Decision-making in Autism Spectrum Conditions

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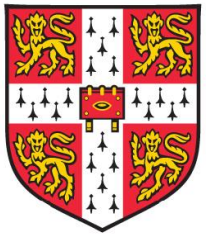

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University Notes

This dissertation is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated in the text.

This dissertation is not substantially the same as any that I have submitted for a degree or diploma or other qualification at any other University and no part thereof has already been or is concurrently being so submitted.

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Summary

Background: The difficulties experienced by intellectually able adults with autism spectrum conditions (ASCs) have been hinted at in autobiographical accounts as well as in the clinical and neuropsychological research literature. Little is known, however, about the nature of these putative difficulties, nor how people with ASCs might best be supported to make decisions for themselves. The aim of this project is to improve understanding of the effects of ASCs on decision-making in a way that may be useful to the development of guidance for those who support decision-making in adults with ASCs.

Method: The project comprised two phases. The first phase was a preliminary survey of the decision-making experiences of adults with ASCs (quantitative and qualitative data). The second phase was an empirical investigation of decision-making in adults with ASCs, compared to a general population control group, which was matched for age, gender and verbal ability (quantitative data). The experimental stimuli were a battery of established and adapted neuropsychological measures, which were selected to substantiate or explore some of the findings from the preliminary survey.

Results: The preliminary survey clearly showed that participants with ASCs perceive a number of difficulties in everyday decision-making. When assessed in the experimental study, the participants with ASCs reported experiencing several problems in decision-making, including avoiding decisions, more frequently than the control group. The behaviour of the ASC group on some of the laboratory tasks of decision-making were consistent with the experiences they reported.

Conclusions: The findings suggest that decision-making can be particularly difficult for adults with ASCs and some possible reasons for these difficulties are identified. The findings also suggest that adults with ASCs, who are intellectually able, may benefit from support when making decisions. Specific recommendations on how to support adults with ASCs, as well as directions for future research, are discussed.

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List of abbreviations

ACC	Anterior cingulate cortex
ADI-R	Autism Diagnostic Interview – Revised
ADOS	Autism Diagnostic Observation Schedule
AQ	Autism Spectrum Quotient
AS	Asperger syndrome
ASC	Autism spectrum condition
CGT	Cambridge Gamble Task
ΔEV	Change in Expected Value
EV	Expected Value
E-S	Empathising-Systemising theory
EVL	Expectancy-Valence Learning model
GDMS	General Decision Making Style inventory
HADS	Hospital Anxiety and Depression Scale
HFA	High-functioning autism
ID/ED	Intradimensional/Extradimensional Shift task
IGT	Iowa Gambling Task
IST	Information Sampling Task
MOT	Motor Screening Task
MRC	Medical Research Council
NAS	National Autistic Society
OTS	One Touch Stockings of Cambridge
PDD	Pervasive Developmental Disorders
PDD-NOS	Pervasive Developmental Disorder Not Otherwise Specified
PFC	Prefrontal cortex
RCT	Risky Choice Task
SC	Skin Conductance
SCL	Skin Conductance Level
SCR	Skin Conductance Response
SSAI	Spielberger State Anxiety Inventory
SSRI	Selective Serotonin Reuptake Inhibitor
μS	Microsiemens
WASI	Wechsler Abbreviated Scale of Intelligence
WCC	Weak Central Coherence

Table of Contents

List of Appendices

CHAPTER 1: INTRODUCTION

1.1 What is decision-making?

Decision-making is the mental process by which one of two or more possible options is selected in order to reach a desired goal (Edwards, 1954; Huitt, 1992). The process can include the formation of preferences, searching for information, preparation to implement the chosen action, and the evaluation of outcomes (Ranyard, Crozier & Svenson, 1997; Ernst & Paulus, 2005). We make decisions every day; these range from decisions that carry very little consequence, such as which sandwich to buy, to decisions that can have significant consequences for our health, relationships, or finances. Decision-making is, therefore, a vital skill and necessary for self-determination.

1.2 Why study decision-making in autism spectrum conditions?

People with autism spectrum conditions (ASCs) experience a number of difficulties in their everyday lives (Tantam, 1991). However, the decision-making of people with ASCs has received relatively little scientific attention. This is surprising given suggestions from a variety of sources that decision-making can be unusually difficult for people with ASCs. Moreover, there is increasing recognition that statutory frameworks seeking to empower and protect adults at risk of lacking capacity for making one or more decisions autonomously (for example, the Mental Capacity Act (*England and Wales*) 2005) are relevant to some people with ASCs (Butcher, 2007). At present, there is very little guidance available for clinicians and carers of adults with ASCs about the ways in which decision-making may be affected by the condition, or suggestions for ways in which these adults could be supported. Current guidance is instead weighted heavily towards clinical conditions for which decision-making has been well studied (for example, intellectual disabilities or dementia, see the Mental Capacity Act (*England and Wales*) 2005: Code of Practice). Understanding more about the impact of ASCs on decision-making is essential for improving the support offered to people with ASCs.

This thesis presents an investigation of decision-making in ASCs. In this first chapter, the literature on decision-making in the neurotypical population is summarised, providing an overview of the different approaches available to study decision-making, as well as the

developing models grounded in standard human capabilities. The characteristics of ASCs are then discussed before the literature relating to decision-making in ASCs is reviewed in detail.

1.3 Previous research in decision-making

1.3.1 *Legal aspects*

The legal systems in most democratic countries approach decision-making as a functional ability; assessment of decision-making is focused on whether a person has the ability, or 'capacity', to make one or more specific decisions (see Grisso & Appelbaum, 1995; Wong, Clare, Gunn & Holland, 1999). The decisions considered within legal frameworks tend to relate to health and social care, as well as financial decisions (see Guardianship and Administration Act (*South Australia*) 1993; Adults with Incapacity (*Scotland*) Act 2000; Mental Capacity Act (*England and Wales*) 2005, *MCA*). Under the *MCA*, an adult is considered to lack the capacity to make one or more specific decisions only if he or she is demonstrably unable, due to an 'impairment of mind or brain' (s. 2(1), *MCA*), to: a) understand the information relevant to the decision; b) retain that information; c) use or weigh that information as part of the decision-making process; or d) communicate, by any means, his or her choice (s. 3(1), *MCA*). These are referred to as 'functional abilities' for decision-making capacity.

The definition of incapacity used in the *MCA* (and in the legislation of other countries) requires that the person has, first, an 'impairment of mind or brain', and secondly that this impairment affects the functional abilities required for decision-making. Research on decision-making in this context has, therefore, focused on people with a range of clinical conditions. Numerous studies, using standardised, legally-relevant decisions, such as consent to medical treatment or participation in research, have investigated the capacity of men and women with: intellectual disabilities (for example, Grisso & Appelbaum, 1995; Arscott, Dagnan & Kroese, 1999; Wong, Clare, Holland, Watson & Gunn, 2000; Suto, Clare, Holland & Watson, 2005a), dementia (for example, Marson, Chatterjee, Ingram & Harrell, 1996; Wong et al., 2000; Moye, Karel, Gurrera & Azar, 2005), physical illness (for example, Casarett, Karlawish & Hirschman, 2003; Raymont et al., 2004), and mental health problems (for example, Grimes, McCullough, Kunik, Molinari & Workman, 2000; Wong et al., 2000; Palmer & Jeste, 2006; Candilis, Fletcher, Geppert, Lidz & Appelbaum, 2008).

For the most part, these studies have demonstrated that the capacity to make a particular decision can be affected by the condition in question. At the same time, they emphasise that a diagnosis alone is not a sufficient basis for concluding that a person lacks the capacity to make a specific decision. A particular theme of the legally-relevant research is the identification of cognitive, medical, and other personal characteristics that can help practitioners to identify those who are at an increased risk of lacking capacity, and how they might best be supported when making decisions. Important predictors of decision-making capacity are cognitive functions, such as attention, working memory, semantic memory, processing speed, planning (see Murphy & Clare, 1995; Marson et al., 1996; Dymek, Atchinson, Harrell & Marson, 2001; Murphy & Clare, 2003; Palmer & Jeste, 2006) as well as age and education (see Casarett et al., 2003). These factors have all been shown to affect one or more of the functional abilities required for decision-making capacity.

Legally-relevant studies have also focused on the psychological factors present in specific conditions that can compromise *weighing* in the decision-making process more or less independently of the other functional abilities. A phobia, for example, may compromise decision-making capacity in situations involving the object of fear. This was demonstrated in the leading case of a pregnant woman, *Re MB* (medical treatment) [1997] 2 FLR 426, who, prior to going into labour, had given consent to delivery by Caesarean section. However, she then withdrew her consent at the point of labour because of her phobia of needles. It was established by the court that, although Ms MB adequately understood the need for the operation, her '*panic fear of needles dominated everything at the critical point* [and] *she was not capable of making a decision*' (*Re MB*, p427). Similarly, cognitively able patients with anorexia nervosa may lack the capacity to consent to feeding treatment due to their intense fear of weight gain and/or their perception of the seriousness of their condition, which, again, may affect the thought processes specific to the decision (Tan, Hope & Stewart, 2003).

1.3.2 *Thought processes in decision-making*

The earliest theories of decision-making attempted to describe how decisions should be made by proposing formal models of normative social and economic behaviour (see Fishburn, 1988). Central to these normative models is the notion of rational choice. This notion assumes that decisions are taken only after the benefits and costs of each action have been weighed at which point the action with the highest value (subjective or material) is selected

(Pascal, 1660, translated in Krailsheimer, 1966; Zey, 1998). One of the most important models of rational choice is the *Subjective Expected Utility* theory (von Neumann & Morgenstern, 1947), which assumes that decisions can be reached by quantifying the personal utility of each outcome and weighting them by the subjective probabilities of their occurrence. However, normative theories of decision-making are limited in their ability to predict human behaviour (Simon, 1957). First, the requirements for making a rational choice (such as having full knowledge about the available actions and their likely consequences, as well as stable preferences about the outcomes that can be used to rank actions) are not always met (Hickson & Khemka, 1999). Secondly, the cognitive processes believed to underpin decision-making, such as memory and attention, are limited in their capacity (see Miller, 1956; Broadbent, 1958; Waugh & Norman, 1965; Baddeley, 1996). These limitations may potentially compromise the ability to undertake a rational analysis. Acknowledgement of these limitations has lead to the development of modified models, such as *Prospect Theory* (Kahneman & Tversky, 1979) and *Bounded Rationality* (Simon, 1957), which attempt to identify the human limitations and biases for carrying out complex analyses and making rational choices.

The strategies employed by decision-makers to overcome their limitations have been the focus of much research. The pioneering studies of Kahneman and Tversky and their colleagues indicated that people use a number of heuristics (mental 'short-cuts') to simplify some of the complex mental processes involved in decision-making (see for example, Tversky & Kahneman, 1974; Gilovich, Griffin & Kahneman, 2002; Kochler & Harvey, 2004). Most of the time, heuristics facilitate adaptive and efficient decision-making; in some situations, however, their use can result in systematic biases towards particular response options (Kahneman, Slovic & Tversky, 1982). Demonstrations of the use of heuristics typically involve presenting people with questions constructed to offer a 'rational' choice, and an 'incorrect' choice that follows naturally from the heuristic-led thought process. The most well-known heuristics include the *representativeness* heuristic, which describes the tendency for people to evaluate the probability of an event by the degree to which the event resembles their experiences in real life. Specifically, events that appear more representative of reality are judged as more likely to occur than events that are less representative (Kahneman & Tversky, 1972). Other well-known heuristics include the *availability* heuristic, which is a tendency to evaluate the probability of an event by the ease with which examples

of that event can be brought to mind (Tversky & Kahneman, 1973), and the *anchoring-adjustment* heuristic, which is the tendency to make judgments using one value as a reference point (an 'anchor') and adjusting that value to produce an estimate (see Tversky & Kahneman, 1974). Less well-known heuristics and biases include: the *Peak-end rule*, whereby past experiences are judged most on the peak of the experience and how that experience ended (Kahneman, Diener & Schwarz, 1999), and *Escalation of Commitment*, in which people tend to continue to commit resources to a project in which they have already invested, despite new evidence suggesting the continued investment is not cost-effective (Staw, 1976). In real life contexts, it has been shown that heuristics can play a role in judgements about population sizes (Wilson, Houston, Etling & Brekke, 1996), inferences about people (Tversky & Kahneman, 1983), evaluation of salary offers (Neale & Bazerman, 1991), and can even influence sentencing decisions in court (Englich & Mussweiler, 2001).

Another major theme in psychological research on decision-making concerns the identification of individual differences. Scott & Bruce (1995), for example, proposed that people rely to different extents on five, non-mutually exclusive, decision-making styles, defined as '*the learned habitual response pattern exhibited by an individual when confronted with a decision situation*' (Scott & Bruce, 1995, p820). The styles proposed are: i) a *rational* style, characterised by comprehensive searches for information and logical evaluation of alternatives; ii) an *intuitive* style, characterised by attention to salient details and feelings; iii) a *dependent* style, characterised by a tendency to search for advice and support from others; iv) an *avoidant* style, characterised by a tendency to avoid decision-making whenever possible; and v) a *spontaneous* style, characterised by a tendency to complete the decision-making process as quickly as possible. These styles of decision making correlate with measures of performance and personal characteristics. The *rational* style, for example, is associated with positive ratings of managerial performance (Russ, McNeilly & Comer, 1996), and an internal locus of control (Biacco, Laghi & D'Alessio, 2009). The *avoidant* style is associated with negative stress, indexed by higher levels of the stress hormone, cortisol, during decision-making (Thunholm, 2008). Similar styles of decision-making have been proposed by Janis & Mann (1977). However, their model of decision-making styles assumes that people approach decision-making with a *vigilant* (rational) style wherever possible, and use less adaptive strategies, such as passing the responsibility to another person, only where a rational style cannot be adopted.

1.3.3 *Cognitive, emotional, and motivational processes involved in decision-making*

The roles of basic cognitive, emotional and motivational processes in decision-making have been assessed in an extensive literature. Cognitive processes enable mental representation and manipulation of the information upon which decisions are based, emotional processes can contribute to an evaluation of the personal significance of the information, and motivational processes determine the goals of the decision-maker (Hickson & Khemka, 1999).

The cognitive processes receiving the most attention in decision-making are categorised as 'executive functions'. These are higher cognitive processes that enable complex, goal-directed behaviour and are believed to be mediated by the frontal lobes (Russo et al., 2006; Suchy, 2009). These include: a) *working memory*, which is the ability to actively store information needed for further processing or reasoning (Baddeley & Hitch, 1974); b) *planning*, which is the ability to model a sequence of actions in order to carry out a specific task, and to monitor the planned sequence of actions and update it as required (Shallice, 1982; Morris, Miotto, Feigenbaum, Bullock & Polkey, 1997; Hill, 2004b); c) *attentional flexibility*, which is the ability to shift back and forth between multiple tasks or mental sets (Head, Bolton & Hymas, 1989; Miyake et al., 2000); d) *response inhibition*, which is the ability to suppress behaviour that would otherwise interfere with the process of achieving a goal (Dempster, 1992; Verbruggen & Logan, 2008); and e) *generativity* (also known as ideational fluency), which is the ability to generate novel ideas and/or multiple responses to stimuli (Milgram & Arad, 1981; Wilson, Gilley, Tanner & Goetz, 1992). During decision-making, these cognitive processes facilitate mental representation of situational features and potential consequences, recall of similar decision-making experiences, categorisation of alternatives, recall of declarative information, and the selection of a problem solving-strategy (Brand, Labudda & Markowitsch, 2006). Several studies have shown that impairments of executive function (for example, in populations with frontal lobe injury, or dementia) are associated with impairments in decision-making in laboratory-based tests (Manes et al., 2002; Brand et al., 2005; Brand, Recknor, Grabenhorst & Bechara, 2007; Sinz, Zamarian, Benke, Wenning & Delazer, 2008). However, the relationship between executive function and decision-making is complex and decision-making may be impaired even in the absence of cognitive impairments (see Mimura, Oeda & Kawamura, 2006).

The influence of emotion in decision-making has been demonstrated through several different strands of research. The influential *somatic marker* hypothesis proposed by Bechara and his colleagues (see Bechara, Tranel, Damasio & Damasio, 1996; Bechara, Damasio, Tranel & Damasio, 2005) provides an account of how emotions may guide choice. In their research, decision-making was stimulated using the specially developed Iowa Gambling Task (IGT, see Bechara, Damasio, Damasio & Anderson, 1994). In the IGT, participants make repeated selections from four decks of cards in order to win as much money as possible. Unbeknownst to the participants, two of the decks are weighted with large wins and large losses in such a way that repeated selection leads to a net loss of money (disadvantageous decks). The other two decks are weighted with smaller wins but fewer losses so that repeated selections from these decks leads to a net gain of points (advantageous decks). Bechara et al. (1996) found that, prior to making disadvantageous choices, neurotypical participants developed anticipatory skin conductance responses, reflecting increased autonomic arousal even before they reported conscious awareness of the presence of advantageous and disadvantageous decks. In contrast, patients with prefrontal ventromedial brain damage, who presented risky decision-making in real life, failed to develop these anticipatory markers. Bechara *et al.* proposed that affective (emotional) somatic states are unconsciously associated with potential response options and form emotional markers that guide the reasoning process. Reasoning may, therefore, be biased against response options associated with negative somatic markers. This would, Bechara and colleagues argue, adaptively aid decision-making in situations where response options are too numerous or complex to be processed adequately by conscious reasoning alone. This hypothesis has, however, been criticised on the basis that participants have more conscious knowledge of the risks than originally assumed (Dunn, Dagleish & Lawrence, 2005; Maia & McClelland, 2004; Brand et al., 2007).

Other research has shown that decision-making may be adversely affected by emotion. High levels of anxiety may affect decision-making by altering the patterns of autonomic arousal that reflect somatic markers (Ernst & Paulus, 2005; Miu, Heilman & Houser, 2008). In a review of the literature, Etzioni (1988) concluded that elevated anxiety can reduce capacity for abstract thinking and bias the evaluation of significant and trivial information. Low mood is also associated with disadvantageous decision-making on the Iowa Gambling Task (see de Vries, Holland & Witteman, 2008).

Motivation can also affect decision-making by influencing the extent to which people engage in decision-making tasks (Hickson & Khemka, 1999). Janis and Mann (1977) proposed that a fully motivated decision-maker engages in a number of stages required for decision-making (the proposed stages are: canvassing alternatives, canvassing objectives, careful evaluation of consequences, searching for information, unbiased assimilation of new information, planning for implementation and contingencies), whereas less motivated decision-makers engage in only some of these processes. Motivation is itself influenced by a number of factors, which include confidence in decision-making abilities (Janis & Mann, 1977; Scott & Bruce, 1995), a sense of agency (Radford, Mann, Ohta & Nakane, 1993; Bacanli, 2006), and the extent to which the decision-maker is interested in the content of the decision (McGuire & McGuire, 1991). Within the decision-making process, motivation is believed to play a particularly important role in the selection of goals that determine the decision-maker's evaluation of the different courses of action (Hickson & Khemka, 1999). Recently, a computational model of decision-making performance on the IGT (the *Expectancy-Valence Learning* model) has been developed to quantify differences in a specific motivational process between individuals (Busemeyer & Stout, 2002). The model provides a parameter estimate of the extent to which decision-makers are motivated by immediate wins or motivated to avoid loss. The model has been applied to several clinical groups. For example, chronic illegal drug users have been found to have a motivational bias for immediate wins, which is consistent with the theory that signals of positive reward carry more weight than signals of risk and may be a maintaining factor in substance misuse (Stout, Busemeyer, Lin, Grant & Bonson, 2004; Yechiam, Busemeyer, Stout & Bechara, 2005).

1.3.4 *Neurobiology of decision-making*

Neurobiological studies of decision-making have indicated the involvement of several brain regions in decision-making that are consistent with the involvement of cognitive, emotional and motivational processes as outlined above. These studies involved clinical groups with defined lesions, as well as neuroimaging paradigms with healthy volunteers. For example, patients with damage to the prefrontal cortex (PFC) demonstrate impairments in decision-making on the IGT: they make fewer selections from the advantageous decks compared to controls (Manes et al., 2002). Since the PFC is associated with several executive functions (see for example, Owen, Sahakian, Semple, Polkey & Robbins, 1995; Stuss et al., 2000) this observation is consistent with the hypothesised importance of executive function. Other

research has demonstrated activity in regions that are associated with memory (the hippocampus and posterior cingulate) in informed decision-making, while the amygdala is involved in 'guessing' decisions that are made without all the relevant information (Ernst et al., 2002; Ernst et al., 2004). The amygdala is believed to be important in evaluating the emotional significance of information, and can also play a role in motivation (Ernst & Paulus, 2005). Another important neural region in decision-making appears to be the anterior cingulate cortex (ACC), which is believed to play a role in processing uncertain information and generating arousal in decision-making (Critchley, Mathias & Dolan, 2001), as well as integrating information about success and errors (Carter, Botvinick & Cohen, 1999). A novel study of decision-making, carried out by Braeutigam and colleagues (Braeutigam et al., 2001), identified activity in Broca's area (language function) during deliberative, quasi-naturalistic choice-making. The authors proposed that activity in this region showed that silent vocalisation may be part of the decision-making processes in situations where a clear preference is not present. These studies provide a useful starting point for understanding some of the processes and abilities involved in decision-making. However, their interpretation can be affected by the complex connectivity of the brain, as well as individual differences, especially in lesion pathology (for review, see Fellows & Farah, 2005).

1.3.5 *Conclusions*

In summary, the study of decision-making has been a major research theme in several disciplines: law, economics, social psychology, psychology, and neuroscience, reflecting the paramount importance of decision-making as a life skill. Although decision-making is a complex process, involving both conscious and unconscious processes, the research just surveyed has contributed to an understanding of the abilities required for decision-making, the nature of individual differences, and the specific processes through which decisions can be made. An important finding, drawn particularly from the psychological research, is that human decision-making is not perfect, but is capable of selecting good courses of action most of the time. The next section presents a summary of the characteristics of ASCs; the literature relating to decision-making in ASCs is then considered in detail.

1.4 Autism spectrum conditions (ASCs)

1.4.1 *Introduction to ASCs*

Autism spectrum conditions (ASCs) are characterised by life-long behavioural abnormalities in: i) reciprocal social interaction; ii) communication; and iii) restricted, repetitive and stereotyped patterns of behaviour, interests and activities (World Health Organisation, 1992; American Psychiatric Association, 1994). The autistic condition was first characterised by the psychiatrist Leo Kanner in 1943, who identified eleven boys each with an impairment in relating to other people, an insistence on sameness in their routine or environment, and with some special abilities (Kanner, 1943). Soon after Kanner's description was published, the physician Hans Asperger independently described a group of intellectually able adolescents with similar traits to the children described by Kanner. Asperger proposed that an 'autistic psychopathy' was common to the young people he described, despite wide individual differences in the presentation of symptoms (Asperger, 1944). Several decades later, autistic disorders have been conceptualised as Pervasive Developmental Disorders (PDD) and are believed to form a continuum of social and communication impairments: the autism spectrum (Wing, 1991). Along this spectrum, specific diagnoses of ASCs include: autism, high-functioning autism (HFA), Asperger syndrome (AS), and Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS).

The distinction between the specific diagnoses is a source of some debate. According to the Diagnostic and Statistical Manual, fourth edition (DSM-IV, American Psychiatric Association, 1994) and the International Classification of Diseases, tenth edition, (ICD-10, World Health Organisation, 1992), AS is characterised by the same features as autism, but without a delay in language and cognitive development within the first three years of life. However, Gillberg and Gillberg's criteria for AS (Gillberg & Gillberg, 1989), which is also in clinical use, includes subtle problems in language such as use of formal or pedantic language, and literal rather than communicative interpretation. Gillberg and Gillberg's criteria also include motor clumsiness, which are not included in the DSM-IV and ICD-10 core criteria. PDD-NOS is generally considered a milder ASC (see Hoekstra, Bartels, Cath & Boomsma, 2008), and may be diagnosed when the defining characteristics of autism have become apparent only after 3 years of age. Alternatively, PDD-NOS may be diagnosed when some or all of the traits presented are borderline for a diagnosis of autism or AS (American Psychiatric Association, 1994).

The intellectual functioning of adults with ASCs varies widely; approximately 15% of people with an ASC are believed to have an intellectual disability (see Gillberg & Soderstrom, 2003), although, by definition, adults with HFA and AS have IQ scores in the normal range (or above) as well as relatively well-developed language skills (see Frith, 2006; Mackinlay, Charman & Karmiloff-Smith, 2006). A recent estimate of the prevalence of ASCs suggested that they affect 1.2 in every 100 people (Baird et al., 2006). Note, however, that estimates of the prevalence of ASCs vary considerably, reflecting differences in study methodologies (for review, see Williams, Higgins & Brayne, 2006).

1.4.2 *Aetiology of ASCs*

1.4.2.1 Genetic evidence

ASCs are highly heritable, as indicated by the twin study carried out by Bailey and colleagues (Bailey et al., 1995). They found that 60% of monozygotic twins were concordant for a diagnosis of autism, while no dizygotic twins were concordant for autism. Consistent with this finding, features of the broader autism phenotype (which will be discussed below), such as enhanced attention to detail, impaired understanding of the beliefs of others, and superior intuitive understandings of physics have been found in the relatives of people with ASCs (Baron-Cohen & Hammer, 1997; Baron-Cohen et al., 1998). The genetic underpinnings of ASCs appear to involve a complex combination of rare mutations and polymorphisms common in the general population (for review, see O'Roak & State, 2008). Specific genes implicated in the pathology of ASCs are currently being identified, and include genes contributing to sex hormones and neural growth (Chakrabarti et al., 2009).

1.4.2.2 Psychological theories

Several current psychological theories provide an account of the cognitive and behavioral characteristics of ASCs. Three of the major theories, Weak Central Coherence, Executive Dysfunction and Empathising-Systemising Theory, are summarised here.

Weak Central Coherence (WCC), first proposed by Frith (1989), proposes a weakness in people with ASCs to extract the global meaning of information. Instead, information is perceived in a more fragmented fashion. This weakness, which can be seen at different levels of processing (Happé, 1996, 1997), may contribute to the social and communication impairments of people with ASCs. For example, WCC can affect the ability to use semantic

context to infer meaning from language (for example, Happé, 1997; Catarino et al., *in press*) and to perceive meaning in facial expressions and non-verbal language (see Plaisted, Saksida, Alcántara & Weisblatt, 2003). An enhanced attention to detail may also underpin the circumscribed interests observed in ASCs (see Ozonoff, Pennington & Solomon, 2006). Recently, however, a modified theory has been proposed, suggesting that attention to local details reflects a superiority of local processing mechanisms, rather than a general deficit in global processing mechanisms (see Mottron, Dawson, Soulières, Hubert & Burack, 2006).

Executive Dysfunction refers to impairments in the executive functions, which were described in the earlier section summarising the cognitive processes in decision-making (Section 1.3.3). Impairments in specific executive functions have been observed in people with HFA (Ozonoff, Pennington & Rogers, 1991; Hughes, Russell & Robbins, 1994). This broader phenotype is also observed in the relatives of people with ASCs (Hughes, Leboyer & Plumet, 1999). In general, these impairments provide an account for the behavioural rigidity and insistence on sameness that characterises ASCs. Furthermore, impairments in planning can affect participation in social interaction, which requires constant monitoring and updating (see Hill, 2004a). However, the theory does not explain the superior abilities sometimes demonstrated by people with ASCs (see for example, Baron-Cohen, 2009), nor is executive dysfunction demonstrated in all individuals with ASCs (see Rajendran & Mitchell, 2007). Nevertheless, given the relevance of these associated impairments in ASCs to decision-making, specific difficulties in executive function are discussed in detail in the next section.

The final theory to be summarised here is the *Empathising-Systemising* (E-S) theory proposed by Baron-Cohen (2002; 2009). Consistent with the view that ASCs lie on a continuum, this theory proposes that ASCs can be explained by a discrepancy between empathising and systemising abilities, which themselves lie on a continuum in the general population. Empathy is the ability and tendency to produce an appropriate emotional response to another person's thoughts and feelings, while systemising is the drive to understand and construct rule-based systems (Baron-Cohen, 2006). The E-S theory proposes that ASCs arise when the ability to empathise is low and the ability to systemise is high. This two-factor theory provides an account that explains both the social difficulties observed in ASCs and the strengths, such as the ability to become an expert in a highly specialised area.

The psychological theories provide useful frameworks for understanding and predicting the behaviours and abilities of people with ASCs. A great deal of research is concerned with refining these theories and understanding the relationships between them (for example, South, Ozonoff & McMahon, 2007). However, they are not complete models of ASCs, either because they are unable to explain *all* of the behaviours or impairments demonstrated by people with the condition, or because more research is required to test the predictions that they make.

1.5 Literature review of decision-making in ASCs

There is little systematic information about the extent to which decision-making may be affected by ASCs. There are, however, four sources which suggest that, in some situations, decision-making may be problematic for people with ASCs: i) autobiographical accounts written by people of exceptional talent, such as Temple Grandin; ii) clinical accounts of specific situations in which decision-making appears to be compromised; iii) evidence of cognitive, emotional and neurobiological abnormalities that are relevant to decision-making; and iv) a small number of published studies looking at specific decision-making processes in people with ASCs. In this section, the state of the literature is summarised by considering each of these source types in turn.

1.5.1 *Autobiographical accounts of decision-making difficulties in ASCs*

The autobiographical accounts of several well-known people with ASCs provide some insight into the types of difficulties that can be experienced. Temple Grandin, for example, described how the tendency for people with ASCs to think in pictures can cause the decision-making process to become '*locked up and overloaded with pictures coming in all at once*' (Grandin, 2000, p2). Claire Sainsbury has described how having to choose food '*on the spot*' can be very difficult (Sainsbury, 2000, p104), while Wendy Lawson, when describing the effects of anxiety, wrote that '*even the smallest decision, for example, what to eat or what to wear can seem like an impossible task. As individuals with an autism spectrum disorder we feel this way most of the time!'* (Lawson, 2001, p104). Finally, Jen Birch has described how even simple decisions that involve choosing between only two options (in this case, which of two calendars to purchase) can be enormously difficult: '*I have never been 'normal' in this respect, needing more time than the average person in order to weigh up my options, come to a decision, cope with the sudden change of options (in this case, changing my decision at*

rapid-fire pace - which can be a very difficult thing for me to do), and mentally process data in general…it is the moment of decision-making which is (often) the difficulty for me' (Birch, 2003, p213). These accounts suggest that difficulty with decision-making can be a frequent occurrence and can affect several aspects of everyday life for people with ASCs. They are consistent with the reports of a teacher who has observed that even simple choices can be stressful and take a long time for children with AS (Winter, 2003). These reports are also consistent with parental reports of greater indecisiveness in adolescents and young adults with AS, compared to the general population, which were quantified using the Indecisiveness Scale (Frost & Shows, 1993; Johnson, Yechiam, Murphy, Queller & Stout, 2006). The accounts presented above provide some vivid descriptions of the difficulties that people with ASCs can experience. They are, however, limited in that they are the personal accounts of only a few people.

1.5.2 *Clinical accounts of the impact of characteristic features on decision-making*

Clinical case studies suggest ways in which some of the characteristic features of ASCs may impact upon decision-making. In particular, these case studies describe how intense circumscribed or 'special' interests may bias decision-making in favour of options that allow an individual to pursue that interest, regardless of its consequences. Howlin (2004) for example, describes a man who spends all his time and money on computer magazines and, as a result, cannot pay his bills (p139); a man who collected so much electrical equipment that he was eventually unable to enter his house (p142); and a man whose fascination with washing machines caused him to trespass into other peoples' houses to watch their machines (p304). In the same vein, Woodbury-Smith et al. (2010) described a number of individuals whose pursuit of unusual, but not illegal, 'special' interests has resulted in criminal offending. Given this wealth of anecdotal evidence it seems possible that special interests in ASCs, due to their pathological intensity, may dominate the normal weighing of relevant information and compromise capacity in a manner analogous to a phobia (see Section 1.3.1). These accounts do not, however, include an assessment of the individual's capacity to make these particular decisions. As a result, it is unknown whether these individuals experience a conflict when making these particular decisions or whether they do not understand that there is a decision to be made.

1.5.3 *Cognitive, emotional, motivational, and neurobiological abnormalities*

ASCs are associated with a number of impairments in executive functions (for a review see Happé & Frith, 1996). As discussed earlier, executive functions are cognitive abilities that enable complex, goal-directed behaviour and are involved in decision-making. The specific impairments identified in people with ASCs and their possible effects on decision-making are sunmarised below.

- *Attention shifting and focusing impairments* (see Goldstein, Johnson & Minshew, 2001). These may limit a person's ability to focus on relevant information and switch between different mental representations of the possible actions and outcomes.

- *Working memory impairments* (see Joseph, Steele, Meyer & Tager-Flusberg, 2005). Specifically, there is evidence that adults with HFA are impaired in tests of spatial working memory, rather than verbal working memory (Williams et al., 2005; Luna et al., 2006). Furthermore, it appears that impairments in spatial working memory reflect reduced capacity, rather than impaired function (Steele et al., 2007). Reduced working memory capacity may affect decision-making by impeding the temporary storage and manipulation of goal-related information (Joseph et al., 2005; Russo et al., 2006). As a result, people with ASCs may have particular difficulty making decisions in which there are several factors to consider, consistent with the account provided by Grandin (2000). However, evidence of impaired spatial working memory in ASCs is mixed: Ozonoff & Strayer (2001) found no impairment in children and adolescents with HFA across five different tests of working memory (including spatial span); instead, working memory performance was correlated simply with age and IQ.

- *Inhibitory control impairments* (see Minshew, Luna & Sweeney, 1999; Luna, Doll, Hegedus, Minshew & Sweeney, 2006; Christ, Holt, White & Green, 2007). Inhibitory control refers to the ability to suppress behaviour or cognition that would otherwise interfere with the process of achieving a behavioural or cognitive goal (Christ et al., 2007). Unsurprisingly, impaired inhibitory control is associated with poorer decision-making on the neuropsychological tasks of decision-making (for example, Quednow et al., 2007), where choices appear to be made too early for a full consideration of available

information. Evidence of impaired inhibitory control in ASCs is, however, inconsistent (see Ozonoff & Strayer, 1997; Hill, 2004b).

- *Planning impairments* (see Ozonoff et al., 1991; Hughes et al., 1994; Ozonoff et al., 2004; Mackinlay et al., 2006). Planning is a complex, dynamic mental process in which a series of actions are sequentially organised, constantly monitored, evaluated and updated as necessary (Hill, 2004a). Planning abilities enable prospective consideration of response options (Manes et al., 2002), and evaluation and adjustment for mistakes in reasoning (Welie & Welie, 2001). Although the relationship between impairments in planning and decision-making has not been studied in ASCs, impaired planning is associated with riskier decision-making in adults with dorsomedial lesions (Manes et al., 2002), and in healthy volunteers taking Diazepam (Deakin, Aitken, Dowson, Robbins & Sahakian, 2004).

- *Generativity impairment* (see Hill, 2004b; Turner, 1999). Generativity, or fluency, refers to the capacity to generate novel ideas or multiple responses to stimuli. Impairments in generativity demonstrated in ASCs may translate into difficulty generating available courses of action and prospectively considering their possible consequences. The importance of generativity in decision-making has been recognised for people with intellectual disabilities and forms the basis of several interventions to improve their decision-making skills (Hickson & Khemka, 1999).

Among people with ASCs, the impact of these cognitive difficulties may be further exacerbated by high levels of anxiety (Tantam, 2000; Gillott, Furniss & Walter, 2001). Motivation for decision-making may also be affected in a number of ways by ASCs: decision-making may be affected by an associated lack of self-confidence (see Murray & Lesser, 2006), and the 'monotropic' tendency associated with the condition (Murray, Lesser & Lawson, 2005) may mean that adults with ASCs are simply not interested in the content of many decisions (outside of any special interest).

Neurobiological abnormalities identified using neuroimaging techniques have been found in a number of studies investigating brain bases for the impairments in social cognition, language function, and repetitive and restricted behaviour and interests that characterise ASCs (DiCicco-Bloom et al., 2006). Several of the brain regions implicated in ASC psychopathology are also associated with decision-making processes (Johnson et al., 2006). For example, there is evidence from both fMRI and PET studies of people with ASCs that reduced amygdala, prefrontal medial, and anterior cingulate activity are associated with deficits in emotion perception and theory of mind (Baron-Cohen et al., 1999; Castelli, Frith, Happé & Frith, 2002; Kana, Keller, Minshew & Just, 2007; Ke et al., 2008). Reduced activity in Broca's area has also been associated with autistic deficits in semantic and language processing and is believed to be a region with abnormal neurodevelopment in intellectually able adults with ASCs (Harris et al., 2006).

At the microscopic level, there is evidence of numerous neuronal abnormalities in ASCs that are likely to impact upon cognition (for a review, see Schmitz & Rezaie, 2008). For example, abnormalities in the organisation and width of frontopolar cortical modules, known as 'minicolumns', have been observed in both post-mortem and recent stereological studies of people with autism (Casanova et al., 2006). These abnormalities may impede normal information processing and integration by altering functional GABAergic systems and lateral inhibition of neuronal activity (DiCicco-Bloom et al., 2006; Schmitz & Rezaie, 2008). There is also a theoretical account suggesting that Von Economo neurones (bipolar cells located in the anterior cingulate cortex), which may aid decision-making under uncertainty (Allman, Hakeem & Watson, 2002), may be abnormally developed in ASCs (Allman, Watson, Tetreault & Hakeem, 2005). Allman and his colleagues proposed that abnormal development of Von Economo neurones may "*cause poor intuitive decision-making in situations involving considerable uncertainty, especially in social contexts*" (Allman et al., 2005, p371). They proposed this hypothesis on the basis that functional abnormalities in the anterior cingulate cortex are observed in ASCs, and abnormal perceptions of social stimuli in ASCs may impact upon the post-natal, experience-dependent development of Von Economo neurones. Allman et al. concluded that people with ASCs may lack the benefit of intuition in rapid decision-making under uncertainty, and therefore require greater deliberation time.

Together, these studies provide evidence of abnormalities in ASCs that may affect decision-making. This evidence is, however, based upon indirect links between abnormalities observed in ASCs and similar abnormalities in other clinical groups that are associated with impaired decision-making. The literature relating to impairments in executive functions in ASCs is also not clear cut, although there is a general consensus that ASCs are associated with deficits in planning ability and attention shifting (Hill, 2004b).

1.5.4 *Previous studies of decision-making by people with ASCs*

The final source of literature to be considered is a small number of laboratory-based studies that have investigated specific decision-making processes in ASCs. The earliest of these (Johnson et al., 2006) used a version of the Iowa Gambling Task (IGT) to examine motivational processes in children and adolescents with AS compared to participants from the general population. Compared to the control group, they found that the participants with AS demonstrated a more erratic pattern of choices, which could result in disadvantageous decision-making (Yechiam et al., 2005). However, the difference in performance between the groups (AS group: 6% improvement; Control group: 18% improvement) was not significant, and the authors concluded that their sample size may have been too small to detect a significant difference (n = 15 and 14, respectively).

Johnson et al. examined motivational processes in decision-making using the *Expectancy-Valence Learning* model, *EVL*, Busemeyer & Stout, 2002). The *EVL* is a computational model that quantifies the separate contributions of: i) a learning and memory factor (the tendency to be influenced by recent outcomes and to forget or discount past outcomes); ii) a motivational factor (the tendency to be attracted to wins and indifferent to losses); and iii) a response consistency factor (the tendency to make choices erratically). They found that the participants with AS appeared to learn the contingencies associated with each deck in a similar way to the control group. However, compared to the control group, the participants with AS demonstrated a non-significant trend towards increased sensitivity to loss. Again, the authors suggested that their sample size was too small to detect this difference (i.e. their study lacked power). There was, however, a significant difference between the groups in the response consistency factor. This finding is consistent with the initial observation that the participants with AS made choices more erratically. Johnson and colleagues concluded that the participants with AS were less influenced by the motivational properties (expectancies

about the outcome) that they assigned to the different decks. This conclusion should, however, be interpreted cautiously, as, for almost half the participants (45%), the *EVL* model did not fit the data better than a control model (the Bernoulli model), which takes no account of learning from previous choices.

The second laboratory-based study (Minassian, Paulus, Lincoln & Perry, 2007) examined the flexibility of decision-making by adults with high-functioning autism (HFA) using a two-choice prediction task. In this study (HFA group: n = 16, Control group: n = 14), participants were asked to predict over a series of trials whether a picture of a car would appear to the left or right of a computer screen while the researchers covertly manipulated the error rates (low, medium and high) of the participants' choices. They found that the participants with HFA demonstrated some flexibility in their choices by changing their prediction after guessing incorrectly (the so-called 'win-stay/lose-shift' strategy). However, they also found that, compared to participants from the general population, their use of the 'win-stay/lose-shift' strategy was more pronounced when the pre-determined error rate was low. This finding indicates that the decision-making of participants with HFA was influenced more by errors when errors were rarely experienced than when they were experienced frequently. Consistent with the non-significant trend observed by Johnson et al., this suggests that people with ASCs may be influenced differently by the gains and losses of previous choices.

The third study (De Martino, Harrison, Knafo, Bird & Dolan, 2008) examined the effects of 'framing' on monetary decisions for adults with ASCs. The 'framing effect' describes the influence of the format in which different options are presented (Tversky & Kahneman, 1981). For example, people in the general population tend to prefer a probabilistic loss over a certain loss, but prefer a certain gain over a probabilistic gain, even if the expected loss or gain of the two choices is equivalent. The framing effect is believed to be mediated by the *affect* heuristic, in which an emotional response to the language of the frame guides the choice (De Martino, Kumaran, Seymore & Dolan, 2006). In this study (ASC group: n = 14; Control group: n = 15), the participants were presented with a series of two-choice decisions. At the beginning of each trial, they were informed about the amount of money that they would receive to play that trial (for example, 'you receive £50'). They were then told that they would not be able to keep the whole amount, but would need to choose between a certain option (for example, 'you keep £20') and a gamble option (showing a probability that

they would keep all of the starting amount, and a probability that they would lose all of the starting amount). For each trial type, the certain option was presented in a 'gain' frame, which stated the amount of money that participants could keep (for example, 'you keep £20'), and a 'loss' frame, which stated the amount of money that participants would lose (for example, 'you lose £30'). They found that, compared to participants from the general population, the adults with ASCs showed less susceptibility to the framing effect, making more logical choices. Furthermore, the participants with ASCs did not demonstrate autonomic responses (measured using the galvanic skin response) indicating a lack of emotional involvement in the task. The authors proposed that ASCs confer enhanced logical consistency. However, this emotional detachment may take place at the expense of integrating emotional information, which can be beneficial in everyday situations where information is often ambiguous and/or incomplete. This finding suggests a reduced reliance on the *affect* heuristic (see Slovic, Finucane, Peters & MacGregor, 2002).

The fourth study (Yechiam, Arshavsky, Shamay-Tsoory, Yaniv & Aharon, 2010) examined the frequent switching behaviour demonstrated by the participants in Johnson et al. (2006). Using the IGT, they found that children and young adults with ASCs (n = 15) demonstrated shifting patterns similar to participants in Johnson et al (2006). Yechiam et al. also found that the *EVL* model did not provide a good fit of the data for half the participants with ASCs. They therefore developed a new cognitive model, which assumes that deck choice on the IGT is influenced by the exploratory value of the response option, rather than its outcome value (as in the *EVL*). This model was more successful in predicting the choices of the participants with ASCs and concluded that, in contrast to controls (n = 28), decision-making in ASCs is motivated more by a tendency to explore outcomes, rather than a tendency to maximise profit.

The final study (South, Dana, White & Crowley, 2010) examined risk-taking in children and adolescents with ASCs (n = 40). Risk-taking was assessed using the Balloon Analogue Risk-Taking Task (Lejuez et al., 2002). In this task, participants are asked to pump up a virtual balloon without making the balloon burst. They select how many pumps they would like to give the balloon, earning a point for each pump if the balloon does not burst. Risk-taking is therefore indexed by the number of pumps that participants choose to give the balloon. The maximum number of points available (i.e. the number of pumps before the balloon bursts) is

randomised for each trial. They found no significant difference in the overall risk-taking scores of the participants with ASCs compared to the control participants (n = 37). However, they did find that, in the ASC group only, risk-taking increased as levels of anxiety increased. This finding was unexpected since there is a large literature suggesting that risk-taking decreases with anxiety, as was the case in their control group. They also found that risk-taking increased with behavioural inhibition in the ASC group, and behavioural activation in the control group. On the basis of these findings, they proposed that risk-taking in ASCs is motivated by a fear of failure, whereas risk-taking in the control group is motivated by sensitivity to reward. These findings are limited, however, by the difference in levels of anxiety between the participants with ASCs and the control group; the participants with ASCs had much higher levels of anxiety and it is difficult to know whether the relationship with risk-taking is specific to ASCs, or is a product of higher anxiety overall.

Despite their various limitations, these studies suggest that decision-making processes may be different for people with ASCs, compared to those in the general population. The studies of Johnson, Minassian, Yechiam and South and their colleagues all suggest differences in motivational processes, which affect the goals of the decision-maker (Hickson & Khemka, 1999). The study by DeMartino and colleagues suggests that people with ASCs are more logical in their decision-making, but that, in everyday contexts, they may find decision-making more difficult.

1.5.5 *Summary from the literature on decision-making in ASCs*

The literature suggests that a small number of people with ASCs (those with published autobiographical accounts, see Section 1.5.1) experience decision-making as particularly difficult, perhaps reflecting the known impairments and abnormalities in cognitive, emotional, motivational, and neurobiological processes that are involved in decision-making. The experiences reported in the autobiographical accounts may also reflect differences in motivational and emotional processes in decision-making that are suggested by the laboratory-based studies of decision-making in ASCs. Finally, the clinical accounts suggest that decision-making capacity may, in some situations, be compromised by characteristic features of the condition, such as special interests.

1.6 Rationale for the thesis

Decision-making is an essential skill in everyday life; decision-making abilities, and how they can be maximised, are an important consideration in current policy and clinical practice. There are suggestions from a variety of sources that decision-making may be affected (often adversely) by ASCs. However, little is known about the extent to which people with ASCs experience difficulties in everyday life, and only a small number of studies have investigated how specific decision-making processes may differ for people with ASCs, compared to the general population. This means that there is little information available for clinicians about ways in which people with ASCs might be supported with decision-making.

1.7 Aims

The aims of this thesis are: i) to investigate whether people with ASCs experience particular difficulties with decision-making; and ii) if so, to assess empirically some of the possible ways in which decision-making may be different for them, compared to the general population. The overall aim is to improve understanding about the effects of ASCs on decision-making in a way that may be useful in the development of appropriate guidance for those who support decision-making in adults with ASCs.

1.8 Summary of thesis presentation

The first aim of the thesis is addressed by an exploratory survey of the decision-making experiences of adults with ASCs. The findings from this study are presented in Chapter 2. The survey identifies a number of areas for potential research, leading to the formulation of seven specific research questions and hypotheses for an experimental study, which involved laboratory experiments investigating people with ASCs as well as a control group. The questions selected for further study and the methods used to test them are described in Chapter 3. The participants of the experimental study are described in Chapter 4. The research findings for each of the specific research questions are presented in Chapters 5 – 11 (the research hypotheses are presented at the beginning of each of these results chapters). The final discussion, bringing together the findings and their implications for clinical practice, is presented in Chapter 12 together with a discussion of the limitations of the present study and the possibilities for future research.

CHAPTER 2: PRELIMINARY SURVEY OF DECISION-MAKING EXPERIENCES IN ASCS

Chapter 1 comprised an introduction to the literature suggesting that decision-making may be affected by autism spectrum conditions (ASCs). Since empirical studies require a great deal of resources, an initial aim of the research was to evaluate whether an empirical study of decision-making in ASCs would be worthwhile, and, if so, which aspects of decision-making should be the focus for such a study. To this end, an initial survey of decision-making experiences was carried out. The findings from this survey, and their implications for the research subsequently carried out, are presented here.

2.1 Background

The literature reviewed in Chapter 1 suggested that some people with ASCs may have difficulty with decision-making, compared to those in the general population. The autobiographical accounts describe general problems in everyday situations (see Section 1.5.1), while clinical accounts describe problems in specific situations that are related to core features of the condition (i.e. decisions involving a person's special interest, see Section 1.5.2). The neuropsychological literature suggests that there may be differences in the cognitive, emotional, and motivational processes that are involved in decision-making (see Sections 1.5.3 and 1.5.4).

The aim of this preliminary survey was to collect information about the decision-making experiences of adults with ASCs and thereby highlight areas of potential interest for future research. A questionnaire was designed specifically for this research and comprised both quantitative and qualitative items. The quantitative items covered areas identified in the literature as potentially significant for people with ASCs, while the qualitative items were included to allow for any unanticipated insights. As the survey was only an exploratory study, there was no control group. Instead, the survey questionnaire was also completed by family members and support workers of adults with ASCs. These people were included to obtain an objective perspective on the decision-making experiences of people with ASCs and how they believed the presence of an ASC could impact on decision making.

2.2 Method

2.2.1 *Participants*

The survey was completed by 189 people, 133 of whom described themselves as adults with ASCs (*participants*). The remaining 56 respondents were family members or support workers of men and women with ASCs (*informants*). Thirteen participants were excluded from the final analysis because they reported a self-recognised diagnosis of an ASC, rather than a diagnosis made by a relevantly qualified practitioner (n = 10), or because they did not provide information about the profession of the person who had made their diagnosis (n = 3). Four informants were excluded for the same reasons. The data presented are therefore based on the responses of 120 participants and 52 informants, who reported a diagnosis of an ASC that had been made by a relevantly qualified practitioner (for example, a psychologist). All participants (including those who were reported on) were aged 16 years or more since this is the definition of an adult in the UK legislation (i.e. Mental Capacity Act (*England and Wales*) 2005) to which the research is relevant.

As participants were able to complete the questionnaire anonymously, it is not known how many of the family members and support workers were related to, or supported, the participants with ASCs; for this reason, the responses from the two groups were analysed separately. Information about the two groups of participants is shown in Table 2.1.

Table 2.1 *Information about the two groups of participants in the initial survey*

	Participants with ASCs	**People with ASCs (reported on by a family member or support worker)**
N	120	52 (46 family members)
Mean age	37 years (16 – 74 years)	28 years (16 – 65 years)
% male	52%	79%
Types of ASCs	84% Asperger syndrome 9% High-functioning autism 6% Other ASD or ASC 1% Autism	64% Asperger syndrome 15% High-functioning autism 4% Other ASD or ASC 17% Autism
Reported method of diagnosis	98% Medical doctor or psychologist 2% Other relevantly qualified practitioner	94% Medical doctor or psychologist 6% Other relevantly qualified practitioner
% reporting higher education qualifications	53%	27%

Participants were recruited via advertisements in *Communication* and *Asperger United*, two publications produced by the National Autistic Society (NAS), and to members of locally-based autism support organisations in the UK. The participants were recruited between June and November 2008.

2.2.2 *Design*

A questionnaire, to be completed online or by post, was designed and piloted with two national experts (one with a diagnosis of AS) employed by the NAS. The questionnaire was modified in response to their suggestions and comments, and the final version was approved by the Cambridge Psychology Research Ethics Committee. To restrict access, the survey was password protected with a password supplied in the advertisements.

The survey appeared in two versions: one for participants with an ASC and the other for family members and support workers of adults with an ASC (reproduced in Appendix A and B). The questionnaire for adults with an ASC presented closed questions about:

a) demographic information, including age, gender, and details of diagnosis;
b) the extent of perceived difficulties in relation to particular types and features of decisions (for example, decisions that need to be made quickly);

c) the frequency with which particular problems are experienced in decision-making (for example, difficulty remembering the information);
d) the extent to which participants believed that their own decision-making was enhanced or disrupted by their ASC; and
e) the extent to which any 'special' or circumscribed interest interfered with making decisions.

These questions were presented using multiple choice options, Likert-type scales, and visual analogue scales, which have been successfully used in previous studies with adults with ASCs and intellectual disabilities (see Dagnan & Ruddick, 1995; Berthoz & Hill, 2005). The questionnaire also provided the opportunity for participants to provide unstructured accounts of their decision-making experiences and the perceived effects of ASCs.

The questionnaire items for family members and support workers were similar to those above but asked for their perspective on the decision-making of the person they knew and whether they had any concerns about the person's decision-making.

2.2.3 *Data analysis*

2.2.3.1 Quantitative data

The quantitative data were anlysed using descriptive statistics and non-parametric tests where applicable. As this was an exploratory study, two-tailed tests of significance ($\alpha = 0.05$) were used.

2.2.3.2 Qualitative data

The written accounts (provided by 99 (83%) participants and 38 (73%) informants) were analysed to a level of detail consistent with the overall aims of the study. Thus, rather than seeking to document features such as the construction of external and constraining moral norms (Silverman, 1987), or interpretive repertoires (Potter, 1996), the analysis presented takes respondents' answers as essentially truthful and straightforward representations of the participants' experiences. The analysis itself was guided by the principles of Thematic Analysis (see Braun & Clarke, 2006), which is a flexible approach used to summarise the key features of data. The process of analysis was as follows: i) familiarisation with the entire data set (LL); ii) production of a summary of the views and experiences reported (LL); iii)

discussion of the summary findings within the research team and organisation of the findings into themes that captured the common features of the data (LL and the supervisors); iv) independent review of a sub-sample of the data by another researcher (MR) to check the interpretive validity of the chosen themes; v) review and refinement of the chosen themes (LL, the supervisors, and MR); vi) re-analysis of the entire data set for features relevant to the chosen themes (LL, see Figure 2.1); and vii) final check of the coherence of the themes with a selection of extracts (LL and the supervisors). The data were analysed using the qualitative software package, Atlas.ti (Muhr, 2004).

Figure 2.1 *Coding guidelines for the qualitative data*

The written responses of each participant were examined for the following features:

- indications of a general dislike of and/or difficulty with decision-making;
- reasons for disliking decision-making or finding it difficult;
- whether the person reported only positive or negative effects of ASCs on decision-making, or both?
- advantages of ASCs for decision-making; and
- ways in which decision-making has been/could be supported.

2.3 Results

Contrary to expectations, the written accounts provided by the participants were very detailed. For this reason, the findings presented here focus on the thematic component of the analysis. The data provided by informants, as well as the responses to the closed questions, are presented alongside the findings from the written accounts of the participants with ASCs. A complete summary of the responses to the closed questions is presented in Appendix C.

2.3.1 *Dislike of, and/or difficulties with, decision-making*

Overwhelmingly, the participants with ASCs reported that they disliked decision-making and experienced difficulties in a range of contexts. Semantic features indicative of these experiences were prominent (27 participants) and included general reports of dislike or difficulty (e.g. '*I find it hard to make decisions*', 25 year old woman), as well as references to feelings of limited confidence, anxiety, exhaustion and fatigue, during, or as a result of,

making decisions. In addition, several participants reported that they tried to avoid making decisions (9 participants). Extracts illustrating some of these features are presented in Figure 2.2. This material was not addressed in most of the closed questions. However, consistent with the reports of anxiety, 87% of participants reported that they 'sometimes' (43%) or 'often' (44%) became anxious when making decisions (3% 'never', 9% 'rarely').

The accounts of participants with ASCs were corroborated by the informants. Several reports indicated that the person with an ASC disliked and/or found decision-making difficult (11 informants), with particular features of this difficulty/dislike being anxiety (5 informants) and a lack of confidence (5 informants).

Figure 2.2 *Extracts indicative of general dislike of, and/or difficulty with, decision-making*

Outright report of difficulty/anxiety/lack of confidence

'Until doing this survey I didn't really think about how many everyday decisions I find difficult. I *do* find many decisions difficult, which is possibly one of the reasons I feel constantly stressed – also knowing that no matter how hard I try, I am so often wrong in the decisions I make.'

- 59 year old man

Lack of confidence

I find it hard to make decisions on my own without asking other people about it. Due to Asperger's syndrome giving me low self-esteem it means that I have to have reassurance from other people that what I am doing is right. This has prohibited me from making bold decisions.

- 20 year old man

Avoidance/exhaustion

If I am shopping, I find that I try to consider every variable before choosing. This frequently results in choosing not to make a choice as the effort becomes exhausting.

- 49 year old man

Anxiety/lack of confidence

Being worried about the decision being wrong. Lack of confidence in own ability. Being used to relying on others making decision on their [her] behalf.

- Parent of a 20 year old woman

Slow/avoidance

If there are too many choices with no obvious superior choice, that slows down decision making. (She avoids decisions in supermarkets by buying *all* the possible choices for an item she wants.) If there is a way to escape making a decision (e.g. delaying until the all but one shop has shut), she'll find a way to do that.

- Partner of a 36 year old woman

2.3.2 *Reasons for dislike of, and/or difficulties with, decision-making*

Where participants with ASCs provided explanations for their dislike of, and/or difficulties with, decision-making, these could generally be placed into one of three broad, but not necessarily distinct, categories: 1) *problems engaging in decision-making*; 2) *problems in reaching a decision*; and 3) *fears of adverse judgements about the decision made.*

2.3.2.1 Problems engaging in decision-making

Problems engaging in the decision-making process were described by 18 (18%) participants. These were characterised as difficulties obtaining and understanding relevant social information (11 participants), having a tendency to act on the basis of rules or previous actions (8 participants), and having a tendency to act impulsively, especially when feeling pushed or overloaded with information (5 participants).

Difficulties similar to these were described by 14 (37%) of the informants providing written responses. Consistent with these, 75% of informants reported that the person with an ASC 'sometimes' (29%) or 'often' (46%) did not understand relevant information, while 81% considered that he or she 'sometimes' (37%) or 'often' (44%) did not know what the different choices were.

2.3.2.2 Problems in reaching a decision

Reports of difficulties in reaching decisions were identified in 50 (51%) of the written accounts. These appeared to relate to problems in cognitive and affective processes, and were characterised as follows:

- problems caused by easily becoming stressed (10 participants);
- problems becoming overloaded or overwhelmed by the information (9 participants);
- over-thinking about the decision or ruminating on minor details (9 participants);
- problems in working with unknown or missing information (8 participants);
- difficulty with mental organisation of relevant information (6 participants);
- slowness in processing information (6 participants);
- problems imagining abstract concepts and projecting consequences (5 participants);
- problems staying focused on the decision to be made (3 participants);
- problems considering emotions, which were either under- or over-weighted (3 participants); and

- a tendency to spend too much time gathering information (3 participants).

Extracts illustrating some of these problems are presented in Figure 2.3. Consistent with the reports of difficulties in the cognitive processes that underlie decision-making, 71% of participants reported that they 'sometimes' (28%) or 'often' (43%) had difficulty remembering the relevant information, while 83% reported that they 'sometimes' (35%) or 'often' (48%) did not know what the consequences of their choice would be.

Biases in reasoning caused by features of the condition also seemed to cause particular problems. Two participants reported that they felt unduly influenced or distracted by their 'special' interest, while others reported that their decision-making was affected by a strong desire to avoid social interaction (7 participants), changes in routine or environment (4 participants), and/or outcomes associated with uncertainty (4 participants). An extract illustrating one of these problems is presented in Figure 2.3.

The problems reported by the informants were similar to those reported by the participants. However, the only interference described by the informants related to decisions made in the pursuit of 'special' interests (6 informants). Their assessment of the impact of such interests (based on responses to a closed question) was more extreme than those of the participants with ASCs: 15% family members or support workers reported that the level of interference was 'extremely severe', compared to only 4% of the participants with ASCs.

Figure 2.3 *Participants' reasons for disliking decision-making and/or finding it difficult*

1. Problems engaging in the decision-making process

Making decisions by rules or on the basis of previous actions

''If the exact type of food I buy is not available I don't know what to do – do I go without or do I ask someone or go to a different place, but then I will get lost or will they also not have it – have they stopped making it or have they changed the ingredients or packaging… I think is not the worries others have … but they seem not to have so many rules to follow.'

- 48 year old woman

2. Problems in reaching decisions

Overload

'The greater number of factors involved, the more likely I am to 'freeze'. If that happens I may postpone deciding until the problem goes away, or it becomes so urgent that I abandon rational analysis and make a reactive, even random, choice.'

- 49 year old man

Biases in reasoning associated with features of the condition

'I feel that my condition gets in the way of pretty much all decisions I make as everything depends on whether or not I will have to be around people.'

- 28 year old woman

Taking a long time to make decisions/gathering information

'[it is difficult] when there isn't much time to make a decision in. He needs lots of time, reassurance and information before he can even think of making a decision. He will spend hours researching things making it look as if he is putting off making a decision'.

- Parent of a 24 year old male

3. Fear of adverse judgements about the decision made

'I worry what others will think about the decision I make. I want to be treated fairly and equally and so try to think about how the decisions would be presented to a non-autistic person and what they would choose and how those options and choices would be viewed by others and then I want to choose the option that as closely as possible matches the options the other would have and make; this however normally confuses me and just makes the decision harder!'

- 29 year old woman

2.3.2.3 Fears of adverse judgments about the decision made

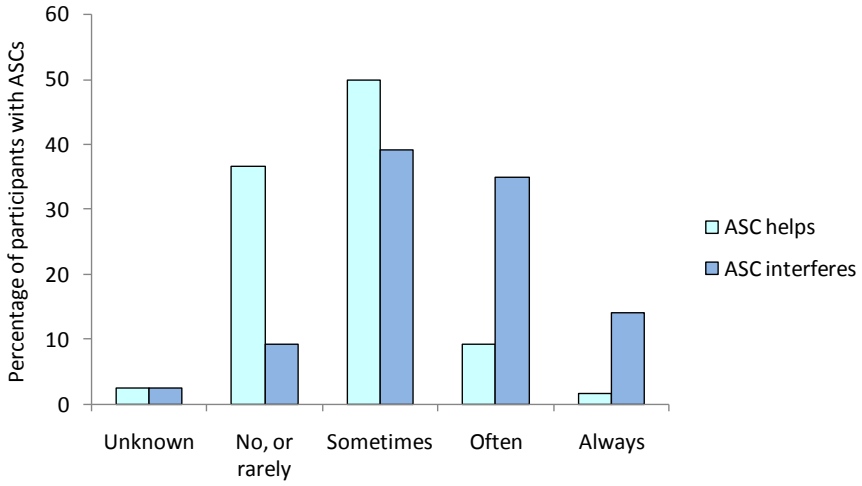
Statements suggesting a fear of (negative) judgments from others were identified in 20 (20%) of the written accounts. For some people, these fears were related to concerns about appearing 'autistic'. As the extract in Figure 2.3 illustrates, attempts to conceal their ASC sometimes greatly complicated the decision-making process.

2.3.3 *The benefits and disadvantages of ASCs on decision-making*

The responses to two closed questions about the frequency with which ASCs might help and interfere with decision-making are shown in Figure 2.4 . For both groups, the difference between the ratings for the two questions was significant (participants: z = -5.96, $p<0.001$; informants: z = -5.23, $p<0.001$), indicating that ASCs were perceived more often as a hindrance to, rather than a help with, decision-making. There was a difference between the two groups, however, with a greater proportion of informants rating the condition as 'often' or 'always' a hindrance compared to the participants (77% and 48%, respectively, χ^2 (1, N=166) = 13.00, $p<0.001$). Consistent with this finding, 61% of the informants were entirely negative in their written accounts, compared with only 31% of the participants. The responses of those with the condition were more nuanced than those of the informants: they were more likely than the informants to present 'mixed' responses, identifying both benefits and disadvantages in relation to decision-making (62% and 29%, respectively).

Figure 2.4 *Perceived interference and benefits from ASCs on decision-making*

a) Participants with an ASC (n = 120)



b) Family members and support workers of adults with an ASC (n = 52)

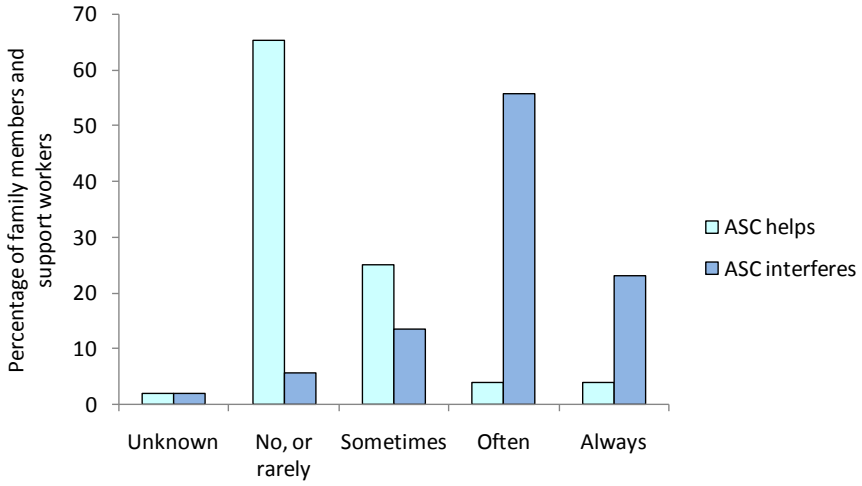


Figure 2.4 shows the distribution of responses to two questions about how often ASCs can help and interfere with decision-making. The distribution of responses indicates that both groups perceived that ASCs were more often a hindrance than a help with decision-making.

Despite the generally negative view of the effects of ASCs on decision-making, a number of benefits were identified. Participants with ASCs described how their condition assisted them in developing strategies for decision-making (8 participants), applying logic (15 participants), considering details and gathering information (15 participants), and choosing options without concern for the opinions of others (5 participants). It was also thought that the strong values they held as people with ASCs helped to guide their decision-making (21 participants). The same benefits were also identified, albeit less frequently, by the informants.

Some of these benefits, however, were also perceived as disadvantages. For example, the tendency to adhere rigidly to strategies could be detrimental in situations where rules could not be applied (4 participants, 2 informants), while attempting to apply logic could frustrate decision-making in situations where information was missing (4 participants). In addition, the tendency to analyse information thoroughly was associated with reports that decision-making could be slow and overwhelming (4 participants), while strong values could impede the consideration of other factors and frustrate decision-making when involving other people with different values (3 participants). For some participants (10 with ASCs, 3 informants), the advantages described were specific to particular situations and were presented alongside more widespread difficulties with decision-making.

2.3.4 *Support with decision-making*

A few of the participants described ways in which their ability to make decisions had been, or could be, supported. These were: having patience and understanding from those around them (2 participants); making decisions in an environment with minimal distractions (1 participant); and discussing decisions with trusted people (1 participant). Successful strategies reported by informants were: presenting the person with an ASC with clear, narrow options (2 informants), providing plenty of time for the decision (1 informant), and providing reassurance that he or she would be able to make the particular decision (3 informants).

2.4 Summary of findings

The findings from this exploratory study suggest that decision-making is perceived as difficult and burdensome by many of the participants with ASCs. While some benefits are identified, these are, in certain situations, ‘double-edged’. The responses of the informants

were in general consistent with the responses of the participants with ASCs. However, the informants tended to view the impact of ASCs on decision-making more negatively than the participants with ASCs.

2.5 Discussion

This exploratory study was carried out to establish whether an empirical study of decision-making in ASCs would be worthwhile, and, if so, which aspects of decision-making could be the focus for such a study.

Consistent with the literature reviewed in Chapter 1, the findings from this study suggest that decision-making can be particularly difficult for some adults with ASCs. Decision-making was associated with anxiety, feelings of limited confidence, exhaustion and fatigue, and a tendency to avoid decision-making. Specific difficulties related to: i) problems engaging in decision-making, for example having a tendency to make choices on the basis of previous actions, and: ii) problems in reaching decisions, for example, being unduly influenced by a desire to avoid uncertainty, slowness in decision-making, and a tendency to excessively gather information. In addition, a significant number of participants reported that they found decision-making difficult because they were fearful of being judged negatively by others. In some cases, these difficulties appeared to be extreme. The phrase '*analysis paralysis*', used by one participant to describe a complete breakdown of the decision-making process, appeared to capture the experiences of many. While some benefits of the condition were identified (for example, a tendency to apply logic and to thoroughly analyse information), these benefits could be 'double-edged' and in other situations frustrate decision-making.

The difficulties reported are consistent with previous autobiographical accounts, known features of the condition, and previous studies of decision-making in ASCs. For example, the reports of mental 'freezing' and taking a long time to make decisions are consistent with Temple Grandin's description of the decision-making process becoming '*locked up*' (Grandin, 2000). Problems in foreseeing consequences, remembering information, and staying focused on the decision are consistent with known impairments in executive functions (Hill, 2004a), while reports of bias from special interests are consistent with clinical accounts (Woodbury-Smith et al., 2010). Finally, the reports of exhaustion are consistent with the

finding that people with ASCs demonstrate reduced reliance on a heuristic normally used to reduce the cognitive demands of decision-making (De Martino et al., 2008).

The difficulties reported by the informants were generally similar to those reported by the participants with ASCs themselves, but were more negative (for example, identifying fewer benefits of the condition). Such differences may simply reflect the different perspectives of the two groups of participants, but may also reflect variations in the sample populations: a greater proportion of the participants with ASCs had achieved higher education qualifications and had diagnoses of higher-functioning ASCs (HFA and AS) rather than autism. Consequently, the insights from the two groups are not directly comparable, and, for this reason, they were analysed separately. From a methodological perspective, the study would have been improved by obtaining matched responses from family members of the participants with ASCs. However, the recruitment of independent groups permitted us to obtain a larger sample size than would otherwise have been possible.

There are other limitations of this study. First, it was not possible to confirm the diagnoses of the participants. To resolve this as best as possible, only participants reporting diagnosis by a relevantly qualified practitioner were included in the study. Secondly, given the known ratio of men to women with ASCs (see Hill, 2004b), a disproportionately large number of the respondents were women. An equal gender ratio, however, is not unique to this study (see, for example, Barnes, Lombardo, Wheelwright & Baron-Cohen, 2009). Thirdly, the survey was limited by its self-report nature. However, the use of self-reported information is commonplace in psychological research, and has been found to provide valuable insights into the experiences of people with ASCs (for example, Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001; Hill, Berthoz & Frith, 2004). Furthermore, the broad agreement between the participants and informants provides some evidence of the reliability of the perceptions reported by the participants with ASCs. Finally, since there was no control group, the study does not provide information about whether the experiences reported are unique to people with ASCs; the specificity of the experiences reported is indicated only by the perceptions of family members and support workers.

Despite these limitations, the findings from this exploratory study are consistent with fragmentary evidence from the literature relating to decision-making for people with ASCs,

and suggest that further research on decision-making in ASCs would be worthwhile. Moreover, they highlight a number of areas for future research, which include:

- the experiences of decision-making of people with ASCs;
- speed of decision-making;
- anxiety levels during decision-making;
- flexibility in decision-making;
- tendency to gather information and avoid uncertainty
- avoidance of decision-making;
- the effects of special interests on decision-making;
- logic in decision-making;
- reliance on heuristics in decision-making;
- confidence in decision-making; and
- the relationship between executive functions and decision-making performance in ASCs.

The methods available for empirical assessment of decision-making, and the selection of research areas for the subsequent experimental study, are discussed in the next chapter.

CHAPTER 3: MATERIALS AND METHODS

This chapter reviews the main approaches used in the study of decision-making and considers the areas of decision-making that will form the focus of this research. The specific research questions and methods used in this thesis are then described in detail.

3.1 Current approaches to the study of decision-making

Previous research in decision-making has led to the development of at least four distinct paradigms. The first of these involves the use of questionnaires to identify personal characteristics (e.g. cognitive styles) that can influence decision-making (e.g. Frost & Shows, 1993; Scott & Bruce, 1995; Mann, Burnett, Radford & Ford, 1997). Typically, questionnaire items describe behaviours or feelings that may be experienced during decision-making and these are rated by the respondent using Likert or Likert-type scales. This approach has provided information about the broad strategies that people tend to rely on to make different types of decisions (e.g. The Melbourne Decision-Making Questionnaire, Janis & Mann, 1977, and the General Decision Making Style inventory, Scott & Bruce, 1995), as well as patterns of individual differences in decision-making (e.g. Shiloh, Koren & Zakay, 2001). The advantages of this approach are that questionnaires are feasible for use with large samples and provide insight into real-life experiences across a range of contexts; clear limitations of the approach are that the use of questionnaires depends upon participants' ability to self-report, which may, among other things, be influenced by the perceived social desirability of the response options, memory, or a bias towards extreme responses (see Paulhus & Vazire, 2007; van de Mortel, 2008). It is also difficult to determine the validity of the responses without observing the behaviours in the context they were reported (Kagan, 2007).

A second approach involves the use of vignettes to present specific decision situations. Typically, participants are asked to imagine themselves in the situation and describe the action that they would take. This approach has proved valuable in the study of decision-making capacity (e.g. Grisso, Appelbaum, Mulvey & Fletcher, 1995; Marson et al., 1996; Wong et al., 2000; Suto, Clare, Holland & Watson, 2005b), where participants' understanding, retaining, and weighing of the information has been assessed. The main strengths of this approach are that the decisions have a 'real' context and can capture the

complexity encountered in real life. It is also possible to tailor the vignettes to resemble closely a particular situation faced by the participants at the time (e.g. consent to treatment, Wong et al., 2000). A disadvantage of this approach is that vignettes can require an ability to imagine being in the situation, unless they have been constructed to resemble a situation actually faced by the person. Another disadvantage is that the decisions presented are very specific, which can make it difficult to generalise the findings to other situations (although this specificity is crucial in research assessing decision-making capacity). In addition, the decisions can usually be presented only once, and this limits the potential of the approach for use in studies assessing neuropsychological and biological processes in decision-making, in which the measurement of multiple responses is often required.

A third approach is the use of laboratory-based tasks, which have been developed to study the cognitive and neurobiological processes involved in decision-making. The decisions are often presented visually on a computer and participants are asked to make choices involving explicit or implicit probabilistic information. The use of these tasks has contributed greatly to understanding of the neuropsychological basis of decision-making deficits in different conditions (for example, frontal brain damage, Bechara et al., 1994; Manes et al., 2002), and a number of tasks have been developed to assess specific processes in decision-making. These include the Iowa Gambling Task (IGT, Bechara et al., 1994, 1999), which was developed to assess learning and emotional processing in decision-making, and the Information Sampling Task (IST, Clark, Robbins, Ersche & Sahakian, 2006), which was developed to assess the tendency to gather and evaluate information prior to making a decision. The number of tasks has increased in recent years as researchers modify existing tasks for new investigations (for example, the Hungry Donkey Task, Crone & Van der Molen, 2004, which is a version of the IGT adapted for children), or create novel tasks (for example, Delay Discounting Tasks, Steinberg et al., 2009) to assess different processes in decision-making. Mathematical models of component processes that may contribute to decision-making on these tasks are also burgeoning, such as the *Expectancy-Valence Learning* model (Busemeyer & Stout, 2002), which attempts to quantify the separate influences of learning and motivation on the Iowa Gambling Task, and the *Utility-Caution* model (Zhao & Costello, 2007), which attempts to quantify the development of perceived utility of the options and an emotional response to the outcomes of consecutive choices. The main advantages of this approach are that the tasks may be presented visually, thereby

reducing the requirement for imagination, and the simple decisions can be manipulated to capture generic features of real-life decisions (for example, risk, delay-based reward, or uncertainty, see Cavedini, Gorini & Bellodi, 2006; Salmond et al., 2006). The ease of manipulation also makes it possible to present the decisions multiple times, and as a result they can be suitable stimuli for investigating biological processes in decision-making, and for obtaining reliable measures of latency. The main disadvantages of this approach are that the decisions lack ecological validity and that motivation can decrease when several trials are required.

A fourth approach involves the use of quick, quiz-type questions, constructed to identify systematic deviations from 'rational' decision-making. This paradigm has provided information about specific psychological strategies that are commonly used to tackle complex decisions encountered in real life (for example, the use of heuristic short-cuts to make decisions, Tversky & Kahneman, 1974; Kahneman et al., 1982). The advantages are that the questions are feasible for use with large samples and a number of questions assessing different strategies have been developed. A disadvantage is that large samples are required to assess group differences.

3.2 Research areas and methods for the experimental investigation

The literature reviewed in Chapter 1 and the findings of the initial survey identified a number of areas that may be relevant for understanding decision-making in ASCs. It was therefore necessary to select a number of research areas that might feasibly be explored within a PhD project.

The first area selected considered experiences of decision-making. Since the initial survey did not involve a control group, it was important that the experimental study should include an assessment of whether the profile of self-reported experiences of decision-making was different for people with ASCs compared to those in the general population.

Other research areas were selected to establish whether the experiences reported in the initial survey were consistent with behaviour and psychophysiology measured on established laboratory tests of decision-making. The choice of areas to study is then influenced by the

range of standardised tests of decision-making that are available. Since a number of tests are able to assess: i) flexibility and risk-taking in decision-making; ii) tendencies to gather information prior to making decisions; and iii) the speed of decision-making, these aspects of decision-making were selected for the experimental study. Assessment of anxiety in decision-making was also considered important, given the prominence of anxiety in the survey reports.

Finally, two other research areas were selected because of their potential to account for some of the particular difficulties described by the survey participants with ASCs. The first area was motivation in decision-making. This relates to one of the few previous studies of decision-making in ASCs (Johnson et al., 2006, see Section 1.5.4), which suggested that differences in motivational processes exist. However, the result found by Johnson et al. only approached significance and the authors concluded that their sample size had been too small to detect a significant difference. The findings of their study indicated that people with ASCs may be influenced more by negative outcomes than those in the general population. If this is the case, increased attention to negative outcomes in ASCs could account for the decision-related anxiety reported by participants with ASCs (see Fowles, 1987), as well as their dislike of uncertainty (see Yechiam et al., 2005).

The second of these additional research areas concerns whether the reports of exhaustion and mental overload in the initial survey can be attributed to a reduced reliance on heuristics in decision-making. Heuristics are general strategies ('short-cuts') that are used to simplify some of the complex mental processes involved in decision-making (see Tversky & Kahneman, 1974). Reduced reliance on a particular heuristic was demonstrated in a previous study of decision-making in ASCs (De Martino et al., 2008, see Section 1.5.4), although reliance on other types of heuristics is unknown.

The specific research questions are presented in the following section.

3.3 Specific research questions

This thesis aims to develop our understanding of the effects of ASCs on decision-making by addressing seven main research questions. The questions below define the scope of this investigation.

Compared to participants from the general population:

1. Do participants with ASCs experience decision-making differently?
2. Do participants with ASCs demonstrate different flexibilities and greater caution in their decision-making?
3. Do participants with ASCs gather more information prior to making a decision?
4. Do participants with ASCs take longer to make decisions?
5. Are participants with ASCs more aroused when making decisions?
6. Do participants with ASCs demonstrate differences in motivational processes in decision-making?
7. Do participants with ASCs demonstrate reduced reliance on heuristics to make decisions?

Together, these questions address: i) whether the profile of self-reported experiences distinguishes participants with ASCs from control participants; ii) whether the experiences reported are consistent with behaviour measured by established neuropsychological tests of decision-making; and iii) whether there are differences in the decision-making processes of people with ASCs that can account for some of the difficulties they described.

3.4 Methods used in this investigation

The measures used in this investigation are summarised in Table 3.1. Each measure is then described in detail.

Table 3.1 *Summary of measures and the research areas they address*

Research area	Measures	Type of measure
Self-reported experiences	Adapted questionnaire of decision-making experiences	Questionnaire
	General Decision Making Style inventory (GDMS)	Questionnaire
Behaviour and physiological characteristics	Cambridge Gamble Task (CGT)	Laboratory task
	Information Sampling Task (IST)	Laboratory task
	Adapted Risky Choice Task (RCT)	Laboratory task
Decision-making processes	Iowa Gambling Task (IGT)	Laboratory task
	Heuristic demonstrations	Quiz-like questions

3.4.1 *Adapted questionnaire of decision-making experiences*

The questionnaire used in the initial survey was adapted by removing the items requesting unstructured accounts and by introducing three additional Likert-type questions. These changes significantly reduced the time required to complete the questionnaire and provided an opportunity to explore three issues identified as particularly problematic by the participants of the initial survey. These were: a) mental 'freezing' during decision-making ('*analysis paralysis*'); b) taking a long time to make decisions; and c) feeling exhausted by decision-making. This version of the questionnaire is reproduced in Appendix D.

3.4.2 *General Decision Making Style Inventory (GDMS)*

The General Decision Making Style Inventory (GDMS) is a measure of five different, but not mutually exclusive, styles of decision-making. The measure was developed by Scott & Bruce (1995), and has good construct validity (Loo, 2000, Thunholm, 2004). Decision-making style is considered to be a habitual response pattern to a decision situation but also depends on cognitive abilities such as information processing, self-evaluation and self-regulation (Scott & Bruce, 1995; Thunholm, 2004). The five styles of decision-making indexed by the measure are shown in Table 3.2. This measure of decision-making style was selected over the questionnaire developed by Mann et al. (1997) because it provides a

measure of the tendency to avoid decision-making, which was identified as an issue in the initial survey.

Table 3.2 *Description of decision-making styles indexed by the GDMS*

General Decision Making Style	Defining characteristics
Rational	Comprehensive search for information and logical evaluation of alternatives
Intuitive	Attention to salient details and reliance on feelings
Dependent	Search for advice and support from others
Avoidant	Avoidance of decision-making wherever possible
Spontaneous	Completion of the decision-making process as quickly as possible

The questionnaire presents 25 statements about how people might go about making important decisions. Participants indicate their agreement to the statements using a five-point Likert scale, ranging from 'strongly disagree' to 'strongly agree'.

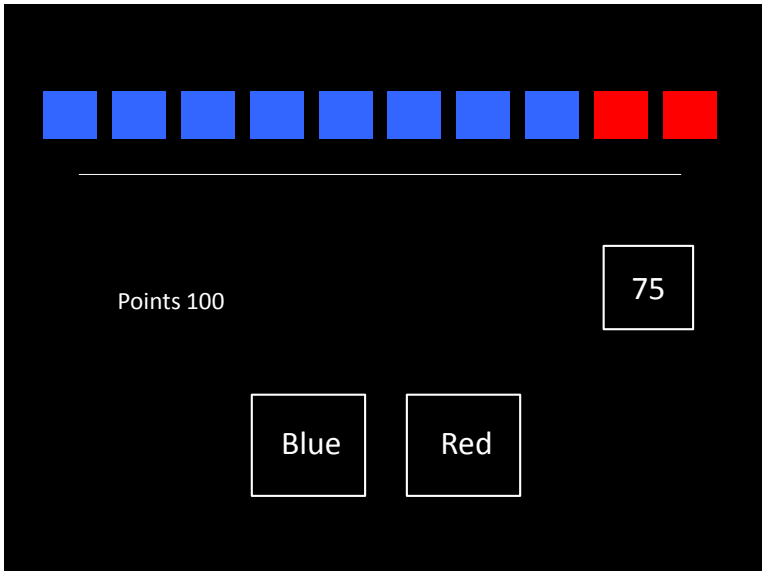
3.4.3 *Cambridge Gamble Task (CGT)*

The Cambridge Gamble Task (CGT, Rogers et al., 1999) assesses speed, risk-taking and flexibility of decision-making. It is considered to be a task of decision-making 'under risk' (see Brand et al., 2007) because participants are presented with explicit information about the values of the choices and the expected probability of their occurrence. This information is presented visually on a computer screen. It is an established test of decision-making that has been used successfully with participants in a number of clinical groups (see Rahman, Sahakian, Hodges, Rogers & Robbins, 1999; Manes et al., 2002; Chamberlain et al., 2007; DeVito et al., 2008; Lawrence, Luty, Bogdan, Sahakian & Clark, 2009).

The CGT is part of the Cambridge Neuropsychological Test Automated Battery (CANTAB) and is presented on a touch-screen computer (Paceblade Slimbook 110 series). Participants are presented with a ten boxes, each of which is coloured red or blue. The ratio of red to blue boxes differs on each trial (72 trials) from 9:1 to 1:9. Participants are told that the computer has hidden a yellow token beneath one of the boxes and their task is to guess the colour of the box that is hiding the token. Participants indicate their choice by touching the word 'red' or

'blue', which is displayed beneath the row of boxes. Once they have chosen, they are then asked to bet a proportion of their points (5%, 25%, 50%, 75%, or 95%) on their choice being correct. The available bets are presented 2.5 seconds apart in ascending or descending order, depending on the condition of the task (participants complete the task in both conditions, with the order of the conditions counterbalanced across participants). Participants are asked to try to win as many points as possible. The task display is shown in Figure 3.1.

Figure 3.1 *Screen display for the CGT*



Produced with permission from Cambridge Cognition Ltd.

The four principal outcome measures of the CGT are: i) *deliberation time*, which is the time taken for the participant to choose which colour of box is hiding the token; ii) *risk-adjustment*, which quantifies the tendency of participants to bet a greater proportion of points in response to more favourable box ratios (a type of flexibility); iii) *delay aversion*, which quantifies the tendency to choose the bets presented earlier rather than later in the trial (another type of flexibility); and iii) *risk-taking* (i.e. the overall proportion of points bet).

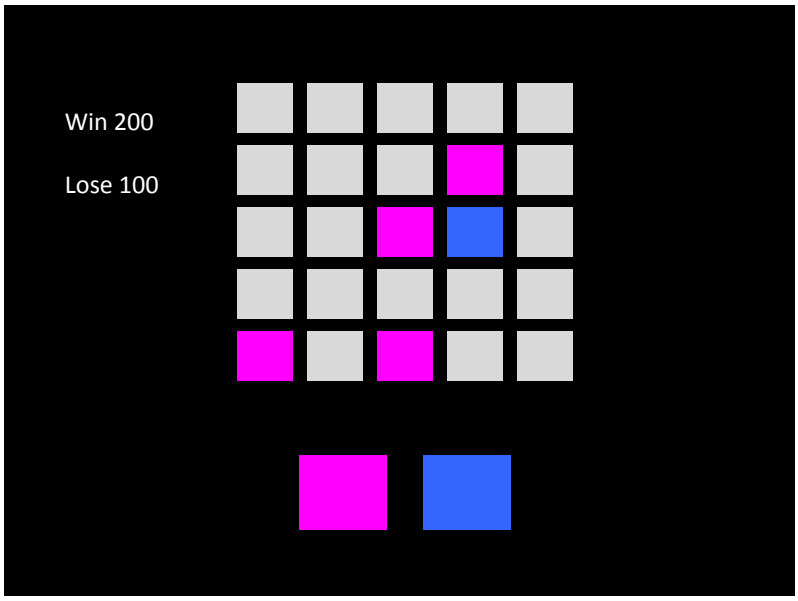
3.4.4 *Information Sampling Task (IST)*

The Information Sampling Task (IST, Clark et al., 2006) is also part of the CANTAB. This task provides a measure of the tendency to gather information prior to making a decision, as well as the time taken to make a decision. Like the CGT, the IST is a task of decision-making 'under risk', and is a well-established measure that has been used successfully with a

number of clinical groups (see Clark et al., 2006; Chamberlain et al., 2007; DeVito et al., 2008; Clark, Roiser, Robbins & Sahakian, 2009; Lawrence et al., 2009). The information relevant to the decisions is presented visually on the touch-screen computer screen.

In the IST, participants are presented with a 5 × 5 array of grey boxes, behind each of which is one of two hidden colours. The participants are instructed to open (by pressing) a box to reveal its colour, and to open as many boxes as they wish before deciding which of the two colours is in the majority. Participants indicate their decision by pressing one of the two coloured panels at the bottom of the screen. The task is presented ten times in each of two conditions: i) a Fixed Win condition, in which the total number of points available for a correct decision is 100, regardless of how many boxes are opened; and ii) a Decreasing Win condition, in which the total number of points available for a correct decision starts at 250 and decreases by 10 points with every box that is opened. In both conditions, the cost of an incorrect decision is 100 points. The order of the two conditions is counterbalanced across participants. The task display is shown in Figure 3.2.

Figure 3.2 *Screen display for the IST*



Produced with permission from Cambridge Cognition Ltd.

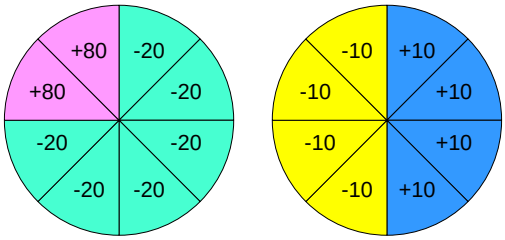
The principal outcome measures for the IST are: i) the mean number of boxes opened; ii) the mean probability that the decision made will be correct; and ii) the mean time taken to open the boxes and make the final decision.

3.4.5 *Adapted Risky Choice Task (RCT)*

The Risky Choice Task (RCT, Rogers et al., 2003) assesses flexibility and risk-taking behaviour by presenting decisions with different probabilities of winning and losing. The paradigm was first used to investigate the effects of tryptophan depletion on reward cue processing in healthy volunteers, and was subsequently adapted to investigate flexibility, risk-taking, and susceptibility to 'framing' (the *affect* heuristic) in adolescents with Conduct Disorder (Fairchild et al., 2009). This task was selected because it provides an opportunity to measure behaviours identified as potentially significant for people with ASCs compared to the general population (see Section 1.5.4 and Section 2.3.2.1), and because the task could be modified to assess levels of arousal during decision-making. For this project, the task was adapted by creating a new condition, in which participants were not required to make a choice, but were informed that the computer would make the decision on their behalf. Arousal related to decision-making (measured using the galvanic skin response) was then quantified by comparing levels of arousal in the two conditions.

In the version of the task used in this project, participants are presented with two on-screen 'roulette' wheels, each with eight segments showing the number of points that will be won or lost if a 'spin' of the wheel selects that segment (see Figure 3.3).

Figure 3.3 *Example of two 'roulette' wheels presented on the RCT*



Participants are then given four seconds to select, by key press, one of the wheels on which they wish to gamble. This wheel is then 'spun' and the outcome (the number of points on the segment that the ticker lands on) is presented. One of the wheels always functions as a 'control wheel' with a 0.5 chance of winning 10 points and a 0.5 chance of losing 10 points (Expected Value = 0). The other wheel, the 'experimental wheel', presents different

probabilities of winning and losing points. The number of points and probability of a win are such that the difference in Expected Value (EV) between the two wheels varies systematically across eight trial types. The wins, losses and differences in EV of the trial types are shown in Table 3.3.

Two additional trial types, where both wheels have equal EVs, are also included to assess the effect of a 'frame' upon decision-making. One of these trial types (the 'gain' frame) presents a wheel with a certain gain of 40 points (EV = 40) and a wheel with 0.5 chance of gaining 80 points and a 0.5 chance of gaining 0 points (EV = 40)). The other trial type (the 'loss' frame) presents a wheel with a certain loss of 40 points (EV = -40) and a wheel with a 0.5 chance of losing 80 points and a 0.5 chance of losing 0 points (EV = -40). The framing effect was described by Tversky & Kahneman (1981), who demonstrated that participants in the general population are moderately risk-averse when considering possible gains and moderately risk-taking when considering possible losses.

Table 3.3 *The ten trial types used in the RCT*

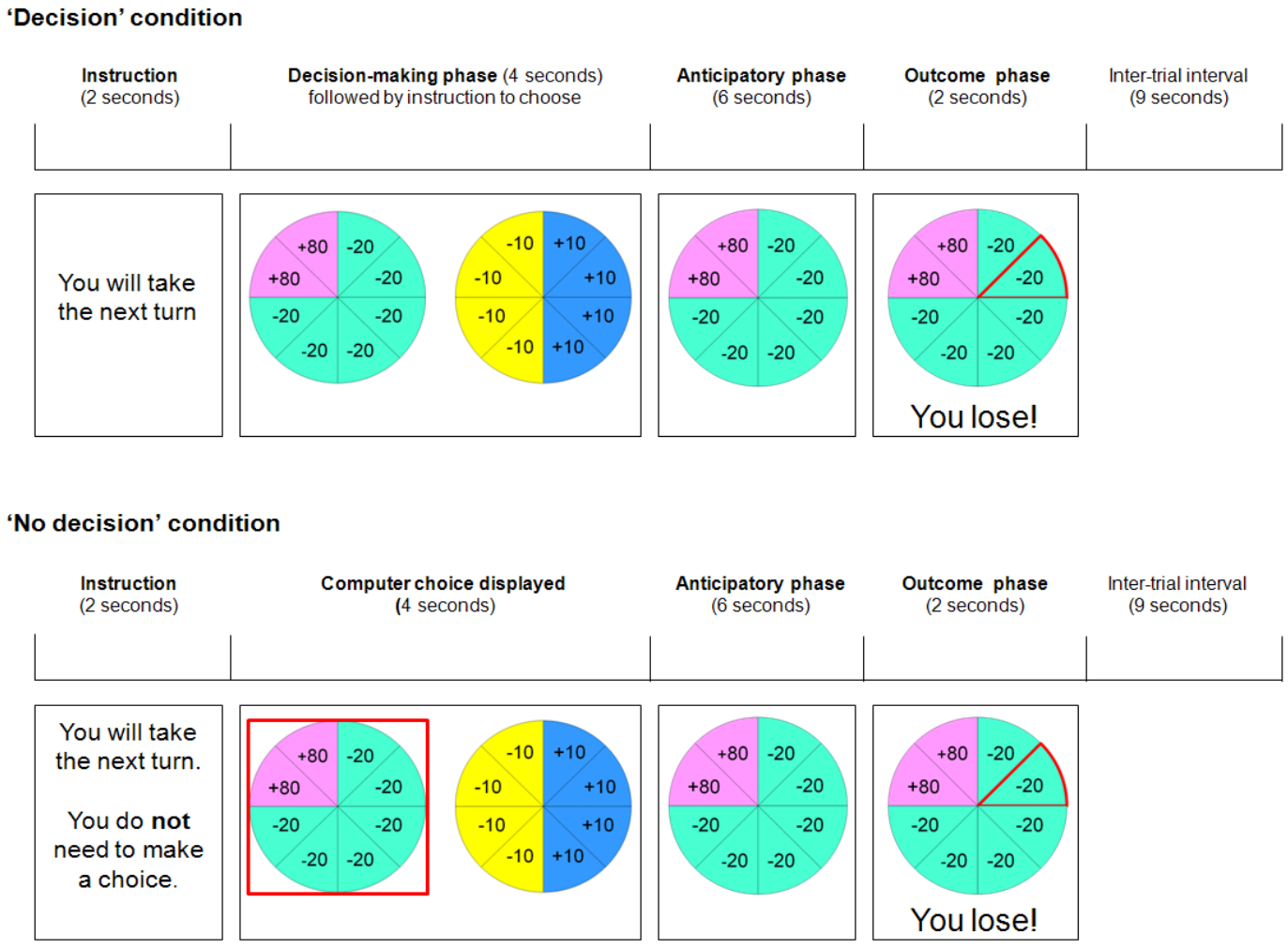
Trial type	**Experimental wheel**				**Control wheel**				**Difference in EV (ΔEV) between the two wheels**
	P(Win)[1]	Win	Loss	EV	P(Win)	Win	Loss	EV	
1	0.25	20	-80	-55	0.50	10	-10	0	-55
2	0.25	80	-80	-40	0.50	10	-10	0	-40
3	0.25	20	-20	-10	0.50	10	-10	0	-10
4	0.75	20	-80	-5	0.50	10	-10	0	-5
5	0.25	80	-20	+5	0.50	10	-10	0	+5
6	0.75	20	-20	+10	0.50	10	-10	0	+10
7	0.75	80	-80	+40	0.50	10	-10	0	+40
8	0.75	80	-20	+55	0.50	10	-10	0	+55
9	0.50	0	-80	-40	0.00	0	-40	-40	0 (loss frame)
10	0.50	80	0	+40	1.00	40	0	+40	0 (gain frame)

[1] P(Win) denotes the probability of a win

3.4.5.1 Adaptation of the RCT to study arousal in decision-making

For this investigation, the RCT was adapted to assess group differences in electrodermal arousal (a physiological correlate of anxiety) during decision-making. Two conditions were introduced: one where participants were instructed to make their own decision ('decision' condition) and the other where they were informed that the computer would make the decision for them ('no decision' condition). Changes in arousal were then compared between the two conditions. A schematic of a trial in the two conditions is shown in Figure 3.4.

Figure 3.4 *Schematic of conditions in the adapted RCT*



Participants were presented with four blocks of 20 trials each. The order of the trials was pseudo-random, with each trial type presented twice in each block, once in the 'decision' condition, and once in the 'no decision' condition. The framing trials were an exception to this and were always presented in the 'decision' condition to provide sufficient behavioural data to assess the effect of the frame (see Fairchild et al., 2009). The order of presentation of the four blocks was controlled using a Latin Squares counter-balancing system to reduce potential order effects. Participants also received five practice trials to check that they understood the task and to reduce the effects of novelty on electrodermal arousal. The total testing time, with a short break between each block, was approximately 40 minutes. The task programme was adapted by Dr Mike Aitken (Department of Experimental Psychology, University of Cambridge) and executed using the Whisker Control System (Cardinal & Aitken, 2001). The task instructions are reproduced in Appendix E.

3.4.5.2 Measurement and interpretation of arousal

Arousal was measured using skin conductance (SC). Briefly, SC is a measure of the electrical resistance of the skin, which is modulated by small changes in sweating associated with arousal. SC is recorded by passing an electrical current between two electrodes placed on the surface of the skin, and the change in resistance is recorded. Increases in SC to specific events are termed skin conductance responses (SCRs). They are typically observed 1 to 3 seconds after the event and have a half-recovery time ranging from 2 to 10 seconds (Dawson, Schell & Filion, 2000).

SC increases during states of anxiety due to activation of the sympathetic nervous system (Geddes, Gray, Millar & Asbury, 1993; Court, Greenland & Margrain, 2008). However, increases in SC may also reflect arousal associated with other cognitive and biological events, such as mental effort (e.g. Kahneman, Tursky, Shapriro & Crider, 1969). For this reason, participants were asked to provide retrospective self-reports of anxiety and effort experienced during the task using visual analogue scales (see Appendix F) and pre-and post-test versions of the Spielberger State Anxiety Inventory (SSAI, Spielberger, Gorusch & Lushene, 1970). In the post-test version of the SSAI, participants were asked to complete the questions in relation to their feelings during the decisions (see Margrain, Greenland & Anderson, 2003), and the pre-test score was then subtracted from the post-test score (higher difference scores

indicating higher levels of anxiety during decision-making). These measures were included to assist interpretation of changes in skin conductance.

3.4.5.3 Task design implications for the measurement of SCRs

The inter-trial interval was set at 9-seconds to ensure that event-related changes in SC were likely to have returned to normal before the start of the next trial. Although half-recovery time for SCRs ranges from 2 to 10 seconds, this interval was chosen to allow substantial recovery of SC while creating a task of reasonable length to maintain participants' interest (see, for example, Crone, Somsen, Van Beek & van der Molen, 2004).

3.4.5.4 Skin conductance acquisition

SC level was recorded continuously during the task using the MP150 system, SCL amplifier (GSR100C) and transducer (TSD203) (BIOPAC Systems Inc. Goleta, California) at a rate of 200Hz. The transducer was filled with isotonic electrode gel and attached to the distal phalanges of the index and middle fingers on the left hand. Before the task, SC was recorded for 5 minutes while the participant rested. This allowed the signal to settle and also provided information about each participant's basal SC level. During the task, the presenting computer sent digital markers to the acquisition computer to record the onset of events during each trial. Data were analysed offline using AcqKnowledge 3.7.2 (BIOPAC Systems Inc.).

3.4.6 *Iowa Gambling Task (IGT)*

The Iowa Gambling Task (IGT, Bechara et al., 1994) is a laboratory-based paradigm widely used to assess decision-making in people with clinical conditions (for review, see Section 1.3.3). Unlike the CGT, IST and RCT, it is a task of decision-making 'under ambiguity' (see Brand et al., 2007), because participants are not provided with explicit information about the values and expected probabilities of the response options. The task was selected for use in this project because a previous study (Johnson et al., 2006, see Section 1.5.4) suggested that differences in motivational processes for decision-making on the IGT might be observed with a sufficiently large sample of participants with ASCs (for details of the power calculation, see Section 4.2.).

In the IGT, participants make repeated selections from four decks of cards in order to win as much money as possible. Unbeknownst to participants, two of the decks are weighted with

large wins and large losses in such a way that repeated selection from these decks leads to a net loss of money. The other two decks are weighted with smaller wins but fewer and smaller losses so that repeated selections from these decks leads to a net gain of points. Successful performance on the IGT depends upon learning these contingencies and making more selections from the two advantageous decks. The contingencies used in this version of the task are shown in Table 3.4.

Table 3.4 *Contingency scheme for the IGT as used by Bechara et al. (1994)*

Deck	Win	Lose	Net profit over 10 trials
A	$50 every card	$50 with probability $^1/_2$	+$250
B		$250 with probability $^1/_{10}$	
C	$100 every card	$150, 200, 250, 300 or 350 each with probability $^1/_{10}$	-$250
D		$1250 with probability $^1/_{10}$	

Performance is measured in five consecutive blocks of twenty trials each. Overall performance on the IGT is measured as the change in the proportion of advantageous selections in each block during the course of the task.

In this study, the IGT was presented on a computer and participants used a cordless optical mouse to select the cards. The instructions read to participants were the same as those used by Bechara, Damasio, Damasio & Lee (1999) and are reproduced in Appendix G. In addition to these instructions, participants were informed that they would receive some real money at the end of the game depending on how well they had scored. This was to maintain their motivation. Due to ethical considerations, the payment schedule was designed so that both groups of participants had an equal chance of remuneration. Scores of up to $5500 were rewarded with £2.00 and scores of over $5500 (an extremely unlikely score) were rewarded with £3.00. Negative scores were remunerated with £2.00 for 'having a good go'.

3.4.6.1 The *Expectancy-Valence Learning* (*EVL*) model

According to Busemeyer & Stout (2002), individual choice patterns on the IGT depend on at least three factors: a) a motivational factor (the tendency to be attracted by gains and indifferent to losses); b) a learning-rate (cognitive) factor (the tendency to be influenced by recent outcomes and to forget or discount past outcomes); and c) a response factor (the

tendency to make choices erratically due to factors such as fatigue or boredom). These factors can be quantified using the *Expectancy-Valence Learning* (*EVL*) model (Busemeyer & Stout, 2002). This is a mathematical model that yields estimates for three parameters, which relate to these three factors. Comparison of the distributions of these parameters between groups may provide an explanation for any observed differences in performance on the IGT.

Briefly, the model assumes that after each trial, the decision-maker experiences an affective reaction to the outcome, termed valence. This is calculated as a weighted average of the salience of all of the wins and losses experienced up to that point. The salience depends on an attention weight parameter (denoted *w*) that ranges from 0 to 1. A value of 0 characterises a decision-maker greatly attracted to wins and indifferent to losses, and a value of 1 characterises a decision-maker with a strong aversion to loss.

In a second part of the model, decision-makers are assumed to develop expectancies about the valence that will be experienced by making a selection from each deck. These expectancies depend upon a learning/memory parameter (denoted *a*), which also ranges from 0 to 1. A value of 0 reflects a small but persistent influence of information acquired over a long span of trials, whereas a value of 1 reflects strong recency effects and discounting of information from more distant trials.

Finally, the model assumes that the participants' choice of deck for each trial depends on the expectancies generated for each deck and the consistency with which they make use of these expectancies. The response consistency parameter (denoted *c*) is estimated by assuming that the probability of choosing a given deck on trial *t* is determined by: i) the strength of the expectancy for that deck relative to the sum of those for the other decks, and ii) an additional variable controlling the consistency between choices and expectancies. This additional variable is determined by assuming that response consistency increases with experience according to a defined power function. The resulting estimate of the response consistency parameter ranges from –5 to +5. A value of +5 reflects consistent application of the expectancies assigned to each of the decks, whereas a value of –5 reflects random selection.

In this investigation, estimates of the three parameters in the EVL model were calculated using a Matlab code provided by Dr Elad Yechiam (Technion, Israel Institute of Technology).

3.4.7 *Heuristics questions*

To assess the extent to which people with ASCs rely on heuristics to make decisions, six short, quiz-like questions, well established in psychological research, were presented to the participants. The questions selected were demonstrations of reliance on the *Representativeness*, *Availability*, and *Anchoring-Adjustment* heuristics, which are three of the most well known cognitive biases in decision-making (see Tversky & Kahneman, 1974). In addition, susceptibility to the traditional 'framing effect' (Tversky & Kahneman, 1981) was assessed, given recent evidence that the framing effect is underpinned by an *Affect* heuristic (De Martino et al., 2006), which is disrupted in ASCs (De Martino et al., 2008). To ensure that the results would not be affected by the specific difficulties people with ASCs have with social understanding and mentalising (see Baron-Cohen, 1995), none of the questions involved making judgments about people. The questions selected are reproduced in Appendix H; however, a brief description of the theory underlying each demonstration is presented here. To control for possible order effects, the presentation order of the six questions was randomised.

3.4.7.1 Demonstration of the *Representativeness* heuristic

As outlined in Chapter 1, the *Representativeness* heuristic is a tendency to evaluate the probability of an event by the degree to which the event resembles the general population. Specifically, events that appear more representative of the general population are judged as more likely to occur than events that are less representative (Kahneman & Tversky, 1972). As a result, judgments made using the *Representativeness* heuristic are insensitive to information that should have an effect on judgment, such as the role of chance, and the size of the sample.

The two questions selected to assess reliance on *Representativeness* were developed by Kahneman & Tversky (1972). The first question asks participants to judge how many families of six children in a city have the birth order 'Boy Girl Boy Boy Boy Boy', given that 72 families have the birth order 'Girl Boy Girl Boy Boy Girl'. Although both birth orders are

equally likely, they are not equally representative of the proportions of men and women in the population, and, as a result, most people judge that the number of families is less than 72. The second question asks participants to judge whether the number of days on which more than 60% of babies born are boys is greater in a small hospital (about 15 babies born each day), a large hospital (about 45 babies born each day), or equally likely in both. Although variation about the mean reduces as sample size increases, most people erroneously judge the number of days to be equally likely in both hospitals. This is because the judgment is made by attending to the wrong information: the *similarity* (representativeness) of the proportions (60% boys) to the corresponding parameter in the general population (50% boys). The effects of the sample size on variation about the mean are not considered (Tversky & Kahneman, 1974).

To reduce the possibility of a response bias, the order of the response options for the small and large hospitals was counterbalanced across participants. The response option for equal likelihood was kept in the third position, since it is analogous with the response option, 'neither of the above'.

3.4.7.2 Demonstration of the *Availability* heuristic

The *Availability* heuristic is the tendency to evaluate the probability of an event, by the ease with which examples of that event can be brought to mind (Tversky & Kahneman, 1973). While this is often a useful heuristic, its use can result in bias where the response options differ in their 'imaginability', or the effectiveness of a technique to search for examples.

The two questions selected to assess reliance on this heuristic were developed by Tversky & Kahneman (1973). The first question presented participants with a diagram of X's and O's in 6x6 grid, and asks them to consider the number of paths of X's and O's that could be drawn by starting with a symbol at the top row, ending with a symbol on the bottom row, and passing through exactly one symbol (X or O) in each row. The grid is shown in Figure 3.5.

Figure 3.5 *Tversky and Kahneman's 1973 demonstration of the Availability heuristic*

X X O X X X
X X X X O X
X O X X X X
X X X O X X
X X X X X O
O X X X X X

Participants are asked to judge whether there are more paths containing five X's and one O, or more paths containing six X's and no O's. Since the diagram contains five times as many X's as O's, there are more paths containing six X's. However, most people judge that there are more paths containing five X's and one O as the only paths immediately visible (those going vertically from top to bottom) all contain five X's and one O. All other paths require the mental realisation that other paths may be constructed by linking symbols in different columns. In this example, the wrong answer is often selected due to the ease of imaginability. The order of response options was counterbalanced across participants.

The second question asks participants to judge whether the letter 'r' appears more frequently in the first or third position of words (of three letters or more) in the English language. The letter 'r' occurs more frequently in the third position; however, most people judge the letter 'r' to occur more often in the first position. This is because it is much easier to call to mind words beginning with a letter than words with the letter in the third position. This is an example of a response bias due to the effectiveness of a search set. The order of the response options was counterbalanced across participants.

3.4.7.3 Demonstration of the *Anchoring-Adjustment* heuristic

The *Anchoring-Adjustment* heuristic describes the tendency to make judgments using one value as a reference point (an 'anchor') and adjusting that value to produce an estimate. Estimates made in this way, however, are often biased towards the value of the anchor due to insufficient adjustment (Tversky & Kahneman, 1974). The demonstration selected for use in this study was developed by Bar-Hillel (1973). It shows how insufficient adjustment from an initial reference point can result in bias in the evaluation of the probability of conjunctive and

disjunctive events. Conjunctive events are events with an outcome that must occur at every stage of a process, and disjunctive events are events in which an outcome can occur at any stage of a process.

In this task, participants are asked to choose between two gambles, one of which is a 'simple' gamble (e.g. drawing a red marble from a bag containing 50% red marbles), and the other is either a 'conjunctive' gamble (e.g. drawing a red marble seven times in a row, with replacement, from a bag containing 90% red marbles) or a 'disjunctive' gamble (e.g. drawing a red marble at least once in seven draws, with replacement, from a bag containing 10% red marbles). Here, the probability of winning the simple gamble is 0.5 and the probability of winning the conjunctive gamble is 0.478. Nevertheless, most people prefer the conjunctive gamble over the simple by insufficiently adjusting the 90% probability of the single event to the 48% probability of the event occurring four times in a row. Conversely, most people prefer the simple gamble to the disjunctive by insufficiently adjusting the 10% probability of the single event to the 52% probability of the event occurring on any one of seven trials.

In the original study, Bar-Hillel presented each participant with four trials (randomly selected from 20 different trial types) in the simple vs. conjunctive condition, and four trials (randomly selected from 10 different trial types) in the simple vs. disjunctive condition. They found that the trial types eliciting the strongest bias were those with an extreme proportion (e.g. 90% or 10% red marbles) in one of the bags. To reduce the length of task, participants in the present study were shown only the three trial types in each condition that had produced the most consistent bias in the original study (at least 75% of the participants demonstrating a bias). Although the paradigm has not been adapted in this way before, the results presented by Bar-Hillel suggest that that each of these trials provide an independent demonstration of *anchoring-adjustment*, and single trials are often presented as an example of the heuristic (see, for example, Tversky & Kahneman, 1974). For each trial in the present study, participants were presented with a summary of the two gambles on two separate cards. The cards provided information about: i) the number of red and white marbles in each bag; ii) the chance of drawing a red marble at each step (presented as a percentage), and; iii) in the compound and disjunctive gambles, the number of times needed to draw successfully. The order of the trials and the two conditions were fully counterbalanced across participants. The

left-right position of the cards was also counter-balanced to control for an effect of the order of presentation of the two gambles.

3.4.7.4 Demonstration of the 'framing effect'

The 'framing effect' occurs when preference for a particular option can be changed by presenting the same options in different formats (Tversky & Kahneman, 1981). In a series of experiments, Tversky & Kahneman (1981), demonstrated how choices worded to concentrate on the gains often produced risk-averse responses, and choices worded to concentrate on loss often produced risk-seeking choices. There is evidence that this effect is mediated by an emotional response to the language of the frame, which guides preference (De Martino et al., 2006). Here, the framing effect is assessed using one of the questions developed by Tversky & Kahneman (1981). The question was presented to each participant in both the 'gain' and the 'loss' versions. The order of presentation of the two frames was counterbalanced.

3.4.8 *Summary of the selected paradigms*

The selected paradigms, and the research questions they will address, are shown in Table 3.5.

Table 3.5 *Summary of experimental paradigms used in this investigation and the specific research questions they will address*

Area of research	Research questions (Compared to the general population:)	Tasks						
		Survey	GDMS	CGT	IST	RCT	IGT	Heuristics
Self-reported experiences	Do participants with ASCs experience decision-making differently?	✓	✓					
Behaviour and physiological characteristics	Do participants with ASCs demonstrate different flexibilities and greater caution in decision-making?			✓		✓		
	Do participants with ASCs gather more information prior to making decisions?				✓			
	Do participants with ASCs take longer to make decisions?			✓	✓			
	Are participants with ASCs more aroused when making decisions?					✓		
Decision-making processes	Do participants with ASCs demonstrate differences in motivational processes in decision-making?						✓	
	Do people with ASCs demonstrate reduced reliance on heuristics to make decisions?					✓		✓

3.5 Measurement of individual characteristics

In addition to the paradigms described above, several measures of individual characteristics relevant to decision-making were obtained. These provided an opportunity to assess the contribution of these characteristics to group differences in decision-making, and also to recruit groups of participants with similar verbal abilities.

3.5.1 *Intellectual ability*

Intellectual ability was assessed using the Wechsler Abbreviated Scale of Intelligence (WASI, Wechsler, 1999). This is a short, reliable measure providing scores of Verbal IQ, Performance IQ and Full-Scale IQ (VIQ, PIQ, and FSIQ, respectively). Scores are standardised around a general population mean of 100. The WASI requires specific training to administer and takes approximately 40 minutes to complete. Inter-rater reliability was established by double scoring 8 (10%) of the assessments by an independent rater. The intraclass correlation coefficient was $r_i = 0.996$.

3.5.2 *Planning ability*

Planning ability was assessed using the One-touch Stockings of Cambridge (OTS) task, which is part of the CANTAB. This task was selected because it is quick to administer (10 minutes) and has been shown to reveal ASC-related impairments in planning (see Ozonoff et al., 2004). Participants are presented with two on-screen arrangements of coloured balls, and asked to work out the minimum number of moves required to make the bottom arrangement look like the top arrangement, by moving the balls in the bottom arrangement, one at a time, according to a set of rules. Participants are presented with twenty problems of varying difficulty. Performance is measured as the mean number problems solved, and the mean number of attempts to solve problems with a minimum of five moves (the hardest problems).

3.5.3 *Working Memory*

Working memory was assessed using the Digit Span test, which is part of the Wechsler Adult Intelligence Scale –Third Edition (WAIS-III, Wechsler, 1997). This measure was selected because it is reliable, quick to administer (5 minutes), and is not affected by individual differences in reading ability. In the first part of the task, participants are read sequences of numbers of increasing length and asked to repeat each sequence immediately after its presentation. In the second stage, participants are read different sequences of numbers and

asked to repeat each sequence backward. The scores awarded for each sequence are summed to provide an overall score for each participant.

3.5.4 *Attention shifting*

Attention shifting was measured using the Intradimensional/Extradimensional shift (ID/ED) task, which is part of the CANTAB. The task is short (10 minutes), easy to administer and more sensitive to ASC-related deficits in set-shifting than the similar Wisconsin Card Sorting Task (Heaton, Chelhune, Talley, Kay & Curtiss, 1993; Ozonoff, 1995; Hughes et al., 1999). Participants are presented with samples of stimuli consisting of coloured shapes and white lines. Over a series of trials, they are provided with feedback to learn a rule for selecting the correct exemplar. However, after six consecutive correct selections, the rule is changed and participants have to learn the new rule. The task difficulty increases over eight stages: the earlier stages involve learning a new rule in the same 'dimension' as the previous stage (termed an 'intradimensional shift', for example, switching from one pink shape to the other pink shape); later in the task, participants have to learn a new rule in a different dimension (termed an 'extradimensional shift', for example, switching from the pink shape to one of the white lines). Performance was measured as the number of errors made at the extradimensional shift stage of the task, since this is the stage that is sensitive to ASC-related impairments in attention shifting (Ozonoff et al., 2004). The total number of errors (adjusted for any stages that were not passed) is also reported.

3.5.5 *Motor screening*

A task of motor screening (MOT) is a prerequisite of all the tasks administered using the CANTAB. This task provides a demonstration of how the touch-screen should be used, as well as an indication of each participant's motor speed. Participants use the tip of the forefinger of their dominant hand to touch ten crosses as they appeared on the screen. The task takes less than one minute to administer.

3.5.6 *Anxiety and Depression*

Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS, Zigmond & Snaith, 1983). This assessment was developed for use in the general population. It was selected for use because it has been shown to have good validity (Bjelland, Dahl, Haug & Neckelmann, 2002), and is quick to administer (4 minutes).

Participants respond using a four-stage Likert-type scale. Seven questions contribute to a score for anxiety, and seven questions contribute to a score for depression.

3.6 Presentation order of the tasks in the experimental investigation

All the tasks were completed in a single testing session as far as possible (69 out of 78 participants), which took approximately 5 hours with breaks. Eight of the remaining participants completed the tasks over two sessions separated by less than two weeks. One participant completed the task over two sessions that were 4½ weeks apart. Levels of anxiety and depression (HADS) were reassessed in the second testing session if the testing sessions were more than two days apart; the appropriate values were used in all statistical analyses. The order of the tasks was carefully considered so that demanding tasks were presented early on when participants were least fatigued (see Lezak, Howieson, Loring, Hannay & Fischer, 2004), and tasks requiring sustained concentration were separated by tasks that required less effort to complete. The order of the four laboratory tasks was counter-balanced using a Latin Squares design to reduce potential order effects. The assessment of depression and anxiety was made at the beginning of the session to help ensure that transient effects on mood, which can occur as a result of completing such questionnaires (see Mark, Sinclair & Wellens, 1991), had had an opportunity to recover before administration of the decision-making tasks (approximately 1½ hours later); the mood assessment was not presented at the end of the session to avoid any influence from perceived performance on the tasks. The testing session also included two assessments used to confirm diagnosis of ASCs. One, the Autism Spectrum Quotient (AQ, see Section 4.3), was administered to all participants, the other was an observational assessment, the Autism Diagnostic Observation Schedule (ADOS, see Section 4.3), which was administered only to participants with ASCs at the end of their testing session. This ensured that the testing sessions followed the same format for both groups. The order of presentation of the tasks is shown in Table 3.6.

Table 3.6 *Task order in the testing session*

Item No.	Task	Length (approx)
1	HADS	5 minutes
2	WASI	40 minutes
3	AQ	10 minutes
4	MOT	1 minute
5	ID/ED	10 minutes
6	Questionnaire of decision-making experiences	10 minutes
7	Laboratory task 1: (either **CGT**, IST, IGT or RCT)	20 minutes
8	Digit Span	5 minutes
9	Laboratory task 2: (either CGT, **IST**, IGT or RCT)	10 minutes
10	Heuristics	10 minutes
11	Laboratory task 3: (either CGT, IST, **IGT** or RCT)	15 minutes
12	GDMS	5 minutes
13	Laboratory task 4: (either CGT, IST, IGT or **RCT**)	50 minutes
14	OTS	10 minutes
(15)	ASC assessment (ADOS) – *ASC group only*	40 minutes
TOTAL TIME		**4 hours (+ breaks)**

3.7 Ethical approval

The experimental study received ethical approval from the Cambridge Psychology Research Ethics Committee. The approved Information Sheets and Consent Forms are reproduced in Appendix I.

CHAPTER 4: PARTICIPANTS

This chapter describes the participants recruited for the experimental study. The participants of the experimental group were adults with ASCs, while the participants of the control group were adults without ASCs who were recruited from the general population.

4.1 Recruitment

Participants with ASCs were recruited via advertisements to members of the NAS, locally-based autism support organisations in the UK, and disability support centers in local colleges and universities; letters of invitation were also sent to volunteers registered with the University of Cambridge Autism Research Centre volunteer database living within a reasonable distance of Cambridge, and to participants of the initial survey who had requested to be contacted with information about future studies. Participants from the general population were recruited via advertisements in the local community, universities, colleges, and by word-of-mouth. Recruitment took place between May 2009 and January 2010.

4.2 Participants

Forty two people with an ASC and forty one people without an ASC were recruited to the study. They were all aged between 16 and 65 years. The lower age limit reflects the definition of an adult in the Mental Capacity Act *(England and Wales)* 2005, and the upper age limit was selected as the incidence of cognitive decline due to conditions such as dementia increases significantly above this age (e.g. Hofman et al., 1991). Five participants were excluded due to low Verbal IQ (less than 90) or concern over the validity of their diagnosis of an ASC (see Section 4.3). As a result, 38 participants with an ASC and 40 participants without an ASC (and who had no family members with an ASC) were included in the final analyses.

The target sample size had been 45 participants in each group. This sample size was selected to be able to detect a group difference on the computational model of the IGT of the same magnitude and direction as that reported by Johnson et al. (2006) with almost 90% power at $\alpha = 0.1$ (one-tailed). As discussed in Chapter 1, their result tended towards a significant difference in attention to the motivational properties of choices, but in their opinion the result

was not significant due to the small sample size of the study. Unfortunately for the present study, it was not possible to recruit more than 83 participants in the time available. The actual sample size obtained would, therefore, have been able to detect a difference of the same magnitude and direction as Johnson et al. (2006) with 80% power at $\alpha = 0.1$ (one-tailed).

4.3 Confirmation of diagnosis of an ASC

All participants in the ASC group reported that they had received a clinical diagnosis of an ASC from a qualified practitioner. To confirm their reports, information about the participants' diagnosis was sought by contacting the clinical service in which the diagnosis was originally made, or a service which had access to the relevant records. In six cases, this information was not sought because the Autism Diagnostic Interview – Revised (ADI-R, Lord, Rutter & Le Couteur, 1994) had recently been carried out as part of another study in the same research group and the scores for these participants were available. The ADI-R is a comprehensive, semi-structured interview that can be used to make a diagnosis of an ASC according to ICD-10 diagnostic criteria. It requires specific training to administer and is carried out with an informant (usually a parent) who is able to provide information about the participant's social and communication development, and restricted, repetitive, and stereotyped patterns of behaviour and interests in early life. The ADI-R scoring schedule provides cut-off scores that are required for diagnosis of an ASC. Where information from the clinical service was not available (5 participants), the ADI-R was carried out.

The information provided by the clinical services (for 31 participants) varied considerably in the detail provided and the apparent thoroughness of the diagnostic assessment. While many of the reports described a thorough assessment procedure that included taking a developmental history from an informant (20 participants), other reports lacked detail about the assessment procedure (4 participants), or described procedures that did not involve taking a developmental history (7 participants).

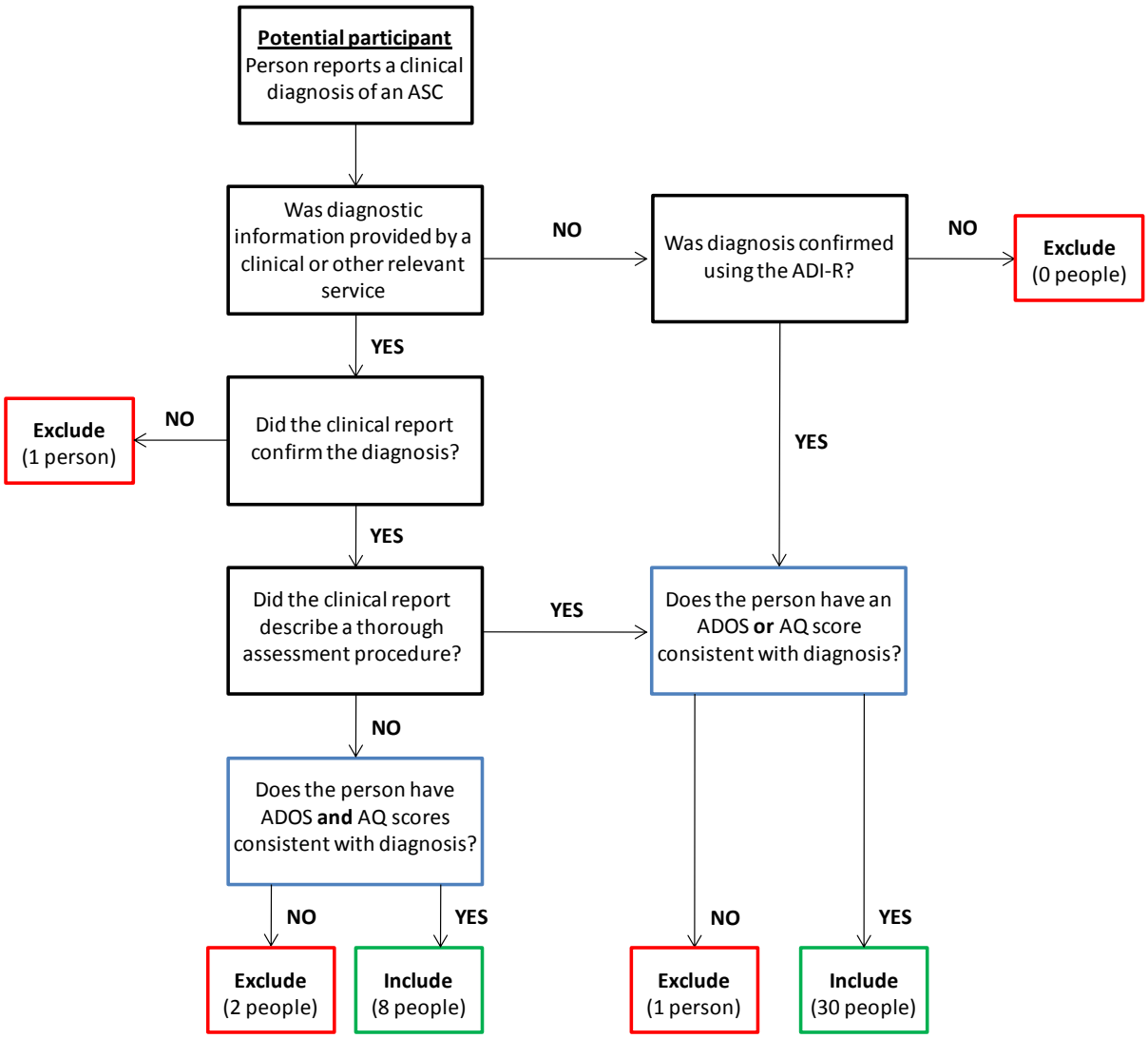
To ensure that the participants included in the final analysis had a valid diagnosis of an ASC, information provided by the clinical reports and the ADI-R was put together with information from two other assessments carried out in the testing sessions. These were the Autism Diagnostic Observation Schedule Module 4 (ADOS-G, Lord et al., 1989), a standardised

observation schedule requiring specific training to administer, and the Autism Spectrum Quotient (AQ, Baron-Cohen et al., 2001), a 50-item self-administered questionnaire providing a score of the number of autistic traits. While these measures do not on their own provide sufficient information to make a diagnosis of an ASC, they provide clinically relevant information that may be useful in a diagnostic assessment: the ADOS scoring schedule provides a cut-off for autism spectrum disorder, although individuals with AS or PDD-NOS may or may not meet this criterion (Baird et al., 2006); the AQ has good discriminate validity at a threshold score of 26/50, at which 83% of people with an ASC will be correctly classified (Woodbury-Smith, Robinson, Wheelwright & Baron-Cohen, 2005). Inter-rater reliability on the ADOS was established by double coding four (10%) of the videotaped assessments with an independent rater, very experienced in using this assessment with people with ASCs and a trainer in its administration. The agreement between the codes assigned by the two raters was 95% (*kappa = 0.884*, almost perfect agreement, see Landis & Koch, 1973).

For the experimental study, participants with a diagnosis of an ASC confirmed by a report of a thorough assessment, or the ADI-R, were included if *either* their ADOS *or* AQ scores were consistent with a diagnosis of an ASC. Participants with a diagnosis confirmed by a weaker clinical report were included only if their ADOS *and* AQ scores were consistent with a diagnosis of an ASC.

The procedure followed for diagnostic inclusion is shown in Figure 4.1.

Figure 4.1 *Diagnostic inclusion flowchart*



4.4 Other exclusion criteria

Other exclusion criteria, for both groups of participants, were diagnosis of schizophrenia or a related disorder, Attention Deficit Hyperactivity Disorder, and Bipolar Disorder. Since anxiety and depression are extremely common in people with ASCs, due a number of complex biological and social factors (see Tantam, 2000), reports of anxiety and depression were not exclusion criteria for this investigation, although a measure of depression and anxiety (see Section 3.5.6) was obtained for each participant during the testing session. People taking the medication diazepam, which is known to affect decision-making (Deakin, Aitken, Dowson et al., 2004), were not recruited to the study, nor were those reporting acquired brain damage with lasting effects on cognition, and those reporting regular and

significant recreational drug use (the heaviest user reported taking recreational drugs 3 – 4 times a year; all other participants reported that they had been drug free for at least 1 year, with the exception of a participant who reported that he had taken cocaine on two occasions 5 months prior to his participation). All participants spoke English as their first, or a fully bilingual, language.

Of note, seven participants with ASCs were taking Selective Serotonin Reuptake Inhibitor (SSRI) medication for depression or anxiety and two participants were taking anxiolytics. One participant in the control group was taking a tricyclic antidepressant. These drugs may have effects on decision-making cognition similar to those described by Deakin, Aitken, Dowson et al. (2004b) and there is evidence that decision-making is modulated by the serotonin system (see Brand et al., 2006). However, due to the widespread use of these medications in clinical populations, several studies of decision-making in clinical populations have included participants taking SSRI medication (see, for example, Chamberlain et al., 2007). The recent decision-making study carried out by De Martino et al. (2008) found that their results were not affected when the participants with ASCs taking SSRI medication were excluded from the analysis. In the interests of caution, all analyses presented in this study are carried out with and without these participants to check that these medications do not alter the results.

Finally, three participants (one with an ASC and two in the control group) reported that they had a colour vision impairment. The only task in which colour vision impairments could have been problematic is the Information Sampling Task. Therefore, the participants with a colour vision impairment were instructed to report any trials in which they could not distinguish the two displayed colours. This affected between one and two trials in each condition for each of these participants. Their scores were adjusted to exclude the affected trials.

4.5 Participant characteristics

Since it was not possible to match the participants individually, an attempt was made to match the two groups for age, gender and Verbal IQ, which are factors known to impact on decision-making cognition (e.g. Deakin, Aitken, Robbins & Sahakian, 2004). The distributions of age and Verbal IQ are shown in Figure 4.2 and Figure 4.3. Other

information, including scores of anxiety, depression and executive function, are summarised in Table 4.1.

Figure 4.2 *Age distributions for both groups of participants*

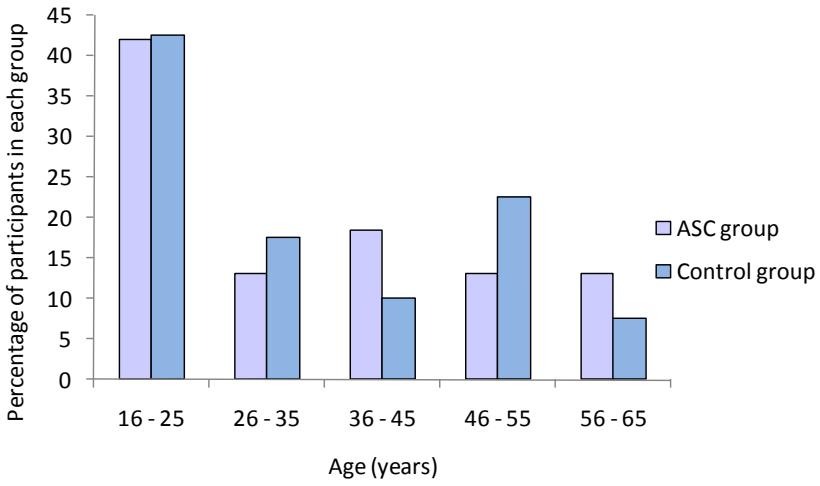


Figure 4.3 *Verbal IQ distributions for both groups of participants*

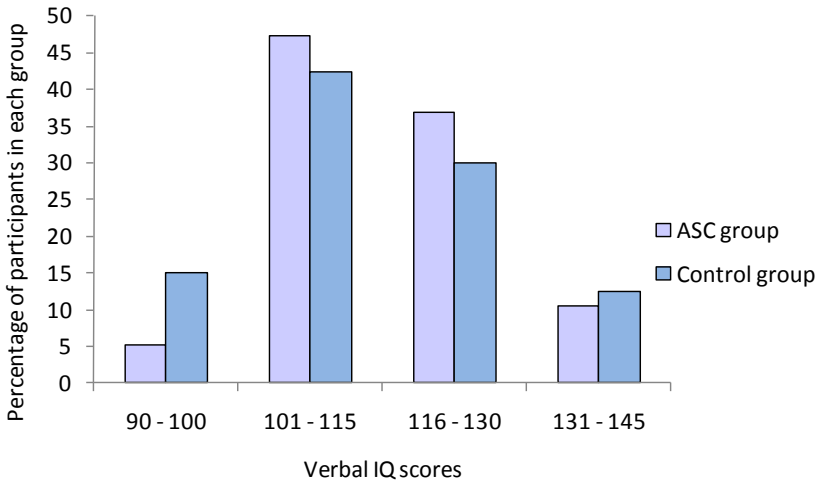


Table 4.1 *Summary of participant characteristics*

Characteristic	ASC group (n = 38)	Control Group (n = 40)	Test of group difference
% male	65.8	67.5	$\chi^2 = 0.03$, $p = 0.87$
Mean age in years	34.03 (*15.47*)	34.03 (*14.54*)	$z = -0.15$, $p = 0.89$
Mean Verbal IQ	116.4 (*10.15*)	114.2 (*11.75*)	$t(76) = 0.89$, $p = 0.38$
Digit Span: mean score	19.1 (*4.67*)	18.8 (*4.50*)	$t(76) = 0.32$, $p = 0.75$
ID/ED: EDS mean errors	6.2 (*9.14*)	6.8 (*8.15*)	$z = -0.14$, $p = 0.89$
ID/ED: EDS mean trials to criterion	15.6 (*13.27*)	17.7 (*13.77*)	$z = -1.18$, $p = 0.24$
OTS: Mean number of problems solved at the first attempt	17.4 (*3.14*)	17.3 (*2.31*)	$z = -0.99$, $p = 0.32$
OTS: Mean attempts to solve problems requiring five moves	1.4 (*0.69*)	1.5 (0.46)	$z = -1.34$, $p = 0.18$
HADS: Anxiety	10.6 (*3.60*)	5.4 (*2.68*)	$t(76) = 7.27$, $p < 0.001$
HADS: Depression	4.7 (*3.24*)	1.6 (*1.60*)	$z = -5.07$, $p < 0.001$

Table 4.1 shows a summary of the characteristics of both groups. Values are presented as mean (SD), unless otherwise specified. The groups did not differ in their gender distribution, age, or Verbal IQ. The measures of executive function also did not differ between the groups. Compared to the control group, the participants with ASCs had significantly higher scores of anxiety and depression. These results did not change when the participants taking antidepressant or anxiolytic medication were excluded.

ID/ED = Intradimensional/Extradimensional shift task of attention shifting (EDS refers to the stage involving the extradimensional shift); OTS = One-Touch Stockings of Cambridge; HADS = Hospital Anxiety and Depression Scale.

CHAPTER 5: DO PARTICIPANTS WITH ASCS EXPERIENCE DECISION-MAKING DIFFERENTLY TO PARTICIPANTS IN THE CONTROL GROUP?

5.1 Background

The measures used to address whether participants with ASCs experience decision-making differently from those in the control group were: i) the adapted questionnaire of decision-making experiences; and ii) the General Decision Making Style Inventory (GDMS, Scott & Bruce, 1995). A full description of these measures is provided in Sections 3.4.1 and 3.4.2, respectively. To summarise, the questionnaire of decision-making experiences was an adapted version of the questionnaire developed for the initial survey (see Appendix D). The GDMS is a 25-item questionnaire probing reliance on several styles of decision-making, but importantly including an *avoidant* style. These measures provided quantitative data.

5.2 A priori hypotheses

Based on the literature reviewed in the Chapter 1, the following predictions were made. Compared to the control group, it was expected that participants with ASCs would report:

1. more frequent experiences of problems due to thoughts or feelings that hinder the decision-making process;
2. higher ratings of difficulty associated with particular features of decisions; and
3. greater reliance on the *avoidant* style of decision-making.

In addition, it was expected that:

4. participants with ASCs would report interference from their condition when making decisions.

5.2.1 *Experimental details*

5.2.1.1 Participants

The data presented from the adapted questionnaire and the GDMS are based on the responses of the 38 participants with ASCs and the 40 control participants who were recruited to the experimental study (see Section 4.2).

5.2.1.2 Analyses

The data were analysed using chi-squared tests, and parametric and non-parametric difference tests, as appropriate. Given the directionality of the hypotheses, one-tailed tests of significance ($\alpha = 0.1$) were used. For tests that involved multiple comparisons, the threshold for significance was adjusted using Dunn-Sidak's correction ($\alpha' = 1 - (1 - \alpha)^{1/c}$, where *c* denotes the number of comparisons involved in the analysis (see Howell, 1997). In the experimental study, the effects of medication were controlled for by repeating each of the analyses with and without the ten participants with ASCs taking antidepressant or anxiolytic medication. Exclusion of these participants did not affect any of the findings reported below.

5.3 Results

5.3.1 *Frequency of problems experienced during decision-making*

The responses relating to the frequency with which twelve types of problems are encountered during decision making are shown in Table 5.1. The distributions of responses were compared between groups using the χ^2 test for linear trend (also known as the Mantel-Haenszel statistic, see Howell, 1997). Consistent with the initial hypothesis, the participants with ASCs reported experiencing all but one of the listed problems more frequently than the participants in the control group.

Table 5.1 *Summary of responses to questions about the frequency with which particular problems are experienced during decision-making*

Problem experienced during decision-making		**Response (*% of participants*)**				**χ^2 statistic for linear trend**
		Never	*Rarely*	*Sometimes*	*Often*	
Frequent changes of mind about the decision	ASCs	0	50	21	29	$\chi^2(1) = 2.65^{\dagger}$, *p = 0.10*
	Controls	15	32.5	52.5	0	
Concern or worry about making the decision	ASCs	2.5	16	44.5	37	$\chi^2(1) = 18.3^{\dagger}$, *p<0.001**
	Controls	10	50	35	5	
Concerned or worry about making the 'wrong' choice	ASCs	0	13	40	47	$\chi^2(1) = 13.6^{\dagger}$, *p<0.001**
	Controls	2.5	35	52.5	10	
Lack of confidence	ASCs	5	16	50	29	$\chi^2(1) = 23.7$, *p<0.001**
	Controls	22.5	52.5	25	0	
Uncertainty about the consequences	ASCs	3	26	45	26	$\chi^2(1) = 11.2^{\dagger}$, *p = 0.001**
	Controls	10	52.5	32.5	5	
Uncertainty about which factors are relevant	ASCs	8	16	47	29	$\chi^2(1) = 28.4$, *p<0.001**
	Controls	37.5	47.5	15	0	
Difficulty remembering all the relevant information	ASCs	10	29	32	29	$\chi^2(1) = 22.9$, *p<0.001**
	Controls	37.5	52.5	10	0	
No knowledge of the choices available	ASCs	11	34	37	18	$\chi^2(1) = 13.0^{\ddagger}$, *p<0.001**
	Controls	35	47.5	17.5	0	
Difficulty asking for help	ASCs	8	18	37	37	$\chi^2(1) = 24.4$, *p<0.001**
	Controls	37.5	42.5	17.5	2.5	
Mental 'freezing' and inability to make the decision	ASCs	8	13	47	32	$\chi^2(1) = 34.3$, *p<0.001**
	Controls	45	45	10	0	
Spending too much time thinking about the decision	ASCs	3	13	35	49	$\chi^2(1) = 23.1^{\dagger}$, *p<0.001**
	Controls	5	51	41	3	
Experience of exhaustion	ASCs	10	24	34	32	$\chi^2(1) = 27.7$, *p<0.001**
	Controls	47.5	42.5	10	0	

† Responses of '*Never'* and '*Rarely'* were collapsed to meet the assumption for chi-squared tests that 80% of cells have an expected frequency of 5 or more (see Pallant, 2005).

‡ Responses of '*Sometimes'* and '*Often'* were collapsed to meet the assumption for chi-squared tests that 80% of cells have an expected frequency of 5 or more (Pallant, 2005)

* χ^2 is significant at $\alpha' = 0.0087$ ($\alpha = 0.1$, one-tailed, adjusted using Dunn-Sidak's correction for multiple comparisons)

Table 5.1 shows the percentage of participants in each group giving each type of response. Participants with ASCs reported experiencing all but one of the listed problems (frequent changes of mind) more frequently than the control group.

5.3.2 *The difficulty associated with different features of decisions*

The mean ratings of difficulty for decisions involving different features are shown in Table 5.2. Ratings of difficulty were indicated on unmarked visual analogue scales, scaled to range in difficulty from 0 ('Not difficult') to 1 ('Very difficult'). Prior to analysis, the ratings were arcsine transformed [$f(x) = 2\arcsin(x^{½})$],) as is appropriate whenever the variance is proportional to the mean (Howell, 1997; Rahman et al., 1999). The data were screened for extreme outliers, which were defined as mean ratings more than three times the interquartile range from the upper or lower quartiles (see Pallant, 2005). Two control participants were excluded from one of the analyses (the decision requires talking to another person) on this basis.

Consistent with expectations, the participants with ASCs reported greater difficulty with three features of decisions. These were: the decision has to be made quickly (ASC group: $M = 0.60$, $SD = 0.29$; Control Group: $M = 0.34$, $SD = 0.22$, ($t(68.2) = 4.3$, $p<0.001$); ii) the decision involves a change of routine (ASC group: $M = 0.62$, $SD = 0.28$.; Control Group: $M = 0.29$, $SD = 0.23$, $t(76) = 5.8$, $p<0.001$); and iii) the decision involves talking to others (ASC group: $M = 0.60$, $SD = 0.25$; Control Group: $M = 0.18$, $SD = 0.18$, $z = -6.3$, $p<0.001$,$\alpha' = 0.01$). The difficulty ratings for the other features of decisions did not differ significantly between the groups. The scores are summarised in Table 5.2.

Table 5.2 *Mean ratings of difficulty associated with different features of decisions*

Feature	Rating of difficulty *(proportion of the visual analogue line, SD)*		Group difference
	ASC participants	Control participants	
The decision is about something trivial	0.33 (*0.27*)	0.20 (*0.24*)	*z* = -2.12, *p = 0.034*
The decision has to be made quickly*	0.60 (*0.29*)	0.34 (*0.22*)	*t*(68.2) = 4.32, *p<0.001**
The decision involves a change of routine*	0.62 (*0.28*)	0.29 (*0.23*)	*t*(76) = 5.80, *p<0.001**
The decision is about a favourite interest or activity	0.28 (*0.24*)	0.22 (*0.21*)	*z* = -1.47, *p = 0.14*
The decision requires talking to another person*	0.60 (*0.25*)	0.18 (*0.18*)	*z* = -6.28, *p<0.001**
The decision affects others	0.61 (*0.27*)	0.54 (*0.26*)	*t*(76) = 1.23, *p = 0.22*
The decision is about health	0.39 (*0.30*)	0.30 (*0.27*)	*z* = -1.17, *p = 0.24*
The decision will have a big effect on the future	0.65 (*0.27*)	0.66 (*0.23*)	*t*(76) = -0.21, *p = 0.83*
Other people have strong feelings about the choice	0.51 (*0.33*)	0.57 (*0.22*)	*t*(62.6) = -0.64, *p = 0.52*
The reasons for and against are finely balanced	0.75 (*0.22*)	0.67 (*23.0*)	*t*(76) =1.44, *p = 0.15*

* *t* or z are significant at α' = *0.0105* (α = 0.1, one-tailed, adjusted using Dunn-Sidak's correction for multiple comparisons)

Table 4.2 shows the mean ratings of difficulty that both groups of participants associated with different features of decisions. For ease of comparison, the data are shown as the percentage of the distance between 'Not difficult' and 'Very difficult', rather than the distance in mm along the visual analogue line. The difference tests, however, show statistics based on the transformed scores. Compared to the control group, the participants with ASCs rated: i) quick decisions; ii) decisions involving a change of routine; and iii) decisions that require talking to others, as significantly more difficult.

5.3.3 *General decision making styles*

The mean scores for each style of decision-making (assessed using the GDMS) are shown in Figure 5.1. Consistent with the initial hypothesis, the participants with ASCs reported greater reliance on the *avoidant* style of decision-making, compared to the control group (ASC group: *M* = 2.9, *SD = 0.96*; Control group: *M* = 2.4, *SD = 0.65*, *t*(64.5) = 2.54, *p = 0.014*).

Figure 5.1 *Mean scores for the five styles of decision-making assessed using the GDMS*

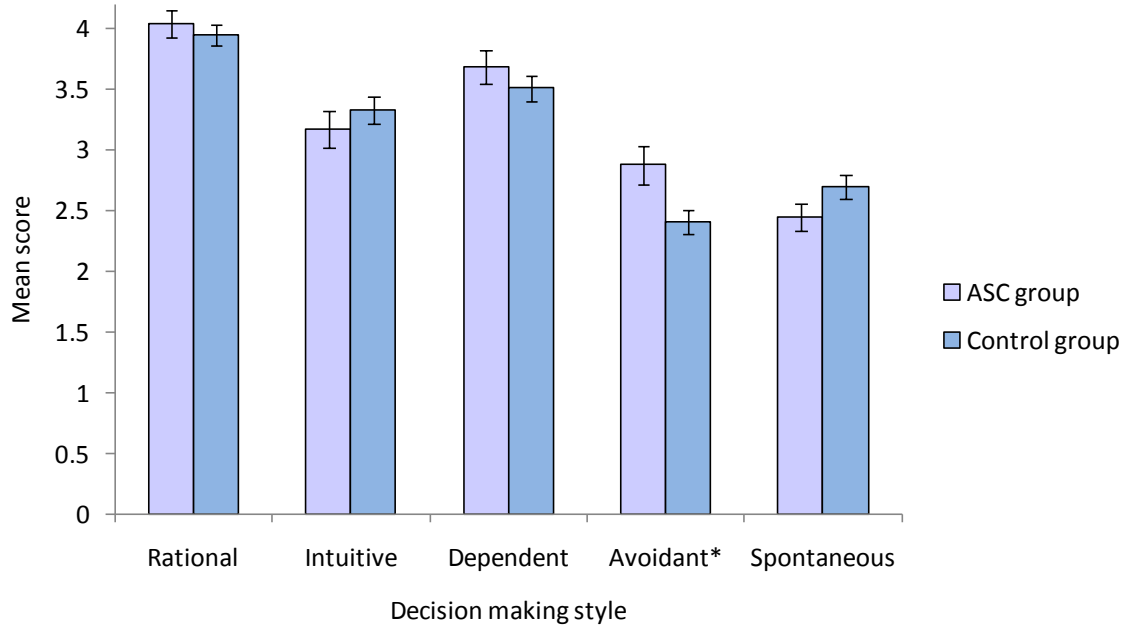


Figure 5.1 shows the mean scores of both groups of participants for the five decision making styles assessed using the GDMS. Error bars represent the Standard Error of the Mean. Consistent with the initial hypothesis, participants with ASCs reported a greater tendency to avoid decision-making.

5.3.4 *Perceived interference from ASCs on decision-making*

The responses of participants with ASCs to two closed questions about the frequency with which ASCs can help and interfere with decision-making are shown in Figure 5.2. Consistent with the initial hypothesis, the distribution of responses for 'interference' from ASCs was skewed towards response options indicating a greater frequency of interference. Moreover, the distribution of responses for 'help' from ASCs was skewed towards response options indicating a lower frequency of help. The difference between the ratings for the two questions was significant (z = -3.3, $p<0.001$), indicating that ASCs were more often perceived as a hindrance than a help with decision-making.

Figure 5.2 *Distribution of responses to two questions about how often ASCs can help and interfere with decision-making*

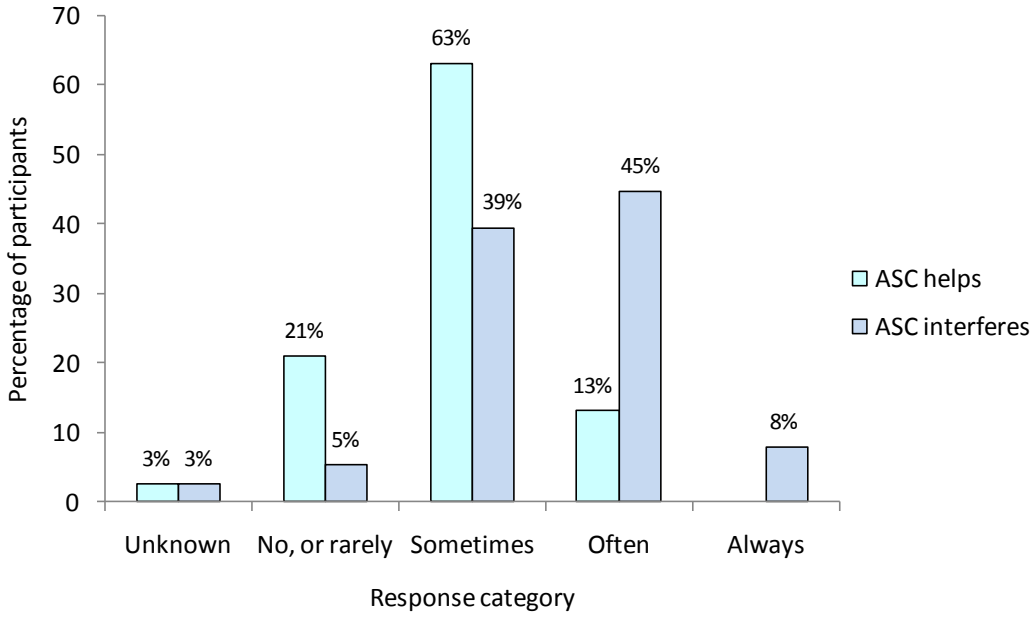


Figure 5.2 shows the distribution of responses for the participants with ASCs to two questions about the frequency with which they believe their condition can help or hinder with decision-making. Consistent with the initial hypothesis, ASCs were more often perceived as a hindrance than a help with decision-making.

5.4 Supplementary analyses

a) *Relationships with depression and anxiety*

The relationships between perceived frequency of interference from ASCs and scores of depression and anxiety were assessed using one-way ANOVA for linear trend (see Field, 2005). Both analyses indicated that as scores of depression and anxiety increased, the perceived frequency of interference from ASCs also increased (*Depression*: $F(1, 33) = 9.1$, $p = 0.005$; *Anxiety*: $F(1, 33) = 8.5$, $p = 0.006$, $\alpha' = 0.025$, two-tailed).

b) Relationships with executive functions

Two of the questionnaire items seemed particularly relevant to the executive functions of *planning* and *working memory*. The questionnaire items were: i) difficulty knowing the consequences of decisions; and ii) difficulty remembering the relevant information. The relationships between these items and the measures of *planning* and *working memory* (see

Sections 3.5.2 and 3.5.3) were assessed using one-way ANOVA for linear trend in the ASC group. The relationships between these measures were not significant (difficulty knowing the consequences and *planning*: $F(1, 34) = 0.002$, $p = 0.96$; difficulty remembering the information and *working memory*: $F(1, 34) = 0.265$, $p = 0.61$).

c) Informal test-retest reliability analysis

Although the test-retest reliability of the adapted questionnaire was not established, it was possible to compare the responses of eleven participants who completed both versions of the questionnaire. The intra-class correlation coefficient (r_i, two-way mixed model for absolute agreement) for the total ratings of frequency with particular problems in decision-making was $r_i = 0.81$, $p<0.001$ and that for the total ratings of difficulty with particular features of decisions was $r_i=0.47$, $p = 0.035$. The questions about the extent to which ASCs might help or interfere with decision-making were answered identically in both studies by eight out of the ten participants (one participant did not provide an answer to these questions).

5.5 Summary of findings

Consistent with the initial hypotheses, the participants with ASCs reported experiencing several of the expected problems in decision-making more frequently than the participants in the control group. The mean difficulty ratings for some types of decisions were also higher in the ASC group. In addition, the distributions of responses to the questions about the frequency with which ASCs can help or interfere with decision-making suggested that ASCs were perceived more often as a hindrance than a help with decision-making. Consistent with the initial hypothesis, the responses to questions on the GDMS suggested that participants with ASCs tend to avoid decision-making more often than the participants in the control group.

5.6 Discussion of results

The findings suggest that participants with ASCs experience greater difficulty with decision-making, compared to the participants in the control group. Specifically, decision-making in ASCs was associated with anxiety, exhaustion, mental 'freezing', and other problems in the required cognitive process. Decision-making was also more likely to be avoided. These findings are consistent with the quantitative and qualitative findings from the initial survey.

Some of the difficulties reported are consistent with known features of the condition. For example, the difficulties in foreseeing consequences and remembering information are consistent with known impairments in executive functions (see, for example, Hill, 2004b). Surprisingly, however, there were no significant relationships between the frequency of two problems that seemed, theoretically, most related to the executive functions assessed in this study. This suggests that, in this sample at least, some of the specific difficulties reported were not due to impairments in the assessed executive functions.

It is possible that the difficulties reported by the participants with ASCs are exacerbated by higher levels of anxiety and depression. The supplementary analysis (*a*) indicated that ratings of perceived frequency of interference from ASCs increased proportionally with levels of anxiety and depression. These relationships may reflect findings from previous research, in which anxiety and low mood are associated with disadvantageous decision-making on laboratory tasks (for example, Miu et al., 2008), and in ASCs, where, in contrast to the general population, heightened anxiety is associated with increased risk-taking (South et al., 2010). It is not possible, however, to infer the causality of these relationships because the result may also reflect a tendency for participants with ASCs to perceive their abilities negatively because of their depressed or anxious state of mind. Future studies assessing behavioural differences in the decision-making of people with and without ASCs, matched for levels of anxiety and depression, may be able to address this issue.

Consistent with the views reported in the initial survey, the GDMS indicated that ASCs were more likely to avoid decision-making, compared to control participants. Furthermore, the known relationship between the *avoidant* style and higher levels of cortisol release during decision-making (Thunholm, 2008), is consistent with the view that decision-making is stressful for people with ASCs.

A limitation of the questionnaire was that the test-retest reliability was not established. It is, however, reassuring to note that the responses of 11 participants who took part in both studies were reasonably consistent between the two versions of the questionnaire, despite systematic differences in the circumstances in which the two questionnaires were completed. Another limitation of the questionnaires was that the response options were not balanced to control for biased responding (such as a tendency to select response options based on their position in

the list, see Paulhus & Vazire, 2007). Again, however, it is reassuring to note that the distributions of the response patterns to the questions about the frequency with which ASCs can help or interfere with decision-making were skewed in opposite directions. This suggests that, for this question at least, the participants were responding to the question and not the position of the response option (see Paulhus & Vazire, 2007).

Despite these limitations, the findings from these questionnaires are consistent with suggestions from the literature, as well as the initial survey, and suggest that decision-making may be particularly difficult for people with ASCs.

CHAPTER 6: DO PARTICIPANTS WITH ASCS DEMONSTRATE REDUCED FLEXIBILITY AND GREATER CAUTION IN DECISION-MAKING?

6.1 Background

This chapter considers two aspects of decision-making that were highlighted as potential issues in the initial survey. The first is flexibility, which is the degree to which the decision-making of an individual is sensitive to changes in task-related information (Minassian et al., 2007). The second is risk-taking, which is the degree to which the decision-making of an individual favours options associated with the possibility of a large, positive outcome (but with the risk of a large negative outcome) at the expense of options associated with smaller, but more certain, outcomes (Mellers, Schwartz & Weber, 1997; Leland & Paulus, 2005). These aspects of decision-making are related, since flexibility may be indexed by changes in risk-taking across different situations. For example, Sinz et al. (2008) examined changes in risk-taking that resulted from controlling the probability of receiving a large, positive outcome. When comparing participants with ASCs to controls, differences in flexibility and risk-taking may co-occur (for example, decision-making may appear less flexible if participants with ASCs take fewer risks). Alternatively, differences in flexibility and risk-taking may occur independently (for example, risk-taking may vary appropriately across different situations, but remain low throughout). Schematic illustrations of four possible combinations of variations in flexibility and risk-taking in ASCs and controls as the probability of success is varied are shown in Figure 6.1.

Figure 6.1 *Schematic of possible combinations of differences in decision-making flexibility and risk-taking*

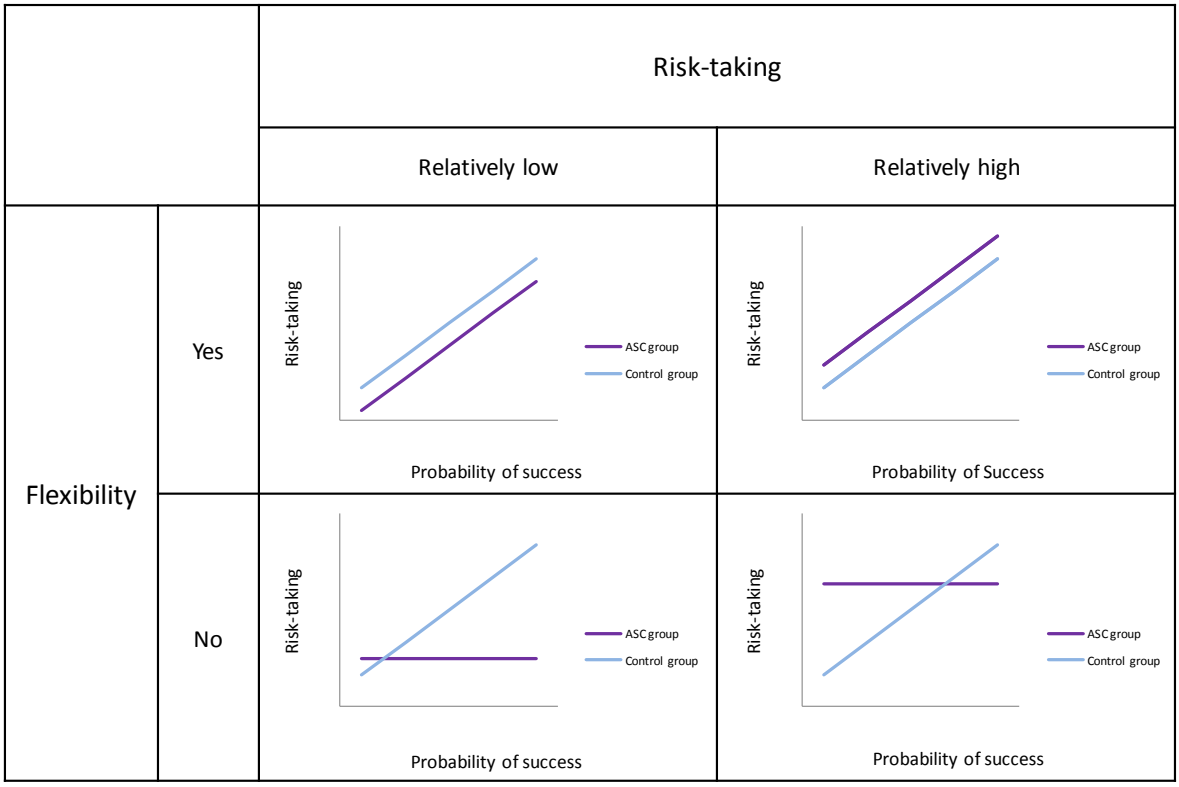


Figure 6.1 shows four possible combinations of differences in flexibility and risk-taking, when comparing participants with ASCs to control participants. The schematic assumes that, as demonstrated in previous research (e.g. Sinz et al., 2008), control participants increase their preference for risky choices as the probability of success increases.

The rationale for investigating flexibility stems from reports in the initial survey that participants with ASCs can have difficulty engaging with decisions and may make decisions in order to replicate previous choices (see Section 2.3.2.1). This is consistent with research suggesting that people with ASCs can have difficulty adapting to changes in the environment (Goldstein et al., 2001; Shu, Lung, Tien & Chen, 2001; Hill, 2004b). To date, the only aspect of decision-making flexibility to have been studied in ASCs is sensitivity to changes in feedback (Minassian et al., 2007, see Section 1.5.4). Other aspects of decision-making flexibility, such as sensitivity to changes in probabilistic information and the order in which options are presented have yet to be studied.

The motivation for assessing risk-taking stems from reports in the initial survey that participants with ASCs experience high levels of anxiety when making decisions (see Section 2.3.1), which is associated, in other studies, with reduced risk-taking (for example, Raghunathan & Pham, 1999; Maner & Schmidt, 2006; Maner et al., 2007; Fairchild et al., 2009). In addition, a recent study carried out by De Martino et al. (2008), used a two-choice gambling task to examine framing effects in ASCs (see Section 1.5.4). They identified a non-significant trend ($p = 0.058$) towards reduced risk-taking in participants with ASCs, compared to control participants. However, since the number of participants with ASCs recruited to that study was small (n = 14), the study may have lacked the necessary power to be able to detect a real difference between the groups. Here, the aim is to assess risk-taking in ASCs with a larger sample size.

The tasks used to assess these aspects of decision-making were the Risky Choice Task (RCT, Rogers et al., 2003) and the Cambridge Gamble Task (CGT, Rogers et al., 1999). These tasks were described in detail in Sections 3.4.5 and 3.4.3. To summarise, the RCT presents participants with two virtual 'roulette' wheels on a computer screen. Each of these wheels has eight segments showing the number of points that can be won or lost if a 'spin' of the wheel selects that segment. On each trial[2], participants choose one of the wheels on which to gamble. This wheel is then 'spun' by the computer and the outcome (the number of points on the segment that the ticker lands on) is presented. One of the wheels is a 'control' wheel (always showing four segments that will win 10 points, and four segments that will lose 10 points; Expected Value[3] = 0). The other wheel, the 'experimental' wheel, presents different probabilities of winning and losing different numbers of points in such a way that the difference in the Expected Values (ΔEV) of the two wheels is varied systematically. The potential wins and losses of the experimental wheel are always larger than the ten points shown on the control wheel. Participants are asked to try to win as many points as possible. The dependent measure is the proportion of trials on which the 'experimental' (risky) wheel was chosen.

The CGT measures flexibility via sensitivity to changes in probabilistic information and the order in which options are presented, both of which are important determinants of choice

[2] In the 'decision' condition (see Section 3.4.5)

[3] Expected Value = (4 × 10) + (4 × -10)

(von Neumann & Morgenstern, 1947; Kahneman & Tversky, 1979; Doya, 2008; Lawrence et al., 2009). Risk-taking is defined as the proportion of risky to safe choices. To summarise the CGT, participants are presented with a row of ten boxes, on a computer screen, each of which is coloured either red or blue. The ratio of red to blue boxes differs on each trial (72 trials), ranging from 9:1 to 1:9. Participants are told that the computer has hidden a token beneath one of the boxes, and that they must guess the colour of the box that is hiding the token. Once they have chosen, they are then asked to bet a proportion of their points (5%, 25%, 50%, 75%, or 95%) on their choice being correct. The available bets are presented 2.5 seconds apart in ascending or descending order, depending on the condition of the task. Participants are asked to try to win as many points as possible.

The measures of the CGT are: i) *risk-adjustment*, which quantifies the tendency of participants to bet a greater proportion of points in response to more favourable ratios (this is calculated as [(2 × % points bet 9:1 trials) + (% points bet 8:2) – (% points bet 7:3) – (2 × % points bet 6:4) / mean % points bet], so that higher scores indicate greater risk-adjustment (flexibility); ii) *delay aversion*, which quantifies the tendency to choose the bets presented earlier rather than later in the trial; and iii) *risk-taking*, which is the mean proportion of points bet on each of the different trial types (i.e. ratio of blue to red) in each condition. These measures include only the trials in which participants chose the colour in the majority (where applicable), since this ensures assessment of sensitivity to the changing conditions (see Rahman et al., 1999). The *quality of decision-making* is the proportion of trials for which participants choose the majority colour. This is reported because it provides information about the extent to which participants understand, and are engaged by, the task.

The tasks used in the present study assess risk-taking and flexibility differently. The RCT presents decisions with two choices under different probabilities of winning and losing. Changes in the difference of Expected Values between the two wheels typically results in a predictable pattern of choices (see Fairchild et al., 2009). Like the RCT, the CGT also provides an index of the influence of changes in probabilistic information on decision-making. However, the CGT is more complex than the RCT, as it provides five response options instead of two. The CGT also provides an opportunity to assess the impact of delay on decision-making. Typically, participants bet a higher proportion of their points when the

betting options are presented in a descending rather than an ascending order (Rahman et al., 1999; Lawrence et al., 2009).

6.2 A priori hypotheses

Based on the findings from the initial survey, as well as previous studies on the behavioural rigidity and anxiety in ASCs, the following predictions were made. Compared to the control group, it was hypothesized that the participants with ASCs would demonstrate:

1. reduced *flexibility* on the RCT;
2. reduced *risk-taking* on the RCT;
3. similar scores for *quality of decision-making* on the CGT;
4. reduced *risk-adjustment* on the CGT;
5. reduced *delay-aversion* on the CGT; and
6. reduced *risk-taking* on the CGT.

In addition, it was expected that:

7. levels of anxiety (as measured using the Hospital Anxiety and Depression Scale, HADS, see Section 2.5.6) would correlate with overall *risk-taking* on the CGT.

6.2.1 *Experimental details*

6.2.1.1 Participants

The tasks were completed by 38 participants with ASCs, and 40 control group participants, all meeting the inclusion criteria for the study (see Section 3.2.2). Two participants (one ASC group, one control group) were excluded from the RCT due to a technical failure. One participant (control group) was excluded from the CGT analysis because their *quality of decision-making* score was a statistical outlier (defined as more than three times the interquartile range from either quartile boundary, Field, 2005). This participant's score was extremely low (choosing the most likely option on only 45% of the trials), suggesting that they did not have an adequate understanding of the task or that they were not sufficiently engaged by it. All other participants had *quality of decision-making* scores of 72% or higher.

6.2.1.2 Data analysis

Raw scores are expressed as proportions and so were arcsine transformed [$f(x) = 2\arcsin(x^{½})$],) as is appropriate whenever the variance is proportional to the mean (Howell, 1997; Rahman et al., 1999). The transformed data were analysed using repeated measures

ANOVA, where assumptions about the normality of residuals were met. Greenhouse-Geisser corrections were applied when the assumption of sphericity was violated. Non-parametrically distributed data were analysed using Mann-Whitney U tests and Friedman tests, with correction for multiple comparisons (Dunn-Sidak correction, $\alpha' = 1 - (1 - \alpha)^{1/c}$, where *c* is the number of comparisons in the analysis) . Given the directionality of the hypotheses, one-tailed tests of significance ($\alpha = 0.1$) were used.

Exploratory correlations (using Pearson and Kendall's correlation coefficients, for normally and non-normally distributed data, respectively) were carried out to assess the influence of anxiety and depression on the dependent measures. Scatterplots were inspected visually for outliers. There were no significant correlations between these measures and the dependent variables of the RCT and CGT; as a result, they are not included as covariates in following analyses (see Clark et al., 2009).

The effects of antidepressant and anxiolytic medication were controlled for by repeating each of the analyses with and without the nine participants with ASCs and one control participant taking these medications. Any changes to the results obtained are reported.

6.3 Results

6.3.1 *Proportion of risky choices by trial type on the RCT*

The mean proportion of trials on which the 'experimental' (risky) wheel was chosen is shown in Figure 6.2. These data were extremely skewed, with several outliers in both groups (more than 30% of participants in each group were outliers in at least one trial type). Since so many participants were identified as outliers, they were not excluded from the analysis and non-parametric difference tests were used. Mann-Whitney U tests did not reveal group differences on any of the trial types (all $p>0.11$). This suggests that both groups made similar proportions of risky choices. In addition, both groups demonstrated a strong effect of trial type (ASC group: Friedman χ^2 (9) = 236.9, $p<0.001$; Control group: Friedman χ^2 (9) = 289.1, $p<0.001$). This suggests that both groups of participants modified their choices in response to changes in the probabilistic information.

Figure 6.2 *The mean proportion of risky choices for each trial type of the RCT*

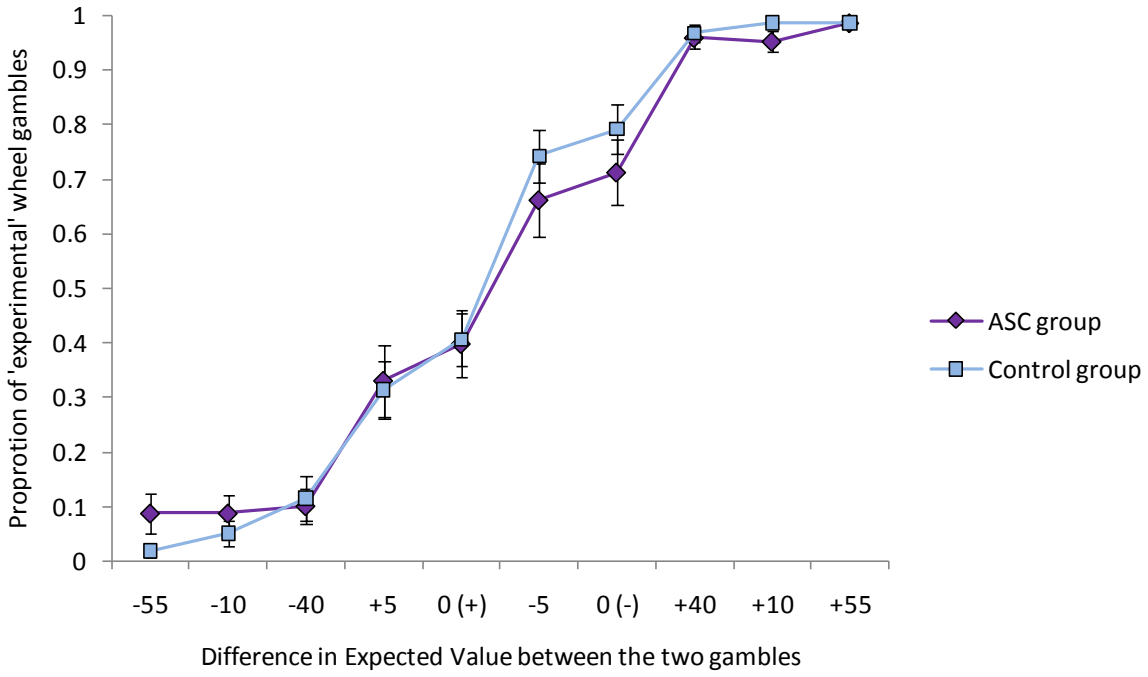


Figure 6.2 shows the mean proportion of trials on which participants in both groups selected the 'experimental' (risky) gamble. Error bars represent one standard error of the mean. The trial types are ordered according to the degree of preference for the 'experimental' wheel gamble observed in the neurotypical population (see Fairchild et al., 2009). The trials labeled 0(+) and 0(-) refer to the 'framing trials' (see Section 2.4.4); these are discussed in Chapter 10. Both groups demonstrated sensitivity to the difference in the expected values of the two wheels. There were no significant differences in the proportion of risky choices between the two groups.

6.3.2 *Quality of decision-making on the CGT*

Both groups demonstrated quality of decision-making scores that were significantly above chance (ASC group: $M = 0.96$, $SD = 0.068$, $t(37) = 41.7$, $p<0.001$; Control group: $M = 0.99$, $SD = 0.017$, $t(38) = 179.4$, $p<0.001$), indicating that they understood the task. However, there was a significant difference in the mean scores of the two groups ($z = -2.58$, $p = 0.010$). When the ten participants taking antidepressant or anxiolytic medications were excluded from the analysis ($M = 0.93$, $SD = 0.072$), the difference was no longer significant (ASC group: $M = 0.97$, $SD = 0.065$; Control Group: $M = 0.99$, $SD = 0.017$, $z = 1.50$, $p = 0.14$).

6.3.3 *Risk-adjustment on the CGT*

The risk-adjustment scores were compared between the groups using repeated measures ANOVA with Condition (ascending, descending), Condition Order (ascending first, descending first), and Group. Condition Order was not a significant factor ($p = 0.20$) and was therefore excluded from the analysis (see Lawrence et al., 2009). Contrary to expectations, the groups did not differ in their risk-adjustment scores (ASC group: $M = 1.79$, $SD = 1.20$; Control Group: $M = 1.73$, $SD = 0.86$, $F(1, 75) = 0.027$, $p = 0.87$). There was an effect of Condition ($F(1, 75) = 10.7$, $p = 0.002$), as both groups demonstrated greater risk-adjustment in the ascending condition, compared to the descending condition. The Group × Condition interaction was not significant ($F(1, 75) = 2.32$, $p = 0.13$), however, indicating that the groups adjusted their choices similarly in the two conditions.

6.3.4 *Delay aversion*

The scores for delay aversion are shown in Figure 6.3. The scores were analysed using a 2-way ANOVA with Condition Order and Group. Contrary to the initial hypothesis, the groups did not differ in their delay aversion scores ($F(1, 73) = 0.028$, $p = 0.87$), since both groups made slightly larger bets in the descending condition, compared to the ascending condition (ASC group: $M_{\text{ascending}} = 0.46$, $SD = 0.19$, $M_{\text{descending}} = 0.57$, $SD = 0.19$; Control group: $M_{\text{ascending}} = 0.50$, $SD = 0.15$, $M_{\text{descending}} = 0.60$, $SD = 0.17$). There was a significant effect of Condition Order ($F(1, 73) = 18.7$, $p<0.001$), as participants completing the ascending condition first demonstrated greater delay aversion. The Group × Condition Order interaction was not significant ($F(1, 73) = 0.37$, $p = 0.55$), however, indicating that the groups were affected similarly by the order of the two conditions.

Figure 6.3 *Delay aversion scores on the CGT by Condition Order*

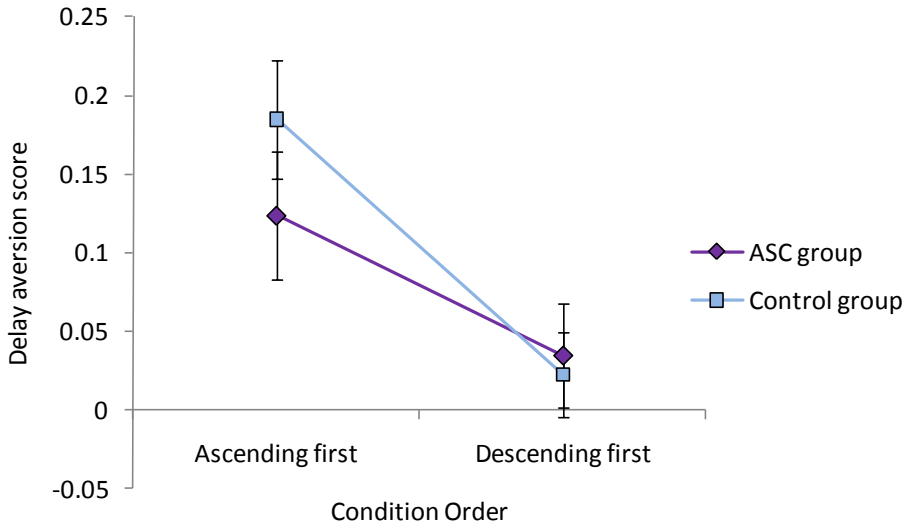


Figure 6.3 shows the mean delay aversion scores for both groups of participants, separated according to Condition Order. The delay aversion scores did not differ significantly between the groups. Participants completing the ascending condition first demonstrated higher delay aversion scores.

6.3.5 *Risk-taking*

The proportion of points that were risked for each of the trial types on the CGT is shown in Figure 6.4. The proportions of points risked were analysed using a repeated measures ANOVA with Condition (ascending, descending), Trial Type (9:1, 8:2, 7:3, 6:4, 5:5 ratios of coloured boxes), Condition Order (ascending first, descending first) and Group (ASC, controls). Condition Order was not a significant factor ($p = 0.17$) and was therefore excluded from the analysis. Contrary to the initial hypothesis, the groups did not differ significantly in the overall proportion of points risked ($F(1, 75) = 1.49$, $p = 0.23$). There was a significant effect of Trial ($F(1.76, 132.2) = 228.48$, $p<0.001$), indicating that participants bet fewer points as the ratio of coloured boxes became less favourable. There was also a significant effect of Condition ($F(1, 300) = 29.1$, $p<0.001$), indicating that participants bet more points in the descending condition. There were no significant interactions between Group, Condition or Trial, consistent with the analyses for risk-adjustment and delay aversion (above). This provides further evidence that the groups adjusted their decision-making similarly across the different trial types and conditions. These results did not change when the participants taking antidepressant or anxiolytic medications were excluded.

Figure 6.4 *Mean proportion of points bet across different trial types of the CGT*

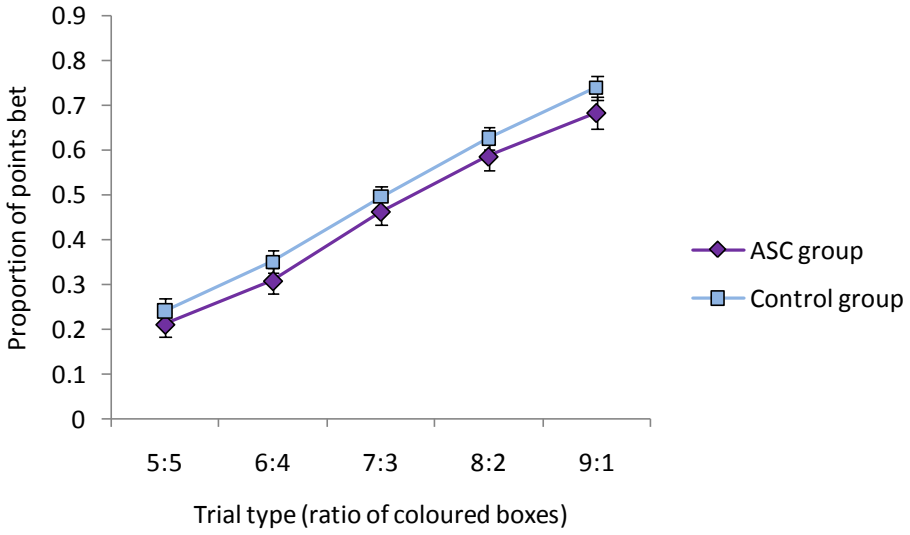


Figure 6.4 shows the mean proportion of points bet on the different trial types of the CGT (averaged across condition) for both groups of participants. Error bars represent the Standard Error of the Mean. The groups did not differ in the mean proportions of points bet across all trial types

6.4 Post-hoc analyses

The relationships between risk-taking, flexibility and anxiety were assessed as part of the main analysis presented in this chapter; no significant relationships were found when all the participants were considered together. However, the findings from a very recent study suggest that a post-hoc analysis of the group relationships between anxiety and these measures may be worthwhile. South et al. (2010) found that the relationship between anxiety and risk-taking was significantly different for an ASC group of children and adolescents compared to the corresponding control group. The authors used a risk-taking paradigm (Balloon Risk Task, Lejuez et al., 2002) that was similar to the CGT, but did not provide information about the probability of success. They found that, in contrast to the typically developing control group, the participants with ASCs demonstrated increased risk-taking with increased anxiety. The results from the present study therefore provide an opportunity to test whether the finding of South et al. extends to risk-taking and related measures that are assessed using different tasks.

The correlations between anxiety and the dependent measures of the RCT and CGT for both groups (excluding participants taking antidepressants or anxiolytics) are presented in Table 6.1. As exploratory analyses, two tailed tests of significance were used ($\alpha = 0.05$), with the Dunn-Sidak correction for multiple comparisons. Risk-taking scores for each task were collapsed across trial types to form a single variable for that task. This was justified by the lack of significant Group × Trial type interactions in the main analyses. Scatterplots were used to identify outliers; two participants were excluded from two of the analyses on this basis.

Table 6.1 *Correlations between anxiety and risk-taking measures on the RCT and CGT*

Measure	**Correlation**		**Comparison of correlations between the two groups**
RCT risk-taking	ASC Controls	$r_{28} = 0.208$, $p = 0.29$ $r_{37} = 0.370$, $p = 0.027$	$z = -0.349$, $p = 0.73$
CGT *risk-taking*	ASC Controls	$r_{28} = 0.398$, $p = 0.036$ $r_{38} = 0.080$, $p = 0.63$	$z = 1.303$, $p = 0.19$
CGT *risk-adjustment* (flexibility)	ASC Controls	$r_{29} = -0.46$, $p = 0.012$ $r_{38} = 0.160$, $p = 0.34$	$z = -2.544$, $p = 0.011$*
CGT *delay aversion*	ASC Controls	$r_{29} = -0.112$, $p = 0.56$ $r_{37} = 0.359$, $p = 0.024$	$z = -1.874$, $p = 0.061$

**Significant at α' = 0.0127*

The results show that only the relationship between CGT risk-adjustment and anxiety differed significantly between the groups. As levels of anxiety increased in the ASC group, flexibility of decision-making decreased. However, the flexibility of decision-making in the control group did not vary with levels of anxiety. Although the relationships between CGT risk-taking and anxiety did not differ significantly between the groups, the significant correlation in the ASCs was in the same direction as that found by South et al. (2010). Inclusion of participants taking antidepressants and anxiolytics affected two of the findings: i) it reduced the strength of the relationship between risk-adjustment and anxiety in ASCs ($r_{38} = -0.375$); and ii) increased the strength of the relationship between delay aversion and anxiety in ASCs ($r_{38} = -0.249$).

6.5 Summary of findings

Both groups demonstrated flexibility in their decision-making on the RCT and CGT by adjusting their choices in response to changes in the probabilistic information, and to changes in the order in which the options were presented. The participants with ASCs did not demonstrate reduced risk-taking on either the RCT or the CGT; this is contrary to the initial hypotheses. A post-hoc analysis revealed that, in contrast to the control group, levels of anxiety were associated with reduced flexibility in the ASC group. Antidepressant and anxiolytic medications appeared to affect the quality of decision-making scores (although these participants still had a mean score significantly above chance, 93%).

6.6 Discussion of results

This study was carried out to assess whether: i) the reports of rigidity in everyday decision-making were consistent with a quantitative measure of flexibility of decision-making; and ii) whether participants with ASCs were more cautious in their decision-making, compared to participants in the control group. The only previous study to have examined flexibility in decision-making in ASCs focused on the influence of feedback (Minassian et al., 2007). In contrast, the RCT and the CGT assess the influence of changes in probabilistic information provided to the participant. The CGT also assesses the effects of delay on decision-making. The only study to have assessed risk-taking in ASCs (De Martino et al., 2008) demonstrated a non-significant trend towards reduced risk-taking in a small group of people with ASCs.

Surprisingly, the findings did not provide evidence of reduced flexibility in the decision-making of participants with ASCs. Both groups adjusted their choices in response to changes in probabilistic information, making riskier choices when the odds were favourable. Likewise, both groups were influenced by the presentation order of the available options, making riskier choices when such choices were presented first. These findings are consistent with those found in other neurotypical groups using the CGT (for example, Manes et al., 2002). The participants with ASCs did not demonstrate reduced risk-taking. This was not consistent with the non-significant trend observed found by De Martino et al. (2008), although this may reflect the larger number of trials in their study.

Some of the findings were affected by excluding participants with ASCs who were taking antidepressant or anxiolytic medications. The participants taking these medications demonstrated poorer quality decisions (choosing the majority colour in the CGT less reliably), and exclusion of these participants affected the group-specific relationships observed between risk-adjustment, delay aversion and anxiety. The findings for quality of decision-making may simply reflect poorer concentration in these participants, since these medications may be associated with fatigue and drowsiness (Bull et al., 2002). The relationship between anxiety and risk-adjustment may have been affected by the known action of SSRI medication on reducing activity in brain regions associated with caution in decision-making (Paulus, Rogalsky, Simmons, Feinstein & Stein, 2003; Samanez-Larkin, Hollon, Carstensen & Knutson, 2008; Simmons, Arce, Lovero, Stein & Paulus, 2009). Finally, the relationship between anxiety and delay aversion may have been affected by the known effect of SSRI and anxiolytic medication on impulsivity and tolerance of delay (Wolff & Leander, 2002).

The findings from this study suggest that the participants with ASCs evaluated information and made decisions in a similar manner to the control group. However, it is possible that the decisions presented on the RCT and CGT are too easy to capture the real-life difficulties reported by the participants with ASCs. The participants were provided with explicit information about the probabilities of wins and losses for each choice, and, as a result, the available choices were directly comparable. In contrast, the choices that led to difficulties reported in the initial survey typically involve a number of known and unknown variables (see for example, Figure 2.3). It is possible, therefore, that the idealized tasks used in this study were inadequate to reproduce some of the reported difficulties.

There was, however, an interesting relationship observed between measures of flexibility of decision-making and anxiety in the ASC group. In contrast to the control group, the participants with ASCs demonstrated less flexibility as their anxiety scores increased. This suggests that high levels of anxiety in ASCs may exacerbate difficulties engaging with decisions, consistent with reports of their making decisions rigidly or impulsively when feeling overwhelmed with information (see, for example, Section 2.3.2.1). In addition, a significant relationship between increased risk-taking on the CGT and anxiety was found for participants with ASCs, even though the difference between the two groups was not

significant. This finding was contrary to the initial expectations of this research, that increased anxiety would be associated with reduced risk-taking (see for example, Raghunathan & Pham, 1999), but is consistent with the results of South et al. (2010). These authors found that, in contrast to a control group of typically developing young people, children and adolescents with ASCs took more risks as scores of anxiety increased during a laboratory-based task. To explain this, these authors proposed that risk-taking in ASCs was motivated to a greater extent by fear of failure, whilst risk-taking in the control group was motivated more by sensitivity to reward. That finding, together with the findings from the present study, suggests that anxiety in ASCs can have a profound effect on decision-making, and one that appears to differ to that found in the general population. It is possible, however, that these relationships reflect the effects of an elevated level of anxiety, rather than an interaction between ASCs and anxiety. Future studies may be able to better understand the effects of ASC and anxiety on risk-taking and decision-making flexibility by including a control group selected to have high levels of anxiety.

CHAPTER 7: DO PARTICIPANTS WITH ASCS GATHER MORE INFORMATION PRIOR TO MAKING A DECISION?

7.1 Background

The findings from the initial survey suggested that people with ASCs often find decision-making time-consuming and overwhelming. Such experiences were attributed to a dislike of uncertainty and the concomitant tendency to spend time gathering information (see Section 2.3.2.2). This chapter considers whether the reports are consistent with scores on a laboratory measure of the amount of information gathering associated with making a decision.

The task used to assess whether participants with ASCs gather more information prior to making a decision was the Information Sampling Task (IST, Clark et al., 2006). This task was described in detail in Section 3.4.4. To summarise, participants were presented with a 5×5 array of grey boxes, behind each of which was one of two hidden colours. The participants were instructed to open (by pressing) a box to reveal its colour, and to open as many boxes as they wished before deciding which of the two colours was in the majority. Participants indicated their decision by pressing one of the two coloured panels at the bottom of the screen. The task was presented ten times in each of two conditions: i) a Fixed Win condition, in which the total number of points available for a correct decision was 100, regardless of how many boxes were opened; and ii) a Decreasing Win condition, in which the total number of points available for a correct decision started at 250 and decreased by 10 points with every box that was opened. In both conditions, the cost of an incorrect decision was 100 points.

The dependent variables of interest were: i) the mean number of boxes opened prior to the decision being made; and ii) the mean probability that the choice made is correct, given the information available at the time of the decision ('*Probability Correct*', see Clark et al., 2006). For each trial, this probability was calcuated using the formula:

$$Probability\ Correct\ = \ 2^{-z} \sum_{k=A}^{z} \binom{z}{k}$$

where z = 25 – (the number of boxes opened) and A = 13 – (the number of open boxes of the chosen colour). For example, if a participant opened 8 boxes distributed 6:2 and chose the colour in the visible majority, the probability that the decision made is correct would be 0.83.

The mean number of boxes opened and the '*Probability Correct*' are typically highly correlated (see Clark et al., 2009). Under certain circumstances, however, the mean number of boxes opened can provide only a limited index of the amount of information gathered. For example, the probability of making a correct decision having opened 20 boxes distributed 10:10 is 0.5; the corresponding probability having opened 20 boxes distributed 15:5 is 1. The '*Probability Correct*' is, therefore, a better indicator of the certainty tolerated when making decisions 'under risk' (where information about the probability of success is available, see Brand et al., 2007). For this reason, '*Probability Correct*' is considered the primary, and more ecologically valid, variable of interest (Clark et al., 2009). The mean number of 'errors' made by participants (i.e. choosing a colour not in the visible majority at the time of the decision) is also reported.

7.2 A priori hypotheses

Based on the finding from the initial survey that people with ASCs have a tendency to gather information, the following predictions were made:

1. participants with ASCs would sample more information prior to making decisions on the IST, compared to the control group (indicated by a higher mean number of boxes opened and higher '*Probability Correct*' scores); and
2. the '*Probability Correct*' scores would increase proportionally with the frequency of self-reported problems taking a long time to make decisions (self-report item from the questionnaire of decision-making experiences, see Section 3.4.1).

7.2.1 *Experimental details*

7.2.1.1 Participants

The data presented are based on the responses of 38 participants with ASCs and 40 participants in the control group.

7.2.1.2 Data analysis

The analysis presented follows the statistical procedures carried out in previous studies that used the IST (see Clark et al., 2009; Lawrence et al., 2009). These were repeated measures ANOVA, where assumptions about the normality of residuals were met, and Mann-Whitney U tests for non-parametric data. The relationship between continuous and ordinal data were analysed using ANOVA tests for linear trend (Field, 2005). '*Probability Correct*' scores were arcsine transformed [$f(x) = 2\arcsin(x^{½})$, where x is the mean '*Probability Correct*'] as is appropriate for scores expressed as proportions (see Howell, 1997) and two statistical outliers, one in each group, defined as more than 3 times the interquartile range from the upper quartile boundary (see Field, 2005), were excluded. Given the directionality of the hypotheses, one-tailed tests of significance ($\alpha = 0.1$) were used.

The scores of depression and anxiety (assessed using the Hospital Anxiety and Depression Scale, Zigmond & Snaith, 1983) did not correlate with the mean number of boxes opened or '*Probability Correct*' in either condition (8 correlations, the largest correlation observed was for depression and '*Probability Correct*' in the Decreasing Win condition, Kendall's $\tau = -0.119$, *p=0.19*). These variables are not included, therefore, as covariates (see Clark et al., 2009) in the statistical analyses. The effects of antidepressant and anxiolytic medication were controlled for by repeating each of the analyses with and without the ten participants (9 ASCs, 1 control) taking these medications. The '*Probability Correct*' scores, and their relationship with a self-reported problem in decision-making, were affected by excluding these participants; for these analyses, therefore, the results presented are based only on the scores of the participants who were not taking antidepressant or anxiolytic medication (ASC group: n = 29; Control group: n = 39). All other findings were unaffected and are reported based on the results of all participants (ASC group: n = 38; Control group: n = 40).

7.3 Results

7.3.1 *The mean number of 'errors' made on the IST*

The groups did not differ in the mean number of 'errors' made on the IST (Fixed Win, ASC group: $M = 0.34$, $SD = 0.67$; Control group $M = 0.55$, $SD = 1.2$, $z = -0.92$, $p = 0.36$; Decreasing Win, ASC group: $M = 0.79$, $SD = 1.38$; Control group: $M = 0.65$, $SD = 0.95$, $z = -0.20$, $p = 0.84$). These results suggest that both groups had a good understanding of the task.

7.3.2 *Information gathering*

7.3.2.1 Mean number of boxes opened on the IST

The mean number of boxes opened per trial for the two conditions of the IST is shown in Figure 7.1. Both groups demonstrated sensitivity to task instructions by opening more boxes in the Fixed Win compared to the Decreasing Win condition ($F(1, 76) = 106.04$, $p<0.001$). However, contrary to the initial hypothesis, the groups did not differ in the mean number of boxes opened ($F(1, 76) = 1.97$, $p = 0.16$), and the Group × Condition interaction was not significant ($F(1, 76) = 0.0024$, $p = 0.88$). This suggests that both groups adjusted their box opening similarly across the two conditions.

Figure 7.1 *Mean number of boxes opened on both conditions of the IST*

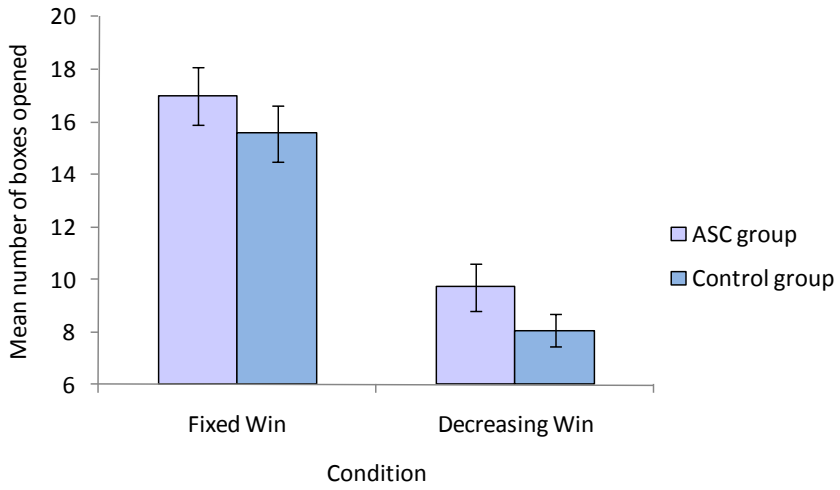


Figure 7.1 shows the mean number of boxes opened per trial by the two groups of participants for each of the two conditions of the IST. Error bars represent one Standard Error of the Mean. Both groups opened more boxes in the Fixed Win compared to the Decreasing Win condition. The mean number of boxes opened in a given condition did not differ between the groups.

7.3.2.2 Mean 'Probability Correct' on the IST

Contrary to the initial hypothesis, the '*Probability Correct*' scores did not differ significantly between the groups when all participants, excluding two outliers, were included in the analysis ($F(1, 74) = 1.84$, $p = 0.18$). This result changed, however, when the ten participants taking SSRI or anxiolytic medications were excluded. One of the two outliers was no longer an outlier in the new ASC group and they were therefore included in the following analysis (ASC group: n = 29; Control group: n = 38). The scores for both groups, after excluding

these participants, are shown in Figure 7.2. Both groups demonstrated sensitivity to task instructions by making decisions with a higher probability of success in the Fixed Win compared to the Decreasing Win condition ($F(1, 65) = 63.8$, $p<0.001$). However, consistent with the initial hypothesis, the participants with ASCs made decisions with a higher probability of being correct ($F(1, 65) = 4.14$, $p = 0.046$). The Group × Condition interaction was not significant ($F(1, 65) = 0.532$, $p = 0.47$), indicating that the participants with ASCs made decisions with a higher probability of being correct, given the information gathered, in both conditions.

Figure 7.2 *Mean Probability Correct for both conditions of the IST*

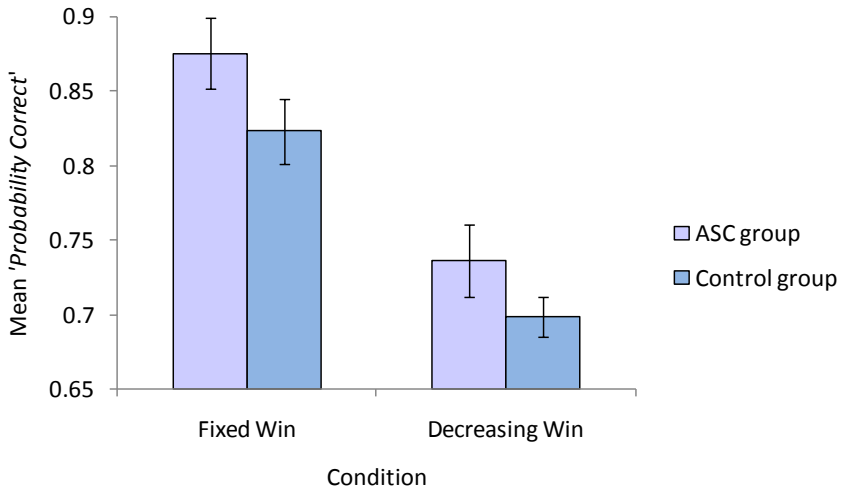


Figure 7.2 shows the mean 'Probability Correct' scores for both groups of participants (excluding ten participants taking antidepressant or anxiolytic medication) on both conditions of the IST. Error bars represent one Standard Error of the Mean. Both groups made decisions with a greater chance of success in the Fixed Win condition, compared to the Decreasing Win condition. Participants with ASCs required higher certainties before making a decision.

7.3.3 *Relationships between information gathering and self-reported problems in decision-making*

The relationship between information gathering on the IST and the self-reported frequency of problems taking a long time to make decisions was assessed using ANOVA for linear trend. For this analysis, the mean '*Probability Correct*' scores were collapsed across the two conditions to form a single variable. This is justified by the absence of a significant Group ×

Condition interaction (see Clark et al., 2009). There was a significant relationship between '*Probability Correct*' and this self-reported problem when the participants taking antidepressant or anxiolytic medication were excluded ($F(1, 63) = 6.01$, $p = 0.017$). This suggests that as information gathering increased so too did the self-reported frequency of problems in taking a long time to make decisions.

7.4 Summary of findings

The main finding is that the participants with ASCs (who were not taking antidepressant or anxiolytic medication) made decisions with a higher degree of certainty. On average, the participants with ASCs sampled information until they had an 81% probability of being correct, whereas control participants sampled information until they had a 76% probability of being correct. Furthermore, the mean '*Probability Correct*' was associated with the self-reported frequency of problems with taking too long to make decisions. These findings are consistent with the initial hypotheses. However, the group difference in information sampling was not reflected in the mean number of boxes opened, as had been hypothesised.

7.5 Discussion

This study was carried out to assess whether the reports of excessive information gathering in decision-making in ASCs were consistent with a quantitative measure of pre-decisional information gathering. Overall, the findings provide some support for such reports. The probability of being correct at the point of decision ('*Probability Correct*') was higher in participants with ASCs, and the expected relationship between the '*Probability Correct*' scores and the self-reported frequency of problems taking a long time to make decisions was significant. The finding that this applied only to participants who were not taking antidepressant or anxiolytic medication was consistent with previous research: SSRI medication is associated with reduced activation of the posterior and middle insula in healthy volunteers (Simmons et al., 2009), and increased activation and responsivity of the insula is associated with anxiety and cautious decision-making following punishment (Paulus et al., 2003; Samanez-Larkin et al., 2008). The participants taking these medications may, therefore, have felt less cautious and tolerated greater uncertainty in their decisions.

Finally, the significant relationship between the self-reported frequency of problems taking a long time to make decisions and the '*Probability Correct*' scores on the IST provides evidence to support the validity of the questionnaire of decision-making experiences (see Section 3.4.1). In the initial survey, written reports of excessive information gathering were associated with taking a long time to make decisions; this is reflected in this quantitative experiment. It is possible, however, that other factors, such as slower cognitive processing (see Bowler, 1997), also contribute to the experience of taking a long time to make decisions. Latency of decision-making is considered in the next chapter.

CHAPTER 8: DO PARTICIPANTS WITH ASCS TAKE LONGER TO MAKE DECISIONS?

8.1 Background

The time required to make decisions in everyday life was identified as problematic by many of the adults with ASCs who took part in the initial survey of decision-making experiences. This chapter uses two tasks to assess whether such reports are consistent with quantitative measures of decision-making speed. The two tasks used here are the Cambridge Gamble Task (CGT) and the Information Sampling Task (IST). These are described in detail in Sections 3.4.3 and 3.4.4, respectively.

To summarise, the CGT is a laboratory-based task in which participants are presented with a row of ten boxes, each of which is coloured red or blue. The ratio of red to blue boxes differs on each trial (72 trials), ranging from 9:1 to 1:9. Participants are told that the computer has hidden a token beneath one of the boxes, and that they must guess the colour of the box that is hiding the token. Once they have chosen, they are then asked to bet a proportion of their points on their choice being correct. Participants are asked to try to win as many points as possible. Latency of decision-making (termed the 'deliberation time') is calculated as the mean time taken to make the decision, measured from the start of the trial.

In the IST, participants are presented with a 5 × 5 array of grey boxes, behind each of which is one of two hidden colours. Participants are instructed to open (by pressing) a box to reveal its colour, and to open as many boxes as they wish before deciding which of the two colours was in the majority. Participants indicate their decision by pressing one of the two coloured panels at the bottom of the screen. The task is presented ten times in each of two conditions: i) a Fixed Win condition, in which the total number of points available for a correct decision is 100, regardless of how many boxes are opened; and ii) a Decreasing Win condition, in which the total number of points available for a correct decision starts at 250 and decreases by 10 points with every box that is opened. In both conditions, the cost of an incorrect decision is 100 points. Latency of decision-making in this task (termed 'choice latency', see DeVito et al., 2008) is calculated as the mean time between opening the final box and

guessing which colour is in the majority. The mean number of boxes opened was presented in 7.3.2.1).

Both measures of latency provide information about the time taken to make simple choices. They differ, however, because of differences in the tasks used to measure them. The CGT presents decisions with explicit information about the probability of success whereas the IST encourages participants to make decisions with incomplete information. In addition, deliberation time (CGT) covers only a single decision about which colour to choose, whereas choice latency (IST) covers a decision about which colour to choose as well as a decision to stop gathering information and commit to a choice. Exceptions to this were trials on the IST in which participants opened all of the boxes; these decisions were made with complete information about the distribution of the two colours and without the opportunity to gather more information. Participants were more likely to open all the boxes in the Fixed Win condition of the IST (ASC group: 27% of trials; Control group: 24% of trials), compared to the Decreasing Win condition (less than 1% overall).

In addition, choice latency on the IST may be influenced by the number of boxes opened by the participant since previous research has shown that decision-making latency increases as the information load increases (Malpas & Joyce, 1969). For this reason, it was expected that participants would take longer to make decisions on trials in which they opened more boxes. The number of boxes opened was therefore controlled for when comparing group differences in latency on the IST.

Since the tasks involved making a motor response to communicate the decisions, motor speed was assessed using the Motor Screening Task (MOT, see Section 3.5.5). This measure was included to control for group differences in motor speed, if necessary.

8.2 A priori hypotheses

The initial survey found that participants with ASCs reported frequently experiencing problems in taking a long time to make decisions. Based on these findings, the following predictions were made.

Compared to the control group, it was expected that participants with ASCs would demonstrate:

1. longer deliberation time on the CGT; and
2. longer choice latency on the IST.

In addition,

3. deliberation time and choice latency would correlate with the frequency of self-reported problems of taking a long time to make decisions.

8.2.1 *Experimental details*

8.2.1.1 Participants

The data presented are based on the responses of 38 participants with ASCs and 40 participants in the control group. One participant (control) was excluded from the CGT analysis due to poor understanding of the task (n = 39, see Section 6.2.1.1).

8.2.1.2 Data analysis

To reduce skew, deliberation times (CGT) and choice latencies were transformed using a reciprocal transformation [$f(x) = 1/x$, with x = mean deliberation time]. Data were analysed using t-tests, univariate and repeated measures ANOVA, where appropriate. Greenhouse-Geisser corrections were applied when the assumptions of sphericity were violated. Non-parametrically distributed data were analysed using Mann-Whitney U tests. Given the directionality of the hypotheses, one-tailed tests of significance ($\alpha = 0.1$) were used. Separate analyses within the same task were corrected for multiple comparisons using the Dunn-Sidak correction ($\alpha' = 1 - (1 - \alpha)^{1/c}$, where c is the number of comparisons in the analysis).

Exploratory correlations (using Pearson and Kendal's correlation coefficients for normally and non-normally distributed data, respectively) were carried out to assess the relationships between anxiety and depression (assessed using the Hospital Anxiety and Depression Scale, HADS) and the dependent measures. There was a significant relationship between depression and overall deliberation time on the CGT (Kendall's $\tau = -0.202$, $p = 0.013$). However, depression was not included as a covariate in the ANOVA because the assumption of homogeneity of regression was not met (see Pallant, 2005). Depression and anxiety did not correlate with any of the other dependent measures, and were therefore not included as covariates in the ANOVA (Clark et al., 2009). The effects of medication were controlled for

by repeating each analysis with and without the ten participants taking antidepressant (SSRI or tricyclic) or anxiolytic medication. This did not affect any of the findings.

8.3 Results

8.3.1 *Motor speed on the MOT*

The mean motor response latencies did not differ significantly between the groups (ASC group: M = 861.1 msec, SD = *249.3*; Control group: M = 853.6 msec, SD = *187.2*, $t(68.6) = 0.15$, $p = 0.88$). This suggests that any observed differences in response latencies on the decision tasks are not due to differences in motor speed.

8.3.2 *Deliberation time on the CGT*

The mean deliberation times for all trial types of the CGT are shown in Figure 8.1. The data were analysed using a repeated measures ANOVA with Trial type (5 levels: 9:1, 8:2, 7:3, 6:4, and 5:5 colour ratios) and Group (2 levels: ASCs and controls). Consistent with the initial hypothesis, there was a main effect of Group ($F(1, 75) = 8.05$, $p = 0.006$), indicating that the participants with ASCs took longer to make the decisions. There was also a significant effect of Trial type ($F(2.9, 214.5) = 92.24$, $p<0.001$), indicating that both groups of participants took longer to make the decisions when the ratio of red to blue boxes was finely balanced. The Group × Trial type interaction was not significant ($F(2.9, 214.5) = 2.13$, $p = 0.10$), suggesting that both groups increased their response times similarly as the decisions became more finely balanced.

Figure 8.1 *Mean deliberation times for both groups of participants on the CGT*

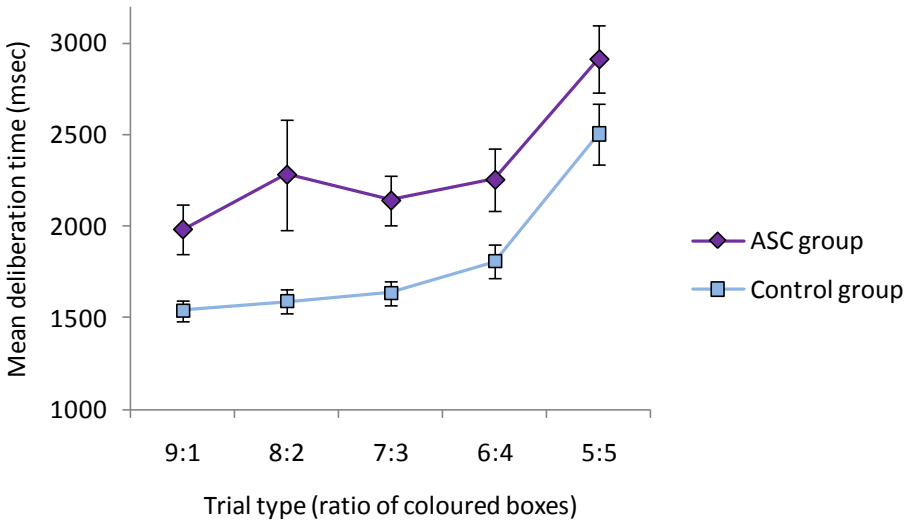


Figure 8.1 shows the mean deliberation times for both groups of participants on all trial types of the CGT. Error bars represent one Standard Error of the Mean. Consistent with the initial hypothesis, the participants with ASCs took longer to make the decisions, compared to the control group. Both groups took longer to make the decisions when the ratio of red to blue boxes was less certain (e.g. 5:5 red to blue boxes).

8.3.3 *Choice latency on the IST*

The mean response latencies for the two conditions of the IST are shown in Table 8.1. The participants with ASCs demonstrated significantly longer choice latencies than participants in the control group ($F(1, 76) = 5.85$, $p = 0.018$). Both groups took longer to make the decisions in the Fixed Win compared to the Decreasing Win condition ($F(1, 76) = 28.8$, $p<0.001$). The Group × Condition interaction was not significant ($F(1, 76) = 0.063$, $p = 0.80$), indicating that both groups were affected similarly by the two conditions.

However, as discussed in Chapter 7, the groups differed in the amount of information they chose to sample, and this may have had an impact on choice latency (i.e. having more information to process may increase the time taken to make a decision). For this reason, the relationship between choice latency and the mean number of boxes opened in the corresponding condition was assessed using correlations and is shown in Table 8.1. There was a significant correlation between choice latency and the mean number of boxes opened in the corresponding condition. The choice latencies of the groups were therefore compared in

separate ANOVAs with the mean number of boxes entered as a covariate. The difference between the groups was not significant in either condition (Decreasing Win: $F(1, 75) = 2.95$, $p = 0.090$; Fixed Win: $F(1, 75) = 0.96$, $p = 0.33$, $\alpha' = 0.051$). This suggests that the reduced speed demonstrated by the ASC group on the IST reflected increased information gathering (see Section 7.3.2.2).

Table 8.1 *Mean choice latencies and relationship with the mean numbers of boxes opened on the IST*

	Decreasing Win condition		**Fixed Win condition**	
	Choice latency (msec) (*SD*)	Relationship with the number of boxes opened	Choice latency (msec) (*SD*)	Relationship with the number of boxes opened
ASC participants	2528.7 (*1556.0)*	$r = -0.313$, $p = 0.056$	3866.2 (*2817.6*)	$r = -0.747$, $p<0.001$
Control participants	1820.5 (*706.3*)	$r = -0.348$, $p = 0.028$	2881.1 (*1677.6*)	$r = -0.732$, $p<0.001$

8.3.4 *Relationships between decision-making latency and self-reported problems*

The relationship between decision-making latency on the CGT and the IST and the self-reported frequency of problems taking a long time to make decisions were assessed using ANOVA for linear trend. For this analysis, the mean deliberation times were collapsed across the five trial types to form a single variable, and the mean choice latencies were collapsed across the two conditions to form a single variable. This was justified by the absence of significant Group × Trial type and Group × Condition interactions (see Clark et al., 2009). The relationship between deliberation time (CGT) and this self-reported problem approached significance after correcting for multiple comparisons ($F(1, 72) = 3.91$, $p = 0.052$, $\alpha' = 0.0501$). The relationship between choice latency (IST) and this self-reported problem was significant ($F(1, 72) = 6.81$, $p = 0.011$). This suggests that as the frequency of self-reported problems with taking a long time to make decisions increased so too did decision-making latency on the tasks.

8.4 Summary of results

Consistent with the initial hypotheses, the participants with ASCs took longer to make the decisions presented on both the CGT and IST, compared to the control group. However, the

difference in choice latency on the IST was not significant after controlling for the mean number of boxes opened. Finally, there was a significant relationship between the frequency of self-reported problems with taking a long time to make decisions and choice latency. The relationship between this self-reported problem and deliberation time approached significance.

8.5 Discussion of results

This study was carried out to assess whether the reports of taking a long time to make decisions were consistent with two quantitative measures of decision-making speed. The findings provide support for such reports. Compared to the control group, the participants with ASCs took longer to make the decisions presented on the CGT and IST, which did not appear to reflect differences in motor speed.

The finding that participants with ASCs took longer to make the decisions on the CGT suggests that reduced speed in decision-making can occur even for decisions that are very straightforward. This reduction in speed is consistent with previous research demonstrating reduced response speed to comprehension questions in ASCs (see Bowler, 1997). It is, of course, possible that the increased latency reflected slower perceptual processing of the number of coloured boxes. However, this interpretation is not supported by a previous study demonstrating comparable inspection times (the 'stimulus exposure time required to make a simple perceptual judgment, for example, the relative length of two lines') between individuals with high-functioning autism and control participants (Wallace, Anderson & Happé, 2009).

The decisions presented on the IST were more complex than those presented on the CGT. Participants were required to evaluate the available information about the frequency of the two colours *and* (in most trials) make a decision about whether to gather more information or commit to a choice. The longer latencies demonstrated by the participants with ASCs were consistent with the findings for the CGT. However, in this case, the latencies of the two groups did not differ after controlling for the amount of information that was sampled. This suggests that the longer latencies on the IST are underpinned by the tendency for participants with ASCs to gather more information prior to making the decisions. Possible reasons for this are that the time taken to evaluate the information increases as the information load

increases (Malpas & Joyce, 1969), and/or that participants seeking more information are more cautious and take longer to consider their action.

The significant relationship between the self-reported frequency of problems to make decisions and latency of decision-making on the IST provides some evidence for the validity of the questionnaire of decision-making experiences. However, given the effect of information gathering on this measure of latency, this relationship is more likely to reflect group differences in information gathering than speed of processing. The finding that the relationship between decision-making latency on the CGT and this self-reported problem approached significance, suggests that participants in both groups were aware of their limitations in making decisions, since their reports tended to reflect their behaviours.

Limitations of these measures are that the decisions presented were simple. However, as a result of this, the findings suggest that decision-making can take longer in ASCs independently of other factors reported to make decision-making difficult (for example, busy environments, the involvement of others, significant consequences, and time pressure). A second limitation of these measures was the use of the touch-screen CANTAB apparatus to record response times. Although the relevant instructions regarding the position of the screen and participant were followed, participants of different heights would have made slightly different movements to touch the screen. There is, however, no reason to suspect a systematic difference between the groups. Future studies may be able to obtain more accurate response times using key press or button box equipment.

The findings from these tasks indicate that people with ASCs may benefit from additional time to make decisions. However, little is known about the circumstances in which additional time may be most helpful. Future studies seeking to understand more about the factors affecting decision-making speed in ASCs could consider the effect of systematically increasing the number of variables and imposing time limits. Study of these factors could help to discern whether the increased decision-making latency demonstrated in ASCs reflects a processing difficulty in decision-making in ASCs or a difference in decision-making style (i.e. a tendency to take greater care over decisions).

CHAPTER 9: ARE PARTICIPANTS WITH ASCS MORE AROUSED WHEN MAKING DECISIONS?

9.1 Background

The findings in the initial survey suggested that people with ASCs experience high levels of anxiety when making decisions (see Section 2.3.1). This chapter uses an adapted version of the Risky Choice Task (RCT, Rogers et al., 2003; Fairchild et al., 2009) to assess whether these reports are consistent with an established empirical measure of physiological arousal, a correlate of anxiety, during decision-making.

The RCT was described in detail in Section 3.4.5. To summarise, a computer program presents participants with two 'roulette' wheels, each with eight segments showing the number of points that can be won or lost if a 'spin' of the wheel selected that segment. Participants are asked to chose (by key press) which of the two wheels they wish to gamble on to try to win as many points as possible. This wheel was then 'spun' digitally and the outcome (the number of points on the segment selected) is presented and added to the participant's score. The difference in the Expected Value (ΔEV) between the two wheels is varied systematically across eight trial types (32 trials, ranging from -55 to +55). Trials were presented in a pseudorandom order, with each trial type presented four times in two conditions: one where participants were instructed to make their own decision ('decision' condition) and the other, a control condition, where they were informed that the computer would make the decision for them ('no decision' condition).

In addition, participants were presented with two trial types with equal Expected Values, each presented eight times. These trials, one presenting the decision in terms of wins[4], the other in terms of losses,[5] were included to assess the effect of a 'frame' on decision-making (discussed further in Chapter 11, Section 11.3.4.2). However, they are considered here as a third condition in which finely balanced decisions are presented ('finely balanced' condition).

[4] Control wheel: 1.0 chance of winning 40 points; Experimental wheel: 0.5 chance of winning 80 points and 0.5 chance of winning nothing

[5] Control wheel: 1.0 chance of losing 40 points: Experimental wheel: 0.5 chance of losing 80 points,

The dependent variable for behavioural performance was the proportion of trials on which the 'experimental' (risky) wheel was chosen. Arousal during decision-making was assessed by comparing changes in skin conductance (the skin conductance response, SCR, Dawson et al., 2000) between the conditions. Increased skin conductance is a physiological correlate of anxiety (see Geddes et al., 1993; Court et al., 2008).

Changes in skin conductance can, however, reflect other cognitive and biological events, such as mental effort (Kahneman et al., 1969). For this reason, participants were asked to provide retrospective self-reports of anxiety and effort experienced during the task using visual analogue scales and pre-and post-test versions of the Spielberger State Anxiety Inventory (SSAI, Spielberger et al., 1970). In the post-test version of the SSAI, participants were asked to complete the questions in relation to their feelings during the decisions (see Margrain et al., 2003), and the pre-test score was then subtracted from the post-test score (higher difference scores indicating higher levels of anxiety during decision-making). These measures were included to assist interpretation of changes in skin conductance.

9.2 A priori hypotheses

Based on the general findings from the initial survey that people with ASCs experience high levels of anxiety during decision-making, and that finely balanced decisions can be particularly difficult, the following predictions were made. Compared to the control group, it was expected that the participants with ASCs would:

1. demonstrate greater arousal in the 'decision' condition, compared to the 'no decision' condition;
2. demonstrate greater arousal for finely balanced decisions ('finely balanced' condition) compared to trials with a difference of Expected Value ('decision' condition); and
3. demonstrate larger skin conductance responses overall; and
4. report higher levels of anxiety while making decisions, with no difference in levels of mental effort, compared to when the computer was making the decisions.

In addition, it was expected that:

5. retrospective reports of anxiety during the task would correlate with the SCR amplitude for the trials in which participants made decisions.

9.2.1 *Experimental details*

9.2.1.1 Participants

The task was completed by 38 participants with ASCs and 40 participants in the control group who met criteria for inclusion in the main study (see Section 4.2). However, a number of participants were excluded from the final analysis. Participants taking antidepressant (SSRIs or tricyclic) or anxiolytic medication (9 ASC participants, 1 control participant) were excluded because of the possible effects of these medications on skin conductance (Spohn, Thetford & Cancro, 1971; Breyer-Pfaff, Gaertner & Giedke, 1982; Shores, Pascualy, Lewis, Flatness & Veith, 2001; Bond, Wingrove, Baylis & Dalton, 2003), in addition to their effects on anxiety. One participant in each group was excluded because of a technical failure. Finally, three participants in each group were excluded because their minimum skin conductance level (SCL) during the task was less than 1μS, which is outside of the normal range (1 – 20μS, see Indovina, 2008). The data presented are therefore based on the responses of 25 participants with ASCs and 35 participants in the control group. The gender distribution, mean age and Verbal IQ (VIQ) of the two groups did not differ significantly (see Table 9.1).

Table 9.1 *Participant characteristics*

Characteristic	**Participants with ASCs (n = 25)**	**Participants in the control group (n = 35)**	**Test of group difference**
% male	68%	74%	$\chi^2(1, N = 60) = 0.284$, $p = 0.59$
Mean age (years) (*SD*)	30.2 (*13.7*)	33.4 (*14.6*)	$t(58) = -0.934$, $p = 0.35$
Mean Verbal IQ (*SD*)	117 (*11.6*)	113 (*11.6*)	$t(58) = 1.23$, $p = 0.23$

To control for the effects of other medications that might affect the sympathetic nervous system (asthma medication (salbutamol, Symbicort®, 2 participants), medication for high blood pressure (Doxasozin, 1 participant), medication for diabetes (metformin, 2 participants), and a non-steroidal anti-inflammatory (Diclofenac, 1 participant)), use of these medications was included as a between-subjects factor in the analyses (ANOVA). There was no significant effect of these medications.

9.2.1.2 Acquisition and analysis of SCRs

SCL was recorded continuously during the task using the MP150 system, SCL amplifier (GSR100C) and transducer (TSD203) (BIOPAC Systems Inc. Goleta, California) at an acquisition sample rate of 200Hz. The epochs of interest were the 5 seconds period starting 0.5 seconds after the onset of the stimulus in the decision-making phase. The minimum and maximum SCL values within these epochs, and the times at which they occurred, were extracted using Windows Visual Basic software programmed by Dr Barney Dunn (MRC Cognition and Brain Sciences Unit, Cambridge). For each trial, SCR amplitude was calculated as the range of SCL values within the corresponding epoch. This amplitude was then multiplied by the direction of the change: positive changes reflect an increase in SCL over the 5 second period, whereas negative changes reflect a decrease in SCL over the 5 second period. Mean SCR amplitude was calculated by averaging amplitude values across all trials in which a positive response occurred (Dawson et al., 2000).

Data were analysed using repeated measures ANOVA, where assumptions about the normality of residuals were met. Non-parametrically distributed data were analysed using Mann-Whitney U and Wilcoxon tests, using the Dunn-Sidak correction for multiple comparisons ($1 - (1 - \alpha)^{1/c}$, where c is the number of comparisons in the analysis). Given the directionality of the hypotheses, one-tailed tests of significance were used ($\alpha = 0.1$). Scores expressed as proportions were arcsine transformed [$f(x) = 2\arcsin(x^{½})$],) as is appropriate whenever the variance is proportional to the mean (Howell, 1997; Rahman et al., 1999). SCR amplitude values were subjected to a logarithmic transformation [$f(x) = \text{Log}_{10}(x + 0.1)$] to reduce skew. Exploratory correlations were carried out to assess the influence of general levels of anxiety and depression (as measured using the Hospital Anxiety and Depression Scale, see Section 2.5.6) on the dependent measures. These variables were included as covariates in the ANOVA where correlations were significant (Clark et al., 2009), and the assumption of homogeneity of regression was met (Pallant, 2005).

The behavioural data for the RCT were presented in Chapter 6. The groups did not differ in their proportions of risky choices.

9.3 Results

9.3.1 *SCR amplitude for 'decision' vs. 'no decision' trials*

The mean SCR amplitude for the trials in each condition of the RCT is shown in Figure 9.1. Consistent with expectations, there was a significant effect of Group ($F(1, 56) = 2.99$, $p = 0.089$), indicating larger overall SCR amplitude in the ASC group compared to the control group. However, there was no effect of Condition ($F(1, 56) = 0.476$, $p = 0.49$) and the Group × Condition interaction was not significant ($F(1, 56) = 0.140$, $p = 0.71$). This suggests that changes in arousal were not related to whether or not the participant or computer made the decisions.

Figure 9.1 *Mean SCR amplitude for the three trial types of the RCT*

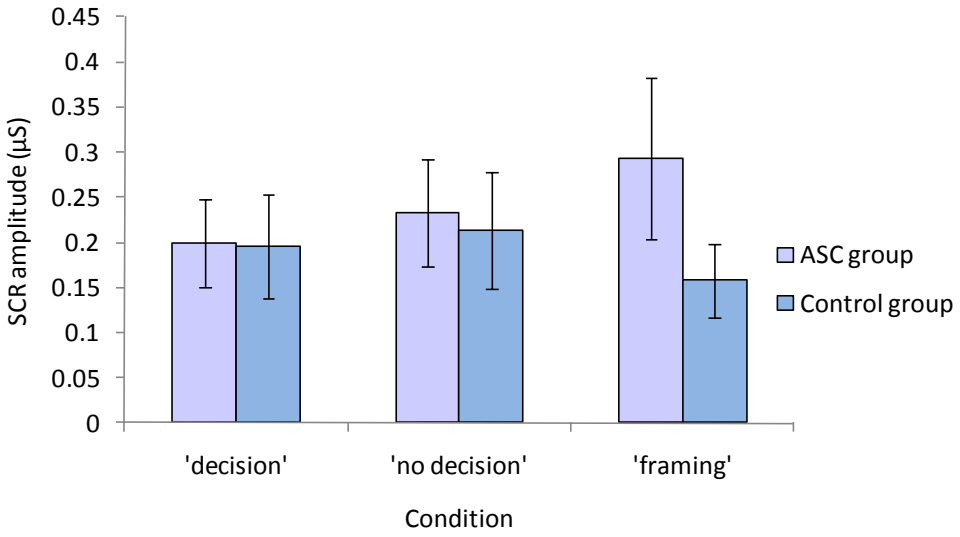


Figure 9.1 shows the mean SCR amplitude for all three conditions of the RCT for both groups of participants. Error bars represent one standard error of the mean. Contrary to expectations, there were no significant differences in the SCR amplitudes between the conditions for either group.

9.3.2 *SCR amplitude for 'decision' vs. 'framing' trials*

The mean SCR amplitudes for 'decision' and 'finely balanced' trials were compared using repeated measures ANOVA with general anxiety (measured using the Hospital Anxiety and Depression Scale, HADS) as a covariate, since this measure correlated significantly with SCR amplitude for 'finely balanced' trials (Kendall's $\tau_{(60)} = 0.195$, $p = 0.033$). Consistent

with expectations, there was a main effect of group ($F(1, 55) = 2.91$, $p = 0.094$), indicating larger overall SCR amplitude in the ASC group, compared to the control group. However, there was no effect of Condition ($F(1, 55) = 0.00$, $p = 0.99$), and the Group × Condition interaction was not significant ($F(1, 55) = 0.183$, $p = 0.67$). This suggests that changes in arousal were not related to whether decisions were finely balanced or weighted with differences in EV.

9.3.3 *Retrospective reports of anxiety and mental effort during decision-making*

9.3.3.1 Group comparisons of retrospective anxiety and mental effort

Contrary to expectations, the participants with ASCs did not report retrospectively higher levels of anxiety when making the decisions, as measured using the difference between pre- and post-SSAI scores (ASC group: $M = 0.38$, $SD = 12.0$; Control Group: $M = 4.26$, $SD = 7.2$, $t(34.4) = -1.55$, $p = 0.17$).

The mean ratings for the self-reported measures of anxiety and mental effort, as measured using visual analogue scales, are shown in Figure 9.2.

Consistent with the result for the SSAI scores, the groups did not differ in their mean rating of anxiety experienced during decision making ($z = -0.43$, $p = 0.67$). The groups also did not differ in their mean ratings of anxiety when the computer made the decisions ($t(58) = -0.49$, $p = 0.62$); nor did they differ in their ratings of mental effort when they were making the decisions (and $t(58) = 0.71$, $p = 0.48$). However, interestingly, both groups reported higher levels of anxiety when the computer was making the decisions rather than when they themselves were making the decisions (ASC group: *Wilcoxon* $z = -2.10$, $p = 0.025$; Control group: *Wilcoxon* $z = -3.82$, $p<0.001$).

These results suggest that the groups experienced the decisions as similarly anxiety provoking and effortful. Participants felt more anxious when the computer was making the decisions, compared to when they themselves were making the decisions.

Figure 9.2 *The mean ratings of anxiety and mental effort on the RCT as measured using visual analogue scales*

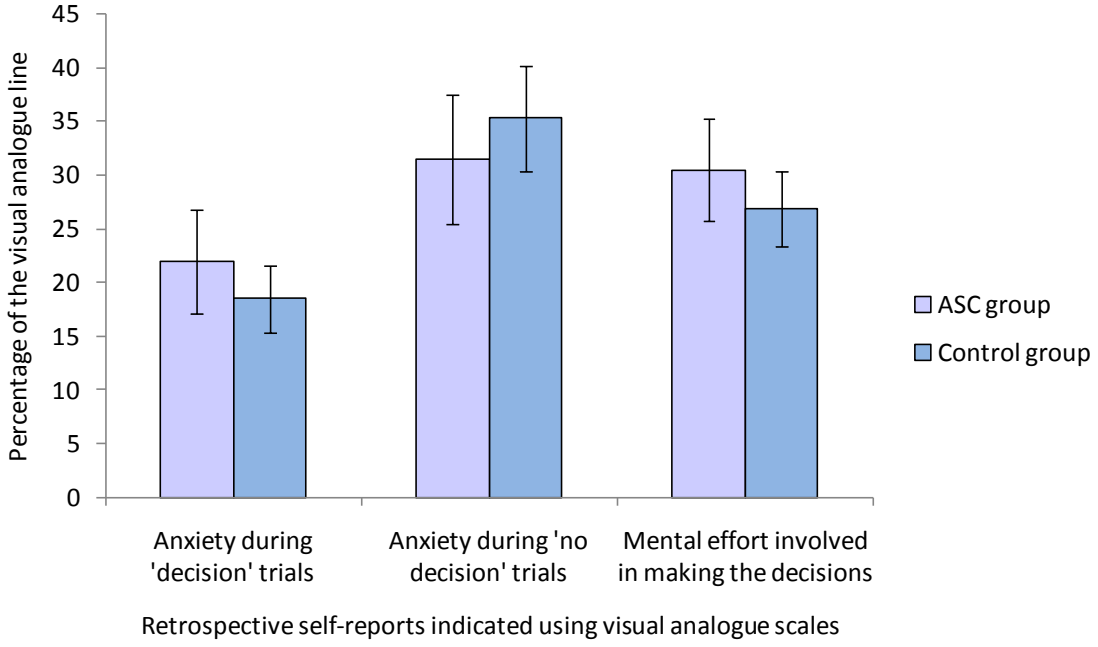


Figure 9.2 shows the mean ratings on visual analogue scales representing anxiety and mental effort during the RCT for both groups of participants. The data are presented as a percentage of the visual analogue line (45.7mm long, ranging from 'no anxiety' and 'no effort', to 'extremely anxious' and 'a great deal of effort'); error bars represent one standard error of the mean. Contrary to expectations, both groups experienced higher levels of anxiety when the computer made the decisions, rather than when they made the decisions. There were no differences in any of the ratings between the groups.

9.3.3.2 Relationship between self-report measures of anxiety and mental effort and SCRs

There were no significant correlations between SCR amplitude for 'decision' trials, 'framing' trials, or 'no decision' trials with the self-report measures of anxiety and mental effort (all $p>0.051$, $\alpha' = 0.017$). These results suggest that the SCR amplitudes did not reflect experiences of anxiety and mental effort during the task.

9.4 Summary of findings

Consistent with the initial hypothesis, the participants with ASCs demonstrated larger SCRs, compared to the control group. However, contrary to expectations, the participants with ASCs did not demonstrate relatively larger SCRs when they were making the decisions

compared to when the computer was making the decisions, or when making finely balanced decisions compared to decisions weighted with differences in EV. Contrary to expectations, the groups did not differ in their reports of anxiety or mental effort when making the decisions. Both groups reported significantly higher levels of anxiety when the computer was making the decisions, compared to when they themselves were making the decisions. However, neither self-reported levels of decision-related anxiety or effort correlated significantly with SCR amplitude.

9.5 Discussion

This study was carried out to assess whether the survey reports of anxiety, and difficulty in making finely balanced decisions, were consistent with a commonly-used physiological measure of arousal during decision-making. Overall, the findings did not provide support for such reports. While the participants with ASCs demonstrated larger SCRs overall, neither group demonstrated a significant difference in arousal between trials in which they made the decision, and trials in which the computer made the decision. This suggests that the increased arousal in the participants with ASCs was not specific to decision-making on this task. The finding that overall SCR amplitudes were larger in the ASC group compared to the control group is consistent with previous research assessing SCRs in ASCs (see De Martino et al., 2008) and was attributed to higher levels of general anxiety. Neither group demonstrated a significant difference in arousal between clear-cut and finely balanced decisions.

The self-reported measures of decision-related anxiety and mental effort did not correlate with the index of arousal (SCR amplitude), and there were no significant differences in the self-reported experiences of the two groups. However, the participants reported significantly higher levels of anxiety when the computer was making the decisions compared to when they were making the decisions.

There are several possible explanations for these findings. Firstly, the task may have been too abstract and/or simplistic to capture the higher levels of decision-related anxiety reported by participants with ASCs. The participants were provided with explicit probabilities about the expected wins and losses for each wheel, and the two choices were directly comparable. In contrast, the difficulties reported in the initial survey often involved choices with a number

of known and unknown variables (see for example, Figure 2.3). A second possibility is lack of motivation for the task. The decisions did not have significant consequences, such as monetary reward and punishment, and this may have limited the emotional engagement of the participants. In addition, the nine second interval between the feedback and the start of the next trial resulted in a lengthy task and the participants may have lost interest. This interval was selected to allow changes in skin conductance to return to baseline by the start of the next trial (see Dawson et al., 2000). However, some studies have used shorter intervals, such as 6 seconds (Bechara et al., 1999), in order to maintain participants' involvement in the task (Crone et al., 2004).

A third possibility is that changes in decision-related arousal were masked by stronger feelings of anxiety when the computer was making the decisions. This may reflect higher levels of anxiety associated with an external locus of control (see, for example, Sandler & Lakey, 1982), and the related possibility that the computer may make an unfavorable decision. Future studies seeking to avoid this effect could present, as an alternative control ('no decision') condition, trials in which the two wheels are identical. These trials would not involve weighing EVs (as in the 'decision' condition) or the gain/loss format (as in the 'finely balanced' condition) of the two wheels, but would remove the possibility of the computer making an unfavorable selection.

To conclude, the findings from this study do not provide quantitative support for the reports of decision-related anxiety in ASCs. However, this finding may not be generalisable beyond the confines of the specific task used here. As an example, this study found that participants with ASCs did not demonstrate reduced anxiety when the computer made decisions. However, they may experience reduced anxiety when, in the real world, decisions are made on their behalf by people they know and trust. In this study, the computer's selection was random and participants would have learnt that the computer could not be trusted to make a good decision. Future studies seeking to better validate reports of decision-related anxiety could, therefore, present more realistic decisions that involve a parent or another trusted person making some decisions on the participant's behalf. This may provide a more realistic environment to examine arousal in decision-making in ASCs.

CHAPTER 10: DO PARTICIPANTS WITH ASCS DEMONSTRATE DIFFERENCES IN MOTIVATIONAL PROCESSES IN DECISION-MAKING?

10.1 Background

The task used to address whether people with ASCs demonstrate differences in motivational processes in decision-making was the Iowa Gambling Task (IGT, Bechara et al., 1999), which was described in detail in Section 3.4.6. To summarise, this is a laboratory-based task of decision-making in which participants make repeated selections from four decks of cards in order to win as much money as possible. Unbeknownst to participants, two of the decks are weighted with large wins and large losses in such a way that repeated selection from these decks leads to a net loss of money. The other two decks are weighted with smaller wins but fewer and smaller losses so that repeated selections from these decks leads to a net gain of points. Successful performance on the IGT depends upon learning these contingencies and making more selections from the two advantageous decks.

The contributions of specific cognitive and motivational processes to performance on the IGT can be assessed using the *Expectancy-Valence Learning* (*EVL*) model (Busemeyer & Stout, 2002), which was described in Section 3.4.6.1. Briefly, this model provides estimates for three parameters, in turn relating to: i) a learning and memory factor (the tendency to be influenced by recent outcomes and to forget or discount past outcomes); ii) a motivational factor (the tendency to be attracted to wins and indifferent to losses); and iii) a response factor (the tendency to make choices erratically due to factors such as boredom and fatigue).

10.1.1 *Previous studies using the IGT with participants with ASCs*

Two studies have used the IGT to study decision-making in adolescents and young adults with ASCs. The first study was carried out by Johnson et al. (2006), in which IGT performance and the *EVL* parameters were compared between 15 participants with Asperger syndrome (AS) and 14 age and IQ-matched control participants. They used a version of the task similar to that used by Bechara et al. (1999), although they extended it from 100 to 150 trials, and used slightly different contingencies to reflect the real amounts of money won and lost by the participants. The nature of the contingencies (i.e. one deck with a large win on

every trial and $^{1}/_{10}$ probability of a very large loss) were the same as in the original task developed by Bechara et al. (1994, 1999). They found that participants with AS learnt the contingencies associated with each deck in a similar way to the control group, but were less influenced by the motivational properties (expectancies about the outcome) they assigned to the decks (indexed by a lower estimate for the response consistency parameter, *c*). This 'response inconsistency' was also reflected in an analysis of the number of consecutive selections that were made from the same deck; the participants with ASCs tended to make much smaller numbers of consecutive selections from the same deck and shifted between the decks more frequently. By comparing their findings to the IGT performance of people with brain damage to the prefrontal ventromedial cortex and the amygdala described in the literature (for review, see Yechiam et al., 2005), Johnson and her colleagues interpreted the response in ASCs as an abnormal interaction between the brain regions involved in learning the contingencies and the brain regions involved in choice behaviour. In addition, there was a trend towards poorer IGT performance in the ASC group, driven by their response inconsistency, and a trend towards greater attention to loss as measured using the *EVL* model, but they concluded that their sample was too small to detect these differences.

The second study was carried out by Yechiam et al. (2010). They used a version of the IGT identical to original task developed by Bechara et al. (1994), which had 100 trials. The findings from this study were similar to those described by Johnson et al. (2006), as they too found a tendency for the participants with ASCs to shift more frequently between the decks and make fewer consecutive selections from the same deck. They did not, however, find any significant differences in the parameters of the *EVL* model between the groups, nor was the *EVL* model able to predict the choices of the ASC group with as great an accuracy as for the control group. To account for the observed differences in the behaviour of the two groups, they examined the selection patterns using a new cognitive model, which assumes that exploring alternatives holds greater value for the decision-maker than the actual outcomes of the alternatives. They found that this model was better at predicting the choices of the participants with ASCs, and they interpreted this as a difference in reinforcement learning style, characterised by a greater tendency to explore response options.

10.2 The IGT in the present investigation

This investigation aimed to carry out a study similar to Johnson et al. (2006), using a larger sample of participants with ASCs. The deck contingencies were, however, identical to those used by Bechara et al. (1994, 1999) and Yechiam et al. (2010), as these are recommended for use with *EVL* model (see Busemeyer & Stout, 2002, and Stallen, 2006). The task was adapted to enable participants to make 150 trials; however, a technical problem prevented the number of selections from each deck exceeding 100. For this reason, the data presented are based on the first 115 trials, which is the maximum number of trials for which all participants had the four response options available. The dependent measure of task performance was the proportion of choices from the advantageous decks in five consecutive blocks of 23 trials.

10.3 A Priori hypotheses

Based on the findings from Johnson et al. (2006), the following predictions were made.
Compared to the control group, the participants with ASCs would:

1. Make fewer advantageous choices;
2. Shift more frequently between the four response options (reflected by a lower number of consecutive selections from the same deck);
3. Be less influenced by the motivational properties (expectancies about the outcome) they assigned to the decks (reflected by a lower estimate for the response consistency parameter, *c*, calculated using the *EVL* model);
4. Demonstrate greater attention to losses compared to wins (reflected by a higher estimate for the attention weight parameter, *w*, calculated using the *EVL* model).

10.3.1 *Experimental details*

10.3.1.1 Participants

The task was completed by 38 participants with ASCs and 40 control participants. Three participants in the control group were excluded from the final analysis because they responded abnormally. These participants made over eighty consecutive selections from Deck B before sampling the other decks. Two of these participants failed to sample from all of the decks. As a result, the final analyses are based on the data from 38 participants with ASCs and 37 control participants. The effects of medication were controlled for by repeating each of the analyses with and without the ten participants (nine ASC group, one control

group) taking antidepressant or anxiolytic medication. Any changes to the findings are reported.

10.3.1.2 Data analysis

Where possible, data were analysed using parametric tests. For these tests, scores represented as proportions were transformed using the arcsine transformation ([$f(x)$ = 2arcsin(proportion score)^{½}]; see Howell, 1997) to reduce the skew of residuals. The maximum run lengths and the Learning/Memory parameter of the *EVL* model were log transformed [$f(x)$ = log(score)] to reduce skew. Greenhouse-Geisser corrections were applied where the assumption of sphericity was violated. Given the directionality of the hypotheses, one-tailed tests of significance ($\alpha = 0.1$) were used.

Exploratory correlations were carried out to assess the influence of general levels of anxiety and depression (as measured using the Hospital Anxiety and Depression Scale, see Section 3.5.6) on the dependent measures. Scatterplots were inspected visually for outliers. These variables were included as covariates in the ANOVA where correlations were significant (Clark et al., 2009), and the assumption of homogeneity of regression was met (Pallant, 2005).

10.4 Results

10.4.1 *Decision-making performance on the IGT*

The performance of the two groups of participants on the IGT is shown in Figure 10.1. Repeated measures ANOVA of Block (5 levels: 5 consecutive blocks of 23 trials) by Group (2 levels: ASC and controls) showed a main effect of Block ($F(3.5, 252.2) = 26.65$, $p<0.001$), indicating that both groups learnt to make more selections from the advantageous decks. Contrary to expectations, an effect of Group indicated that, compared to controls, the participants with ASCs made a greater proportion of advantageous choices ($F(1,73) = 4.49$, $p = 0.037$). The Block × Group interaction was also significant ($F(3.5, 252.2) = 4.44$, $p = 0.003$). A simple effects analysis revealed that the interaction was due to the superior performance of the ASC group in the final block of trials ($F(1,74) = 9.01$, $p = 0.004$). The same analysis also revealed that the participants with ASCs made a significant improvement between Blocks 1 and 2, which was not the case in the control group (ASC group:

$M_{difference}$ = *0.39, p<0.001*; Control group: $M_{difference}$ = *-0.21, p = 0.25*). Together, these findings suggest that the ASC group improved at a faster rate than the control group.

Figure 10.1 *Performance on the IGT for the ASC and control groups*

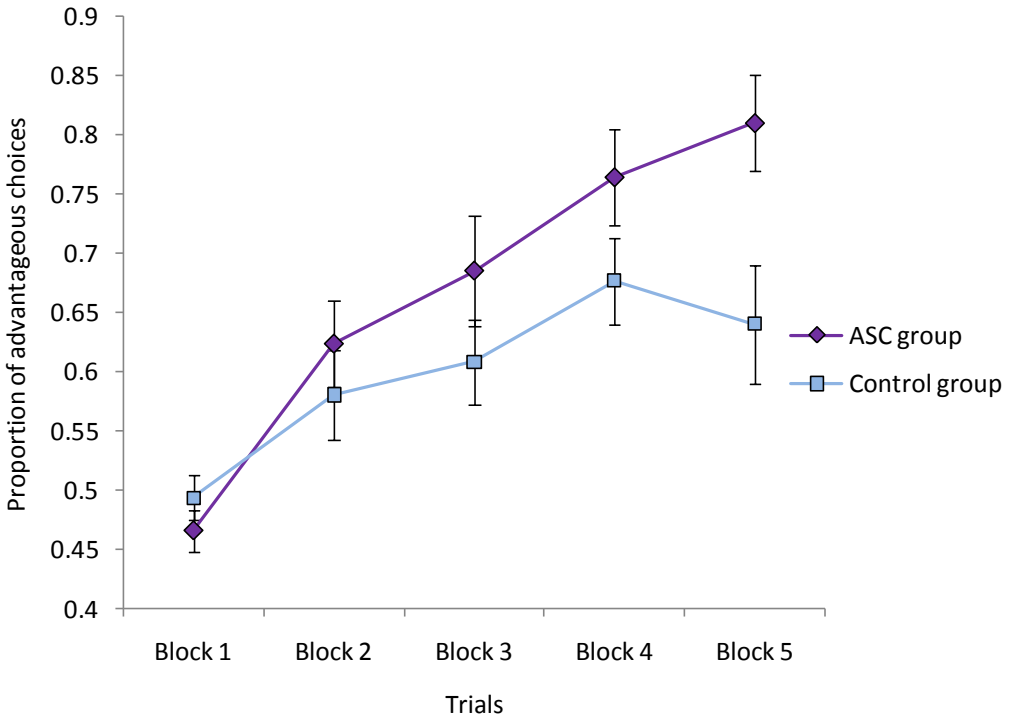


Figure 10.1 shows the mean proportion of choices from the advantageous decks (A and B) for each consecutive block of 23 selections (115 trials in total), for both groups of participants. Error bars represent one standard error of the mean. Both groups made a greater proportion of advantageous choices as the task progressed. However, compared to the control group, the participants with ASCs demonstrated greater overall improvement on the IGT.

Consistent with this finding, overall improvement on the task, measured as the difference in the proportion of advantageous selections between the first and final block of trials, was significantly higher in the ASC group (z = -3.07, p = *0.002*). Overall improvement on the IGT is shown in Figure 10.2.

Figure 10.2 *Overall improvement on the IGT for both groups of participants*

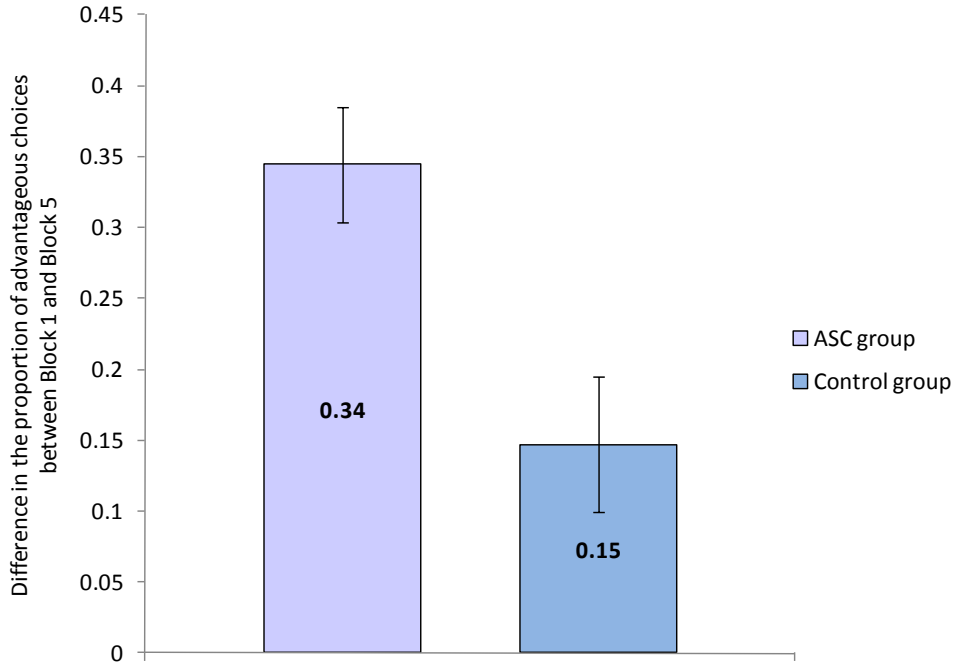


Figure 10.2 shows the mean improvement in performance on the IGT for both groups. This is calculated as the difference in the proportion of advantageous selections between Block 5 and Block 1. Error bars represent one standard error of the mean. Participants with ASCs demonstrated greater overall improvement on the IGT, compared to the control group.

10.4.2 *Selection patterns on the IGT*

Analysis of the maximum number of consecutive selections from a single deck (termed 'run length', see Johnson et al., 2006) revealed a distinct selection pattern between the two groups. However, this distinction was contrary to the pattern expected. For the advantageous decks, the participants with an ASC made longer stretches of consecutive choices from the same deck, compared to participants in the control group (ASC group: M = 29.6 trials, SD = *27.24*; control group: M = 12.1 trials, SD = 16.2, z = *-3.80*, p < *0.001*). The mean maximum run length for the disadvantageous decks did not differ between the groups (ASC group: M = 7.5 trials, SD = *5.87*; Control group: M = 6.2 trials, SD = *3.43*, z = -0.07, p = *0.95*). The mean maximum run length for the advantageous and disadvantageous decks is shown in Figure 10.3.

Figure 10.3 *Mean maximum run lengths of consecutive choices from the same deck*

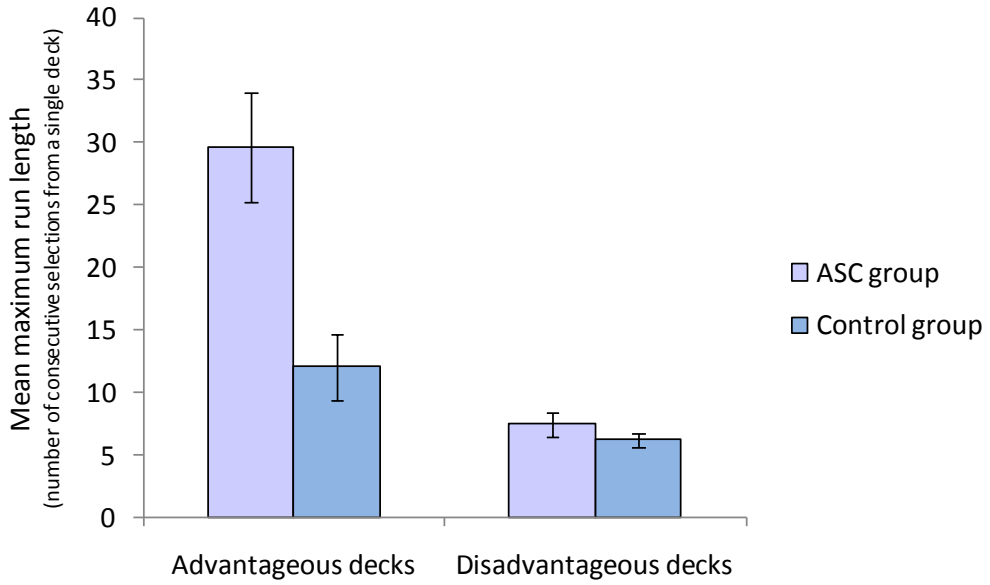


Figure 10.3 shows the mean maximum run lengths of consecutive choices from the same deck on the IGT, for both the ASC and control groups. Error bars represent one standard error of the mean. The mean maximum run length for the advantageous decks was significantly longer for the ASC group, compared to the control group. However, there was no significant difference for the disadvantageous decks

Examples of the typical selection pattern demonstrated by two participants with an ASC are shown in Figure 10.4. These are shown alongside the selection patterns of the two control participants most closely matched to them for age and Verbal IQ. This shows how the participants with ASCs made more consecutive selections from the same deck towards the end of the task when they had learnt the contingencies. This suggests that exploration and/or risk-taking by making occasional selections from the disadvantageous decks was limited in the ASC group. The possibility that the control participants did not learn the overall contingencies is not supported by the findings from the main repeated measures ANOVA (see section 10.4.1), which found a main effect of Block.

Figure 10.4 *IGT selection patterns for two participants with an ASC and control participants of similar age and intellectual ability*

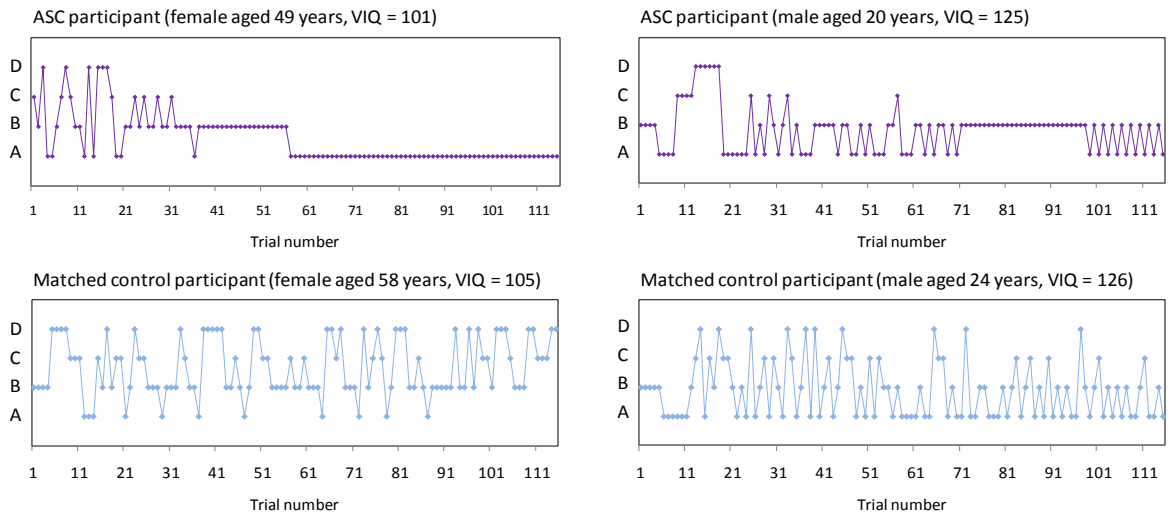


Figure 10.4 shows the IGT selection patterns for two participants with an ASC, and the control participants most closely matched to them for age and Verbal IQ. The participants with ASC made much longer stretches of consecutive selections from the same deck, especially towards the end of the task when they had learnt the contingencies.

10.4.3 *Application of the Expectancy-Valence Learning (EVL) model*

The response patterns of individuals were investigated using the *EVL* model, which provides estimates for three parameters believed to contribute to performance on the IGT (see Section 3.4.6.1). The fit of the *EVL* model (its ability to predict the trial by trial selections for each participant) was evaluated by comparing it with a control model (the Bernoulli model), which takes no account of learning from past outcomes. This was calculated using the G^2 statistic (Busemeyer & Wang, 2000), which is an analogue of the χ^2 statistic. Positive values of G^2 indicate that the fit of the *EVL* model to the data is superior to that of the control model; negative values indicate that the fit of the control model is superior to that of the EVL model. The fit of the *EVL* model was satisfactory: 80% of the participants had positive values of $G^{2.}$ This is virtually identical to the 78% of neurotypical participants producing positive G^2 values in Busemeyer & Stout (2002) when they developed the model. The overall fit of the *EVL* model was better than that found by Johnson et al. (2006), in which only 55% of participants overall had positive values of G^2, (χ^2 (1, N = 76) = 5.94, $p = 0.026$); they did not present data regarding the fit of the *EVL* model for each group separately. In the present

study, the fit of the *EVL* model did not differ between the ASC and control groups (χ^2 (1, N = 76) = 0.32, $p = 0.57$). This differs from the result found by Yechiam et al. (2010).

10.4.4 *Comparison of the EVL model parameters*

The mean and median estimates of the three parameters produced by the *EVL* model for each group are shown in Table 10.1. None of the three parameters differed between the groups. It is surprising that the response consistency parameter, denoted *c*, did not differ significantly between the groups, given the significantly longer run lengths demonstrated by the participants with ASCs. However, the direction of the non-significant difference in *c* is consistent with the longer run lengths demonstrated in the ASC participants. These results suggest that both groups: i) integrated information about the deck contingencies across the task; and ii) paid similar overall attention to losses compared to wins.

Table 10.1 *Summary of the estimated EVL model parameters for both groups of participants*

Group	**Learning/memory (*a*)**			**Attention to losses (*w*)**			**Response consistency (*c*)**		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
ASCs (n = 38)	0.23	0.08	*0.32*	0.44	0.39	0.27	1.57	1.34	*2.06*
Controls (n = 38)	0.22	0.05	*0.35*	0.47	0.42	0.28	0.98	1.19	*1.78*

Table 10.1 shows a summary of the three EVL model parameter estimates for the ASC and control groups. The Learning/memory parameter, a, ranges from 0 to 1, with 0 reflecting learning over long spans of trials and 1 reflecting strong recency effects; the Attention to losses parameter, w, ranges from 0 to 1, with 0 reflecting a strong attraction to wins, and 1 reflecting a strong aversion to loss; the Response consistency parameter, c, ranges from -5 to +5, with -5 reflecting random selection, and +5 reflecting consistent application of the expectancies assigned to each deck. There are no significant differences between the groups using the parameters generated for 115 trials.

10.4.5 *Post-hoc analysis*

Since the participants with ASC demonstrated a superior performance on the IGT, a post-hoc analysis was carried out to examine the relationship between IGT performance and particular experiences of difficulty in decision-making in everyday life. Three self-reported problems

in decision-making (from the questionnaire of decision-making experiences, see Section 3.4.1) were selected for this analysis, which could, in theory, be a consequence of a more logical (in this case, better quality) decision-making analysis. These were: i) problems taking a long time to make decisions; ii) problems with mental 'freezing' (overload); and iii) problems with exhaustion. One participant was an outlier (more than 3 times the interquartile range from the quartile boundary) and removed from the first and second of these analyses.

There was a significant relationship between the self-reported frequency of problems with taking a long time to make decisions and performance on the IGT, when the participants taking antidepressants or anxiolytics were excluded (ASC group: $F(1, 24) = 9.10$, $p = 0.006$). As the frequency of this self-reported problem increased, so too did performance on the IGT. The relationships between the self-reported frequency of problems with mental 'freezing' and exhaustion were not related to IGT performance ($F(1, 34) = 0.122$, $p = 0.73$, $F(1, 34) = 0.55$, $p = 0.46$, respectively, $\alpha' = 0.025$, $\alpha = 0.05$).

10.5 Summary of findings

Contrary to expectations, the participants with ASCs demonstrated significantly better performance on the IGT, compared to the control group. Contrary to the initial hypothesis, the participants with ASCs shifted less frequently between the decks, compared to the control group. Contrary to expectations, the participants did not demonstrate greater attention to losses, as measured using the EVL model parameter; neither did they demonstrate reduced response consistency, compared to control participants. Contrary to the results of Yechiam et al. (2010), the *EVL* model provided a good fit for the response patterns of the majority of participants, both with and without ASCs. Finally, the superior performance demonstrated by participants with ASCs was related to the self-reported frequency of slowness in decision-making in real life.

10.6 Discussion of results

The choices made by this group of participants with ASCs did not resemble those made by the participants recruited by Johnson et al. (2006) and Yechiam et al. (2010). Their participants made distinctly erratic choices compared to the control participants, despite both groups demonstrating that they had learnt the contingencies associated with each deck. In contrast, in the present study, the opposite pattern of responding was observed, although, as

in the previous studies, both groups demonstrated that they had learnt the contingencies. No differences were found in the groups' attention to loss using the *EVL* model, which does not support the prediction made by Johnson et al. (2006).

The superior performance of the participants with ASCs is likely to be due to the consistency with which they made selections from one advantageous deck. This consistency may reflect a dislike of risk-taking; towards the end of the task, the typical strategy demonstrated by control participants was to make most selections from the advantageous decks with occasional selections from the disadvantageous decks (after all, Deck D could still provide a large win on 9 out of 10 selections). While this is a reasonable strategy, it produces a lower proportion of advantageous choices when analysed in blocks of consecutive trials, as shown in Figure 10.1. It is also possible that the participants with ASCs were better able to focus on the objective of the task without losing interest.

Differences between the findings in the present and previous studies may reflect differences in the ages of the sample populations. The participants recruited by Johnson et al. (2006) and Yechiam et al. (2010) were considerably younger (M = 16.1 years, $SD = 2.3$ and M = 15.6 years, $SD = 2.8$, respectively), than the participants recruited for this study (M = 34.0 years, $SD = 15.5$. Adolescents have been found to make more risky choices on the IGT, compared to young adults (Cauffman et al., 2010), and this may account for the more erratic choices demonstrated by the adolescents with ASCs in the previous studies. The only other known difference between the participants recruited in present and previous studies is that the AQ scores would have been higher in Yechiam et al. (2010). They used a cut-off score of 32, whereas a cut-off score of 26, found to have good specificity as a screen for diagnosis (Woodbury-Smith et al., 2005), was used in this study to provide additional information about diagnostic integrity. However, this explanation for the difference in findings was not supported by an analysis of the correlation between IGT performance and AQ (Kendall's τ = 0.0, $p>0.999$) for the ASC participants in this study.

It is of interest that, for the participants with ASCs, there was a significant relationship between self-reported slowness to make decisions in real life and quality of decision-making on the IGT. This suggests that participants with ASCs who reported problems with deliberation time may be those who made more logical decisions.

A key limitation of the IGT is that it lacks ecological validity, despite capturing the aspect of uncertainty that is associated with many decisions in real life. It is, however, widely used to assess decision-making, and its inclusion in this study has provided information about the performance of a large group of people with ASCs, who are older than those previously studied. The findings differ from those of previous studies, but suggest that adults with ASCs are not only able to focus on these types of decisions, but also to learn by experience to make advantageous decisions. The response patterns may also reflect a reluctance to take risks once the deck contingencies have been learnt. A real-life implication of these findings, supported by the correlation with self-reported problems slowness in decision-making, may be that people with ASCs attempt to make logical decisions, which demand time and cognitive resources, to a greater extent than is typical within the general population. This interpretation is consistent with the finding by De Martino et al. (2008) that people with ASCs are more logical in laboratory-based tasks of decision-making.

CHAPTER 11: DO PARTICIPANTS WITH ASCS DEMONSTRATE REDUCED RELIANCE ON HEURISTICS?

11.1 Background

Heuristics are general strategies ('short-cuts') used to simplify some of the complex mental processes involved in decision-making (Tversky & Kahneman, 1974; Gilovich et al., 2002; Kochler & Harvey, 2004, see Section 1.3.2). Most of the time, they facilitate adaptive and efficient decision-making; in some situations, however, their use can result in systematic biases towards particular response options (Kahneman et al., 1982). Heuristics, and the biases they generate, are typically demonstrated in research by using questions carefully constructed to offer a 'rational' or 'correct' choice, and an 'incorrect' choice that leads naturally from the heuristic-led thought process.

The findings from the initial survey suggested that people with ASCs often find decision-making overwhelming and exhausting (see Section 2.3.1 and Section 2.3.2.2). Since heuristics can reduce the cognitive demands of decision-making, the focus of this chapter is to consider whether the additional effort in decision making reported by people with ASCs might be explained by a reduced reliance on heuristic short-cuts. It is important to note, however, that robust demonstrations of heuristic-led biases tend to require large sample sizes (e.g. N = 100) due to the limited, categorical response options of the questions that demonstrate the bias. For this reason, the data presented in this chapter should be considered as merely exploratory, and highlight potential areas for future research.

The tasks used to assess reliance on heuristics were six short, quiz-like questions (described in detail in Section 3.4.7) and the Risky Choice Task (RCT) (described in Section 3.4.5). Together, these questions have been shown to demonstrate reliance on the: i) *Representativeness; ii) Availability; iii) Anchoring-Adjustment;* and iv) *Affect* heuristics, which are four of the most well known biases in human decision-making (see Tversky & Kahneman, 1974; Gilovich et al., 2002; see Section 3.4.7 for description of each of these heuristics.). A summary of these tasks is shown in Table 11.1.

Table 11.1 *Summary of tasks used to assess reliance on heuristics in decision-making*

Heuristic	Task/Question	Summary	Demonstrable error/bias	Original finding
Representativeness	Birth Order (Kahneman & Tversky, 1972)	Judge how many families of six children in a city have the birth order 'B G B B B B' if 72 families have the birth order 'G B G B B G'.	*Misconception of chance*, influenced by the similarity of the sample to the parent population.	82% of participants incorrectly judged the number of families to be less than 72. (N = 92)
	Hospital Births (Kahneman & Tversky, 1972)	Judge whether the number of days on which more than 60% of babies born are boys is greater in a small hospital, a large hospital, or about the same in both.	*Insensitivity to sample size*, influenced by attending to the similarity of the percentage (60% boys) to the parent population (50% boys)	56% of participants incorrectly judged the number of days to be about the same in both hospitals; 24% incorrectly judged the number of days to be greater in the large hospital. (N = 50)
Availability	Path Frequency (Tversky & Kahneman, 1973	Judge whether one type of path is more frequent than another type of path in a 6x6 grid of two types of symbols (X and O). Paths of six symbols are constructed by linking symbols from the top to the bottom of the grid. The two path types considered are those containing 5X's and 1O, and those containing 6X's and no O's.	*Bias of imaginability*, due to the immediate visibility of several examples of the less frequent path type; examples of the other path type require mental visualization.	76% of participants incorrectly judged the less frequent path type (5X's and 1O) as more numerous. (N = 50)
	'R' Position (Tversky & Kahneman, 1973)	Judge whether the letter 'R' is more likely to appear in the first or third position in English words, of three letters or more.	*Bias due to the effectiveness of a search technique*, as it is easier to call to mind words that being with a letter than words with the letter in the third position.	69% of participants incorrectly judged that the letter would be more likely to appear in the first than the third position of words. (This includes responses for four additional letters of similar positional frequency to 'R'). (N = 152)
Anchoring-adjustment	Conjunctive Vs. Simple gambles (Bar-Hillel, 1973)	Judge whether to take a simple gamble (e.g. pick one red marble from a bag containing 50% red marbles) or a conjunctive gamble (e.g. pick a red marble seven times in a row, with replacement, from a bag containing 90% red marbles).	*Insufficient adjustment* down from the simple probability to the conjunctive probability.	80% of participants incorrectly chose the conjunctive over the simple gamble. (N = 15)
	Disjunctive Vs. Simple gambles (Bar-Hillel, 1973)	Judge whether to take a simple gamble (e.g. pick one red marble from a bag containing 50% red marbles) or a disjunctive gamble (e.g. pick a red marble at least once in seven draws, with replacement, from a bag containing 10% red marbles).	*Insufficient adjustment* up from the simple probability to the disjunctive probability.	80% of participants incorrectly chose the simple over the disjunctive gamble. (N = 20)
Affect	Asian Flu (Tversky & Kahneman, 1981)	Choose one of two treatment programmes to combat a pandemic. One programme has a certain outcome, the other is probabilistic. The question is presented in two formats; one focusing on the lives saved, the other focusing on lives lost. The question is presented once in each format	*Framing effect*, charactersied by the tendency to be risk averse when considering possible gains and risk taking when considering possible losses.	72% of participants were risk averse in the gain frame; 22% of participants were risk averse in the loss frame. (N = 155)
	Risky Choice Task (Fairchild et al., 2009)	Choose one of two gambles with equal expected values. One has a certain outcome, the other is probabilistic. The question is presented in two formats; one presenting wins, the other presenting losses. The question is presented eight times in each format.		Risk taking occurred on 45% of 'gain-focused' trials and 71% of 'loss-focused' trials. (N = 84)

11.2 A priori hypotheses

Combining the findings from the initial survey with the finding that adults with ASCs are generally less susceptible to framing effects underpinned by the *Affect* heuristic (De Martino et al., 2008), the following predictions were made. Compared to the control group, participants with ASCs would demonstrate:

1. reduced reliance on the *Representativeness* heuristic (indicated by more participants with ASCs selecting the correct options on the Birth Order (Appendix H*i*) and/or the Hospital Births (Appendix H*ii*) questions);
2. reduced reliance on the *Availability* heuristic (indicated by more participants with ASCs selecting the correct option on the Path Frequency question (Appendix H*iii*) and/or selecting the options with equal frequency on the 'R' position (Appendix H*iv*) question);
3. reduced reliance on the *Anchoring-Adjustment* heuristic (indicated by more participants with ASCs selecting the conjunctive and simple gambles that have a higher likelihood of success) (Appendix H*v* and H*vi*); and
4. reduced reliance on the *Affect* heuristic (indicated by a reduced susceptibility to the framing effect on the Asian Flu question (Appendix H*vii*) and the RCT).

In addition, it was expected that susceptibility to the *Affect* heuristic would:

5. correlate negatively with an index of the number of autistic traits;
6. correlate negatively with particular self-reported difficulties in decision-making that may, in theory, reflect more effortful processing: i) exhaustion during decision-making; ii) mental 'freezing' during decision-making; and iii) slowness in decision-making.

11.2.1 *Experimental details*

11.2.1.1 Participants

The data presented are based on the responses of 38 participants with an ASC and 40 participants in the control group. The effects of medication on the RCT were controlled for by repeating each of the analyses with and without the ten participants taking antidepressant or anxiolytic medication. Exclusion of these participants did not affect the findings. This control was not applied to the data for the quiz-like questions, as large sample sizes are required for meaningful analysis of this type of categorical data.

11.2.1.2 Data analysis

Data from the quiz-like questions were analysed using chi-squared tests of independence (N = 78), and data from the RCT were analysed using non-parametric statistics, due to non-normality of the means and residuals after applying an arcsine transformation (see Howell, 1997). Relationships between variables were examined using Kendall's correlation coefficient (for two continuous variables) and ANOVA linear contrasts (for one continuous and one ordinal variable). To control for multiple comparisons, the Dunn-Sidak correction was applied to these analyses. Given the directionality of the hypotheses, one-tailed ($\alpha = 0.1$) tests of significance were used. The exception to this was the chi-squared tests, which are, by their nature, are non-directional. The chi-squared tests were thresholded at $\alpha = 0.05$.

11.3 Results

11.3.1 *Reliance on the Representativeness heuristic*

11.3.1.1 Misconceptions of chance influenced by similarity to the parent population

The distribution of responses to the Birth Order question is shown in Figure 11.1. The data presented are based on the responses of 72 participants, as four participants with an ASC and two participants in the control group did not feel able to answer this question. Contrary to the initial hypothesis, the distribution of responses to the Birth Order question did not differ between the groups (χ^2 test of independence (1, N = 72) = 0.01, $p = 0.92$). The modal response in both groups was that the number of families with the birth order 'B G B B B B' would be less than 72 (ASC group: 65%; Control group: 66%). While the distribution of responses in the control group is consistent with findings of Kahneman & Tversky (1972) (in which 82% of participants judged that the number of families would be less than 72; χ^2 (1, N = 130) = 3.75, $p = 0.053$) [f], the bias demonstrated in this study is clearly less pronounced. These findings suggest that there is no difference in the tendency of the groups to rely on the *Representativeness* heuristic to answer this question. However, the participants in the control group did not demonstrate a bias as strong as was expected, based on the findings of the original study.

[f] Chi-squared test of independence between the control group in the present study and the participants recruited by Kahneman and Tversky (1972) (n = 38 and n = 92, respectively).

Figure 11.1 *The distribution of participants' responses to the 'Birth Order' question*

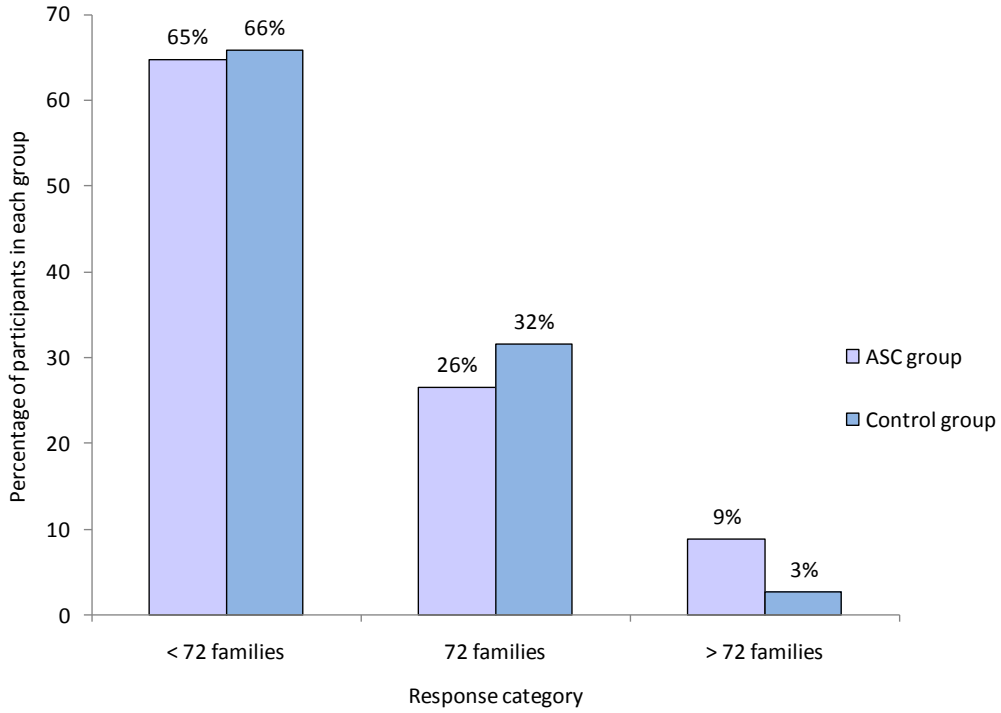


Figure 11.1 shows the distribution of responses of both groups of participants to the Birth Order question. According to Kahneman and Tversky (1972), reliance on the Representativeness heuristic is demonstrated by a tendency to judge that the number of families with the 'B G B B B B' will be less than 72. This is the modal response in both groups of participants.

11.3.1.2 Insensitivity to sample size

The distribution of responses is shown in Figure 11.2. Contrary to the initial hypothesis, the distribution of responses to the Hospital Births question did not differ between the groups ($\chi^2(2, N = 78) = 0.80$, $p = 0.67$). The modal response in both groups was that the number of days on which 'more than 60% of babies born were boys' would be the *same* in the small and the large hospital (ASC group: 53%; Control group: 60%). This finding is consistent with that of Kahneman & Tversky (1972), in which 56% of participants judged that the number of days would be the same in the small and the large hospital, ($\chi^2(2, N = 90) = 1.21$, $p = 0.55$). This apparent lack of sensitivity to sample size suggests that both groups tend to rely on the *Representativeness* heuristic to answer this question.

Figure 11.2 *The distribution of responses to the Hospital Births question*

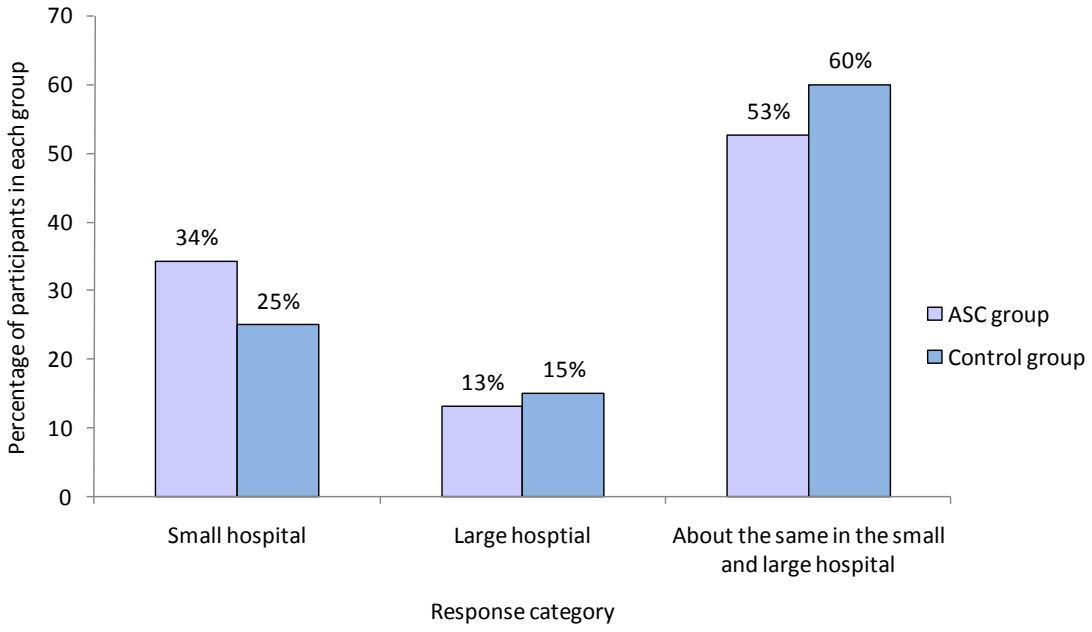


Figure 11.2 shows the distribution of responses of both groups to the Hospital Births question. According to Kahneman & Tversky (1972), reliance on the Representativeness heuristic is demonstrated by a tendency to judge that the number of days on which 'more than 60% of the babies born were boys' would be the same in a small and a large hospital. This is the modal response in both groups of participants.

11.3.2 *Reliance on the Availability heuristic*

11.3.2.1 Bias of imaginability

The distribution of responses to the Path Frequency question is shown in Figure 11.3. The data presented are based on the responses of 77 participants, as one participant in the control group did not feel able to answer the question. A slightly smaller proportion of participants with an ASC selected the incorrect answer, compared to the control participants (53%, and 59%, respectively). While the direction of this difference in the distributions is consistent with the initial hypothesis (that the participants with ASCs would demonstrate a smaller *Availability* heuristic-led bias) the response distributions of the two groups do not differ significantly ($\chi^2(1, N = 77) = 0.31$, $p = 0.58$). The distribution of responses in the control group was consistent with the findings of Tversky & Kahneman (1973), in which 76% of participants judged that there were more paths containing 5X's and 1O, ($\chi^2(1, N = 89) = 2.95$, $p = 0.086$), although the bias demonstrated by the control participants in the present study is less pronounced than was found in the original study (see Discussion, Section 11.5).

These findings show that the groups did not differ in their tendency to rely on the *Availability* heuristic, although the control group demonstrated a bias smaller than expected given the response distribution found by Tversky & Kahneman (1973). However, as exploratory data, the response distribution does indicate a slight trend towards reduced bias in the ASC group.

Figure 11.3 *The distribution of responses to the Path Frequency question*

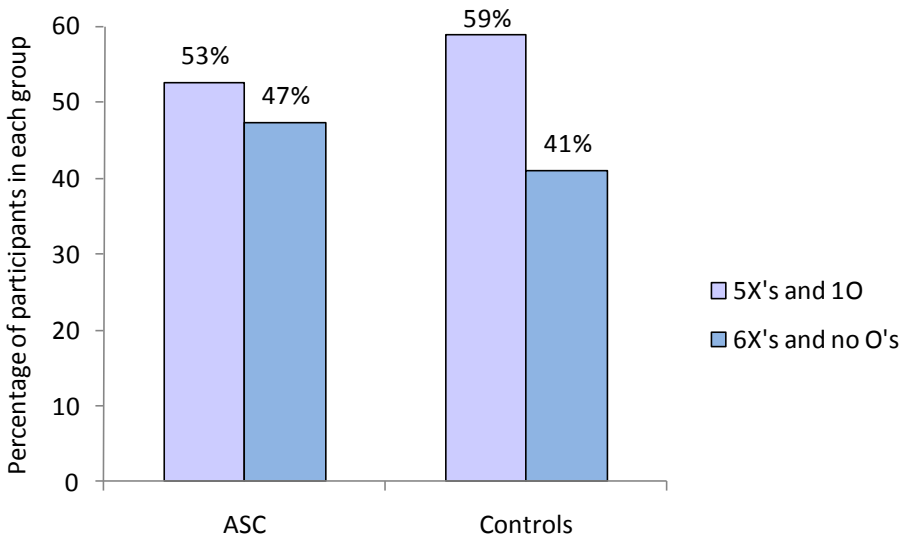


Figure 11.3 shows the distribution of responses of both groups to the Path Frequency question. According to Tversky & Kahneman (1973), reliance on the Availability heuristic is demonstrated by a tendency to judge that there are more paths containing 5X's and 1O than paths containing 6X's and no O's. The modal response in both groups was that paths of 5X's and 1O would be more frequent than paths of 6X's and no O's. Although a greater proportion of the control group judged this path type to be more frequent, the distribution of responses does not differ significantly between the groups.

11.3.2.2 Bias due to the effectiveness of the search technique

The distribution of responses to the 'R' Position question is shown in Figure 11.4. A smaller proportion of participants with an ASC selected the incorrect answer, compared to the control participants (54% and 74%, respectively). The direction of this difference is consistent with the initial hypothesis, but the difference between the groups is not statistically significant $\chi^2(1, N = 76) = 3.42$, $p = 0.065$). Analysed separately, however, the response distribution of the ASC group did not differ from chance (χ^2 goodness-of-fit (1, N = 37) = 0.11, $p = 0.75$), while the response distribution of the control group did differ significantly from chance (χ^2 goodness-of-fit (1, N = 39) = 9.26, $p = 0.002$). The distribution of responses in the control group was consistent with the findings of Tversky & Kahneman (1973), in which 69% of participants selected the incorrect option ($\chi^2(1, N = 191) = 0.41$, $p = 0.52$).

These findings suggest that reduced reliance on the *Availability* heuristic may be associated with ASCs, although the difference in the distributions of responses between the groups only approached statistical significance with this sample size. Replication of these proportions with a larger sample size (e.g. $n > 74$)[g] would provide sufficient power to test this hypothesis.

[g] This is the sample size required to detect a difference in the observed proportions with 70% power.

Figure 11.4 *The distribution of responses to the 'R' Position question*

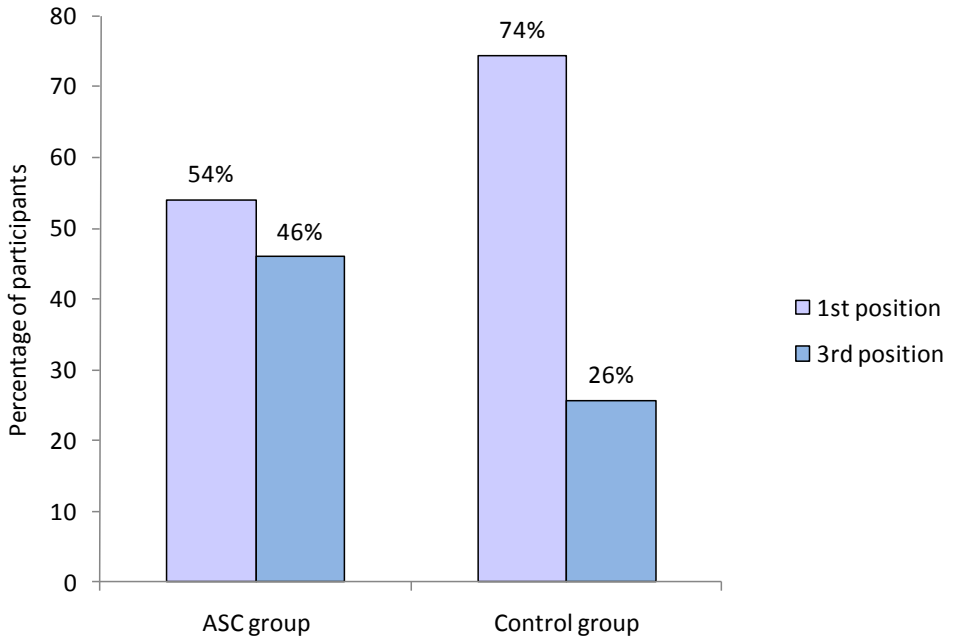


Figure 11.4 shows the distribution of responses for both groups of participants to the 'R' Position question. According to Tversky & Kahneman (1973), reliance on the Availability heuristic is demonstrated by a tendency to judge that the letter 'R' occurs more frequently in the first than the third position in English words. Although a smaller proportion of participants with ASCs selected the first position, compared to the control group, the difference in the distribution of responses between the two groups only approached significance.

11.3.3 *Reliance on the Anchoring-Adjustment heuristic*

11.3.3.1 Insufficient adjustment when choosing between conjunctive and simple gambles

The distribution of responses to the three Conjunctive vs. Simple Gamble questions is shown in Figure 11.5. Contrary to the initial hypothesis, the groups did not differ in their responses ($\chi^2(3, N = 78) = 5.49$, $p = 0.14$). However, the modal response for the ASC group was to choose 2 out of 3 conjunctive gambles (45%) and the modal response for the control group was to choose 3 out of 3 conjunctive gambles (33%). This is in line with initial expectations. The bias demonstrated by the control group was not as pronounced as that found by Bar-Hillel (1973). This may be attributed to the fact that for Question B the distribution of responses in the control group was not consistent with the distribution found by Bar-Hillel (1973) ($\chi^2(1, N = 55) = 4.04$, $p = 0.045$).

These results do not provide evidence to support the hypothesis that the participants with ASCs relied less on the *Anchoring-Adjustment* heuristic to answer these questions than the control group. However, as exploratory data, the response distributions do show a slight trend towards reduced bias in the ASC group.

Figure 11.5 *The distribution of responses for the Conjunctive vs. Simple Gambles question*

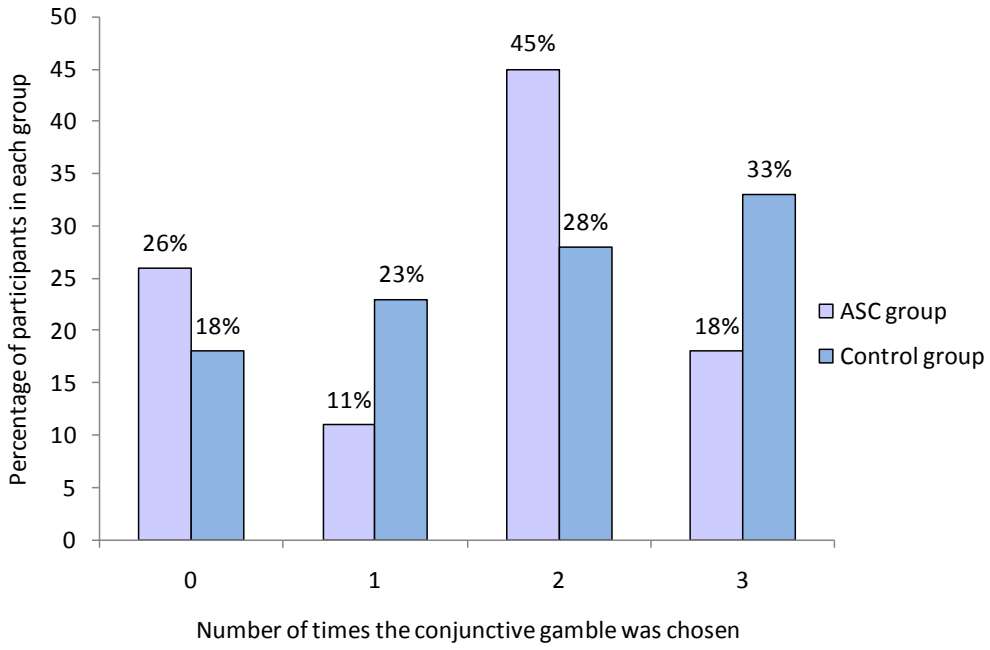


Figure 11.5 shows the distribution of responses for both groups of participants to the Conjunctive vs. Simple gamble questions. According to Bar-Hillel (1973) and Tversky & Kahneman (1974), reliance on the Anchoring-Adjustment heuristic is demonstrated by a tendency to select conjunctive gambles more often than simple gambles. The modal response in the ASC group was to choose 2 out of 3 conjunctive gambles, whereas the modal response in the control group was to choose 3 out of 3 conjunctive gambles. However, the distribution of responses does not differ significantly between the groups.

11.3.3.2 Insufficient adjustment when choosing between disjunctive and simple gambles

The distribution of responses to the Disjunctive vs. Simple Gambles questions is shown in Figure 11.6. Contrary to the initial hypothesis, the groups did not differ in their responses $\chi^2(3, N = 78) = 4.26$, $p = 0.23$). The modal response of the ASC participants was to choose 1 out of 3 simple gambles, and the modal response in the control group was to choose 2 out 3 simple gambles. The distribution of responses in the control group was not consistent with

the distributions found by Bar-Hillel (1973) for any of the three questions. These findings, therefore, imply that neither group relied upon the *Anchoring-Adjustment* heuristic to answer these questions.

Figure 11.6 *The distribution of responses to the Disjunctive vs. Simple Gambles questions*

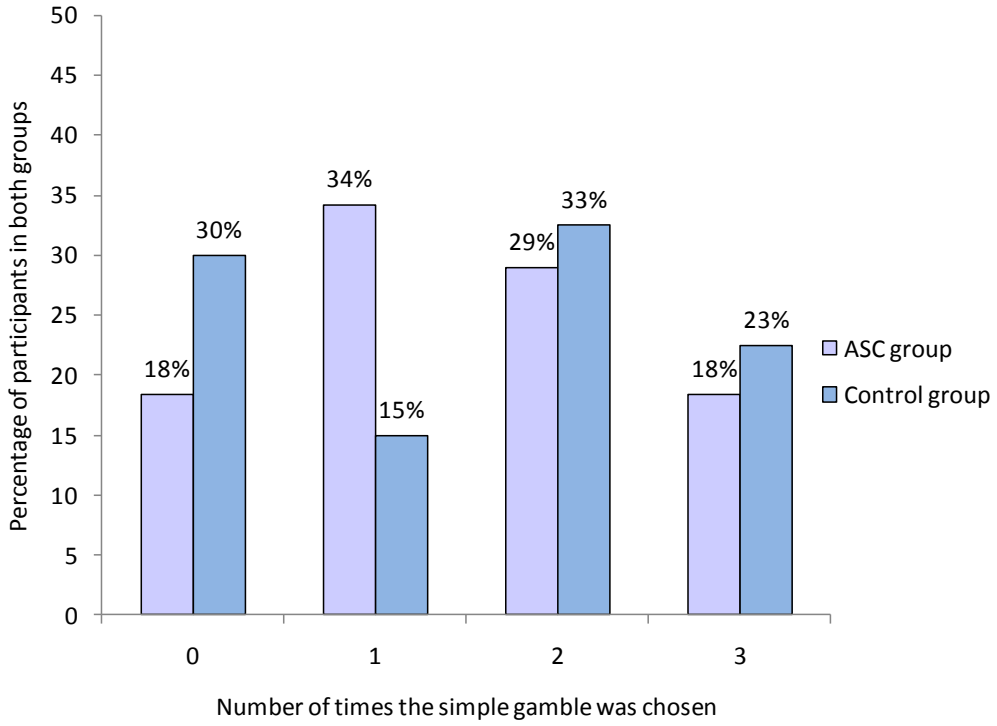


Figure 11.6 shows the distribution of responses for both groups to the Disjunctive vs. Simple Gamble questions. According to Bar-Hillel (1973) and Tversky & Kahneman (1974), reliance on the Anchoring-Adjustment heuristic is demonstrated by a tendency to select simple gambles more often than disjunctive gambles. The distribution of responses suggests that neither group relied on the Anchoring-Adjustment heuristic to answer these questions.

11.3.4 *Reliance on the Affect heuristic*

11.3.4.1 The framing effect on a the Asian Flu question (single trial)

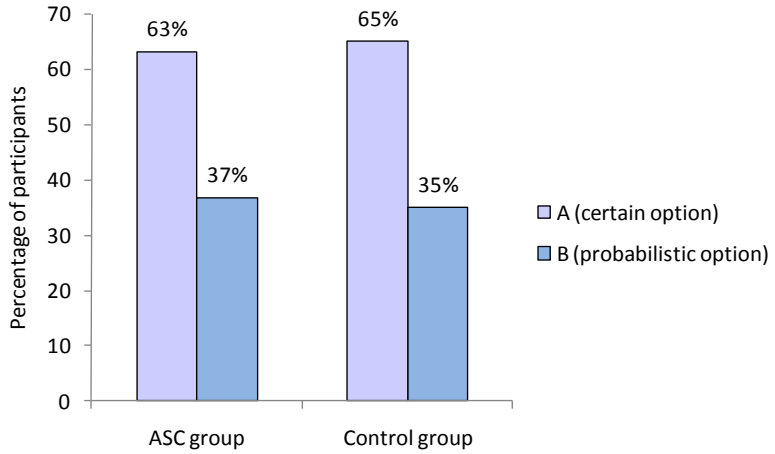
The distribution of responses to the two question formats of the Asian flu question is shown in Figure 11.7. Contrary to the initial hypothesis, the groups did not differ in the distribution of their responses to the two versions of the question (Gain-focused format: $\chi^2(1, N = 78) = 0.03$, $p = 0.87$; Loss-focused format: $\chi^2(1, N = 78) = 0.79$, $p = 0.38$). However, the direction of the small, non-significant difference between the groups in the

Loss-focused format (ASC group: 50% participants selected the risk taking option; Control group: 60% participants selected the risk taking option) is in line with the initial hypothesis. The absence of a significant finding in the present study may be due to the smaller bias demonstrated by the control group, compared to the participants recruited by Tversky & Kahneman (1981). In their study, 78% of control participants selected the risk-seeking option in the Loss-focused format, which is significantly different from the corresponding proportion found in the present study ($\chi^2(1, N = 195) = 5.44$, *p = 0.02)*.

Despite the above negative findings, it is worth considering the consistency of participants' responses (whether risk-averse or risk-taking) on the two question formats, since DeMartino et al (2008) report enhanced consistency between positive and negatively framed questions in people with ASCs that was independent of individual differences in risk-taking. These data are shown in Figure 11.8. The participants with ASCs in the present study were more consistent in their responses between the two question formats. In the ASC group, 82% of participants were consistent in their choices, while only 55% of the control were consistent in their choices ($\chi^2(1,N = 78) = 4.36$, *p = 0.037*). This suggests that, overall, the participants with ASCs were less influenced by the wording of the question and more consistent in their responses compared to the control group.

Figure 11.7 *The distribution of responses to the two formats of the Asian Flu question*

a) Gain-focused format



b) Loss-focused format

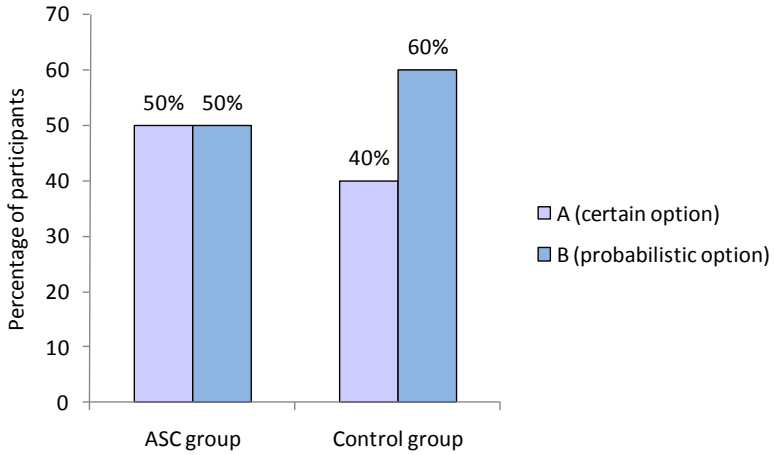


Figure 11.7 shows the distribution of the responses of both groups to the Asian Flu question: a) shows the responses to the Gain-focused format of the question; b) shows the responses to the Loss-focused format of the question. According to Tversky & Kahneman (1981) and DeMartino et al. (2006), the framing effect is underpinned by the Affect heuristic, which is demonstrated by a tendency to be risk-averse (preferring the certain option) when focusing on gains, and risk-seeking (preferring the probabilistic option) when focusing on losses. Although the proportion of the participants with ASCs selecting the risk-seeking option is smaller in the Loss-focused format, compared to the control group, the distributions of responses do not show a statistically significant difference between the groups.

Figure 11.8 *The proportion of participants responding consistently between the two formats of the Asian Flu question*

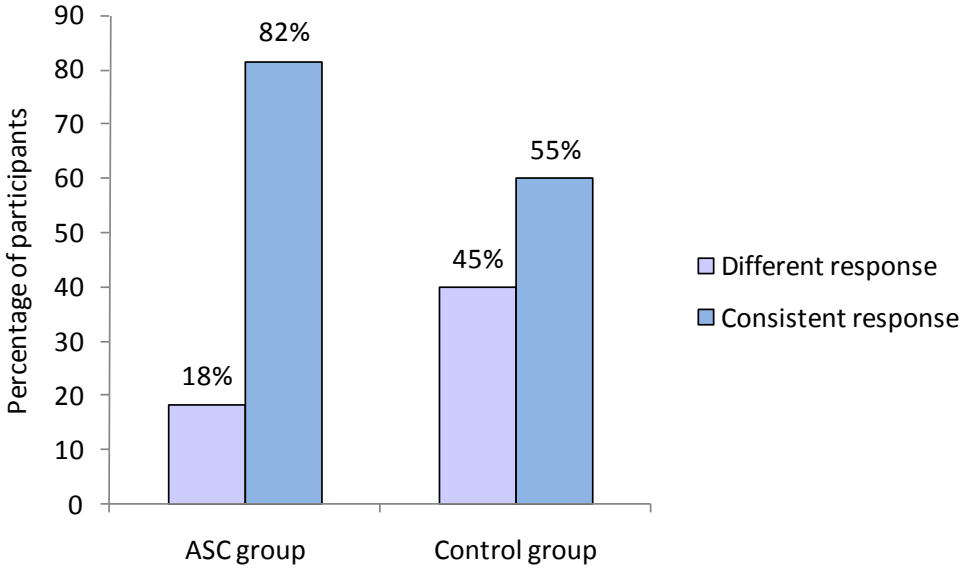


Figure 11.8 shows the proportions of participants in both groups responding consistently between the two formats of the Asian Flu question. According to Tversky & Kahneman (1981), the format of the questions elicits a framing effect demonstrated by preference reversal. The participants with ASCs demonstrated greater consistency in their responses (whether risk-averse or risk-taking), compared to the control group.

11.3.4.2 The framing effect on the Risky Choice Task (multiple trials)

The proportion of probabilistic choices made in each condition of the Risky Choice Task (RCT) is shown in Figure 11.9. Contrary to the initial hypothesis, the participants with ASCs did not demonstrate reduced susceptibility to the framing effect (z = -1.17, p = *0.24*), although the small non-significant difference in the magnitude of the framing effect between the groups (ASC group: 31% fewer risky choices in gain frame compared to the loss frame; Control group: 38% fewer risky choices in the gain frame compared to the loss frame) is in the direction predicted by the initial hypothesis. Both groups demonstrated a framing effect by choosing the probabilistic (risk-taking) option more frequently in the Loss condition, compared to the Gain condition (ASC group: z = -3.83, p<0.001; Control group: z = -4.53, *p<0.001*). These findings suggest that participants with an ASC demonstrated a framing effect similar to that of the control participants on the RCT.

Figure 11.9 *The proportion of probabilistic (risky) choices made in the Loss-frame and Gain-frames on the Risky Choice Task*

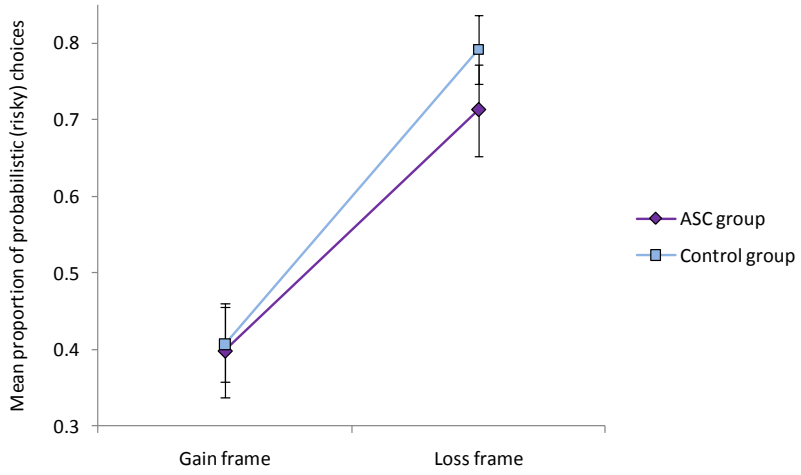


Figure 11.9 shows the mean proportion of trials in which the probabilistic (risky) gamble was chosen for the two framing conditions of the Risky Choice Task, for both groups of participants. According to Tversky & Kahneman (1981), participants tend to be risk-averse (preferring the certain option) when focusing on gains, and risk-taking (preferring the probabilistic option) when focusing on losses. Both groups demonstrated a framing effect by choosing the probabilistic option more often in the Loss frame compared to the Gain frame. There was no difference in the mean magnitude of the framing effect between the groups. The magnitude of the framing effect was calculated by subtracting the proportion of probabilistic choices in the Gain frame from the proportion of probabilistic choices in the Loss frame.

11.3.4.3 Correlations between the framing effect and relevant participant characteristics

Although the groups did not differ in their susceptibility to the framing effect on the RCT, two correlation analyses were carried out to establish whether magnitude of the framing effect (a continuous variable) was inversely related to: 1) the Autism Spectrum Quotient (AQ) score; and 2) the frequency of self-reported problems with i) mental 'freezing' ('*analysis paralysis*') during decision-making, ii) taking a *long time* to make decisions, and iii) feeling *exhausted* by decision-making (self-reports provided by the survey questions administered in the experimental study, see Section 3.4.1). The survey questions selected for analysis were those with a theoretical link to more effortful processing in decision-making. The magnitude of the framing effect was calculated by subtracting the proportion of risky choices made in the gain frame, from the proportion of risky choices made in the loss frame.

There was no overall correlation between AQ scores and the magnitude of framing effects on the RCT (Kendall's τ = -0.086, $p = 0.30$). This suggests that susceptibility to the framing effect is not related to this index of the number of autistic traits. The magnitude of the framing effect was, however, inversely related to the self-reported frequency of mental 'freezing' during decision-making ($F(1, 72) = 5.29$, $p = 0.025$, $\alpha' = 0.0259$). The relationships between magnitude of the framing effect and feelings of exhaustion and slowness during decision-making were not significant ($F(1, 72) = 0.361$, $p = 0.062$ and $F(1, 71) = 0.322$, $p = 0.57$, respectively). This suggests that reduced susceptibility to the framing effect, thought to be underpinned by the *Affect* heuristic, is associated with more frequent feelings of mental 'freezing' ('*analysis paralysis*') during decision-making. This relationship is consistent with the view that reliance on heuristics can reduce the cognitive demands required to make certain decisions.

11.4 Summary of findings

Contrary to the initial hypotheses, the participants with ASCs responded similarly to the control group on the tasks constructed to demonstrate reliance on the *Representativeness, Anchoring-Adjustment* and the *Affect* heuristics. However, the results suggest a trend for participants with ASCs to demonstrate reduced reliance on the *Availability* heuristic although a larger scale study would be required to confirm this trend. While the groups did not differ in their susceptibility to the framing effect on the Asian flu question, the participants with ASCs were less likely to reverse their preference (whether risk-averse or risk-taking) between

the two question formats. Finally, the framing effect, as measured by the Risky Choice Task (RCT), did not differ between the groups and was not associated with an index of the number of autistic traits. Reduced framing effects were, however, associated with the frequency of self-reported problems of mental 'freezing ('*analysis paralysis'*) during decision-making.

11.5 Discussion of results

This exploratory study was carried out to assess whether reduced reliance on heuristic short-cuts could account for the feelings of exhaustion reported by people with ASCs in the initial survey of decision-making experiences. For the most part, the findings from the quiz-like questions and the RCT do not provide evidence to support this hypothesis. In particular, the participants with ASCs demonstrated clear reliance on the *Representativeness* heuristic for the Hospital Births question, and a robust framing effect on the RCT. However, the findings from the 'R' Position question, tends to suggest that participants with ASCs are less reliant on the *Availability* heuristic than control participants. In addition, the findings from the Asian Flu question suggest that participants with ASCs are less likely to reverse their preference (whether risk-averse or risk-taking) with a change in the question format, compared to the control participants.

For most of the tasks, there were small, non-significant differences in the distributions of responses between the groups that were consistent with the initial hypotheses; the main limitation in carrying out a robust test of these hypotheses appears to be the sample size. While the demonstrations published by Tversky & Kahneman, and their colleagues typically used a sample size in excess of 50, the sample size in the present study was significantly smaller than this since the investigation was powered on the basis of a test described in an earlier chapter. If further studies were to be conducted, it would be particularly worthwhile considering the 'R' position question, since, based on the proportions found here, the initial hypothesis may be adequately tested with around 80 participants.

The similarity between the groups may also be due to the responses of the control group. Although the distribution of responses between the present control group and the participants in the original studies did not differ significantly from one another in the Birth Order, Path Frequency, Avian Flu (gain frame), and Conjunctive vs. Simple gamble questions, the biases demonstrated by the control group in this study were clearly less pronounced than previously

reported. It is, therefore, difficult to know whether the lack of a statistically significant difference between the ASC and control groups is a real effect or indicates an abnormal control group. It is possible that the general method of administration of the questions reduced their effectiveness as demonstrations of heuristic-led biases. For example, perhaps the payment offered to participants in Kahneman & Tversky (1972) and Bar-Hillel (1973), increased motivation to attempt the questions? Alternatively, the within-subject design may have provided cues signaling the need to override the heuristic responding system (e.g. Kahneman & Tversky, 2000), which might include the feeling that a series of 'trick' questions were being presented. This can be a particular problem with participants of high intellectual ability (like many of those recruited in the present study), who are better able to override their heuristic-led response when they recognise the need to do so (Stanovich & West, 2008). It is important to note, however, that many heuristic-led biases are surprisingly independent of cognitive ability (Stanovich & West, 2008; Morsanyi, Primi, Chiesi & Handley, 2009). Another possible explanation is that the control participants' understanding of probability and statistics may be superior to the psychology undergraduates recruited to the original studies. In the support of this hypothesis, 43% of the control participants had further education qualifications in a scientific or mathematical field.

Specific differences in the administration of two of the questions may also have contributed to the smaller biases demonstrated by the control group, compared to the findings of the original studies. The effectiveness of the Path Order question may have been reduced by reproducing the test card with a smaller distance between the columns of symbols (5mm) in the 6x6 grid, than was presented in the original study (7mm), as a larger distance may further encourage vertical visualisation of the paths. The administration of this question was also affected by the need to point out an example of a path with the first two participants of the study, who did not understand the written instructions that were reproduced from the original study. For consistency, this practice was continued with all the participants, but may have emphasised the instruction that paths can be made by linking symbols in different columns.

The administration of the Asian Flu question differed from the original study by presenting both formats of the question to each participant (within-subjects), rather than just one format of the question (between-subjects, see Tversky & Kahneman, 1981). Although the order of presentation of the questions was fully counterbalanced, and the order of all six quiz-like

questions was randomised, some participants may have recognised the equivalence of the response options and answered the second question differently as a result (see the above discussion about the effects of within-participant designs). This may explain the consistency demonstrated by the participants with ASCs. Analysis of the first format of the question presented to participants, however, would be based on sample sizes that are too small to be meaningful (n = 19). To establish whether the enhanced consistency demonstrated by the participants with ASCs is due to increased recognition of the equivalence of the response options, or a traditional framing effect, repetition of the (within-participant) experiment with a larger sample of participants would be required.

The similarity between the performance of the two groups in the framing trials of the RCT was not consistent with the findings of De Martino et al. (2008). In this study, which did not use the RCT but a novel task developed by the researchers, participants with ASCs demonstrated reduced susceptibility to framing compared to controls. It is possible, however, that this difference was due to the larger number of trials presented by De Martino and his colleagues (192 trials, compared to 16 trials in the RCT), and differences in the task presentation of the gambles, which involved representations of money rather than points. The mean ages and intellectual ability of the participants with ASC recruited by De Martino and his colleagues were similar to the participants in the present study (M_{age} = 34.8 years (*SD = 7.9*), M_{FSIQ} = 112.1 (*SD = 13.5*), compared to M_{age} = 34.0 years (*SD = 15.5*) and M_{FSIQ} = 119.2 (*SD = 10.6*), respectively). The consistency demonstrated on the Asian Flu question (whether risk-taking or risk-averse), does, however, support their finding that participants with ASCs are more logical in their choices, even though the pattern of choices in the Loss frame in the current study did not provide statistically significant evidence of a traditional framing effect.

Although this exploratory aspect of the present study has produced few conclusive findings, it is of interest that the relationship between the magnitude of the framing effect on the RCT and the self-report measure of mental 'freezing' ('*analysis paralysis*') during decision-making is significant. This suggests that reduced reliance on framing effects, believed to be underpinned by the *Affect* heuristic, is associated with experiences of effortful decision-making. It is possible, therefore, that reduced reliance on heuristics makes a small contribution to the experiences of people with ASCs during decision-making. The findings

of this exploratory study highlight reliance on heuristics as an area of potential future research. In particular, these results suggest that the recruitment of the large sample sizes required for this type of analysis would be warranted.

CHAPTER 12: GENERAL DISCUSSION

The focus of this research has been the decision-making experiences and processes of intellectually able adults with Autism Spectrum Conditions (ASCs). While adults with ASCs are able, in many situations, to make decisions for themselves, there are suggestions from a variety of sources that decision-making can be difficult for them. Consistent with this suggestion, there is increasing recognition that statutory frameworks seeking to empower and protect adults at risk of lacking capacity for making one or more decisions autonomously (for example, the Mental Capacity Act (*England and Wales*) 2005) are relevant to some people with ASCs (Butcher, 2007). At present, there is limited guidance available for clinicians and carers of adults with ASCs about the ways in which decision-making may be affected by the condition, or guidance about how these adults could be supported. This research has investigated some of the putative difficulties experienced by people with ASCs when making decisions. In this final chapter, the main findings are summarised and their implications for clinical practice and future research, together with some limitations of the project, are discussed.

12.1 Main findings of the research

12.1.1 *Survey of decision-making experiences*

An initial aim of the research was to evaluate whether an empirical study of decision-making cognition in ASCs would be worthwhile and, if so, which aspects should be the focus of such a study. To this end, a national survey of the decision-making experiences of adults with ASCs, which included the perspectives of family members and support workers of adults with ASCs, was carried out. The findings suggested that decision-making could be difficult for many adults with ASCs. Decision-making was reported to be associated with anxiety, feelings of limited confidence, exhaustion and fatigue, and a tendency to avoid decision-making. In addition, a number of specific difficulties were reported that could generally be placed into three broad, but not necessarily distinct, categories: i) problems engaging in decision-making; ii) problems in reaching a decision; and iii) fears of negative judgements about the decision made. These problems were listed in Section 2.3.2.

Despite the generally negative view of the effect of ASCs on decision-making, a number of benefits of the condition were also identified. These included enhanced abilities to apply logic, consider details and gather information, and to develop strategies for decision-making. Moreover, some of these benefits could be 'double-edged' in that they could also frustrate decision-making in certain situations. For example, the tendency to consider details and gather information, while viewed as generally positive, could be detrimental in situations where decisions needed to be made quickly.

The main conclusion drawn from the survey was, therefore, that decision-making is perceived as an area of difficulty for people with ASCs. The findings suggested some differences in the decision-making experiences and processes of people with ASCs compared to the general population, although further empirical studies are required to quantify these more precisely.

12.1.2 *Experimental study of decision-making in ASCs*

To develop some of the findings from the survey, an empirical investigation was carried out using five tests of decision-making. Importantly, this part of the research involved comparing the experiences and behaviours of participants with ASCs to those of control participants recruited from the general population. Taken together, the specific research questions attempted to establish: i) whether the profile of self-reported experiences distinguished participants with ASCs from control participants; ii) whether the experiences reported were consistent with behaviour measured by established neuropsychological tests of decision-making; and iii) whether there were differences in the decision-making processes of people with ASCs that could account for some of the difficulties they described. The research questions formulated are summarised in Table 12.1 together with the corresponding findings.

Table 12.1 *Summary of findings from the experimental study of decision-making in ASCs*

Research Question	**Overall conclusion**	**Description of findings** (*participants with ASCs compared to the control group*)	**Section**
Do participants with ASCs experience decision-making differently to participants in the general population?	Yes	• Participants with ASCs experience several problems with decision-making more frequently than the control group. Specific problems include: anxiety, exhaustion, mental 'freezing' and slowness. • Participants with ASCs experience particular difficulty with decisions that involve: i) a change of routine; ii) talking to others; and iii) that need to be made quickly. • Participants with ASCs report greater avoidance of decision-making. • Participants with ASCs believe that their condition is more often a hindrance than a help with decision-making.	5.3.1 5.3.2 5.3.3 5.3.4
Do participants with ASCs demonstrate reduced flexibility and greater caution in their decision-making?	No	• Participants with ASCs demonstrate similar levels of flexibility and risk-taking in decision-making to the control group. • In the ASC group (and not the control group), increased anxiety is correlated with reduced flexibility in decision-making.	6.3.1 – 6.3.5 6.4
Do participants with ASCs gather more information prior to making a decision?	Yes	• Participants with ASCs make decisions with a higher degree of certainty. • Across both groups, the tendency to make decisions with a higher degree of certainty is associated with self-reported problems of slowness in everyday decision-making.	7.3.2.2
Do participants with ASCs take longer to make decisions?	Yes	• Participants with ASCs take longer to make decisions on two laboratory tasks. • Across both the ASC and control groups, the time taken to make the decisions increases with an individual's tendency to make decisions with a higher degree of certainty.	8.3.2 & 8.3.3 8.3.3

Research Question (cont.)	Overall conclusion	Description of findings (cont.)	Section
Are participants with ASCs more aroused when making decisions?	No	• Although participants with ASCs demonstrate generally higher levels of arousal, they do not demonstrate increased arousal while making decisions. • Both the ASC and control groups experience greater anxiety when the computer makes the decisions, rather than when they themselves make the decisions.	9.3.1 9.3.3
Do participants with ASCs demonstrate differences in motivational processes in decision-making?	No	• Participants with ASCs are motivated by positive and negative feedback in a manner similar to that of control participants. • Participants with ASCs make a greater proportion of advantageous decisions and demonstrate less variation in their choices. • The tendency for participants with ASCs to make advantageous choices is associated with self-reported problems of slowness in everyday decision-making.	10.4.4 10.4.1 10.4.5
Do participants with ASCs demonstrate reduced reliance on heuristics to make decisions?	No (but…)	• Participants with ASCs demonstrate similar reliance on the *Representativeness* and *Affect* heuristics to the control group. • Participants with ASCs demonstrate a non-significant trend towards reduced reliance on the *Availability* heuristic. • Participants with ASCs are more consistent in their choices, and less influenced by the wording of the question. • Across both groups, reduced reliance on the *Affect* heuristic was associated with self-reported problems of mental 'freezing' in everyday decision-making.	11.3.1 & 11.3.4.2 11.3.2 11.3.4.1 11.3.4.3

Overall, the results indicated that people with ASCs experience significant problems in decision-making in everyday life. Their performance on some of the standard laboratory tests of decision-making were also consistent with the experiences they reported (increased information gathering, slowness, and enhanced logic). When compared to the control participants, the participants with ASCs did not demonstrate differences in two decision-making processes (motivation and reliance on heuristics), although there was a non-significant trend for participants with ASCs to rely less on the *availability* heuristic. If found to be significant in a larger sample, this finding could account for their experiences of exhaustion and mental overload in decision-making.

The findings of this thesis relate to decision-making in a real-world, as well as a laboratory, context. The consistency between some of the self-report and behavioural findings is particularly striking when the differences between the two contexts are considered. The self-reported experiences related to decision-making in complex situations with multiple factors that could affect a person's ability to decide (for example, social pressure, Asch, 1956; a large number of alternatives, Fasolo, McClelland & Todd, 2007; busy environments and interruptions, Sperier, Vessey & Valacich, 2003; and personal significance, such as a special interest, Howlin, 2004). In contrast, the laboratory tasks assessed decision-making under controlled and optimal conditions: the environment was quiet and without distraction; the number of choices was limited; participants did not have to generate the alternative courses of action for themselves; and the decisions did not carry serious consequences. The differences between laboratory and real-world settings may be particularly significant for people with ASCs, since evidence from a number of studies suggests that people with ASCs are more sensitive to, and likely to feel overwhelmed by, environmental stimuli (for example, Kootz, Marinelli & Cohen, 1982; Minshew & Hobson, 2008) and are also more likely to feel anxious in social situations (for example, Bellini, 2006; Kuusikko et al., 2008). The behavioural measures that were not consistent with the self-reported experiences may, therefore, simply reflect these differences of context.

Nevertheless, the findings may be combined to identify situations that would be expected to be very difficult for a person with an ASC. A difficult decision may be characterised by the following features: the decision needs to be made quickly; information about options and their consequences is limited; other factors (such as environmental noise or the prospect of

talking to people) are contributing to heighted anxiety; and other people are putting pressure on the person to make the decision in a particular way.

These factors may be relevant in a number of real-life situations. For example, healthcare decisions may need to be made quickly in a single consultation. Within education, people may have to make decisions that involve a number of different options (for example, which courses to take, whether to remain in education). In both of these situations, but particularly in the latter, the outcomes may involve a number of unknowns. In social care systems, people with ASCs are often presented with choices about how to spend their personal budgets (for example, Self-Directed Support, see Putting People First, 2007), and how to spend their time (for example, Personalisation, see Carr, 2010) and these are matters that others may have strong feelings about. It is interesting to note the tension between the findings of this research and these social care policies: the findings suggest that decision-making can be an unpleasant activity for some people with ASCs and yet, through legislation and policy, they are encouraged to make decisions within their everyday lives. Resolution of this tension may require attention to improving the experience of decision-making for people with ASCs.

12.2 Practical implications of the research

The findings from this research suggest a number of recommendations for ways in which people with ASCs could be better supported to make decisions. The strategies may include:

1. Addressing stress and anxiety already present at the time of the decision. The detrimental effects of anxiety on decision-making are well-known, and the findings have shown that the ability to be flexible in decision-making may be compromised by high levels of anxiety in ASCs. It therefore seems sensible to address, if possible, any underlying anxiety prior to the attempt to encourage someone to make a decision. Anxiety may be addressed with reassurance (in particular reassurance that the individual will not be judged negatively), removal of stressors, or simply trying to ensure that decisions are made at a time when the person is likely to be relatively relaxed. There is some evidence that cognitive behavioural techniques may be successful in alleviating anxiety in some people with ASCs (see Sze & Wood, 2007; Wood et al., 2009), although these were not assessed as part of the present research.

2. Providing additional time to make decisions and reassurance that there is no need to rush. The participants described slowness in decision-making as a particular problem, and this was supported by longer response times on the decision-making tests.
3. Presenting closed (rather than open) questions. This may reduce experiences of mental overload in ASCs.
4. Minimising irrelevant stimuli in the environment. This may alleviate experiences among people with ASCs of feeling overwhelmed by decision-making.
5. Providing encouragement and reassurance. The findings indicated that people with ASCs can view their abilities to make decisions negatively. However, their performance on the standard tests of decision-making indicated that, in fact, they are able to make decisions of similar quality to those in the general population. Indeed, in some situations the quality of decisions made by those with ASCs is superior to that of the general population. Reassurance that the person is capable of making decisions may, therefore, be helpful. This may also help to reduce anxiety levels (see 1 above).
6. Tailoring the decision-making process to match the person's strengths in decision-making. The research indicated that people with ASCs can be more logical in their decision-making. Providing all the relevant information in a clear format may therefore help the person to focus on the analytical part of the process, rather than becoming distracted by information gathering.

Of course, these recommendations are general and may not apply to particular individuals with an ASC. Efforts to provide support will, therefore, require an assessment of the person's individual strengths and weaknesses. These recommendations will also appear to be common sense for many families, support workers and practitioners with experience of working with people with ASCs. However, their dissemination and inclusion in guidance may be useful, since, as Preece & Jordan (2007) found in their study of social workers, even those who are frequently involved in providing support around key decisions can have limited awareness of the condition and its impact in everyday life.

Outside of clinical and social care services, the findings may be of use to others who also provide support to individuals around important decisions, such as college tutors, disability

support staff in educational and occupational settings, volunteer advisors (for example Citizens Advice Bureau volunteers), and advocates.

12.3 Limitations of the research

The limitations of individual tasks in the study have been discussed in the relevant previous chapters. There are, however, a number of more general limitations; these are considered here.

12.3.1 *Participants*

12.3.1.1 Sampling bias

As with most research studies involving people with ASCs, the participants were those who accepted an invitation to take part and were able to make arrangements to attend the research site. As a result, the sample may not be representative of the population of people with ASCs; the ASC group in this study was above average intellectual ability and demonstrated no impairments in the measured executive functions. Furthermore, these were people who were keen to participate in research. The findings from this research may not, therefore, be generalisable beyond this population.

12.3.1.2 Participant characteristics

The age range of the participants was rather wide (16 – 65 years). Since age is an important factor in decision-making behaviour (Deakin, Aitken, Robbins et al., 2004), the statistical analyses may have been more powerful if a narrower age range of participants had been recruited. However, to control for the effect of age as best as possible, the groups were matched for age.

A further limitation is that the scores of depression and anxiety were significantly higher in the ASC group compared to the control group. This was not surprising since anxiety and depression are very common in people with ASCs (see Kim, Szatmari, Bryson, Steiner & Wilson, 2000; Tantam, 2000). However, it is difficult to discern whether group differences observed (in some tests only) may be attributed to higher levels of anxiety and/or depression or a result of the presence of an ASC. Statistical control of anxiety and depression was carried out wherever it was necessary and possible to do so. Nonetheless, the situations where anxiety could not be controlled for statistically (for example, where the assumption of

homogeneity of regression was not met) indicated an effect of anxiety or depression that was specific to the participants with ASCs. However, this may simply have reflected the higher ratings of anxiety in the participants with ASCs. From the perspective of everyday life, it is noted that the experiences of many people with ASCs may be influenced by high levels of anxiety and depression. From an academic perspective, the recruitment of participants in the control group with similar levels of anxiety and depression to those in the experimental group would have helped to control for any specific effect of anxiety and/or depression on task performance.

Ten participants (nine in the ASC group, one in the control group) were taking antidepressant or anxiolytic medications that could have affected their performance on the decision-making tasks. To control for this, each analysis was repeated without these participants. However, it should be noted that this solution created its own limitation; there were smaller and less equal group sizes, which reduces the power and robustness of statistical tests.

Finally, this research did not consider the heterogeneity of people with ASCs. There is, of course, considerable heterogeneity in the behaviours and impairments demonstrated by people with ASCs (Rutter & Schopler, 1987; Ring, Woodbury-Smith, Watson, Wheelwright & Baron-Cohen, 2008). The participants with ASCs in this research were treated, however, as a single group. While this approach is commonly taken in other studies (for example, De Martino et al., 2008; Yechiam et al., 2010), there is increasing recognition that future studies should seek to identify behavioural subtypes within the group in order to identify the most effective treatments for individuals (South et al., 2010). The findings presented are, therefore, general findings about population differences between control participants and participants with ASCs; they are unlikely to apply equally to all individuals with ASCs.

12.3.2 *Reliability*

It is a significant limitation that the test-retest reliability of the measures developed specifically for this research (the questionnaires of decision-making experiences and the adapted Risky Choice Task) was not established. At best, there was an informal comparison of the responses of the eleven participants who completed both the survey and experimental versions of the questionnaire (see Section 3.4.1). The other measures employed in the research were, however, established measures that have been developed for research use.

12.3.3 *Validity*

The validity of the questionnaires of decision-making experiences was not formally assessed prior to their use in the study. Instead, only post-hoc and piecemeal analyses were carried out. One of these was a general comparison of the survey responses of participants with ASCs and family members and support workers of adults with ASCs. However, the study design would have been strengthened by obtaining matched responses from family members and support workers of the participants.

Other problems of validity concern the laboratory-based tests of decision-making. While they were designed to capture elements of decision-making that are encountered in real life (see Cavedini et al., 2006; Salmond et al., 2006), they present decisions that are abstract and, at face value, lack ecological validity. Nevertheless, the majority of the tests had been developed to the standard required for general research use and there is evidence that performance on the tasks is associated with particular problems in real-life decision-making (see for example, Clark et al., 2006, in which observations of impulsive decision-making in substance abusers are found to be associated with increased tolerance of uncertainty as measured by the Information Sample Task). Moreover, in the present research it was possible to compare the behavioural measures with responses on the questionnaire of decision-making experiences that were relevant to those measures. For example, the relationship between self-reported problems of slowness and speed of decision-making on the behavioural tasks was assessed. In most cases, the measures from the tests were related to a particular experience in decision-making. This provides some support for the validity of both the questionnaires and the tests of decision-making.

12.4 Implications for future research

One of the main limitations of the research was that the decision-making tasks were simplified and lacked ecological validity. As a result it is difficult to establish the extent to which the observed similarities and differences between the ASC and control groups are related to the subtleties of real-world decision making that may lead to the difficulties reported by the participants. Future studies should, therefore, consider assessing decision-making in ASCs using more realistic tasks. A starting point for such research could be the adaptation of the paradigms developed by Braeutigam and colleagues to study decision-making (for example, Braeutigam, Stins, Rose, Swithenby & Ambler, 2001; Ambler,

Braeutigam, Stins, Rose & Swithenby, 2004). These paradigms involve shopping decisions (a class of decision that was identified as problematic in several of the survey accounts) and have enabled identification of several neural processes involved in decision-making, such as silent vocalisation and the effect of familiarity on choice. Other paradigms could be developed that present medical decisions, or decisions with several stages, such as planning a journey. Development of more realistic paradigms may enable a better investigation of whether some of the difficulties reported by people with ASCs can be supported empirically.

Another consideration for future research may be the effect of anxiety on decision-making in ASCs. Anxiety was highlighted as an important factor in some of the results of the research. However, due to the difference in base levels of anxiety between the groups, it was not possible to establish whether underlying anxiety was the cause of group differences or whether decision-making heightens anxiety and exerts specific effects in ASCs. Inclusion of a control group with high levels of anxiety may be able to address this issue. However, this may not be straightforward as the nature of anxiety may differ between people in the general population with anxiety disorders and people with ASCs.

Finally, interventions to assist with indecisiveness and avoidance of decision-making have been developed for use in Cognitive Behaviour Therapy (see Beck, 1995; Dugas & Ladouceur, 2000; Steketee, Frost, Wincze, Green & Douglass, 2000). Future research could involve an evaluation of these decision-making 'training' interventions for improving confidence and reducing anxiety around decision-making in ASCs, which may be helpful for some individuals.

12.5 Final conclusions

Decision-making is an essential part of everyday life and the findings from this research suggest that decision-making can be particularly difficult for people with ASCs. The research has also identified some of the possible reasons for these difficulties. The findings suggest that adults with ASCs, who have an intellectual ability in the normal range, may nevertheless benefit from support when making decisions. Such support might include acknowledgement of particular strengths in decision-making that are associated with ASCs, allowing additional time to make decisions, and addressing issues of anxiety. Previously, little was known about the impact of ASCs on decision-making, nor how people with ASCs might best be supported

to make decisions for themselves. These findings provide a scientific background to decision-making in ASCs that can contribute to the development of appropriate guidance on how best to support this group of men and women in decision-making.

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Appendix A: Survey questionnaire adults with an autism spectrum condition

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Survey

FOR MEN AND WOMEN WITH AN AUTISM SPECTRUM CONDITION

This survey is part of a research project being carried out by Miss Lydia Luke, Dr Isabel Clare, and Dr Howard Ring, who work in the Section of Developmental Psychiatry, University of Cambridge.

This questionnaire will take approximately 30 minutes to complete.

Please read the information about this project on the next page before beginning the questionnaire

Project information

What is this research project about?
This project is about decision-making in everyday life. We are interested in the kinds of decisions that adult men and women (aged 16 years or more) with autism spectrum conditions face in their lives and why some decisions might be difficult. This research is relevant to recent legislation (the *Mental Capacity Act 2005* and the *Adults with Incapacity (Scotland) Act 2000*) which seeks both to empower people who are able to make decisions for themselves, and protect those who are unable to make one or more decisions. At present, we know little about how people with autism spectrum conditions make every day decisions, or whether they face particular difficulties in decision-making.

Who are we?
We are clinicians and researchers who work in the Section of Developmental Psychiatry, University of Cambridge. The research team are Miss Lydia Luke, Dr Isabel Clare and Dr Howard Ring.

How long will it take to do this questionnaire?
It will take approximately 30 minutes to complete this questionnaire.

Do I have to answer all the questions?
No. We would like you to complete as much of the questionnaire as possible, but you do not have to answer any questions if you do not want to.

Will my answers and information be kept confidential?
Yes. Your completed questionnaire will be anonymised by replacing your name with a code, which will be known only to members of the research team. Your contact details will also be removed from the questionnaires and kept with your name and code in a locked filing cabinet in the Section of Developmental Psychiatry, University of Cambridge. We will not give any of your personal details to other people. We will keep this data for a minimum of 5 years, after which it will be destroyed in accordance with good research practice.

What will happen to the study results?
The results will form part of my Ph.D. thesis and will be presented at conferences and written up in journals. If any of your individual answers are used, they will be totally anonymous and will not identify you in any way.

Do I have to take part in this study?
No. It is up to you to decide whether or not you would like to take part. You are free to withdraw at any time. Please contact Lydia Luke if you wish to withdraw after sending us your completed questionnaire.

Who has reviewed this study?
This study has received ethical approval from the University of Cambridge Psychology Research Ethics Committee.

What should I do if I have any questions about the research?
Please contact Lydia Luke (lrl29@medschl.cam.ac.uk or on 01223 746100) if you have any questions about this research.

Consent form

Project title: Decision-making by men and women with an autism spectrum condition
Name of Researchers: Miss Lydia Luke, Dr Isabel Clare & Dr Howard Ring

Before beginning the questionnaire, please demonstrate your understanding of the nature of this study by reading the statements and ticking the boxes below

	Please tick
1. I have read and understand the information about this study	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	☐
3. I understand that my anonymised answers will be incorporated into an account of this research that will be presented at conferences and in journals and written up as part of a Ph.D. thesis.	☐
4. I agree to take part in the above study.	☐

Please print your name and sign and date this page before beginning the questionnaire

Name: _____

Signature: _____

Date: _____

If you have any questions about this research please contact Lydia Luke by email lrl29@medschl.cam.ac.uk or by telephone on 01223 746100

SECTION 1: About you

1. Are you:
☐ Male
☐ Female

2. What is your age? _____

3. How would you describe your Ethnicity?

White	☐ British ☐ Irish ☐ Any Other White Background
Mixed	☐ White and Black Caribbean ☐ White and Black African ☐ White and Asian ☐ Any Other Mixed Background
Asian or Asian British	☐ Indian ☐ Pakistani ☐ Bangladeshi ☐ Any Other Asian Background
Black or Black British	☐ Caribbean ☐ African ☐ Any Other Black Background
Chinese or Other Ethnic Group	☐ Chinese ☐ Any Other (*please specify*)

4. What is your nationality? _____

5. What is the first half of your postcode?
(E.g. if your postcode is CB1 4DP, then just write CB1)
_____

6. Where do you live?
☐ With your parents/ guardian
☐ On your own
☐ With a partner
☐ Supported living arrangement
☐ Hostel accommodation
☐ In residential accommodation with support workers
☐ In residential accommodation without support workers
☐ Other _____ (*please specify*)

7. What condition do you have?

☐ Autism
☐ High-functioning autism
☐ Asperger syndrome
☐ Autism Spectrum Condition
☐ Other _____ (*please specify)*

8. How were you diagnosed?

☐ A medical doctor or psychologist diagnosed you in childhood
☐ A medical doctor or psychologist diagnosed you in adulthood
☐ Self-recognised diagnosis
☐ Other _____ (*please specify*)

9. Schools and colleges attended:

☐ School up to age 16
☐ School/ college up to age 18
☐ Higher education after 18 (*please specify course title*) _____
☐ Post-graduate qualification (*please specify*) _____
☐ None of these

10. Employment:

☐ Full or part-time employment (*please specify your job*) _____
☐ Full or part-time voluntary work (*please specify your job*)_____
☐ Full or part-time work experience
☐ Full-or part time government training scheme
☐ Not in any form of paid or voluntary work, or work experience or training

☐ Still in full or part-time education

SECTION 2: Different types of decisions

There are different types of everyday decisions. Some decisions are more difficult to make than others. We would like you to think about how difficult some decisions are for you.

1. How difficult might you find the following decisions?
Please place a vertical mark on each line to indicate how difficult you might find the following decisions.

Below is an example of how difficult somebody might find the decision of whether or not to go out with an umbrella or not.

	Decision	**Difficulty**
Example	Whether or not to go out with an umbrella or not	*Not difficult* |-----|----------| *Very difficult*

Now please answer these questions.

	Decision	**Difficulty**
1	How to spend my free time	*Not difficult* |----------| *Very difficult*
2	What to wear for the day	*Not difficult* |----------| *Very difficult*
3	What to order from a restaurant menu	*Not difficult* |----------| *Very difficult*
4	Whether to do something different from what I usually do	*Not difficult* |----------| *Very difficult*
5	Whether to have my hair cut	*Not difficult* |----------| *Very difficult*
6	How to spend my money	*Not difficult* |----------| *Very difficult*
7	Whether to spend money on something I am interested in	*Not difficult* |----------| *Very difficult*
8	Whether to see a doctor when I feel unwell	*Not difficult* |----------| *Very difficult*

	Decision	Difficulty
9	Whether to agree to medical treatment that a doctor suggests	*Not difficult* |----------| *Very difficult*
10	Where to live	*Not difficult* |----------| *Very difficult*
11	Where to go on holiday	*Not difficult* |----------| *Very difficult*
12	How often to see my family	*Not difficult* |----------| *Very difficult*
13	Whether to phone someone in your family who is having problems	*Not difficult* |----------| *Very difficult*
14	Whether to meet someone new this week	*Not difficult* |----------| *Very difficult*
15	Whether to help a stranger who asks you for directions	*Not difficult* |----------| *Very difficult*
16	Whether to ask a shop assistant where a particular item is	*Not difficult* |----------| *Very difficult*
17	Whether to ask a stranger for directions when you are lost	*Not difficult* |----------| *Very difficult*
18	Whether to phone the police if you see people vandalising a bus stop	*Not difficult* |----------| *Very difficult*
19	Which train or bus to catch to be somewhere on time	*Not difficult* |----------| *Very difficult*

SECTION 3: What makes decisions difficult?

There are two kinds of things that might make decisions difficult. The decision could be difficult because of the nature of the decision, or it could be difficult because of the way we think or feel.

Things about the nature of the decision:

1. How much would the following make a decision hard for you?
Please place a vertical mark on each line to indicate how difficult this would make the decision for you?

		How much would this make a decision difficult for you?
1	The decision is about something trivial and it doesn't matter what I choose	*Not difficult* |----------| *Very difficult*
2	The decision has to be made quickly	*Not difficult* |----------| *Very difficult*
3	The decision involves changing my routine	*Not difficult* |----------| *Very difficult*
4	The decision is about a favourite activity or interest of mine	*Not difficult* |----------| *Very difficult*
5	The decision requires talking to another person	*Not difficult* |----------| *Very difficult*
6	The decision affects other people and not just me	*Not difficult* |----------| *Very difficult*
7	The decision is about my health	*Not difficult* |----------| *Very difficult*
8	The decision will have a big effect on my future	*Not difficult* |----------| *Very difficult*
9	Other people have strong feelings about what I should choose	*Not difficult* |----------| *Very difficult*
10	The reasons for and against a decision are finely balanced	*Not difficult* |----------| *Very difficult*

Things about me:

2. How *often* do the following make decisions hard for you?
Please tick the box that best fits your experience

		This is *never* a problem	**This is *rarely* a problem**	**This is *sometimes* a problem**	**This is *often* a problem**
1	I become concerned or worried about making the decision	☐	☐	☐	☐
2	I become concerned or worried about making the 'wrong' choice	☐	☐	☐	☐
3	I don't know what the consequences of my choice will be	☐	☐	☐	☐
4	I don't know what I should be thinking about to make the decision	☐	☐	☐	☐
5	I find it hard to remember all the things I need to think about before making a decision	☐	☐	☐	☐
6	I don't know what the different choices are	☐	☐	☐	☐
7	I keep changing my mind	☐	☐	☐	☐
8	I find it difficult to ask for help	☐	☐	☐	☐

3. Can you think of any other things that might make a decision difficult for you?
Please write your answer in the space below. Your answer can include things about the decisions themselves or things about your decision-making.

SECTION 4 (optional): Autism and decision-making

1. Do you think that your autism spectrum condition helps you to make decisions?

☐ No, or rarely (*please go to question 3*)
☐ Sometimes
☐ Often
☐ Always

2. Can you give an example of a decision that your autism spectrum condition has helped you to make?

3. Do you think that your autism spectrum condition interferes with your ability to make decisions?

☐ No, or rarely (*please go on to the next page*)
☐ Sometimes
☐ Often
☐ Always

4. Can you give an example of a decision where your autism spectrum condition has interfered with your ability to make the decision?

SECTION 5: Interests and activities

Sometimes things that people are particularly interested in can get in the way of making decisions, so we'd like to know what things really interest you or attract your attention.

1. Please list any activities or interests that you are very interested in:

2. If one of your interests or activities is your favourite, please write it here:

_____

3. How often is this interest or activity on your mind?

☐ Less than 1 hour a day, or only occasionally
☐ Between 1 and 3 hours a day
☐ More than 3 hours a day

☐ Not applicable

4. Do you think that your favourite interest or activity interferes with your ability to make some decisions?

☐ Not at all (*please turn over to the next page)*
☐ Mildly or slightly interferes with my decision-making
☐ Moderately or definitely interferes with my decision-making
☐ Severely interferes with my decision-making
☐ Extremely severely interferes with my decision-making

☐ Not applicable

5. Can you give an example from your own life where your favourite interest or activity has interfered with your ability to make a decision?

SECTION 6: Participating in future research

We plan to conduct more studies of decision-making by people with autism spectrum conditions. These studies will be conducted in Cambridge during 2008 and 2009.

If you are interested and would like to receive more information about participating in these studies, please provide your contact details on this page. We may contact you with more information in the next few months.

If you provide your contact details, you are not making any commitment to participate in these studies and you can withdraw at any time.

Name: _____

Telephone number: _____

Email address: _____

☐ *I would prefer to be contacted by email*
☐ *I would prefer to be contacted by telephone*
☐ *I would prefer to be contacted by post*

Thank you for completing this questionnaire about decision-making

PLEASE POST THIS QUESTIONNAIRE BACK TO US IN THE STAMPED ADDRESSED ENVELOPE PROVIDED.

If you have any questions about this research, or at any time wish to withdraw, please contact Lydia Luke by email lrl29@medschl.cam.ac.uk or on 01223 746100

Appendix B: Survey questionnaire for family members and support workers of adults with an autism spectrum condition

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Survey

FOR FAMILY MEMBERS (OR SUPPORT WORKERS) OF PEOPLE WITH AN AUTISM SPECTRUM CONDITION

This survey is part of a research project being carried out by Miss Lydia Luke, Dr Isabel Clare, and Dr Howard Ring, who work in the Section of Developmental Psychiatry, University of Cambridge.

This questionnaire will take approximately 30 minutes to complete.

Please read the information about this project on the next page before beginning the questionnaire

Project information

What is this research project about?
This project is about decision-making in everyday life. We are interested in the kinds of decisions that adult men and women (aged 16 years or more) with autism spectrum conditions face in their lives and why some decisions might be difficult. This research is relevant to recent legislation (the *Mental Capacity Act 2005* and the *Adults with Incapacity (Scotland) Act 2000*) which seeks both to empower people who are able to make decisions for themselves, and protect those who are unable to make one or more decisions. At present, we know little about how people with autism spectrum conditions make every day decisions, or whether they face particular difficulties in decision-making.

Who are we?
We are clinicians and researchers who work in the Section of Developmental Psychiatry, University of Cambridge. The research team are Miss Lydia Luke, Dr Isabel Clare and Dr Howard Ring.

How long will it take to do this questionnaire?
It will take approximately 30 minutes to complete this questionnaire.

Do I have to answer all the questions?
No. We would like you to complete as much of the questionnaire as possible, but you do not have to answer any questions if you do not want to.

Will my answers and information be kept confidential?
Yes. We will not ask you to give your name or any other personal details. We will keep the questionnaire data for a minimum of 5 years, after which it will be destroyed in accordance with good research practice.

What will happen to the study results?
The results will form part of my Ph.D. thesis and will be presented at conferences and written up in journals. If any of your individual answers are used, they will be totally anonymous and will not identify you in any way.

Do I have to take part in this study?
No. It is up to you to decide whether or not you would like to take part. You are free to withdraw at any time. Please contact Lydia Luke if you wish to withdraw after sending us your completed questionnaire.

Who has reviewed this study?
This study has received ethical approval from the University of Cambridge Psychology Research Ethics Committee.

What should I do if I have any questions about the research?
Please contact Lydia Luke (lrl29@medschl.cam.ac.uk or on 01223 746100) if you have any questions about this research.

Consent form

Project title: Decision-making by men and women with an autism spectrum condition
Name of Researchers: Miss Lydia Luke, Dr Isabel Clare & Dr Howard Ring

Before beginning the questionnaire, please demonstrate your understanding of the nature of this study by reading the statements and ticking the boxes below

	Please tick
1. I have read and understand the information about this study	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	☐
3. I understand that my anonymised answers will be incorporated into an account of this research that will be presented at conferences and in journals and written up as part of a Ph.D. thesis.	☐
4. I am aged 18 years or older	☐
5. I agree to take part in the above study.	☐

Please print your name and sign and date this page before beginning the questionnaire

Name: _____

Signature: _____

Date: _____

If you have any questions about this research please contact Lydia Luke by email lrl29@medschl.cam.ac.uk or by telephone on 01223 746100

SECTION 1: About you and the person you are related to or support

1. What is your relationship to an adult with an autism spectrum condition?

☐ Parent
☐ Parent and main carer
☐ Paid support worker
☐ Other _____ (*please specify*)

2. Is this person:

☐ Male
☐ Female

3. How old is he or she? _____

4. How would you describe his or her background?

White	☐ British ☐ Irish ☐ Any Other White Background
Mixed	☐ White and Black Caribbean ☐ White and Black African ☐ White and Asian ☐ Any Other Mixed Background
Asian or Asian British	☐ Indian ☐ Pakistani ☐ Bangladeshi ☐ Any Other Asian Background
Black or Black British	☐ Caribbean ☐ African ☐ Any Other Black Background
Chinese or Other Ethnic Group	☐ Chinese ☐ Any Other (*please specify*)

5. What is his or her nationality? _____

6. What is the first half of his or her postcode?

(E.g. if your postcode is CB1 4DP, then just write CB1)

_____

7. Where does he or she live?

☐ With you in your home
☐ On his or her own
☐ With a partner
☐ In residential accommodation with support workers
☐ In residential accommodation without support workers
☐ Other _____ (*please specify*)

8. What condition does he or she have?

☐ Autism
☐ High-functioning autism
☐ Asperger's syndrome
☐ Autism Spectrum Condition
☐ Other _____ (*please specify)*

9. How was he or she diagnosed?

☐ A medical doctor or psychologist diagnosed him or her in childhood
☐ A medical doctor or psychologist diagnosed him or her in adulthood
☐ Self-recognised diagnosis
☐ Other _____ (*please specify*)

10. What level of education has he or she reached?

☐ School up to age 16
☐ School/ college up to age 18
☐ Higher education after 18 (*please specify course title*) _____
☐ Post-graduate qualification (*please specify*) _____
☐ None of these

11. His or her employment:

☐ Full or part-time employment (*please specify job title*) _____
☐ Full or part-time voluntary work (*please specify work type*) _____
☐ Full or part-time work experience
☐ Full or part-time government training scheme
☐ Not in any form of paid or voluntary work, or experience or training

☐ Still in full or part-time education

SECTION 2: Your concerns about the person's decision-making

1. Do you have any of the following concerns about his or her decision-making?
Please place a mark on each line to indicate how much the following are a concern for you

	Concern	**How much does this concern you?**
1	The person makes decisions that put his or her well-being and/or safety at risk	*Not concerned* |----------| *Very concerned*
2	The person makes decisions that put *other peoples'* well-being and/or safety at risk	*Not concerned* |----------| *Very concerned*
3	The person makes decisions without really understanding the consequences	*Not concerned* |----------| *Very concerned*
4	The person is easily influenced by others	*Not concerned* |----------| *Very concerned*

SECTION 3: Different types of decisions

1. How difficult would he or she *generally* find the following types decisions?
Please place a mark on each line to indicate how difficult she or she would find the following decisions. Please tick the box if the person would <u>not</u> be able to make the decision.

	Decision	**How much would this make the decision difficult?**	**He or she would <u>not</u> be able to make this decision**
1	How to spend his or her free time	*Not difficult* |----------| *Very difficult*	☐
2	What to wear the day	*Not difficult* |----------| *Very difficult*	☐
3	What to order from a restaurant menu	*Not difficult* |----------| *Very difficult*	☐
4	Whether to do something different from what he or she normally does	*Not difficult* |----------| *Very difficult*	☐
5	Whether to have a hair cut	*Not difficult* |----------| *Very difficult*	☐
6	How to spend his or her money	*Not difficult* |----------| *Very difficult*	☐
7	Whether to spend money on something that he or she is interested in	*Not difficult* |----------| *Very difficult*	☐
8	Whether to see a doctor when he or she feels unwell	*Not difficult* |----------| *Very difficult*	☐
9	Whether to agree to medical treatment that a doctor suggests	*Not difficult* |----------| *Very difficult*	☐
10	Where to live	*Not difficult* |----------| *Very difficult*	☐

Please continue to answer these questions on the next page

	Decision	How much would this make the decision difficult?	He or she would <u>not</u> be able to make this decision
11	Where to go on holiday	*Not difficult* |----------| *Very difficult*	☐
12	How often to see family	*Not difficult* |----------| *Very difficult*	☐
13	Whether to phone a relative who is having problems	*Not difficult* |----------| *Very difficult*	☐
14	Whether to meet someone new	*Not difficult* |----------| *Very difficult*	☐
15	Whether to help a stranger who asks him or her for directions	*Not difficult* |----------| *Very difficult*	☐
16	Whether to ask a shop assistant where a particular item is	*Not difficult* |----------| *Very difficult*	☐
17	Whether to ask a stranger for directions when he or she is lost	*Not difficult* |----------| *Very difficult*	☐
18	Whether to phone the police after witnessing a bus stop being vandalised	*Not difficult* |----------| *Very difficult*	☐
19	Which train or bus to catch to be somewhere on time	*Not difficult* |----------| *Very difficult*	☐

SECTION 4: What makes some decisions difficult?

There are two kinds of things that might make decisions difficult. A decision could be difficult because of the nature of the decision, or it could be difficult because of personal factors affecting how we think or feel at the time. The following questions ask you to think about *why* some decisions may be difficult for the person.

The nature of decision:

1. How much would each of the following make a decision difficult for him or her?
Please place a mark on each line to indicate how difficult the following would make a decision for the person.

		How much would this make the decision difficult?
1	The decision is about something trivial and the actual choice doesn't matter	*Not difficult* |----------| *Very difficult*
2	The decision has to be made quickly	*Not difficult* |----------| *Very difficult*
3	The decision involves a change to his or her routine	*Not difficult* |----------| *Very difficult*
4	The decision is about his or her favourite activity or interest	*Not difficult* |----------| *Very difficult*
5	The decision requires talking to another person	*Not difficult* |----------| *Very difficult*
6	The decision affects other people besides him or her	*Not difficult* |----------| *Very difficult*
7	The decision is about his or her health	*Not difficult* |----------| *Very difficult*
8	The decision will have a big effect on his or her future	*Not difficult* |----------| *Very difficult*
9	Another person has given them advice or an opinion about what they should choose	*Not difficult* |----------| *Very difficult*
10	The reasons for and against the decision are finely balanced	*Not difficult* |----------| *Very difficult*

Personal factors:

2. How often do the following make decisions difficult for him or her?
Please tick the box that best fits your experience

		This is *never* a problem	**This is *rarely* a problem**	**This is *sometimes* a problem**	**This is *often* a problem**	**Don't know**
1	He or she becomes concerned or worried about making the decision	☐	☐	☐	☐	☐
2	He or she is concerned or worried about making the 'wrong' choice	☐	☐	☐	☐	☐
3	He or she can't think through the consequences of different choices	☐	☐	☐	☐	☐
4	He or she finds it hard to remember all the information that is needed to make the decision	☐	☐	☐	☐	☐
5	He or she doesn't realise what the possible choices are	☐	☐	☐	☐	☐
6	He or she doesn't understand the information that is needed to make the decision	☐	☐	☐	☐	☐
7	He or she keeps changing their mind	☐	☐	☐	☐	☐
8	He or she finds it difficult to ask for help	☐	☐	☐	☐	☐

3. Can you think of any other things that make some decisions difficult for him or her?
Please write your answer in the space below. Your answer can include things about the nature of decisions, or personal factors.

SECTION 5 (optional): Autism and decision-making

1. Do you think the person's autism spectrum condition *helps* him or her to make decisions?

☐ No, or rarely (*please go to question 3*)
☐ Sometimes
☐ Often
☐ Always

2. Can you give an example of a decision that the person's autism spectrum condition helped him or her to make?

3. Do you think that the person's autism spectrum condition *interferes* with his or her ability to make decisions?

☐ No, or rarely (*please go on to the next page*)
☐ Sometimes
☐ Often
☐ Always

4. Can you give an example of a decision where the person's autism spectrum condition has interfered with his or her ability to make the decision?

SECTION 6: His or her interests and activities

Many people with autism spectrum conditions are very interested in a particular thing or an activity. If the person you know has a particular interest in something, we would like to know if this ever interferes with their decision-making.

2. Please list any activities or interests that the person you know is very interested in:

2. If he or she has one interest or activity that seems to be a particular favourite, please write it here:_____

3. How often do you think this interest(s) or activity(ies) is on his or her mind?

☐ Less than 1 hour a day, or only occasionally
☐ Between 1 and 3 hours a day
☐ More than 3 hours a day
☐ Don't know

4. If a decision involves this interest(s) or activity(ies), do you think his or her ability to make the decision is affected?

☐ Not at all
☐ Mildly or slightly impairs his or her decision-making
☐ Severely interferes impairs his or her decision-making
☐ Extremely interferes impairs his or her decision-making
☐ Don't know

5. Can you give an example of a decision where this person's favourite interest(s) or activity(ies) has interfered with his or her ability to make a decision?

Please describe this decision

Thank you for completing this questionnaire about decision-making

PLEASE POST THIS QUESTIONNAIRE BACK TO US IN THE STAMPED ADDRESSED ENVELOPE PROVIDED.

If you have any questions about this research, or at any time wish to withdraw, please contact Lydia Luke by email lrl29@medschl.cam.ac.uk or on 0122 3746100

Appendix C: Summary of findings from the preliminary survey of decision-making experiences

1. Frequency of problems experienced during decision-making

Problem experienced during decision-making		**Response (*% of participants*)**				
		Unknown	*Never*	*Rarely*	*Sometimes*	*Often*
Concern or worry about making the decision	Participants	1	3	9	43	44
	Informants	8	2	6	25	60
Concerned or worry about making the 'wrong' choice	Participants	1	3	8	41	48
	Informants	8	10	8	25	50
Uncertainty about the consequences	Participants	1	3	13	35	48
	Informants	4	4	6	29	58
Frequent changes of mind about the decision	Participants	2	11	28	25	34
	Informants	6	8	31	25	31
Difficulty asking for help	Participants	0	7	8	50	55
	Informants	2	0	8	15	75
No knowledge of the choices available	Participants	3	12	27	36	23
	Informants	0	6	13	37	44
Difficulty remembering all the relevant information	Participants	2	13	14	28	43
	Informants	6	13	8	17	56
Uncertainty about which factors are relevant (*Participants only*)	Participants	2	8	18	37	36
Difficulty understanding the relevant information (*Informants only*)	Informants	0	10	15	29	46

For all but one of the listed problems (frequent changes of mind), the responses of both groups are skewed towards more frequent experiences of problems in decision-making.

2. The difficulty associated with different features of decisions

Feature	Rating of difficulty *(mean proportion of the visual analogue line, SD)*	
	Participants with ASCs (n = 120)	Family members and support workers (n = 52)
The decision is about something trivial	0.47 (0.33)	0.61 (*0.33*)
The decision has to be made quickly	0.74 (*0.27*)	0.79 (*0.26*)
The decision involves a change of routine	0.76 (*0.26*)	0.83 (*0.18*)
The decision is about a favourite interest or activity	0.29 (*26.1*)	0.36 (*0.33*)
The decision requires talking to another person	0.67 (*0.28*)	0.75 (*0.24*)
The decision affects others	0.67 (*0.31*)	0.67 (*0.33*)
The decision is about health	0.46 (*0.30*)	0.64 (*0.33*)
The decision will have a big effect on the future	0.74 (*0.30*)	0.75 (*0.29*)
Other people have strong feelings about the choice	0.63 (*0.33*)	0.64 (*0.32*)
The reasons for and against are finely balanced	0.69 (*0.30*)	0.76 (*0.25*)

The decisions rated as most difficult by the participants with ASCs were decisions that: i) involved a change of routine; ii) needed to be made quickly; and iii) would have a big effect on the future. The decisions rated as most difficult by the family members and support workers, on behalf of the person they knew, were decisions that: i) involved a change of routine, and ii) needed to be made quickly; and iii) that were finely balanced.

3. Interference from special interests

Extent to which a special interest is perceived to interfere with decision-making	**Percentage of participants**	
	Participants with ASCs (n = 120)	Family members and support workers (n = 52)
Unknown/not applicable	12%	17%
Not at all	40%	35%
Mildly or slightly interferes	23%	21%
Moderately or definitely interferes	17%	*
Severely interferes	5%	12%
Extremely severely interferes	4%	15%

**Due to an error, this response option was not available for the family members and support workers. As a result the figures reported in the main text are the extreme response options.*

4. Levels of concern reported by family members and support workers for specific problems in decision-making

Concerns about the decision-making of the person they know	**Rating of concern** *Mean proportion of the visual analogue line (SD)*
Concern about the person's own safety	0.52 (*0.32*)
Concern about the safety of others	0.42 (*0.34*)
Concern about the person making the decision without understanding the consequences	0.68 (*0.27*)
Concern about how easily influenced the person is	0.66 (*0.30*)

Appendix D: Adapted questionnaire of decision-making experiences

Decision-making experiences

There are different types of everyday decisions. Some decisions are more difficult to make than others. We would like you to think about how difficult some decisions are for you.

1. How difficult might you find the following decisions?
Please place a vertical mark on each line to indicate how difficult you might find the following decisions.

Below is an example of how difficult somebody might find the decision of whether or not to go out with an umbrella or not.

	Decision	Difficulty
Example	Whether or not to go out with an umbrella or not	*Not difficult* |-----|----------| *Very difficult*

Now please answer these questions.

	Decision	**Difficulty**
1	How to spend my free time	*Not difficult* |----------| *Very difficult*
2	What to wear for the day	*Not difficult* |----------| *Very difficult*
3	What to order from a restaurant menu	*Not difficult* |----------| *Very difficult*
4	Whether to do something different from what I usually do	*Not difficult* |----------| *Very difficult*
5	Whether to have my hair cut	*Not difficult* |----------| *Very difficult*
6	How to spend my money	*Not difficult* |----------| *Very difficult*

	Decision	Difficulty
7	Whether to spend money on something I am interested in	*Not difficult* |——————————| *Very difficult*
8	Whether to see a doctor when I feel unwell	*Not difficult* |——————————| *Very difficult*
9	Whether to agree to medical treatment that a doctor suggests	*Not difficult* |——————————| *Very difficult*
10	Where to live	*Not difficult* |——————————| *Very difficult*
11	Where to go on holiday	*Not difficult* |——————————| *Very difficult*
12	How often to see my family	*Not difficult* |——————————| *Very difficult*
13	Whether to phone someone in your family who is having problems	*Not difficult* |——————————| *Very difficult*
14	Whether to meet someone new this week	*Not difficult* |——————————| *Very difficult*
15	Whether to help a stranger who asks you for directions	*Not difficult* |——————————| *Very difficult*
16	Whether to ask a shop assistant where a particular item is	*Not difficult* |——————————| *Very difficult*
17	Whether to ask a stranger for directions when you are lost	*Not difficult* |——————————| *Very difficult*
18	Whether to phone the police if you see people vandalising a bus stop	*Not difficult* |——————————| *Very difficult*
19	Which train or bus to catch to be somewhere on time	*Not difficult* |——————————| *Very difficult*

There are two kinds of things that might make decisions difficult. The decision could be difficult because of the nature of the decision, or it could be difficult because of the way we think or feel.

2. How much would the following make a decision hard for you?

Please place a vertical mark on each line to indicate how difficult this would make the decision for you?

Features of decisions:

		How much would this make a decision difficult for you?
1	The decision is about something trivial and it doesn't matter what I choose	*Not difficult* |——————————| *Very difficult*
2	The decision has to be made quickly	*Not difficult* |——————————| *Very difficult*
3	The decision involves changing my routine	*Not difficult* |——————————| *Very difficult*
4	The decision is about a favourite activity or interest of mine	*Not difficult* |——————————| *Very difficult*
5	The decision requires talking to another person	*Not difficult* |——————————| *Very difficult*
6	The decision affects other people and not just me	*Not difficult* |——————————| *Very difficult*
7	The decision is about my health	*Not difficult* |——————————| *Very difficult*
8	The decision will have a big effect on my future	*Not difficult* |——————————| *Very difficult*
9	Other people have strong feelings about what I should choose	*Not difficult* |——————————| *Very difficult*
10	The reasons for and against a decision are finely balanced	*Not difficult* |——————————| *Very difficult*

Things about me:

3. How *often* do the following make decisions hard for you?

Please tick the box that best fits your experience

		This is *never* a problem	**This is *rarely* a problem**	**This is *sometimes* a problem**	**This is *often* a problem**
1	I become concerned or worried about making the decision	☐	☐	☐	☐
2	I become concerned or worried about making the 'wrong' choice	☐	☐	☐	☐
3	I lack confidence in my decisions	☐	☐	☐	☐
4	I don't know what the consequences of my choice will be	☐	☐	☐	☐
5	I don't know what I should be thinking about to make the decision	☐	☐	☐	☐
6	I find it hard to remember all the things I need to think about before making a decision	☐	☐	☐	☐
7	I don't know what the different choices are	☐	☐	☐	☐
8	I keep changing my mind	☐	☐	☐	☐
9	I find it difficult to ask for help	☐	☐	☐	☐
10	My mind 'freezes' and I am unable to make the decision	☐	☐	☐	☐
11	I spend too much time thinking about the decision	☐	☐	☐	☐
12	I find making the decision exhausting	☐	☐	☐	☐

4. Do you think that your autism spectrum condition helps you to make decisions?

☐ No, or rarely
☐ Sometimes
☐ Often
☐ Always

5. Do you think that your autism spectrum condition interferes with your ability to make decisions?

☐ No, or rarely
☐ Sometimes
☐ Often
☐ Always

Thank you for completing these questions

Appendix E: Task instructions for the adapted Risky Choice Task

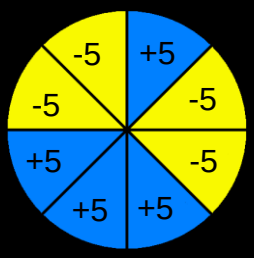
The aim of this task is to win as many points as you can. At the beginning of each round you will be given 100 points.

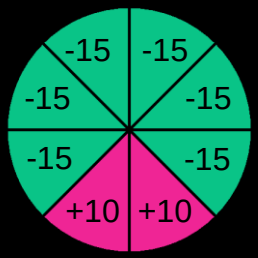
A round consists of 20 trials; on each trial you will see two wheels. On some trials, you must choose the wheel you think will give you the best chance of winning the most points. On the other trials, the computer will make the decision for you.

You will see a message before every trial telling you whether you will take the next turn or whether the computer will take the next turn.

Here is an example of two wheels. The pink wedges on the right-hand wheel show the number of points you could win if you chose that wheel (10); the green wedges on the right-hand wheel show the number of points you could lose (15). The blue wedges on the left-hand wheel show the number of points you could win (5); the yellow wedges on the right-hand wheel show the number of points you could lose (5).

The proportion of blue:yellow and pink:green represent your chances of a win or a loss. Take the right-hand wheel as an example: This wheel has 2 win wedges and 6 loss wedges. So if you chose this wheel you would have a greater chance of losing than winning. Take the left-hand wheel as another example: It has 4 win wedges and 4 loss wedges therefore, if you chose this wheel you would have a 50:50 chance of winning (and a 50:50 chance of losing). Do you have any questions so far?





Simply use the mouse to click on the wheel of your choice. The wheel you choose will appear in the centre of the screen. Just like in a game of wheel of fortune, a ticker will spin around the wheel and eventually land on one of the 8 wedges. The wedge it lands on will tell you if you have won or lost that trial.

Sometimes you will be presented with a wheel that has some blank wedges. If the ticker lands on a blank wedge you neither win nor lose any points.

You must choose one wheel on each round where the computer is not making the decision for you

You must wait for the following message before making your choice:

Please Choose Now

There will be a sound to tell you whether you have won or lost as well as a message at the bottom of the screen. The computer will add or subtract the points won or lost to your running points total at the top of the screen. Your score can go below zero if necessary.

At the end of 20 trials your score will be shown. Press the space bar when you are ready to start the next round. You will play a total of 4 rounds, which will take about 40 minutes.

Appendix F: Visual analogue scales for the Risky Choice Task

1. **How anxious were you about making the decisions?**

   Please place a mark on the line to indicate your answer

   Not at all anxious |----------| Extremely anxious

2. **How much effort was required to think about the information and make the decisions?**

   Please place a mark on the line to indicate your answer

   No effort at all |----------| A great deal of effort

3. **How anxious were you when the computer was making the decisions?**

   Please place a mark on the line to indicate your answer

   Not at all anxious |----------| Extremely anxious

Appendix G: Instructions for the Iowa Gambling Task

1. In front of you on the screen, there are four decks of cards, A, B, C, and D.
2. I want you to select one card at a time, by clicking on the card, from any deck you choose.
3. Each time you select a card from a deck, the colour of the card turns red or black, and the computer will tell you that you won some pretend money in the form US dollars. I won't tell you how much money you will win. You will find out along the way. Every time you win, the green bar gets longer.
4. Every so often, however, when you click on a card, the computer tells you that you won some money, but then it says that you also lost some money. I won't tell you when you will lose or how much you will lose. You will find out along the way. Every time you lose, the green bar gets shorter.
5. You are absolutely free to switch from one deck to another any time you wish.
6. The goal of the game is to win as much money as possible, and if you find yourself unable to win, make sure you avoid losing money as much as possible.
7. *We will give you some real money at the end of the game depending on how well you have scored. (added for the present study)*
8. I won't tell you for how long the game will continue. You must keep on playing until the computer stops.
9. You will get 2000 dollars credit (see the green bar) to start the game. At the end we will see how much you won or lost. The red bar here is a reminder of how much money you borrowed to play the game.
10. One last thing, it is important to know that the colours of the cards are irrelevant in this game. The computer does not make you lose money at random. However, there is no way to figure out when the computer will make you lose. All I can say is that you may find yourself losing money on all of the decks, but some decks will make you lose more money than others. You can win if you stay away from the worst decks.
11. Do you have any questions?
12. Good luck!

Source:

Bechara, A., Damasio, H., Damasio, A.R. & Lee, G.P. (1999). Different contributions of the human amygdala and ventromedial and prefrontal cortex to decision-making. *The Journal of Neuroscience*, *19*, *5473 – 5481*.

Appendix H: Demonstrations of heuristics

i) Birth order (Kahneman and Tversky, 1972)

All families of six children in a city were surveyed. In 72 families the exact order of births of boys and girls was G B G B B G.

What is your estimate of the number of families surveyed in which the exact order of births was B G B B B B?

ii) Hospital births (Kahneman and Tversky, 1972)

A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. However, the exact percentage varies from day to day. Sometimes it may be higher than 50%, sometimes lower.

For a period of 1 year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?

A. The larger hospital
B. The smaller hospital
C. About the same (that is, within 5% of each other)

iii) Path frequency (Tversky and Kahneman, 1973)

Consider the following diagram:

X X O X X X
X X X X O X
X O X X X X
X X X O X X
X X X X X O
O X X X X X

A path in this diagram is any descending line which starts at the top row, ends and the bottom row, and passes though exactly one symbol (X or O) in each row.

Are there more paths containing six X's and no O's, or more paths containing five X's and one O?

iv) 'R' position (Tversky and Kahneman, 1973)

The frequency of appearance of letters in the English language was studied. A typical text was selected, and the relative frequency with which various letters of the alphabet appeared in the first and third positions in words was recorded. Words of less than three letters were excluded from the count.

Consider the letter R. We would like you to judge whether this letter appear more often in the first or in the third position, and to estimate the ratio of the frequency with which it appears in these positions.

Is R more likely to appear in:

☐ the first position?

☐ the third position?

v) Conjunctive vs Simple gambles (Bar-Hillel, 1973)

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 10 red marbles, 10 white marbles • Chance of drawing a red marble is 50% • Pick a red marble 4 times in a row (replacing the marble each time)	• 2 red marbles, 18 white marbles • Chance of drawing a red marble is 10% • Pick a red marble

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 18 red marbles, 2 white marbles • Chance of drawing a red marble is 90% • Pick a red marble 7 times in a row (replacing the marble each time)	• 10 red marbles, 10 white marbles • Chance of drawing a red marble is 50% • Pick a red marble

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 12 red marbles, 8 white marbles • Chance of drawing a red marble is 60% • Pick a red marble 5 times in a row (replacing the marble each time)	• 2 red marbles, 18 white marbles • Chance of drawing a red marble is 10% • Pick a red marble

vi) Disjunctive vs Simple gambles (Bar-Hillel, 1973)

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 5 red marbles, 15 white marbles • Chance of drawing a red marble is 25% • Pick a red marble at least once in 8 draws (replacing the marble each time)	• 18 red marbles, 2 white marbles • Chance of drawing a red marble is 90% • Pick a red marble

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 2 red marbles, 18 white marbles • Chance of drawing a red marble is 10% • Pick a red marble at least once in 9 draws (replacing the marble each time)	• 12 red marbles, 8 white marbles • Chance of drawing a red marble is 60% • Pick a red marble

Bag 1 – 20 marbles	Bag 2 – 20 marbles
• 10 red marbles, 10 white marbles • Chance of drawing a red marble is 50% • Pick a red marble at least once in 4 draws (replacing the marble each time)	• 18 red marbles, 2 white marbles • Chance of drawing a red marble is 90% • Pick a red marble

vii) Asian flu (Tversky and Kahneman, 1981)

(Gain frame)

Imagine that the UK is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programmes to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programmes are as follows: If Programme A is adopted, 200 people will be saved. If Programme B is adopted, there is a 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved. Which of the two programmes would you favour?

(Loss frame)

Imagine that the UK is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programmes to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programmes are as follows: If Programme A is adopted, 400 people will die. If programme D is adopted, there is a 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. Which of these two programmes would you favour?

Appendix I *:* Information Sheets and Consent Forms for the experimental study

i) Information Sheet for participants with autism spectrum conditions

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Lydia Luke
Cambridge Intellectual & Developmental
Disabilities Research Group (CIDDRG)
Douglas House
18b Trumpington Road
Cambridge CB2 8AH
Tel: 01223 746031
Email: lrl29@medschl.cam.ac.uk

Participant Information Sheet

Decision-making in Autism study

We would like to invite you to take part in a research study. Before you decide you need to understand why this research is being done and what it would involve for you. Please take time to read the following information carefully. You can contact us if anything is not clear or you would like more information.

What is this research study about?

This study is about decision-making by people with autism spectrum conditions. We are trying to find out if there are differences in the way that people with autism spectrum conditions make decisions, compared to people who do not have autism spectrum conditions.

This research is relevant to recent legislation (such as the *Mental Capacity Act (England & Wales) 2005),* which currently provides very little guidance about how decision-making may be affected by autism spectrum conditions, or how some people with ASCs might best be supported with decision-making.

Who are we?

We are clinicians and researchers who work in the Department of Psychiatry, University of Cambridge. The research team are Ms Lydia Luke, Dr Isabel Clare, and Dr Howard Ring.

What will happen if I decide to take part?

We will ask you to visit us at the University of Cambridge. The visit will last about 6 hours and this includes breaks. If you prefer, you can visit us twice and do the study over two sessions. During your visit(s) we will:

- Ask you some questions about your autism spectrum condition
- Give you some puzzles to try that involve words, numbers and pictures
- Ask you some questions about how you make decisions and how you think and feel
- Ask you to do four different decision-making tasks on a computer. For each one, we will ask you to make choices between different options and to try to win as many 'points' as possible.

During one of the decision-making tasks, we will measure your heart rate and how much you sweat on your fingertips. To do this we will place plastic sensors on your wrist, ankle, and two of your fingers. This procedure is not unpleasant or painful.

If you take part, you will be reimbursed for your travel expenses (2nd class rail fare, bus fare, or your own transport) and you will receive £30.00 to cover your time and subsistence costs.

Other information we may ask you

In order to understand more about your autism spectrum condition, we may ask you provide the contact details of a clinical or other service that can confirm your diagnosis. This may include the Autism Research Centre in Cambridge if you have taken part in a study there. **You can choose not to provide this information and still take part in our study.** If you would be happy for us to contact a clinical or other service, we will ask you to sign a letter of authorisation.

We may also ask if you would be happy for us to telephone one of your parents to ask for more information about your autism spectrum condition. It is often helpful to find out information about what you were like when you were very young, before you started school. We would arrange to talk to your mother or father at a time that suited them. We would not speak to them for more than two hours, unless they would like to take more time to complete the interview. **Again, you can**

choose for us not to contact one of your parents and still take part in the study. We will not interview your parent if they do not want us to.

Will my answers and information be kept confidential?

Yes. Your answers will be anonymised by replacing your name with a code, which will be known only to members of the research team. Your contact details will be kept in a locked filing cabinet in the Cambridge Intellectual & Developmental Disabilities Research Group (CIDDRG) at the University of Cambridge. We will not give any of your personal details to other people. We will keep this information for a maximum of 5 years, after which it will be destroyed in accordance with good research practice.

Will any video tapes be used?

Yes. We would like to video you for one of the tasks. A small proportion of the films will be looked at by another researcher in the Department of Psychiatry to confirm my assessment. The video recording will be stored electronically on a DVD and the original tape will be destroyed. The DVD will be anonymised by replacing your name with a code, and kept in a locked filing cabinet in the CIDDRG at the University of Cambridge. The recording will be kept for a maximum of 5 years from the start of my PhD (October 2007), after which it will be destroyed in accordance with good research practice. Copies of the recording will not be made. The recording will not be made available for any purposes other than the research project. We will ask you if you are happy to be videotaped before starting the study. **You can choose not to be videotaped and still take part in the study.**

What will happen to the study results?

The results will form part of a Ph.D. thesis and will be presented at conferences and written up in journals. If any of your individual answers are used, they will be completely anonymised and it will not be possible for you to be identified in any way.

Do I have to take part in this study?

No. You do not have to take part and you are free to withdraw at any time without explanation.

What if there is a problem?

If you are worried about anything to do with the research you can ask to speak to one of the researchers. The person will do their best to answer your questions. They can be contacted on 01223 746031. If you are still unhappy and want to complain formally you can do this through the University of Cambridge Research Services on 01223 333543.

The research only involves asking some questions and doing some tasks on the computer while your heart rate and fingertip sweating are recorded, so we think it is unlikely that you will have any problems. If however, during the course of the study, something goes wrong that hurts you and may be due to someone's negligence, then you may have grounds for legal action for compensation against the University of Cambridge. You may have to pay your own legal costs in any legal action.

Who has reviewed this study?

This study has received ethical approval from the University of Cambridge Psychology Research Ethics Committee.

What should I do if I have any questions, concerns, or would just like more information?

Please contact Lydia Luke (lrl29@medschl.cam.ac.uk or 01223 746031) or the project supervisor, Dr Isabel Clare (on 01223 746100), if you have any questions or concerns about this research. You can also write to Ms Lydia Luke or Dr Isabel Clare using the address at the top of this letter.

If you are aged 16 – 18 years and would like to take part, you should discuss this with your parents/guardians before contacting the research team.

ii) Consent Form for participants with autism spectrum conditions

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Lydia Luke (*PhD Student*)
CIDDRG, Douglas House
18b Trumpington Road
Cambridge CB2 8AH
01223 746100 or lrl29@medschl.cam.ac.uk

Consent form

Project title: Decision-making by men and women with an autism spectrum condition
Name of Researchers: Ms Lydia Luke, Dr Isabel Clare & Dr Howard Ring

Please demonstrate your understanding of the nature of this study by reading the statements and ticking the boxes below:

		Please tick
1	I have read and understand the information about this study	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	☐
3	I understand that my anonymised answers will be incorporated into an account of this research that will be presented at conferences and in journals and written up as part of a Ph.D. thesis.	☐
4	I understand that if something goes wrong or I am hurt as a result of someone's negligence, then I may have grounds for a legal action for compensation against the University of Cambridge but I may have to pay my legal costs.	☐
5	I am happy to be videotaped and understand that the recording will be anonymised and identified only by a code and will not be used for any purpose other than the research project.	(☐)
6	I am happy to provide the contact details of a clinical or other service that can confirm my diagnosis.	(☐)
7	I am happy to provide the contact details of one of my parents (if available) for them to be asked to be interviewed.	(☐)
8	I agree to take part in the above study.	☐

Please print your name and sign and date this page

Name: _____ Signature: _____ Date: _____

If you have any questions or concerns about this research, please contact Ms Lydia Luke or Dr Isabel Clare by telephone or post at the above address

iii) Information Sheet for participants in the control group

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Lydia Luke
Cambridge Intellectual & Developmental
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18b Trumpington Road
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Email: lrl29@medschl.cam.ac.uk

Participant Information Sheet for Healthy Volunteers

Decision-making in Autism study

We would like to invite you to take part in a research study. Before you decide you need to understand why this research is being done and what it would involve for you. Please take time to read the following information carefully. You can contact us if anything is not clear or you would like more information.

What is this research study about?

This study is about decision-making by people with autism spectrum conditions. We are trying to find out if there are differences in the way that people with autism spectrum conditions make decisions, compared to people who do not have autism spectrum conditions.

This research is relevant to recent legislation (such as the *Mental Capacity Act 2005),* which currently provides very little guidance about how decision-making may be affected by autism spectrum conditions, or how people with ASCs might best be supported with decision-making.

Who are we?

We are clinicians and researchers who work in the Department of Psychiatry, University of Cambridge. The research team are Ms Lydia Luke, Dr Isabel Clare, and Dr Howard Ring.

What will happen if I decide to take part?

We will ask you to visit us at the University of Cambridge. The visit will last about 5¼ hours and this includes breaks. If you prefer, you can visit us twice and do the study over two sessions.

During your visit(s) we will:

- Give you some puzzles to try that involve words, numbers and pictures
- Ask you some questions about how you make decisions and how you think and feel
- Ask you to do four different decision-making tasks on a computer. For each one, we will ask you to make choices between different options and to try to win as many 'points' as possible.

During one of the decision-making tasks, we will measure your heart rate and how much you sweat on your fingertips. To do this we will place plastic sensors on your wrist, ankle, and two of your fingers. This procedure is not unpleasant or painful.

If you take part, you will be reimbursed for your travel expenses (2nd class rail fare, bus fare, or you own transport) and you will receive £30.00 to cover your time and subsistence costs.

Will my answers and information be kept confidential?

Yes. Your answers will be anonymised by replacing your name with a code, which will be known only to members of the research team. Your contact details will be kept in a locked filing cabinet in the Department of Psychiatry, University of Cambridge. We will not give any of your personal details to other people. We will keep this information for a maximum of 5 years, after which it will be destroyed in accordance with good research practice.

What will happen to the study results?

The results will form part of my Ph.D. thesis and will be presented at conferences and written up in journals. If any of your individual answers are used, they will be completely anonymised and it will not be possible for you to be identified in any way.

Do I have to take part in this study?

No. You do not have to take part and you are free to withdraw at any time without explanation.

What if there is a problem?

If you are worried about anything to do with the research you can ask to speak to one of the researchers. The person will do their best to answer your questions. They can be contacted on 01223 746031. If you are still unhappy and want to complain formally you can do this through the University of Cambridge Research Services on 01223 333543.

The research only involves asking some questions and doing some tasks on the computer while your heart rate and fingertip sweating are recorded, so we think it is unlikely that you will have any problems. If however, during the course of the study, something goes wrong that hurts you and may be due to someone's negligence, then you may have grounds for legal action for compensation against the University of Cambridge. You may have to pay your own legal costs in any legal action.

Who has reviewed this study?

This study has received ethical approval from the University of Cambridge Psychology Research Ethics Committee.

What should I do if I have any questions, concerns, or would just like more information?

Please contact Lydia Luke (lrl29@medschl.cam.ac.uk or on 01223 746031) or the project supervisor, Dr Isabel Clare (on 01223 746100), if you have any questions or concerns about this research. You can also write to Lydia Luke or Dr Isabel Clare using the address at the top of this letter.

If you are aged 16 – 18 years and would like to take part, you should discuss this with your parents/guardians before contacting the research team.

If you would like to participate, please contact Lydia Luke

(lrl29@medschl.cam.ac.uk or 01223 746031)

iv) Consent Form for participants in the control group

Decision-making in Autism

UNIVERSITY OF CAMBRIDGE

Lydia Luke
PhD Student
CIDDRG, Douglas House
18b Trumpington Road
Cambridge CB2 8AH
Tel: 01223 746031

Consent form

Project title: Decision-making by men and women with an autism spectrum condition
Name of Researchers: Ms Lydia Luke, Dr Isabel Clare & Dr Howard Ring

Please demonstrate your understanding of the nature of this study by reading the statements and ticking the boxes below:

		Please tick
1	I have read and understand the information about this study	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected.	☐
3	I understand that my anonymised answers will be incorporated into an account of this research that will be presented at conferences and in journals and written up as part of a Ph.D. thesis.	☐
4	I understand that if something goes wrong or I am hurt as a result of someone's negligence, then I may have grounds for a legal action for compensation against the University of Cambridge but I may have to pay my legal costs.	☐
5	I agree to take part in the above study.	☐

Please print your name and sign and date this page

Name: _____ Signature: _____ Date: _____

If you have any questions or concerns about this research, please contact Ms Lydia Luke or Dr Isabel Clare by telephone or post at the above address