(*SD* = 1.50)	(*SD* = 1.60)
Control	Similarity	4.59	4.50	4.19	2.35
(*N* = 51)		(*SD* = 1.14)	(*SD* = 1.12)	(*SD* = 1.47)	(*SD* = 1.18)
	Difference	4.46	4.64	3.84	2.42
		(*SD* = 1.12)	(*SD* = 1.01)	(*SD* = 1.45)	(*SD* = 1.22)

Interactions (significant)

The same two-way interactions between ratings and thematic relatedness $F(1,106) = 14.45$, $p < .001$, $\eta_p^2 = .47$ and between taxonomic and thematic relatedness $F(1,106) = 14.45$, $p < .001$, $\eta_p^2 = .47$ were also found. A higher mean rating was given in the similarity condition (*M* = 4.31) compared to the difference condition (*M* = 4.07) when pairs were thematically related ($p = .03$). There was no significant difference between the similarity rating (*M* = 3.36) and difference rating (*M* = 3.53) for thematically unrelated pairs.

Pairs that were taxonomically related but not thematically related (*M* = 4.63) were rated higher than those related taxonomically and thematically (*M* = 4.57). Pairs sharing thematic relations but not taxonomic were rated higher (*M* = 3.81) compared to when pairs were not related in either way (*M* = 2.26). Pairwise comparisons showed significant differences ($p < .001$) between mean rating for A+T+ (*M* = 4.57) and A-T+ (*M* = 3.81), and A+T- (*M* = 4.63) and A-T- (*M* = 2.26).

In this study, autism featured only in a marginally significant two-way interaction with taxonomic relatedness, $F(1,106) = 4.14$, $p = .04$, $\eta_p^2 = .04$. Figure 3.12 shows that when pairs are taxonomically related, autistic participants gave a higher mean rating (*M* = 4.65) compared to control participants (*M* = 4.55) and when pairs were taxonomically unrelated, autistic participants gave a lower mean rating (*M* = 2.87) compared to control participants (*M* = 3.20). However, pairwise comparisons showed that none of these differences were statistically significant ($p > .05$).

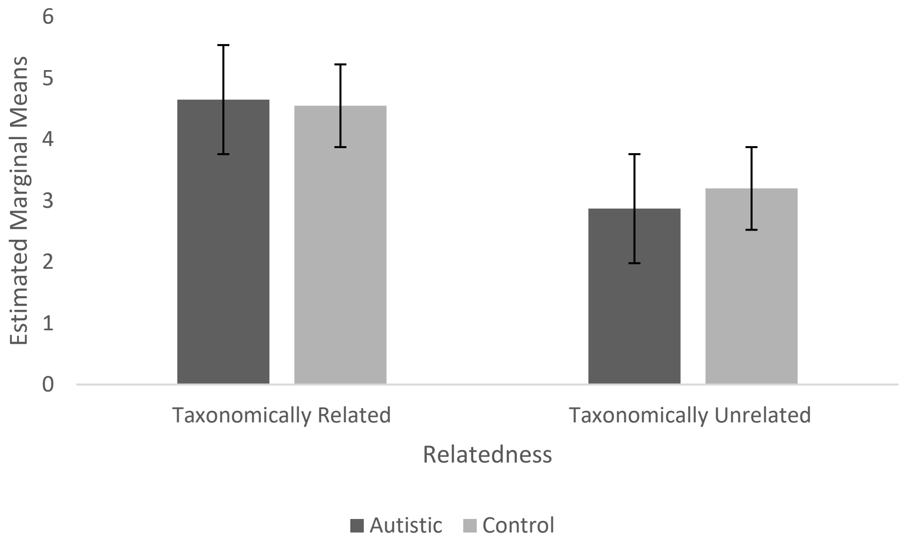


Figure 3.12. Estimated marginal means from autistic and control participants for taxonomic relatedness.

The same pattern of a significant 3-way interaction was found between ratings, taxonomic relatedness, and thematic relatedness, $F(1, 106) = 4.19$, $p = .04$, $\eta_p^2 = .04$. Figure 3.13 shows that when pairs were both taxonomically and thematically related, there was higher mean rating for similarity ($M = 4.65$) compared to when rating difference ($M = 4.49$) for the A+T+ pair type. When pairs were taxonomically related but not thematically related, there was a lower mean rating for similarity ($M = 4.59$) compared to difference rating ($M = 4.67$) for the A+T- rating. Ratings of similarity were higher for pair types that were taxonomically unrelated but thematically related (A-T+) ($M = 3.98$) compared to difference ratings ($M = 3.64$), with pairwise comparisons showing this difference to be statistically significant ($p = .02$)

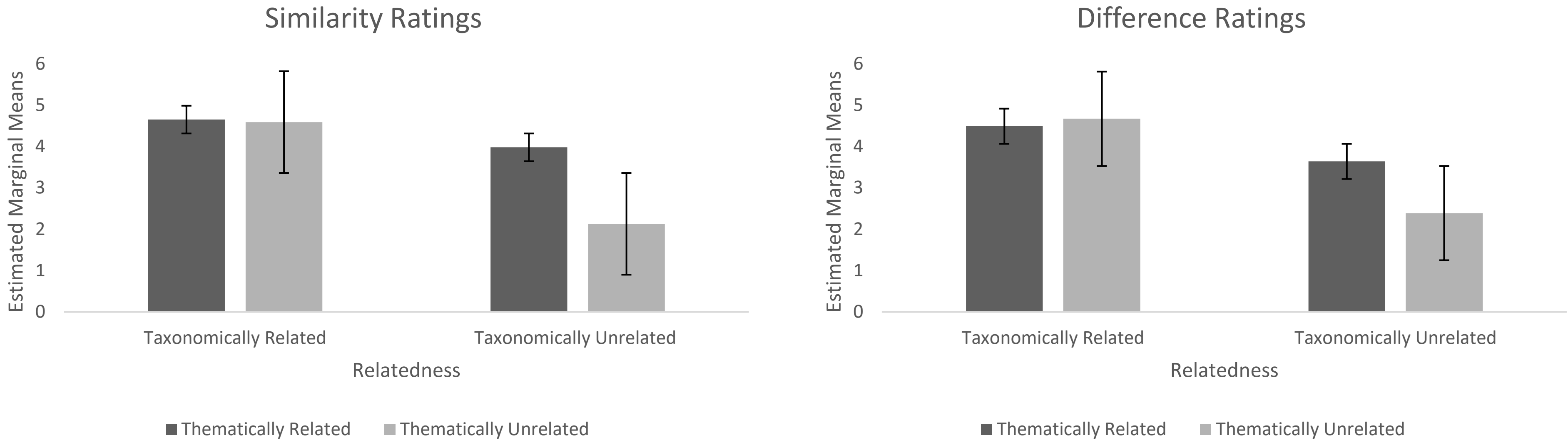


Figure 3.13. Estimated marginal means for all pair types across the similarity and difference conditions.

Anxiety, Intolerance of Uncertainty and Sensory Sensitivity

Independent sample t-tests were conducted on the scores for general anxiety (GAD), intolerance of uncertainty (IUS) and sensory sensitivity (SHS).

Significantly higher self-reported scores of general anxiety (GAD) were found in the autistic group (M = 11.77) compared to the control group (M = 8.16), $t(106) = 3.16$, $p < .001$, $d = .61$, one-tailed. Scores between 0-4 indicate minimal anxiety, 5-9 mild anxiety, 10-14, moderate anxiety, and scores greater than 15 are indicative of severe anxiety. The autistic group also reported higher scores of Intolerance of Uncertainty (M = 46.30) than the control group (M = 34.75), $t(106) = 5.78$, $p < .001$, $d = 1.11$, one-tailed and higher scores of sensory sensitivity (M = 88.37) compared to the control group (M = 76.39), $t(106) = 4.73$, $p < .001$, $d = .92$, one-tailed.

Correlations between measures

Correlation analyses were conducted to see whether AQ-10 and RAADS-14 scores and other autistic traits, such as anxiety, intolerance of uncertainty, and sensory sensitivity, correlated with participants' performance. See Table 3.15 for a correlation matrix.

Table 3.15.

Correlation matrix showing relationship between five measures: AQ-10, RAADS-14, GAD, IUS, and SHS.

Measures	1. AQ-10	2. RAADS-14	3. GAD	4. IUS	5. SHS
1. AQ-10	-				
2. RAADS-14	.81**	-			
3. GAD	.44**	.46**	-		
4. IUS	.55**	.63**	.70**	-	
5. SHS	.52**	.53**	.33**	.57**	-

** Correlation is significant at the 0.01 level

There was one significant *negative* correlation between GAD scores and difference ratings for A+T-, $t(106) = -.22$, $p = .02$. See Figure 3.15. The higher the reported level of anxiety, the lower the difference ratings for the pairs sharing only a taxonomic relationship (A+T-) i.e. the more different these items were judged to be from each other.

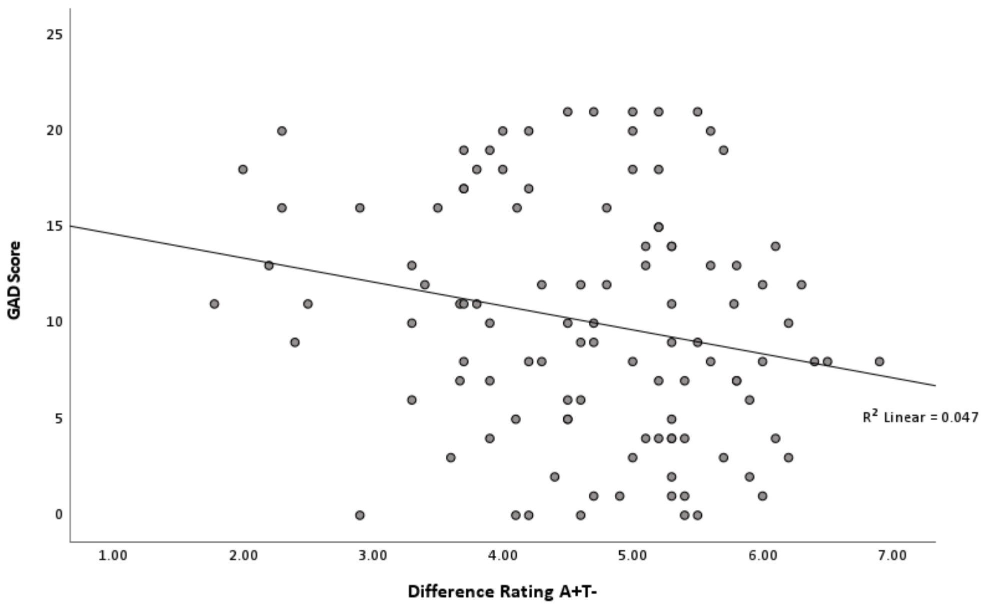


Figure 3.15. Significant negative correlation between measures of general anxiety and difference ratings for A+T-.

3:8 Discussion

The aim of this study was to investigate how autistic and control participants make similarity and difference ratings when the same participants are asked to rate *both* similarity and difference. As with the previous study, the results showed that pairs that are taxonomically related or thematically related are given higher mean ratings compared to pairs that are not taxonomically related or not thematically related. In the similarity condition compared to the difference condition, pairs that were thematically related received higher mean ratings. This finding suggests an overall pattern of non-inversion whereby pairs that are rated as very similar are not necessarily rated as being very different. When pairs were not thematically related, there was no difference between similarity and difference ratings. The relationship between taxonomic and thematic relatedness found that a higher mean rating was given to pair types when they were taxonomically related but not thematically related, compared to both taxonomically and thematically related, and a higher mean rating was given to pair types that were thematically related but not taxonomically related, compared to those neither taxonomically nor thematically related.

Pairs that were both taxonomically and thematically related received higher mean ratings in the similarity condition compared to the difference condition. If pairs were taxonomically related but not thematically related, they received a lower similarity rating compared to the difference rating. Given that pairs that share a taxonomic relationship tend to be more alignable, the noticing of shared features also offers the opportunity to find more differences through comparison. When pairs were thematically related but not taxonomically related, there was a higher mean rating for similarity compared to difference, and when pairs were neither taxonomically nor thematically related, there was a lower mean rating for similarity compared to difference.

As expected, the autistic participants had higher self-reported levels of general anxiety, intolerance of uncertainty, and sensory hypersensitivity compared to the control group. Interestingly, levels of general anxiety were significantly negatively correlated with difference ratings for the A+T- pair, which is consistent with our expectation that autistic people who experience high levels of anxiety are more likely to notice differences. This relationship suggests that the higher the anxiety, the more likely participants were to rate differences between pairs that were taxonomically related but not thematically related. No such correlation was observed between levels of anxiety and difference ratings for the A+T+ rating, suggesting that higher anxiety does not necessarily correlate with higher difference ratings when pairs are both taxonomically and thematically related. Correlation analyses also confirmed that high levels of autistic traits, as measured by the AQ-10 and RAADS-14, are associated with high levels of anxiety, intolerance of uncertainty, and sensory sensitivity, suggesting that these traits are particularly prominent in this group and could be considered stable characteristics in autism.

In this study, autistic participants performed in a similar way to control participants when rating similarity and difference (i.e., the significant 3-way interaction between autism, ratings, and thematic relatedness was not found). Overall, when pairs had a clear taxonomic or thematic relationship, they were given higher ratings than when they did not. In particular, pairs that were thematically related were given higher similarity ratings. However, there was no difference between similarity and difference ratings in pairs that were thematically unrelated. Unlike in the previous experiment, which identified a subset of autistic participants who gave very low ratings for pairs that were thematically related but not taxonomically related, no such group was identified in this experiment. One explanation for this is that, although an attempt was made to reduce the likelihood that the participants would adjust their similarity or difference ratings by presenting them in blocks, participants were aware from the instructions that they would be rating the same pairs twice, which possibly resulted in demand characteristics.

Experiment 3 repeated Experiment 2 but within-subjects. It was anticipated that a similar subgroup would be found in order to establish whether their difference ratings were higher than the controls. However, no such subgroup was identified. If the reason for this was the demand characteristics discussed earlier, further attempts using this task in its current form would not be helpful. Given that a large proportion of the participants, both autistic and non-autistic, stated that their main strategy when making ratings was “I just went with a feeling of similarity and picked a number on the scale that reflected that feeling”, it may be that future studies should consider an alternative response. A commonality and difference ‘listing’ task (as used by Wisniewski & Bassok, 1999) could replace the rating scales and better reflect the thoughts of participants.

The next study aimed to use a different methodology to assess potential hypersensitivity to difference in autistic participants. Since forming categories is a matter of grouping items together on the basis of similarity to other members of the same category and difference to members of other categories, the following chapter reports the use by autistic participants and controls on a long-standing ‘test’ of categorisation, a card sort task using both familiar and unfamiliar stimuli.

CHAPTER FOUR – Card Sort

4:1 Experiment 4 – Introduction

There are several theories surrounding the ways in which people form categories. Categories are the real-world referent of concepts (i.e., mental representations). One such theory is prototype theory, which suggests that people categorise objects or things based on a mental representation of a typical example of that category (Rosch, 1973). For example, a robin may be seen as a more prototypical example of ‘birds’ than a penguin. The more closely something fits with the prototype, the more likely it is to be categorised in that group. In contrast, exemplar theory suggests people categorise based on several previously encountered examples (Medin & Shafer, 1978). Exemplar theory allows the development of more distinct categories by considering the variations within a category. For example, when trying to categorise a type of bird, it may share some features of one bird and some features of another bird, but also several differences which make it different enough to form its own category. Finally, the family resemblance theory of categorisation suggests that there are no clearly defined features within categories, and instead, there are various overlapping similarities between members (Rosch & Mervis, 1975; Medin et al., 1987).

Given that previous research has highlighted that autistic people tend to focus on local over global processing and may have a reduced sensitivity to contextual information (Frith, 1989; Vermeulen, 2015), several studies have been conducted to examine how this may impact the way in which autistic people form categories. When looking at prototype formation in autism, the findings have been mixed with some studies suggesting there may be a difficulty with prototype formation. Klinger and Dawson (2001) found that if category learning could be solved using a rule-based approach (e.g., this is stimuli ‘x’. All stimuli ‘x’ share ‘y’ feature), both autistic and control participants could learn the new category. However, when the task involved no clear rules (e.g., participants were not told of a rule that they could apply to form categories), the autistic participants were not able to abstract prototypes to form a new category. Gastgeb et al. (2012) further supported this and found that autistic participants had difficulty forming prototypes and categorising dot patterns. In their study, participants were presented with a series of dot patterns consisting of the prototype, low distortion patterns, high distortion patterns, and patterns that were high distortion but of a different prototype. Participants were required to indicate whether a dot pattern presented was a member of a category seen previously by clicking either a “Yes” or “No” button. It was found that control participants performed better than autistic participants across all dot pattern types, with autistic participants showing significantly poorer performance with high distortion patterns compared to the control group. One suggestion from this study is that autistic participants have ‘fuzzy category boundaries’ leading to difficulty categorising information that is less typical of a category.

However, in another study using dot patterns by Froehlich et al. (2012), autistic participants were found to perform similarly to a control group, though it was found that autistic participants could categorise a pattern more easily when it was less distorted vs highly distorted compared to the prototype, suggesting that prototype formation when categorising dot patterns is intact in autistic people, but that there may be a difficulty in generalising what was learned about a category to new stimuli (Froehlich et al., 2012). These findings suggest that, for autistic participants, there may be a greater reliance on rules and specific examples they have encountered previously (exemplar theory) for successful category formation. Other studies that have used perceptual stimuli have found that autistic participants perform similarly to control participants but that they take significantly longer to learn the categories (Bott et al., 2006; Soulières et al., 2011). A possible explanation for the slower categorisation process is the finding that, alongside difficulties with prototype formation, autistic participants are also less likely to use overall similarity in the way suggested by the family resemblance theory. As a result, autistic participants are more likely to form ‘hyper-specific representations’ focusing on details. As such, this will likely impact the speed at which autistic participants form categories and the ability to generalise to new stimuli (Church et al., 2010).

Card sort tasks have been used previously with autistic participants but mainly with children and using stimuli suitable for perceptual and not conceptual discrimination (e.g., groupings made by shape or colour). These card sorts were usually directed by a rule that was either told to participants or that they had to learn through feedback. Often, the focus of the investigation has been the child’s ability to switch from one rule to another (Dichter et al., 2010; Li Yi et al., 2012; Reed et al., 2011; Reed, 2018). In contrast to this, the aim of this study was to see how adult autistic participants form categories (which typically rely on grouping items based on similarity) using non-perceptual stimuli in free card sorting tasks (i.e., no rule provided and no feedback).

For the first task, participants were shown a list of 25 items and asked to group them in whichever way they felt was best. This task included a taxonomic-thematic cross-categorisation, whereby it was possible for participants to make taxonomic categories (based on shared features), thematic categories (based on situation or context), or a mixture of the two (features and context). It was expected that the autistic participants would create more taxonomic categories over thematic categories compared to the control group due to the autistic group's reduced use of contextual information, as discussed in Chapter 1 (Vermeulen, 2015). It was decided to also examine the categorisation of stimuli that were not in themselves already familiar categories, but were also not perceptual, as in the case of dot patterns or artificial creatures. The second task used 34 ‘personal constructs’ as stimuli. Personal constructs were proposed by George Kelly (1955) as representing the ways in which people discriminate between all elements of their environment, their primary role being to support ‘anticipation’. Constructs are bipolar in that they have two contrasting poles, such as ‘extrovert -v- introvert’. When ‘categorising’ constructs, there are many ways in which they could be seen as similar, as there are no pre-determined categories. Overall, it was expected that the autistic participants would make more categories, with fewer items in each, than the control participants, as categories were less likely to be formed based on overall similarities (such as sharing one pole) and instead separated by their differences.

4:2 Methods

4:2:1 Participants

A total of 70 participants (*M* = 37.43, *SD* = 12.63, range = 18-64) took part in the study. Twenty-four participants had a formal diagnosis of Autism Spectrum Condition, 9 participants stated they were self-diagnosed/awaiting assessment, and 37 participants indicated they were not autistic. Of the autistic group (including self-diagnosed/awaiting assessment), 18 identified as male, 13 identified as female, and 2 as ‘other’. The remaining 37 participants formed the control group consisting of 20 males and 17 females (see Table 4.1). The autistic and control participants were recruited via Prolific Academic.

Table 4.1.

Participants’ demographic information.

	Autistic (*N* = 33)	Control (*N* = 37)
Mean age	33.28 *(11.27)*	41.03 *(12.79)*
Gender split		
Male	18	20
Female	13	17
Other	2	-
Mean AQ-10 score	7.33 *(2.13)*	2.57 *(1.74)*
Mean RAADS-14 score	31.48 *(7.40)*	9.81 *(7.42)*

Using G*Power, an a-priori power analysis was conducted based on a 2 x 2 mixed design (f = .18, α = .05, 1 – β = .8) which calculated a total minimum sample size of 66 participants. Weak effects have been reported in the previous experiments in this programme of work; however, Shipp et al. (2021) found strong effects between thematic and taxonomic choices between autistic and control participants. Given that there are mixed findings relating to effect size, the effect size for this study was calculated by using η^2 = .03 (weak-moderate effect).

4:2:2 Design

The study used a mixed design with group status (autistic vs control) as the independent, between-subjects variable. For the first task only, the within-subjects factor was the group type (taxonomic vs thematic). The dependent variable was the mean number of categories created by the autistic and control participants.

4:2:3 Materials

The stimuli used in the first categorisation task were chosen by the experimenter to allow for the possibility of creating either taxonomic (Professions, Food, Drinks, Vehicles, Clothing) or thematic categories (Beach, Wedding, Christmas, Restaurant, Party). For example, participants may group ‘water’, ‘champagne’, ‘eggnog’, ‘wine’, and ‘lemonade’ and label the category as ‘drinks’ (taxonomic categorisation). Alternatively, participants may group the words ‘lifeguard’, ‘ice cream’, ‘water’, ‘boat’ and ‘bikini’ and label the category as ‘beach’ (thematic categorisation). Participants saw the list of items (*N* = 25) within the table and not the taxonomic and thematic category labels (See Table 4.2).

The second categorisation task used 34 constructs (e.g., a pole with two contrasting words, such as ‘extrovert -v- introvert’)**.** For a list of all constructs used, see Table 4.3. Constructs are typically used in research within Personal Construct Psychology, but unlike in the first task, there were no specific expectations on the part of the experimenter regarding the sort of groupings that would be made.

Participants completed the Autism Quotient 10 (AQ-10; Allison et al., 2012) and Ritvo Autism & Asperger Diagnostic Scale (RAADS-14; Eriksson et al., 2013) to allow for assessment of the homogeneity of the autistic sample. Participants also completed the Generalised Anxiety Disorder 7-Item Scale (GAD-7; Spitzer et al., 2006), Intolerance of Uncertainty Short Form Scale (IUS-12; Carlton et al., 2007), and Sensory Hypersensitivity Scale (SHS; Dixon et al., 2014).

Table 4.2.

Items included for Task 1.

	Beach	Wedding	Christmas	Restaurant	Party
Professions	Lifeguard	Vicar	Santa	Waitress	Entertainer
Food	Ice cream	Cake	Mince pies	Steak	Sandwiches
Drinks	Water	Champagne	Eggnog	Wine	Lemonade
Vehicles	Boat	Limousine	Sleigh	Taxi	Car
Clothing	Bikini	Suit	Jumper	Jacket/tie	Fancy dress

Table 4.3.

Constructs included for Task 2.

Cautious -v- Reckless	Careful -v- Selfish
Safe -v- Not Safe	Anxious -v- Not Anxious
Obedient -v- Reckless	Obedient -v- Delinquent
Antisocial -v- Friendly	Careful -v- Unorganised
Liking Order -v- Unpredictable	Uncaring -v- Compassionate
Silly -v- Sensible	Sensible -v- Reckless
Careful -v- Careless	Conformity -v- Rebellion
Reasonable -v- Nonsensical	Selfish -v- Caring
Friendly -v- Ruse	Responsible -v- Irresponsible
Nonconformist -v- Conformist	Reasonable -v- Not Reasonable
Uncaring -v- Empathetic	Obedient -v- Disobedient
Authoritarian -v- Non-authoritarian	Follows the Rules -v- Breaks the Rules
Caring -v- Narcissistic	Approachable -v- Abrupt
Dutiful -v- Lazy	Unproblematic -v- Troublemaker
Disregardful -v- Sympathetic	Laidback -v- Uptight
Powerful -v- Powerless	Compliant -v- Lawless
Consistent -v- Ambiguous	Helpful -v- Selfish

4:2:4 Procedure

Participants completed the study online using Qualtrics and KardSort (an online card-sorting platform). For the first sorting task, participants were shown the 25 items and asked to create categories, grouping the items that they felt go best together. Participants were told that they could make as many or as few categories as they liked and that there were no right or wrong answers. Participants were required to give the categories they had created a label. If participants wished to explain why they felt certain items went best together, there was a text box in which they could add additional comments. The same instructions were repeated for the second sorting task using the 34 constructs. For both tasks, participants self-paced. Due to the software used, the length of time spent on each task could not be measured. All participants completed the AQ-10, RAADS-14, GAD, IUS, and SHS on Qualtrics.

4:3 Results

The initial data set consisted of 70 participants. The data of three participants was removed for failure to adhere to task instructions. The final data analysis was conducted on the remaining 67 participants (24 autistic, 9 self-diagnosed/awaiting assessment, 34 control).

A one-way ANOVA was conducted to compare the mean AQ-10 scores between the autistic group, the self-diagnosed group, and the control group. There was a significant effect of group on AQ-10 scores, $F(2, 66) = 47.58$, $p < .001$, $\eta^2 = .60$ with a significant difference ($p < .001$) between the mean AQ-10 scores from the autistic group ($M = 7.33$) and the control group ($M = 2.59$). The difference between the self-diagnosed group ($M = 7.33$) and the control group was also significant ($p < .001$). There was no significant difference between the autistic group and the self-diagnosed group ($p = 1$).

A one-way ANOVA was conducted to compare the mean RAADS-14 scores between the autistic group, the self-diagnosed group, and the control group. There was a significant effect of group on RAADS-14 scores, $F(2, 66) = 72.66$, $p < .001$, $\eta^2 = .69$ with a significant difference ($p < .001$) between the mean RAADS-14 score from the autistic group ($M = 31.08$) and the control group ($M = 9.47$). The difference between the self-diagnosed group ($M = 32.56$) and the control group was also significant ($p < .001$). The difference between the self-diagnosed group and the autistic group was not statistically significant ($p = 1$). Given that the self-diagnosed group scored highly on both the AQ-10 and RAADS-14 and that the autistic and self-diagnosed groups were not statically different from each other but were both significantly different from the control group, it was decided that the self-diagnosed group ($N = 9$) would be added to the autistic group ($N = 24$).

An independent samples t-test found that the difference in mean AQ-10 scores between the autistic ($M = 7.33$) and control group ($M = 2.59$) was statistically significant, $t(65) = 9.83$, $p < .001$, $d = 2.4$, one-tailed. An independent samples t-test found that the difference in mean RAADS-14 scores between the autistic ($M = 31.48$) and the control group ($M = 9.47$) was statistically significant, $t(65) = 12.11$, $p < .001$, $d = 2.96$, one-tailed. Therefore, the autistic group had higher self-reported levels of autistic traits on both measures.

The mean number of categories made for both the category card sort and the constructs card sort can be seen in Table 4.4. An independent samples t-test found that the mean difference in number of categories made for the category card sort between autistic participants (*M* = 4.82) and the control participants (*M* = 4.91) was not statistically significant, $t(65) = -.30$, $p = .77$, two-tailed. An independent samples t-test found that the mean difference in number of categories made for the constructs card sort between autistic participants (*M* = 3.15) and control participants (*M* = 2.62) was not significant, $t(65) = 1.63$, $p = .11$, two-tailed.

Table 4.4.

Mean number of categories in the category card sort and construct card sort made by autistic and control participants.

	Task 1 Named Categories	**Task 2 Constructs**
Autistic	4.82 (*SD* = 1.53)	3.15 (*SD* = 1.60)
Control	4.91 (*SD* = 1.00)	2.62 (*SD* = 1.02)

Task 1

Within the category card sort, the mean number of taxonomic and thematic categories (see Table 4.5) between the autistic and control participants was compared. Only two participants made a mixed category (e.g., a taxonomic item and a thematic item included under the same category label). A 2 (Group Status: Autistic vs Control) x 2 (Category Type: Taxonomic vs Thematic) ANOVA was conducted using Category Type as the within-subjects factor and Group Status as the between-subjects factor. The main effect of category type was statistically significant, $F(1, 65) = 117.98$, $p < .001$, $\eta_p^2 = .65$, with estimates of marginal means showing that overall, the mean number of taxonomic categories (*M* = 4.01) was greater than the mean number of thematic categories (*M* = .79). The main effect of autism was not statistically significant, $F(1, 65) = .33$, $p = .57$, and therefore there was no interaction between autism and category type, $F(1, 65) = .004$, $p = .95$.

Table 4.5.

Mean number of taxonomic and thematic categories made by autistic and control participants within the category card sort.

	Taxonomic	**Thematic**
Autistic	3.97 (*SD* = 1.88)	.73 (*SD* = 1.10)
Control	4.06 (*SD* = 1.46)	.85 (*SD* = 1.18)

The independent samples t-test analyses looking at the mean number of categories for the category card sort and construct card sort were re-rerun after removing any participants who made only one overall category in either the first card sort or the construct card sort, and all results were not significant.[10] There were no significant correlations between the number of categories made and any of the other measures completed by participants (AQ-10, RAADS-14, GAD-7, IUS-12, and SHS).

Task 2

Given that there were no expectations of any pre-determined categories for the constructs card sort compared to the category card sort that potentially prompted taxonomic and/or thematic categorisation, the data was explored further to investigate whether there was an overlap in the naming of categories (referred to as 'category labels') between autistic and control participants (e.g., how many categories were given the same name by both groups). Table 4.6 shows the construct category labels which overlapped between the two groups with a frequency of at least 5 in one of the groups[11] (i.e., five or more autistic *or* control participants generated the same category label name). The remaining category labels and frequencies (number of participants who used each category label) can be found in Appendix I. Across the autistic and control groups, a total of 73 category labels were generated. Of those labels, there were seven category labels that overlapped between the two groups, with a frequency of at least five or more in one of the groups. A further 15 category labels overlapped between the autistic and control groups, though for these labels, the frequency was less than 5 in either one of the groups. Thirty-two category labels were unique to the autistic group (43.84% as a proportion of the total number of category labels), and 19 labels were unique to the control group (26.03%). Participants were given the option to provide an explanation for their category labels. A total of 20 participants provided an explanation (10 autistic, 10 control; see Table 4.7), and it was found that the autistic participants provided a greater number of overall words in their explanations compared to the control participants (461 vs 306, respectively).

[10]Category card sort (Autistic: M = 5.07, (SD = 1.23); Control: M = 4.98, (SD = 1.06), p = .50)
Constructs card sort (Autistic: M = 3.37, (SD = 1.52); Control: M = 2.90, (SD = .82), p = .15)

[11]Except for the category label 'opposites' which was of interest as none of the autistic participants used this label despite the constructs having opposite poles suggesting that they were less inclined to offer a general category label.

Table 4.6.

Common category labels from both autistic and control participants.

	Autistic	**Control**
Personality	10	8
Behaviour	6	10
Emotion	6	4
Feelings	5	2
Social	5	5
Authority/obedience/rules	6	7
Opposites	0	9

Table 4.7.

Number of autistic and control participants who provided an explanation for their category labels and the overall number of words used.

	Autistic	**Control**
Number of participants who provided an explanation	10	10
Overall number of words in the explanations	461	306

Correlations

In the autistic group, there was a significant positive correlation between the number of taxonomic categories and AQ-10 scores: $r(31) = .46$, $p = .008$. The higher the number of taxonomic categories, the higher the level of self-reported autistic traits.

There was a significant negative correlation between the number of construct categories and GAD scores: $r(31) = -.38$, $p = .03$. The higher the number of construct categories, the lower the level of self-reported anxiety.

There were no other significant correlations in the autistic group.

In the control group, there was a significant negative correlation between the number of taxonomic categories and AQ-10 scores: $r(32) = -.36$, $p = .04$. The higher the number of taxonomic categories, the lower the level of self-reported autistic traits.

There was a significant negative correlation between the number of construct categories and IUS scores: $r(32) = -.38$, $p = .03$. The higher the number of construct categories, the lower the level of self-reported intolerance of uncertainty.

There were no other significant correlations in the control group.

4:4 Discussion

Typically, previous studies looking at category formation in autistic people have used perceptual stimuli (Church et al., 2010; Froehlich et al., 2012; Gastgeb et al., 2012); the purpose of this study was to investigate how autistic participants form categories when using non-perceptual card-sort tasks. It was expected that, overall, the autistic participants would make more categories across both card-sort tasks compared to the control group, as being hypersensitivity to difference would suggest that autistic participants are not using overall similarity to form categories but are instead focusing on differences between to-be-sorted items. However, there was no difference in the number of categories created between the groups for the first card-sort task or the constructs task. Within the first card-sort task, which facilitated the development of taxonomic or thematic categories, it was also expected that autistic participants were more likely to make taxonomic categories that rely on features compared to thematic categories with a contextual component. However, this was not found; there was no difference between the autistic and control groups in terms of taxonomic and thematic categories, suggesting that autistic participants formed categories similarly to control participants, with both groups demonstrating a preference for taxonomic categories over thematic ones. For autistic participants, the number of taxonomic categories significantly correlated with AQ-10 scores, with the higher the number of taxonomic categories, the higher the level of self-reported autistic traits. The number of construct categories was associated with lower levels of anxiety. However, in the control group, the number of taxonomic categories was *negatively* correlated with AQ-10 scores and the number of constructs was associated with lower levels of intolerance of uncertainty. In general, it appears that autistic participants, when categorising real-world concepts as opposed to dot patterns, form categories in a similar way to a control group. However, the standard deviations suggest a wider variance in performance among the autistic participants on both tasks compared to the control group.

Creating familiar stimuli for cross-classification limited the choice of items for this type of study, and no control for typicality was conducted. It is possible that within the thematic and taxonomic groups, some items are favoured as being more typical of one type. For example, it may be that lemonade has been for some participants encountered more often as a ‘drink’ than as something you have at a party. Frequency of instantiation (i.e., how often items are encountered as members of category) has been cited as accounting for unique typicality variance in categories (Barsalou, 1985). It is for this reason that ‘tests’ of categorisation are frequently conducted with artificial categories, but results from those studies to ‘real categories’ involving prior knowledge can not necessarily be generalised.

The card-sort task involving the constructs (e.g., a pole with two contrasting words such as ‘extrovert -v- introvert’) introduced an element of ambiguity, as potential emerging categories were less clear (unlike the first card-sort task, which were in themselves already categories and so the obvious groupings would be in an overarching item or event-based category). This was supported by the finding that many more category labels for the sorted constructs were created by both groups of participants. Although there was no significant difference in the mean number of construct categories created between the autistic and control groups, further analysis of the construct data revealed that autistic participants made more unique categories (that is, categories whose labels did not overlap with those created by the control group) compared to the control participants. This suggests three possibilities: 1) autistic participants placed a greater emphasis on the difference between constructs, leading to more category labels than the control group; 2) control participants are more likely to overgeneralise and therefore not differentiate between constructs; or 3) a combination of one and two. Six categories overlapped the autistic and control participants with a frequency of five or more. Those categories were: ‘Personality’, ‘Behaviour’, ‘Emotion’, ‘Feelings’, ‘Social’ and ‘Authority/Obedience/Rules’. Interestingly, despite findings that alexithymia (the inability to recognise, express, or describe emotions) is common amongst autistic individuals (Kinnaird et al., 2019), eleven references were made to ‘Emotion’ and ‘Feelings’ (combined) by the autistic group, compared to six from the control group. This suggests that autistic participants can recognise and effectively group together emotions (when presented as textual words over images) and, in turn, may suggest that they were incorporating contextual information given that categories such as ‘Emotion’ and ‘Feelings’ are abstract and conceptual.

One category of particular interest was the category ‘Opposites’. The frequency of this in the control group was nine, compared to zero in the autistic group. The constructs themselves constitute opposites[12]; however, none of the autistic participants used this category label, suggesting that they were less likely to use a general term that could encompass all the constructs. Lastly, participants were given the opportunity to provide an explanation for their category labels. A total of 20 participants provided an explanation (10 autistic, 10 control), though the explanations by autistic participants were overall longer (461 words) compared to the control participants (306 words). This suggests that autistic participants provide more detailed explanations compared to control participants and may expand existing literature on

[12] In the practice Personal Construct Psychology, one named pole of a construct is elicited first and then the client is asked to say what, for them, would be the opposite of that pole (Kelly, 1955).

the autistic proclivity for detail for perceptual stimuli (Jolliffe & Baron-Cohen, 1997; Shah & Frith, 1993) to include non-perceptual stimuli.

Since the items in task 1 were designed to be sorted in one of two ways, taxonomically or thematically, the finding that, among the autistic participants, the number of taxonomic categories was associated with relatively high levels of self-reported autistic traits suggests that it was easier to recognise feature-based properties over context. The other significant correlation within the autistic group was that the higher the number of construct categories that were created, the lower the level of self-reported anxiety. This could be interpreted as going against the role of hypersensitivity to difference, which would predict that high levels of anxiety would lead to the sorting of these novel constructs into many small categories since a basis of similarity was hard to find. It is also possible that faced with an overwhelming number of differences, those with relatively high levels of anxiety were unable to find a basis for categorisation and, therefore, in order to complete the task, created one or two categories with many items in, as illustrated by an autistic participant who stated in their justification for grouping all items into one category that they *"couldn't see how to differentiate between the word pairs"*.

Although performance in this task did not demonstrate the overall hypersensitivity to difference in the autistic participants in the way that was anticipated, there were some differences that emerged in the comparison to controls, particularly in the labelling of the categories and in the level of detail provided as to the reasons for those groupings. There were constraints on what else could be shown given that the task was conducted online, and this will be discussed further in Chapter 6.

CHAPTER FIVE – Virtual Reality Technology

5:1 Experiment 5 – Introduction

Virtual reality (VR) technology uses computer-generated images and objects to produce scenes and environments with which individuals can virtually interact. In a review of virtual reality technology, VR was found to have a wide range of applications, including in psychology research (Slater & Sanchez-Vives, 2016). It is thought that the use of VR technology may be particularly suitable for autistic people due to the opportunity to simulate a real-life situation but in a controlled manner and in an environment where the autistic individual feels safe (Parsons & Cobb, 2016). A case study exploring whether the use of VR would be beneficial in clinical practice noticed significant improvements when cognitive behavioural therapy (CBT) was performed in a virtual environment compared to face-to-face with a CBT therapist (De Luca et al., 2021). Several studies have explored the use of virtual reality technology with a view of 'improving social skills and functioning' (Kandalaft et al., 2012) or 'enhancing communication skills' (Bravou et al., 2022) in autistic individuals; however, little research has been conducted on using VR to specifically assess cognitive and perceptual skills in this group.

Given that the previous experiments outlined in this thesis have used artificial experimental tasks to investigate hypersensitivity to difference, this experiment aimed to conduct a small-scale pilot study to investigate the feasibility of using virtual reality technology as a potential methodology for investigating hypersensitivity to difference in autistic people. One possible advantage of such technology is the ability to increase the ecological validity of tasks to assess cognitive processes more accurately. To do this, a virtual environment was created in which changes were made with the suggestion that participants with high autistic traits would implicitly notice more changes than the low autistic traits group.

5:2 Methods

5:2:1 Participants

Eleven participants (*M* = 28.82, *SD* = 7.79, range = 21-49) took part in the pilot study. Five of the participants identified as male, five as female, and one participant indicated that they would prefer not to say. Due to ethical concerns around the task, autistic individuals were not recruited. Instead, participants from the general population were recruited and completed measures of autistic traits to separate them into high and low autistic traits groups. To determine whether participants were in the 'high' or 'low' autistic traits group, participants completed the Autism Quotient 10 (AQ-10; Allison et al., 2012) and Ritvo Autism & Asperger Diagnostic Scale (RAADS-14; Eriksson et al., 2013). By scoring above the threshold in at least one of the measures (6 or more for the AQ-10, fourteen or more for the RAADS-14), 5 of the participants made up the ‘high’ autistic traits group, with the remaining 6 participants forming the ‘low’ autistic traits group (See Table 5.1 for descriptive statistics). All participants were recruited via advertising on campus at the University of Hertfordshire. The advert stated that the researcher was looking for participants from the *general population* to take part in a study using virtual reality technology.

An independent samples t-test was conducted to compare the mean AQ-10 and RAADS-14 scores between the high and low autistic traits groups. The results showed that the difference between the mean AQ-10 scores between the high autistic traits group (M = 6) and the low autistic traits group (M = 3) was not statistically significant, $t(8) = 1.47$, $p = .18$, $d = .93$, two-tailed. Therefore, there was no difference between the two groups using the AQ-10 as a measure of autistic traits. The difference between the mean RAADS-14 scores between the high autistic traits group (M = 24) and the low autistic traits group was statistically significant, $t(4.43) = 3.32$, $p = .03$, $d = 2.10$, two-tailed (equal variances not assumed). Therefore, there was a difference between the two groups in terms of autistic traits when using the RAADS-14 as a measure of such traits.

Table 5.1.

Descriptive statistics relating to low and high autistic traits groups.

	High autistic traits (*N* = 5)	**Low autistic traits (*N* = 6)**
Mean age *(SD)*	32.40 *(10.95)*	25.83 *(3.76)*
Gender split		
Male	1	4
Female	3	2
Prefer not to say	1	-
Mean AQ-10 score *(SD)*	6.00 *(3.00)*	3.60 *(9.46)*
Mean RAADS-14 score *(SD)*	24.00 *(9.46)*	9.60 *(3.67)*

5:2:2 Design

The study used a between-subjects design. The independent variable was group status (high vs low autistic traits), and the dependent variable was the mean number of changes detected using virtual reality technology.

5:2:3 Materials

A virtual reality simulation of the psychology lab at the University of Hertfordshire was created to be viewed within the virtual reality headset (see Figures 5.1, 5.2, 5.3, and 5.4 for comparisons between the original virtual reality room and the virtual room following changes, from all four sides of the room). A total of 15 changes were made that covered five different change types (colour change, location change, removal of objects, addition of objects, and content changes; see Table 5.2 for a list of all changes).

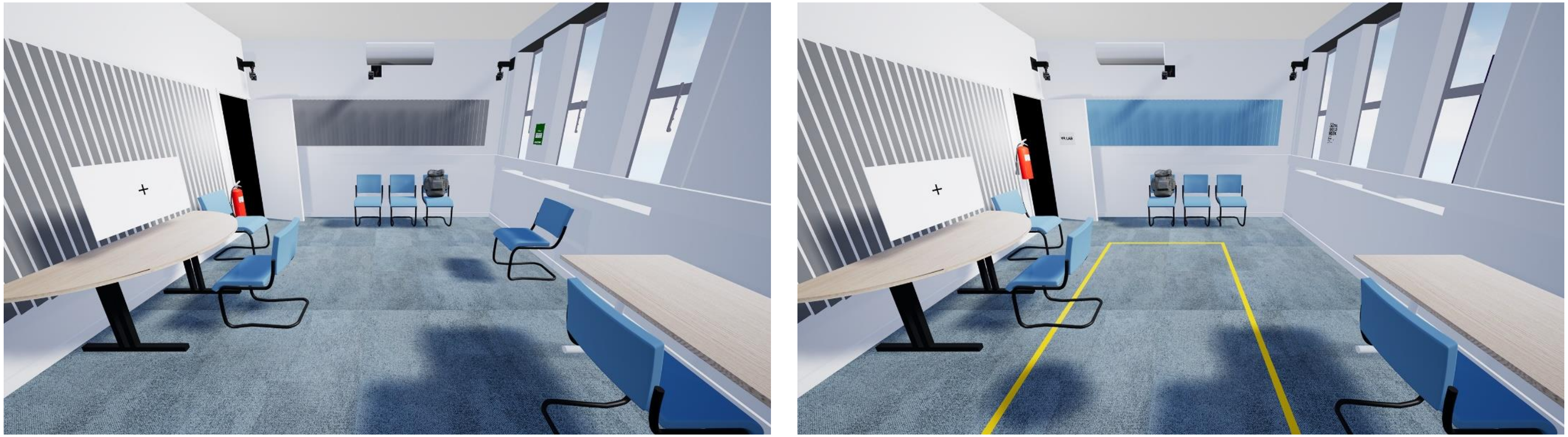


Figure 5.1. Side 1 – before and after changes (left to right)

Figure 5.2. Side 2 – before and after changes (left to right)

Figure 5.3. Side 3 – before and after changes (left to right)

Figure 5.4. Side 4 – before and after changes (left to right)

Table 5.2.

Types of changes made to virtual reality room.

Change type	**Example**
Colour	Change colour of blinds
	Change colour of green board
	Orange makers on carpet
Location	Move air conditioning unit
	Move fire extinguisher
	Move bag to different chair
Remove	Remove two (motion-capture) cameras
	Remove handles from windows
	Remove chair by window
Add	UH logo to wall outside virtual window
	Add a clock
	Add a sign to the door
Content	Change existing first aid sign
	Change content on large screen
	Change content on small screen

Participants completed the Autism Quotient 10 (AQ-10; Allison et al., 2012) and Ritvo Autism & Asperger Diagnostic Scale (RAADS-14; Eriksson et al., 2013) to classify participants into two groups: 'high' vs 'low' autistic traits. Participants also completed the Generalised Anxiety Disorder 7-Item Scale (GAD-7; Spitzer et al., 2006), Intolerance of Uncertainty Short Form Scale (IUS-12; Carlton et al., 2007), and Sensory Hypersensitivity Scale (SHS; Dixon et al., 2014). An Edu-Logger was used during three points in the experiment to take a real-time anxiety reading. This was done by placing small sensors on each participant's fingers.

5:2:4 Procedure

Each participant was tested separately. To begin, the participant was taken to a quiet room to complete demographic information such as age, gender, and education level on Qualtrics. All participants also completed the AQ-10, RAADS-14, GAD, IUS, and SHS. Following this, the participant was taken to the VR Lab and asked to take a seat. A baseline anxiety measure was collected using the Edu-Logger, which involved placing small sensors on the tip of the participant's fingers. A VR technician was present during the testing to explain the headset to the participant. When the participant was ready, they were asked to put the headset on, and they were guided into the VR room to the centre (the centre of the virtual room was identical to the centre of the real room). Participants were asked to spend two minutes looking around to acclimate to the virtual reality environment. This was done not only to assess whether participants experienced VR sickness but also to encourage them to look around the environment in preparation for the later changes. After two minutes, participants were guided back to a seat and were given verbal instructions on completing a lexical decision-making task as a distractor, in which they were presented with a randomly selected single word on the virtual reality screen and asked to verbally state whether each word was a real-word or a non-word. For a list of all words used, see Appendix J. Participants were then told that another participant might be present within the virtual reality environment during the task; however, this was not the case but was intended to imitate a natural environment more similar to a real-life scenario where unexpected changes occur all the time, thus potentially inducing a level of 'real-world' anxiety. At this point, a second real-time anxiety measure was taken. Once participants had completed the lexical decision-making task, they were asked to stand up and return to the centre of the room. Participants were told to spend a further two minutes looking around the room before removing the headset, again to encourage them to look around the environment following the changes made. Once each participant had removed the headset, they were asked whether they had noticed any changes to the virtual environment in the second look-around compared to the first. The participants verbally stated the changes they had noticed, and the researcher recorded the responses. A final real-time anxiety measure was taken, and the participant was taken back to a quiet room to take part in a short interview, which formed part of an extended debrief (see Appendix K for transcripts of the interviews, including the interview questions).

5:3 Results

The initial data set consisted of eleven participants. It transpired that one participant had been aware of certain details of the study before taking part, and so their data was removed. The final data analysis was conducted on the remaining 10 participants (5 in the high autistic traits group and 5 in the low autistic traits group).

The mean number of changes detected by the high and low autistic traits group can be seen in Table 5.3. An independent samples t-test found that the difference in mean number of changes between the two groups was not statistically significant, $t(8) = -.97$, $p = .36$, $d = -.62$, two-tailed. There was no difference between the two groups in terms of number of changes detected. Further analysis was conducted to examine the mean number of changes by change type between the high and low autistic traits groups (see Table 5.4). Four t-tests were carried out to analyse each of the pairs, and the alpha level was adjusted accordingly

($\alpha = .0125$).[13] None of the independent samples t-tests for the colour, location, add, and content change types between the high and low autistic traits groups were significant ($p > .01$).

Table 5.3.

Mean number of changes detected by high and low autistic traits group.

High autistic traits (*N* = 5)	**Low autistic traits (*N* = 5)**
7.40 (*SD* = 2.07)	8.60 (*SD* = 1.82)

Table 5.4.

Mean number of changes by change type in high and low autistic traits groups.

	High autistic traits (*N* = 5)	**Low autistic traits (*N* = 5)**
Colour	2.20 (*SD* = .45)	2.20 (*SD* = .45)
Location	1.75 (*SD* = .96)	1.20 (*SD* = .45)
Remove	-	1.00 (*SD* = .00)
Add	2.00 (*SD* = 1.00)	2.00 (*SD* = .71)
Content	1.80 (*SD* = .71)	2.40 (*SD* = .89)

A breakdown of the changes found by individual participants can be seen in Table 5.5. The type of change that was most difficult to detect for both groups, in terms of frequency, were changes involving the removal of objects, suggesting that this type of change was particularly difficult to spot. More of the low autistic traits group found all the content changes compared to the high autistic traits group. Both groups were equally as good at detecting changes that involved the addition of objects. Performance for colour and location changes was similar between the two groups.

[13] A t-test was not carried out for the 'remove' change type as none of the participants in the high autistic traits group found any of the changes within this change type.

Table 5.5.

Number of changes detected broken down by change type for high and low autistic traits groups.

		High autistic traits					Low autistic traits				
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Colour	Blinds	✓		✓	✓	✓		✓			
	Green board	✓	✓		✓	✓	✓	✓	✓	✓	✓
	Marker		✓	✓		✓	✓	✓	✓	✓	✓
Location	AC unit			✓					✓		
	Fire extinguisher			✓	✓		✓	✓			✓
	Bag	✓	✓	✓	✓				✓	✓	
Remove	Cameras						✓			✓	✓
	Window bars							✓			
	Chair										
Add	UH logo	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Clock		✓	✓				✓			✓
	VR lab sign		✓	✓	✓			✓	✓	✓	✓
Content	First aid sign	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Large screen	✓	✓	✓		✓		✓	✓	✓	✓
	Laptop			✓				✓	✓	✓	

On the self-report measure of general anxiety, the mean difference between the high autistic traits group (*M* = 7.40) and the low autistic traits group (*M* = 6.60) was not statistically significant, *t*(8) = .41, *p* = .69, *d* = .26, two-tailed. During the experiment, three 'real-time' anxiety measures were taken: a baseline measure before the start of the study, a measure after the introduction of an unexpected change, and a final measure at the end of the study. Table 5.6 shows the mean anxiety measures for the high and low autistic traits group during the three points the anxiety measure was taken. Independent samples t-tests were conducted to compare the mean real-time anxiety measures between the two groups and each point (1, 2, and 3); however, none were significant (*p* > .05 in all cases).

Table 5.6

Mean real-time anxiety measures at points 1, 2, and 3 between the high autistic traits and low autistic traits groups.

	High autistic traits (*N* = 5)	**Low autistic traits (*N* = 5)**
Anxiety 1	64.89 (*SD* = 21.08)	83.54 (*SD* = 13.23)
Anxiety 2	67.76 (*SD* = 6.66)	91.76 (*SD* = 37.41)
Anxiety 3	71.76 (*SD* = 11.69)	69.71 (*SD* = 11.38)

The difference in mean intolerance of uncertainty self-report score between the high autistic traits group (*M* = 38.40) and the low autistic traits group (*M* = 30.40) was not statistically significant, *t*(8) = 1.20, *p* = .26, *d* = .76, one-tailed. The difference in mean sensory hypersensitivity self-report score between the high autistic traits group (*M* = 92.00) and low autistic traits group (*M* = 63.00) was statistically significant, *t*(8) = 3.84, *p* = .005, *d* = 2.43, two-tailed, with the high autistic traits group reporting higher levels of sensory sensitivity compared to the low autistic traits group.

Correlations

There was a significant negative correlation between IUS and number of changes detected, *r*(8) = -.64, *p* = .05. The higher the intolerance of uncertainty score, the fewer changes detected.

Interview data

In order to gain a better understanding of whether VR technology could be a suitable type of methodology for use in the future with autistic participants, the interview transcripts from the low and high autistic traits groups were examined. Overall, nine participants (total *N* = 10) stated that using the VR headset matched their expectations of using the technology. One participant stated that the VR room was much brighter and clearer than real life. All participants enjoyed using the headset. Participants reported to have particularly enjoyed the novelty of the experiment, the immersive experience, that the VR room was the same as the real room, and that the VR headset precisely tracked the participant's movements (again, this was because the VR room was an exact replica of the real room participants had entered at the start of the experiment). Common reasons for disliking the VR headset included that it was difficult to wear if the participant also wore glasses, sensory issues around the feeling of the headset on the participant's face (the material was described as sticky and hot on the skin), the headset was heavy, and the screen appeared pixelated/grainy (newer models of VR headsets have improved this). Participants were reminded that measures of anxiety were taken during the study and asked whether there were any other points in the experiment where they felt particularly anxious. Most participants did not report feeling anxious at any other point in the study. One participant stated that they felt anxious at the start of the study, and another participant expressed some anxiety about their performance on the word task. All participants reported that they had been comfortable with the non-invasive measures of anxiety. Nine of the ten participants stated that they *did not* anticipate that there would be changes made to the virtual environment following the word task and that detecting the changes did not necessarily produce any negative emotions. Detecting the changes was described by participants as being surprising, fun, and satisfying.

5:4 Discussion

This pilot study aimed to investigate the use of virtual reality technology with an autistic sample with a view to establishing whether this could be used as a technique for assessing real-world hypersensitivity to difference. There were no significant differences between the high and low autistic traits groups in the number of changes detected or the type of changes detected. Furthermore, unlike in previous experiments, the high and low autistic traits groups experienced similar levels of self-reported and real-time anxiety levels and self-reported intolerance of uncertainty. This suggests that despite the groups differing at trait level on one of the measures (RAADS-14), the high autistic traits group would not necessarily meet the clinical threshold for diagnosis. A significant negative correlation emerged between intolerance of uncertainty scores and the number of changes detected, suggesting that high levels of intolerance of uncertainty were associated with a reduction in the number of changes detected. Given the link between intolerance of uncertainty and anxiety, this finding is in contrast with the proposed theory, which suggests that high anxiety, which leads to intolerance of uncertainty, is related to hypersensitivity to difference. There was a significant difference in sensory hypersensitivity scores, with the high autistic traits group reporting higher levels of sensory sensitivity than the low autistic traits group.

Despite the benefits of virtual reality technology in increasing the ecological validity of tasks, it is important to note that it is still unable to replicate real life completely. For example, the ability to interact with objects and sensory experiences differ in virtual reality. Although participants were not informed that there would be changes to be found, it was still evident to them, based on their responses in the interview, that they were taking part in an experimental task, and therefore, there were no real-life consequences to not detecting changes. This could also explain why there was no significant difference between the two groups in terms of anxiety levels. In particular, it was expected the high autistic traits group to experience a higher real-time anxiety measure after they were presented with an unexpected change (e.g., there would be another participant present taking part in the virtual reality study); however, again, there was no difference between the two groups suggesting that changes to an experimental setting may not induce the same level of anxiety for autistic people, compared to when they occur in real life. In fact, most participants reported that there were not any specific points in the experiment where they felt anxious and that the VR headset was what they expected it to be. Interestingly, a positive of the VR headset noted by participants was that it replicated the real-life room and precisely tracked movements. This likely provided a sense of familiarity to the participants and may explain why the anxiety levels between the high and low autistic traits groups were not significantly different. All participants reported having enjoyed the study using VR; however, an important consideration for further use with an autistic sample is the potential sensory challenges associated with wearing the VR headset. Although the task has not shown the effects in this study, both the very small sample size and the absence of any formally diagnosed or self-diagnosed autistic participants means that it is difficult to draw any firm conclusions about how a wider group of autistic participants would respond. It is still the case that VR technology may offer an opportunity to test for hypersensitivity to difference in a setting that is closer to a real situation in which changes may occur.

CHAPTER SIX – Discussion

Overview

The preceding chapters aimed to explore the proposal that some autistic people experience a 'hypersensitivity to difference' from which several other autistic traits flow. In Chapter 1, a cognitive model was presented, drawing on previous literature, that placed hypersensitivity to difference as a central, underlying trait. A series of experimental tasks were conducted to explore whether autistic adults exhibited hypersensitivity to difference, how this could be measured, and to consider any potential relationships between hypersensitivity to difference and other autistic traits. This concluding chapter will begin by summarising the experimental tasks conducted for this programme of work and how the findings fit the proposed model. The limitations of the research and suggestions for future research will also be discussed.

6:1 Change Blindness Task

Experiment 1 of Chapter 2 used the change blindness paradigm. The purpose of this study was two-fold – firstly, the study aimed to extend the findings of Loth et al. (2008) by adding additional types of changes as well as controlling for the typicality of items in the scenes, to consider the limits of attention to detail in autistic individuals. Secondly, to examine whether the change blindness paradigm may be a suitable measure of hypersensitivity to difference. Previous research has demonstrated that autistic individuals exhibit a proclivity towards detail (Frith, 1989) and, in some studies, an enhanced ability to detect change using the change-blindness paradigm (Ashwin et al., 2017; Fletcher-Watson et al., 2012; Smith & Milne, 2009). Additionally, there is evidence to suggest that autistic individuals may struggle to integrate contextual information because of this focus on detail (Vermeulen, 2015). Furthermore, autistic individuals have been found to experience heightened levels of anxiety, sensory differences, and an intolerance of uncertainty (Boulter et al., 2014; de Bruin et al., 2007; O'Neil & Jones, 1997). In Experiment 1, participants were presented with five scenes (bathroom, bedroom, kitchen, living room, and office) and four different change types (congruent, detail, position, and incongruent). It was expected that overall, the autistic participants would detect more changes and at a faster rate than the non-autistic group. It was thought that autistic participants would excel at identifying differences in objects where detail and position had changed, as well as congruency with the schema of the room, due to a lesser reliance on schematic knowledge, whereas the non-autistic group would be better and faster at detecting changes that were incongruent to a scene due to the increased influence of contextual information. As predicted, compared to the non-autistic group, autistic participants had higher self-reported levels of generalised anxiety, intolerance of uncertainty, and sensory hypersensitivity, therefore demonstrating that these traits, which are present across the population, appear to be heightened in autistic individuals. The findings from the experimental task, however, did not support previous research demonstrating a reduced change blindness in autistic participants. Across all change types, autistic participants had slower reaction times compared to the control group. Although the results did not show the predicted advantage in the autistic group for detecting changes, the study did partially support Loth et al. (2008) in that the use of context did not significantly impact this group, given that performance by autistic participants was stable across change types. As noted in Chapter 2, the conclusions drawn from this finding need to be treated with caution since the 'contextual insensitivity' was also shown by the non-autistic participants.

6:1:1 Methodological Inconsistencies and Co-occurring Conditions

A review of the studies using change blindness with autistic participants, both in the introductory chapter and the discussion section of Chapter 1, illustrated methodological inconsistencies, which may explain the mixed findings reported in the literature when using this paradigm. Each of the studies varied in the length of image presentation and the timing of the mask (a grey blank screen presented between the original and changed image), as well as the ways in which participants were asked to respond. Furthermore, the age of participants between studies differed, with some studies recruiting autistic children and adolescents and other studies having an autistic adult sample. It can be inferred that hypersensitivity to difference is present in the early developmental trajectory of autistic individuals through better performance in change blindness tasks (e.g., faster and more accurate at detecting changes between images) by autistic children (Smith & Milne, 2009; Fletcher-Watson et al., 2012), which in some studies appears to continue into adulthood (Ashwin et al., 2017) whilst other studies using autistic adults found no difference in change blindness compared to a non-autistic control group (Hochhauser et al., 2018). Another factor that may need to be considered is the prevalence of co-occurring conditions amongst the autistic samples recruited in such studies. Autism often co-occurs with several other conditions, such as anxiety (including specific phobias, obsessive-compulsive disorder (OCD), and social anxiety disorder; Kent & Simonoff, 2017) as well as other neurodevelopmental conditions, including attention deficit hyperactivity disorder (ADHD; Hours et al., 2022) and tic disorders or Tourette syndrome (Canitano & Vivanti, 2007). Interestingly, when using the change-blindness paradigm with children who have ADHD, it was found that they responded more slowly and less accurately than a control group (Maccari et al., 2012). This may be due to difficulties with switching attention or disengaging attention (Cepeda et al., 2000; Gupta & Kar, 2009). However, in a study looking at change blindness and anxiety, it was found that participants with high anxiety were faster at detecting changes in emotional stimuli (positive, negative, or neutral), particularly negative stimuli. High-anxiety participants were also faster at detecting a change in the positive scene compared to low-anxiety participants (Forte et al., 2021). One may, therefore, expect hypersensitivity to difference to occur only in a subgroup of autistic participants, and in particular, autistic participants who also have co-occurring anxiety-based conditions and fewer difficulties with attentional control.

6:2 Rating Similarity and Difference

Chapter 3 reported the findings of two experiments in which participants were asked to rate similarity *or* difference between items (Experiment 2) and similarity *and* difference between items (Experiment 3). The purpose of this choice of task was to make use of a direct measure of the perception of similarity and difference. In Experiment 2, autistic and non-autistic participants were randomly allocated to a similarity or difference rating condition. They were asked to rate 40 pairs of items on a 7-point scale (1 – not at all similar/different, 7 – extremely similar/different). Difference ratings were reverse scored to facilitate comparison with similarity ratings such that a similarity rating of 1 (not at all similar) was comparable with a difference rating of 1 (extremely different). For each trial set, the base was paired with an item that was both taxonomically and thematically related (A+T+; e.g., milk and coffee), taxonomically related but not thematically related (A+T-; e.g., milk and lemonade), thematically related but not taxonomically related (A-T+; e.g., milk and cow) and neither taxonomically related or thematically related (A-T-; e.g., milk and horse). Participants were also required, for one pair from each pair type (A+T+, A+T-, A-T+, and A-T-), to state what they were thinking after they made their similarity or difference rating. Based on the hypersensitivity to difference model, it was expected that there would be a different impact of thematic and taxonomic relatedness on similarity and difference ratings, such that autistic participants would overall provide higher difference ratings compared to non-autistic participants. It was also expected that they would provide higher similarity ratings for taxonomically related pairs (due to such pairs sharing features) and lower ratings for thematically related pairs which are rooted in context and association. Of particular interest in this study was the three-way interaction between autism, ratings, and thematic relatedness, which showed that thematic relatedness was less influential in similarity ratings for autistic participants compared to non-autistic participants. This is in line with the model, which stipulates that hypersensitivity to difference is related to an interference in the perception of similarity through a reduced use of context. This was further supported by a significant negative correlation between AQ-10 scores and similarity ratings for the A-T+ pair type. The higher the measure of autistic traits, the lower the similarity ratings for pairs that only had a thematic component, indicating a reduced sensitivity towards contextual information. It was also found that there was a significant difference between the two groups on the A-T+ (thematic only) pair type, which warranted further exploration. Additional analyses revealed a subset of autistic participants who provided very low similarity ratings for the A-T+ pair type. These participants were of particular interest as they did not seem to take into account thematic relationships and performed significantly differently (in that they provided lower similarity ratings for pairs that only had a thematic relationship) from non-autistic participants and, perhaps more importantly, from the remaining autistic participants, further highlighting the importance of identifying subgroups in autism research. This will be discussed in this chapter under the heading 'Subgroups & Age of Diagnosis'.

Despite the results not demonstrating a difference in the difference ratings between autistic and non-autistic participants, an interesting pattern emerged through the protocols, which showed that when asked to rate similarity, autistic participants were much more likely to reference the way in which pairs were different, particularly taxonomically, compared to the non-autistic group and in the similarity condition were much less likely to comment on the ways in which pairs were similar thematically. Interestingly, when asked to explain the differences between pairs, both autistic and non-autistic participants were more likely to reference the way in which they were similar as opposed to different. Autistic participants made a greater proportion of comments relating to taxonomic difference compared to control participants but made a similar proportion of thematic similarity comments, suggesting that autistic participants can incorporate context to consider thematic association but that they also recognise that an association does not equal 'similarity'. This study highlighted that autistic participants can and do perceive similarity, though it may not be the first thing they notice. In this experiment, a general theme of non-inversion emerged, which showed that similarity and difference are not inversely related. Of interest to the researcher, therefore, was whether, when participants were asked to rate *both* similarity and difference, the autistic participants who gave very low similarity ratings would also give very high difference ratings, demonstrating an inversion effect.

In Experiment 3, autistic and non-autistic participants rated the same 40 pairs twice – once for similarity and once for difference. This was done in blocks in an attempt to reduce the likelihood that participants would modify their ratings through reasoning that if Pair A received a similarity rating of 'X', then it should receive a difference rating of 'Y'. This study involved the addition of measures of general anxiety, intolerance of uncertainty, and sensory hypersensitivity in anticipation of identifying a sample of autistic participants demonstrating hypersensitivity in this task. In line with the previous experiment, this experiment also highlighted an overall pattern of non-inversion. However, the three-way interaction between autism, ratings, and thematic relatedness was not found, nor was a sub-group of autistic participants identified. A potential explanation for this is that the smaller overall sample size in this experiment reduced the likelihood of the subgroup being present. As expected, the autistic participants did have higher self-reported levels of general anxiety, intolerance of uncertainty, and sensory hypersensitivity compared to the non-autistic group.

6:2:1 Protocols and Ratings

The protocols collected in Experiment 2 indicated a disparity between ratings and protocols in that the proportion of comments related to difference by the autistic participants was not reflected in their difference ratings (no difference in difference ratings between autistic and non-autistic participants). This raises an interesting question about the value of protocols. For example, can protocols reveal subconscious processing in cognitive tasks? In a study by Nisbett and Wilson (1977) in which participants demonstrated that they had been influenced by words they had seen previously, when asked how they made their choices, they did not report being influenced by the previous words, suggesting that they were not introspecting. However, in response to Nisbett and Wilson (1977), Smith and Miller (1978) counter-argued that participants do have access to their own cognitive processes but are only likely to report these when they know the purpose of the experiment. Petitmengin et al. (2013) draw these two arguments together to conclude that individuals are typically unaware of their decision-making processes but can potentially access these when prompted to do so. For example, in a study by Johansson et al. (2005), participants were presented with images of faces and asked to choose which they found more attractive. Participants were either presented with the chosen face or with a face they did not choose and were asked to justify their choice. It was found that in 79.6% of cases, participants provided an explanation for a choice they *did not* make. However, in a partial replication of the study, participants who provided their justification through an 'elicitation interview' in which the image of the face was presented face down, and participants were prompted to recall the image and their choice, they were much more likely (80% of cases) to detect the instances in which a manipulation had taken place (e.g., they were presented with a face they did not chose). This suggests that participants can provide more accurate and detailed responses relating to their decision-making when prompted to introspect. The use of protocols in Experiment 2 revealed a tendency for autistic participants to focus on difference, which was not otherwise demonstrated through difference ratings. One possible explanation for this is that autistic participants were not using the protocols as a way of justifying their ratings. It could be that for this group, it is much easier to describe the ways in which the pairs were different as opposed to rating on a scale in which the numbers are seen as arbitrary. For example, aside from the two anchor points on a Likert scale denoting the extreme end of the scale for both similarity and difference (1 – not at all similar/different, 7 – extremely similar/different), the remaining points on the scale could be perceived as being very vague in terms of what the number represents. In a study by Stacey and Cage (2023) looking at the autistic experience of decision-making and research questionnaires, it was found that several factors can affect an autistic person's response, including the quality and quantity of information available, the time they had to decide, fear of making the wrong decision, as well as external stimuli such as noise. Interestingly, Likert scales, in particular, were highlighted as being problematic, though in the study by Stacey and Cage (2023), it was related specifically to the RAADS-14. Some participants stated that the scales were too restrictive and did not include a 'sometimes' options, which more accurately reflected real-life experiences. Furthermore, participants stated that it was difficult because the boundaries between the different options on the scale were not clear enough. It could be argued that this is heightened in Likert scales that only use numbers and, therefore, do not provide any framework on which to answer by choosing the option that fits most closely. The scales used in Experiments 2 and 3 of this thesis had written descriptor anchors on either end but no indication of the meaning of the ratings in between. This may explain why participants, when asked what strategy they used to make similarity and difference ratings, opted for a 'feeling' of similarity or difference. Interestingly, this was the case for both autistic and non-autistic participants, suggesting that performance on numerical Likert scales between the two groups was comparable. Autistic participants also expressed, in the aforementioned study (Stacey & Cage, 2023), that Likert scales did not facilitate the opportunity to provide more information. This may explain the finding that autistic participants provided many more detailed responses compared to non-autistic participants, both when collecting protocols in Experiment 2 and later when explaining category labels in Experiment 4. It may be that instead of rating scales, a similar study whereby participants are asked to list similarities and differences between items may be a more effective measure of hypersensitivity to difference. These findings highlight the importance of working with autistic people in the design of research studies to maximise the suitability of the methodology for this group. This will be further discussed under the subheadings 'Difficulties Accessing a Sample' and 'The Importance of Participatory Research'.

6:2:2 Subgroups & Age of Diagnosis

The traits and characteristics associated with autism have also been demonstrated in the general population (Ronald & Hoekstra, 2011; Skuse et al., 2005), suggesting that autism is not a discrete condition but instead lies on a continuum of 'human' traits that are perhaps more extreme or prevalent in autistic individuals. Autism is highly heterogeneous in that it presents with a wide range of traits that can be present to varying degrees, even *within* the autistic population. Interestingly, however, many autistic people do share 'core traits' such as those presented in both the hypersensitivity to difference model and the diagnostic criteria;

there is also a degree of commonality in the co-occurring conditions, suggesting that there may, in fact, be a degree of homogeneity. There are many reasons why a unifying theory of autism is yet to be agreed upon, including the way in which the diagnostic criteria have evolved over time (Mottron & Bzdok, 2020), variations in the emergence of autism during the developmental trajectory (Ozonoff et al., 2008), and the multifactorial etiology and neural basis of autism (McPartland et al., 2011; Sauer et al., 2021). A recent study has suggested that, based on brain patterns and behaviour, there may be four different subtypes of autism. Two of the subtypes were found to have above-average verbal intelligence; one group also had 'severe deficits' in social communication but fewer repetitive behaviours, and the fourth group had less 'social impairment' but more repetitive behaviours (Buch et al., 2023). It is not unreasonable to suggest, therefore, that there may also be cognitive subtypes within this group. As such, the model developed for this thesis may not explain the experience of all autistic participants but perhaps a subgroup of participants such as those identified in Experiment 2. The findings may still be evident in the wider autistic population but to a lesser extent. It could be that autistic participants demonstrating a hypersensitivity to difference also experience particularly high levels of anxiety, intolerance of uncertainty and sensory sensitivities within the autistic population. Future research in this area is likely to be needed to identify this subgroup of autistic participants more carefully during the recruitment process. This point will be returned to later in the chapter.

Across the experimental tasks in this thesis, 158 autistic participants who had a formal diagnosis provided the age they were when they received their diagnosis. In this sample, diagnostic age ranged from 2 to 59 years old, with the mean age being 23 years old. In a review of 56 studies between 2012 and 2019 (total N = 120,540) across 40 countries, it was found that the mean age of diagnosis was 60.48 months (approximately five years old). This suggests that the participants in our experimental work may be considered to have received a 'late diagnosis' of autism. Many autistic individuals use the word 'masking' to refer to the conscious or unconscious suppression of natural autistic traits and behaviours. For example, the individual may refrain from stimming due to reactions from others, or they may learn scripts as a way of navigating social situations. Masking may be one of the reasons for a late diagnosis, but it also has several other consequences, including mental health difficulties and burnout (Leedham et al., 2020; Raymaker et al., 2020). It may be that in some cases, and in the context of this research, a late diagnosis in some circumstances has the effect of exposing autistic individuals to a greater range of experiences (e.g., parents of young children with an autism diagnosis may avoid taking their child to certain places which they feel will be overwhelming for them). As a result, the late-diagnosed autistic individual attempts to navigate the world through learned behaviours and coping strategies. For example, although their default setting may be to recognise difference, they have learned through interaction with others that this is not typical of the general population and, therefore, consciously pay attention to similarity. Therefore, the concept of masking may extend to cognitive functions in autistic adults. As such, it may be that hypersensitivity to difference is more likely to be identified in children, those diagnosed as a child, or autistic adults who are less prone to masking.

6:3 Card-sorting Tasks

Chapter 4 made use of two free card-sort tasks as a different method that could highlight hypersensitivity to difference in autistic adults. It was assumed that this task would require the ability to notice similarities between items, in order to group them into categories, and the differences that separate one group from another.[14] The first card-sort task involved 25 items that could elicit the formation of taxonomic categories (e.g., the items 'water', 'champagne', 'eggnog', 'wine' and 'lemonade' may have given rise to a category called 'drinks'), thematic categories (e.g., 'lifeguard', 'ice cream', 'water', 'boat' and 'bikini' which may have given rise to a category called 'beach'), or a mixture of both. The second card-sort task included 34 constructs (a dimension of discrimination with two contrasting words such as 'extrovert -v- introvert'). There are many ways in which constructs can be categorised, and therefore, this task introduced an element of ambiguity. In both card-sort tasks, participants were told that they could make as many or as few categories as they thought best and that there were no right or wrong answers. Participants were also given the opportunity to explain their choice of category label. Overall, it was expected that autistic participants would make many more categories, with fewer items in each, compared to non-autistic participants, as hypersensitivity to difference would suggest that the autistic participants would be more likely to separate items based on their differences, as opposed to grouping by similarities. Statistical analyses showed that there were no significant differences between autistic and non-autistic participants in the number of categories made for the category card sort task. Overall, all participants made more taxonomic categories compared to thematic categories. There was also no difference between the two groups in terms of the number of construct categories made. However, given that there was no expectation of any predetermined categories for the construct card sort (unlike the category card sort), the data was further examined to compare the types of category label names autistic and non-autistic participants provided. There was some overlap in the naming of categories between autistic and non-autistic; however, autistic participants had a larger number of unique category labels. Autistic

[14] Although there have been questions raised about similarity as an exclusive basis of categorisation (Rips, 1989; Rips & Collins, 1993).

participants also provided more detailed explanations for their category labels. The findings from this study suggested that when categorising items, as opposed to dot patterns, autistic participants formed categories in a similar way to non-autistic participants. This methodology was not successful in highlighting hypersensitivity to difference in autistic participants but did raise some interesting differences between the groups in terms of how the novel constructs were labelled once they had been grouped, and the level of detail provided by the autistic participants in their reasons for the groupings. This may be worth pursuing with modifications for future use. Although the online format was easy to administer and complete, it meant that additional data could not be collected. Typically, when this task is completed face-to-face, the process of the forming of categories can be observed in more detail. For example, in this study, it is unclear how many times participants changed their minds when forming categories; did autistic participants hesitate and revisit their decisions more or less often than non-autistic participants? It would also be useful to include concurrent verbal protocols, which are thought to provide a greater insight into how decisions are made (Kuusela & Paul, 2000). It can be seen from both this study and the protocols collected in Experiment 2 of Chapter 3 that the use of qualitative data may be a better indicator of the noticing of difference by autistic participants, which does not always align with their performance on the main experimental task.

6:4 Virtual Reality Technology

Experiment 5 of Chapter 5 used virtual reality technology (VR) in a small study designed to assess the feasibility of VR as a potential methodology to be used with autistic participants. Unfortunately, due to concerns from the Ethics Committee around recruiting autistic participants for this study, it was necessary to recruit participants from the general population and use measures of autistic traits to separate the participants into high and low autistic traits groups. This will be discussed further under the subheadings ‘Difficulties Accessing a Sample’ and ‘The Importance of Participatory Research’. In this study, participants (tested separately) completed a lexical decision task while wearing a VR headset that immersed them in a virtual room, which was a replica of the very room in which they started the experiment. As such, the VR headset was able to track their movements perfectly. For example, at the start of the study, when the participant was asked to walk to the centre of the room and look around for two minutes, the centre of the virtual room aligned with the centre of the ‘real’ room. A baseline measure of anxiety was taken at the start of the study using the Edu-Logger, which involved placing small sensors on the tip of the participant’s fingers. The VR technician was present and explained the headset to the participant. Once the participant had put the headset on, they were told to move to the centre of the room and spend two minutes looking around to acclimate to the virtual reality environment. One reason for this was to assess whether the participant experienced any VR sickness, but it was also done to encourage the participant to take a careful look around in preparation for the later changes. Once they had done this, the participant was told that they would be participating in a lexical decision-making task, in which they were presented with a series of words and asked to verbally state whether this was a real-word or a non-word. The data from this task was not analysed as the task was only used to distract the participant from anticipating the true aim of the study. The participant was also told that another participant may be present within the virtual reality environment. The purpose of this was to introduce an unexpected change that would perhaps induce a level of anxiety, like that which may occur following an unexpected change in a real-world situation. Following this, a second real-time anxiety measure was taken. After completion of the lexical decision-making task, the participant was again asked to move to the centre of the room, and before removing the headset, they were advised to spend another two minutes looking around. At this point, a number of changes had been made to the virtual environment. Upon removing the headset, participants were asked whether they had noticed any changes to the virtual environment in the second look around, compared to the first, and to verbally state the changes they had noticed. Once they had done this, a final real-time anxiety measure was taken, and the participant was taken to a quiet room to take part in a short interview, which formed part of an extended debrief. It was expected that the high autistic traits group would detect more changes than participants in the low autistic traits group.

The results showed that there was no difference between the two groups in terms of the number of changes detected, nor was there a difference in the type of change detected (change types included colour changes, location changes, removal of objects, adding of objects and content changes). There was also no difference between the two groups on the self-report anxiety measure or the three real-time anxiety measures and no difference between self-reported levels of intolerance of uncertainty. The high autistic traits group reported higher self-reported levels of sensory sensitivity compared to the low autistic traits group. A significant negative correlation emerged between the number of changes and intolerance of uncertainty, suggesting that higher levels of intolerance of uncertainty were associated with *fewer* changes detected. This finding was in contrast with the theory presented in this thesis, which suggests that high anxiety, which leads to intolerance of uncertainty, is related to hypersensitivity to difference. It was perhaps unsurprising that significant differences did not emerge in this experiment, given the very small sample size (N = 10). Although the purpose of this study was to increase the ecological validity of the task, following the previous experimental tasks, it is important to remember that a VR simulation cannot replace a real-world experience. For an autistic person who is hypersensitive to difference, this is likely to be multisensory in a way that cannot be replicated through VR, which is limited to visual stimuli. Constantly noticing sensory stimuli may make it hard to habituate to such information, leading to feelings of sensory overload. This leads to the environment feeling unpredictable, and any changes can feel threatening. In the VR study, there are no consequences for participants if the changes are not detected. In real life, however, not being able to make accurate predictions, as a consequence of being hypersensitive to difference, would be expected to lead to high levels of anxiety and intolerance of uncertainty.

It was revealed through the interview data that for many of the participants, the VR headset was what they expected it to be, which may explain the lack of difference in anxiety levels in the high and low autistic traits groups, as participants were already familiar with the technology. Participants also mentioned that they liked that the virtual room was identical to the room they had entered before starting the experiment, again suggesting that there was an element of familiarity which may have mitigated the effects of the unexpected change (i.e., another participant potentially being present during the experiment). Participants reported that the experiment was 'fun' and 'satisfying', indicating that it was, in fact, viewed as an experiment and perhaps a game, and therefore there were no consequences to not detecting difference. If this study was repeated with a larger sample, the virtual room could be a different room altogether, which would possibly serve the purpose of testing for changes in anxiety levels as well as reducing the interference of memory for the actual room. It seems that VR may be a suitable methodology for use with autistic participants in a different context, particularly if mobile headsets can be used to run tests of various types in the participants' homes, increasing participation from participants who may prefer not to travel to unknown locations, such as a lab. Potential sensory challenges will still need to be considered, as highlighted by some participants (e.g., the weight of the headset and how it feels on the participant's face).

6:4:1 Difficulties Accessing a Sample

Prior to the virtual reality study, the experimental tasks in this thesis were conducted online because of the restrictions introduced during the COVID-19 pandemic. Although this allowed the recruitment of a larger number of participants than would otherwise have been the case, many of the autistic participants were recruited via Prolific Academic and the non-autistic participants via the University of Hertfordshire's Psychology SONA System, through which students may sign up to take part in a choice of research studies to receive course credit. This is likely to have resulted in a self-selection bias. The non-autistic participants were all psychology students, and the autistic participants were unlikely to have included individuals who had higher support needs and, therefore, were not necessarily typical or representative of the autistic population. It was also not possible to make use of any measures of verbal or reading skills, although it was, arguably, reasonable to assume that these individuals would not have made themselves available to take part in online surveys and experiments if they felt that they would not be able to understand what was being asked of them.

The face-to-face data collection, however, also has its difficulties. Local autistic meeting groups were found to be reluctant to provide a platform for research participation requests. In expecting the participation of individuals with high levels of anxiety who are endeavouring to avoid new environments or travelling by public transport, there would inevitably be difficulties; attending a lab to take part in a study with strangers could be the very type of experience they may be seeking to limit. Experiment 5 also highlighted the possible difficulty in accessing the approval of Ethics Committees for face-to-face research with an autistic adult sample due to concerns for the well-being of autistic participants under experimental conditions.

6:5 The Importance of Participatory Research

Many autistic individuals, including myself, believe research on autism should have autistic input either through being autistic-led or by being conducted alongside autistic individuals in what is known as participatory research (Cornwall & Jewkes, 1995). There are several benefits to including autistic people in research, in particular, ensuring that the research being conducted is important and relevant to autistic people. It has been noted that there is a discrepancy between what autistic people consider to be priorities in research and the funding pattern in the UK for autism research (Pellicano et al., 2014). Furthermore, autistic involvement in research can provide diverse perspectives and improve study design and accessibility. Such collaborations can also increase trust between the autistic community and researchers (Gowen et al., 2019). Participatory research can have positive benefits relating to ethical considerations in that it is possible to ensure that studies are carried out in a respectful and sensitive manner through both the design of the study (e.g., the language used in the wording of questions and in describing participants) and in considering any support that may be required throughout the process.

6:6 Hypersensitivity to Difference, Anxiety, & Sensory Experiences

Recognising that autistic individuals may be hypersensitive to difference can have important implications, particularly around interventions used to manage anxiety in this group. For many people, Cognitive Behavioural Therapy (CBT) can be a useful way of managing anxiety, with studies highlighting that CBT can have long-term effectiveness for both children and adults with a range of anxiety disorders, including panic disorder, social phobia, obsessive-compulsive disorder, generalised anxiety disorder and post-traumatic stress disorder (DiMauro et al., 2013; Kodal et al., 2018). The aim of CBT is to help individuals recognise thoughts and situations that they find anxiety-provoking, with a view of challenging their perception through behavioural experiments, such as gradually exposing the individual to their anxieties to reduce ‘irrational beliefs’ and to develop coping strategies. However, for an autistic individual who is constantly noticing difference, it may be that alternative approaches are required. As discussed previously, many autistic people experience sensory sensitivities, which can lead to feelings of anxiety and vice versa. Constantly exposing autistic people to situations in which they may experience sensory overload is unlikely to be effective due to a reduction in sensory habituation, as demonstrated through electroencephalography data (Jamal et al., 2021). This suggests that the sensory hypersensitivity of autistic individuals is intrinsic, and as such, frequent exposures will not lessen the experience of sensory overload and associated anxiety. Furthermore, anxiety around situations that may be perceived as ‘irrational’ to non-autistic people (e.g., fear of crowds) may not be to the autistic person who is likely experiencing sensory discomfort. Combining this with the idea that autistic people are less likely to incorporate prior knowledge or context to generalise to other situations, it may be that for autistic individuals, each experience, no matter how familiar, is perceived as new in some way, which again is likely to provoke anxiety as the environment becomes unpredictable. For example, each time an autistic person goes to their favourite restaurant, they may notice that the lights are different, or the music is playing at a different volume; perhaps there are new smells this time, or the furniture has changed. Unlike a non-autistic person who may enter the environment and focus on similarity (both to the previous experience at that restaurant and across to other restaurant experiences), autistic people have a proclivity for noticing difference, which can lead to anxiety. As a result, autistic people can often be perceived as being rigid and inflexible through their routines, repetitive behaviours, and insistence on sameness. However, it could be argued that it is these very things that are the coping strategies for the high anxiety experienced by autistic individuals. Routines, repetitive behaviours, and insistence on sameness provide a level of predictability in what is, for an autistic person, an ever-changing world. Referring to the theory of monotropism (Murray et al., 2005), which was discussed in the introductory chapter (Chapter 1), the intensely focused interests experienced by autistic people could be another way of managing anxiety and an attempt to control the overwhelming noticing of difference. Autistic individuals may need to narrow down into specific topic areas as a way of screening out the processing of other stimuli. For autistic people, minimising the amount of difference that is being experienced minimises uncertainty and increases predictability; therefore, routines, repetitive behaviours, insistence on sameness, and highly focused interests may all be useful ways of reducing anxiety and should not be prevented. It could be that the hypersensitivity to difference theory can also encompass the social and communication differences noted in autistic people. For example, autistic people may be constantly noticing and monitoring the changing facial expressions, body language, and tone of voice of the person they are communicating with, which could be a reason for difficulties with eye contact as the individual is trying to process an overwhelming amount of information.

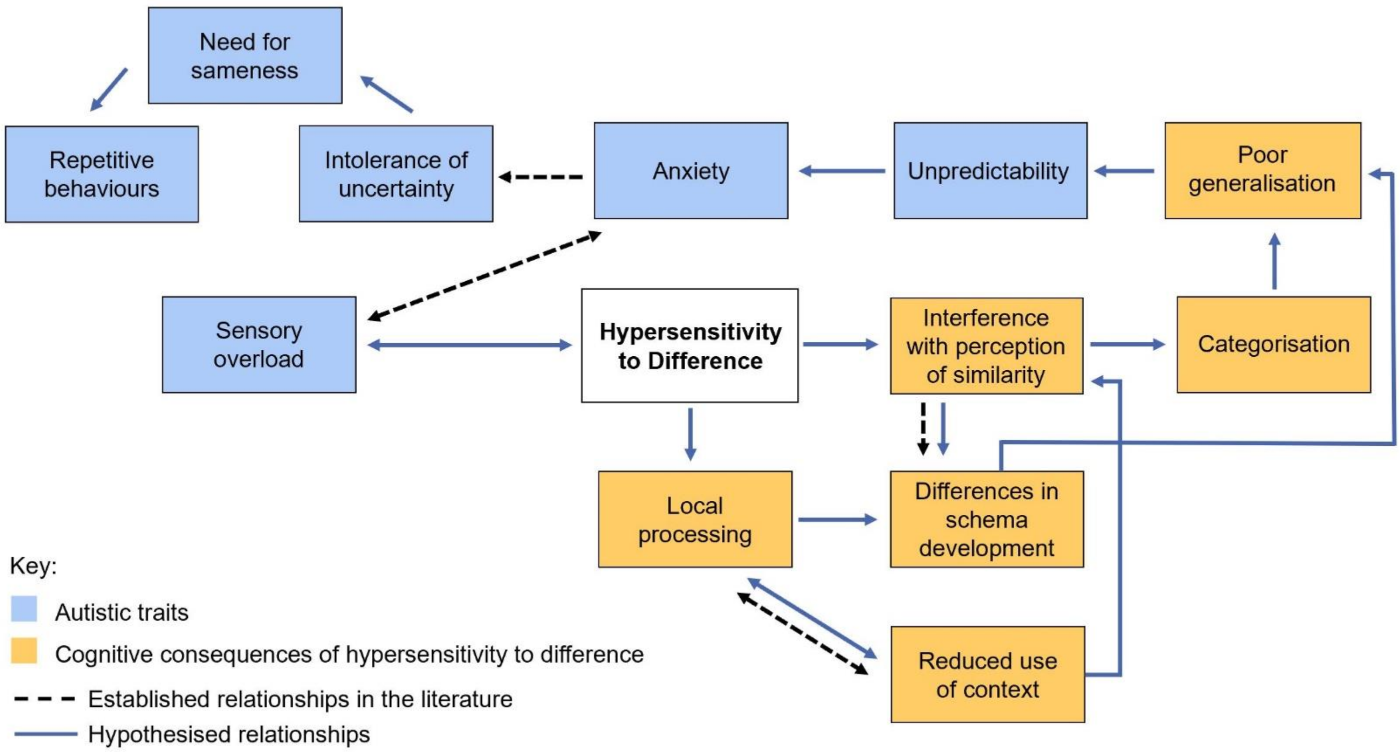
Although hypersensitivity to difference is central to the model proposed in this thesis, it is with the understanding that it is the innate sensory system of autistic people that most likely gives rise to that hypersensitivity. This is supported by a very recent review article by Falck-Ytter and Bussu (2023), which proposes that, given the role of sensory processing in the development of cognitive functions, a sensory-centred approach to understanding autism is necessary. For example, neuroimaging research highlights that there are variations in the brain circuits of autistic and non-autistic people relating to sensory processing across several sensory domains and that such 'network inefficiencies' emerge in the early life of individuals who go on to receive an autism diagnosis (Lewis et al., 2017; Robertson & Baron-Cohen, 2017). This links in with the idea that hypersensitivity to difference is likely to emerge in the developmental period and may interfere with the perception of similarity, which could impact the development of cognitive skills by interrupting the acquisition of learning (e.g., difficulties with category formation as discussed in Chapter 1). As emphasised at the start of the thesis, that is not to say that autistic people do not notice similarity at all. For example, if autistic people did not have any perception of similarity, when encountering a new example of a known object (e.g., a different type of cup) they would be unable to recognise that it is, in fact, still a cup. For autistic people, however, the disposition towards noticing difference seems to override similarity such that they see the differences between objects or situations before they see the similarity. Therefore, the ability to activate the perception of similarity is intact in autistic people; however, it is not necessarily an automatic function or the default perceptual style of this group, and likely stems from differences in the sensory processing system that lead to an inability to 'naturally' screen out sensory input; if nothing is ignored, then differences exponentially increase (e.g., an autistic person may be more prone to notice a small mark on the chair they usually sit on, compared to non-autistic people).

6:7 General Summary

This thesis has reported a programme of experimental work incorporating both well-known and novel approaches, such as the change-blindness paradigm, similarity and difference ratings (which had not previously been used with an autistic sample), card-sorting, and the use of virtual reality technology to assess whether such methodologies could be a potentially suitable demonstration of hypersensitivity to difference in autistic people. Many studies looking at the perceptual strengths of autistic people, such as attention-to-detail, which is proposed to be linked to hypersensitivity to difference through local processing, have typically used visual tasks. The change-blindness paradigm did not offer direct support for a hypersensitivity to difference, with autistic participants performing slower across change types compared to non-autistic participants. This could be explained by the methodological inconsistencies highlighted in research studies using this technique, as discussed earlier in this chapter. Similarly, the VR study did not demonstrate a hypersensitivity to difference between a low and high autistic traits group in terms of the number of changes detected. Findings from the interview data, however, did suggest that such technology could be a useful methodology, in a different context, for use with autistic participants. A future study using VR would require a much larger sample of participants with a diagnosis of autism, as well as modifications to the stimuli. For example, it may have been more pertinent for the virtual room to be different to the research room, thus reducing the feeling of familiarity towards the surroundings. The similarity and difference rating tasks illustrated a reduced use of context in autistic participants who provided lower similarity ratings for pairs of items that shared thematic-only relationships, and this was particularly evident in a subgroup of autistic participants. Although there were no differences between the difference ratings, protocol analyses did reveal that autistic participants noticed many more taxonomic differences and made fewer comments relating to thematic similarity compared to the control group, which raised questions concerning the relationship between the thoughts that were presented about the ratings being made, and the ratings themselves.

Similarly, with the card-sorting tasks, although autistic participants appeared to form categories in a similar way to non-autistic participants based on the statistical analyses, the qualitative data revealed that autistic participants provided many more category label names and more detailed justifications for their choices compared to the non-autistic group, supporting a tendency to perceive differences over overall similarity. The similarity and difference ratings studies and card-sorting tasks highlighted a clear need for more studies that allow autistic people to state what they are noticing. A future improvement to the similarity and difference task may involve enhancing the qualitative aspect of the task (e.g., collecting fewer ratings and more protocols) or using alternative methods such as asking participants to *list* similarities and differences between items or situations. Refinements to the recruitment strategy and changes to the delivery of the tasks (face-to-face instead of online) would allow for greater opportunities to identify potential subgroups of autistic participants in whom hypersensitivity to difference may be particularly detectable. It would also be interesting to conduct similar studies, to those presented above, using autistic children and adolescent samples to investigate whether there is a particular point in the developmental course where hypersensitivity to difference becomes observable, and to consider any factors for why this may or may not continue into adulthood. To conclude the thesis, the model will be revisited; the evidence summarised, what has been learned from conducting this programme of work and suggestions for future research based on the model.

6:7:1 Evidence for the Hypersensitivity to Difference Model



In the model introduced in this thesis, hypersensitivity to difference, in the autistic experience of the environment is proposed as the ‘central’ trait that underlies and explains several other traits. It is thought that interference in the perception of similarity affects the ability to anticipate and predict aspects of new experiences, which is likely to be linked to differences in the sensory system of autistic people. This may suggest that differences in sensory experiences must be primary. That being said, any disruptions in the ability to organise sensory information as being similar to previous experiences would also result in sensory overload; hence, the two-way connection in the model between these two crucial ways in which autistic individuals experience the world differently to non-autistic people.

“On everything in life, I was overwhelmed with a mass of details and I realised I had to group them together and try to figure out unifying principles for masses of data” (Grandin, 2009; p. 1437)

Grandin seems to be describing having to do consciously and with effort what the non-autistic brain does subconsciously to deal with the 'masses of data' that the sensory system provides to everyone.

Since similarity is the way in which much of this data is mentally organised, not just for the sake of avoiding sensory overload, but to allow more incoming data to be quickly recognised and used to guide action, then disruption will occur in the organisation of knowledge (**categorisation**) as well as how to associate things (e.g., objects) with the scenarios/situations/events in which they frequently occur (**schemas**). This will affect the ability to anticipate future events, making the world less predictable. That is not to say that autistic people do not use similarity at all in the organisation of knowledge, but the process may be slower or different in this group.

The resulting **unpredictability** may be so extreme that it leads to very high **anxiety** levels (non-autistic people may also experience anxiety as a result of unpredictability, though perhaps to a lesser degree). The **intolerance for the uncertainty** (unpredictability) and associated anxiety leads to behaviours that may help to satisfy the need to increase predictability, referred to as a **need for sameness**. These behaviours could include **repetitive** motor movements or patterns of behaviour, strict routines, and 'restricted' interests.

The model also proposes that local processing arises, not from an inability to process broader input, but from an active focusing of attention to details as a way to filter out the 'masses of data'. This would account for findings that autistic individuals can make use of global processing if prompted to do so, which demonstrates that global processing is available to autistic people but not necessarily automatically initiated.

The empirical work reported in the thesis has made only limited progress in identifying individuals to whom this model may apply. Given the heterogenous nature of autism, or perhaps the overarching way it is labelled, it was suspected at the outset that the model would describe the experience of a subgroup of those diagnosed autistic.

It can be seen from the chapter summaries that data clearly demonstrating an autistic hypersensitivity to differences in the tasks has not been forthcoming and consideration has been given to possible explanations. However, there have been data arising that did show differences in the performance between the autistic and non-autistic groups:

1) Support was found in Experiment 2 for the proposal made in this thesis (also implied or stated in more recent research) that a compromised perception of similarity could be found in a subgroup of autistic adults. For methodological reasons, it was not possible to link this to a heightened perception of difference, but a clear difference in performance within the autistic group on the similarity ratings suggests that there is a reduction in focusing on similarity and overlooking differences.

2) The protocols in Experiment 2 were of value in showing that, when explaining ratings of similarity, some autistic participants did make use of contextualised, schematic knowledge of the items in referring to thematic similarity between them, but others, particularly in the subgroup, either made no reference to these relationships or dismissed them as irrelevant. This was the case for most of the protocols provided by the subgroup. Overall, thematic similarity, arising from a shared context, featured in their protocols to a lesser extent than for the non-autistic participants. Thematic similarity was also referred to less than taxonomic similarity. The detail of the autistic protocols also showed access to knowledge of perceptual and functional features, suggesting that this aspect of their category organisation was not unusual. Where pairs shared no taxonomic relationship, autistic participants tended to list more taxonomic <u>differences</u> than non-autistic participants when explaining their <u>similarity</u> judgements.

   When explaining ratings of difference**,** all participants commented more on similarities, of both types, than difference, although relatively more taxonomic similarities were mentioned than thematic. These similarities were often mentioned <u>before</u> comments on what made them different. This provides further evidence that the autistic participants do have access to reasons to find items similar in this task even when asked specifically to rate differences. For the pairs sharing only a thematic relationship, both autistic and non-autistic participants seemed to be inclined to comment on taxonomic relatedness, but autistic participants showed a higher proportion of taxonomic differences.

   In these ways the protocols served to provide evidence of autistic access to taxonomic category details and to contextualised knowledge of items that underlies a perception of thematic relationship. Nevertheless, they were also inclined to give more consideration to taxonomic differences than non-autistic participants and the subgroup, in particular, tended to dismiss thematic relations as playing a part in judging similarity.

3) In Experiment 4, although the number of groups made from the unfamiliar stimuli did not demonstrate a difference between the autistic and non-autistic samples. Once again, the qualitative data, in the form of the labels given by participants to the groups that they had formed, showed both ‘overlap’ and differences. The overlap of labels comprised broad concepts such as Personality, Behaviour and Emotion. In the autistic data, there were almost 44% of category labels that were unique to their group compared to 26% that were unique to the non-autistic group. In both groups, these unique category labels included some generalised descriptions such as ‘person-centred traits’ (non-autistic) and ‘personal attitudes’ (autistic), but others were very specific such as ‘sensible’, ‘self-control’, ‘employee traits’ and these seemed to be more prevalent amongst the labels generated by the autistic participants. This suggests autistic participants formed more narrow, specific categories.

6:7:2 What Has Been Learned?

Despite slow progress in finding supporting evidence for the model, a great deal has been learned through the work completed:

- As already noted by Charman et al. (2011), finding behavioural evidence for underlying cognitive differences is not easy.
- If hypersensitivity to difference is most likely to be found in a subgroup within those diagnosed autistic that is characterised by very high levels of anxiety and/or co-occurring anxiety conditions, then individuals meeting these criteria should be recruited for new studies.
- Since the learning of categories and acquisition of schema occurs early in life, the effects of hypersensitivity to difference on cognitive skills may be more obvious early in childhood.
- The behaviours associated with hypersensitivity to difference may also be more evident in childhood due to the amount of masking and social learning that occurs in adulthood, and possibly improved language skills.
- In view of the two points made above, age of diagnosis should be recorded when conducting new studies with adults.
- Personal accounts of experience from autistic adults may be useful in several ways:
    a. Guiding the search for the subgroup in terms of alternative experimental tasks
    b. Constituting evidence in their own right

- Further qualitative data collection, including individual interviews and concurrent verbal protocols from experimental groups, may show what standard measures do not capture. The phrasing used in protocols may also show how autistic and non-autistic samples differentially 'weigh' similarity and difference based on which is said first (e.g., these are similar in these was but… vs these are different in these ways but…).
- Since many cognitive tasks conducted with adults involve the presentation of stimuli as words, measures of verbal skill are required.
- Advantages of conducting face-to-face studies need to be considered against the larger samples that can be recruited online. Given the criticism of small samples and the heterogeneous nature of autism, online recruitment has considerable advantages but also, as noted through this thesis, several limitations.
- It is possible that convincing evidence of the model may not be gained through experimental studies for one or more possible reasons:
    a. The experimental tasks are not capturing the spontaneous heightened awareness of difference in everyday environments compared to non-autistic individuals for whom the awareness of similarity often overrides many differences.
    b. The association between hypersensitivity to difference, anxiety and the traits that stem from that may only arise in actual situations in the life of the autistic individual when there are consequences of the unpredictability they are experiencing. Changes that have implications for how the autistic individual will need to act and interact with the environment may have the greatest impact on other traits as suggested by the model. For example, noticing a small change in the arrangement of furniture within a familiar meeting room in a university, which is unlikely to be noticed by non-autistic attendees, may raise anxiety to such a level for the autistic individual that entering or staying in the room is not an option.
- Arguably the most important point is that cognitive skills which have previously been thought of as being 'impaired' or 'deficient' in autism, can be present in autism, but are not necessarily automatically used. Awareness of this should be reflected in the language used when discussing 'differences' between autistic and non-autistic individuals.

6:7:3 Future Work

1) Run the similarity/difference study again, but with the requirement to list similarities and difference instead of rating, with the prediction that more differences will be listed by autistic adults.
2) Investigate other tasks that rely on knowledge of events in context, i.e., application of event schema to show differences in how this affects predictions (inductive/inferential reasoning)
3) Aim to assist in increasing the behavioural research conducted with adults.
4) Further consideration of the relationship to language.
5) Testing of the role of hypersensitivity to difference in social schemas and the relationship to event schemas.
6) Further investigation of the need for sameness, intolerance of uncertainty, anxiety and the effect of schema violations as being on a continuum of non-autistic to autistic individuals.

6:8 Conclusion

The model introduced in this thesis was designed to examine whether hypersensitivity to difference is a central cognitive trait that is linked to, and can explain, several other autistic traits. It is considered that the task with the most potential for further use in seeking evidence for the model is an adapted version of the similarity/difference rating task reported in Chapter 3, with a view to collecting qualitative data of listed differences rather than ratings. The evidence attained so far has shown reduced use of context in autistic participants, a degree of interference in the perception of similarity, and differences in categorisation as suggested by protocols. As well as replicating previously established relationships between anxiety, intolerance of uncertainty, and sensory hypersensitivity. What remains to be tested more effectively are the links hypothesised in Chapter 1 between the various cognitive and behavioural traits. It seems too soon to consider re-drawing the model at this time as further research exploring other methods and measures could provide greater validation of the core trait of hypersensitivity to difference. It may be time to abandon a search for a single explanation for autism as suggested by Happe et al. (2006), but if the model gains support through new empirical evidence, it would offer a single explanation in a subgroup of autistic individuals for both cognitive and behavioural traits. These individuals may be those who manifest more ‘extreme’ traits, such as particularly high levels of anxiety, and have important implications for how this can be managed. For this group of autistic people and their non-autistic friends, relatives, or colleagues, it could clarify and explain why certain behaviours occur and the purpose they serve. By being aware that their autistic experience is very different to that of the non-autistic experience, it is hoped that there can be more support in minimising the impact of change. For example, having routines, engaging in repetitive behaviours, and focusing on special interests would all be encouraged as a way of managing unpredictability, instead of the assumption that such behaviours need to be reduced. For autistic people, it is hoped that there will be greater recognition and confidence in the several important ways in which we can self-manage and self-regulate as we attempt to navigate an ever-changing world.

References

Allison, C., Auyeung, B., & Baron-Cohen, S. (2012). Toward brief “Red Flags” for autism screening: The Short Autism Spectrum Quotient and the Short Quantitative Checklist for Autism in toddlers in 1,000 cases and 3,000 controls. *Journal of the American Academy of Child and Adolescent Psychiatry*, *51*(2), 202–212

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Ashwin, C., Chapman, E., Howells, J., Rhydderch, D., Walker, I., & Baron-Cohen, S. (2014). Enhanced olfactory sensitivity in autism spectrum conditions. *Molecular Autism*, *5*, 1-9.

Ashwin, C., Wheelwright, S., & Baron-Cohen, S. (2017). Differences in change blindness to real-life scenes in adults with autism spectrum conditions. *Plos one*, *12*(10), e0185120.

Ashwin, E., Ashwin, C., Rhydderch, D., Howells, J., & Baron-Cohen, S. (2009). Eagle-eyed visual acuity: an experimental investigation of enhanced perception in autism. *Biological psychiatry*, *65*(1), 17-21.

Asperger, H. (1944). Die ‘Autistichen psychopathen’ im kindesalter. *Archiv fur Psychiatrie und Nervenkrankheiten, 117* (1), 76-136.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* The MIT Press.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"?. *Cognition*, *21*(1), 37–46.

Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11*(4), 629–654.

Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of experimental psychology: learning, memory, and cognition*, *11*(4), 629.

Bartlett F.C. (1932). *Remembering: A study in experimental and social psychology*, Cambridge, UK Cambridge University Press.

Bellini, S. (2004). Social skill deficits and anxiety in high-functioning adolescents with autism spectrum disorders. *Focus on autism and other developmental disabilities*, *19*(2), 78-86.

Ben-Sasson, A., Hen, L., Fluss, R., Cermak, S. A., Engel-Yeger, B., & Gal, E. (2009). A meta-analysis of sensory modulation symptoms in individuals with autism spectrum disorders. *Journal of autism and developmental disorders*, *39*, 1-11.

Berenbaum, H., Bredemeier, K., & Thompson, R. J. (2008). Intolerance of uncertainty: Exploring its dimensionality and associations with need for cognitive closure, psychopathology, and personality. *Journal of anxiety disorders*, *22*(1), 117-125.

Bervoets, J., Milton, D., & Van de Cruys, S. (2021). Autism and intolerance of uncertainty: an ill-fitting pair. *Trends in Cognitive Sciences*, *25*(12), 1009-1010.

Bott, L., Brock, J., Brockdorff, N., Boucher, J., & Lamberts, K. (2006). Perceptual similarity in autism. *Quarterly journal of experimental psychology*, *59*(7), 1237-1254.

Boucher, J. (2012). Putting theory of mind in its place: psychological explanations of the socio-emotional-communicative impairments in autistic spectrum disorder. *Autism*, *16*(3), 226-246.

Boulter, C., Freeston, M., South, M., & Rodgers, J. (2014). Intolerance of uncertainty as a framework for understanding anxiety in children and adolescents with autism spectrum disorders. *Journal of autism and developmental disorders*, *44*, 1391-1402.

Bravou, V., Oikonomidou, D., & Drigas, A. S. (2022). Applications of virtual reality for autism inclusion. A review. *Retos: nuevas tendencias en educación física, deporte y recreación*, (45), 779-785.

Broadbent, D. E. (1958). The selective nature of learning.

Brosnan, M. J., Gwilliam, L. R., & Walker, I. (2012). Brief report: the relationship between visual acuity, the embedded figures test and systemizing in autism spectrum disorders. *Journal of autism and developmental disorders*, *42*, 2491-2497.

Brown, R. (1958). How shall a thing be called?. *Psychological review*, *65*(1), 14.

Buch, A. M., Vértes, P. E., Seidlitz, J., Kim, S. H., Grosenick, L., & Liston, C. (2023). Molecular and network-level mechanisms explaining individual differences in autism spectrum disorder. *Nature Neuroscience*, *26*(4), 650-663.

Buhr, K., & Dugas, M. J. (2009). The role of fear of anxiety and intolerance of uncertainty in worry: An experimental manipulation. *Behaviour research and therapy*, *47*(3), 215-223.

Burack, J. A. (1994). Selective attention deficits in persons with autism: Preliminary evidence of an inefficient attentional lens. *Journal of Abnormal Psychology, 103*(3), 535–543.

Burack, J. A., Joseph, S., Russo, N., Shore, D. I., Porporino, M., & Enns, J. T. (2009). Change detection in naturalistic pictures among children with autism. *Journal of Autism and Developmental Disorders*, *39*, 471-479.

Canitano, R., & Vivanti, G. (2007). Tics and Tourette syndrome in autism spectrum disorders. *Autism*, *11*(1), 19-28.

Carleton, R. N., Mulvogue, M. K., Thibodeau, M. A., McCabe, R. E., Antony, M. M., & Asmundson, G. J. (2012). Increasingly certain about uncertainty: Intolerance of uncertainty across anxiety and depression. *Journal of anxiety disorders*, *26*(3), 468-479.

Carleton, R. N., Norton, M. A., & Asmundson, G. J. (2007). Fearing the unknown: a short version of the Intolerance of Uncertainty Scale. *Journal of anxiety disorders*, *21*(1), 105–117.

Cepeda, N. J., Cepeda, M. L., & Kramer, A. F. (2000). Task switching and attention deficit hyperactivity disorder. *Journal of abnormal child psychology*, *28*, 213-226.

Charman, T., Jones, C. R., Pickles, A., Simonoff, E., Baird, G., & Happé, F. (2011). Defining the cognitive phenotype of autism. *Brain research*, *1380*, 10-21.

Cherry, E. C. (1953). Some experiments on the recognition of speech, with one and with two ears. *Journal of the Acoustical Society of America, 25,* 975–979.

Chung, S., & Son, J. W. (2020). Visual perception in autism spectrum disorder: a review of neuroimaging studies. *Journal of the Korean Academy of Child and Adolescent Psychiatry*, *31*(3), 105.

Church, B. A., Krauss, M. S., Lopata, C., Toomey, J. A., Thomeer, M. L., Coutinho, M. V., ... & Mercado, E. (2010). Atypical categorization in children with high-functioning autism spectrum disorder. *Psychonomic bulletin & review*, *17*, 862-868.

Comer, J. S., Roy, A. K., Furr, J. M., Gotimer, K., Beidas, R. S., Dugas, M. J., & Kendall, P. C. (2009). The intolerance of uncertainty scale for children: a psychometric evaluation. *Psychological assessment*, *21*(3), 402.

Constantino, J. N. (2002). *The Social Responsiveness Scale.* Los Angeles: Western Psychological Services.

Cornwall, A., & Jewkes, R. (1995). What is participatory research?. *Social science & medicine*, *41*(12), 1667-1676.

Crane, L., Goddard, L., & Pring, L. (2009). Sensory processing in adults with autism spectrum disorders. *Autism : the international journal of research and practice*, *13*(3), 215–228.

Davis III, T. E., Hess, J. A., Moree, B. N., Fodstad, J. C., Dempsey, T., Jenkins, W. S., & Matson, J. L. (2011). Anxiety symptoms across the lifespan in people diagnosed with autistic disorder. *Research in autism spectrum disorders*, *5*(1), 112-118.

de Bruin, E. I., Ferdinand, R. F., Meester, S., de Nijs, P. F., & Verheij, F. (2007). High rates of psychiatric co-morbidity in PDD-NOS. *Journal of autism and developmental disorders*, *37*, 877-886.

De Luca, R., Leonardi, S., Portaro, S., Le Cause, M., De Domenico, C., Colucci, P. V., ... & Calabrò, R. S. (2021). Innovative use of virtual reality in autism spectrum disorder: A case-study. *Applied Neuropsychology: Child*, *10*(1), 90-100.

Deutsch, J. A., & Deutsch, D. (1963). Attention: Some theoretical considerations. *Psychological Review, 70*(1), 80–90.

Dichter, G. S., Radonovich, K. J., Turner-Brown, L. M., Lam, K. S., Holtzclaw, T. N., & Bodfish, J. W. (2010). Performance of children with autism spectrum disorders on the dimension-change card sort task. *Journal of autism and developmental disorders*, *40*, 448-456.

DiMauro, J., Domingues, J., Fernandez, G., & Tolin, D. F. (2013). Long-term effectiveness of CBT for anxiety disorders in an adult outpatient clinic sample: A follow-up study. *Behaviour research and therapy*, *51*(2), 82-86.

Dixon, E. A., Benham, G., Sturgeon, J. A., Mackey, S., Johnson, K. A., & Younger, J. (2016). Development of the Sensory Hypersensitivity Scale (SHS): a self-report tool for assessing sensitivity to sensory stimuli. *Journal of behavioural medicine*, *39*, 537-550.

Eriksson, J. M., Andersen, L. M., & Bejerot, S. (2013). RAADS-14 Screen: validity of a screening tool for autism spectrum disorder in an adult psychiatric population. *Molecular Autism*, *4*, 1-11.

Falck-Ytter, T. (2015). Gaze performance during face-to-face communication: A live eye tracking study of typical children and children with autism. *Research in Autism Spectrum Disorders*, *17*, 78-85.

Falck-Ytter, T., & Bussu, G. (2023). The sensory-first account of autism. *Neuroscience and Biobehavioral Reviews*, *153*.

Falck-Ytter, T., Bölte, S., & Gredebäck, G. (2013). Eye tracking in early autism research. *Journal of neurodevelopmental disorders*, *5*(1), 1-13.

Fletcher-Watson, S., Leekam, S. R., Connolly, B., Collis, J. M., Findlay, J. M., McConachie, H., & Rodgers, J. (2012). Attenuation of change blindness in children with autism spectrum disorders. *British Journal of Developmental Psychology*, *30*(3), 446-458.

Fletcher-Watson, S., Leekam, S. R., Turner, M. A., & Moxon, L. (2006). Do people with autistic spectrum disorder show normal selection for attention? Evidence from change blindness. *British Journal of Psychology*, *97*(4), 537-554.

Forte, G., Favieri, F., Oliha, E. O., Marotta, A., & Casagrande, M. (2021). Anxiety and attentional processes: The role of resting heart rate variability. *Brain sciences*, *11*(4), 480.

Frith, U. (1989). *Autism: Explaining the enigma.* Oxford: Wiley-Blackwell.

Frith, U., & Snowling, M. (1983). Reading for meaning and reading for sound in autistic and dyslexic children. *British journal of developmental psychology*, *1*(4), 329-342.

Froehlich, A. L., Anderson, J. S., Bigler, E. D., Miller, J. S., Lange, N. T., DuBray, M. B., ... & Lainhart, J. E. (2012). Intact prototype formation but impaired generalization in autism. *Research in autism spectrum disorders*, *6*(2), 921-930.

Gastgeb, H. Z., Dundas, E. M., Minshew, N. J., & Strauss, M. S. (2012). Category formation in autism: can individuals with autism form categories and prototypes of dot patterns?. *Journal of autism and developmental disorders*, *42*, 1694-1704.

Gentner, D., & Wolff, P. (1997). Alignment in the processing of metaphor. *Journal of memory and language*, *37*(3), 331-355.

Gibbs, R. W. (1992). Categorization and metaphor understanding.

Gilhooly, K. J., Fioratou, E., Anthony, S. H., & Wynn, V. (2007). Divergent thinking: Strategies and executive involvement in generating novel uses for familiar objects. *British Journal of Psychology*, *98*(4), 611-625.

Golonka, S., & Estes, Z. (2009). Thematic relations affect similarity via commonalities. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(6), 1454–1464.

Gowen, E., Taylor, R., Bleazard, T., Greenstein, A., Baimbridge, P., & Poole, D. (2019). Guidelines for conducting research studies with the autism community. *Autism policy & practice*, *2*(1 A new beginning), 29.

Grandin T. (2009). How does visual thinking work in the mind of a person with autism? A personal account. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *364*(1522), 1437–1442.

Green, A. E., Kenworthy, L., Mosner, M. G., Gallagher, N. M., Fearon, E. W., Balhana, C. D., & Yerys, B. E. (2014). Abstract Analogical Reasoning in High-Functioning Children with Autism Spectrum Disorders. *Autism Research*, *7*(6), 677-686.

Grimes, J. (1996). On the failure to detect changes in scenes across saccades. *Perception*, *5*, 89-110.

Gupta, R., & Kar, B. R. (2009). Development of attentional processes in ADHD and normal children. *Progress in brain research*, *176*, 259-276.

Happé, F. G. (1995). The role of age and verbal ability in the theory of mind task performance of subjects with autism. *Child development*, *66*(3), 843-855.

Happé, F., Ronald, A., & Plomin, R. (2006). Time to give up on a single explanation for autism. *Nature neuroscience*, *9*(10), 1218–1220.

Hellendoorn, A., Wijnroks, L., & Leseman, P. P. (2015). Unraveling the nature of autism: Finding order amid change. *Frontiers in psychology*, *6*, 359.

Hobson, R. P. (2012). Autism, literal language and concrete thinking: Some developmental considerations. *Metaphor and Symbol*, *27*(1), 4-21.

Hochhauser, M., Aran, A., & Grynszpan, O. (2018). How adolescents with autism spectrum disorder (ASD) spontaneously attend to real-world scenes: use of a change blindness paradigm. *Journal of Autism and Developmental Disorders*, *48*, 502-510.

Hodgson, A. R., Freeston, M. H., Honey, E., & Rodgers, J. (2017). Facing the unknown: Intolerance of uncertainty in children with autism spectrum disorder. *Journal of applied research in intellectual disabilities*, *30*(2), 336-344.

Holaway, R. M., Heimberg, R. G., & Coles, M. E. (2006). A comparison of intolerance of uncertainty in analogue obsessive-compulsive disorder and generalized anxiety disorder. *Journal of anxiety disorders*, *20*(2), 158-174.

Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984). Development of analogical problem-solving skill. *Child development*, 2042-2055.

Honke, G., & Kurtz, K. J. (2019). Similarity is as similarity does? A critical inquiry into the effect of thematic association on similarity. *Cognition*, *186*, 115-138.

Hours, C., Recasens, C., & Baleyte, J. M. (2022). ASD and ADHD comorbidity: what are we talking about?. *Frontiers in Psychiatry*, *13*, 154.

Hyde, K. L., Samson, F., Evans, A. C., & Mottron, L. (2010). Neuroanatomical differences in brain areas implicated in perceptual and other core features of autism revealed by cortical thickness analysis and voxel-based morphometry. *Human brain mapping*, *31*(4), 556-566.

Jamal, W., Cardinaux, A., Haskins, A. J., Kjelgaard, M., & Sinha, P. (2021). Reduced sensory habituation in autism and its correlation with behavioral measures. *Journal of Autism and Developmental Disorders*, *51*, 3153-3164.

Johansson, P., Hall, L., Sikstrom, S., & Olsson, A. (2005). Failure to detect mismatches between intention and outcome in a simple decision task. *Science*, *310*(5745), 116-119.

Jolliffe, T., & Baron-Cohen, S. (1997). Are people with autism and Asperger syndrome faster than normal on the embedded figures test?. *Journal of Child Psychology and Psychiatry, 38* (5), 527-534.

Kaldy, Z., Kraper, C., Carter, A. S., & Blaser, E. (2011). Toddlers with autism spectrum disorder are more successful at visual search than typically developing toddlers. *Developmental science*, *14*(5), 980-988.

Kandalaft, M. R., Didehbani, N., Krawczyk, D. C., Allen, T. T., & Chapman, S. B. (2013). Virtual reality social cognition training for young adults with high-functioning autism. *Journal of autism and developmental disorders*, *43*, 34-44.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217–250.

Kelly, G. (1955). Personal construct psychology. *Nueva York: Norton*.

Kemner, C., Van Ewijk, L., Van Engeland, H., & Hooge, I. (2008). Brief report: Eye movements during visual search tasks indicate enhanced stimulus discriminability in subjects with PDD. *Journal of Autism and Developmental Disorders*, *38*, 553-557.

Kent, R., & Simonoff, E. (2017). Prevalence of anxiety in autism spectrum disorders. *Anxiety in children and adolescents with autism spectrum disorder*, 5-32.

Kerns, C. M., & Kendall, P. C. (2012). The presentation and classification of anxiety in autism spectrum disorder. *Clinical Psychology: Science and Practice, 19*(4), 323–347.

Kikuchi, Y., Senju, A., Tojo, Y., Osanai, H., & Hasegawa, T. (2009). Faces do not capture special attention in children with autism spectrum disorder: A change blindness study. *Child Development*, *80*(5), 1421-1433.

Kinnaird, E., Stewart, C., & Tchanturia, K. (2019). Investigating alexithymia in autism: A systematic review and meta-analysis. *European Psychiatry*, *55*, 80-89.

Klinger, L. G., & Dawson, G. (2001). Prototype formation in autism. *Development and psychopathology*, *13*(1), 111-124.

Kodal, A., Fjermestad, K., Bjelland, I., Gjestad, R., Öst, L. G., Bjaastad, J. F., ... & Wergeland, G. J. (2018). Long-term effectiveness of cognitive behavioral therapy for youth with anxiety disorders. *Journal of anxiety disorders*, *53*, 58-67.

Kuusela, H., & Paul, P. (2000). A comparison of concurrent and retrospective verbal protocol analysis. *The American Journal of Psychology, 113*(3), 387–404.

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception and Performance, 21*(3), 451–468.

Leedham, A., Thompson, A. R., Smith, R., & Freeth, M. (2020). 'I was exhausted trying to figure it out': The experiences of females receiving an autism diagnosis in middle to late adulthood. *Autism*, *24*(1), 135-146.

Leekam, S. R., Nieto, C., Libby, S. J., Wing, L., & Gould, J. (2007). Describing the sensory abnormalities of children and adults with autism. *Journal of autism and developmental disorders*, *37*(5), 894–910.

Leslie, A. M. (1987). Pretense and representation: The origins of "theory of mind." *Psychological Review, 94*(4), 412–426.

Lewis, J. D., Evans, A. C., Pruett Jr, J. R., Botteron, K. N., McKinstry, R. C., Zwaigenbaum, L., ... & Gu, H. (2017). The emergence of network inefficiencies in infants with autism spectrum disorder. *Biological psychiatry*, *82*(3), 176-185.

Lewis, V., & Boucher, J. (1988). Spontaneous, instructed and elicited play in relatively able autistic children. *British Journal of Developmental Psychology*, *6*(4), 325-339.

Lin, E. L., & Murphy, G. L. (2001). Thematic relations in adults' concepts. *Journal of experimental psychology: General*, *130*(1), 3.

Liss, M., Saulnier, C., Fein, D., & Kinsbourne, M. (2006). Sensory and attention abnormalities in autistic spectrum disorders. *Autism : the international journal of research and practice*, *10*(2), 155–172.

Lopez, B., & Leekam, S. R. (2003). Do children with autism fail to process information in context?. *Journal of child psychology and psychiatry*, *44*(2), 285-300.

López, B., Donnelly, N., Hadwin, J., & Leekam, S. (2004). Face processing in high-functioning adolescents with autism: Evidence for weak central coherence. *Visual Cognition*, *11*(6), 673-688.

Loth, E., Carlos Gómez, J., & Happé, F. (2008). Detecting changes in naturalistic scenes: Contextual inconsistency does not influence spontaneous attention in high-functioning people with autism spectrum disorder. *Autism Research*, *1*(3), 179-188.

Loth, E., Gómez, J. C., & Happé, F. (2008). Event schemas in autism spectrum disorders: The role of theory of mind and weak central coherence. *Journal of autism and developmental disorders*, *38*, 449-463.

Loth, E., Gómez, J. C., & Happé, F. (2011). Do high-functioning people with autism spectrum disorder spontaneously use event knowledge to selectively attend to and remember context-relevant aspects in scenes?. *Journal of autism and developmental disorders*, *41*, 945-961.

Loth, E., Happé, F., & Gómez, J. C. (2010). Variety is not the spice of life for people with autism spectrum disorders: frequency ratings of central, variable and inappropriate aspects of common real-life events. *Journal of Autism and Developmental Disorders*, *40*, 730-742.

Maccari, L., Casagrande, M., Martella, D., Anolfo, M., Rosa, C., Fuentes, L. J., & Pasini, A. (2013). Change blindness in children with ADHD: A selective impairment in visual search?. *Journal of Attention Disorders*, *17*(7), 620-627.

Markman, A. B., & Gentner, D. (1993). Splitting the differences: A structural alignment view of similarity. *Journal of memory and language*, *32*(4), 517-535.

Marks, L. E., Hammeal, R. J., Bornstein, M. H., & Smith, L. B. (1987). Perceiving similarity and comprehending metaphor. *Monographs of the Society for Research in Child Development*, i-100.

McPartland, J. C., Wu, J., Bailey, C. A., Mayes, L. C., Schultz, R. T., & Klin, A. (2011). Atypical neural specialization for social percepts in autism spectrum disorder. *Social neuroscience*, *6*(5-6), 436-451.

Medin, D. L., & Schaffer, M. M. (1978). Context theory of classification learning. *Psychological review*, *85*(3), 207.

Medin, D. L., Goldstone, R. L., & Gentner, D. (1990). Similarity involving attributes and relations: Judgments of similarity and difference are not inverses. *Psychological Science*, *1*(1), 64-69.

Medin, D. L., Wattenmaker, W. D., & Hampson, S. E. (1987). Family resemblance, conceptual cohesiveness, and category construction. *Cognitive psychology*, *19*(2), 242-279.

Mercado III, E., Chow, K., Church, B. A., & Lopata, C. (2020). Perceptual category learning in autism spectrum disorder: Truth and consequences. *Neuroscience & Biobehavioral Reviews*, *118*, 689-703.

Mirman, D., & Graziano, K. M. (2012). Individual differences in the strength of taxonomic versus thematic relations. *Journal of experimental psychology: General*, *141*(4), 601.

Mirman, D., Landrigan, J. F., & Britt, A. E. (2017). Taxonomic and thematic semantic systems. *Psychological bulletin*, *143*(5), 499.

Mitchell, P., & Ropar, D. (2004). Visuo-spatial abilities in autism: A review. *Infant and Child Development: An International Journal of Research and Practice*, *13*(3), 185-198.

Molesworth, C. J., Bowler, D. M., & Hampton, J. A. (2008). When prototypes are not best: Judgments made by children with autism. *Journal of autism and developmental disorders*, *38*, 1721-1730.

Morsanyi, K., & Holyoak, K. J. (2010). Analogical reasoning ability in autistic and typically developing children. *Developmental science*, *13*(4), 578-587.

Mottron, L., & Bzdok, D. (2020). Autism spectrum heterogeneity: fact or artifact?. *Molecular psychiatry*, *25*(12), 3178-3185.

Mottron, L., Dawson, M., Soulières, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: an update, and eight principles of autistic perception. *Journal of autism and developmental disorders*, *36*(1), 27–43.

Muris, P., Steerneman, P., Merckelbach, H., Holdrinet, I., & Meesters, C. (1998). Comorbid anxiety symptoms in children with pervasive developmental disorders. *Journal of anxiety disorders*, *12*(4), 387-393.

Murray, D., Lesser, M., & Lawson, W. (2005). Attention, monotropism and the diagnostic criteria for autism. *Autism*, *9*(2), 139-156.

Nauta, M. H., Scholing, A., Rapee, R. M., Abbott, M., Spence, S. H., & Waters, A. (2004). A parent-report measure of children’s anxiety: psychometric properties and comparison with child-report in a clinic and normal sample. *Behaviour research and therapy*, *42*(7), 813-839.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology, 9*(3), 353–383.

Neil, L., Olsson, N. C., & Pellicano, E. (2016). The relationship between intolerance of uncertainty, sensory sensitivities, and anxiety in autistic and typically developing children. *Journal of autism and developmental disorders*, *46*, 1962-1973.

Nelson, H. E., & Willison, J. (1991). *National adult reading test (NART)* (pp. 1-26). Windsor: Nfer-Nelson.

Nimmo-Smith, V., Heuvelman, H., Dalman, C., Lundberg, M., Idring, S., Carpenter, P., ... & Rai, D. (2020). Anxiety disorders in adults with autism spectrum disorder: A population-based study. *Journal of Autism and Developmental Disorders*, *50*, 308-318.

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological review*, *84*(3), 231.

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of personality and social psychology*, *35*(4), 250.

Northrup, J. B., Libertus, K., & Iverson, J. M. (2017). Response to changing contingencies in infants at high and low risk for autism spectrum disorder. *Autism Research*, *10*(7), 1239-1248.

Nosofsky, R. M. (1988). Similarity, frequency, and category representations. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*(1), 54–65.

O'Neill, M., & Jones, R. S. (1997). Sensory-perceptual abnormalities in autism: a case for more research?. *Journal of autism and developmental disorders*, *27*(3), 283-293.

O'Regan, J. K., Rensink, R. A., & Clark, J. J. (1999). Change-blindness as a result of 'mudsplashes'. *Nature*, *398*(6722), 34.

O’Riordan, M. A. (2004). Superior visual search in adults with autism. *Autism*, *8*(3), 229-248.

O'Riordan, M., & Plaisted, K. (2001). Enhanced discrimination in autism. *The Quarterly Journal of Experimental Psychology: Section A*, *54*(4), 961-979.

O'Riordan, M. A., Plaisted, K. C., Driver, J., & Baron-Cohen, S. (2001). Superior visual search in autism. *Journal of Experimental Psychology: Human Perception and Performance*, *27*(3), 719.

Osherson, D. N., Smith, E. E., Wilkie, O., Lopez, A., & Shafir, E. (1990). Category-based induction. *Psychological review*, *97*(2), 185.

Ozonoff, S., Heung, K., Byrd, R., Hansen, R., & Hertz-Picciotto, I. (2008). The onset of autism: patterns of symptom emergence in the first years of life. *Autism research*, *1*(6), 320-328.

Palmer, T. E. (1975). The effects of contextual scenes on the identification of objects. *Memory & cognition*, *3*(5), 519-526.

Parsons, S., & Cobb, S. (2016). State-of-the-art of virtual reality technologies for children on the autism spectrum. In *Technology and Students with Special Educational Needs* (pp. 77-88). Routledge.

Pellicano, E., & Burr, D. (2012). When the world becomes 'too real': a Bayesian explanation of autistic perception. *Trends in cognitive sciences*, *16*(10), 504-510.

Pellicano, E., Dinsmore, A., & Charman, T. (2014). What should autism research focus upon? Community views and priorities from the United Kingdom. *Autism*, *18*(7), 756-770.

Petitmengin, C., Remillieux, A., Cahour, B., & Carter-Thomas, S. (2013). A gap in Nisbett and Wilson's findings? A first-person access to our cognitive processes. *Consciousness and cognition*, *22*(2), 654-669.

Plaisted, K. C. (2001). Reduced generalization in autism: An alternative to weak central coherence. In J. A. Burack, T. Charman, N. Yirmiya, & P. R. Zelazo (Eds.), *The development of autism: Perspectives from theory and research.* (pp. 149–169). New Jersey: Lawrence Erlbaum.

Plaisted, K., O'Riordan, M., & Baron-Cohen, S. (1998). Enhanced visual search for a conjunctive target in autism: A research note. *The Journal of Child Psychology and Psychiatry and Allied Disciplines*, *39*(5), 777-783.

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with Autism Show Local Precedence in a Divided Attention Task and Global Precedence in a Selective Attention Task. *The Journal of Child Psychology and Psychiatry and Allied Disciplines, 40*(5), 733-742.

Posner, M. I., & Keele, S. W. (1968). On the genesis of abstract ideas. *Journal of Experimental Psychology, 77*(3), 353–363.

Raymaker, D. M., Teo, A. R., Steckler, N. A., Lentz, B., Scharer, M., Delos Santos, A., ... & Nicolaidis, C. (2020). "Having all of your internal resources exhausted beyond measure and being left with no clean-up crew": Defining autistic burnout. *Autism in adulthood*, *2*(2), 132-143.

Reed, P. (2018). Behavioural flexibility of children with Autism Spectrum Disorder on a card-sorting task with varying task difficulty. *Heliyon*, *4*(10).

Reed, P., Watts, H., & Truzoli, R. (2013). Flexibility in young people with autism spectrum disorders on a card sort task. *Autism*, *17*(2), 162-171.

Remington, A., & Fairnie, J. (2017). A sound advantage: Increased auditory capacity in autism. *Cognition*, *166*, 459-465.

Remington, A., Swettenham, J., Campbell, R., & Coleman, M. (2009). Selective attention and perceptual load in autism spectrum disorder. *Psychological science*, *20*(11), 1388–1393.

Rensink, R. A., O'Regan, J. K., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8*(5), 368–373.

Rips, L. J. (1989). Similarity, typicality, and categorization.

Rips, L. J., & Collins, A. (1993). Categories and resemblance. *Journal of Experimental Psychology: General*, *122*(4), 468.

Robertson, A. E., & Simmons, D. R. (2013). The relationship between sensory sensitivity and autistic traits in the general population. *Journal of Autism and Developmental disorders*, *43*, 775-784.

Robertson, C. E., & Baron-Cohen, S. (2017). Sensory perception in autism. *Nature Reviews Neuroscience*, *18*(11), 671-684.

Rodgers, J., & Ofield, A. (2018). Understanding, recognising and treating co-occurring anxiety in autism. *Current developmental disorders reports*, *5*, 58-64.

Rodgers, J., Farquhar, K., Mason, D., Brice, S., Wigham, S., Ingham, B., ... & Parr, J. R. (2020). Development and initial evaluation of the anxiety scale for autism-adults. *Autism in Adulthood*, *2*(1), 24-33.

Rodgers, J., Glod, M., Connolly, B., & McConachie, H. (2012). The relationship between anxiety and repetitive behaviours in autism spectrum disorder. *Journal of autism and developmental disorders*, *42*, 2404-2409.

Ronald, A., & Hoekstra, R. A. (2011). Autism spectrum disorders and autistic traits: a decade of new twin studies. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*, *156*(3), 255-274.

Ronconi, L., Gori, S., Ruffino, M., Molteni, M., & Facoetti, A. (2013). Zoom-out attentional impairment in children with autism spectrum disorder. *cortex*, *49*(4), 1025-1033.

Rosch, E. H. (1973). Natural categories. *Cognitive psychology*, *4*(3), 328-350.

Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive psychology*, *7*(4), 573-605.

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology*, *8*(3), 382–439.

Ross, B. H., & Kennedy, P. T. (1990). Generalizing from the use of earlier examples in problem solving. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *16*(1), 42.

Sauer, A. K., Stanton, J., Hans, S., & Grabrucker, A. (2021). Autism spectrum disorders: etiology and pathology. *Exon Publications*, 1-15.

Schadenberg, B. R., Reidsma, D., Evers, V., Davison, D. P., Li, J. J., Heylen, D. K., ... & Pellicano, E. (2021). Predictable Robots for Autistic Children—Variance in Robot Behaviour, Idiosyncrasies in Autistic Children’s Characteristics, and Child–Robot Engagement. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *28*(5), 1-42.

Schank, R. C., & Abelson, R. P. (1975, September). Scripts, plans, and knowledge. In *IJCAI* (Vol. 75, pp. 151-157).

Shah, A., & Frith, U. (1993). Why do autistic individuals show superior performance on the block design task?. *Journal of Child Psychology and Psychiatry, 34* (8), 1351-1364.

Shipp, N. J., Davidson, L., & Anthony, S. H. (2021). *Thematic and taxonomic categorisation in autistic adults*. Experimental Psychology Society, EPS Online, United Kingdom.

Simmons, S., & Estes, Z. (2008). Individual differences in the perception of similarity and difference. *Cognition*, *108*(3), 781-795.

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921-929.

Skuse, D. H., Mandy, W. P., & Scourfield, J. (2005). Measuring autistic traits: heritability, reliability and validity of the Social and Communication Disorders Checklist. *The British Journal of Psychiatry*, *187*(6), 568-572.

Slater, M., & Sanchez-Vives, M. V. (2016). Enhancing our lives with immersive virtual reality. *Frontiers in Robotics and AI*, *3*, 74.

Sloman, S. A., Over, D., Slovak, L., & Stibel, J. M. (2003). Frequency illusions and other fallacies. *Organizational behavior and human decision processes*, *91*(2), 296-309.

Smiley, S. S., & Brown, A. L. (1979). Conceptual preference for thematic or taxonomic relations: A nonmonotonic age trend from preschool to old age. *Journal of Experimental Child Psychology*, *28*(2), 249-257.

Smith, E. R., & Miller, F. D. (1978). Limits on perception of cognitive processes: A reply to Nisbett and Wilson.

Smith, E., & Medin, D. (1999). The exemplar view. In E. Margolis & S. Laurence (Eds.), *Concepts: Core readings* (p. 207–221). The MIT Press.

Smith, H., & Milne, E. (2009). Reduced change blindness suggests enhanced attention to detail in individuals with autism. *Journal of Child Psychology and Psychiatry*, *50*(3), 300-306.

Soulières, I., Mottron, L., Giguère, G., & Larochelle, S. (2011). Category induction in autism: Slower, perhaps different, but certainly possible. *Quarterly journal of experimental psychology*, *64*(2), 311-327.

Spackman, E., Smillie, L. D., Frazier, T. W., Hardan, A. Y., & Uljarević, M. (2023). Characterizing subdomains of insistence on sameness in autistic youth. *Autism Research*.

Spence S. H. (1998). A measure of anxiety symptoms among children. *Behaviour research and therapy*, *36*(5), 545–566.

Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Archives of internal medicine*, *166*(10), 1092-1097.

Stacey, R., & Cage, E. (2023). “Simultaneously Vague and Oddly Specific”: Understanding Autistic People's Experiences of Decision Making and Research Questionnaires. *Autism in Adulthood*, *5*(3), 263-274.

Stark, E., Stacey, J., Mandy, W., Kringelbach, M. L., & Happé, F. (2021). Autistic cognition: charting routes to anxiety. *Trends in Cognitive Sciences*, *25*(7), 571-581.

Stark, E., Stacey, J., Mandy, W., Kringelbach, M. L., & Happé, F. (2021). 'Uncertainty attunement' has explanatory value in understanding autistic anxiety. *Trends in Cognitive Sciences*, *25*(12), 1011-1012.

Taboas, A., Doepke, K., & Zimmerman, C. (2023). Preferences for identity-first versus person-first language in a US sample of autism stakeholders. *Autism : the international journal of research and practice*, *27*(2), 565–570.

Tavassoli, T., Miller, L. J., Schoen, S. A., Nielsen, D. M., & Baron-Cohen, S. (2014). Sensory over-responsivity in adults with autism spectrum conditions. *Autism*, *18*(4), 428-432.

Townsend, J. T., & Ashby, F. G. (1978). Methods of modeling capacity in simple processing systems. *Cognitive theory*, *3*, 199-139.

Townsend, J. T., & Ashby, F. G. (1983). *Stochastic modeling of elementary psychological processes*. CUP Archive.

Treisman, A. M. (1964). Selective attention in man. *British Medical Bulletin, 20*(1), 12–16.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive psychology*, *12*(1), 97-136.

Trembath, D., Germano, C., Johanson, G., & Dissanayake, C. (2012). The experience of anxiety in young adults with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities*, *27*(4), 213-224.

Tsagkaridis, K., Watson, C. E., Jax, S. A., & Buxbaum, L. J. (2014). The role of action representations in thematic object relations. *Frontiers in human neuroscience*, *8*, 140.

Tversky, A. (1977). Features of similarity. *Psychological review*, *84*(4), 327.

Vallee-Tourangeau, F., Anthony, S. H., & Austin, N. G. (1998). Strategies for generating Van de Cruys, S., Evers, K., Van der Hallen, R., Van Eylen, L., Boets, B., De-Wit, L., & Wagemans, J. (2014). Precise minds in uncertain worlds: predictive coding in autism. *Psychological review*, *121*(4), 649.

Vanmarcke, S., Noens, I., Steyaert, J., & Wagemans, J. (2018). Change detection of meaningful objects in real-world scenes in adolescents with and without autism spectrum disorder. *Autism*, *22*(6), 728-739.

Vermeulen, P. (2015). Context blindness in autism spectrum disorder: Not using the forest to see the trees as trees. *Focus on autism and other developmental disabilities*, *30*(3), 182-192.

Volden, J., & Johnston, J. (1999). Cognitive scripts in autistic children and adolescents. *Journal of Autism and Developmental Disorders*, *29*, 203-211.

Volden, J., Holdgrafer, G., & Mulcahy, R. F. (1993). Pragmatic Language Dysfunction in Autism: “Competence” or “Performance”?. *Journal of Clinical Speech and Language Studies*, *3*(1), 36-53.

Vosniadou, S., & Ortony, A. (Eds.). (1989). *Similarity and analogical reasoning*. Cambridge University Press.

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical psychology review*, *29*(3), 216-229.

Widmayer, S. A. (2004). Schema theory: An introduction. *Retrieved December*, *26*, 2004.

Wigham, S., Rodgers, J., South, M., McConachie, H., & Freeston, M. (2015). The interplay between sensory processing abnormalities, intolerance of uncertainty, anxiety and restricted and repetitive behaviours in autism spectrum disorder. *Journal of autism and developmental disorders*, *45*(4), 943–952.

Wimmer, L., Steininger, T. M., Schmid, A., & Wittwer, J. (2023). Category learning in autistic individuals: A meta-analysis. *Psychonomic Bulletin & Review*, 1-24.

Wing, L., & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: Epidemiology and classification. *Journal of Autism and Developmental Disorders, 9*(1), 11–29.

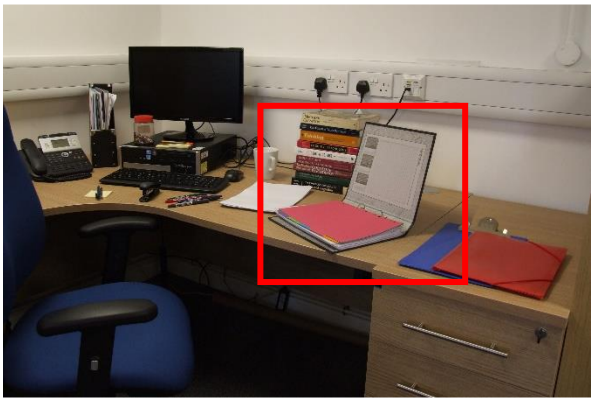
Wisniewski, E. J., & Bassok, M. (1999). What makes a man similar to a tie? Stimulus compatibility with comparison and integration. *Cognitive psychology*, *39*(3-4), 208-238.

Yi, L., Liu, Y., Li, Y., Fan, Y., Huang, D., & Gao, D. (2012). Visual scanning patterns during the dimensional change card sorting task in children with autism spectrum disorder. *Autism Research and Treatment*, *2012*.

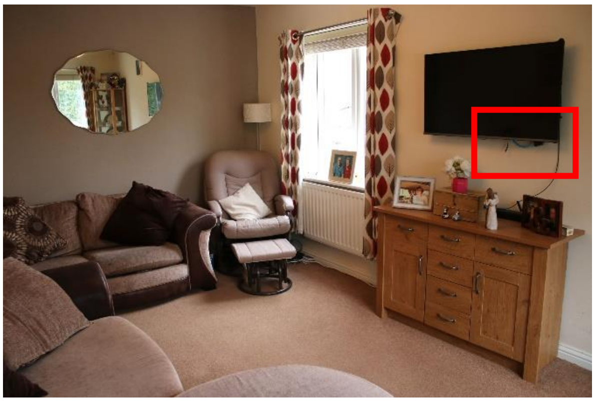
Appendices

Appendix A – Base bathroom, bedroom, living room, kitchen, and office images

Appendix B – Congruent changes

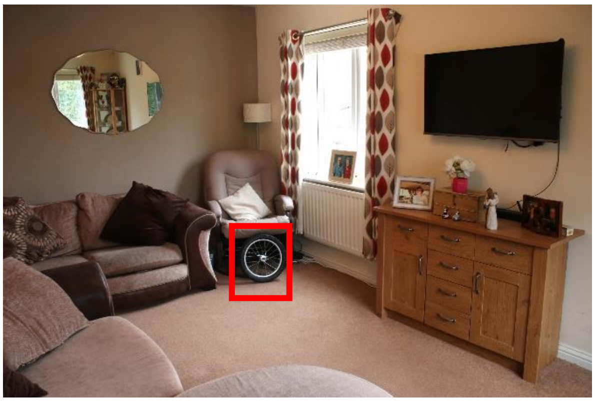
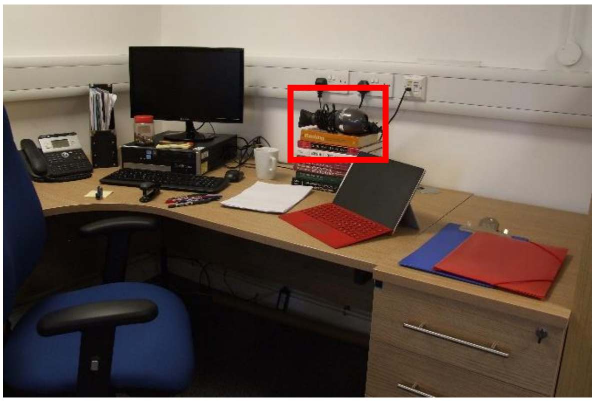


Appendix C – Detail changes



Appendix D – Incongruent changes



Appendix E – Position changes

Appendix F – Protocols and codes

AUTISTIC SIMILARITY – CHAIR_TABLE_PROTOCOL
I was effectively thinking how similar they both were to one another. **NI**
Pieces of furniture **NI**
They have similar shapes, with four legs and a flat surface. **SIMTAX** Often they are made from the same material too. **SIMTAX**
They are both wooden surfaces **SIMTAX** on which you can put things, so are similar in that way, **SIMTAX** but they are also different as they serve different purposes. **DIFFTAX**
They both look kind of similar, **SIMTAX** and they're both furniture. **SIMTAX** They're often paired together. **NI** But they're used for different things. **DIFFTAX**
They're both furniture **TAX** & they (can) go together **SIMTHEM** however they serve differing functions. **DIFFTAX**
Both are common pieces of furniture, **SIMTAX** typically found in the same room **SIMTHEM** both typically made out of wood, with a flat surface and four legs. **SIMTAX** They are frequently paired or come as a matched set. **SIMTHEM**
Are chair and table similar **NI**
you can sit on them both really **SIMTAX** and they both have 4 legs **SIMTAX** but they are different **GENDIFF**
They both are made from wood **SIMTAX** normally and are found together. **SIMTHEM**
both are peices of furniture, **SIMTAX** but serve different purposes so are moderately similar **DIFFTAX**

You can't have a chair without a table. The same goes for the reverse. They're a natural pairing. **NI**
They go together as a pair of objects **SIMTHEM** but also the words have the same number of letters and are the same kind of shape. **NI** They are both solid. **SIMTAX**
both are furniture **SIMTAX** but have different functions (you sit on a chair) **DIFFTAX**
They are both furniture, **SIMTAX** but different in shape **DIFFTAX** and function. **DIFFTAX**
Sitting at a chair and table **NI**
They are often paired together, **SIMTHEM** though chairs can often function on their own/be by themselves, so the two are closesly linked but not inextricably. **NI**
I was thinking about how a chair and a table are usually found together in a set **SIMTHEM** but they are not the 'same' item in that sense. **DIFFTAX**
They are similar in both being items of furniture, **SIMTAX** and therefore having related uses. **SIMTAX** However they are still distinct items **GENDIFF**
They are the same category of object: dining room furniture **SIMTAX**
both have 4 legs **SIMTAX** and can hold things **SIMTAX**
Chair and table go together and they function together as one unit most of the time so they're quite similar in that regard. **SIMTHEM**
I was picturing our dining room table, where we have chairs that match it. **SIMTHEM**
They both count as furniture **SIMTAX** but aren't completely similar. **GENDIFF**
both items of furniture **SIMTAX**
they're not that similar

NI but they can be made out of the same thing SIMTAX and both be in the same room SIMTHEM
Although they are different items, they are complementary. GENDIFF You often sit at a table when you are sitting in a chair. SIMTHEM
you sit on a chair. SIMTAX they might both be wood or metal/ even plastic. SIMTAX but you dont sit on a table and you wouldnt eat off a chair... DIFFTAX
They are both pieces of furniture SIMTAX and often found together SIMTHEM
You can use a chair like a table and vice versa NI
How similar they are by their close relation i.e. someone sits on a chair at a table. SIMTHEM
they are both furniture SIMTAX and you can place stuff on them SIMTAX you can also sit on both SIMTAX however not regularly on a table however they still have different functions DIFFTAX
A chair goes under a table SIMTHEM and you sit on a chair to work at a table SIMTHEM
You can sit on both theoretically SIMTAX
Food NI
chair for sitting down. Table for things on table not person.***[15] **DIFFTAX**
Chairs and tables can be made from the same materials SIMTAX and can be used together SIMTHEM and sold as a set. SIMTHEM They are different shapes DIFFTAX and can be used independently. DIFFTAX
a dining room

[15] *** indicates that a 3rd coder was consulted

NI
they are both items of furniture **SIMTAX**
Both are pieces of furniture found in the same setting **SIMTHEM** and are used together to achieve one goal e.g. eating dinner. **SIMTHEM** Both are often also good for interior design and can be customisable **SIMTHEM**
chair to sit on and table to sit at **NI**
they're both pieces of furniture, **SIMTAX** possibly made of same material, possibly not. **NI** they can be used in complementary usage **SIMTHEM**
Both pieces of furniture **SIMTAX** which often come together as a pair. **SIMTHEM**
They are both in the same room **SIMTHEM**
both are wood, **SIMTAX** have 4 legs **SIMTAX** and you use them together in dining room **SIMTHEM**
They both have similar structure and purpose (both have at least 3 legs, both are made to have things on top of them **SIMTAX** and in similar situations), **SIMTHEM** but their specific purposes differ in that a table is for putting objects on and the chair is for putting people on. **DIFFTAX**
Although they are generally made from the same material, **SIMTAX** they are not the same thing. You can't have multiple people sitting around a chair eating. **GENDIFF**
Both furniture **SIMTAX** plus they can be used together for eating or a desk. **SIMTHEM**
They are both pieces of furniture **SIMTAX**, however could potentially be different because of the design **DIFFTAX**
They are both pieces of furniture **SIMTAX** which go together in a set **SIMTHEM**
It is familiar as both are usually used together

SIMTHEM
They go together as a group of furniture to make a dining table. SIMTHEM
Both furniture, SIMTAX but with different functions. DIFFTAX
they are both (usually) four legged flat pieces of furniture. SIMTAX you can sit on both. SIMTAX also chairs are often at tables SIMTHEM
I wasnt thinking specifically about anything NI
They both have a flat surface to lay things on / sit on, SIMTAX both generally have legs, most commonly 4. SIMTAX However, chairs have backs which tables don't DIFFTAX and the function is different (sitting versus putting things on it), DIFFTAX although both can (and are) used for the other function, e.g. I might sit on a table when I'm teaching and I might put my clothes on a chair in the bedroom.******* NI
Chairs always seem to sit around a table. SIMTHEM

AUTISTIC SIMILARITY – KNIFE_SAW_PROTOCOL
I was thinking how similar they were to one another when comparing them.

NI
Tools that you use NI
Both are tools with a metal blade and a handle, SIMTAX and both are designed for cutting. SIMTAX However they are very different shapes DIFFTAX and they are used in different ways. DIFFTAX The way in which they cut items is also very different. DIFFTAX
They both fulfill the same purpose (i.e. to cut things) SIMTAX but generally the things that they are cutting are different and you would use one for (for example) wood and another for meat DIFFTAX
Knives are much smaller than saws usually. DIFFTAX You make the same motion using both more or less. SIMTAX They have a similar function SIMTAX but you use them on different types of objects (food versus wood). DIFFTAX
They're both implements for cutting things with – SIMTAX where both (admittedly only sometimes in the case of a knife) can have a serrated edge. SIMTAX However, one is more typically a kitchen or eating implement (though there are craft knives & the like) & the other is always a tool. DIFFTAX
Both are cutting implements, SIMTAX typically handled manually by a person, SIMTAX featuring a handle and cutting edge, SIMTAX both typically made of metal, SIMTAX sometimes with wooden or plastic handles. SIMTAX Dissimilar in that saws are typically much bigger and for cutting non-food objects. DIFFTAX
how similar are knife and saw NI
they are both sharp SIMTAX and used for cutting SIMTAX and are both made of metal SIMTAX
They can both cut things

SIMTAX
both are used for cutting, SIMTAX but do so in different ways, DIFFTAX and normally used to cut different types of objects, DIFFTAX moderately similar NI
They are both edged implements. SIMTAX
Although as objects they are similar, as words they have very different shapes. Knife is long and pointy and saw is short and squat. Knife is shiny, saw is rough. The 'i' (eye) sound is very manmade and manufactured, the 'aw' in saw is very earthy and animal. NI
Both are tools for cutting things, SIMTAX but a knife is generally used in kitchens (although also survival) DIFFTHEM a saw is much bigger DIFFTAX and used in DIY or by arbologist DIFFTAX
They are both cutting instruments, SIMTAX but a saw can be sharper than a knife (cutlery). DIFFTAX
A knife and saw being both used to cut things SIMTAX
There both cutting implements SIMTAX but I would tend to more closely associate knives with other kitchen utensils and cutlery and saws with other tools DIFFTHEM
Both items can cut things SIMTAX but one is a food based tool and the other has specific purposes in building trades. DIFFTAX
These items have related uses - both can be used to cut other objects – SIMTAX however they are distinct and not always closely associated. NI
A knife is a utensil for eating, a saw is a carpentry tool. DIFFTAX They exist in different categories. NI
both are the same shape SIMTAX and used to cut things, SIMTAX one just has a bigger handle DIFFTAX
They both cut SIMTAX

and are both sharp SIMTAX and the only real difference between them is size. DIFFTAX
To me, saws are giant knives that has many uses. NI
They are both tools SIMTAX but have different purposes DIFFTAX so i thought the middle was best NI
both used for cutting objects SIMTAX
they can both be tools SIMTAX but they wouldn't really be used for the same type of things DIFFTAX
They are both tools for cutting through things. SIMTAX
they both cut. SIMTAX both available in serrated and smooth format. SIMTAX not entirely similar as you wouldn't use a saw to cut beef... and you wouldn't saw wood with a knife. DIFFTAX it would take far too long and is completely inadequate to do the job NI
they both perform the same action of cutting something. SIMTAX A knife is for food and a saw for bigger items DIFFTAX
Both sharp SIMTAX and used to cut things. SIMTAX I knife can be serrated like a saw SIMTAX
A knife and a saw are both used to cut things so they both share a similar purpose SIMTAX but as objects their objectives are completly different. DIFFTAX
they both are used for cutting things SIMTAX one is for bigger things and the other is to cut smaller things DIFFTAX
They both are used to cut things SIMTAX
They both cut things SIMTAX
cutting stuff SIMTAX
Saw is for big things as woods. Knife for buttering or cut foods

DIFFTAX
similar because both are used for cutting SIMTAX but also come in many shapes and sizes for many purposes. NI
Tools NI
they both cut things SIMTAX
A knife and saw both are handheld tools that include a handle and a blade. SIMTAX Both can cut an assortment of items/objects. SIMTAX A knife can be even more similar when considering serrated knives in which a sawing motion is often used for cutting. SIMTAX
both used for cutting SIMTAX
they are both used to cut things, saw things, in particular, SIMTAX although there is a significant size difference between the two. DIFFTAX
Both blades used to cut things SIMTAX
They are both used to cut SIMTAX
both are sharp, SIMTAX have metal blades, SIMTAX can be used to cut SIMTAX
They both have similar functions SIMTAX and similar shapes, SIMTAX but both are used in different situations that the other would make little sense to use them in. DIFFTHEM
They are both sharp SIMTAX and cut things, SIMTAX but a knife is used to cut lighter things, DIFFTAX whereas a saw is used to chop trees etc - is more pointy DIFFTAX
A saw is like a larger knife but more sharp but see a knife. NI
They are both potentially weapons. SIMTAX
They both cut something SIMTAX although they are very different in size

DIFFTAX and how deep they can cut. GENDIFF
They are both sharp SIMTAX and used to cut SIMTAX
They are both cutting tools SIMTAX with jagged edges SIMTAX usually made of metal. SIMTAX
Both items are cutting implements. SIMTAX
both sharp objects used to cut things so are similar. SIMTAX however they are different shapes/sizes DIFFTAX and cut different sorts of things DIFFTAX
I wasn't thinking specifically about anything NI
Knives and saws have the same function (cutting something), SIMTAX both are made of metal, SIMTAX both are sharp SIMTAX and both can come in different formats. SIMTAX In this case, I wouldn't think of a dinner knife (I would rate the similarity between a dinner knife and a saw more like a 5), but a knife in general including hunting knives, so a sharp metal object. NI However, saws have teeth which knives (generally) don't have. DIFFTAX
They are both sharp objects SIMTAX that have the same function - cutting into stuff SIMTAX

AUTISTIC SIMILARITY – DOG_VET_PROTOCOL
I was thinking of vets where you take your dogs SIMTHEM

You take your dog to the veterinarian SIMTHEM
Both are mammals SIMTAX with similar physical features, i.e. four limbs, SIMTAX two eyes SIMTAX hair etc. SIMTAX However they are still different species DIFFTAX and look DIFFTAX and act extremely differently from each other. DIFFTAX
I don't think they're very similar at all, NI because whilst a dog would perhaps need the attention of a veterinarian at some point SIMTHEM they are not things that are comparable. DIFFTAX I rated it 2 rather than 1 as they do share some overlap in that a veterinarian might provide medical aid to a dog. NI
A dog is an animal whilst a veterinarian is a person and a particular profession. DIFFTAX They don't have much in common except both being mammals, SIMTAX and dogs going to the vet for treatment. SIMTHEM As individual concepts they're completely different. GENDIFF
Well, they're not completely dissimilar NI as they're both mammals SIMTAX & a vet would treat a dog - SIMTHEM however one is a person's job & the other is an animal/pet. DIFFTAX
Both are intelligent animals SIMTAX with four limbs, SIMTAX with two biological sexes, SIMTAX both are typically associated with the category of 'pets'.*** **NI CHANGE TO SIMTHEM** Otherwise both are seperate orders of animalia DIFFTAX and have highly different morphology. DIFFTAX
how similar are dog and veterinarian

NI
a dog is an animal and a veterinarian is a human DIFFTAX
A dog is an animal a veterinarian is a person. DIFFTAX
humans and dogs ar completely different types of animals DIFFTAX
Veterinarians operate chiefly on pets. Dogs are very popular pets. SIMTHEM
Dog is short, simple and basic. Veterinarian is long and fancy and complicated. They are very different people. (Maybe oddly) I don't see any hierarchy between the words - they're both good and quite satisfying words to say out loud, but almost like opposites - at the ends of a scale.*** NI
A vet is someone who fought in the war (no I'm joking it's a human who looks after animals) and a dog is an animal. NI Both are mammals SIMTAX but there is little similarity between canine and homosapien DIFFTAX
A dog is an animal, whereas a vetinarian is a human. DIFFTAX
A vet looks after a dog SIMTHEM
they are closely related, as you'd have to take a dog to a vet, SIMTHEM but vets aren't exclusively for dogs, so I might rank 'pet' and 'veterinarian' or 'vet' and 'doctor' closer NI
One is a pet, and another is a job role. DIFFTAX They are not similar words/things but merely two words that can be used in the same area (as in you would take your dog to a vet) SIMTHEM
Although these are clearly distinct (an animal and a human and/or occupation title) DIFFTAX they also have close associations - dogs being the animal most commonly treated by vets. SIMTHEM
Although conceptually I know a dog can be treated by a veterinarian, and a vet may come into regular contact with dogs, SIMTHEM and a vet is a type of animal (human): I do not place them into the same categories. A dog is a "pet" animal and a vet is a "career". DIFFTAX
one is a person and one is a dog DIFFTAX
They're not exactly similar but dogs need vets and vets have dogs as patients so you kind of think of them together. SIMTHEM
Dogs are one of the many animals that a veterinarian takes care of. SIMTHEM
Ones a human and ones an animal DIFFTAX

although maybe i should have considered they are both mammals.. **NI**
dog is an animal, veterinarian is a person who treats sick animals, not similar at all **DIFFTAX**
vets look after dogs, dogs needs to go to the vets sometimes **SIMTHEM**
A vet will often examine a dog, therefore they are closely related **SIMTHEM** albeit there are many differences between them. **GENDIFF**
a veterinarian is a person and doesnt look like a dog or walk on all 4s. **DIFFTAX** a dog doesnt hold a stefascope **DIFFTAX** or perform animal surgeries.. no thumbs. **DIFFTAX** a dog can go to a vet but thats the only time id put them together **SIMTHEM**
One is an animal, the other a job occupation. **DIFFTAX** A vet will work with a dog but I don't identify them as similar******* **DIFFTHEM**
One is a job type and one is an animal **DIFFTAX**
A veterinarian works with dogs all the time usually so they are familiar with dogs and have an instrinsic relation to them **SIMTHEM**
when dogs are sick they go to a vet **SIMTHEM**
You may take your dog to the vet **SIMTHEM** and dogs and vets are both mammals **SIMTAX**
A vet treats a dog **SIMTHEM**
my dog **NI**
Dog is a animal. vet is a person doctor for unwell animals **NI**
the only similarity I can think is that dogs and vets are often spoken about at the same time. **NI** The vet helps the dog. **SIMTHEM**
a dog is a pet and a vet works with pets **SIMTHEM** but they are not similar in themselves **GENDIFF**
they are associated with each other because a vet cares for dogs **SIMTHEM**
A dog is an animal that when hurt or sick can be treated by a veterinarian who specialises in the treatment and health of animals. **SIMTHEM**

Someone who owns or considers owning a dog may also scout out local veterinarians so that their pet can get help when needed **SIMTHEM**
both animal related **SIMTAX**
not at all alike as one is human animal and the other is a canine. **DIFFTAX** i should have taken into consideration, however, that they are both mammals and therefore have some degree of similarity **SIMTAX**
They are not similar... one is a profession, one is an animal **DIFFTAX**
Some link but not close **NI**
both go to vets **SIMTHEM**
One's an animal and one is the profession of a human, **DIFFTAX** both have slight ties to each other but overall the similarities are minuscule aside from association **NI**
One is an animal (a pet) and one is an animal nurse **DIFFTAX**
Dogs goes to a veterinarian **SIMTHEM** plus vets i think study and know more about dogs than cats and small animals. **SIMTHEM**
A dog is an animal and a veterinarian is a profession. **DIFFTAX**
Dog and humans are two different species. **DIFFTAX**
A dog is an animal and a veterinarian looks after animals **DIFFTAX**
A dog probably one of the most common animals that a veterinarian treats. **SIMTHEM**
One's a human profession, and the other is an animal. **DIFFTAX** While vets do work with dogs, this link does not equal similarity.*** **DIFFTHEM**
not that similar because dog is an animal and a vet is a person. **DIFFTAX** however they are related in some way because vets treat dogs **SIMTHEM**
I wasn't thinking specifically about anything **NI**
Just because a vet works with dogs doesn't make them similar.*** **DIFFTHEM** A vet is a human being, stands on two legs, talks, can think creatively; a dog is an animal with fur, walks on four legs and can't think creatively. **DIFFTAX** Now that I'm writing this down I'm thinking I might have scored it a 2 actually, because they are both sentient beings who are alive and can feel emotions. **SIMTAX**
Veternarian's often look after dogs as they are a very common pet

SIMTHEM

AUTISTIC SIMILARITY – MUG_CHAMP_PROTOCOL
I was thinking how similar they were to each other. **NI**

You don’t put champagne in a mug NI
A mug is a hard ceramic container for liquids with a handle on the side. Champagne is a sparkling alcoholic liquid. DIFFTAX They are extremely different. GENDIFF Their only similarity is that they are both in some way related to the act of drinking but this is a very small connection in my opinion. SIMTAX
Mugs and champagne don't share any of the same qualities or functions. DIFFTAX Whilst I suppose it is possible to drink champagne out of a mug it is not typically done. I struggled with whether to put this choice as a 1 or a 2 but ultimately decided that just because a mug is a drinking vessel doesn't mean that champagne would typically be drank from one so in my mind they have no overlap. NI
A mug is a vessel for liquid, whereas champagne is a specific liquid. DIFFTAX They're associated but as individual items they're not similar at all in any of their properties. DIFFTAX
Whilst I guess you could drink champagne from a mug, it's not a usual pairing... NI Whilst one is a vessel for drinking (usually hot) drinks from - whilst the other is a sparkling/effervescent alcoholic drink that's usually served at a very low temperature. DIFFTAX
One is a drinking vessel, the other is a drink. DIFFTAX One is solid the other liquid. DIFFTAX One is typicallt reusable, the other is a consumable. DIFFTAX Shape and use is completely different, DIFFTAX although both are generally associated with the category of 'drinking', especially 'alcohol'. SIMTHEM
how similar are mug and champagne NI
a mug is a ceramic receptacle for usually warm drinks, DIFFTAX champagne is a cold fizzy drink for special occasions DIFFTHEM
one is a drink the other is a container. DIFFTAX
mug is a solid object, champers is. a liquid DIFFTAX
Mugs are rarely, if ever, associated with champagne. DIFFTHEM
I like the idea of someone drinking champagne out of a mug. Really, why shouldn't you? The notion it needs a special glass is pretty random. But, as words, they are very different. Mug is short and solid, champagne is twirly and has quite a high opinion of itself (although it isn't as fancy as it likes to think it is). They are just a bit connected by the Gs, which is what stops them being completely different.

NI
A mug is a recepticle for liquid, champagne is a drink. DIFFTAX It is very rare for a person to drink champagne from a mug (although I have) NI
A mug is an item used for drinking out of and champagne is a drink, they are not similar items. DIFFTAX
Pour champange into mug NI
Both are related to drinking SIMTAX but I never accosicate the two together in my mind GENDIFF
One is a holder for liquid and champagne is a type of drink. DIFFTAX Whilst you may put champagne in a mug, they are not 'similar' GENDIFF
These have some similarity in that they relate to drinks and drinking, SIMTAX however they are very different, one being a utensil, one a drink DIFFTAX
You do not pour champagne into a mug - so a mug and champagne does not go together. DIFFTHEM
both can be bottle shaped SIMTAX
Mug is a container for hot drinks and champagne is a liquid often served chilled so they really have nothing to do with each other. DIFFTAX
Champagne isn't usually served in a mug, from my understanding NI
Champagne is had in a glass so I didnt see any link to a mug NI
mug is a vessel to hold liquid in, champagne is an alcoholic beverage, not similar at all DIFFTAX
you can drink champagne out of a mug but people don't really do that NI
Champagne can be served/drunk from a mug, so they are both objects/things used in the process of drinking. SIMTAX
a mug you drink out of, champagne is a liquid which you cant drink out of. DIFFTAX sure you can put champagne in the mug. but champagne isnt what i think of when i hear mug NI
Champagne is a drink and a mug holds drinks DIFFTAX but not linked to drinking champagne from NI
One is a solid container and the other is a type of liquid DIFFTAX
Not really related, you would not typically put champagne into a mug NI
not linked

NI
A mug is something you drink from, and champagne is a drink DIFFTAX but I didn't think they are very similar because you drink one but can only drink from the other. DIFFTAX
I don't see how they are related in anyway NI
pop the cork NI
both are for drinking SIMTAX
Mugs contain drinks generally and champagne is a drink. SIMTAX
they are not similar as one can contain liquid and the other is a liquid but you would not drink champagne in a mug DIFFTAX
they are not related at all because one is a liquid and one is a drinking vessel DIFFTAX
A mug is designed for holding liquids whilst champagne is a liquid. Whilst a mug is not the right kitchenware for champagne, it is still an option
mug is solid champagne id liquid DIFFTAX
that they are not similar at all. NI one is a beverage and the other a receptacle for drinking hot beverages usually DIFFTAX
They have no similarity. One is liquid one is solid DIFFTAX
Champagne is for special occasions where as a mug is for everyday use. DIFFTHEM
one is a cold drink the other holds a hot drink DIFFTAX
One is a consumable liquid, the other is a solid object. DIFFTAX
One stores a drink, and the other is an alcoholic drink DIFFTAX
Mug and champagne have nothing in comman the only reason i gave it a one was that you could drink champagne in a mug (it is possible) NI
A mug is an item you can drink from yet the champagne is the actual drink. DIFFTAX
One is an object and the other is a drink. DIFFTAX
A mugs holds liquid and champagne is a liquid SIMTAX but you don't usually champagne in a mug DIFFTAX
They are unrelated because you would not drink champagne out of a mug. DIFFTAX
Champagne is a beverage. Mug is a container. DIFFTAX
one is a drink and the other is a type of cup so they're not similar. DIFFTAX

champagne and glass or mug and tea/coffee would have had a slightly higher similarity (still not that similar) **NI** but mugs and champagnes definitely don't go together **NI**
I wasn't thinking specifically about anything **NI**
One is an object, the other is a liquid. **DIFFTAX** A mug cannot be consumed, **DIFFTAX** it is solid, **DIFFTAX** its used to drink from; **DIFFTAX** whereas champagne is something that is drunk (and not from a mug), **DIFFTAX** it is liquid, **DIFFTAX** and can't really be used for anything other than consumption **DIFFTAX** whereas a mug can be used for storage as well and is therefore a bit more versatile. **DIFFTAX**
Mugs are normally used for hot liquids, and not cold, bubbly ones such as champange. **DIFFTAX**

AUTISTIC DIFFERENCE – CHAIR_TABLE_PROTOCOL
You can also sit on a table. **SIMTAX**

a chair and a table NI
I was thinking that they are interrelated because you often find them together, you use a chair to sit at a table. SIMTHEM They are similar because you sit things on them both, you sit people on chairs and plates, cutlery, glasses, flowers etc on tables. SIMTAX But they are also different as tables and chairs can be found separately DIFFTHEM and you wouldn't sit on a table or sit flowers on a chair. DIFFTAX
Both have four legs SIMTAX and a surface SIMTAX
They can be separate pieces NI
They are similar as they are both items of furniture SIMTAX but different as they have different functions DIFFTAX
a chair is designed for sitting on. tho both have 4 legs there designed for 2 diffrerent purposes. DIFFTAX
Technically they're different words*** NI but you associate chairs and tables together so I rated them fairly similar SIMTHEM
They are both furniture SIMTAX but have different functions DIFFTAX
Theyre both pieces of furniture, I was going to go extremely similar SIMTAX but they have different purposes so therefore they are slightly different than extremely similar DIFFTAX
Completely different objects DIFFTAX
they are both 'furniture' SIMTAX and may be similar material SIMTAX
Chair and table are often grouped together as part of a set especially in dining table and chair where it is necessary to sit and eat food at a table. SIMTHEM Both are furniture items . SIMTAX
a table goes next to a chair, SIMTHEM but then I realised that they are quite different as a chair is for sitting and a table is for putting things on. if that makes sense? DIFFTAX

Chairs are for sitting on. Tables are for placing things on. DIFFTAX
They are both furniture SIMTAX and can serve the same purpose. You can use a chair as a table and sit on a table. SIMTAX
A chair is for supporting you while you eat and a table is to support your food. NI
Both items are household furniture, SIMTAX often made out of the same materials SIMTAX and put in the same room. SIMTHEM The only main difference is their function. DIFFTAX
that they are both furniture SIMTAX
Thinking about how they are both pieces of furniture. SIMTAX
I was wondering if was supposed to be comparing the objects or the words NI
They have dfferent functions. You sit on a chair and you sit at a table. DIFFTAX
They're usually made from the same stuff SIMTAX and both serve a function that is part of the same process. SIMTAX
I was thinking that functionally they are different DIFFTAX but they also are commonly paired together SIMTHEM
You could sit on both SIMTAX They are made from the same materials SIMTAX
You can buy these as a set SIMTHEM but they have different functions. DIFFTAX
Tables and chairs are often associated with each other - for working, eating, etc. SIMTHEM
They are not really similar NI but associated with each other SIMTHEM and if you really want you can use them a bit interchangeably SIMTAX
They ususally come as a set SIMTHEM and as such will be made from the same or similar material SIMTAX and will match each other aesthetically SIMTAX

They are from the same properties SIMTAX
They tend to be made of similar materials, using similar techniques. SIMTAX Both are types of furniture. SIMTAX They tend to be found together. SIMTHEM
they need to be used together*** SIMTHEM
i was thinking about how they would be used i.e. sitting in a chair and eating at a table SIMTHEM
Sort of similar. Made of similar materials, SIMTAX both furniture. SIMTAX You sit on one and sit at the other. SIMTAX
A chair and table go very well together and are usually associated with one another. SIMTHEM
They go together and match you sit on a chair at the table so they go together SIMTHEM
They both serve different purposes DIFFTAX
Both objects are furniture, SIMTAX can be made of the same materials and by the same people. SIMTAX They are often sold together SIMTHEM but are used for different but related activities, you might sit on the edge of a table for a casual conversation but you wouldn't eat your dinner from a chair DIFFTAX
BOth are pieces of furniture SIMTAX and both can be utilised as each other in reverse. Sitting, eating from etc. SIMTAX
they are both furniture SIMTAX but one is for sitting on and one is not DIFFTAX
They are both furniture items SIMTAX and are frequently used together. SIMTHEM
They dont look the same DIFFTAX
both are furniture SIMTAX and go together SIMTHEM
A chair and a table are fairly similar. NI

Traditionally, both are made of wood **SIMTAX** and tend to come together as a matching set. **SIMTHEM** They both carry out a linked purpose: the table allows someone to place things on it and the chair allows you to utilise the table by sitting on it. **SIMTAX**
They are aesthetically very different, **DIFFTAX** though have related meanings so I picked a number nearish the middle **NI**
Both can be used as either so not completely different **SIMTAX** but tend to look different/have diifferent features, eg a table is generally a flat surface with legs. A chair often has a back and a slightly shaped or cushioned surface. **DIFFTAX**
That the chair goes with a table **SIMTHEM**
They go together **SIMTHEM**
Both are types of furniture, **SIMTAX** however, they are different types of furniture **DIFFTAX**
you sit on chairs but you don't sit on a table, the uses of these two things are different **DIFFTAX** even though they are often used together **SIMTHEM**
Same category - furniture, **SIMTAX** same features when thinking of traditional chairs and tables - made of wood, **SIMTAX** four legs, **SIMTAX** straight lines; **SIMTAX** similar associations - frequently used together (for eating, work, etc.) **SIMTHEM**

AUTISTIC DIFFERENCE – KNIFE_SAW_PROTOCOL
Both are used to cut things. **SIMTAX** A szaw can basically be a very big knife, or a knife is a very small saw.

NI
a knife and a saw NI
Both have serrated edges SIMTAX and are used to cut things SIMTAX but they re different in size DIFFTAX and appearance DIFFTAX and cut different materials. DIFFTAX
This one threw me, because they seem completely different GENDIFF but they actually have a similar purpose SIMTAX
a knife is used for cutting food and a saw is for cutting bigger objects such as wood DIFFTAX
They are similar in that they both cut things SIMTAX but have very different applications GENDIFF
both designed to cut. SIMTAX basically build the same SIMTAX just diffrent sizes DIFFTAX
They're both tools used to cut things in some way SIMTAX
Both sharp options NI
Theyre not that different because they can both cut things. SIMTAX the main similarity is in serrated blades which function almost identically to a saw SIMTAX
Both cut, SIMTAX but cut different things DIFFTAX so similar. NI
they are both metal SIMTAX and cut things. SIMTAX the only difference is scale - saws cut bigger things than knives DIFFTAX
though both knife and saw are tools used for cutting, SIMTAX each has a different usage DIFFTAX and purpose.

DIFFTAX Knife is used to cut and or slice whereas saw is for sawing and cutting. DIFFTAX Both however are made of metal SIMTAX
it depends on the type of knife. In my head I was picturing a sharp chef's knife which cuts in a slicing action. but if it was a serrated knife then it has many similarities to a saw NI
They are both sharp tools. SIMTAX
They are both tools SIMTAX but the knife is used for cutting food while the saw for cutting wood DIFFTAX
A knife and saw both cut through materials. SIMTAX The only slight difference is one is bigger than the other. DIFFTAX
Both are tools used to cut things SIMTAX and have a roughly similar shape, SIMTAX but their usage is very different. A knife is used for food while a saw for materials like wood or metal. DIFFTAX They are also used by different people at different times. DIFFTHEM
gardening work NI
Both are used for cutting. SIMTAX
I thought, both choppy and monosyllabic NI
A knife can be small but a saw is larger. DIFFTAX Althought both are used to cut things. SIMTAX
Both are made of metal SIMTAX and function to cut things. SIMTAX
you use the same motion of action for both SIMTAX but they serve different functions DIFFTAX
A saw is just a big knife NI
Saw is specifically for cutting metal or wood. DIFFTAX Knife's dare for cutting other things. DIFFTAX Also most knifes are used in a kitchen and saws are used for DIY. DIFFTHEM
They are both tools

SIMTAX but used for different activities DIFFTAX in very different settings DIFFTHEM
Both cut, SIMTAX but in different ways DIFFTAX
Both are used for cutting things, SIMTAX most table knives are toothed like saws SIMTAX
They are both used to cut things SIMTAX but they are not similar in any other way NI
They are both tools used for cutting things, SIMTAX but different sizes DIFFTAX and for different purposes. DIFFTAX
they are related NI
I was think that they were both cutting tools, SIMTAX but also how their cutting action differed slightly DIFFTAX
Both can look similar, SIMTAX used for cutting, SIMTAX Handle SIMTAX and metal blade. SIMTAX Not the same though. DIFFTAX
A knife and saw are both used for cutting purposes. SIMTAX
both sharp SIMTAX and cut things SIMTAX
They are both sharp objects SIMTAX that serve to fulfill similar purposes SIMTAX
Both are cutting tools, SIMTAX usually made of metal, SIMTAX but the knife often uses a smooth action while the saw rotates or goes back and forth.

DIFFTAX Knives don't always have a seratted edge but a saw always will. DIFFTAX Also a knife can be used in many contexts--violence, food prep, crafts--while saws tend to be used only in industry or craftwork DIFFTHEM
Both can be used to cut in some way, SIMTAX Both have the same fundtion SIMTAX
they are both for cutting, SIMTAX but for cutting entirely different things DIFFTAX
They are both cutting tools, SIMTAX but they are used in very different circumstances DIFFTHEM and a knife is something that people use daily whereas a saw is only used occasionally. DIFFTHEM
They do the same thing SIMTAX and a serrated knife looks like a saw SIMTAX
both are used for cutting different things but with same outcome SIMTAX
Both have sharp metal blades SIMTAX that are used for cutting things. SIMTAX However, a knife is usually for food and a saw is for wood or metal. DIFFTAX You could use a saw in the place of a knife when cooking but it probably wouldn't work as well. SIMTHEM
Similar actions performed with the objects, SIMTAX but very different etymological roots NI
Both same principle NI but knife can be smooth or serrated. Saw is only serrated. DIFFTAX Saw tends to be bigger than a knife. DIFFTAX So very similar but have recognisable differences. NI
That they both cut into things SIMTAX
A saw is a long knife with teeth NI
Both are types of tools, SIMTAX both can be sharp

SIMTAX and are used for cutting things SIMTAX but have a different design DIFFTAX
they are both used to cut things, SIMTAX but one is for big things and one is for small things DIFFTAX
Both used for cutting SIMTAX made of similar materials SIMTAX type of edge SIMTAX and cut made SIMTAX

AUTISTIC DIFFERENCE – DOG_VET_PROTOCOL
They are related, SIMTHEM

but they are different things. GENDIFF A dog is an animal, a vet is a person. DIFFTAX
a dog and a vet NI
They are similar in that they are often found in the same places and same circles SIMTHEM but a dog is a pet and an animal whereas a vet is a person and a trained specialist. DIFFTAX
They go together as pair, SIMTHEM but they are very different things. GENDIFF
because when I think of vets I think of dogs NI
They are very different as one is an animal and one is an occupation DIFFTAX but they are related because veterinarians great dogs SIMTHEM
one is human who has trained to care for animals. dogs and quadpeduial and veterinarians are mainly bipeds. veterinrians are mainly higher in itelligance and
I rated them similar because dogs and vets are associated together SIMTHEM
A dog is a animal and a veterinarian is a job - DIFFTAX they link because it is a veterinarians job to care for a dog SIMTHEM
One works with animals and the other is an animal. DIFFTAX they're both living creatures SIMTAX so they share that in similarity but not much else. NI
One is an animal and one is human DIFFTAX
they are both living creatures, SIMTAX but they have very different functions DIFFTAX
Dog is an animal and veterinarian is a person and an occupation. DIFFTAX They may be linked as a vet can treat a dog for an illness. SIMTHEM (if we assume that the dog needs medical treatment when not all dogs need to be treated by a vet, e.g wild feral dogs) NI
they both belong in the same category in my head. NI
Dogs are pets, veterinarians are people. DIFFTAX
A dog is not a person and a vet is not a dog DIFFTAX
A dog is an animal and a vet is a human being.

DIFFTAX
A dog is an animal that can't talk, DIFFTAX do complex things, DIFFTAX and isn't as intelligent as a veterinarian who is a human being capable of many more things. DIFFTAX A vet often works on dogs, SIMTHEM but that does't make them more similar to each other. NI
dog at a vets NI
Somewhat similar as veterinarians work on dogs. SIMTHEM
Lots of syllables in veterinarian NI
A dog is an animal. DIFFTAX A vet is someone who can see the dog when they are ill. SIMTHEM A vet is usually a person. DIFFTAX
While both mammals, one is a human and the other is canine DIFFTAX
both technically animals SIMTAX but a vet is human and works on all different types of animals including dogs. SIMTHEM Dogs have no similar behavior DIFFTAX or function DIFFTAX
One is an animal The other takes care of animals DIFFTAX
A Veterinarian is an occupation for a person a dog is a domesticated animal. DIFFTAX I scored this as a 6 because of the reason a veterinarian works with animals of which a dog is one. SIMTHEM So that was my link between the two. NI
A vet would likely look after a dog if it was unwell or injured SIMTHEM
They are two objects often seen together SIMTHEM but not similar in function DIFFTAX or form DIFFTAX
They are different species DIFFTAX
One helps the other

SIMTHEM
The rating would depend on the context, but confusing the two would have serious consequences. NI
Veterinarian takes care of dogs SIMTHEM
I was thinking about the relationship between dog and vet i.e. the vet would provide a service for the dog SIMTHEM
Completely different things. GENDIFF Just cause a vet works with dogs, doesn't mean they're similar. I just ate an apple. Doesn't mean I'm like an apple. NI
They are linked through the fact that a dog will be taken to a veterinarian if they are sick. SIMTHEM
dogs go to the vet SIMTHEM
A dog is not a human DIFFTAX
One is an animal, which may do a basic job/task, the other is a human who has taken several years of education to look after animals. DIFFTAX while they are both alive SIMTAX and could be seen in the same context SIMTHEM they could not fulfil each others roles DIFFTAX
Both in some way fight a war, NI they live, SIMTAX hey function as beings, SIMTAX but different genetics DIFFTAX and purpose DIFFTAX
a dog goes to the vet SIMTHEM but one is human and one is an animal DIFFTAX
Dogs often go to a veterinarian for medical treatment so I find it easy to think of the two words together. SIMTHEM
One is a human, one is a dog DIFFTAX
although vets treat dogs - that's the only connection; SIMTHEM they are wholly different in their make-up and functions DIFFTAX
A vet works with dogs and provides a service for them. SIMTHEM

A vet is very knowledgeable about dogs.
Extremely different words, **NI** but dogs and vets interact regularly **SIMTHEM**
Dog is canine, vet is human. **DIFFTAX** mild similarities as both are mammals **SIMTAX** but no one would ever confuse the two. **NI**
That vets help dogs feel better **SIMTHEM**
Totally different. **GENDIFF** But something could be even more different eg dark matter **NI**
Veterinarians are humans, dogs are not **DIFFTAX** and while vets do deal with dogs **SIMTHEM** they have nothing in common **GENDIFF**
a veterinarian is a person and a dog is an animal, **DIFFTAX** they could both be in the same place at the vets **SIMTHEM** but they are not the same thing **GENDIFF**
Different types of animal **DIFFTAX**

AUTISTIC DIFFERENCE – MUG_CHAMP_PROTOCOL
A mug is typically for hot drinks, champagne is served cold. **DIFFTAX** Also one is a liquid and the other is a solid object!

DIFFTAX
a mug and some champagne NI
one is a drink and one is something you drink from, DIFFTAX their only common factor is that they both touch your mouth. SIMTAX
One wouldn't generally drink champagne from a mug, and they are completely different things. But they can work together.
as you do not drink from a mug for champagne NI
They have no relation to each other. You wouldn't even drink champagne from a mug NI
-
mug designed to hold liqued one is a liquied. DIFFTAX
I didn't rate them similar because they're not usually associated together DIFFTHEM
Different as one is a object and the other is a drink DIFFTAX but they link are you can drink champagne out of a mug SIMTAX
a mug would hold liquids but champagne is a liquid, so they are not similar. DIFFTAX
Two different objects DIFFTAX
mug is a drinking vessel, but just because champagne is a drink, shouldn't, imo, make it similar to mug. DIFFTAX it could be 'associated with' a drinking vessel, SIMTHEM but is very dissimilar to a mug. GENDIFF
A nug is a vessel for containing liquid but it is not meant for containing champagne. DIFFTAX Champagne is usually drunk out of a glass/flute. DIFFTAX Champagne is usually a posh drink mostly used for entertaining or for celebratory events whereas a mug is used for everyday purposes and mostly to serve or coffee for ordinary events DIFFTHEM
one is a liquid, a liquid can go in a mug SIMTAX
Mug is a cup. Champagne is a beverage. DIFFTAX
They are related but very tentatively. SIMTHEM The mug is a drinking vessel while the champagne is a drink. DIFFTAX
Mug is generally for coffees and other hot drinks. Champagne is cold and served in a glass. DIFFTAX
A mug can be used to drink champagne, SIMTAX

but it's a completely different thing. GENDIFF It's a container for holding liquids while champagne is only a liquid. DIFFTAX You can't drink out of champagne, and you can't pour yourself a mug. DIFFTAX
drinking champagne in a mug NI
You drink champagne from a glass not a mug so not a close link. DIFFTAX
I'm panicking. Should I be comparing the objects or purely the words? NI
A mug is used to for drinks. Champagne is a sparkly, bubbly drink used for celebrations. SIMTAX
One is a solid container and the other a liquid DIFFTAX
a mug will usually hold hot drinks DIFFTAX and is a solid object. DIFFTAX Champagne is usually served in a glassware flute DIFFTAX and is a alcoholic liquid DIFFTAX
One holds drinks one is a drink DIFFTAX
Very different. GENDIFF One is a cold liquid alcoholic drink and the other is an object you hold warm to hot liquids in. DIFFTAX
One is a drink and the other is a receptacle for holding drinks, DIFFTAX but I hope people wouldn't put champagne in a mug... NI
A mug is a vessel to hold liquids and champagne is a liquid, so they again can be linked indirectly SIMTAX but this is not the same as being similar GENDIFF
You could drink champagne from a mug but it's not traditionally done NI
One is used for liquid, one is a liquid SIMTAX
One is a liquid and one is a solid. DIFFTAX
champagne can be put in mug NI
I was thinking that you could drink champagne from a mug, but that it would not be usual to do so NI
Not similar other than one is a drink and the other you can drink from. DIFFTAX

You can drink Champagne from a mug; however this would be considered unusual as it is normally from a glass. **NI**
one is a celebration drink and the other is what you drink tea from **DIFFTHEM**
Chapagne is a fermented wine which is a liquid and a mug is a solid object **DIFFTAX**
A mug is a ceramic container for liquid, **DIFFTAX** champagne is an overpriced sparkling beverage made from grapes in a specific region of france. **DIFFTAX** These items would not usually interact **NI**
Solid vs liquid there is no similarity to function form or anything else **DIFFTAX**
one is a liquid and one is solid, **DIFFTAX** you could use a mug for drinking champagne but most people don't **NI**
A mug is usually used to drink tea or coffee, but not to drink champagne. **DIFFTAX**
Mug holds liquids, Champagne is a liquid. **NI** Theyre not the same because they cant do the same thing **DIFFTAX**
a mug wouldn't be used for champagne – **DIFFTAX** one is a drink while the other is simply a vessel but can be used for anything **DIFFTAX** and would be closer connected to other things **NI**
Champagne is a drink whereas a mug is a utensil that can be used to drink from. **DIFFTAX** However, this doesn't provide much of a link as champagne is drank from a glass. **DIFFTAX**
Some similar sounds when said but very different worss **NI**
mug is solid container. champagne is liquid and has to be contained. **NI**
Who puts Champagne in a mug? **NI**
Different objects, **DIFFTAX** different states, **DIFFTAX** different use, **DIFFTAX** but some things are even more different eg mug and romance **NI**
Mugs and champagne bottles both hold liquid **SIMTAX** but have very different designs **DIFFTAX**

champagne could be drank from a mug, but it is not usually, so i don't think they are very similar **NI** as one is a drink and one is something you drink out of, but they don't match up well **DIFFTAX**
Mug is a solid object to drink from, Champagne is a liquid to drink - solid v liquid **DIFFTAX**

NON-AUTISTIC SIMILARITY – CHAIR_TABLE_PROTOCOL
the two items go together **SIMTHEM** and have 4 legs **SIMTAX** and are often made of the same materials

SIMTAX
The chair and table are used for sitting . SIMTAX Furthermore, mainly made out of wood. SIMTAX
you use them together, you sit on a chair at a table SIMTHEM
Chair and table are both furniture SIMTAX and they are usually together SIMTHEM
that they went together SIMTHEM
mostly made of the same materials SIMTAX and often used in unison SIMTHEM however can be used for different purposes DIFFTAX and therefore not extremenly similar only very similar NI
they tend to be found in the same place SIMTHEM but are not for the same function DIFFTAX
You normally see a chair when there is a table. SIMTHEM
theyre both always together and usually used at the same time SIMTHEM
That chair and table goes hand in hand, SIMTHEM though not similar in terms of similarity but in terms of things that go together. SIMTHEM
they go together, often when you see a chair you see a table and vice versa SIMTHEM
They are both furnitures SIMTAX
Nothing NI
Their structure, SIMTAX Use SIMTAX and usual location SIMTHEM
A chair has a different purpose to a table. DIFFTAX
Something you sit on NI Furniture SIMTAX Wooden SIMTAX

I believe they are really similar as they have just some pieces less or more from each other SIMTAX
They are both objects which go together SIMTHEM but the words don't look similar so in-between being similar and not NI
are furniture SIMTAX
the similarities of when they are used SIMTAX
I think there are different things GENDIFF but because they go together everywhere metaly appear similary SIMTHEM
they are both pieces of furniture SIMTAX
Both made of wood SIMTAX both furniture SIMTAX both in the dining room often SIMTHEM
chair and table are very often seen together SIMTHEM
They go together, SIMTHEM but are they actually similar? NI
FURNITURE SIMTAX
I was picturing the chair and table set in my house, SIMTHEM and thinking about their appearance SIMTAX and function. SIMTAX
a chair is for people to sit on, SIMTAX a table is for objects to be placed on SIMTAX
How likely they are to be confused NI and how they often appear in same places SIMTHEM and have similar uses. SIMTAX
Chair and table are both furniture so are similar SIMTAX but very different as well GENDIFF
Chair and table go together for meals or working at. SIMTHEM
i thought what they looked like

SIMTAX
They are paired to serve the same purpose, **SIMTAX** made from similar materials, **SIMTAX** however look very differently. **DIFFTAX**
both household furniture **SIMTAX**
they're both furniture, **SIMTAX** both have a flat surface on which things or people can be placed or sat, **SIMTAX** both often made of same materials **SIMTAX** however their primary functions differ **DIFFTAX**
furniture **SIMTAX** that normally goes along **NI**
They are both items of items of furniture so on that basis they are similar, **SIMTAX** however not identical. **GENDIFF**
They are similar as table and chairs go together **SIMTHEM**
You sit on a chair at the table. **SIMTHEM**
Food **NI**
chairs go with tables **SIMTHEM**
I was thinking about how little they are the same **GENDIFF**
A kitchen with a dining table and chairs **SIMTHEM**
Dinner*** **SIMTHEM CHANGE TO NI**
Table & chairs is often a combination used together so literally they are similar words but written down they are not similar at all **NI**
Dining room, set, matching **SIMTHEM**
I imagined them together in a kitchen **SIMTHEM**
They both go together in a dining and working environment; to use a table you often need to be seated at a chair. **SIMTHEM**
Both items have 4 legs **SIMTAX** and can often be made of similar materials **SIMTAX** but they ae quite different in terms of function

DIFFTAX
the two items usually appear together, SIMTHEM have four legs SIMTAX and are made of similar materials SIMTAX
that is was worded the wrong way round NI
They are both types of furniture SIMTAX but with different purposes DIFFTAX and can be made from a range of different materials depending on their use DIFFTAX
A chair is for sitting on, a table for putting things on - DIFFTAX however table and chairs do 'go together' SIMTHEM they don't usually look alike. DIFFTAX
They are objects that go hand in hand, you sit in a chair and use the table. SIMTHEM
Chair and table can be classified as furniture which makes them similar. SIMTAX

NON-AUTISTIC SIMILARITY – KNIFE_SAW_PROTOCOL
both serrated blades SIMTAX used for cutting SIMTAX
Both of them are usin for cutting materials. For same purpose. SIMTAX

both used for cutting SIMTAX
They are both used for cutting SIMTAX but the material they cut are different from each other DIFFTAX
that they were similar NI but also had different functions DIFFTAX although actually i suppose they both cut! SIMTAX
knife and saw can be used for the same purposes of cutting things SIMTAX and are both very sharp SIMTAX however used in different contexts and environments, DIFFTHEM also one may be more powerful and useful than the other DIFFTAX
both can be used to cut items SIMTAX
Knife and saw are used to cut things. SIMTAX
they're both sharp. SIMTAX both used to cut into things SIMTAX
Both knife and saw can cut, SIMTAX though in a different way.. DIFFTAX
a saw is like a bigger version of a knife but that is their key difference which doesn't make them extremely similar, DIFFTAX they are also used for very different things DIFFTAX
Nothing NI
Nothing NI
Shape SIMTAX and function SIMTAX
They are both used to cut with a sawing motion. SIMTAX Similar purpose. SIMTAX
Use to cut something SIMTAX Both sharp objects SIMTAX Similar shaped objects

SIMTAX
they are moderately similar for me NI
They are both sharp objects SIMTAX
does not have similarity NI
the similarities of how they are used SIMTAX
to my they are different GENDIFF
they both cut things SIMTAX and are sharp SIMTAX
both sharp SIMTAX both used to cut things SIMTAX both can be dangerous SIMTAX both should stay away from children NI
both are sharp SIMTAX and are used to cut things SIMTAX but they look differentely DIFFTAX and used for cutting different things DIFFTAX
Similar purposes, SIMTAX different contexts DIFFTHEM
USED TO CUT ITEMS SIMTAX
I pictured an ordinary kife versus a saw and assessed their functions and similarities. NI
they are both made from metal SIMTAX and used to cut things SIMTAX
They are very similar objects NI and they look similar SIMTAX and evoke similar feelings. NI
They are very similar they do the same thing SIMTAX
Knife and saw are cutting implements SIMTAX
i thought about how they both do the same job

SIMTAX
I don't see any similarity, GENDIFF neither in function, DIFFTAX nor in appeareance. DIFFTAX
Both for cutting SIMTAX but used in different contexts DIFFTHEM
both are sharp objects SIMTAX used for cutting SIMTAX
they both cut SIMTAX
They are both tools that are used in DIY so are similar in that respect, SIMTHEM however they're used in different circumstances so there's a degree of difference. DIFFTHEM
They are both sharp objects SIMTAX
They both cut things whether it be wood, metal or food. SIMTAX
Wood NI
they are both serrated tools SIMTAX
I was thinking about cutlery my mind wandered NI
They are both used for cutting things SIMTAX
DIY work SIMTHEM
Both tools used, SIMTAX but in very different contexts DIFFTHEM and the words themselves are quite different NI
Both sharp SIMTAX
Both are tools used in a similar fashion SIMTAX
Both are required to cut through an object. SIMTAX
Both a knife and a Saw are used for cutting things by hand SIMTAX
I see little in common between the two GENDIFF except that they are sharp SIMTAX
i was thinking more of pen knife than a table knife

NI
Both have blades SIMTAX but very different in size DIFFTAX and purpose DIFFTAX
One part of me was saying they are very similar in the fact that they both cut, SIMTAX however a knife is usually used as cutlery when eating DIFFTHEM and a saw if usually used when sawing wood. DIFFTHEM Also the difference in size. DIFFTAX
They are pretty similar as they are both tools used for cutting. SIMTAX
They both perform the task of cutting SIMTAX and can be used interchangeably. if I do not have a knife but have a saw, I can use the saw to cut my bread. SIMTHEM

NON-AUTISTIC SIMILARITY – DOG_VET_PROTOCOL
a vet looks after a dog so they are similar in the aspect that they would often be seen together SIMTHEM
The dog get treated by veterinarian. SIMTHEM

the dog visits the veterinarian when its ill **SIMTHEM** and they both are living things **SIMTAX**
Veterinarians treat dogs **SIMTHEM**
they are associated but not similar*** **NI**
dogs can be helped by veterinarian, **SIMTHEM** however not the same as one is human and one is an animal **DIFFTAX**
different species **DIFFTAX** but a veterinarian would have a large association with a dog **SIMTHEM**
Dog is an animal, but veterinarian is a human. **DIFFTAX**
veterinarians work with dogs **SIMTHEM**
The vet is the doctor for animals **SIMTHEM**
if a dog is ill it goes to the vets and vets tend to deal with a lot of dogs **SIMTHEM** but it a vet wouldn't be the first thing I thought about if I saw a dog whereas if I saw a vet the first thing I would think about would be a dog **NI**
Nothing **NI**
Nothing **NI**
What they are and how they relate **NI**
A dog is an animal, a veterinarian is a human. **DIFFTAX**
they are moderately similar as they are linked to each other **SIMTHEM** but not like in physical shape **DIFFTAX**
A veterinarian is a pet doctor and a dog is a pet **SIMTHEM**
have similiraty **NI**
how often they are associated **NI**
differents but job related **NI**
they are closely related - you may associate one with the other **NI**
both animal related dog goes to the vet **SIMTHEM**
dogs are being healed by veterinarians **SIMTHEM**
They go together, but aren't really similar

DIFFTHEM
LIFE AFTER MILTARY NI
i was thinking about a vets office, and the similarities between a dog and veterinarian. SIMTHEM
dog is an animal kept as a pet, vet is a highly educated human DIFFTAX
Whilst they can have some similar associations, they are very different and don't have to be associated with each other. GENDIFF
They’re linked but not actually similar as one is an animal and one is human DIFFTHEM
You take your dog to the veterinarian when dog is ill SIMTHEM
i thought how they are not the same as one is an animal and one is a human DIFFTAX
They are not similar, but there is a connection between them DIFFTHEM
They go together. Vets are seen with dogs. SIMTHEM
both living beings so they are similar in that sense, SIMTAX however a vet is a human and has a lot more independency than a dog making it different in a lot of ways DIFFTAX
the work of the vet NI
Dog ad veterinarian are similar in that there's a certain degree in which they relate to each other. NI
They aren’t similar really but the dog can visit the vet DIFFTHEM
You would take your dog to see a veterinarian. SIMTHEM
Cat NI
vets care for dogs SIMTHEM
Thinking about the similarities NI
Dogs go to the vets when ill SIMTHEM
A check up SIMTHEM
they are often used in combination with a veterinarian treating dogs so i found them to be very similar, SIMTHEM just different written down NI
Administers treatment to dogs SIMTHEM
They are linked but not closely (like dog and cat) NI

A veterinarian would treat and care for a dog. SIMTHEM
Dogs are carnivorous animals whereas a vegetarian is a non-meat eater (the term is usually associated with humans not animals so there is not even that likeness). NI
I associate the vet with dogs because he mostly takes care of them SIMTHEM
that they always need a vet at some point SIMTHEM
I felt these were closely linked as a vet is where you would take a dog and who you would go to for help and advice SIMTHEM
A dog is a four legged animal DIFFTAX and whilst it may visit a veterinarian for treatment etc. a veterinarian is a human being. DIFFTHEM
They are related but not similar, DIFFTHEM one is a human profession and the other is an animal. DIFFTAX
The veterinarian treats the dog SIMTHEM but one is an animal and the other is human. DIFFTAX

NON-AUTISTIC SIMILARITY MUG_CHAMP_PROTOCOL
its not that similar NI while champagne is in a bottle its poured typically into a glass a mug tends to be for hot liquids like soup DIFFTAX

you drink out of a mug and champagne is a drink SIMTAX
Mug is hardly used to drink champaign NI
mug is very functional, everyday, DIFFTAX and champagne is glamorous and special DIFFTHEM
mug you cab drink out of and sometimes when you don't have a champagne glass you can use a mug NI
one is a liquid the other is an object which hold liquid but usually not champagne/alcohol DIFFTAX
Mug is an object but champagne is not an object. DIFFTAX
you can still drink champagne from a mug. NI
Mug is not meant for drinking champagne NI
you dont put champagne in a mug NI but you do put it in a glass and a glass is similar to a mug but not completely SIMTAX
I should rate them as less similar NI
You can still drink champagne in a mug if there are no wine glass NI
The function of each item NI
A mug is an object and champagne is a liquid. DIFFTAX
No resemblance NI
as its a drink so its definitely linked to a mug SIMTAX
A mug is an object you put a hot liquid in whereas champagne is an actual drink and a cold one DIFFTAX
no similiraty NI
what champagne is drank from NI
there are different GENDIFF
they are not related at all NI
mug isnt often used to pour chamgane into it NI one holds a liquid the other is a liquid DIFFTAX
people do not drink champagne from mugs but from glasses DIFFTAX
Both related to drinks, SIMTAX

but definitely don't go together DIFFTHEM
CHAMPAGNE CAN BE POURED INTO A MUG BUT A MUG IS NOT USUAL TABLEWARE FOR IT NI
I was thinking about a bottle of champagne and then thought f the mug I have in front of me. NI
mug is a receptical for a drink, champagne is an alcoholic drink SIMTAX
They have similar associations, SIMTHEM but often champagne is not drunk from a mug and therefore not very similar. NI
Not similar at all NI
If you are desperate and have nothing else to drink champagne out of…you can drink it out of a mug! NI
one is a glass and one is a drink DIFFTAX
Don't look similar DIFFTAX and don't complement each other. DIFFTHEM
Both drink-related SIMTAX but different drinks DIFFTAX and different contexts DIFFTHEM
mug is an object used for drinking, champagne is a beverage. DIFFTAX different state matters, DIFFTAX different purposes. DIFFTAX
they seem unrelated but one could put champagne in mug if they can't find a glass NI
Mug and champagne are not directly related to each other in any obvious way. NI If I were going to drink some champagne and had no other suitable glasses, I may choose a mug, however this would not be my ideal choice. NI
They are completely opposite NI
You would never use a mug for champagne, NI also champagne is a liquid and a mug is an object. DIFFTAX
Party NI
mugs don't usually hold champagne DIFFTAX

and champagne is not a cup like mugs **DIFFTAX**
The similarities **NI**
Not very similar as one is an object and one is a drink **SIMTAX**
Wine glasses **NI**
These are almost never used together **DIFFTAX** and written down are very different words. **NI** Hardly ever in the same context **DIFFTHEM**
Rarely is champagne poured into a mug **NI**
They are linked but not closely **NI**
You could drink champagne from a mug, but you wouldn't really, would you?! **NI**
A mug is the vessel that contains a drink whereas champagne is a sparkling wine. There is no link **DIFFTAX**
I see nothing in common in these words **NI**
that I dont like champers **NI**
Personally I enjoy drinking Champagne from a mug as the ceramic keeps it cool (free tip for you there) **NI** But also Champagne is a beverage and a mug is a receptacle for drinks – **SIMTAX** even if it's not technically the correct one I still think there are associations **SIMTHEM**
A mug is usually used for hot drinks whereas champagne is usually drunk in glasses not mugs. **DIFFTAX**
They are not similar at all, one is a drink the other is a household dish. **DIFFTAX**
one is cutlery and the other is cutlery. **SIMTAX**

NON-AUTISTIC DIFFERENCE – CHAIR_TABLE_PROTOCOL
Both are pieces of furniture **SIMTAX** which are primarily found together in the house, **SIMTHEM** but also serve different functions

DIFFTAX and are different in form DIFFTAX
I was thinking a table can be used as a chair and a chair can be a table. SIMTAX
I was thinking that although they are used for different things DIFFTAX but they still belong to the same category. SIMTAX
They look quite different DIFFTAX and are different in function. DIFFTAX
They go together SIMTHEM
They are both furniture, SIMTAX but for different purposes DIFFTAX
They go together SIMTHEM
They are both furniture SIMTAX usually made of the same materials. SIMTAX
They are similar and go together SIMTAX
I imagined what a chair look like and table, SIMTAX a chair is for sitting SIMTAX
THEY GO TOGETHER SIMTHEM
Chair and table goes with each other when sitting and writing or when its meal time SIMTHEM
they are both used for practical use SIMTAX
both items are often used together SIMTHEM
They are two different types of objects DIFFTAX with different functions. DIFFTAX
They are connected in similar ways NI but they have different uses. DIFFTAX
They are two components of a set often linked together. SIMTHEM
I thought that they’re compatible SIMTHEM but not similar at all in Terms of function DIFFTAX
They are different pieces of kitchen furnishings***

DIFFTHEM
MATERIALS NI
Nothing NI
chair and table usually come together SIMTHEM
Tables and chairs typically have 4 legs SIMTAX They are both pieces of furniture that can hold things SIMTAX
That they are different GENDIFF but they belong together SIMTHEM
sitting down for dinner SIMTHEM
Chair and table are both different objects as one is sat on and the other is to place things on, DIFFTAX however they are similar in the sense that they are used together e.g., an individual sitting at their desk needs a chair SIMTHEM
Chair is to sit on table is to put things on DIFFTAX
a chair is used to sit at a table SIMTHEM
both furniture, SIMTAX can be made out of same things, SIMTAX seen together SIMTHEM but have different purposes DIFFTAX
They go together SIMTHEM
Used together so easily paired up SIMTHEM
Chairs are for sitting and Tables are not. DIFFTAX That Chairs and Tables could be made out of the same materal which makes them similar SIMTAX
Both are often made of the same materials, SIMTAX and are used in conjunction with each other. SIMTHEM
You use both things together so they have the similarities SIMTHEM
They're both items of furniture SIMTAX that tend to go together; SIMTHEM similar but ultimately they are different objects

GENDIFF
Chairs and tables belong together SIMTHEM but are separate GENDIFF
they're both pieces of furniture SIMTAX but have different purposes DIFFTAX but are often close to each other, SIMTHEM maybe i should have chosen 2? NI
They are both pieces of furniture SIMTAX and are often you have them both together SIMTHEM
they are both furniture si similar SIMTAX but not the same GENDIFF
they are furnitures SIMTAX
They are slightly similar because both have four legs, SIMTAX but it is easy to tell by looking what is a chair and what is a table. DIFFTAX They aren't defined by the number of legs they have. So while they are similar, in that they are both pieces of furniture SIMTAX that often go together, SIMTHEM they are also different. GENDIFF
Different cos one you sit on and the other you sit at DIFFTAX
They are both used when eating.. SIMTHEM Can be made from the same matairal SIMTAX and are classed as furniture SIMTAX
I don't think they are that different because they usually go together. Where you have a table, you would normally have a chair with it as well SIMTHEM
We need a chair to sit at the table. SIMTHEM
How much to rate them as being similar or different! NI
They are somewhat similar because they're both furniture SIMTAX that are often used in conjunction, SIMTHEM but not quite the same and they serve different purposes.

DIFFTAX
Well, they often go together, SIMTHEM one can be substituted for the other to some extent, SIMTAX they tend to have similar forms, SIMTAX and they are often made of the same/similar materials. SIMTAX
They both have surfaces SIMTAX and usually 4 legs, SIMTAX and are often made out of the same type of materials SIMTAX
They are both furniature SIMTAX
Eating Dinner SIMTHEM
They're entirely different objects, GENDIFF they just have proximity to usually being together, SIMTHEM as items they're entirely different though
They are related inanimate items. SIMTAX They are both items of furniture SIMTAX and are often made from the same material SIMTAX and utilised together as a set, SIMTAX but they perform different functions. DIFFTAX
you cant eat off a chair and you cant really use a table as a seat DIFFTAX
they are different objects, DIFFTAX not completely different because they can be in the same room SIMTHEM and used at the same time SIMTHEM
that they go together SIMTHEM and can both be sat on SIMTAX
They are similar because they often appear together. SIMTHEM
They have different functions DIFFTAX but they can be constructed in a similar way and go together as a set SIMTHEM

NON-AUTISTIC DIFFERENCE – KNIFE_SAW_PROTOCOL
Both are usually made of metal **SIMTAX** and are used to cut things **SIMTAX**

but there are massive differences in the contexts where they are used DIFFTHEM and the items they are used to cut DIFFTAX
they are both used for cutting SIMTAX and I can cut with a saw and I could use a knife to saw if I really needed to. SIMTHEM
I was thinking about their size and what they are mostly used for. NI
A knife is just a smaller version of a saw, SIMTAX they are similar in function SIMTAX and only diffrerent in size DIFFTAX
Both things cut SIMTAX
They are both cutting devices SIMTAX
They both cut, SIMTAX but cuts Different things DIFFTAX
Both are bladed tools. SIMTAX
they are not the same however they have a slight difference with a knife being used in everyday life and a saw not
what they are used for, NI a knife is for cutting food and a saw is for cutting wood DIFFTAX
THEY PERMED ALMOST SAME TASK NI
Knife could be used both indoors and outdoors for, even could be used as cutlery while saw is used outdoors DIFFTHEM and no version of it can be used at the dining table. DIFFTAX
they are both used to chop things and practically SIMTAX
ones a tool for objects and ones a tool to eat DIFFTAX
Knife is used to cut food, but saw is used to cut tree. DIFFTAX So, both are used for cutting things. SIMTAX
They are similar NI but with different uses GENDIFF
they both cut things SIMTAX but are not interchangeable in each others common setting.

DIFFTHEM
Same shape SIMTAX and purpose SIMTAX
Both are tools to cut SIMTAX
SHARP SIMTAX
they both are used to cut things with SIMTAX
Both used to cut things SIMTAX Tools SIMTAX
They are different utensils GENDIFF but do similar things SIMTAX
sawing wood NI
a knife and saw are used to do the same thing SIMTAX however they are different in the sense of what it is that they are being used to cut DIFFTAX
Both are used to cut things SIMTAX but one is more dangerous NI and they have different contexts DIFFTHEM
no resemblance between the two GENDIFF
both have similar uses SIMTAX and even visually similar SIMTAX but saw is bigger DIFFTAX and for cutting tougher material DIFFTAX
Their both used to cut things SIMTAX
Used in the same way SIMTAX but for different things GENDIFF
They are both used for Cutting items SIMTAX but different because a saw is cerated DIFFTAX
They are both used for cutting and chopping which are similar. SIMTAX

You could use a knife to whittle small pieces of wood for example, a saw would be used for bigger pieces of wood. **DIFFTAX**
Both sharp objects **SIMTAX** used to cut things **SIMTAX**
They both are used to cut **SIMTAX** but generally for different purposes **DIFFTAX**
They can look very similar **SIMTAX** and possess similar characteristics **SIMTAX**
they both have cutting edge **SIMTAX** but they are supposed to cut different things **DIFFTAX**
They are both cutting tools, **SIMTAX** the only thing that differs is what they are able to cut. **DIFFTAX**
both are used for cutting **SIMTAX** and have similar shapes **SIMTAX**
you can cut with both **SIMTAX**
Similar but different. **NI** Both are sharp **SIMTAX** but they have different and distinct uses. **GENDIFF** You wouldn't use a saw to butter your toast, for example. **DIFFTAX**
Saw is for sawing and a knife is for eating or cutting **DIFFTAX**
They are both made for cutting **SIMTAX** and can be used similarly **SIMTAX**
A knife and a saw both serve similar functions – **SIMTAX** of cutting things up **SIMTAX** therefore I do not see them as being that different from each other. **NI**
they both cut **SIMTAX**
How similar/different a knife and saw are. **NI** Thinking saw for DIY and knife for eating/preparing food!

DIFFTHEM
They're both objects SIMTAX that serve a similar purpose, SIMTAX but not exactly the same. NI
I couldn't quite decide between 2 and 3 to be honest, NI but they both have similar functions, SIMTAX forms, SIMTAX and made of similar materials. SIMTAX In some cases they can be substituted for one another. SIMTHEM
A saw is a big knife made for cutting bigger materials NI
They are both metal SIMTAX and are used to cut things. SIMTAX
Cutting NI
Both items are used to cut something in half SIMTAX and serve a similar purpose SIMTAX
Both are cutting implements, SIMTAX often made from similar materials. SIMTAX Both are inanimate objects. SIMTAX The can vary in shape (with each other and with themselves). DIFFTAX But they are used in different contexts DIFFTHEM and on different materials/items. DIFFTAX
one is used for cutting up food and the other used for diy DIFFTHEM
they can be used for roughly the same purpose, to cut something SIMTAX
you can use them both to cut things SIMTAX
They are both tools SIMTAX and made of the similar material. SIMTAX However, the purpose and usage are different. DIFFTAX
Both are cutting implements

SIMTAX but are made for cutting different things, **GENDIFF** and a knife is usually a lot smaller than a saw **DIFFTAX**

NON-AUTISTIC DIFFERENCE DOG_VET_PROTOCOL
One is a role which is performed by a human the other is an animal, **DIFFTAX** while a dog is an animal and in this way they are similar **SIMTAX**

they are different concepts. NI
I was thinking the vet fixes the dog if its sick, SIMTHEM but they are both still animals SIMTAX but different. GENDIFF
I was thinking about the difference in species. DIFFTAX
One is a human the other is animal, DIFFTAX they are both living things SIMTAX and are somewhat linked. SIMTHEM
One goes to the other SIMTHEM
A vet cares for animals. A dog is an animal. SIMTHEM
A vet treats a do SIMTHEM
They are a different species DIFFTAX with something in common. NI
the vet treats a dog so they are similar in that way SIMTHEM
one is a person and one is an animal DIFFTAX
SAME GROUP NI
A veterinarian is a human being, a dog is an animal. DIFFTAX I felt there is a relationship between them since a dog would need the Veterinarian's service sometimes SIMTHEM
they are used together SIMTHEM
ones an animal and one is a profession DIFFTAX
Dog is an animal, but veterinarian is a human. DIFFTAX
Same uses NI
They go hand in hand. SIMTHEM
Complimentary SIMTHEM
Human vs animal. DIFFTAX They differ. GENDIFF The god sometimes goes to vet.

SIMTHEM
HELP NI
not to sure to be honest NI
A vet can help check on a dog SIMTHEM but it doesn't have many similarities other than a vet and a dog both being “animals” SIMTAX
They are different but they rely on each other and can be associated with one another SIMTHEM
a dog NI
a veterinarian would treat a dog if the dog is suffering with any problems SIMTHEM
Dog is an animal and the other is a human DIFFTAX
i do not see much similarity as one word is an animal and the other is human, DIFFTAX however both are involved with other animals SIMTAX
vet cares for dogs SIMTHEM both living species, SIMTAX vet is a human DIFFTAX
No relation at all NI
Animal/person DIFFTAX
A dog is an animal a Veterinarian is a proffesion. DIFFTAX You cant be a dog but can be a vet DIFFTAX
A veterinarian is a person who would treat an ill dog. SIMTHEM You would find both in a vet but that is the only similarity. SIMTHEM Two different species altogether. DIFFTAX
Veterinarian takes care of sick dogs SIMTHEM
A dog goes to the vet so they're related, SIMTHEM but they are distinct things because vets treat many animals GENDIFF
They go together SIMTHEM but are not the same thing GENDIFF
they are different species DIFFTAX but they are both mammals

SIMTAX
One is a patient and the other is a care giver, they perform 2 opposite roles DIFFTAX
they are both connected but not the same thing at all NI
the veterinarian will heal the dog SIMTHEM
Very different. GENDIFF A dog is a canine, a veterinarian is a human being. DIFFTAX Whilst a vet may treat a dog, SIMTHEM they are very different beings. DIFFTAX
Dogs an animal and veterinarian is a human DIFFTAX
Even though that are accociated as a dog will go to a vets SIMTHEM they are not the same as one is a animal and the other the person... DIFFTAX But saying that they are both mammals SIMTAX so I might of rated them a little more closely but not much NI
That they are not that different as you would associate taking a dog to the vet if they were ill and needed treatment SIMTHEM
veterinarian takes care of the dog SIMTHEM
About how often you would take a dog to the vet's! SIMTHEM
There's a relationship between the two words, but they don't have a similar meaning. NI
They're clearly very different in some senses, GENDIFF but similar in the sense that they could appear in the same context, SIMTHEM and they're reliant on each other to an extent. NI
They are both animal-related SIMTAX
A dog is an animal and a veterinarian is a person. DIFFTAX
Animal Welfare NI
One is an animal one is a person DIFFTAX
One is a species and one is a job for a person. DIFFTAX They are in completely different catergories. GENDIFF They are both however animate. SIMTAX

one is an animal and the other looks after animals **NI**
one is an animal, one is a human **DIFFTAX**
a dog is treated by a vet **SIMTHEM**
They are not very irrelevant obviously. **NI**
They are related because one treats the others ailments, **SIMTHEM** and they are both mammals, **SIMTAX** but they are very different in terms of how they live their lives **DIFFTAX** and their anatomy **DIFFTAX**

NON-AUTISTIC DIFFERENCE – MUG_CHAMP_PROTOCOL
While champagne is usually served in a flute, **NI** it is conceivable to drink champagne from a mug,

SIMTAX but they one is an item which is used to drink from and the other is a beverage used mostly for celebrations DIFFTAX
I drink champagne but I cant drink a mug. DIFFTAX
One is a drinking vessel and the other an expensive actual drink DIFFTAX
The both hold liquid SIMTAX but look different DIFFTAX
One is for drinking from, the other is for drinking DIFFTAX
They are not similar at all. NI
You don't drink champagne in a mug NI
a mug is for hot drinks usually and champagne is a cold drink DIFFTAX
there is no link between a mug and champagne NI
you drink from a mug but champagne is liquid DIFFTAX
SAME GROUP NI
Mug cannot be used for drinking champagne DIFFTAX though its used for drinking. SIMTAX There is no relationship between both items NI
they arent really used together or they arent similar NI for example they arent both drinks DIFFTAX or both an object DIFFTAX
ones an item to drink from one is a drink DIFFTAX
Mug is an object, but champagne is a drink. DIFFTAX
Same uses SIMTAX but different contents of drinks DIFFTAX
you can drink champagne out of a mug but it is a highly unlikely scenario. NI
Liquid vs type of liquid container DIFFTAX
Can you drink champagne with a mug? I suppose you can NI
DRINK NI

you can drink champagne in a mug if you wanted to NI
One is a drink the other is something that can be used to hold drinks DIFFTAX
You wouldn’t drink champagne out of a mug. Maybe some people might NI
glass of champagne NI
mug is not used to drink champagne in NI
Mug is somehting to put a drink it the other is a drink DIFFTAX
you do not use a mug to drink champagne, DIFFTAX i see no similarity NI
mug carries drink, champagne is a drink SIMTAX
You can drink champagne in a mug NI
Completely different GENDIFF mug is used for hot drinks, DIFFTAX champagne is an alcoholic drink in a bottle DIFFTAX
Mug is a vessel for holding fluid and champagne is a fluid SIMTAX
Mug is a piece of crockery you use to drink out of usually hot beverages. DIFFTAX Champagne is an alcoholic beverage DIFFTAX usually served in a glass, a flute glass or a champagne glass. DIFFTAX
Don't usually drink champagne out of a mug NI
They are both related to drinking, SIMTAX but they're mostly different because a mug is something you drink from DIFFTAX and champagne is a specific drink DIFFTAX
One is a solid vessel the other is a drinking liquid DIFFTAX
you can put champagne in a mug but you shouldn't NI
One is a container to hold liquids, often hot liquids. The other is a liquid, often served cold. DIFFTAX
they are in no way related NI
they are both drinks SIMTAX
Mug and champagne don't really have any correlations. NI

While you could drink champagne from a mug, it's not an association that one would usually make. DIFFTHEM Therefore they are different. GENDIFF
Mug is from drinking from and champagne you drink SIMTAX
Both are associated with drinking SIMTAX
I see them as being very different from each other as I would not associate having champagne in a mug DIFFTHEM
dont match.. champagne glasse with champagne NI
Thinking about how likely you'd be to drink champagne out of a mug (not very!) NI
There's no apparent relationship between the two words, as you wouldn't typically use a mug to serve champagne NI
They're similar in that they're both involved in drinking, SIMTAX and you could serve champagne in a mug (or at least would likely do in a glass, which is pretty similar to a mug). SIMTAX But otherwise a mug's quite different to champagne - GENDIFF made of different material, DIFFTAX has a different form DIFFTAX and function. DIFFTAX
Although champagne could be served in a mug, it's usually served in a glass. DIFFTAX And mugs are also made for warm drinks but champagne is traditionally enjoyed cold. DIFFTAX But its not too different either because both are related to drinks SIMTAX
Mug is a vessel, champagne is a drink DIFFTAX
Champagne in a flute celebrating NI
One is a drinking vessel and the other an actual liquid DIFFTAX
One is crockery and one is a drink. DIFFTAX Completely different categories GENDIFF But they may both be found in a kitchen. SIMTHEM
one you can drink out of and the other you can drink DIFFTAX
a recipient and a liquid, not very similar. DIFFTAX

you can drink champgne from a mug **NI**
They appear together. **SIMTHEM**
One could be used as a vessel for the other if you run out of glasses, **SIMTAX** but apart from that they are very different **GENDIFF**

Appendix G – Autistic subgroup protocols and ratings

	Chair & Table	Rating	Knife & Saw	Rating	Dog & Veterinarian	Rating	Mug & Champagne	Rating
P1	They both look kind of similar, and they're both furniture. They're often paired together. But they're used for different things.	4.00	Knives are much smaller than saws usually. You make the same motion using both more or less. They have a similar function but you use them on different types of objects (food versus wood).	4.80	A dog is an animal whilst a veterinarian is a person and a particular profession. They don't have much in common except both being mammals, and dogs going to the vet for treatment. As individual concepts they're completely different.	1.00	A mug is a vessel for liquid, whereas champagne is a specific liquid. They're associated but as individual items they're not similar at all in any of their properties.	1.00
P2	you can sit on them both really and they both have 4 legs but they are different	4.50	they are both sharp and used for cutting and are both made of metal	5.20	a dog is an animal and a veterinarian is a human	1.20	a mug is a ceramic receptacle for usually warm drinks, champagne is a cold fizzy drink for special occasions	1.00
P3	They both are made from wood normally and are found together.	2.80	They can both cut things	3.90	A dog is an animal a veterinarian is a person.	1.50	one is a drink the other is a container.	1.10
P4	They are both furniture, but different in shape and function.	3.20	They are both cutting instruments, but a saw can be sharper than a knife (cutlery).	4.00	A dog is an animal, whereas a vetinarian is a human.	1.40	A mug is an item used for drinking out of and champagne is a drink, they are not similar items.	1.00
P5	I was thinking about how a chair and a table are usually found together in a set but	3.40	Both items can cut things but one is a food based tool and the other has specific	3.20	One is a pet, and another is a job role. They are not similar words/things but merely two words that	2.00	One is a holder for liquid and champagne is a type of drink. Whilst you may put champagne	1.10

	they are not the 'same' item in that sense.		purposes in building trades.		can be used in the same area (as in you would take your dog to a vet)		in a mug, they are not 'similar'	
P6	both have 4 legs and can hold things	6.00	both are the same shape and used to cut things, one just has a bigger handle	6.56	one is a person and one is a dog	1.90	both can be bottle shaped	1.90
P7	both items of furniture	4.00	both used for cutting objects	5.30	dog is an animal, veterinarian is a person who treats sick animals, not similar at all	1.40	mug is a vessel to hold liquid in, champagne is an alcoholic beverage, not similar at all	1.00
P8	You can use a chair like a table and vice versa	5.30	Both sharp and used to cut things. I knife can be serrated like a saw	5.50	One is a job type and one is an animal	1.70	One is a solid container and the other is a type of liquid	1.00
P9	chair for sitting down. Table for things on table not person.	2.20	Saw is for big things as woods. Knife for buttering or cut foods	3.00	Dog is a animal. vet is a person doctor for unwell animals	1.80	both are for drinking	1.30
P10	they're both pieces of furniture, possibly made of same material, possibly not. they can be used in complementary usage	3.50	they are both used to cut things, saw things, in particular, although there is a significant size difference between the two.	4.20	not at all alike as one is human animal and the other is a canine. i should have taken into consideration, however, that they are both mammals and therefore have some degree of similarity	1.00	that they are not similar at all. one is a beverage and the other a receptacle for drinking hot beverages usually	1.00
P11	Both pieces of furniture which often come together as a pair.	4.60	Both blades used to cut things	5.40	They are not similar... one is a profession, one is an animal	1.50	They have no similarity. One is liquid one is solid	1.20
P12	They both have similar structure and purpose (both have at least 3	4.30	They both have similar functions and similar shapes, but	5.40	One's an animal and one is the profession of a human, both have	1.40	One is a consumable liquid, the other is a solid object.	1.10

	legs, both are made to have things on top of them and in similar situations), but their specific purposes differ in that a table is for putting objects on and the chair is for putting people on.		both are used in different situations that the other would make little sense to use them in.		slight ties to each other but overall the similarities are minuscule aside from association.			
P13	Although they are generally made from the same material, they are not the same thing. You can't have multiple people sitting around a chair eating.	2.20	They are both sharp and cut things, but a knife is used to cut lighter things, whereas a saw is used to chop trees etc - is more pointy	3.00	One is an animal (a pet) and one is an animal nurse	1.50	One stores a drink, and the other is an alcoholic drink	1.10
P14	Both furniture, but with different functions.	5.00	Both items are cutting implements.	6.10	One's a human profession, and the other is an animal. While vets do work with dogs, this link does not equal similarity.	2.00	Champagne is a beverage. Mug is a container.	1.00
P15	I wasnt thinking specifically about anything	1.00	I wasn't thinking specifically about anything	1.00	I wasn't thinking specifically about anything	1.00	I wasn't thinking specifically about anything	1.00
P16	They both have a flat surface to lay things on / sit on, both generally have legs, most commonly 4. However, chairs have backs which tables don't and the function is different (sitting versus putting	4.30	Knives and saws have the same function (cutting something), both are made of metal, both are sharp and both can come in different formats. In this case, I wouldn't think of a	5.40	Just because a vet works with dogs doesn't make them similar. A vet is a human being, stands on two legs, talks, can think creatively; a dog is an animal with fur, walks on four legs and	1.30	One is an object, the other is a liquid. A mug cannot be consumed, it is solid, its used to drink from; whereas champagne is something that is drunk (and not from a mug), it is liquid, and	1.20

	things on it), although both can (and are) used for the other function, e.g. I might sit on a table when I'm teaching and I might put my clothes on a chair in the bedroom.		dinner knife (I would rate the similarity between a dinner knife and a saw more like a 5), but a knife in general including hunting knives, so a sharp metal object. However, saws have teeth which knives (generally) don't have.		can't think creatively. Now that I'm writing this down I'm thinking I might have scored it a 2 actually, because they are both sentient beings who are alive and can feel emotions.		can't really be used for anything other than consumption whereas a mug can be used for storage as well and is therefore a bit more versatile.	

Appendix H – Sample of autistic participants' protocols and ratings

	Chair & Table	Rating	Knife & Saw	Rating	Dog & Veterinarian	Rating	Mug & Champagne	Rating
P1	I was effectively thinking how similar they both were to one another.	4.30	I was thinking how similar they were to one another when comparing them.	4.50	I was thinking of vets where you take your dogs	4.90	I was thinking how similar they were to each other.	4.40
P2	Pieces of furniture	6.10	Tools that you use	5.50	You take your dog to the veterinarian	6.70	You don't put champagne in a mug	1.50
P3	They have similar shapes, with four legs and a flat surface. Often they are made from the same material too.	5.60	Both are tools with a metal blade and a handle, and both are designed for cutting. However they are very different shapes and they are used in different ways. The way in which they cut items is also very different.	5.30	Both are mammals with similar physical features, i.e. four limbs, two eyes hair etc. However they are still different species and look and act extremely differently from each other.	2.10	A mug is a hard ceramic container for liquids with a handle on the side. Champagne is a sparkling alcoholic liquid. They are extremely different. Their only similarity is that they are both in some way related to the act of drinking but this is a very small connection in my opinion.	1.50
P4	They are both wooden surfaces on which you can put things, so are similar in that way, but they are also different as they serve different purposes.	4.30	They both fulfill the same purpose (i.e. to cut things) but generally the things that they are cutting are different and you would use one for (for example) wood and another for meat	5.30	I don't think they're very similar at all, because whilst a dog would perhaps need the attention of a veterinarian at some point they are not things that are comparable. I rated it 2 rather than 1 as they do share some overlap in that a	2.20	Mugs and champagne don't share any of the same qualities or functions. Whilst I suppose it is possible to drink champagne out of a mug it is not typically done. I struggled with whether to put this choice as a 1 or a 2 but ultimately decided that just because a mug is a drinking vessel doesn't mean that champagne would typically be drank from	1.10

					veterinarian might provide medical aid to a dog.		one so in my mind they have no overlap.	
P5	They're both furniture & they (can) go together - however they serve differing functions.	4.90	They're both implements for cutting things with - where both (admittedly only sometimes in the case of a knife) can have a serrated edge. However, one is more typically a kitchen or eating implement (though there are craft knives & the like) & the other is always a tool.	5.20	Well, they're not completely dissimilar as they're both mammals & a vet would treat a dog - however one is a person's job & the other is an animal/pet.	2.70	Whilst I guess you could drink champagne from a mug, it's not a usual pairing... Whilst one is a vessel for drinking (usually hot) drinks from - whilst the other is a sparkling/effervescent alcoholic drink that's usually served at a very low temperature.	1.00
P6	Both are common pieces of furniture, typically found in the same room, both typically made out of wood, with a flat surface and four legs. They are frequently paired or come as a matched set.	5.70	Both are cutting implements, typically handled manually by a person, featuring a handle and cutting edge, both typically made of metal, sometimes with wooden or plastic handles. Dissimilar in that saws are typically much bigger and for cutting non-food objects.	6.20	Both are intelligent animals with four limbs, with two biological sexes, both are typically associated with the category of 'pets'. Otherwise both are seperate orders of animalia and have highly different morphology.	2.20	One is a drinking vessel, the other is a drink. One is solid the other liquid. One is typicallt reusable, the other is a consumable. Shape and use is completely different, although both are generally associated with the category of 'drinking', especially 'alcohol'.	1.10

P7	Are chair and table similar	3.00	how similar are knife and saw	3.40	how similar are dog and veterinarian	2.20	how similar are mug and champagne	1.00
P8	both are peices of furniture, but serve different purposes so are moderately similar	4.00	both are used for cutting, but do so in different ways, and normally used to cut different types of objects, moderately similar	5.00	humans and dogs ar completely different types of animals	2.10	mug is a solid object, champers is. a liquid	1.10
P9	You can't have a chair without a table. The same goes for the reverse. They're a natural pairing.	4.70	They are both edged implements.	5.10	Veterinarians operate chiefly on pets. Dogs are very popular pets.	4.90	Mugs are rarely, if ever, associated with champagne.	2.90
P10	They go together as a pair of objects, but also the words have the same number of letters and are the same kind of shape. They are both solid.	4.80	Although as objects they are similar, as words they have very different shapes. Knife is long and pointy and saw is short and squat. Knife is shiny, saw is rough. The 'i' (eye) sound is very manmade and manufactured, the 'aw' in saw is very earthy and animal.	3.10	Dog is short, simple and basic. Veterinarian is long and fancy and complicated. They are very different people. (Maybe oddly) I don't see any hierarchy between the words - they're both good and quite satisfying words to say out loud, but almost like opposites - at the ends of a scale.	3.30	I like the idea of someone drinking champagne out of a mug. Really, why shouldn't you? The notion it needs a special glass is pretty random. But, as words, they are very different. Mug is short and solid, champagne is twirly and has quite a high opinion of itself (although it isn't as fancy as it likes to think it is). They are just a bit connected by the Gs, which is what stops them being completely different.	1.80
P11	both are furniture but have different	5.30	Both are tools for cutting things, but a knife is generally	5.50	A vet is someone who fought in the war (no I'm joking	3.30	A mug is a recepticle for liquid, champagne is a drink. It is very rare for a person to	1.30

	functions (you sit on a chair)		used in kitchens (although also survival) a saw is much bigger and used in DIY or by arbologist		it's a human who looks after animals) and a dog is an animal. Both are mammals but there is little similarity between canine and homosapien		drink champagne from a mug (although I have)	
P12	Sitting at a chair and table	5.00	A knife and saw being both used to cut things	4.60	A vet looks after a dog	5.00	Pour champange into mug	3.80
P13	They are often paired together, though chairs can often function on their own/be by themselves, so the two are closesly linked but not inextricably.	5.30	There both cutting implements but I would tend to more closely associate knives with other kitchen utensils and cutlery and saws with other tools	5.00	they are closely related, as you'd have to take a dog to a vet, but vets aren't exclusively for dogs, so I might rank 'pet' and 'veterinarian' or 'vet' and 'doctor' closer	5.10	Both are related to drinking but I never accosicate the two together in my mind	1.20
P14	They are similar in both being items of furniture, and therefore having related uses. However they are still distinct items	4.10	These items have related uses - both can be used to cut other objects - however they are distinct and not always closely associated.	4.50	Although these are clearly distinct (an animal and a human and/or occupation title) they also have close associations - dogs being the animal most commonly treated by vets.	3.70	These have some similarity in that they relate to drinks and drinking, however they are very different, one being a utensil, one a drink	1.60
P15	They are the same category	4.70	A knife is a utensil for eating, a saw is a	3.70	Although conceptually I know	4.30	You do not pour champagne into a mug - so a mug and	1.20

	of object: dining room furniture		carpentry tool. They exist in different categories.		a dog can be treated by a veterinarian, and a vet may come into regular contact with dogs, and a vet is a type of animal (human): I do not place them into the same categories. A dog is a "pet" animal and a vet is a "career".		champagne does not go together.	
P16	Chair and table go together and they function together as one unit most of the time so they're quite similar in that regard.	5.10	They both cut and are both sharp and the only real difference between them is size.	5.60	They're not exactly similar but dogs need vets and vets have dogs as patients so you kind of think of them together.	4.10	Mug is a container for hot drinks and champagne is a liquid often served chilled so they really have nothing to do with each other.	1.40

Appendix I – Category label names and number of autistic and control participants who used that category name

		Autistic	Control
Shared category labels (frequency <5) (*N* = 15)	Rebel/rebellion	1	1
	Risk	1	3
	Caring	2	4
	Self	3	1
	Actions	2	1
	Adults vs children	2	1
	Traits	1	2
	Anxiety	1	1
	Organisation	1	1
	General qualities	1	1
	Negative traits	1	1
	Types of people	1	1
	Leadership qualities	1	1
	Characteristics	3	1
	Power related traits	1	1
Unique to autistic group (*N* = 32)	Political	1	
	Importance	2	
	Alphabetical	1	
	Mood	1	
	Consistency	2	
	Common sense	1	
	Neurotypical vs not	1	
	Relaxed	1	
	Sensible	2	
	Precise	1	
	Societal qualities	1	
	Me	2	
	Unhelpful to be	1	
	Helpful to be	1	
	Other	2	
	Concepts	1	
	Employee traits	1	
	Self-control	1	
	Personal attitude	2	
	Orderliness	1	
	Synonyms and antonyms	1	
	Restrictive	1	
	Freeing	1	
	Everything	1	
	Morals	1	
	Ability	1	
	Security	1	
	Mindfulness traits	1	
	Considerate/selfish traits	1	
	Philosophy	1	
	Good/bad people	2	
	Safety vs danger	1	

Unique to control group (*N* = 19)	Personality traits		2
	Person centred traits		1
	Social traits		1
	Attitude to society		1
	Attitudes		2
	Approach to life		2
	Relationships		1
	Working class vs the world		1
	Middle class vs the world		1
	Ruling class vs the world		1
	Judgement		1
	Life skills		1
	Work ethic		1
	Reasoning		1
	Objects		1
	Non informative		4
	Creates trouble or not		1
	Careful vs non careful		1
	Approachable vs unapproachable		1

Appendix J – Words used in lexical decision-making task

Real word	**Non-word**
Impulse	Kerrousy
Cunning	Restaps
Obedience	Edicresce
Abasement	Tedish
Degraded	Clolenny
Verity	Asondment
Gallant	Pomnition
Deceit	Rebience
Gratitude	Atumal
Levity	Cacieas
Overtone	Falesy
Incursion	Misquence
Astore	Scienide
Rarity	Faderal
Depict	Vectue
Blessing	Appruade
Endeavour	Peciaced
Craven	Wropesion
Admonish	Veqety
Adherence	Faughtood

Appendix K – Interview transcripts

HAT-P1

Was using the VR headset what you expected it to be?

Yeah, I think so. Just from like what you've seen in media and stuff about what it’s like to put one on. Yeah, quite impressive, yeah.

Did you enjoy using the VR headset?

Yeah, it was. It was. I think it was quite naughty. It was quite fun.

What did you like/dislike about it?

Yeah, like because it was kind of a novelty. It was kind of like. No, I think yeah, there was like a issue with like the glasses were a bit squished, but that's like you know it's going to be different for everyone. I happened to wear super big glasses today, so kind of my fault. But no. Yeah, no, it was good.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

Not really. I mean, I'm like an anxious person anyway, so the whole thing of fact that I know it's a test environment, it's like a whole thing in itself, but there wasn't anything like putting the headset on or nothing. There was no sort of anxiety around that.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah, that's totally fine.

Did you anticipate that there was going to be changes made to the environment following the word task?

No, not at all. That was a shock, but it was fun.

If you noticed any of the changes, how did this make you feel?

Feel it was like like it was, it was fun. It was like, like I said, it was a bit uncanny, but it was like it was, it was fun it. It wasn't too like shocking or anything. You know, it wasn't like it was like it was like a jump scare or anything. It was like, yeah. It was. It was, yeah it was fun.

Do you have any questions?

No.

HAT-P2

Was using the VR headset what you expected it to be?

About yes, it was.

Did you enjoy using the VR headset?

I did.

What did you like/dislike about it?

I disliked how uncomfortable it kind of was with sensory issues on the face, but I actually quite like the experience of being able to stand up and look around the room and see like the same room, but slightly altered. That's nice.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

No.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah, that was absolutely fine.

Did you anticipate that there was going to be changes made to the environment following the word task?

No.

If you noticed any of the changes, how did this make you feel?

When I noticed one change, I then realised, oh, there were probably other changes, at which point I started looking around more and remembering what I'd currently seen. The first change I spotted was the yellow box on the floor, so I thought there wasn't a box to stand in before, but I thought I might have missed that. And then when I glanced around the room, I saw the clock. And then I thought that clock was definitely not there. And then I looked around a bit more and yeah, noticed the window and just thought, OK, well, that wasn't purple because purple is my favourite colour and that wasn't there before, so that's there. And then I remember the bag being on one of the seats because when I first looked, I remember thinking, oh, it's really neat that they were even added a bag into it. And then I noticed it had actually moved. And yeah, the VR lab sign on the door was, quite, it stood out to me I think so, yeah.

Do you have any questions?

I don't, no. I thought that was really interesting. Thank you for letting me take part.

HAT-P3

Was using the VR headset what you expected it to be?

Yeah, pretty much. Although I don't like the resolution of that VR.

Did you enjoy using the VR headset?

Very much.

What did you like/dislike about it?

I like the fact that it is so immersive, you know, and it's that whole thing of doing a task in 3D is more fun.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

Where I felt anxious doing the word tasks makes me feel any kind of task makes me feel a bit anxious to be fair. So yeah, probably more in the word. Well, I felt probably a bit anxious looking around the room, so I wasn't sure what the task was. And then I felt probably slightly more anxious because I knew what the task was, but then wasn't sure if I knew the answers.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Oh, yeah, yeah, yeah.

Did you anticipate that there was going to be changes made to the environment following the word task?

No

If you noticed any of the changes, how did this make you feel?

Like I'd wish I'd paid more attention before.

Do you have any questions?

No, no, that's good. I enjoyed that very much. Well done.

HAT-P4

Was using the VR headset what you expected it to be?

Yeah, I think so. I think it was very uhm realistic in some sense, it was a little bit like grainy but I feel like at the same time I really felt like I was in the same environment. Does that make sense?

Did you enjoy using the VR headset?

Yeah, it was quite comfortable.

What did you like/dislike about it?

Probably disliked that it was a little bit uncomfortable. I think the material of it was quite sticky and quite hot I think on my skin. But I quite enjoyed being part of the VR. In a sense, it looks again, it looks quite real and I felt like I was in my natural surroundings.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

No, not really. I think that was all quite steady.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah, yeah, that was fine.

Did you anticipate that there was going to be changes made to the environment following the word task?

No it didn't actually.

If you noticed any of the changes, how did this make you feel?

I'm probably a little bit surprised because I thought, oh, that wasn't there last time. Yeah, surprised me a little bit.

Do you have any questions?

No, actually.

HAT-P5

Was using the VR headset what you expected it to be?

Mostly yeah, it was more wouldn't say realistic, but more atmospheric in some way. Like I felt actually like I was in the room, even though you guys were talking and you were basically ghosts around me, it is interesting, but yeah, it's what I expected.

Did you enjoy using the VR headset?

Yeah definitely, definitely.

What did you like/dislike about it?

Well, I like the fact that it's so it tracks very precisely, like everything was in the right place and I could actually touch it that was very, very lovely, but I didn't like the fact that it's so pixelated, but again, it's an older headset, so I'm assuming the newer ones are high resolution.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

Mostly at the start, but I'm guessing that's fair enough, at the start, it did went down.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yes, absolutely.

Did you anticipate that there was going to be changes made to the environment following the word task?

No, absolutely. I mean you might have said it in the in the information sheet, but I didn't read that far probably. So no, I didn't expect them.

If you noticed any of the changes, how did this make you feel?

It's interesting because I'm in the same room, but things are changing around me, so it's interesting, but I mean it's not, it's not terrifying, it's not weird. But yeah, I mean, I'm guessing I'm in, like, a video game scenario, so yeah.

Do you have any questions?

Do I have any questions for you? I don't know how is this different than just presenting on a monitor is the changing of the room a big part of the this method?

Some of the other studies that I've run where I've made changes and I've asked participants to detect those changes, I've told them that there are changes to be found. So we're trying to see, we're looking at people with low and high autistic traits to see whether or not we can capture what people spontaneously attend to when they're not aware that there are going to be changes

OK, fair enough. And the expectation is that a person with autism will or will not notice them more than a person not with autism?

We think autistic people are more likely to notice a lot of changes compared to non-autistic people, that they'll be hypersensitive to the differences around them.

OK.

LAT-P6

Was using the VR headset what you expected it to be?

It's much more brighter. That's how I can see than real life. Because then as soon as I took off, everything looked dull, and soon as I put it on and everything so bright and clear. Well, so it's really weird because you can't see your limbs. Yeah, your hands where did they go. It's really, I think it was really nice.

Did you enjoy using the VR headset?

I enjoyed it very much.

What did you like/dislike about it?

I liked it because it felt it, felt surreal, but real at the same time. I don't think there's anything that I disliked about it. It was fun I liked and when everything changed, it's like, oh, it's like it gets your mind working. Oh, what were the things that changed. And you look around. And the first at first when you told me to look around, I was, like, just looking. You don't have much thought into it, but as soon as you see a change. Oh ok. And then you start actually examining everything and I thought that was really cool.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

No.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah, that was OK.

Did you anticipate that there was going to be changes made to the environment following the word task?

No, not at all. I was wondering why did you tell me to look around and I was like, ok, I thought you just trying to get me used to it. So once it changed I was like, oh, I was supposed to pay attention.

If you noticed any of the changes, how did this make you feel?

It's like, realisation like, oh, I'm supposed to focus on everything but once I realise that it's kind of, interesting because I was like even though I didn't say that I did focus, I was able to still point out so many things even though I wasn't at first actually taking in everything. I think that was really interesting.

Do you have any questions?

No, I don’t.

LAT-P7

Was using the VR headset what you expected it to be?

Actually making use of it, yes, I'm familiar with how VR headsets work, and even the brand of the headset that was used. I wasn't expecting it to be a VR mock up of the room we were in, but that's about it.

Did you enjoy using the VR headset?

Yeah, I'd say. It was quite a lot of fun. The task itself was fairly, it's something that I haven't done before in VR, but felt very familiar to other studies that I've been a part of. It was a fun twist.

What did you like/dislike about it?

I liked well, firstly the novelty of, oh look, I'm in the room that I'm in and just the little details of I can't see my hands. But yeah, the main things that I liked were the actual stimuli themselves, sitting and doing the study. And then obviously the reveal of oh we've changed the room that to me was actually quite a fun game.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

No, not really. I'd say about as far as I got was, you know, quizzing myself as to whether the words were real or not, because they did seem almost real.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah, that was that was fine. That was it was very comfortable. It wasn't invasive and and you made sure to tell me that it was happening when I couldn't see it, so that that was good.

Did you anticipate that there was going to be changes made to the environment following the word task?

No, not in the slightest. I thought that, you know, take a look around the room at the beginning was just to get me kind of used to VR. But yeah, no, that that was quite a fun reveal. I did not expect that at all.

If you noticed any of the changes, how did this make you feel?

I think the psychology brain in me, it had a little bit of a giggle to say aha they had a real goal for this after all. Yeah. It made me feel really like it was fun. It was good.

Do you have any questions?

No.

LAT-P8

Was using the VR headset what you expected it to be?

Yes, I had used it before.

Did you enjoy using the VR headset?

Yeah, yeah. They're always very interesting.

What did you like/dislike about it?

It's to me as a psychology student, it opens up so many interesting possibilities and it sort of gives you an immersion in a different world, even if it's the same one that was there. I don't like, they still weigh quite a bit, and they're a bit grainy still. They're not all that detailed.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

No, no, not at all.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yeah absolutely.

Did you anticipate that there was going to be changes made to the environment following the word task?

Following the word task, I had a feeling that the environment would change. I think I read so in some of the description of the study, and I was given a long enough time to walk around the room to familiarise myself with it, and as if it was a sort of memory test.

If you noticed any of the changes, how did this make you feel?

Um it took a second when I looked around again and I thought something has changed. So no particular emotion except sort of criticalness like curiosity.

Do you have any questions?

No, I don't think so. Just I'd just like to know what whether I missed anything. Or what? What? Whether I invented any.

LAT-P9

Was using the VR headset what you expected it to be?

Yes, I think I've used it a couple of times before so.

Did you enjoy using the VR headset?

Every time.

What did you like/dislike about it?

I think just the technology and the possibilities of how, how it can change everything. Yeah, very interesting.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

I don't think I felt anxious at all, but I think just not having done the study. I think I was more relaxed toward the end. But no actual anxiety.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Very comfortable, yeah.

Did you anticipate that there was going to be changes made to the environment following the word task?

I didn't until I saw the red board. That was the big one, though, yeah.

If you noticed any of the changes, how did this make you feel?

I mean satisfied.

Do you have any questions?

I don't think so, no.

LAT-P10

Was using the VR headset what you expected it to be?

Almost, yes.

Did you enjoy using the VR headset?

Yes, I did.

What did you like/dislike about it?

I liked the fact that it was very close to reality. Of course, there are things that could be improved to make it more, to feel more real.

We took measures of anxiety during the study, but were there any points in the experiment where you felt particularly anxious?

Not really. I don’t think so, no.

Were you comfortable with the non-invasive measure of anxiety (the placement of a small device over the tip of a finger)?

Yes, that was absolutely fine.

Did you anticipate that there was going to be changes made to the environment following the word task?

No, I didn't think there would be any changes made.

If you noticed any of the changes, how did this make you feel?

I was surprised.

Do you have any questions?

No, thank you.