University of Bath

PHD

The Relationship between Autism and Psychosis Traits and Reasoning Style

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Award date:
2016

Awarding institution:
University of Bath

The Relationship between Autism and Psychosis Traits and Reasoning Style

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A thesis submitted for the degree of Doctor of Philosophy

University of Bath

Department of Psychology

September 2016

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my two supervisors, Dr Mark Brosnan and Dr Chris Ashwin. They have provided me with continuous support throughout my PhD and related research. They have both displayed patience, encouragement, and demonstrated immense knowledge in areas pertinent to my research. Their guidance and support has kept my head above the murky and often challenging waters of academia and they have allowed me to become a better psychologist, researcher, and scientist. I could not have asked, neither could I have imagined, having any other supervisors.

Besides my supervisors, I would like to thank all participants who generously donated their time to participate in my research. Without them, this research would not have been possible.

I would also like to thank the prominent leaders in my field of research who donated their time to respond to my probing questions and emails, to which they provided me their knowledge and insight without ever asking for anything in return. Notably, I would like to thank Professor Linden Ball, Abu-Akel, Gordon Pennycook, and Dean Wilkinson. I would also like to thank Rhian Davies for re-kindling my love for clinical psychology by sharing her anecdotes of mental health nursing and keeping me sane during the more challenging periods of this PhD.

I would like to thank my wonderful parents, who endured the brunt of this PhD with me for the last three years! I am grateful for them listening to my endless ramblings about countless career woes, self-doubts, and my own personal madness. Thanks for sticking by me. You are both an inspiration to me and I hope to aspire to live as happily as you both are. Finally, I would like to thank the University of Bath for awarding me with a fully funded Studentship. Without your generous financial support, this research would have remained a fantasy. Thank you!

PUBLICATIONS

Brosnan, M., Hollinworth, M., Antoniadou, K., & **Lewton, M**. (2014). Is Empathizing intuitive and Systemizing deliberative? *Personality and Individual Differences*, *66*, 39-43.

Data from this paper does not appear in this thesis. In addition to my doctoral studies, I conducted some additional research with my supervisor, which is reported in this paper.

Brosnan, M., **Lewton, M**, & Ashwin, C. (2016). Reasoning on the Autism Spectrum: A Dual Process Theory Account. *Journal of Autism and Developmental Disorders*, 1-11.

This paper consisted of two studies. My supervisors led on one study and I led on the other study. This is explicitly acknowledged in the paper. This paper focuses upon the relationship between high and low groups as indexed by the Autism Quotient (AQ; Baron-Cohen et al., 2001) and the Rational Experiential Inventory (REI; Epstein et al., 1996). The data reported in Chapter 5 is a re-analysis of part of the data reported in Study 2 of this paper. The analysis in the thesis explores the independent relationships between autism, psychosis and the discrepancy between autism and psychosis as a continuous variable. The analyses and words are different between the paper and the thesis.

ABSTRACT

The current research project aimed to investigate how various degrees of psychosis and autism traits were associated with different styles of reasoning. Therefore, a series of five studies were conducted that recruited participants who were considered to reside along different points of the psychosis and autism continua. Measures of intuitive and deliberative reasoning style were employed and were used to ascertain whether differing degrees of psychosis and autism reflected different profiles of reasoning style. In addition, a composite score was devised using the raw scores of measures of psychosis and autism traits to test Crespi and Badcocks (2008) diametric disorders hypothesis and to further explore the relationship between the two measures. Overall, the results revealed some evidence that psychosis traits were associated with a more intuitive relative to deliberative style of reasoning, whereas autism traits were reflective of the reverse profile. The findings were also able to shed further light on the intricate relationship between autism and psychotic spectrum disorders.

LITERATURE REVIEW

CHAPTER 1— An Introduction to the Autism and Psychosis Continua and the Theoretical Premises that Connect them

People experiencing psychosis are considered to have difficulty differentiating between what is real and imaginary (Beer, 1998). This interpretation remains valid today as outlined by the latest diagnostic manuals in psychiatry, such as the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-5) (American Psychological Associated, 2013) and the International Classification of Diseases (ICD-10) (World Health Organisation, 2007). The loss of contact with reality can be due to the presence of hallucinations, events defined by DSM-5, when sensory perceptions are stimulated without any external stimuli, e.g. hearing a voice when there is not one. Although hallucinations can occur across various sensory modalities (e.g. tactile, visual, olfactory, etc.), within the context of psychosis, hallucinations are likely to present as verbal auditory hallucinations. For example, it has been reported that at least 70% of individuals who experience psychosis are considered to experience auditory hallucinations (Waters et al., 2012). Another indicator of psychosis can be delusional beliefs. Delusional beliefs are considered fixed beliefs that are held with strong conviction and not shared by the individual's social or cultural environment (APA, 2013). Delusions and hallucinations are often referred to as the 'positive' symptoms of psychosis. The positive symptoms of psychosis can also occasionally result in impairments in social functioning, such as social withdrawal, interpersonal difficulties, and loss of skills in some cases, which are a cluster of symptoms referred to as negative symptoms. However, there remains much disparity amongst clinicians and researchers as to whether the negative symptoms occur before, during, or as a result of the positive symptoms (Blanchard & Cohen, 2006; Lencz et al., 2004). Nonetheless, it is generally agreed that the negative symptoms become more pronounced after the onset of the

positive symptoms of psychosis (Fujii & Ahmed, 2007). From this perspective, the positive symptoms of psychosis are the most striking and of central interest to both researchers and clinicians. According to the DSM-5, symptoms of psychosis may be indicative of a wider mental health disorder. For instance, psychosis has been reported to materialise prior and during the time when people who are diagnosed with Post-traumatic Stress Disorder (Berry et al., 2013), Postpartum Depression (Doucet et al., 2011), Bipolar Affective Disorder (Upthegrove et al., 2015) and Borderline Personality Disorder (Schroeder, Fisher, & Schäfer, 2013). Even so, psychosis remains most commonly associated with, and is considered, a cardinal diagnostic indicator of schizophrenia spectrum disorders.

The DSM-5 categorises schizophrenia under the subheading "Schizophrenia Spectrum and Other Psychotic Disorders". Under this umbrella reside a spectrum of disorders, including: delusional disorder, brief psychotic disorder, schizophreniform disorder, schizophrenia, schizoaffective disorder, substance/medication-induced psychotic disorder, schizotypal personality disorder, psychotic disorder (due to another medical condition, catatonia), other specified schizophrenia spectrum and psychotic disorder. All of these disorders are conceptualised as psychotic disorders as psychosis is their primary feature. The DSM-5 requires a person to experience the positive symptoms of psychosis over an extended period of time in order for a diagnosis of a psychotic disorder to be reached. As reported by Freeman (2007), delusions are found to occur in 80% of individuals with schizophrenia. Specifically, 60% to 90% of patients with schizophrenia are reported to experience auditory hallucinations in contrast to any other psychiatric disorder (Waters, 2010). Such findings support the notion that the positive symptoms of psychosis can be used to dissociate psychotic disorders from other clinical disorders. When people meet the clinical criteria for a psychotic disorder, it is usually because psychosis is causing great distress and disability, which results in everyday functional impairments (APA, 2013).

The underlying cause of psychosis is not wholly understood, although it is generally agreed that psychosis is caused by a series of multiple and interacting variables

involving biological, psychological, and environmental factors as opposed to any single feature per se (Raicar et al., 2016). However, the specific factors that have been implicated are many and wide-ranging, including, for example, pre-natal and post-natal insults such as infections and complications, adverse childhood experiences, aspects of familial environment, urbanicity, and the consumption of cannabis (Allswede et al., 2016; Rytilä-Manninen et al., 2014; Sørensen et al., 2014; Boonstra et al., 2012; Ksir & Hart, 2016). In most cases, antipsychotic medication is the first line of treatment. Antipsychotic medication operates by blocking dopamine function, which is a neurotransmitter produced by the brain. Blocking dopamine production is often found to ameliorate positive symptoms in the majority of patients with a psychotic disorder (Evans, Averbeck, & Furl, 2015; Subotnik et al., 2014). Given the success rate of antipsychotic medication, there clearly appears to be a link between biological influences and the development of positive psychosis symptoms. Nonetheless, there still remains much inconsistency about precisely how positive symptoms occur in the first place, which remains a matter of continuing and evolving debate (e.g. Crespi, 2011; Bentall, 2004).

One way to understand psychosis is to explore the individual differences in how people perceive and experience psychosis symptoms. For example, as discussed by Choong et al. (2007), some people who experience psychosis may experience such phenomenon in a positive light, especially if such experiences are not causing distress or disability. In recent years, there has been an increasing interest in the idea that psychotic experiences are not necessarily restricted to clinical populations and, in fact, occur across a continuum ranging from typicality to disorder (Bartels-Velthuis et al., 2010; Poulton et al., 2000; Shevlin, Murphy, & Dorahy, 2007; McGrath et al., 2015; Beavan, Read, & Cartwright, 2011; Shevlin et al., 2014; van OS, 2009; Wigman et al., 2011; Bebbington et al., 2013). From this viewpoint, experiences such as hearing voices, believing that someone or something is watching you, or having thoughts that may appear perplexing to others, are more common in the general population than previously thought. An accumulative body of research studies has used self-report

measures to inquire about such experiences. These self-report measures probe symptom dimensions of psychosis such as positive and negative symptoms (see, for overview of measures, Mason, 2015). The key findings derived from such studies reveal that many participants report experiencing at least one delusion or hallucination throughout their lifetime in the absence of any mental health or medical disorder. For example, Johns and colleagues (2004) examined psychotic experiences within the British population of adult participants. The results revealed that, out of the 8,580 respondents, just over 5.5% of the sample endorsed one or more items on the Psychosis Screening Questionnaire (PSQ; Bebbington & Nayani, 1995). The PSQ is a questionnaire that directly asks about hearing voices that were not there, attaining beliefs you know to be false, and seeing things that aren't actually there. All participants confirmed that they had never received a formal diagnosis of a mental health disorder, or any form of organic or neurological disorder they may have accounted for such psychotic experiences. More recently, up to 15% of the general population have been found to report some form of psychosis symptom in the absence of a psychotic or medical disorder using similar self-report measures (Balaratnasingam & Janca, 2015). Such findings provide evidence for the notion that psychosis exists on a continuum of severity which blends into the general population, whereby psychotic disorders like schizophrenia spectrum disorders are considered to represent the extreme end of a continuum of psychosis (Binbay et al., 2012). These empirical findings have led theorists such Van Os et al. (2000) and others (Hanssen et al., 2005; Raine, 2006; van Nierop et al., 2012) to suggest that psychosis is, in fact, a continuous phenotype that opposes previous categorical approaches of mental illness, which maintain that symptoms are either present or absent as outlined by the DSM-IV-TR and ICD-10. However, it should be acknowledged that a continuum-based approach to psychosis has been authorised in the DSM-5 to support categorical approaches, which has been shown to be useful in identifying individual differences in the gravity of the condition (APA, 2013). In light of such prosperous findings, the continuum of psychosis is considered to reflect differing intensities of psychotic symptoms that have alternatively been labelled as schizotypal traits, psychosis-

proneness, psychosis-like symptoms, psychotic experiences and psychosis traits (Simons, Jacobs, Jolles et al., 2007). For the sake of clarity and consistency, from this point onwards I shall adopt the term 'psychosis traits' to refer to this psychosis continuum. In addition, in keeping with previous conceptualisations of psychosis and psychotic disorders (Abel-Akel et al., 2015; Claridge, 1997) in this thesis, unless otherwise specified, the term 'psychosis traits' is restricted to the presence of positive psychosis traits only. This is keeping in line with the proposal that the positive symptoms of psychosis are the prime feature of a psychotic disorder.

Psychosis traits have been found to negatively impinge on a range of different cognitive faculties including learning, memory, inhibition, etc. (Reichenberg et al., 2009). In such instances, people with higher degrees of psychosis traits appear to acquire significantly lower scores across all of these domains. However, people with a high expression of psychosis traits have been notably observed to have profound difficulties in social cognition compared to people without psychosis traits. Social cognition is thought of as the "function that includes the perception, interpretation and processing of information that underlies social interactions" (Addington, Girard, Christensen, & Addington, 2010, p. 49). Indeed, such difficulties appear to be central to the disorder and are, therefore, of great interest to both researchers and clinicians. As social cognition plays a substantial and direct role with everyday social behaviour, understanding social cognition and its relationship with psychosis traits has become a major area of investigation (Koelkebeck et al., 2010; Crespi & Badcock, 2008; Badcock, 2009; Fretland et al., 2015). 'Mentalising' has been defined by Bateman and Fonagy (2004) as "the mental process by which an individual implicitly and explicitly interprets the actions of herself and others as meaningful on the basis of intentional mental states such as personal desires, needs, feelings, beliefs, and reasons" (p. 215). Mentalising is therefore a skill that is utilised in order to facilitate the understanding of human beings, their motives and intensions. It is worthwhile to acknowledge that mentalising is often used synonymously with 'empathising'. However, many researchers argue that empathising is considered to be a multidimensional construct, whereby it encompasses

both an affective and cognitive component (Eres, Decety, Louis, & Molenberghs, 2015). The affect component of empathy refers to a person's capacity to respond with an appropriate emotion to another's mental state (Rogers et al., 2007), whilst cognitive empathy is thought of as the same as mentalising, a concept colloquially known as 'theory of mind'. For example, Premack and Woodruff (1978) coined the term 'theory of mind' to refer to the ability of a person to represent the mental states (e.g. thoughts, desires, beliefs) of others, and to use these mental states to predict and understand their behaviour. Many theorists that have assessed empathising across the psychosis continuum appear to refer more to the cognitive, as opposed to the affective, dimension of empathy (Brüne, 2005; Bell et al., 2010).

Individual differences in mentalising abilities are of paramount importance as they play a significant role in everyday social and communication functioning. Given the substantial difficulties in social and communication functioning that arise in people who experience psychosis, understanding these experiences is, indeed, a fruitful avenue and may be a useful starting point for understanding other areas of cognition. Indeed, difficulties with accurate mentalising could undermine one's ability to cope with various afflictions and solve interpersonal issues competently (Kean, 2009). The association between psychosis traits and mentalising impairments is evident in studies that have continuously shown a relationship been the two constructs (Langdon & Coltheart, 2004; Versmissen et al., 2006; Pflum, Gooding, & White, 2013). Such findings suggest people on the psychosis continuum have difficulties in accurately inferring mental states about others when compared to matched Control groups. Support for this assumption has been documented through a series of performance-based measures that are considered to assess mentalising abilities. For example, the Reading the Mind in the Eyes Task (RMET; Baron-Cohen et al., 2001) is a task that requires participants to deduce the mental state or emotion a person is feeling based on the expression of their eyes. Indeed, such a task is considered to be a general measure of mentalising and it is not known whether the RMET specifically involves assessing cognitive or affect empathy. Preserved or enhanced performance on this task is predicated on one's ability to infer

the mental state of others, i.e. accurate mentalising. People who self-report various expressions of psychosis traits acquire significantly lower scores on the RMET in comparison to typical developing Control groups (Bora et al., 2008; Bertrand et al., 2007). For instance, in a meta-analysis by Bora and Pantelis (2013), the authors identified eight studies that demonstrated significant differences between people with a higher expression of psychosis traits (i.e. people with a schizophrenia spectrum disorder) and matched controls. Participants with schizophrenia performed significantly more poorly than the Control groups on the RMET. Furthermore, a study by Barragan et al. (2011) found that participants within the non-clinical population, who were psychometrically identified as experiencing a high expression of psychosis traits as indexed by the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) (Mason et al., 1995), a self-report questionnaire designed for the assessment of psychosis traits in the general population, also exhibit impairments in mentalising on the RMET. In other experimental tasks such as the Faux Pas Recognition Test (Stone et al., 1998), a task that was designed to assess the ability of whether a participant can recognise and accurately infer a social faux pas in a social situation, yielded that participants with schizophrenia were significantly worse in contrast to a matched Control group (Negrão et al., 2016). As expected, such findings have extended to people without a clinical diagnosis of psychosis but who endorse a moderate to high degree of psychosis traits. For instance, Morrison, Brown and Cohen (2013) found that, in contrast to low-scoring groups, participants who endorsed a high degree of psychosis traits exhibited worse performances on the Faux Pas Recognition Test. Considered together, the difficulties in mentalising may be a salient feature of the psychosis continuum.

Frith (2000) was one of the first neurocognitive psychologists to introduce the distinction between ‘under-mentalising’ and ‘hyper-mentalising’. Firth proposed that the errors in mentalising performance observed across the psychosis continuum may occur due to over/hyper-mentalising as opposed to mentalising deficits per se. Sharp (2014) conceptualises ‘hyper-mentalising’ as “a social-cognitive process that involves making assumptions about another person's mental states that go so far beyond

observable data that the average observer will struggle to see how they are justified" (p. 90). Corroborating this idea, Abu-Akel (2003) proposed that mentalising difficulties could range on a continuum from the complete absence of the ability to represent other people's mental states, the ability to accurately mentalise about other mental states, to the atypical or extreme attribution of mental states which result in over-generating hypotheses about mental life. Indeed, Firth later proposed that such exaggerated inferences could be the product of psychosis traits. Recently, a number of researchers have substantiated this claim (Peyroux et al., 2014; Moore & Pope, 2014; McCabe, Leudar, & Antaki, 2004; Crespi & Badcock, 2008; Firth, 2004). This extreme degree of hyper-mentalising is considered to explain paranoid delusions of being spied upon, and why individuals who exhibit psychosis imagine intentional activity in people everywhere, even when it does not exist (Blakemore, Sarfati, Bazin, & Decety, 2003; Russell, Reynaud, Herba, Morris, & Corcoran, 2006). The empirical evidence for hyper-mentalising in psychotic spectrum disorders has been derived from studies whereby participants with a psychotic disorder are observed to ascribe intentions to behaviours that are seen as random by clinical groups without psychosis and healthy Control groups. For example, Fretland et al. (2015) observed how increasing degrees of psychosis traits in a clinical sample of individuals with schizophrenia were found to be positively associated with hyper-mentalising, as assessed by performance on the Movie for the Assessment of Social Cognition (MASC; Dziobe et al., 2006). The MASC is a short video that shows actors' interaction with each other at a dinner party; the video is paused 46 times and participants are asked questions concerning the characters' feelings, thoughts, and intentions. Incorrect inferences would be suggestive of worse social cognition; however, the task also allows participants to over-subscribe the intentions of others. In Fretland et al., it was observed how participants with an increased degree of psychosis traits had a tendency to over-subscribe the mental states of the actors in the video. Elsewhere, other research findings have found how individuals who self-report a high expression of psychosis traits incorrectly ascribe experience and agency to inanimate objects, thus further demonstrating hyper-mentalising (Gray et al., 2011). Furthermore, both Peyroux

et al. (2014) and Moore and Pope (2014) observed that people with schizophrenia and people with psychosis traits decipher sentences and actions as more intentional relative to people who endorse fewer to no psychosis traits. In addition, Uono, Sato & Toichi (2015) found that, within a non-clinical population sample, individuals who scored high on a self-report measure of psychosis traits perceived facial expressions as more exaggerated than those who had few psychosis traits, thus demonstrating hyper-mentalising tendencies.

In general, therefore, it seems that there is strong evidence to suggest that the positive symptoms of psychosis (along with positive psychosis traits) reflect hyper-mentalising tendencies. This is of particular relevance, as dispositions towards hyper-mentalising may not only explain the pertinent features of psychosis (e.g. delusions, paranoia, suspiciousness, ideas of reference, etc.), but may also be a useful indicator of exploring cognitive biases and other pertinent behaviour that is central to psychosis. Indeed, if psychosis traits do reflect a hyper-mentalising style of cognition as some theorists have advocated (Crespi & Badcock, 2008; Firth, 2003; Uono et al., 2015), then predictions may be able to be formulated about how psychosis traits relate to other areas of cognition such as problem-solving, decision-making, information processing, or reasoning (reviewed in Chapter 2), which can be tested within research studies.

As previously discussed, psychosis has been documented to occur in an assortment of mental health disorders. However, psychosis has long been intertwined with another group of disorders referred to as Autism Spectrum Disorders (ASD). Indeed, as put forward by Jänsch (2011), “Of all the relationships between ASD and psychiatric disorders, the most entangled is that with psychosis” (p. 39). This intricate relationship has existed since the conception of psychosis (Kolvin, 1971; Bleuler, 1950; Crespi, 2011). From a historical point of view, Bleuler (1911) first used the term ‘autism’ to describe the extreme self-directedness and profound social withdrawal typically seen in adults who were considered to have schizophrenia (i.e. the negative symptoms). However, it was Leo Kanner that first coined the label ‘early infantile autism’ to characterise children who exhibited the same social withdrawal and detachment behaviour seen in adults

who had schizophrenia (Kanner, 1943). Kanner further highlighted that, although the early infantile autism group shared similar behavioural similarities to people with schizophrenia, other psychotic features were absent (i.e. the delusions and auditory hallucinations). Given the notable absence of positive symptoms of psychosis in ASD, both disorders were formally considered to be independent from one another (APA, 1980). However, mentalising impairments are also found to be central to ASD (Chung et al., 2014). However, as shall become clear, some theorists have proposed that underlying mechanisms that underpin these difficulties in mentalising between ASD and psychosis may, in fact, be diametrically opposing (Crespi & Badcock, 2008; Badcock, 2011). Indeed, it has been hypothesised that individuals with ASD and individuals with a psychotic disorder may reside at the extreme ends of a single overarching continuum of social cognition (Ciaramidaro et al., 2014). In sum, therefore, it appears that ASD and psychosis represent different disorders, as outlined by diagnostic manuals, but they also share similar characteristics in some domains, thus exhibiting some overlap with one another. However, this may be the result of different underlying mechanisms. So, it appears that such disorders have a complex and perplexing relationship. Nevertheless, in order to make any inferences about psychosis and ASD and their respective relationship, it is important to first understand the central features and characteristics of ASD.

Autism Spectrum Disorders

Autism Spectrum Disorders (ASD) are a cluster of developmental disorders that are typified by the DSM-5 (APA, 2013) and which involve a dyad of impairments in social communication and interaction, in conjunction with restricted patterns of behaviour, activities, and interests. The foremost social communication impairment in individuals with ASD is evidenced through the clear abnormalities in their capacity and understanding for reciprocal social interaction (Baron-Cohen, 2009; Coonrod & Stone, 2004). That is, such individuals experience difficulties in the ability to comprehend and predict others' behaviour by reflecting on their feelings, thoughts, emotions, and intentions. These difficulties can materialise in people with ASD by their having difficulty

understanding sarcasm, jokes, and deliberative deception, e.g. lying, bluffing, irony, etc. (Mathersul et al., 2013; Sodian & Frith, 1992; Pexman et al., 2011). Beyond the social characteristics, there are also 'non-social' features that are considered to be central to the diagnosis of ASD. These involve 'restricted and/or repetitive behaviours and interests' (APA, 2013). As outlined by the DSM-5, such interests are increasingly varied and can materialise in the persistence of sameness, or ritualised patterns of behaviour; highly restricted, fixated interests that are abnormal in intensity or focus; hyper or hyposensitivity to sensory input or unusual interests in sensory aspects of the environment. For example, some people with ASD exhibit a fixed interest in bus timetables, whilst others may need to use the same route going to and from a destination, e.g. walking to the supermarket by taking a very specific path. Furthermore, people with ASD can develop an interest in a range of inexplicable objects such as toilet brushes, tarantulas, food packaging, crockery, keys, etc. (Winter-Messiers, 2007). Although the precise mechanisms that underpin these inclinations for fixed and repetitive interests have been extensively debated (South, Ozonoff, & McMahon, 2005), there is evidence to suggest that such interests occur as people with ASD have a 'hyper-developed' drive to construct and analyse rule-based systems (Singleton, Ashwin, & Brosnan, 2014; Baron-Cohen et al., 2009). This propensity for studying systems can result in people with ASD exhibiting difficulties in attention switching (e.g. the ability to switch focus and divide attention up between tasks) and display enhanced attention to detail. While ASD is sometimes perceived as a detrimental disorder, particularly within a social context, there is strong experimental and anecdotal evidence of preserved or superior performance when people with ASD engage in explicit tasks that involve deriving patterns or rules from non-social systems (Baron-Cohen, Wheelwright, Spong, Scahillhr, & Lawson, 2001; Brosnan, 2014). For example, some individuals with ASD have been found to excel in both subjects and careers that involve engineering, mathematics, science and computing (Wei et al., 2013; Escovar et al., 2016).

Comparable to people with psychosis, people across the ASD continuum have also demonstrated significant deficits in mentalising. As indicated as a core diagnostic

indicator of ASD, many people with ASD have been found to have difficulty inferring mental states, beliefs and intentions about others. Consequently, such individuals have been recognised to struggle with tasks such as the RMET and, thereby, acquire significantly lower scores on tasks of mentalising in comparison to typical developing Control groups (Baron-Cohen, Spitz, & Cross, 1993; Loveland, Tunali Kotoski, Chen, & Brelsford, 1995; Celani, Battacchi, & Arcidiacono, 1999; Deruelle, Rondan, Gepner, & Tardif, 2004; Rutherford, Baron-Cohen, & Wheelwright, 2002). These findings have also been extended to more complex and naturalistic social cognitive tasks, such as the Movie for the Assessment of Social Cognition (MASC; Dziobe et al., 2006). In Dziobe et al., participants with a confirmed diagnosis of ASD performed significantly poorer on the MASC relative to a matched Control group. However, in comparison to people with psychosis, people with ASD were not found to be associated with hyper-mentalising based responses, but with inaccurate performance on the MASC, suggesting that people with ASD engaged in 'under-mentalising', which is reflective of under-reporting the mental states from the actors in the video. Further to this, Lahera et al. (2014) found that performance on the MASC could be used to discriminate between people with and without ASD. Participants with ASD could be identified by the high number of under-mentalising answers they selected on the MASC.

Akin to the continuum hypothesis of psychosis, the severity and degree of the behavioural and cognitive characteristics specifically related to ASD (both social and non-social) are theorised to reside on a continuum that grades into the general population (Scheeren & Stauder, 2008; Ruzich et al., 2015; Hoekstra et al., 2008; Woodbury-Smith et al., 2005). Parallel to psychosis, these characteristics are suggested to present at various degrees and intensities throughout the general population, with extreme degrees of these traits representing clinical ASD (Constantino et al., 2003). Identifying these traits is accomplished through using psychometric measures that are predominantly depended on self-report methodologies, such as the Autism Quotient (AQ; Baron-Cohen, Wheelwright, Skinner et al., 2001). The AQ has been used to identify autistic traits in adult population samples of normal intelligence (i.e. people without a

formal intellectual disability). For instance, increasing degrees of autistic traits, as assessed by AQ scores in a college sample, were found to negatively predict performance on the Reading the Mind in the Eyes Task (RMET; Baron-Cohen et al., 2001). Indeed, Miu, Pană and Avram (2012) examined how a group of participants, who obtained scores one standard deviation above the average on the AQ, exhibited worse performance on the RMET (i.e. made more inaccurate inferences of mental states) in comparison to participants who attained little to no autism traits. These findings have also been found to occur in participants who attained a higher number of traits on the AQ, but did not have a formal diagnosis of ASD. For instance, Smeets, Dziobek, and Wolf (2009) found how a higher number of autistic traits correlated with worse performance on the MASC. Indeed, this study was recently replicated by Gökçen, Frederickson and Petrides (2016), who also found that, within a non-clinical population sample, autism traits were negatively associated with performance on both the MASC and the RMET. Collectively, such findings yielded that people who experience elevated levels of autism traits display a similar pattern of difficulties in mentalising as those with a clinical diagnosis of ASD. Such findings highlight the importance of examining autism traits across the autism continuum.

Following on from this, individuals who attain higher scores on psychometric measures of autism traits have been found to demonstrate preserved or sometimes enhanced attention to detail, which has been repeatedly demonstrated across various visual-spatial tasks (Mottron et al., 2003; Edgin & Pennington, 2005). These tasks are particularly insightful, as they shed light on the non-social characteristics of ASD. Indeed, fixed and repetitive interests require attention to detail, which has been measured by tasks such as the Embedded Figures Test (EFT; Witkin, 1971). The EFT involves participants having to identify a series of figures which are embedded and 'hidden' in a larger picture. Faster identification of these figures is generally considered to reflect enhanced attention to detail. For example, Almeida et al. (2014) found how undergraduate students who attained high scores on the autistic quotient outperformed participants with low scores on the AQ on the EFT. High-scoring AQ participants were

quicker at identifying the figures compared to low-scoring AQ participants. Further to this, Grinter et al. (2009) also found how moderate to high levels of autistic traits as measured by the AQ were found to predict enhanced performance on the EFT in a sample of undergraduate students. Beyond the EFT, Richmond et al. (2013) observed how adolescents with elevated AQ scores attained higher scores on a visual working memory task, whereby enhanced performance on such a task required attention to detail. Furthermore, Stewart et al. (2009) observed how undergraduate students with high AQ scores outperformed participants with low AQ scores on a Block Design Task. Considered together, there appears to be a strong empirical basis for self-report measures of AQ correlating with the cognitive strengths observed in clinical ASD. Overall, there is a significant body of research that suggests that the spectrum of autism lies on a continuum that blends into the general population.

In view of all that has been mentioned so far, the psychosis and autism continua appear to share commonalities in certain aspects of behaviour (i.e. deficits in mentalising). More specifically, mentalising difficulties may appear to be the result of two dissimilar underlying processes (i.e. hyper-mentalising in psychosis and under-mentalising in ASD). Fretland et al. (2015) highlight that the distinctions between hyper and hypo-mentalising is fruitful as it can be used to explain some of the relevant social and non-social characteristics related to both ASD and psychosis. Indeed, Murphy (2006) reported that atypical mentalising abilities can be used to discriminate patients with ASD and psychosis from other mental health conditions (e.g. personality disorders). One way to explore the relationship between psychosis and ASD is to look at theories that can explain mentalising abilities across both the ASD and psychosis continua. At the time of writing, there are two dominant theories that attempted to explain the social and non-social behaviours of ASD and psychosis.

The Empathising-Systemising theory

A useful framework for understanding the relationship between psychosis and ASD is the Empathising-Systemising theory (E-S; Baron-Cohen, 2002, 2003, 2009). The E-S theory proposes that humans have acquired two parallel and complementary cognitive-affective systems. By this theory, 'empathising' (hereafter, mentalising) involves the ability to accurately infer mental states from others and respond to these states accordingly, while 'systemising' describes the drive to analyse, understand and manipulate the physical/non-social world (Baron-Cohen, 2002, 2009; Baron-Cohen et al., 2005; Lawson et al., 2004; Nettle, 2007b). According to Baron-Cohen et al. (2003), systemising encompasses the motivation to analyse and construct rule-based systems. The process of systemising primarily involves detecting the 'input-operation-output' rules that control and predict how a system behaves. Systems are wide-ranging and may be mechanical (e.g. a bicycle, car, computer), natural (e.g. the tides, a pond, a tree), abstract (e.g. the syntax of language), collectible (e.g. a library catalogue) or even social (e.g. a rugby team). This suggests that heightened systemising is associated with skills such as navigation, calculation, engineering, map reading, and tool-using (Lindeman, Svedholm-Häkkinen, Lipsanen, 2015), whereas heightened mentalising is reflective of a better understanding of inferring mental states from others, feelings, beliefs, intentions, etc. To put it more unequivocally, some theorists (Svedholm-Häkkinen & Lindeman, 2016) perceive mentalising and systemising as domain-specific focuses developed for understanding psychological and physical phenomena, respectively.

Individual differences in mentalising and systemising can be measured through using either self-report or task-based assessments. Indeed, as discussed in the previous sections, the RMET, MASC and EFT are behavioural tasks which are considered reflective of assessing mentalising and systemising abilities, respectively. Self-report measures include the Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004) and the Systemising Quotient (SQ; Baron-Cohen et al., 2003). Such measures enquire about preferences for elements of social and non-social cognition. Although people tend to utilise both of these abilities to differing degrees, there are clear sex differences in

strengths for mentalising and systemising. Across both behavioural and self-report measures, men on average have higher systemising scores and lower mentalising scores, while women show the reverse pattern (Baron-Cohen, 2002; Baron-Cohen et al., 2005; Chakrabarti & Baron-Cohen, 2006; Wakabayashi et al., 2007). For example, in a large non-clinical population using the EQ and SQ as self-report measures of mentalising and systemising, Wright and Skagerberg (2012) found that, if a female-male pair was selected at random from the sample, the female participant would have the higher empathising score about two-thirds of the time, while the male would have the higher systemising score about two-thirds of the time. Indeed, such findings have extended to behavioural measures, where a meta-analysis assessing performance on the RMET found that females acquired significantly higher scores on the RMET in contrast to male participants (Kirkland et al., 2013), whereas males tend to be superior at tasks that are considered to assess systemising, such as the EFT in contrast to females (Voyer et al., 1995). Consequently, such a model is useful for understanding sex differences in social and non-social cognition.

In the context of the E-S theory, ASD represents an extreme expression of a strongly-skewed profile of enhanced systemising relative to low levels of mentalising (EMB; 'Extreme Male Brain' in Baron-Cohen et al., 2009). Principally, the EMB suggests that ASD is a male condition driven by high levels of testosterone (Baron-Cohen et al., 2005). A rationale for such an assertion is based on evidence that there is a disproportionate amount of males who are affected by ASD in comparison to females (Rutherford et al., 2016). These findings have also extended to non-clinical populations whereby, when using the EQ and SQ, people with an increasing number of autism traits attain significantly higher scores on the SQ relative to the EQ (Grove et al., 2013; Baron-Cohen et al., 2001; Wheelwright, 2006). Considered together, there appears to be robust evidence for the idea that people on the ASD continuum have a preference for systemising relative to mentalising. Indeed, although mentalising and systemising may be associated with performance on a variety of different tasks, it is generally the discrepancy between measures of mentalising and systemising that have been used to

characterise males, females, and people with ASD (Goldenfeld et al., 2005). These findings are useful as they may help explain some of the pertinent features that are central to a diagnosis of ASD. For instance, ASD is characterised by deficits in social difficulties, which may stem from people with ASD attempting to utilise their strengths in systemising during social situations (Brosnan et al., 2014; Golan & Baron-Cohen, 2006). Conversely, repetitive patterns of behaviour, interests, or activities may reflect a high drive for systemising and a deviation away from empathising.

The initial conception of the EMB in the context of E-S theory postulated that the reverse profile of high mentalising relative to low systemising was unlikely to have any detrimental consequences, and was doubtful to engender any psychiatric disorders. However, Baron-Cohen et al. (2009) did suggest that 'hyper-mentalising' and high mentalising relative to low systemising may reflect enhanced social cognition, but was unlikely to have any clinical relevance. However, the reverse profile of high mentalising relative to systemising (termed the 'Extreme Female Brain') has recently been considered to have implications for psychotic spectrum disorders (Abu-Akel & Bailey, 2000; Frith, 2004; Crespi & Badcock, 2008). Using self-report measures of mentalising and systemising (Empathy Quotient and Systemising Quotient, respectively) and the Psychosis Screening Questionnaire (PSQ; Bebbington & Nayani, 1995) to measure psychosis traits, Brosnan, Ashwin, Walker, and Donaghue (2010) found that it was the discrepancy between empathising and systemising (termed the '*empathising bias*') that predicted the occurrence of psychosis traits. This was in contrast to absolute scores on self-report measures of empathising and systemising. Overall, these findings implied that relative scores between these two dimensions were informative of attenuated expressions of psychosis traits in a non-clinical population. These findings can be considered complementary to the EMB and provide support for the EFB. Furthermore, Larson et al. (2015) reported that adults with ASD and psychotic symptoms showed a profile of high empathising relative to systemising than adults with ASD and non-psychotic symptoms, with a particularly exaggerated effect for female participants. This finding suggested that, when ASD was associated with clinical levels of psychosis

symptoms, such individuals exhibited a different profile of empathising and systemising. Similarly, Bremser and Gallup (2012) found that high mentalising relative to systemising predicted higher degrees of psychosis traits as indexed by the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). Specifically, such a profile resulted in such participants' higher levels of magical thinking, suspiciousness and paranoia, all of which are found to occur at extreme degrees in people with a diagnosis of a psychotic disorder (van OS, 2011).

The E-S theory can be considered a useful framework and starting point for predicting cognition amongst people on the ASD and psychosis continua. For example, if ASD and autism traits characterise a profile of higher systemising relative to mentalising, then predictions can be made about the type of cognition such individuals are likely to engage in when presented with incoming information. Besides such a framework being used to explain clinical extremes of ASD and psychosis, the E-S theory also helps to understand the normal variation of cognition found in the typical developing population. However, it should be acknowledged that the EFB is a separate body of research that has yet to be officially integrated into the E-S framework; thus, the E-S theory in isolation may only be useful in explaining cognition in different sexes and ASD but not psychosis.

The Diametric Disorders Hypothesis

Of particular relevance and of central investigation to the current thesis is Crespi and Badcock's (2008) and Badcock's (2009) 'diametric disorder hypothesis'. This theory conjectures that autism and psychosis spectrum disorders reside at opposite ends of a single cognitive continuum, superimposed by dimensions of social and non-social cognition. This theory, which is part of a wider genetic theory termed the 'Imprinted Brain Theory', shares parallels with the Empathising-Systemising (E-S) theory (Baron-Cohen, 2002, 2003, 2009). However, as shall be seen, it differs quite significantly in the way that the theory focuses on genetics and, in particular, genomic imprinting, which results in various expressions of ASD and psychosis traits. The diametric disorders

hypothesis can be viewed as a complementary theory that attempts to link the EMB and EFB together in order to explain the differing aspects of social and non-social cognition. In order to develop a meaningful understanding as well as an appreciation of this theory, it is imperative to begin with a review of the key tenets of the theory and then subsequently proceed with how such a theory can be used to explain the relationship between ASD and the psychosis continua, in addition to exploring how such a theory can be used to predict social cognition.

The diametric disorders hypothesis suggests that any similarities between ASD and psychosis spectrum disorders are mainly superficial (e.g. mentalising deficits). The model argues that the two spectrums of disorders do, in fact, reflect opposing underlying cognitive mechanisms. These cognitive mechanisms are suggested to reflect varying expressions of mentalising and 'mechanistic cognition'. Mechanistic cognition is often thought of as Baron-Cohen et al.'s (2002) use of the term 'systemising', as mechanistic cognition is described as a strong inclination and heightened abilities in domains such as technical, natural, and abstract systems (Baron-Cohen, 2002). Badcock (2009) uses the term 'mechanistic' as it captures a mechanical way of understanding and perceiving the world which has evolved for the interaction with the physical world. As discussed previously (pp. 19-22), people with ASD have demonstrated preserved to enhanced performance on tasks that are considered to examine mechanistic cognition. On the other hand, Badcock (2009) considers mentalising to reflect 'people thinking', which involves the inclination of understanding human beings, their minds, motives and emotions and has evolved in order to interact with other people in the psychological environment. From this point onwards and for the sake of simplicity, I will refer to mentalising and mechanistic cognition to refer to empathising and systemising, as conceptualised by Baron-Cohen et al. (2009; 2011). In accordance with this diametric disorders hypothesis, the autism continuum is characterised by high levels of mechanistic cognition (hyper-mechanistic cognition) coupled with reduced or diminished levels of mentalising (hypo-mentalising). On the other hand, the psychosis continuum is considered to reflect high levels of mentalising (hyper-mentalising)

combined with diminished levels of mechanistic cognition (hypo-mechanistic). The rationale for such a theory is predicated on a wider genetic theory referred to as the 'imprinted brain theory', which is discussed below.

The imprinted brain theory suggests that, during the pre-natal development stage, a mother's egg and a father's sperm engage in an evolutionary struggle to influence gene expression. In most cases, individuals inherit two copies of every allele, one from the mother and one from the father. In typical developing situations, both alleles are operational; but, in some extraordinary circumstances, one of the copies may not become functional, e.g. it is silenced. This has been hypothesised to be the result of imprinting. Within this framework, maternal imprinting results in only the maternal copy of the allele being expressed, whereas paternal imprinting makes sure that only the paternal copy is expressed (Ploeger & Galis, 2011). This genomic altercation of imprinting is suggested to effect behaviour, cognition, physiology, and personality in the developing offspring (Crespi & Badcock, 2008). When maternal imprinting triumphs over paternal imprinting, the offspring is suggested to be smaller at birth, less behaviourally challenging, and be more attuned at understanding and interpreting the mental states of others, e.g. more predisposed to mentalistic thinking. Comparatively, when there is a bias towards paternal genes, this results in the offspring being larger, more behaviourally taxing, and being less accustomed to understanding the mental states of others, yet is more attuned to the 'non-social' or physical state of the world, e.g. predisposed to having greater mechanistic abilities. At the most severe end, paternally expressed genes relative to maternally expressed genes are hypothesised to reflect clinical ASD; in contrast, when maternally expressed genes dominate relative to paternally expressed genes, psychotic disorders are suggested to transpire.

Given the opposing profiles of cognition amongst the psychosis and autism continua, such a hypothesis postulates that diametric cognition should occur between people who reside towards the psychosis end of the continuum in contrast to people who lean towards the autism side of the continuum. The first empirical test to assess diametric cognition beyond the assessments of mentalistic-mechanistic cognition was

conducted by Russell-Smith, Maybery, and Bayliss (2010). The authors examined how local and global perceptual processing was associated with degrees of psychosis traits and autism traits. The authors assessed such perceptual processing using the Embedded Figures Test (EFT). This type of task involves participants identifying a series of hidden figures embedded within a larger image, thus enhanced performance is reliant on a local perceptual processing mode. In accord with a breadth of literature on perceptual processing in ASD, individuals with ASD tend to exhibit a preference for more local, i.e. detailed focused over global, such as integrative processing (see for review Koldewyn, Jiang, Weigelt & Kanwisher, 2013).

As discussed earlier, typical developing populations are considered to have a more global over local processing mode. However, the diametric model renders that a bias towards more global relative to local processing would be embroidered in individuals who endorse positive schizotypal traits. Russell-Smith et al.'s findings disclosed that participants who attained high scores on the AQ but low scores on the positive dimension of the O-LIFE questionnaire displayed enhanced visual processing on the EFT. In contrast, the opposite profile of high O-LIFE scores relative to low AQ scores was associated with decreased performance on the Embedded Figures Test. These findings are supportive of the diametric disorders hypothesis and suggest that autism and positive psychosis traits are diametrically opposite with respect to local versus global processing. Furthermore, research has shown that ASD and psychosis are diametrically opposed in other domains of cognition, such as over-selective attention (Reed & McCarthy, 2012) versus reduced selective-attention (Morris, Griffiths, Le Pelley, & Weickert, 2013), convergent versus divergent thinking (Nettle, 2006), or under- versus over-mentalising (Frith, 2004). Taken together, such findings suggest that the ASD and psychosis continua reflect opposing styles of cognition across a broad range of cognitive operations.

Although there appears to be an emerging body of evidence to suggest diametric cognition exists between ASD and psychosis, many of the aforementioned studies failed to assess psychosis and ASD traits collectively in a single study. This is particularly

surprising given psychosis traits and ASD are known to overlap with one another across both clinical and non-clinical populations (Woodbury-Smith, Boyd, & Szatmari, 2010; Dossetor, 2007). Independent reports have highlighted that ASD and psychosis symptoms occur jointly, proposing common mechanisms and liabilities (Sierro, Rossier, & Mohr, 2016). Indeed, these observations have been demonstrated psychometrically through studies carried out by researchers such as Matsuo et al. (2015). Matsuo et al. examined how degrees of autism traits as measured by the Social Responsiveness Scale for Adults (SRS-A; Constantino & Gruber, 2012), a measure used to assess the social characteristics that characterised ASD, and which were found to occur in individuals with clinical depression, bipolar affective disorder, schizophrenia, and a healthy Control group. The authors found that all psychiatric groups exhibited significantly higher degrees of autism traits relative to the Control group. However, it was the groups of participants with schizophrenia that exhibited the highest amount of autism traits. Similar findings have been found in people with a schizophrenia spectrum disorder using different assessments of autism traits (Lugnegård, Hallerbäck, & Gillberg, 2015; Sheitman et al., 2004), which suggests that such a relationship is not constricted to specific measures. Consider, for instance, Hurst et al. (2007), who examined autism and psychosis traits when using both the Schizotypal Personality Questionnaire (SPQ) and the Autism Quotient (AQ) in a non-clinical population sample. Hurst et al.'s findings revealed that there was significant and positive association between total SPQ score and total AQ score. Indeed, positive and negative psychosis traits were found to significantly correlate with total autism trait scores and individual facets of social and non-social cognition. Furthermore, the strongest relationships were found between the total negative trait scores in the SPQ and the Social Skill dimension of the AQ. Perhaps this is unsurprising, given that negative symptoms of psychosis reflect similar social behavioural characteristics often found in ASD (social withdrawal, poor interpersonal functioning, communication difficulties, etc.). Therefore, it is foreseeable that people with a psychotic disorder endorse autism traits. However, the reverse relationship has also been demonstrated, where participants with ASD have reported a high number of

psychosis traits relative to a healthy Control group using measures such as the Schizotypal Personality Questionnaire (SPQ; Raine, 1991; Spek & Wouters, 2011; Hofvander et al., 2009; Stahlberg, et al., 2004). For example, Barneveld et al. (2011) found that adolescents with ASD self-reported high degrees of psychosis traits using the SPQ relative to a Control group. Indeed, people with ASD attained higher scores on both the negative and positive dimension of the SPQ. As noted by Chisholm, Lin, Abu-Akel and Wood (2015), positive psychotic symptoms are not stated in the diagnostic criteria for ASD. Yet, as the aforementioned studies have highlighted, there is evidence that these such experiences may occur at elevated rates in ASD populations (Bevan Jones et al., 2012; Spain, Sin, & Freeman, 2016). These psychometric observations highlight shared rather than diametrically opposite features for ASD and psychosis. However, it should be noted that such associations have not always been consistent. For instance, several researchers (Nettle, 2006; Wakabayashi et al., 2012; Dinsdale et al., 2013; Spek & Wouters, 2010) have found that positive psychosis traits were unrelated to autism traits and have been considered to reflect the one dimension that demarcates psychotic disorders from autism. Considered together, the overlap between psychosis and autism traits remains inconclusive and further research is needed in order to identify whether this overlap is spurious or consistent across the continua of both psychosis and autism.

According to the diametric disorders hypothesis, co-occurring expressions of autism and psychosis traits in the same individual should result in the 'balancing out' of behaviour. For instance, hyper-mentalising as indexed by psychosis traits matched with an equal level of autism traits in the same individual is likely to result in 'typical' mentalising if a task assessing mentalising abilities were administered. In contrast, high psychosis relative to autism traits (hyper-mentalising relative to hypo-mechanistic cognition) is likely to result in cognition associated with the psychosis continuum (i.e. hyper-mentalising), whereas the reverse profile is likely to result in cognition associated with the autism continuum. Indeed, evidence for this has been found by Abel-Akel et al. (2015). Abu-Akel et al. reported that, in a non-clinical population, perspective-taking difficulties were diminished when both autistic tendencies and positive psychosis traits

were balanced. More specifically, the authors found that, when there was a discrepancy between scores on the Autism Quotient and the Community Assessment of Psychic Experiences Questionnaire (Stefanis et al., 2002), a measure used to investigate the continuum hypothesis of psychosis, difficulties in perspective taking occurred. Consequently, the authors concluded that some individuals may, to some extent, be protective against developing cognitive deficits when there is balanced expression of autistic and psychosis traits. Complementary to this finding, Dinsdale, Hurd, Wakabayashi, Elliot and Crespi (2013) created a composite score called 'PC2', which was computed from the Schizotypal Personality Questionnaire and Autism Quotient scores and represented a scale from positive psychosis to autism, such that individuals with higher values on PC2 exhibit relatively-high positive psychosis scores combined with relatively-low autism scores. PC2 was found to negatively predict mental rotation performance as assessed by the Mental Rotation Test (MRT; Vandenburg & Kuse, 1978) and positively predicted lateralisation using Waterloo Handedness Questionnaire (WHQ; Teenhuis & Bryden, 1989). These relationships with PC2 are consistent with people with a psychotic spectrum disorder and were, therefore, interpreted as providing support for the diametric disorders hypothesis. Finally, in a large sample of French students at top-ranked schools, a group of students with a combination of high autism traits (indexed by the AQ) and high psychosis traits (indexed by the SPQ) were found to have lower academic scores across science-based subjects. These students' scores were significantly lower than participants who endorsed high autism traits, but few to none psychosis traits. The authors concluded that autism traits might impair success in science, a subject considered to be enhanced across the ASD continuum (Baron-Cohen et al., 2001), when associated with psychosis traits (Choteau, Raynal, Goutaudier, & Chabrol, 2016). In light of these findings, it is important to not only consider the independent relationships between psychosis and autism traits with cognition, but also the discrepancy between psychosis and autism traits. Indeed, despite the significant differences between the diametric disorders hypothesis and the Empathising-Systemising theory, both theories are unified through the notion that various degrees of

mentalising and mechanistic cognition are associated with different strengths in cognition, but they also highlight the asymmetries in these dimensions that may have further implications for cognition. Again, these theories further highlight the importance of examining both psychosis and autism traits collectively in the same individual.

In summary, the controversial debate on overlapping versus opposing deficits in ASD and psychosis is ongoing, and its relevancy of other areas of cognition needs to be tested. One way to further explore the relationship between the two continua is to examine different types of cognition that are applicable to both the ASD and psychosis continua. If the two continua are highly overlapping, then we would expect to see common cognition in both disorders; however, if they are indeed opposite ends of a cognitive spectrum, as the diametric disorders hypothesis predicts, then we would expect to see opposite types of cognition between expressions of psychosis and autism traits. However, as the continuum comprises of social and non-social dimensions, it remains to be investigated whether this continuum affects social and non-social cognition respectively, or affects all types of cognition. Within cognitive psychology, reasoning is considered the process of making a calculation of the outcome or reaching a conclusion when accounting for a given set of information (Eysenck & Keane, 2005). Reasoning is reflective of core human capabilities that enable effective interaction and involvement within society, yet it is surprising that it has received relatively little attention within the ASD and psychosis literature. What follows is a brief overview delineating the relationship between different reasoning styles between ASD and psychosis. Importantly, this overview is not meant to be comprehensive or exhaustive, but to familiarise the reader with a context upon which this research is based.

CHAPTER 2—Relationships between Reasoning Styles and Psychosis and Autism Spectrum Disorders

Psychosis crucially involves a distortion in reality which is thought to involve differences, or biases, in reasoning (Connors & Halligan, 2015). Atypical reasoning has been shown by people with psychosis and people who endorse a high degree of psychosis traits through exhibiting a more rapid style of reasoning, termed 'Jumping to Conclusion (JTC) Bias'. A JTC bias demonstrates how people who experience psychosis traits spend less time collecting information before making a decision. In experimental settings, the JTC Bias has consistently been assessed through a task known as 'The Beads Task' (Huq, Garety, & Hemsley, 1988). In the beads task, participants are presented with two jars of beads. Each jar of beads contains a certain ratio of coloured beads. Subsequently, the jars are removed and a single bead is presented to participants one at a time. The objective is for participants to deduce which jar the beads are being drawn from based on the information they have been given, e.g. colour and number of beads. Participants can request as few or as many beads as the like until they feel able to decide which jar the beads are being drawn from. Much of the available literature on psychosis and the JTC bias have consistently found that, relative to matched Control groups, individuals with a psychotic disorder request fewer beads than healthy controls before making a decision (for review see Fine et al., 2007). For example, using a between-group design, Moritz et al. (2007) administered the beads task to a sample of 37 individuals with schizophrenia and a sample of 37 individuals without schizophrenia. The authors found that individuals with schizophrenia were quicker at drawing a conclusion and based their decisions on less evidence than people without schizophrenia. More recently, multiple studies have consequently been published, all of which have mirrored this finding (Dudley, Taylor, Wickham, & Hutton, 2016; McLean, Mattiske, & Balzan, 2016; So, Siu, Wong, Chan, & Garety, 2016). Indeed, these findings have also extended

to clinical groups with other psychotic disorders such as schizoaffective disorder and schizotypal personality disorder (Van Dael et al., 2006).

As previously mentioned, a JTC bias is not restricted to clinical psychotic disorders per se, but has also been found across individuals from the general population who endorse increasing degrees of psychosis traits (Raine, 1991; McKay, Langdon, & Coltheart, 2006; Juárez-Ramos et al., 2014; Rodier et al., 2011). These findings suggest that this hasty mode of reasoning is not restricted to just the extreme degrees of psychosis, but also exists across the psychosis continuum. This particular finding provides evidence that such a reasoning bias is causal and is not necessarily the product of experiencing positive psychosis traits per se. It is of interest to acknowledge that researchers White and Mansell (2009) reported provisional evidence that, in a sample of non-clinical participants, individuals who reported high degrees of psychosis traits reported feeling 'rushed' in contrast to participants who reported few to no psychosis traits. Collectively, these findings suggest that individuals on the psychosis continuum may have an innate disposition for a rapid mode of reasoning. However, alternative accounts have put forward the idea that people who disclose a JTC Bias do so as the result of having higher impulsive tendencies. Impulsivity has been conceptualised as the propensity to act without reflection or appropriate constraint (Milich & Kramer, 1984). People who are impulsive are generally motivated by an underlying thought or limitation. However, several researchers have ruled out this possibility by using a harder version of the beads task, whereby the ratio of coloured beads was 60:40 (Broome et al., 2007; Moritz & Woodward, 2005; Peters, Thornton, Siksou, Linney, & MacCabe, 2008). Collectively, such authors found that a JTC bias did not simply reflect impulsiveness, as the people with psychosis took onto account the base rate change when they were presented with the harder version; yet, they were still deciding on the basis of less evidence than the Control groups. Indeed, these findings suggest that people residing on the psychosis continuum are less likely to appraise and question incoming information and, therefore, are more likely to accept their delusions and

hallucinations. Further to this, these findings highlight a distinctive style of reasoning above and beyond impulsive tendencies.

This rapid style of reasoning that is considered to be associated with the psychosis continuum has also extended beyond the beads task into other domains of reasoning. For example, in contrast to a matched Control group, people with psychosis have been found to seek fewer clues on the '20 Questions Game'. This task encourages participants to decide what the experimenter is thinking based on a series of clues. Participants can request as many or as few clues as they like before making a decision. In a timely study by John & Dodgson (1994), it was found that, in comparison to a Control group and a group of depressed patients, the schizophrenic group requested significantly fewer clues before making a decision. More recently, Merrin, Kinderman and Bentall (2007) compared a non-clinical group with two clinical groups of patients with clinical depression and individuals with schizophrenia on performance on a similar 20-questions game. Merrin and colleagues' findings revealed that it was the schizophrenia group that asked the least amount of questions and, therefore, based their decision on little information. Taken together, these findings further substantiate the idea that people with schizophrenia require a reduced amount of information before making a decision; accordingly, such a finding purports that a hastier mode of responding can materialise in different contexts, and is therefore not a direct result of the beads task per se.

The association between the psychosis continuum and rapid style of reasoning becomes more pronounced when examining studies that have used experimental manipulation to induce different styles of reasoning. Recent experimental studies have demonstrated that, when people with psychotic disorders are encouraged to slow their thinking down, and are educated about how rapid responding can lead to biases in their thinking, individuals have been found to report lower degrees of psychotic symptoms and be less susceptible to reasoning biases at post-assessment (Ross, Freeman, Dunn, & Garety, 2011; Waller et al., 2015; Moritz et al., 2015). For example, Waller et al. recruited participants with delusions who were randomised to either a 'Thinking Well (TW)'

intervention or 'Treatment As Usual (TAU)' intervention. In the TW condition, participants were verbally encouraged to recognise and, where applicable, suppress their rapid, automatic reasoning, and instead engage in a slower and more controlled style of reasoning. In addition to educating participants about fast and slow ways of reasoning, extensive examples were used of how reasoning can sometimes be biased. Further to this, exercises were used to encourage participants to acquire more information before making a decision and generating alternative explanations, thus encouraging participants to slow down their thinking. The TAU condition involved participants engaging in regular care in the community, e.g. engaging with a care coordinator to address social, physical, medication needs, etc. This intervention did not involve any discussions or exercises regarding reasoning. Waller and colleagues reported that participants in the TW condition reported significantly fewer delusional beliefs and paranoid thinking relative to the TAU group during a follow-up review, which occurred eight weeks from the intervention. Indeed, one participant in the TW condition communicated that "It was quite simple. I learnt to slow down and think carefully about the situation. In the future, I will be very hesitant about coming to a fixed conclusion" (p. 1). These results highlight how a rapid style of processing information may play a significant role in the acceptance and maintenance of delusions and hallucinations that are integral to psychosis.

Turning to the diametric disorders hypothesis (Crespi & Badcock, 2008), if psychosis traits are essentially the product of hyper-mentalising then this may contribute to explaining the rapid style of reasoning that appears to occur across the psychosis continuum. For example, Brosnan, Ashwin, and Gamble (2013) found that a profile of high mentalising relative to mechanistic cognition, as indexed by self-report measures, resulted in a jumping-to-conclusion bias. Badcock (2009) proposes that hyper-mentalising can be considered to involve over-interpreting or over-reacting to incoming information, thus a JTC bias may be a natural byproduct of hyper-mentalising or vice versa.

In view of all that has been mentioned, people on the psychosis continuum may exhibit an intrinsic abnormality in some aspect of reasoning (Galbraith, 2013; Cardella, & Gangem, 2015; Garety et al., 2015). This particular abnormality may contribute to explaining the pertinent features of psychosis traits such as delusions, unusual experiences and paranoia. Looking at reasoning in ASD might help shed light on the relationship between ASD and psychosis. If the two disorders are highly overlapping, then we would expect to see common reasoning biases in both disorders; but, if they are indeed opposite ends of a cognitive spectrum, as the diametric disorders hypothesis predicts, then we would expect to see opposite types of reasoning behaviour in ASD.

Reasoning Across the Autism Continuum

Research that has specifically examined reasoning behaviour in people with ASD remains sparse, particularly in comparison to research within other cognitive domains considered pertinent to the diagnosis of ASD, e.g. social cognition, perceptual processing, etc. (Stephanie & Julie, 2015; Maekawa et al., 2011; Hill, 2004). This is surprising, as the stereotypical view of ASD is that individuals are very objective, rational, and logical in contrast to typically developing individuals (Morsanyi, 2010; Robertson, 2009). At the time of writing, a limited amount of attention has been invested in specifically examining whether individuals with ASD exhibit a specific style of reasoning. This is unfortunate, as such an endeavor may contribute to understanding the cognitive and social characteristics typically observed in individuals with ASD. In accord with the diametric disorders hypothesis (Crespi and Badcock, 2008), people with ASD should exhibit a contrasting style of reasoning in comparison to people on the psychosis continuum. Consequently, it would not be unreasonable to predict that individuals with higher levels of autism traits may have a tendency to be less biased with fast reasoning and instead engage in a slower form of reasoning.

Using self-report measures, Luke et al. (2012) identified three core features of reasoning that were particularly problematic for people with ASD. Decisions were difficult to make if they involved talking to others or involved a change in routine – which

may be reflective of the core diagnostic criteria of ASD (respectively, see Chapter 1). The second major area of difficulty in reasoning for those with ASD was when the decision had to be made quickly (Luke et al., 2012). Finally, the third major area found that people with ASD worried about over-thinking about the decision or deliberating on minor details. These self-reflective accounts of reasoning may provide insight into how individuals with ASD utilise their reasoning style on a daily basis. Indeed, further insight into the way people with ASD reason can be made more apparent when considering autobiographical accounts of individuals who live with ASD. For example, Temple Gradin, perhaps one of the most famous individuals with ASD, remarks in her biography that:

"*Since I don't have any social intuition, I rely on pure logic, like an expert computer program, to guide my behaviour. I categorise rules according to their logical importance. It is a complex algorithmic decision-making tree. There is a process of using my intellect and logical decision-making for every decision I make*." (Gradin, 1995, p. 103)

In accord with the aforementioned account, there appears to be some evidence that suggests individuals with ASD prefer to engage in a slower and more effortful style of reasoning than individuals who reside on the psychosis continuum, who appear to employ a more automatic and rapid style of reasoning.

Preliminary work on reasoning behaviour has also been undertaken by Brosnan, Chapman and Ashwin (2014), who administered the Beads Task (Huq, Garety and Hemsley, 1988) to a group of adolescents with ASD and a matched Control group. Brosnan et al. reported that participants with ASD requested more beads relative to the Control group prior to making a decision. The authors coined this style of reasoning as more 'circumspect'. The propensity to acquire more information before making a decision could draw parallels with a slower style of reasoning. As expected, this circumspect reasoning bias was also found in a general population sample, who self-reported higher degrees of autism traits relative to a group of individuals who reported lower degrees of autism traits (Brosnan et al., 2013). Comparably, those from the

general population who self-reported being higher in autism traits also needed more information prior to making decisions when compared to those lower in autism traits (Brosnan et al., 2013). Collectively, these findings are supportive of the idea that individuals experiencing ASD have a preference for slower as opposed to rapid reasoning (Luke et al., 2012). Furthermore, these studies were able to provide support for the diametric disorders hypothesis as the findings in the ASD group demonstrated diametrically opposed biases in reasoning in contrast to studies using people with psychotic disorders.

Examining some of the social difficulties people with ASD experience may also shed light on the type of reasoning style people with ASD engage in. For example, research has supported the notion that people on the ASD continuum exhibit a more effortful and slower style of reasoning during emotional recognition tasks. This has been supported by a wide range of research that suggests people with ASD exhibit longer decision-making times and longer ERP latencies (Behrmann et al., 2005; Capps et al., 1992; McPartland et al., 2004). Rutherford and McIntosh (2007) suggested that people with ASD employ a deliberative and rule-based strategy when recognising emotions, whereas typical participants engage in a more rapid intuitive style of processing. Several theorists have argued that emotion recognition is an automatic and fast process which requires little effortful attention in the typical population (De Sonneville et al., 2002; Thomas et al., 2007). Indeed, such findings may explain why some people with ASD have difficulty in social situations.

A slower form of reasoning in ASD is also consistent with some of the main cognitive theories of ASD that highlight the fact that people with ASD can be characterised by a strong drive for mechanistic cognition (Crespi and Badcocks, 2008; Baron-Cohen et al., 2009). Mechanistic cognition is considered to be a slow and effortful process, whereby theorists such as Badcock (2008) have suggested that a drive towards mechanistic cognition is reflective of a bottom-up and detail-oriented processing.

Dual Process Theories of Reasoning

One way to understand and explain rapid and slow reasoning amongst ASD and psychosis is to draw on reputable cognitive models of typical human reasoning. Dual process theories (hereafter, DPT) are dominant models of human reasoning and have been active in psychology for over 50 years (Frankish & Evans, 2009; Sloman, 2002; Evans, 2003; Stanovich, West, & Toplak 2011). Although there is no definitive definition of what dual process theories are, the assumption that there are at least two modes of processing information remains a unifying feature of all dual process theories (Pennycook et al., 2013; Stanovich & Evans, 2013; Stanovich, 2015). Throughout the literature, these modes of processing have been conceptualised using different terms, e.g. System 1 versus System 2, Type 1 versus Type 2, and Experiential versus Rational, etc. (Evans & Stanovich, 2013; Epstein, 1994). Despite the different nomenclatures and the subtle differences between each dual process mode of reasoning (for review, see Osman, 2004), all theorists tend to cohere around a family resemblance of one mode of processing, being fast, automatic and based on prior beliefs and experiences and independent of cognitive ability (i.e. general intelligence and working memory capacity). The second mode of processing, however, is considered to have attributes whereby it is slower, effortful and dependent on individual differences in cognitive ability. Although various terminology exists to describe these two modes of reasoning, for stylistic convenience and brevity I shall proceed to the terms 'intuitive' and 'deliberative' reasoning respectively.

Within the framework of DPT, although intuitive and deliberative reasoning are considered to be conceptually separate, they are suggested to operate reciprocally, whereby both types of processing contribute to all reasoning (Evans, 2011). Whenever people reason by engaging in hypothetical thinking, deliberative reasoning is suggested to be in operation (Stanovich & Evans, 2013). In contrast, when someone reasons based on previous experiences and, therefore, makes a decision based on what worked in the past, intuitive reasoning is suggested to be in effect. Intuitive reasoning is assumed to provide the default response and tends to dominate most aspects of everyday

reasoning, unless it is amended and overridden by a more effortful deliberative reasoning process (Kahneman, 2003; Kahneman & Frederick, 2005; Evans, 2008). This widely supportive view of reasoning is conceptualised as the 'default-interventionist' model, which places intuitive reasoning as the default mode of processing. Crucially, such a model proposes that deliberative reasoning must be engaged for reflective reasoning to suppress and overrule the intuitive response. One way to assess the validity of such a model is to examine task performance, whereby intuitive and deliberative responses are pitted against one another. Also, examining individual differences in speed of processing and cognitive ability can also be useful for clarifying the existence of such styles of reasoning.

As outlined by Kahneman (2011), one of the most effective and powerful tests that highlight a duality in reasoning, as well as measure a person's disposition to either an intuitive or deliberative reasoning style, is the Cognitive Reflection Test (hereafter, CRT). Consider the following item from the CRT:

"*A bat and a ball cost £1.10. The bat costs £1.00 more than the ball. How much does the ball cost*?"

The incorrect, but automatic, answer is '10 pence', whereby the correct, but slower and more normative, answer is '5 pence'. For most individuals (e.g. 64.9% in Pennycook et al., 2015), the 10 pence answer comes to mind automatically and quickly, whereby, in most cases, the 5 pence answer requires more thought and effort, and is often reached after suppressing the initial intuitive and spontaneous answer in favour of the more deliberative answer. The author of the study explains how the solution to deriving the correct answer is to suppress and/or evaluate the first answer that leaps to mind (Frederick, 2005). Thus, this shows behaviourally demonstrating responses produced by intuitive and deliberative processing. Indeed, higher scores on the CRT (e.g. more 'correct' answers) are conjectured to reflect a stronger willingness to engage in a more deliberative mode of reasoning (Campitelli & Gerrans, 2013). Certainly, performance on this task has been found to successfully predict performance on other

reasoning tasks that require the application of logical reasoning, which is often assumed to be reached through a slower and more effortful process (Toplak, West, & Stanovich, 2014). Indeed, in a large sample of undergraduate students, Frederick (2005) observed that the intuitive responses were associated with preferences for immediate versus delayed outcomes. This specific time preference further substantiates a link between rapid and slow processing, which is connected to intuitive and deliberative reasoning. Recent evidence has supported the association between CRT performance and DPT. For instance, in a timed setting, Travers, Rolison and Feeney (2016) reported that, in a sample of undergraduate students, participants were quicker at providing the intuitive response on the CRT in contrast to the deliberative response, which took at least 10 seconds longer. This suggests that intuitive response comes rapidly in contrast to the deliberative response, which was considered to be slower.

Another key experimental task that highlights the duality in reasoning style is the use of syllogisms. Syllogistic reasoning was first devised by Aristotle and is believed to be the basis of all logical thought (Evans, Newstead, & Byrne, 1993). Syllogisms comprise of two quantified premises and a single conclusion, and such concepts formulate a statement. Each syllogistic statement requires participants to assess the validity of the conclusion using logical reasoning only. In other words, participants have to decide whether the conclusion follows logically from the premises, regardless of whether the premises are true or not. Consider the following syllogism: “All mammals can walk. Whales are mammals. Therefore, whales can walk.” This syllogism is considered logically valid, but unbelievable. Alternatively, consider the following syllogism: “No cigarettes are inexpensive. Some addictive things are inexpensive. Therefore, some addictive things are not cigarettes.” The above syllogism is logically valid and the conclusion is believable. Despite the ability to reason logically being an intrinsic part of human cognition, a plethora of research has persistently demonstrated that people, more often than not, do not commit to following formal rules of logic (Evans & Frankish, 2009; Evans & Stanovich, 2013; Kahneman, 2011). For example, it was demonstrated by several experimental findings (Roberts & Sykes, 2003; Shynkaruk & Thompson, 2006; Evans,

Handley, & Harper, 2001) that, despite people being educated, they still have lower accuracy rates on assessing the validity of syllogisms when the premises conflict with the conclusion. In other words, individuals have a propensity to base judgements on prior beliefs and experiences rather than on a more logical form of reasoning. This distinctive pattern of reasoning is conceptualised as 'belief bias responding'. It has been conjectured that the reason why people are more likely to reason based on their beliefs is that beliefs are automatically and rapidly activated when people think about familiar contents, whereas rule-based reasoning (i.e. reasoning in a logical manner) requires considerable effort (De Neys, 2006). Indeed, evidence for such an assertion has been found through timed experimental studies, which have demonstrated how decreasing the time a participant has to respond to a reasoning task encourages the acceptance of intuitive responses when engaging in various tasks that assess logical reasoning tasks (De Neys, 2006; Evans, 2008; Pennycook et al., 2013). For example, Evans and Curtis-Holmes (2005) examined this idea with a syllogistic reasoning study carried out under limited time. Participants were either forced to respond within 10 seconds or with no time restrictions at all. The authors found that, when participants were forced to respond rapidly, they were significantly less likely to inhibit their intuitive response and, therefore, respond erroneously by demonstrating a belief bias. Comparatively, when participants were given no restrictions on how long they had to respond, there was a statistically significant increase in the number of logically correct answers and a deviation away from the exhibition of belief bias responding. This finding is consistent with the view that belief-based responses are available early and are consequently more pronounced when time limits are insisted. Indeed, such results have also been found using similar tasks, whereby reducing the time participants have to respond to tasks results in more reasoning errors (Schroyens, Schaeken, & Handley, 2003; Roberts & Newton, 2001).

Further evidence for the existence of DPT comes from the research studies that have found that a failure to engage in deliberative reasoning has been linked to individual differences in cognitive ability (Stanovich & West, 2008). For example, higher

performance on tasks that assess logical and probabilistic reasoning skills, which are suggested to be predicated on more deliberative as opposed to intuitive reasoning, are found disproportionally in those individuals with the higher scores of intelligence. Specifically, increased performance on such tasks has been found to correlate positively with traditional measurements of intelligence, such as Scholastic Aptitude Tests scores (Stanovich, 1999) and independent scores on assessment-based measures of intelligence, such as the Wechsler Adult Intelligence Scale and the Ravens Progressive Matrices (Toplak, West, & Stanovich 2011). As expected, higher degrees of working memory capacity have also been found to be positively correlated with more logical responses on reasoning tasks (Fletcher, Marks, & Hine, 2011; Barrett, Tugade, & Engle, 2004). Taken together, these studies reveal that, when people have to solve tasks where there is a straightforward response, together with a normative but less clear-cut, response, people higher in cognitive ability are more likely to choose the logically correct answer (Newstead et al., 2004).

Despite DPT being considered by some theorists as overly simplistic (Diana et al., 2006), there is strong neuroanatomical evidence derived from neuroimaging studies that supports the existence of two different styles of reasoning. For instance, Goel and Dolan (2003) observed that, when participants completed syllogistic reasoning tasks whilst undergoing an fMRI scan, different brain structures became active depending on what responses participants provided. For instance, when a correct 'logical' answer was given, there was increased activation in the right lateral prefrontal cortex. Comparatively, when a more 'intuitive/belief' based response was provided, there was increased activation in the ventral medial prefrontal cortex. Considered together, such findings provide strong evidence for the existence of at least two different styles of reasoning.

Aside from performance-based tasks of intuitive and deliberative reasoning, self-report measures of reasoning style have generally involved administering the REI. The REI is a self-report measure used to ascertain a person's propensity to engage in effortful and logical reasoning, but also their willingness to rely on 'gut feelings' and hunches. The

inclination to rely on gut feelings and hunches is considered to reflect a more rapid and intuitive style of reasoning, thus is considered to reflect preferences for Intuitive processing. In contrast, a disposition towards more logical and effortful reasoning is suggested to relate to a preference for more deliberative processing. Although self-report measures of reasoning are interesting in their own right, they are restricted in terms of objective validity. In contrast, performance measures may provide a more accurate and unbiased assessment of reasoning style, yet such behaviour may not necessarily reflect the type of reasoning style a person self reports. At the time of writing, only a few studies have reported the concurrent validity of the REI; that is, the extent to which the scores from the REI correlate with some other measure that is believed to assess intuitive and deliberative reasoning. People with high self-report deliberative reasoning scores should also have higher normative scores across reasoning tasks. People with high self-report intuition scores should also have higher intuitive responses across reasoning tasks. However, the results of such studies appear to be inconsistent. For example, as highlighted by Brosnan et al. (2016), Pennycook et al. (2015) found how deliberative responses on the CRT were positively correlated with REI self-reported deliberation and negatively with REI self-reported intuition. In addition, intuitive responses on the CRT were found to positively correlate with REI self-report intuition and negatively with REI self-reported deliberation (Pennycook et al., 2015). However, other studies have reported a single positive relationship between deliberation on the CRT and REI (Liberali et al., 2012; Thoma et al., 2015). Thus, the inconsistency between self-reported preference for intuition and behavioural intuition needs to be taken into consideration. These inconsistencies highlight the need to assess both self-report and performance measures of reasoning in order to develop a better understanding of how reasoning style relates to expressions of autism and psychosis traits. Currently, a dearth of research has been reported that has specifically used the CRT or the REI to assess reasoning style with the continua of autism and psychosis.

As outlined in the previous chapter, psychosis and autism are associated with rapid reasoning processes and slower reasoning processes separately, which can be

considered to form the basis of DPT. Indeed, it is plausible to speculate that people residing on the psychosis continuum may exhibit an over-reliance on intuitive reasoning or an under-reliance on deliberative reasoning. In accord with the diametric disorders hypothesis, the reverse profile would be expected to be seen in people across the ASD continuum, whereby autism traits are associated with an over-reliance on deliberative reasoning and an under-reliance on intuitive reasoning. Given the evidence provided in this chapter, and consistent with Crespi and Badcock's (2008) diametric-disorders hypothesis, contrasting intuitive and deliberative reasoning styles may be a salient avenue of prospective research for both these clinical disorders. However, as previously discussed, the relationship between autism and psychosis traits may not be as independent as initially conceived in manuals such as the DSM-5 and ICD-10. Alternatively, there is some evidence to suggest that psychosis and autism traits co-occur in the same individual and may have an interacting effect on cognition. On the other hand, if psychosis and autism are diametrically opposing, then psychosis traits should be negatively associated with autism traits. Considering all of this, it is important to examine autism and psychosis traits collectively in order to deduce inferences about reasoning style across the two continua.

Aims of and hypotheses of current research

The main aims of the dissertation research were:

1. To investigate how measures of autism and psychosis traits are each associated with different styles of reasoning.
2. To investigate how the discrepancy between psychosis and autism trait scores for each individual (a Psychosis-Autism bias score) relates to reasoning style.

3. To explore the relationships between autism and psychosis and reasoning style within social framed content.
4. To explore how autism and positive psychosis traits are associated with one another throughout the autism and psychosis continua.

The hypotheses were:

1. Based on theories of continuum of traits across a population, it was expected that increasing degrees of psychosis traits should relate to a more intuitive style of reasoning, along with a reduced deliberative style of reasoning, while increasing degrees of autism traits should be associated with higher degrees of deliberative reasoning, along with lower degrees of intuitive reasoning.

2. Based on theories of diametrically opposing ASD and psychosis traits, it was expected that Psychosis-Autism Bias (PAB) scores reflecting the relationship between ASD and psychosis trait scores to each other within each participant would show a positive correlation with an intuitive style of reasoning and a negative correlation with deliberative reasoning measures.

3. It was expected that psychosis and autism traits would be associated with different styles of reasoning when the contents of the reasoning tasks were socially framed.

4. If psychosis and autism traits were independent of each other within clinical and non-clinical populations, then these measures would not show a significant relationship with each other. If these traits overlap within individuals, then it would be expected that these traits would be positively associated with one another. If such traits were diametrically opposing, then a negative relationship between measures of positive psychosis and autism should occur.

Chapter 3 - METHODOLOGY

Participants

The populations of interest for the current research project included the general population in some studies, along with people experiencing high expressions of autism and psychosis traits in other studies. The current research recruited individuals from the general population in order to directly test the current aims and to allow comparisons of current results to the wider literature. The current research included both University students and participants from the general population. These groups were chosen as they were considered to be more representative of the general population than University student populations. The methods employed to recruit participants predominantly stemmed from public and online advertisements. In most cases, public advertisements consist of using posters placed around the University campus, word of mouth and email invites to academic mailing lists. However, these methods are determined by people knowing about research participation advertisement and actively reaching out to the researcher to request a time to participate in the research. As a result, there is always a chance that it is the same people participating in the research being offered, which might influence the results. Furthermore, in most cases participants from the general population were either University students (undergraduate and postgraduate students) or staff members at the University of Bath. Although using student populations is generally considered a typical recruitment strategy due to the ease of accessibility, and given that it is generally difficult to find participants who are not in education on such research sites, these convenience samples could have implications on the generalisability of the results to the general population. In addition, using participants who are employed by the University may also restrict the generalisability of the findings when compared to participants who work in other areas. However, there is currently no research to suggest that people working within a University are likely to respond differently to people who do not work in a university. Specifically, the aim of the research is to explore the psychosis and autism continua. Given that an accumulative amount of research findings that suggest autism and

psychosis range on a continuum from disorder to typicality throughout the general population, recruiting people from general population samples is supportive of the aims of the research.

Turning to the higher end of the psychosis continuum, it would be preferable to recruit clinical participants who have a formal diagnosis of a psychotic disorder. From this position, people with a diagnosis of a schizophrenia spectrum disorder are likely to exhibit a high degree of psychosis traits. However, recruiting such clinical populations is a difficult and challenging task. Firstly, clinical populations are difficult to reach and require an extensive ethical assessment and approval from organisations like the National Health Service. This can be a time-consuming application process, whereby approval can take up to 18 months. Although such a rigorous process is desirable when recruiting and working with such vulnerable populations, such a lengthy procedure would have resulted in less studies being completed due to the time constraints of finishing the research within the expected funded timeframe of three years. In addition, there is always a high probability that clinical populations will most likely be in the middle of a treatment plan, or be inpatients on a psychiatric ward. This makes such patients difficult to reach and attempting to recruit participants during their treatment may comprise their care and general well-being. Hence, it is important to consider the welfare of the patients taking part in such research studies, particularly when recruiting patients who actively and acutely experience psychotic symptoms. Further to this, inpatients with schizophrenia and other psychotic disorders may be taking high amounts of medication, e.g. antipsychotic medication, sedatives, anti-anxiety medication, etc., during their inpatient stay on a psychiatric unit. This consumption of medication may make it more difficult for individuals to accurately self-report their behaviour and subjective personality traits.

Taken together, recruiting such participants may be associated with many third party variables that may impact on research findings, thus making findings potentially less reliable and representable. Nonetheless, in order to fully explore the continuum of psychosis, it is imperative that research is not restricted to just general and student

population samples. One way to address this issue is to recruit participants who have a history of psychosis but are not currently actively psychotic (i.e. inpatients on a psychiatric ward). In line with a continuum-based approach to psychosis, such individuals may endorse higher degrees of psychosis traits, thus enabling further analysis of a different point along the continuum. The current recruitment process involved reaching out to participants who had reported experiencing psychosis and had formally received a diagnosis of a psychotic disorder, but who had not had an active psychotic episode for at least a year. A year was selected, as the DSM-5 indicates a participant who does not experience an episode of psychosis for at least a year is considered to be in remission. As a result, this group of participants were conceptualised as individuals who were "in remission from a psychotic disorder". A recent longitudinal study has revealed that individuals in remission from a psychotic disorder still acquire moderate to high degrees of psychotic traits relative to matched Control groups using measures such as the Schizotypal Personality Questionnaire and the O-LIFE questionnaire (Moreno-Izco et al., 2015; Dominguez, Wichers, Lieb, Wittchen, & van Os, 2011).

People in remission from psychosis were recruited in the current research through the mental health charities Mind, Rethink and The Hearing Voices Network. These charities were targeted as they actively encourage and promote professional and academic-based research projects (PhD level and post-doctorate research projects) for individuals who have experience of mental health problems. Also, such charities encourage individuals with a history of mental illness to contribute to current research projects. A particular strength of utilising such a recruitment strategy is that people who use these charities are usually functioning independently within the community and, therefore, are less likely to be consuming high amounts of antipsychotic medication, especially after a year (NICE, 2014). As a result of this, the impact medication has on reasoning performance may become less apparent. Accordingly, the results derived from such research studies are more likely to be generalisable to individuals on the psychosis continuum. However, people with a history of a psychotic disorder are generally considered to exhibit higher degrees of anxiety, depression and substance

misuse in contrast to individuals without a psychotic disorder (Buckley, Miller, Lehrer, & Castle, 2009). In order to constrain such influences, all participants were encouraged to report whether they had ever received any other diagnosis besides a primary psychotic disorder prior to taking part in a study. Where necessary, these co-morbidities were used as control variables in order to fully explore the relationship between reasoning style and psychosis traits. There are, however, a number of restrictions and limitations that need to be considered when recruiting such samples. First and foremost, there is a significant amount of heterogeneity and diversity experienced by people with a psychotic disorder. As reviewed in the introduction to Chapter 1, psychotic disorders are wide-ranging and include a diverse range of disorders (schizophrenia, schizoaffective disorder, etc.). Thus, findings on reasoning style derived from people in remission from schizophrenia may not be true in people with schizoaffective disorder. Secondly, the very definition of 'remission' in psychosis is a contentious issue (see for review Yeomans et al., 2010). Nevertheless, recruiting participants with a history of psychosis was considered suitable and appropriate for the current research studies.

In order explore reasoning across the autism spectrum, individuals with a confirmed clinical diagnosis of Autism Spectrum Disorder (ASD) were examined. The current research recruited participants using three main approaches. In Study 4, participants were recruited through attendance of a university summer school. The university summer school recruited students on the autism spectrum, which focussed on providing insight into university life. In addition to the AQ, the Social Communication Questionnaire (SCQ-Lifetime; Rutter et al., 2003) was also employed for this group. The SCQ is a 40-item parent report measure. The SCQ is a dimensional measure of ASD symptomatology, with a sensitivity of .92 and specificity of .62 (Witwer & LeCavalier, 2008; Brosnan et al., 2016). Secondly, some participants were recruited from the Student Disability Service (SDS) based at the University of Bath. This service was set up for students who had a variety of disabilities including ASD. After acquiring permission from the service head, the study was advertised via email to all students registered with the SDS. However, although all students reported confirmation of an official diagnosis

of ASD, this was not possible to confirm because participants from SDS were living on Campus at the University of Bath and did not have access to their medical documents in order to confirm the diagnosis. This means that confirmation of diagnosis was not verified.

In Study 5, an ASD group was recruited through a charity (Research Autism). Research Autism is a UK charity committed to the promotion of high-quality research into autism. For this study, participants were recruited through the charity and completed the entire study online. Participants confirmed that their diagnosis was made by a suitably qualified practitioner (e.g. a Clinical Psychologist) according to the DSM or ICD-10. This confirmation was held on file and stored securely on the Research Autism website, although was not available to me to view as a result of data protection. Similarity to individuals who have experienced clinical levels of psychosis, individuals with ASD tend to have higher degrees of anxiety and depression. In order to account for this, participants with ASD were asked if they had ever received a diagnosis of any other disorder, or whether they were currently taking any other medication. Where appropriate, this allowed for co-morbidity to be taken into consideration when conducting statistical analyses. Notwithstanding, a significant limitation to this approach was the absence of diagnostic confirmation that participants who completed the study had a confirmed diagnosis of ASD.

Sample and Effect Size Considerations

The current research adopted two types of main analysis throughout; Multiple Linear Regression and Between-Group analysis. In order to ascertain what sample sizes would be needed to detect a Medium to Large effect size, which is an effect size considered appropriate to be considered meaningful (Cohen, 1966), number of avenues were explored.

Previous statisticians and mathematicians have advocated different methods to develop meaningful Multiple Linear Regression equations (Harris's, 1985; Green, 1991). However, given the current relationships examined in the thesis had never been explored, it was difficult to establish a set number of participants that would result in a specific effect size. Notably, Wilson, VanVoorhis and Morgan (2007) suggest that a minimum sample of 50 should be used for multiple regression in order to detect a medium effect size. As a result of Wilson et al. premise, a minimum of 50 participants were sought after for Studies 1 and 2. Indeed, Tabachnick and Fidell (1996) have cautioned that larger samples are required when the dependent variable is skewed, or there is substantial measurement error. Consequently, all dependent variables were examined closely and transformed if they violated the assumption of normality.

Turning to between-group analysis, as recommended by Wilson et al. (2007), in order to achieve a medium to large effect size, 30 participants per group should be recruited as this would lead to about 80% power (the minimum suggested power for an standard study) (Cohen, 1988). Indeed, Cohen conventions suggest an effect size of .20 is small, .50 is medium, and .80 is large. Given the difficulty in recruiting participants with ASD it wasn't always possible to achieve 30 participants in Study 4, however, in Study 5, 40 participants per group were achieved which was supportive of Wilson et al. Indeed, as significant differences were observed in each between-group study, it was interpreted that the sample sizes were satisfactory and pertinent to the aims of the study.

Lab-based assessment and Online assessments

Throughout this doctoral thesis, two types of research approaches were employed to suit the number of participants needed and their availability for testing: Internet-based research designs and laboratory-based designs. Lab-based research was selected for some of the research in the current dissertation as some studies required the use of E-Prime Software, which is experimental software to present stimuli and record responses. E-Prime was utilised to measure working memory capacity, and could only be used in a laboratory setting because it requires specialist software to run which cannot be accessed remotely. Furthermore, Lab-based research is ideal when physical access to participants is available, because it is easier to replicate a laboratory experiment as a standardised procedure is used with all participants. In addition, Lab-based research allowed for the researcher to isolate any difficulties or discrepancies participants had with any tasks or questionnaire. This allowed the researcher to address any issues that came up quickly and efficiently. The limitations of a Lab-based design is that the behaviour in the Lab is very narrow in its range. By controlling the research environment so precisely, behaviour may be very limited. Furthermore, there is a limit to how many participants can complete the study at a time due to restricted lab space. In addition, some people can find such settings intimidating or stressful and, thus, may not perform or respond in the manner that they would do under more naturalistic-based settings. Finally, as participants meet the researcher face to face, there is a higher probability of the participant engaging in more socially desirable behaviour. Collectively, such limitations need to be borne in mind.

Internet-based research designs, e.g. administering questionnaires and tasks online, are rapidly becoming popular amongst researchers and scientists. This is because they provide researchers with the ability to conduct research remotely, allowing for wider access to sampling participants, e.g. wider geographical areas to be covered.

Consequently, this may result in a higher number of participants. In addition, the designs of such studies are considered to be relatively inexpensive as reimbursement for travel expenses is omitted (Denscombe, 2014). Furthermore, it is reported that Internet responses have less of a social desirability effect. Participants are more likely to report true feelings, opinions, experiences, etc. more openly online in comparison to laboratory-based studies, as indicated by several research findings (Tourangeau, Couper, & Steiger, 2003; Bargh & McKenna, 2004; Bargh, McKenna, & Fitzsimons, 2002). This is of particular relevance for the current research, as stigmatisation is commonly associated with individuals who may experience degrees of psychosis or autism traits, which means participants may be less likely to report these experiences in a laboratory setting. Notwithstanding, there are some concerns with using Internet-based designs. Firstly, it is impossible to monitor the environment the participant completes the study in. For example, there is no possible way of knowing whether participants are under the influence of nicotine or caffeine when completing the online questionnaires or tasks. Furthermore, it is not possible to establish whether participants are multitasking and engaging in a second or third activity whilst simultaneously completing the online study, e.g. gaming, chatting, using social networking sites, etc. Although such confounds are almost impossible to alleviate in an online setting, in each Internet study advert, and communicated in the Information Sheet of each study, participants were instructed to complete the study in a quiet setting and avoid being distracted or under the influence of alcohol or other substances in order to complete the study accurately and carefully.

Self-report Measures

Self-report measures are both cost-effective, quick and convenient to administer when assessing various phenomena. Indeed, many self-report measures need to undergo significant standardised testing whereby such measures are tested for both reliability and validity before and after publication. From this perspective, standardised self-report measures are considered to be statistically sound instruments that are able

to capture a host of behavioural, psychological and social information. Notwithstanding this, there are some limitations of self-report measures that should be acknowledged. Measures that depend on participants' self-reports are subjective in nature, thus they are likely to be susceptible to biases. This can be particular pertinent when participants opt to answer in a socially desirable way. Nonetheless, even if a participant answers honestly, there is always a small possibility that they lack the necessary introspective ability to answer accurately.

In order to use the most effective measures to index the constructs under investigation, a review of each of the main self-report measures used throughout the study are discussed below.

Self-Report Psychosis Traits

Over the last several decades, a number of instruments have been constructed to measure degrees of psychosis traits across clinical and non-clinical populations. Increasing scores on such measures are considered to reflect a higher lability towards psychotic spectrum disorders such as schizophrenia. Despite the array of instruments in circulation, it is the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) and the Schizotypal Personality Questionnaire Brief (SPQ-B; Raine, 1998) that are utilised to ascertain degrees of psychotic traits throughout this thesis (see Table 1.0 for review of other measures).

The positive dimension of the full SPQ (SPQ_POS) contains 33 items that can be derived from four different facets. Each facet has 6-8 items. The facets of psychosis traits include: unusual perceptual experiences, suspiciousness, magical thinking, and ideas of reference. The SPQ is scored in a dichotomous fashion, whereby participants select yes/no to each item. Participants are given a score of '1' for each item they respond 'yes' to, and a score of '0' for each item they respond 'no' to. The total scores can range 0-33 on the full version of the SPQ. Scores can range 0-8 on the SPQ-B. In order to explore high and low degrees of psychotic traits, previous studies (Russell-Smith, Maybery, & Bayliss, 2010; Karimi et al., 2007) have dichotomised total scores on the SPQ_POS into

high and low-scoring groups based on specific cut-off scores. Although such a method appears rational, it is not without its limitations. It is almost certain that dichotomising a continuous variable results in loss of statistical power. It is likely that a significant loss of data will occur and the findings will be less generalisable. Given the well-evidenced notion that degrees of psychosis traits are reported to occur on a continuum, it would be more informative to preserve such a measure within a continuous structure. As discussed by Streiner (2013), dichotomising a continuous variable enhances a Type II error and, therefore, should only ever be used when the distribution of the variable under interest is highly skewed. Therefore, the SPQ_POS was used as a continuous measure throughout the presented research studies.

The SPQ has also been found to relatively high convergent validity with other measures; for example, Wuthrich and Bates (2005) reported high correlations between the Chapman Scales and SPQ subscales (i.e. positive traits correlated highly). Additionally, in a study using 270 undergraduate students, Asai et al. (2011) administered both the SPQ and O-LIFE to participants and their results yielded that the two measures were strongly correlated overall (correlations r = .5-.8). In contrast to other measures, the positive dimension of the SPQ covers a broad range of psychotic traits. This is particularly relevant considering positive symptoms of psychosis are multidimensional and are not dichotomised to just experiencing delusions and hallucinations. Furthermore, the SPQ is one of the only measures to be administered to different types of clinical populations, e.g. individuals with active psychosis (Brosey & Woodward, 2015) and individuals in remission from a psychotic disorder (Moreno-Izco et al., 2015). In both studies, such groups score significantly higher on the SPQ relative to matched Control groups. Collectively, these findings further highlight the convergent validity of the measure.

Table 1.0 - Strengthens and Limitations of Current Self-Report Measures of Positive Psychosis Traits

Measure	Author (Year)	Strengths	Limitations
Schizotypal Personality Questionnaire	Raine (1991)	Explicitly designed to assess the entire continuum of positive psychosis. Excellent psychometric properties. Widely used in non-clinical and clinical populations.	No reverse scoring. Analysis of results vulnerable to false positive / false negative responses.
Brief Schizotypal Personality Questionnaire	Raine (1995)	Highly correlated with the full version of the Schizotypal Personality Questionnaire. Quick to administer. One of the most popular measures.	Only has eight items, thus has less variance. No reverse scoring.
Peters Delusional Inventory	Peters et al. (1996)	Comprehensively assesses a wide range of delusional experiences. Adopts a Likert scale for each item, thus reflecting severity of each delusional experience.	Restricted to just delusions. Refrains from inquiring about other phenomena associated with psychosis, e.g. magical thinking, unusual experiences, etc.
Oxford Liverpool Experiences and Feelings Inventory	Mason et al. (2006)	Has been found to be highly correlated with a wide variety of measures of psychotic traits (e.g. SPQ and SPQ-B).	Covers a limited number of positive schizotypal experiences. Has not been applied as widely to the continuum of psychosis as the SPQ.
Psychosis Screening Questionnaire	Bebbington and Nayani (1995)	Quick and easy to administer. Excellent for screening for the absence or presence of a psychotic disorder.	Not appropriate for non-clinical populations. Not suitable for measuring a wider range of positive psychosis traits.
Paranoid Thought Scales	Green et al. (2006)	A reliable and valid tool for assessing paranoid thoughts. Used for clinical and non-clinical populations.	Limited to just paranoid and persecutory thoughts.

Self-Report Autism traits

As was highlighted in Chapter 1, the Autism Quotient (AQ; Baron-Cohen et al., 2001) remains one of the most widely-used measures of autism traits across adult populations of average intelligence (Ruzich et al., 2015). At the time of writing, in contrast to measures of psychosis traits, there are only three central measures of autism traits that are designed for the typically developing population: the Autism Quotient (AQ; Baron-Cohen et al., 2001), the Broader Autism Phenotype Questionnaire (BAPQ; Hurley, Losh, Parlier, Reznick, & Piven, 2007), and the Social Responsiveness Scale (SRS; Constantino et al., 2004; Constantino et al., 2007; Constantino & Todd, 2000; Constantino & Todd, 2003). Notwithstanding this, the AQ remains the only measure that was created for assessing autism traits in typically developing populations. The BAPQ was fashioned for assessing autism traits in people without a clinical diagnosis of ASD who had a family member with ASD. Finally, the SRS has been used to distinguish ASD from other child psychiatric conditions and predominantly focuses on social impairment. The SRS also necessitates a parent/guardian or teacher to complete it. Although all measures are advantageous for examining autism behaviour across the spectrum, it was the AQ that was used in the current research studies. However, there are two variants of the AQ, namely the original 50-item questionnaire and the AQ-Short (AQ-Short; Hoekstra et al., 2011). The 28-item version is a shorter version of the original 50-item question. This allowed for further exploration of autism traits and reasoning using two widely-used measures.

The full version of the AQ is predominantly used throughout the current research. As reflective of ASD, the AQ is a multidimensional measurement whereby it is collapsed into five key domains: Social Skills, Communication, Imagination, Attention to Detail and Attention-Switching. Briefly, these facets are reflective of the core symptomology of ASD. For instance, higher scores on the imagination subscale would be indicative of difficulty in pretend play. Whereas increasing scores of the Communication facet would be suggestive of difficulty engaging in social conversation, facilitating social discussions, and being aware of when to start and stop a conversation,

increasing scores on each of these facets is indicative of autistic pathology. In the current studies, a modification was made to the AQ which involved editing item 9 of the questionnaire from "I am fascinated by dates" to "I am fascinated by dates, e.g. 1/02/1987". This adaption was made based on the original version being considered too ambiguous. In a previous study where the AQ was used, Lewton (2012) found that some participants asked the experimenter for clarification of the term 'dates', enquiring as to whether it referred to calendar dates or the context of social or romantic appointments.

The AQ is considered to be effective at discriminating between individuals with and without clinical ASD. For example, a recent systematic review by Ruzich et al. (2015) evaluated a collection of studies employing the AQ to 6,934 non-clinical participants, as well as 1,963 matched clinical cases of ASD. Ruzich et al. reported that the mean AQ score in a non-clinical population was 16.94, while the mean score in clinical populations was 35.19. These non-clinical means were found in all Control groups throughout the studies 1-5. The clinical ASD group in Study 4 obtained a mean AQ score of 26.12, whereas the clinical ASD group in Study 5 attained a mean AQ score of 25.38. Researchers such as Sizoo et al. (2009) and Woodbury-Smith (2005) have suggested a cut-off score of 25 to warrant further clinical investigation. Many studies have found that increasing degrees of these traits has been seen to reflect cognitive behaviour observed in clinical ASD. In other words, higher scores on measures such as AQ would be related to the most prominent characteristics that are frequently seen in people with clinical ASD.

As reviewed in Chapter 1, the AQ has been used to assess various social and non-social cognitions found in clinical ASD. In most cases, the AQ has been found to predict cognition in the respective direction. For example, higher AQ scores are found to reflect impairments in emotional recognition (Kadak et al., 2012), yet higher degrees of AQ have been found to reflect enhanced local and visual processing (Almeida et al., 2014; Richmond et al., 2013). In addition, as higher degrees of autism are suggestive of higher autistic pathology, the AQ can be considered an appropriate measure to detect autism traits across the continuum.

Self-Report Reasoning Style

As reflected throughout the literature, the Rational Experiential Inventory (REI; Epstein and Pacci, 1996) is used as a measure to determine a person's preference and engagement for 'intuition' and 'deliberation'. From a dual process perspective, intuition is considered a product of intuitive reasoning, thus self-report intuitive reasoning is considered to reflect intuitive reasoning, whilst self-report deliberation is considered the dimension that reflects deliberative reasoning. The deliberative dimension is predicated upon a 'need for cognition' (Cacioppo & Petty, 1982), which measures engagement in, and pleasure of, cognitive activities (Brosnan et al., 2016). The intuitive component was developed to measure engagement and conviction in one's intuitive abilities and is defined as 'faith in intuition' (Epstein et al., 1996; Pacini & Epstein, 1999). Epstein et al. argue that these two information processing modes are orthogonal, such that one can be high or low in either or both of these dimensions.

Throughout the current research studies, the REI is used as a self-report measure of cognitive style. Although other measures are available, such as the Cognitive Style Index (CSI: Allinson & Hayes, 1996), it is the REI that has been empirically demonstrated to accurately reflect dual process models of reasoning (Hodgkinson, Sadler-Smith, Sinclair, & Ashkanasy, 2009). For example, as reviewed in Chapter 2, there is a selection of empirical and neurophysiological evidence that supports the idea that there are two distinctive modes of processing information. Measures such as the CSI put forward the idea that reasoning reflects an unidimensional construct, where deliberation and intuition are regarded as bipolar opposites of a single continuum. This view appears to depart from traditional dual process models of reasoning, in addition to digressing away from the existing empirical evidence. More conclusively, a recent meta-analysis by Wang, Highhouse, Lake, Petersen and Rada (2015) involved conducting a meta-analysis on the REI, CSI, and the General Decision-making Style Inventory (GDMS; Scott and Bruce 1995), a self-report questionnaire that is similar to the REI. Wang and colleagues were interested in examining the associations between the dimensions of intuition and deliberation across all questionnaires, which totalled 75 studies with 80 independent

samples. Wang et al. wanted to examine whether there was evidence for intuition and deliberation as being opposite poles of a single dimension or whether they are orthogonal constructs. Wang et al. findings determined that their meta-analysis concluded that intuition and deliberation were independent constructs, rather than opposite ends of a bipolar continuum. Further to this, confirmatory factor analysis on all questionnaires further supported the existence of two uncorrelated constructs.

Performance-based measures of Reasoning Style

Performance measures of reasoning are useful as they allow for an objective assessment of a person's reasoning style, above and beyond their subjective interpretation of how they believe they engage in a reasoning style. As reviewed in Chapter 2, there are two dominant measures that are considered to examine intuitive and deliberative reasoning styles: the CRT and Syllogistic reasoning. Each of these performance measures will be critically appraised in the subsequent paragraphs.

Performance measure of reasoning: The Cognitive Reflection Test

To behaviourally assess a person's preference for intuitive and deliberative reasoning style, Frederick (2005) created the Cognitive Reflection Test (CRT). Cognitive reflection has been epitomised by Frederick as "the ability or disposition to resist reporting the response that first comes to mind," p. 35. There are three items that make up the CRT. Each item has a potentially intuitive and deliberative answer, as well as the potential for wrong answers (see Table 1.2). Scores can, therefore, range 0-3 for intuition and deliberation. The CRT is not simply ipsative as it is possible to provide a wrong answer; however, providing an intuitive answer does dictate that a deliberative answer was not specified (Note: the intuitive response is a wrong answer). Previously, the CRT had been reported to have a Cronbach alpha ranging between .53 and .66 (Morsanyi, Busdraghi, & Primi, 2014; Frederick, 2005).

Table 1.2 – Original Cognitive Reflection Test (Frederick, 2005)

Item	Possible Answers
A bat and a ball cost £1.10 in total. The bat costs £1.00 more than the ball. How much does the ball cost?	1. 10 pence (incorrect – intuitive) 2. 5 pence (correct – deliberative)
If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	1. 100 minutes (incorrect – intuitive) 2. 5 minutes (correct – deliberative)
In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	1. 24 days (incorrect – intuitive) 2. 47 days (correct – deliberative)

For the current studies produced throughout this thesis, a modification was made to the CRT to replace dollars with pounds for the bat and ball question, as the sample of participants who would be completing the task would be in the UK. In addition, the font size of the items was presented in easy-to-read black Myriad Web 12-point font; this was important, as some evidence has been reported that revealed participants performed better on the CRT when it was presented in a disfluent or difficult to read font (Alter et al., 2007).

The CRT is often presented to participants with only the following instruction: "Please answer the following questions". Participants are then encouraged to write or types their answers. As a result of this, answers other than the intuitive and deliberative

responses can be provided, but are considered 'other answers' and may have resulted from the participants misreading the question, not understanding the question, or simply guessing. Nonetheless, many research studies that have utilised the CRT tend to focus on the intuitive and deliberative responses only. A unique characteristic about the CRT is that it is considered to have a salient intuitive 'lure', whereby participants must resist their initial intuitive response and override it with a more deliberative one. To the author's knowledge, and in line with Björklund and Bäckström (2008), there are few reasoning tasks available that assess intuitive and deliberative answers simultaneously. As a result of this, a number of authors have assessed reasoning behaviour using the CRT as a main method measure of intuition and deliberation, and contrasted such reasoning styles across a broad range of research fields including religiousness, moral reasoning, clinical decision-making, and finance (Norenzayan and Gervais, 2012, Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012; Shenhav et al., 2012; Paxton, Ungar, & Greene, 2012; Nofsinger & Varma, 2007).

Although the CRT has dominated the assessment of intuitive and deliberative reasoning style, several limitations need to be acknowledged. Indeed, the CRT has been publicised widely, as discussed by Sinayev and Peters (2015). Many of the items of the CRT are frequently administered in Internet surveys, displayed in newspaper articles, discussed on radio shows, and are sometimes shown to undergraduates in courses in business studies, psychology and management degrees to highlight duality in reasoning and thinking. In light of such evidence, in each of the current studies produced throughout this doctoral thesis, participants were asked at the end of each study whether they had ever seen or answered the questions before. Participants who had responded positively to seeing these questions could then be controlled for accordingly. This was to guard against knowledge-based effects.

Beyond the popularity of the CRT, issues about what specifically the CRT is measuring has been extensively discussed. For example, Campitelli & Gerrans (2014) investigated whether the CRT was actually assessing mathematical ability as opposed to intuitive and deliberative reasoning. The author's rationale for such a line of inquiry was

founded on the idea that the items that encompassed the CRT were numerically based. After employing mathematical modelling to the items of the CRT (see for review Böckenholt, 2012), the authors concluded that the CRT was measuring both a person's ability of inhibiting an intuitive response, as well as a person's probability of using a mathematical procedure to respond to the questions. In other words, despite the mathematical content of the CRT, the authors still concluded that the CRT was a strong measure of a person's ability to withhold an intuitive response in favour of a more deliberative one. Nonetheless, at least a basic understanding of elementary maths is important for performance on this task. Accordingly, the task should not be administered to anyone who lacks the necessary knowledge of elementary mathematics, e.g. the task would not be suitable for individuals with an intellectual disability. This is a particular relevant concern, as there is some evidence to suggest that individuals who suffer from maths anxiety can become increasingly distressed by the mere presence of items that include numeric data (see Morsanyi, Busdraghi, & Primi, 2015). Nonetheless, the CRT remains the most widely valid and used performance measure of reasoning style.

Performance measure of reasoning: Syllogistic Reasoning

As was pointed out in Chapter 2, syllogistic reasoning is considered the archetype of reasoning, and has been perceived as the most widely-studied example of dual process reasoning (Evans, 2011). Akin to the Cognitive Reflective Test (Frederick, 2005), syllogistic reasoning is assumed to pit intuitive and deliberative processes against one another (Morsanyi & Handley, 2012). In order to provide a more deliberative response to a syllogism, participants must override their initial intuitive response. Put simply, participants must assess the logical validity of a syllogism as opposed to the plausibility of its conclusion.

Throughout studies 2-4, eight syllogistic reasoning problems were administered to participants. These syllogisms were extracted from Heinrichs and Goel (2010). These were selected as such a battery reflected medium difficulty, which is preferable for

adult-based populations. The objective of this task is for participants to assess whether the presented syllogisms are logically valid or logically invalid. In four of the problems, the correct answer was consistent with real-world knowledge and was logically valid; that is, such problems were considered 'congruent'. With the remaining four problems, the correct answers were inconsistent with everyday knowledge, but were logically valid; that is, they were 'incongruent'. The presentation of these syllogisms can be broken down further into: Valid-Believable, Valid-Unbelievable, Invalid-Believable, and Invalid-Unbelievable. The Valid-Believable and Invalid-Unbelievable syllogisms are considered the congruent problems, whereas the Believable-Invalid and Unbelievable-Valid are the incongruent problems.

For each study, participants performed two practice problems (one congruent and one incongruent). Participants then completed the eight problems. All syllogisms were randomised to prevent order effects. Responses were coded 1 for correct (indicating a deliberative, logically valid answer) and 0 for incorrect. Total scores for each participant ranged from 0 to 8, with higher scores reflecting enhanced and more accurate deductive reasoning ability. Independent scores were also calculated for Congruent and Incongruent. These scores could range from 0 to 4. Cronbach's α for this eight-item measure has been reported to be satisfactory at .71.

Having discussed the methodological limitations and restrictions of the methodology applied in the current research project in this chapter, the following chapters present the experimental research undertaken within this research project.

EXPERIMENTAL STUDIES

CHAPTER 4: Relationships between Psychosis and Autism traits and Reasoning Styles as indexed by the REI and CRT

Introduction

Atypical reasoning behaviour has been observed in people across the psychosis and autism continua as assessed through a range of different reasoning tasks (for review see Chapter 2). Previous research has highlighted two contrasting styles of reasoning between people with ASD and people with psychosis. Those with a psychotic disorder and those who endorse psychosis traits have been found to 'jump to conclusions'; that is, to make a decision rapidly based on little evidence (for a review see Fine et al., 2007). This jumping to conclusion bias has been considered to play a role in the formulation and maintenance of delusions and hallucinations (Freeman et al., 2008; White and Mansell, 2009). For example, a rapid style of reasoning may result in people with psychosis accepting their initial beliefs and refraining from engaging in a style of reasoning, which involves acquiring more information to assess the accuracy of their beliefs. Indeed, Holt et al. (2006) compared the 'jumping to conclusion bias' to a dependence on 'gut' feelings over analytic reasoning, which suggests a potential role for reasoning styles and psychotic experiences. On the other hand, people with ASD have been found to be far more 'circumspect' in their reasoning, requiring more information before making a decision (Brosnan et al., 2014). Behavioural observations from teachers and parents have also reported how people with ASD appear to spend more time reasoning and have difficulty when decisions need to be made quickly (Johnson et al., 2006). These difficulties have been further highlighted by qualitative research carried by Luke et al. (2012), who reported that people with ASD preferred to engage in a more effortful and slower form of reasoning compared to matched controls. Developing a comprehensive understanding of reasoning style in relation to autism and psychosis

traits is an important step towards understanding the social and non-social cognitive and behavioural characteristics observed across the psychosis and ASD continua.

Although not without its criticisms, the most widely acknowledged neuroscientific view on reasoning style is the alleged 'dual process theory' of reasoning (Stanovich & Evans, 2013; Evans, 2011; Kahnemann, 2011; Goel et al., 2004; see for review Chapter 2). Within this framework, people are often considered to engage in two distinctive styles of reasoning when presented with incoming information. One style of reasoning is broadly defined as being 'intuitive', whereby it is fast, automatic, based on prior beliefs and experiences and is independent of cognitive ability (e.g. working memory capacity and general intelligence). The second style of reasoning is considered to have opposing attributes to an intuitive style of reasoning and is, therefore, considered more 'deliberative', whereby it is slower, effortful, and draws on cognitive ability. Reported research that has specifically examined relationships with reasoning style across the autism and psychosis continua remains largely absent, although there are a small number of studies that have assessed how psychosis and autism traits are associated with differing dependencies of intuitive and deliberative reasoning styles, as captured by the Rational Experiential Inventory (REI; Epstein and Pacci, 1996) and the Cognitive Reflection Test (CRT; Frederick, 2005), both of which are widely used and well-validated measures of reasoning style (for review of measures see Chapter 3).

Since the diametrical disorders hypothesis proposes opposite patterns of cognition in autism traits versus psychosis traits, as outlined in Chapter 1, this suggests that reasoning should be diametrically opposing in the way that people with autism traits should show the opposite reasoning style to that seen in people with psychosis traits, namely a more deliberative relative to intuitive style of reasoning. Notwithstanding the relationships between autism and psychosis and reasoning style, there is an array of research that has highlighted how expressions of psychosis and autism can co-occur in the same individual (Chisholm et al., 2015; Hofvander et al., 2009; Sheitman et al., 2004; Solomon et al., 2011; see Chapter 1). In the context of such co-occurrence, it is important to determine what the relative impact is of disorder-specific

traits on reasoning style within an individual. Recently, a number of researchers have proposed that the discrepancy between psychosis and autism traits scores can have implications for different areas of cognition (Dinsdale et al., 2013; Del Guidice et al., 2010, 2014; Abel-Akel et al., 2015; Brosnan et al., 2010; Choteau et al., 2016; see Chapter 1). Indeed, both Dinsdale et al. and Abu-Akel at al. observed that the discrepancy between individual scores on measures of psychosis and autism traits had different implications for certain types of cognition in comparison to when they were examined in isolation. With this in mind, it is necessary to measure both autism and psychosis traits jointly, as this will allow inferences about the unique effects of psychosis and autism traits on reasoning style to be made after controlling for any statistical overlap they have with one another.

In addition to measures relating to autism and psychosis traits, the present study includes demographic factors such as gender and age as additional independent variables. There is a strong body of evidence that highlights how gender impacts on different styles of reasoning when indexed using the CRT and REI. Using the CRT, in a large population study (N = 3,428), Frederick (2005) reported how male participants reported more deliberative answers than females, behaviourally demonstrating a preference for a more deliberative style of reasoning. Indeed, this finding has been reported in other studies, whereby males provide more deliberative responses on the CRT and females provide more intuitive responses (Da Silva et al., 2015; Hoppe and Kusterer, 2011; Cueva-Herrero et al., 2015). Potential explanations for such differences have been hypothesised to be based on the idea that, in general, males have higher mathematical abilities and score higher than females in math tests, which may explain the higher performance on the CRT (Brañas-Garza et al., 2015). However, Frederick comments that such reasoning style differences using the CRT are 'unanticipated and suggest no obvious explanation' (p. 38). These findings have also been extended to self-report measures, whereby females self-report a significantly higher inclination for intuitive relative to deliberative reasoning style in contrast to male participants (Epstein, 2003; Sladek, Bond, & Phillips, 2010). As gender differences have been reported in both

the CRT and REI, it is important to take this factor into consideration when examining the relationships between individual differences of psychosis and autism traits and reasoning style.

With regards to individual differences in age, the influence of age is comparatively unreported. In Klaczynski & Lavallee (2005), it was reported that children between the ages of 14 and 18 years had a preference for self-report deliberation using the REI in comparison to adolescents between the ages of 18 and 21 years. Although there is a paucity in research that has specifically looked at reasoning style and age, there is some evidence to suggest that age may impact on preference for intuitive and deliberative reasoning style. For instance, Sladek et al. reported how, as people mature, they are less likely to report relying on their intuition as indexed by the REI and, instead, rely on more deliberative styles of reasoning. Nonetheless, in a study involving 148 adults aged between 40 and 51 years, Handley (2000) reported no relationships between self-report intuition and deliberation and age using the REI. Collectively, such findings produce mixed and inconsistent evidence. Taken together, for the current and subsequent studies, both age and gender will be taken into consideration whilst investigating the main hypothesis of the current thesis. Lastly, to explore whether a predisposition to impulsivity related to rapid responding, an index of impulsivity was also measured as a control measure.

Aims and hypotheses

There are two over-arching aims of the present research study:

1. To test whether measures of autism and psychosis traits predict reasoning style as indexed by both self-report and performance measures using the REI and the CRT.

2. To explore the interaction between autism and psychosis traits by creating a Psychosis-Autism Bias score (hereafter, PAB), which is derived from AQ_Short and SPQ_Brief scores. The purpose of the PAB is to explore whether such a bias demonstrates a relationship with reasoning style.

Based on the outlined literature, it was expected that:

a) SPQ_Brief scores will positively predict intuitive responses on the CRT. SPQ_Brief scores will positively predict self-report intuitive reasoning scores on REI. SPQ_Brief scores will negatively predict self-report deliberative reasoning and negatively predicted number of deliberative responses on the CRT.

b) AQ_Short scores will positively predict deliberative responses on the CRT. AQ_Short scores will positively predict self-report deliberative reasoning using the REI. AQ_Short scores will negatively predict self-report intuitive reasoning and negatively predicted number of intuitive responses on the CRT.

c) Given the scarcity of direct evidence for the creation of a PAB and reasoning style, the PAB was regarded as exploratory in nature. Notwithstanding, in accordance with the diametric disorders hypothesis, and in line with both Brosnan, Ashwin, Walker, & Donaghue (2010) *Empathising_Bias* and Baron-Cohen et al. (2005) Extreme Male Brain theory (see Chapter 1), the discrepancy between psychosis and autism traits could have implications for cognition. From this viewpoint, it was predicted that high psychosis relative to autism traits will relate to intuitive reasoning, while higher autism relative to psychosis traits will relate to deliberative reasoning.

Methods

Participants

A convenience sample of 64 students participated in this study. There were 31 males and 33 females. Participants were aged 18-35 years old (mean=20.90, s.d. = 3.22). Participants included both undergraduate and postgraduate students from the University of Bath. No incentive was offered for participants to take part in the study. No participants reported having a current or previous diagnosis of a psychiatric condition. All participants were native English speakers. The research was approved by the Psychology Departmental Research Ethics Committee at the University of Bath, which implements the ethical guidelines of the British Psychological Society.

Measures of Autism and Psychosis Traits

Autism traits

Autism traits were assessed using the short version of the Autism-Spectrum Quotient (AQ-Short; Hoekstra et al, 2011) for convenience and brevity. The AQ-Short is a 28-item questionnaire that measures autism traits in adult populations of average intelligence. The 28-item version is a shorter version of the original 50-item question (Baron-Cohen et al., 2001; see Chapter 3). Overall scores on the AQ-Short can range from 0 to 28. Increasing scores on this measurement reflect a higher number of autism traits. According to Hoekstra et al., the AQ has good internal consistency with a Cronbach alpha coefficient reported of .85. The Cronbach's alpha values in the current study indicate acceptable to good internal consistency for the total AQ-Short ($\alpha = .80$).

Psychosis Traits

Positive psychosis traits were assessed using the positive dimension of the Brief Schizotypal Personality Questionnaire (hereafter, SPQ-Brief; Raine, 1996) for convenience and brevity. This factor contained eight items and enquired about positive psychosis traits associated with unusual experiences, delusional proneness, aberrant perceptual experiences, and paranoid ideation. The SPQ-Brief was scored in the traditional yes/no format, where participants were given a score of '1' for each item where they responded 'yes', and a score of '0' for each item where they responded 'no'. The total scores could range 0-8. According to Raine (1996), the SPQ-Brief positive subscale has good internal consistency with a Cronbach alpha coefficient reported of .72. In the current study, a Cronbach alpha coefficient was reported as .78

Composite Measure

The Psychosis-Autism Bias (PAB Score)

In addition to exploring the relationship between psychosis and autism traits individually, a composite score was created to calculate the discrepancy between the SPQ-Brief and the AQ within each participant. The scores for the positive dimension of the SPQ-Brief and AQ were each standardised by converting them to z scores. The standardised SPQ-Brief scores were then subtracted from the standardised AQ scores to create a 'Psychosis-Autism Bias (PAB)' score. A score of zero indicated performances on the SPQ-Brief and AQ were equal within a participant. A positive PAB score indicates a higher ratio of positive psychosis tendencies to autism tendencies, while a negative PAB score indicates a higher ratio of autism to psychosis traits. Were the distributions to extend to three standard deviations above and below the mean, theoretically PAB scores could range between plus and minus six (from Brosnan et al., 2010).

Measures of Reasoning Style

Cognitive Reflective Test

The Cognitive Reflection Task (CRT; Frederick, 2005) is a 3-item performance measure of intuitive and deliberative reasoning style. Each question has an intuitive and deliberative answer, as well as the possibility for other wrong answers. Scores can therefore range 0-3 for each subscale: CRT_INT and CRT_DEL (Note: the intuitive response is a wrong answer). Cronbach's alpha in the current study was .57, which suggests modest reliability.

The Rational Experiential Inventory

The Rational Experiential Inventory (REI; Pacci and Epstein, 1996) is a self-report measure of reasoning used to assess a person's willingness and enjoyment for intuitive and deliberative reasoning. Intuitive reasoning is assessed through the use of 20 independent statements. Subsequently, deliberation is assessed through 20 independent statements. Respondents score each item on a 5-point scale, from 1 = completely false to 5 = completely true. Scores of 1 indicate a low ability/engagement and scores of 5 indicate a high ability/engagement for each reasoning style. The dependent variable from this measure is the independent total scores of intuition and deliberation after they have been divided by 10. McLaughlin et al. (2014) have reported that the REI has good overall internal consistency with a Cronbach alpha coefficient reported of .85. As noted, the REI conceptualises intuition as 'experiential' and deliberation as 'rational'. For simplicity, and to avoid any confusion with nomenclature, the current research studies use the terms 'REI_INT' to capture self-report intuitive reasoning and 'REI_DEL' to capture self-report deliberative reasoning. In the present study, the Cronbach's alpha for the intuitive scale is .78, and for the deliberation scale it is .76.

Control Measure

The Barrett Impulsivity Scale

The Barrett Impulsivity Scale (BIS-11; Patton et al., 1995) is a well-validated and most commonly used measure of impulsive personality traits. The BIS-11 is a self-report question that includes 30-items and endeavours to elicit impulsive and non-impulsive behaviours. Scores for each item range from 1 = never/rarely, 2 = occasionally, 3 = often, 4 = almost always/always. Scores potentially range from 30 to 120. Cronbach's alpha for the BIS-11 has been reported to range from .72 to .79 (Pechorro et al., 2015; Dieman et al., 2008). In the current study, Cronbach's alpha is .76.

Procedure

The questionnaires and CRT was administered as an online survey on an electronic online service known as Bristol Online Surveys (BOS) (see http://www.survey.bris.ac.uk), a system to which the University of Bath subscribes. An invitation to participate was distributed via the University's internal email system. The study lasted approximately 25 minutes. The questionnaires and CRT were randomised to prevent order effects. Randomisation of the measures was achieved by setting up multiple links through BOS, with each link having the measures presented on different pages. Different links were emailed out randomly to interested participants. Pending completion of the study, participants were debriefed using a debriefing sheet. All participants gave informed consent.

Data preparation and analysis

All data was exported from the Bristol Online Survey and analysed using the Statistical Package for the Social Sciences (SPSS) version 22. Inspection of the dataset revealed that there was no missing data. This finding isn't particularly surprising, as a feature of the BOS is to alert participants to any unanswered questions. A series of Boxplots were created in order to establish whether there were any outliers for any of the variables under investigation. Visual inspection of the Boxplots revealed that there were no extreme scores on any of the variables under examination.

Formal normality tests (Shapiro-Wilk) indicated that all dependent variables besides the PAB violated the assumption of normality ($p < .05$). However, Tabachnick and Fidell (2007) advise that Histograms and Detrended Normal Q-Q Plots should also be inspected in conjunction with normality tests as a means of assessing the distribution of data points. Normality tests in isolation have been considered misleading, as normality tests can possess low power when the sample size is small (N < 200). As the current sample is less than 200, assessment of normality using the Histograms revealed that the data presented as normally distributed for all of the variables. In addition, analysis of the Detrended Normal Q-Q Plots revealed no real clustering of points, with most data point assembling around the zero line. As a result, the data was interpreted as being normally distributed and, therefore, inferential analysis was conducted using parametric statistics.

Results

Table 4.0 highlights the means, standard deviations, significant test values, and effect sizes of all measures. As gender differences have been reported between many of the measures under investigation, a series of independent sample t-tests were conducted using gender as the independent variable. As illustrated in Table 4.0, female participants were significantly higher than male participants on the CRT-INT (t (62) = -2.25, $p < .05$). However, there were no other significant gender differences between any of the other variables under investigation (all $p > .05$).

Table 4.0

Means, standard deviations (sd), t-values, and effect sizes of measures used (N = 64)

Measure	Total sample (N = 64)	Males (N = 31)	Females (N = 33)	t-value	*d*
AGE	20.91 *(3.23)*	20.30 *(3.06)*	21.55 *(3.33)*	-1.56	-.39
AQ_SHORT	14.96 *(3.40)*	14.48 *(5.62)*	14.90 *(5.23)*	-.308	-.07
SPQ_BRIEF	2.25 *(1.87)*	2.21 *(2.04)*	2.29 *(1.70)*	-.166	-.04
PAB	.01*(1.15)*	-.06 *(1.20)*	.07 *(1.90)*	-.439	-.08
REI_INT	4.35 (*.99*)	4.13 *(.79)*	4.58 *(1.14)*	-.182	-.45
REI_DEL	7.25 (1.28)	7.02 *(1.22)*	7.50 *(1.33)*	-1.48	-.37
CRT_ INT	1.31*(1.18)*	1.00 *(1.15)*	1.65 *(1.14)*	-2.25*	-.56
CRT_DEL	1.56*(1.15)*	1.82 *(1.16)*	1.29 *(1.10)*	1.86	.46
IMPULS	63.84*(11.03)*	62.44 *(6.51)*	65.35 *(14.34)*	-1.06	-.26

Note: AQ_Short = Autism Quotient Score; SPQ_Brief = Positive psychosis Score; PAB = Psychosis-Autism Bias; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; IMPULS = Barratt Impulsivity Score; * = $p < .05$ (one-tailed).

Prior to the main analysis, the relationships amongst the dependent variables for the entire sample were examined. This was carried out to explore the relationships between performance and self-report measures of reasoning style. These relationships are presented in Table 4.1. Partial correlational analyses were selected as previous sex differences had been identified between many of the variables under investigation.

Table 4.1 highlights that overall self-report and performance measures of intuitive and deliberative reasoning correlated in the expected direction. Specifically, self-report intuitive reasoning correlated positively with intuitive responses on the CRT (r = .41 p < .01) and negatively with deliberative responses on the CRT (r = -.40, p <.01). Self-report deliberative reasoning did not significantly correlate with deliberative responses on the CRT. Self-report intuitive scores on the REI did not significantly correlate with self-report deliberative scores on the REI. However, intuitive responses on the CRT negatively correlated with deliberative responses on the CRT (r. = -.94, p <.001). Finally, both impulsivity and age were unrelated to all measures of reasoning style and expressions of psychosis and autism traits (all p > .05).

Table 4.1

Partial correlation analyses for dependent variables assessing reasoning style (N = 64)

	REI_DEL	CRT-INT	CRT_DEL
REI_INT	.03	.41*	-.40*
REI_DEL		-.11	.15
CRT_INT			-.94**

Note: REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; * p < .01, **p < .001 (one-tailed). Controlling for Gender.

Finally, in order to explore the relationship psychosis and autism traits, a zero-order Pearson correlation revealed a modest but positively significant association between the SPQ_Brief and AQ scores (r = .32, *p* <.001), which is consistent with the observed phenotypic overlaps between the autism and psychosis spectra (see Figure 1).

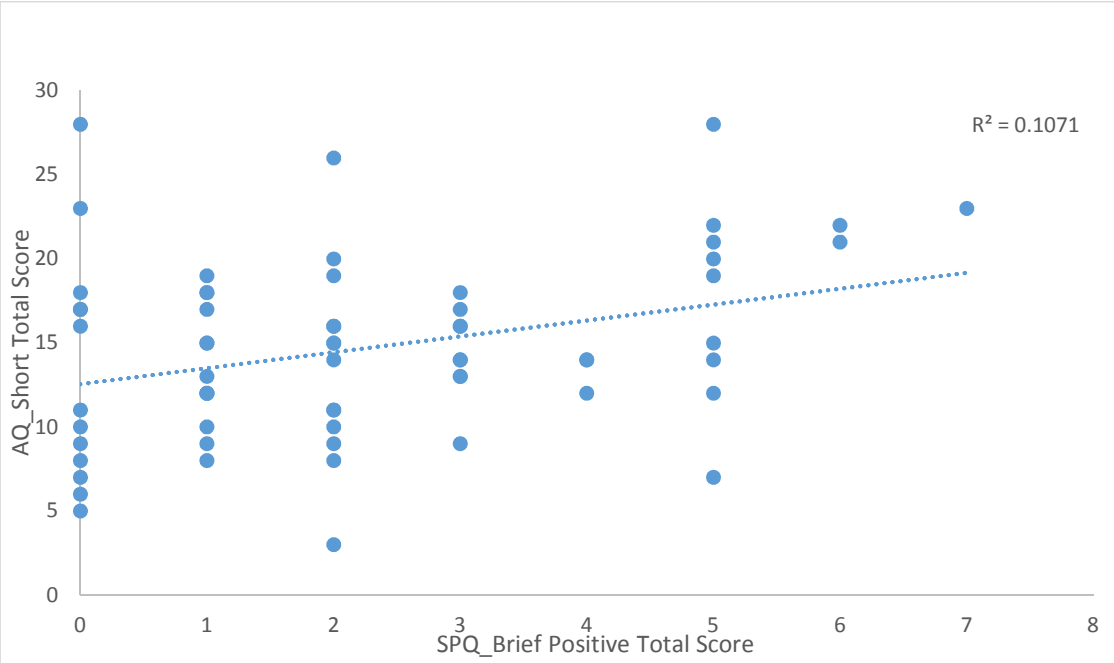


Figure 1. A scatter plot depicting the association between the Autism-Spectrum Quotient Short (AQ_Short) scores and the scores on the Positive scale of the Brief Schizotypal Personality Questionnaire (SPQ_Brief positive scale).

Regression Analyses

To assess the independent relation between deliberative and intuitive reasoning styles and expressions of autism and psychosis traits, a series of multiple linear regression models were conducted. Given the existence of the modest positive correlation between SPQ_Brief and AQ_Short, the need to control for statistical overlap between these two measures was crucial. Consequently, both the AQ_Short and SPQ_Brief were entered into the regression models concurrently as the independent predictor variables. As neither Impulsivity nor Age showed any association with self-

report and performance measures of reasoning style, the independent variables here were confined to SPQ_Brief and AQ. However, Gender was entered into the regression model when CRT_INT was entered as a dependent variable, as a gender effect revealed females provided significantly more intuitive responses on the CRT. Each measure of reasoning style was entered as the dependent variable (CRT_INT, CRT_DEL, REI_INT, and REI_DEL) for each regression model. Subsequently, these models were re-run but replaced AQ_Short and the SPQ_Brief with the PAB.

Psychosis and Autism traits as predictors of Reasoning Style

To test hypotheses (A) and (B), CRT_INT was entered as the dependent variable. The analysis revealed that SPQ_Brief scores were the only positive predictor of intuitive responses on the CRT. The AQ did not significantly predict intuitive responses on the CRT. Adding Gender to the model revealed that SPQ_Brief remained a significant predictor along with Gender. AQ remained non-significant. Entering CRT_DEL as the dependent variable revealed that SPQ_Brief was a significant negative predictor of deliberate responses. AQ_Short was unrelated to CRT_DEL.

AQ scores significantly predicted self-report intuition when REI_INT was entered as the dependent variable, but SPQ_Brief scores did not. When REI_INT was replaced with REI_DEL, neither the SPQ_Brief nor AQ_Short were significant predictors.

Table 4.2

AQ and SPQ_Brief as predictors of Reasoning Style (N = 64)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	SPQ_Brief	.201	.082	**.31**
	AQ	-.030	.028	-.13
Model 2	SPQ_Brief	.199	.079	**.31**
	AQ	-.032	.027	-.14
	Gender	.643	.276	**.27**
CRT_DEL				
Model 1	SPQ_Brief	-.166	.081	**-.26**
	AQ	.027	.028	.12
REI_INT				
Model 1	SPQ_Brief	.120	.066	.22
	AQ	-.075	.023	**-.40**
REI_DEL				
Model 1	SPQ_Brief	.027	.090	.03
	AQ	.056	.031	.23

Note. Bold font indicates significant at p < .05

The Psychosis-Autism Bias as predictor of reasoning style

As indicated in Table 4.3, the PAB was a significant predictor of intuitive responses on the CRT_INT. The PAB remained a significant predictor when Gender was added to the model. Gender was also a significant predictor. When CRT_DEL was entered as the dependent variable, PAB was a significant negative predictor. When CRT_INT was replaced with REI_INT and the PAB score was a significant predictor of self-report intuitive reasoning, PAB was unable to predict REI_DEL.

Table 4.3

PAB Score as predictor of Reasoning Style (N = 64)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	PAB	.262	.122	**.26**
Model 2	PAB	.247	.118	**.24**
	Gender	.613	.279	**.26**
CRT_DEL				
Model 1	PAB	-.240	.119	**-.24**
REI_INT				
Model 1	PAB	.403	.093	**.48**
REI_DEL				
Model 1	PAB	-.049	.137	-.04

Note. Bold font indicates significant at p < .05

Discussion

This study investigated the associations between reasoning style and psychosis traits, autism traits, and the discrepancy between psychosis and autism traits using a sample of typically developing University students. It was demonstrated that the number of intuitive responses on the CRT was positively associated with higher psychosis traits, along with being negatively associated with the number of deliberative responses on the CRT. Psychosis traits were unrelated to self-report intuitive and deliberative reasoning style as assessed by the REI. Autism trait scores were found to be negatively associated with a self-report intuitive reasoning style, but were unrelated to a self-report deliberative reasoning style as indexed by the REI. Autism trait scores were unrelated to the number of intuitive and deliberative responses on the CRT. The PAB was found to be positively associated with the number of intuitive responses on the CRT, in addition to being negatively associated with the number of deliberative responses on the CRT. The PAB was also found to be positively associated with the self-report intuitive reasoning style on the REI, but was unrelated to self-report deliberative reasoning as indexed by the REI. Together, these results are consistent with the diametric disorders hypothesis (Crespi and Badcock, 2008) and show how individual differences in autism and psychosis traits are uniquely associated with different styles of reasoning.

The present result of an association between psychosis traits and the number of intuitive responses on the CRT can be considered complementary to Freeman, Evans and Lister (2012). In a non-clinical sample, Freeman et al. found that increasing degrees of paranoid thinking scores, as assessed through the Paranoid Thought Scale (Green et al., 2008), were positively associated with a more intuitive and less deliberative style of reasoning, as captured by the REI. Paranoid thinking has been considered to play a role in the development of psychosis traits, specifically persecutory delusions (Freeman et al., 2011). The CRT, which is more of a performance measure of intuitive reasoning style and its relationship with psychosis traits, is particularly informative as intuitive responses on the CRT have been found to be highly predictive of reasoning behaviour across other reasoning tasks. In an in-depth analysis, Toplak et al. (2011; 2014) found

that the CRT was a unique predictor of vulnerability to an assortment of reasoning biases. Specifically, drawing on dual process theory (Evans, 2011; Stanovich and Evans, 2013), reasoning biases are thought to occur through the over-reliance on intuitive and an under-reliance on deliberative reasoning. Although defaulting to this intuitive form of reasoning has been argued to be typical in many contexts, this over-reliance on intuitive reasoning may be exaggerated in people residing on the psychosis continuum. It could, therefore, be suggested that this disposition towards intuitive reasoning could factor into people with psychosis making incorrect and inappropriate inferences about the intentions of others, their environment, their first impressions, and beliefs. Indeed, an exaggeration in intuitive reasoning may contribute to explaining reasoning biases central to psychosis, such as the jumping to conclusion bias (Fine et al., 2007). In addition, such a finding provides support for the conception that hyper-mentalising is associated with an intuitive style of reasoning (Badcock, 2009; Crespi & Badcock, 2008). Consequently, individuals who display hyper-mentalising behaviours may be more likely to exhibit a more intuitive style of reasoning.

Contrary to Freeman et al. (2012), the current study found no association between psychosis traits and self-report intuitive or deliberative reasoning style. One possible explanation could be the differences in measures used to index expressions of psychosis traits. As previously noted, Freeman et al. relied on a single measure of paranoid thinking, whilst the current study employed a more inclusive measure of psychosis traits. Although the positive subscale of the SPQ_Brief only had eight items, it covered a diverse range of psychosis traits including magical thinking, suspiciousness, ideas of reference, and unusual cognitive experiences. Nevertheless, the SPQ_Brief was unrelated to both self-report measures of intuitive and deliberative reasoning style. It could be suggested that paranoid thinking may be more pertinent to self-report reasoning style as opposed to other facets of psychosis. Indeed, theorists such as Uono, Sato and Toichi (2015) and Horton et al. (2014) consider the 'ideas of reference' and 'suspiciousness' subscales of the SPQ to represent hyper-mentalising exclusively, whilst

others (Crespi and Badcock, 2008; Gray et al., 2011) consider all the positive facets of the SPQ to reflect hyper-mentalising.

Interestingly, CRT_INT was positively associated with REI_INT and, therefore, it is surprising that there was no relationship between psychosis traits and self-report intuitive reasoning. This result may be explained by the fact that the relationship between self-report and performance measures of reasoning style is not completely clear. For instance, although some findings have found that self-report intuitive and deliberative reasoning is associated with expected intuitive and deliberative responses on the CRT (Pennycook et al., 2016), several other findings have produced mixed results (Liberali et al., 2012; Thoma et al., 2015). Therefore, the variability between self-reported preference for an intuitive reasoning style and performance measures of intuitive reasoning style need to be kept in mind. There are, however, other possible explanations. For example, it could be that people who endorse psychosis traits are less accurate at reflecting on their own reasoning style. Indeed, Freeman, Evans and Lister (2014) reported that people with a clinical diagnosis of a psychotic disorder had difficulty identifying and discriminating between the different types of reasoning styles they engage in. To verify this, a group of participants with higher psychosis traits would need to be examined to see whether such findings are specifically related to the expression of psychosis traits. The results in the current study further highlight the need to study both self-report and performance measures of reasoning style.

Considering autism traits and reasoning style, autism traits negatively correlated with self-report intuitive reasoning, but showed no relationship with self-report deliberative reasoning or deliberative responses on the CRT. As a result, such findings are in line with Luke et al. (2012), who found people with ASD had a propensity to refrain from reasoning quickly and disliked having to make decisions rapidly. Further to this, the current finding is in line with Koirikivi (2014), who found that total autism trait scores were negatively related to the intuitive subscale of the REI. Taken together, these associations provide support for the notion that autism traits are associated with less inclination to engage in an intuitive style of reasoning. However, in line with Levin et al.

(2015), no relationship was reported between autism trait scores and self-report deliberative reasoning. Considered with the absence of relationships between autism traits and CRT measures, along with self-report deliberation, the current study does not support the notion that autism trait scores reflect a propensity for a more deliberative style of reasoning (Brosnan, Hollinworth and Antoniadou, 2014; De Martino et al., 2008). Previous studies have presented evidence that people residing on the autism continuum are more likely to have a slower and more effortful style of reasoning (Morsanyi, 2010; Robertson, 2009; see Chapter 2). Given that the current sample was a university-based population, the dispersion of autisms trait scores using the AQ_Short was restricted. From this position, it could be that people need to surpass a certain severity threshold before autism behaviours reflect cognition observed in ASD. In accord with dual process theory, and in order to override an initial intuitive response in favour of a more deliberative and reflective one, a person must have the motivation, cognitive ability (i.e. working memory capacity and general intelligence) and relevant knowledge to engage in deliberative reasoning in the first place (Evans, 2011; Evans & Stanovich, 2011). From this perspective, it could be that increasing degrees of autism traits indicate the willingness to avoid engaging in an intuitive style of reasoning, but not necessarily a drive to engage in a deliberative reasoning style. Given the absence of correlation between REI_INT and REI_DEL, this is a possible explanation. Another possible explanation may reside in the types of answers given in response to the CRT questions. As there was no relationship between intuitive or deliberative responses on the CRT and AQ_Short scores, increasing degrees of autism traits may have reflected participants providing 'other' responses outside of the typical intuitive or deliberative response. As previously discussed, the CRT is not purely ipsative, as answers beyond the typical intuitive and deliberative responses are not typically analysed. Brosnan et al. (2016) highlight that examining erroneous responses may provide useful insights into whether they emerge from intuitive or deliberative reasoning styles. Finally, given the wide heterogeneity in autism traits, it could be that only certain facets of the AQ are associated with deliberative reasoning style. Specifically, higher scores in facets such as 'Attention

Switching' and 'Attention to Detail' would reflect characteristics that may be associated with deliberative reasoning (e.g. being slower, more effortful). One way to address this for next time would be to examine how the subscales of the AQ are associated with measures of intuitive and deliberative reasoning style.

A dominance of psychosis relative to autism traits (PAB score) was able to predict a reasoning profile characteristic of psychotic spectrum disorders. This finding suggests that increasing tendencies towards psychosis relative to autism traits reflect a drive for intuitive reasoning, which is supportive of Crespi and Badcocks' (2008) diametric disorders hypothesis. In addition, such findings support Brosnan et al. (2010), Abu-Akel et al. (2015) and Dinsdale et al. (2013), who advocate that it is the discrepancy between dimensions of mentalising and mechanistic cognition that has implications for wider cognition and behaviour. Indeed, the current study provides support for the proposal that psychosis traits are characterised by hyper-mentalising and reduced mechanistic cognition, whilst the reverse profile is characteristic of autism traits. Further to this, as a significant positive relationship was found between AQ and SPQ_Brief scores, this suggests that participants in the general population are likely to exhibit both autism and psychosis traits concurrently. Thus, a PAB score is crucial as it allows for inferences about the unique effects of psychosis and autism traits on reasoning style to be made after controlling for any statistical overlap with one another.

A few notable limitations of the study need to be discussed. Firstly, no index of IQ or working memory capacity was undertaken, which is a major limitation of the study. Whilst intuitive reasoning is argued to be independent of cognitive abilities, cognitive ability is an attribute that is dependent of deliberative reasoning. Nonetheless, all the participants were undergraduate students at University, so all had the equivalent of A-level qualifications, albeit the grades could be different. The next study will address the assessment of cognitive ability, by measuring both working memory capacity and general intelligence.

Finally, although the CRT is a validated measure of reasoning style, the CRT only has three items and, therefore, has restricted variance. Further to this, the CRT involves an element of mathematical reasoning. Morsanyi, Busdraghi and Primi (2014) found that mathematical anxiety, as assessed through the Abbreviated Maths Anxiety Scale (AMAS) (Hopko et al., 2003), was a significant predictor of cognitive reflection, whereby higher anxiety predicted more intuitive as opposed to deliberative responses. Consequently, the extent to which such anxiety impacted on current CRT performance was unaccounted for in the current study. As a result, it is necessary to test the generalisability of the proposed relation between reasoning style and autism and psychosis traits in other domains of reasoning.

In sum, the present findings are striking for a number of different reasons. Firstly, there is evidence to suggest that both psychosis and autism traits contribute uniquely to different aspects of reasoning style. In particular, both psychosis and autism traits independently reflect tendencies towards and away from intuitive reasoning. If these findings are relevant for dimensional models of psychosis and autism, we could conjecture that the two spectrum disorders are differently related to distinct reasoning profiles. However, even though SPQ_Brief and the AQ_Short were positively, as opposed to negatively, correlated, as the diametric disorders hypothesis would predict, the discrepancy between the two measures was still informative of reasoning style. This suggests that the relative dominance of one dimension to the other may be insightful for predicting reasoning style. Making an allowance for Crespi and Badcocks' (2008) initial claim of psychosis and autism traits being negatively correlated with one another, it may be the case that ASD and positive psychosis spectra are not diametrically opposed to the degree these authors claim, but instead some specific cognitive profiles which are contrastingly affected in individuals with autistic versus psychosis traits. This is a possibility, given previous studies have reported that certain traits do appear to present oppositely in the two spectra, such as perceptual processing (Nettle, 2006; Russell-Smith et al., 2010; Del Guidice et al., 2014). Taken these findings into consideration, even if the ASD and psychosis continua are not contrasting disorders, as Crespi and Badcock

advocate, they may be diametrically opposed with regard to the influence they have on specific characteristics of cognition or other specific traits. The findings from the current study do provide support for the idea that positive psychosis traits reflect a more intuitive style of reasoning, while autism traits are associated with a deviation away from an intuitive reasoning style.

CHAPTER 5: Psychosis and Autism Traits and Their Relationship to Reasoning Styles: Extending the Investigation to Syllogistic Reasoning

Introduction

Since the previous study employed the short measures of psychosis and autism traits, Study 2 aimed to replicate and extend the previous study but with the full versions of the Autistic Quotient (AQ; Baron-Cohen et al., 2001) and the Schizotypal Personality Questionnaire (SPQ; Raine, 1996). This alteration would address some of the limitations of the previous study by allowing the individual subscales of the SPQ and the AQ to be explored to permit a closer examining of the relationship between individual subscales of psychosis and autism traits on reasoning style. Further to this, inclusion of the full versions would allow for an examination of how certain subscales of psychosis or autism traits are associated with one another. In addition, the study included a nonverbal IQ measure as assessed by the Ravens Progressive Matrices (Raven, 1960), along with a working memory capacity measure assessed by the Operational Span Task (Turner & Engle, 1989). In support of the dual process theory, both constructs are thought to relate to deliberative reasoning style by increasing the likelihood of a person's ability to engage in deliberative reasoning (Evans & Stanovich, 2013; see Stanovich, 1999; Toplak, West, & Stanovich, 2011; Unsworth & Engle, 2005). Differences in these abilities may account for some of the results in the previous study, but were not measured. Taking into consideration such constructs will allow for testing the specificity of the relationships between psychosis, autism, psychosis-autism bias score (PAB), and reasoning styles. As discussed in the Discussion section in Chapter 4 Study 1, the previous study was restricted in employing a single performance measure of reasoning style. To further explore patterns of reasoning between autism and psychosis traits, the current study employed another performance-based task that was conjectured to assess intuitive and

deliberative reasoning styles: syllogistic reasoning (see Chapter 2 for review). Prior to outlining the hypotheses and aims of the current study, a review of syllogistic reasoning and its relationship with the continua of psychosis and ASD is outlined below.

As previously discussed in Chapter 2, syllogistic reasoning is an assessment of logical reasoning which involves presenting participants with statements that encompass two premises and a conclusion. The object of the task is for participants to assume the premises are true regardless of their content and deduce whether the conclusion follows logically from the premise. From this perspective, correctly assessing the validity of a syllogism is reflective of a person's ability to engage in a reasoning manner that is normatively logical (i.e. following formal rules of logic as opposed to reasoning based on beliefs and existing knowledge). As discussed, people who have a more intuitive reasoning style are likely to be less accurate and more like to correctly solve syllogisms when there is a conflict between belief and logic. Indeed, belief bias responding is typically found across various general population samples (Roberts & Sykes, 2003; Shynkaruk & Thompson, 2006; Evans, Handley, & Harper, 2001), but whether such patterns of responding are exaggerated or reduced in relation to psychosis and autism traits has yet to be reported. As far as I am aware, few studies have reported investigating how autism or psychosis traits are specifically associated with syllogistic reasoning performance. Nonetheless, there is a small body of evidence that has examined overall syllogistic reasoning performance across clinical populations of psychosis and ASD, which may shed light on prospective relationships between psychosis and autism traits.

When compared to match Control groups, people with a psychotic disorder are known to exhibit worse reasoning performance when completing syllogisms (Mujica-Parodi et al., 2000; Williams, 1964; Goel et al., 2004; Corcoran, 2003). However, the evidence for this pattern of performance is mixed, with some studies revealing little to no differences in performance when IQ has been controlled for. For example, Mirian et al. (2011) found that there were no differences in accuracy when assessing syllogisms between a group of patients with schizophrenia and a healthy Control group, after

general intelligence had been controlled for. Mirian et al. suggested that, when people with psychotic disorders make mistakes in judging the validity of logical statements, they do so as a result of lower levels of general intelligence, as opposed to an explicit impairment in reasoning. This finding has recently been confirmed by Revsbech et al. (2015) in a similar study, whereby the authors observed there were no significant differences in overall accuracy performance on a syllogism task between participants with schizophrenia and matched controls on a deductive reasoning task once general intelligence had been controlled for. Nonetheless, such studies have relied on single performance scores (total number of correct responses) as opposed to focusing specifically on whether psychosis is associated with belief bias responding per se. Consequently, this suggests that, although people with psychosis may be less competent overall at logical reasoning in comparison to a Control group, the underlying mechanisms behind this deficit have yet to be comprehensively investigated. Speechley et al. (2012) constructed syllogisms such that the believability of the conclusion either conflicted or supported the logical validity of the whole statement (congruent versus incongruent, respectively). In support of previous research studies (Mujica-Parodi et al., 2000; Goel et al., 2004; Corcoran, 2003), Speechley and colleagues found that the group of participants with schizophrenia did perform significantly worse overall in comparison to the Control group when calculating a total accuracy score. However, patients with schizophrenia were significantly less accurate at solving syllogisms when there was a conflict between believability and logical validity in the syllogism (incongruent), whereby participants made more erroneous judgements based on the belief-bias effect, which is suggestive of an over-reliance on an intuitive reasoning style. These findings are suggestive of people on the psychosis continuum, further exhibiting a more intuitive style of reasoning when presented with syllogisms.

Moving forward then, given the preliminary evidence that people residing on the psychosis continuum may display an exaggerated tendency towards belief bias responding, based on the findings from Study 1 in Chapter 4, and consistent with both an independent and diametric model of ASD and psychosis, it can be expected that

autism traits may be negatively predictive of belief bias responding. Nonetheless, research that has specifically examined this hypothesis has remained sparse. As reviewed in Chapter 2, previous studies using clinical samples of ASD have demonstrated that, when participants with ASD reason about problems, they are less likely to take into account relevant contextual information (De Martino et al., 2008; Morsanyi et al., 2010; Pijnacker et al., 2009; McKenzie et al., 2011). For example, Morsanyi, Handley and Evans (2010) reported how people with ASD were less susceptible to the conjunction fallacy in comparison to a matched Control group. The conjunction fallacy is a formal reasoning error that occurs when it is assumed that specific conditions are more probable than a single general one. The ability to refrain from such a fallacy requires one to avoid relying on prior beliefs and experiences, thus adopting a more 'de-contextualised' pattern of responding. The findings from Morsanyi et al. proposed the idea that ASD is associated with a more deliberative, as opposed to an intuitive, style of reasoning when completing syllogisms.

Turning to the relationship between psychosis and autism traits, Study 1 in Chapter 4 found that psychosis and autism traits positively correlated with one another. Despite this positive relationship, the discrepancy between the two scores, as measured by computing a PAB score, still shed light on reasoning style. More specifically, these findings supported the idea that the discrepancy between psychosis traits relative to autism traits was associated with a more intuitive, but not deliberative, style of reasoning. Together, these findings suggest that the relationship between psychosis and autism traits may have implications for reasoning style and is, therefore, worthy of further investigation using the full version of the measures. Based on the findings from Study 1 and the research findings outlined in the current chapter, the aims and hypotheses of the current study are presented below.

Aims and hypotheses

1) To test the relationship of autism and psychosis traits with reasoning using the CRT and REI, along with fuller versions of positive psychosis and autism trait measures and their subscales.

2) To explore whether autism and psychosis traits would show associations with a further measure of reasoning, syllogism accuracy.

3) To test if the relationships between such traits and reasoning style are specific to measures of autism and psychosis traits, or are related to more general cognitive abilities such as NVIQ and working memory capacity scores.

The hypotheses for the aforementioned aims were as follows:

1a) It was expected that total psychosis trait score would be positively associated with intuitive responses on the CRT and REI, and negatively associated with deliberative responses on the CRT and REI. It was further predicted that the 'Suspiciousness' and 'Ideas of Reference' subscales of the SPQ_POS would be positively associated with intuitive responses on the CRT and REI, and negatively associated with deliberative responses on the CRT and REI.

1b) Using the full version of the AQ, it was expected that total autism trait scores would be positively associated with deliberative responses on the CRT and REI and negatively associated with intuitive responses on the CRT and REI. It was further predicted that the 'Attention to Detail' subscale and the 'Attention Switching' subscales would be significant positive predictors of deliberative responses on the CRT and REI, and negatively associated with intuitive responses on the CRT and REI.

1c) It was predicted that PAB score would be significantly associated with intuitive responses on the CRT and REI, and negatively associated with deliberative responses on the CRT.

2a) Given that enhanced accuracy for incongruent syllogisms has been shown to be related to a deliberative style of reasoning (e.g. Toplak et al., 2011), it was hypothesised that accuracy for incongruent syllogisms (i.e. avoiding belief bias responding) would be negatively associated with psychosis traits. For the same reasons, it was expected that performance on congruent syllogisms would not be related to reasoning style, cognitive ability, or psychosis traits, as the intuitive belief-based response would be consistent with logical considerations (Stanovich & West, 2000).

2b) In line with the aforementioned evidence, AQ traits would be positively associated with incongruent syllogism accuracy.

2c) PAB scores would be negatively associated with incongruent syllogism accuracy, but would not be significantly related to congruent syllogisms.

3a) Consistent with the findings from Study 1, it was expected that the total scores of psychosis and autism traits would be positively associated with one another. No predictions were made as to whether any certain facets of the SPQ_POS will be related to specific facets of the AQ.

3b) It was predicted that the relationships between psychosis traits, autism traits and the PAB and reasoning style would all hold after controlling for individual differences in NVIQ and WMC.

Method

Participants

A convenient sample of 95 undergraduate students (43M/42F; mean age = 21.0, s.d. = 4.01) aged 18-31 years old recruited from the University of Bath. All participants were native English speakers. No participants reported ever receiving a diagnosis of a psychiatric condition. Participants were rewarded with course credits for their participation (N = 42) or received £5.00 for their participation. The research was approved by the Psychology Departmental Research Ethics Committee at the University of Bath, which implements the ethical guidelines of the British Psychological Society.

Measures of Autism and Psychosis Traits

Autism traits

Autism traits were assessed using the original full version of the Autism Quotient (AQ; Baron-Cohen et al., 2001). The AQ in the present study had satisfactory consistency, as determined by a Cronbach's alpha of .89 (Woodbury-Smith et al., 2005). For information on administration, scoring and items included in the AQ, see Chapter 3.

Psychosis Traits

Positive psychosis traits were assessed using the positive dimension of the full version of the Schizotypal Personality Questionnaire (SPQ_POS; Raine, 1996). The SPQ_POS positive subscale in the present study had a high level of internal consistency, as determined by a Cronbach's alpha of .76 (Wuthrich & Bates, 2005). For information on administration, scoring and items included in the SPQ_POS, see Chapter 3.

Composite Measure

The Psychosis-Autism Bias (PAB Score)

Parallel to the previous study, the PAB was calculated in the same manner as Study 1, but using the full as opposed to short versions of the AQ and SPQ_POS.

Measures of Reasoning Style

Cognitive Reflective Test

As described in Study 1, the Cognitive Reflection Test (CRT; Frederick, 2005) was used as a performance measure of reasoning style. In the current sample, a Cronbach's alpha was slighter higher, attaining a score of .59, which is considered to reflect modest reliability.

Rational Experiential Inventory

As described in Study 1, the Rational Experiential Inventory (REI; Pacci & Epstein, 1999) was used as a self-report measure of reasoning. In the current sample, in the present study, the Cronbach's alpha for both scales was slightly higher, with the intuitive scale being .88, while the deliberative scale was .79

Syllogistic Reasoning Task

Eight syllogistic reasoning problems were extracted from Kokis, Macpherson, Toplak, West, and Stanovich (2002). The task with these syllogisms was to assess whether they are logically valid or invalid. With four of the problems, the correct answer was consistent with real world validity; that is, such problems were considered 'congruent' (e.g. All birds have feathers. Robins are birds. Robins have feathers). With the remaining four problems, the correct answer was inconsistent with real world knowledge, namely incongruent (e.g. All mammals walk. Whales are mammals. Whales walk). Problems could be further broken down into: invalid-believable, valid-unbelievable, invalid-unbelievable, and valid-believable. Participants performed four practice problems (one of each). Participants then completed the eight problems. Responses were coded 1 for

correct (indicating a deliberative, logically valid answer) and 0 for incorrect. Independent scores were calculated for 'Congruent' and 'Incongruent' syllogisms, while scores could range 0-4 with higher scores representing superior deductive reasoning ability. Cronbach's α for this eight-item measure in the current study was satisfactory at .79.

Control Measure

The Barrett Impulsivity Scale

As described in Study 1, The Barrett Impulsivity Scale (BIS-11; Patton et al., 1995) was used to index impulsivity personality traits. The Cronbach alpha for this measure in the current sample was similar to Study 1, attaining a score of .77.

Measures of Cognitive Ability

Working Memory Capacity (WMC)

The OSPAN task was run using E-Prime software in the Psychology Laboratories at the University of Bath. The OSPAN task requires participants to confirm the truth of math operations while trying to remember a set of unrelated and random letters. When a participant starts the task, they are first presented with an elementary mathematical problem and are required to validate whether the maths problem is true or false (e.g. 5 + 5 = 10?). Subsequently, participants are presented with a random letter (e.g. 'H') that they are expected to remember and recall later. Participants are then presented with a further maths problem and another letter. The math-letter pairings are presented in sets of two to seven items. Afterwards, participants are expected to recall the letters in the order they were presented. The overall OSPAN score was the sum of all recalled letters from sets, in which all letters were recalled in the correct order, ranging from 0 to 75 (OSPAN). Increasing scores on this measure are reflective of higher working memory capacity.

Nonverbal IQ (NVIQ)

The Ravens Progressive Matrices was employed as a measure of nonverbal intelligence. Participants are presented with 60 items. Each item consists of a 3 × 3 matrix of geometric patterns with the bottom right pattern missing. The participants' task is to select the option that correctly completes the matrix. For the first 25 items, there are four patterns to choose from, the remaining 35 items consisting of eight patterns to choose from. Items are divided up into sets of 12 items (A-E). Although the scores can be converted into IQ scores using published norms (Raven, 2000), for simplicity and relevance, raw scores are simply used and could, therefore, vary from 0 to 60. Previous published studies that claim to assess general intelligence have tended to rely on individual raw scores on the RPM (Kumari & Corr, 1998; Moutafi, Furnham, & Tsaousis, 2005). Participants receive a '1' for selecting the correct piece and a score of '0' for selecting the incorrect piece. Questions increase in difficulty as the participants progress. Cronbach coefficients alpha have been reported to be in the range of .88 to .93 (Savage-McGlynn, 2012). In the current study, a Cronbach alpha indicated a score of .85.

Procedure

All testing was untaken in a Laboratory based setting located in the Psychology Department at the University of Bath. When participants arrived they were greeted and provided with an information sheet that they were encouraged to read through, before giving written consent. Once consent had been obtained, they were escorted to an independent cubicle where they were presented with a Desktop PC running Microsoft Windows. All desktop terminals were calibrated to depict the same visual settings, screen resolutions were all adjusted to the recommend screen resolution settings (1680 X 1050). Participants were then presented with either the Operational Span Task that was run off of E-prime 2.0 software or a selection of questionnaires and reasoning tasks that were hosted on the Bristol Online Survey. All measurements were randomised in order to prevent order effects.

Once all tasks and questionnaires were completed participants were thanked and debriefed using a debriefing sheet. Participants either received course credit or £5.00 GBP. The study lasted approximately 70-75 minutes.

Data preparation and analysis

All data was collected and imported to SPSS. Initial screening and cleaning of the data has been described in Study 1 and will not be repeated here. In the first stage of the analysis, descriptive statistics were calculated for all variables. Bivariate correlations were conducted to investigate relationships between the dependent variables of reasoning style. Separate bivariate correlation was conducted to explore the relationship between total SPQ_POS and AQ scores and their respective subscales.

Simultaneous linear multiple regression analyses were then conducted to further determine how measures of psychosis, autism, and the Psychosis-Autism Bias related to different styles of reasoning. Measures of working memory capacity and non-verbal intelligence were also added into the models to verify that such findings held when controlling for individual differences in cognitive ability.

Separate regression analyses were conducted for each subscale of the AQ and the SPQ_POS to see whether any specific facet of either measure was more strongly related to reasoning style than total scores of autism and psychosis trait measures.

Results

Table 5.0 highlights the means, standard deviations, effect sizes, and significant test values for all variables under investigation for the entire sample. A series of independent sample t-tests were conducted using gender as the independent variable to test for gender differences across the variables under investigation. As illustrated in Table 5.0, there were no significant gender differences amongst any of the measures used throughout the current study (all $p > .05$). As expected, within groups, analyses showed that participants were significantly less accurate at determining the validity of incongruent compared to congruent syllogisms (see Figure 1).

Correlations among the dependent variables are presented in Table 5.1. Comparable to Study 1, a correlational analysis was carried out to examine the relationships between all measures of reasoning style for the entire sample. Such correlational analysis allowed an examination of whether accuracy for congruent and incongruent syllogistic reasoning tasks were associated with self-report and other performance-based measures of reasoning style. Due to the number of correlations conducted (15), Bonferroni-corrected significance levels were employed and alpha set at $p = .003$ (i.e. .05/15).

As demonstrated in Table 5.1, CRT_INT was negatively associated with CRT_DEL. CRT_INT was negatively correlated with incongruent accuracy scores and positively correlated with congruent accuracy scores. Lastly, CRT_DEL was positively correlated with incongruent accuracy scores and positively correlated with congruent accuracy scores. Congruent syllogisms scores were positively correlated with incongruent syllogism scores. Age and impulsivity scores were found to be unrelated to all measures of reasoning style (all $p > .05$).

Table 5.0

Means, standard deviations (SD), t-values and effect sizes of measures used in Study 2 (N = 95)

Measure	Total sample (N = 95)	Males (N = 42)	Females (N = 53)	t-value	Cohens D
AGE	21.00 *(4.01)*	21.14 *(3.97)*	20.21 *(3.02)*	.031	.26
AQ	20.00 *(11.53)*	18.60 *(11.59)*	14.35 *(9.44)*	-.344	.40
SPQ_POS	11.12 *(6.58)*	10.19 *(7.95)*	11.88 *(8.75)*	-.830	-.20
PAB	.00*(.94)*	.03 *(.87)*	-.02 *(1.00)*	.255	.05
REI_INT	3.20 *(.62)*	3.15 *(.70)*	3.23 *(.56)*	-.620	.12
REI_DEL	3.51 *(.61)*	3.60 *(.53)*	3.44 *(.66)*	1.30	.26
CRT_ INT	1.35*(1.09)*	1.42 *(1.10)*	1.29 *(1.09)*	.578	.11
CRT_DEL	1.53*(1.17)*	1.62 *(1.18)*	1.32 *(1.12)*	-.818	.26
CONG	3.81 *(.96)*	2.95 *(.92)*	2.88 *(1.00)*	.345	.07
INCONG	1.62 *(1.62)*	1.63 *(1.59)*	1.62 *(1.66)*	.391	.00
IMPULS	63.46 *(11.06)*	64.05 *(8.89)*	62.98 *(12.60)*	-1.06	.09
WMC	45.58 *(13.94)*	44.16 *(14.93)*	44.94 *(13.22)*	-.270	.05
NVIQ	45.51 *(4.24)*	45.02 *(6.77)*	45.46 *(4.06)*	-.390	.07

Note: AQ = Autism Quotient Score; SPQ_POS = Positive psychosis trait Score; PAB = Psychosis-Autism Bias; REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogisms; IMPULS = Barratt Impulsivity Score; WMC = OSPAN Score; NVIQ = Raven Score

Table 5.1

Bivariate correlations for dependent variables assessing reasoning style (N = 95)

	REI_DEL	CRT-INT	CRT_DEL	CONG	INCONG
REI_INT	-.37	.23	-.20	-.18	-.24
REI_DEL		-.28	.26	.20	.29
CRT_INT			-.95*	.48*	-.52*
CRT_DEL				.48*	.52*
CONG					.59*

Note. REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogism. * p <.003

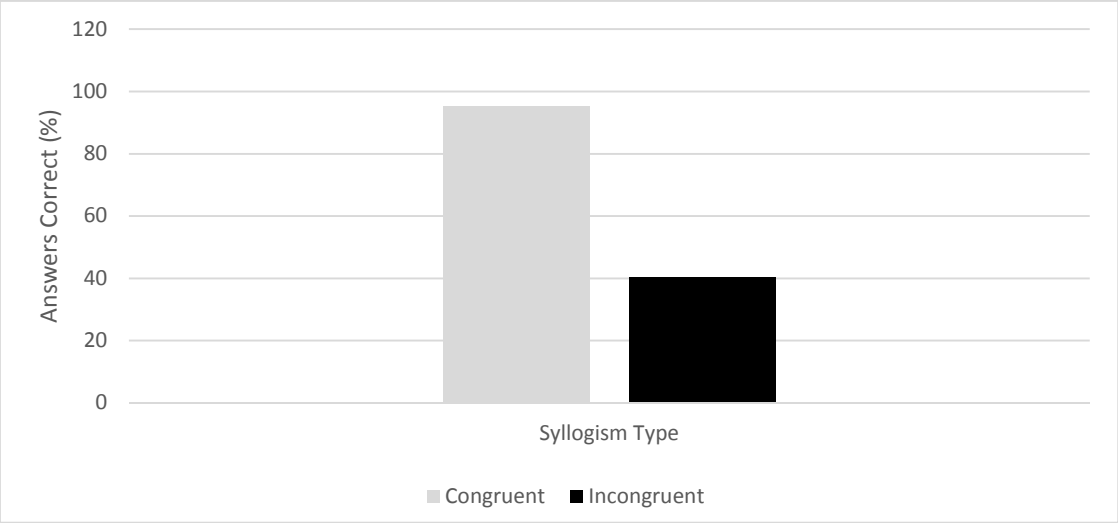


Figure 1: The mean percentage of correct responses for the entire participant sample (n = 95) when assessing the logical validity of syllogisms, in which the premises conflicted with everyday knowledge (i.e. incongruent) or did not conflict with everyday knowledge (i.e. congruent). Note. *** p < .001

In order to test the relationship between AQ and SPQ_POS, a zero-order Pearson correlation was employed and revealed a moderate but positively significant association between total SPQ_POS and AQ scores (r = .48, *p* <.001; see Figure 2). This is consistent with the findings from Study 1 in Chapter 4, and further supports an overlapping relationship between the autism and psychosis continua. In order to explore this relationship further, the relationships between the AQ and the positive SPQ_POS subscales were examined. Pearson product-moment correlation coefficients were calculated. Preliminary analyses showed that assumptions of normality, linearity and homoscedasticity were met. Due to the large number of correlations computed, the alpha level was set conservatively at 0.001 for all analyses in order to minimise Type I error and reduce the likelihood of reporting statistically significant, but inconsequential, relationships. Table 5.2 shows the correlation matrix for these results.

As can been seen in Table 5.2, scores on the subscales of the positive dimension of the SPQ_POS were found to be positively associated with some of the subscales of the AQ. Specifically, the Communication, Social Skills and Imagination facets of the AQ were found to be related to the facets of positive psychosis. However, the Attention to Detail and Attention Switching subscales were not significantly associated with any of the facets of positive psychosis traits.

Table 5.2

Correlations between subscales of the SPQ_POS and AQ

	SPQ_POS_MT	SPQ_POS_SUS	SPQ_POS-IoR	SPQ_POS_Un	AQ_Comm	AQ_SS	AQ_ATD	AQ_AS	
SPQ_POS_MT	-								
SPQ_POS_SUS	.30	-							
SPQ_POS-IoR	.39*	.67*	-						
SPQ_POS_Un	.61*	.53*	.57*	-					
AQ_Comm	.19	.36*	.27	.37*	-				
AQ_SS	.11	.45*	17	.28	.79*	-			
AQ_ATD	.05	.21	.10	.24	.47*	.35*	-		
AQ_AS	.00	.26	.08	.17	.47*	.76*	.24	-	
AQ_IMA	.12	.35*	.20*	.27	.69*	.61*	.46*	.61*	-

Note. SPQ_POS_MT = Magical Thinking; SPQ_POS_SUS = Suspiciousness; SPQ_POS_IoR = Ideas of Reference; SPQ_POS_Un = Unusual Experiences; AQ_Comm = Communication; AQ_SS = Social Skills; AQ_ATD = Attention to Detail; AQ_AS = Attention Switching; AQ_IMA = Imagination. ** = p <.001*

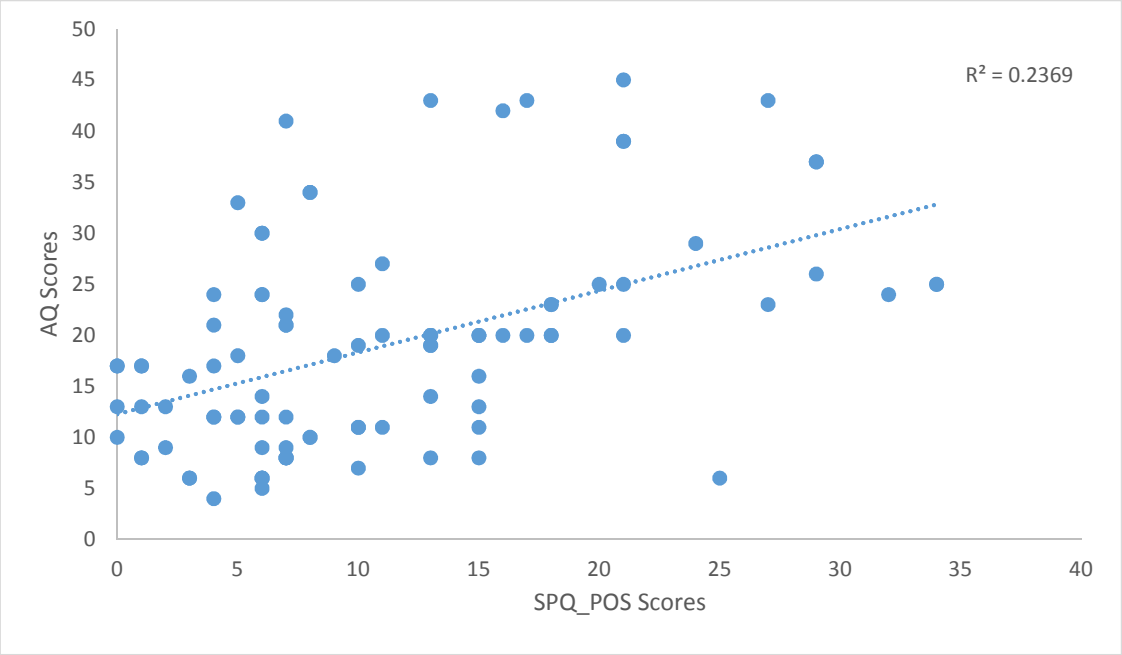


Figure 2. A scatter plot depicting the association between the Autism Spectrum Quotient (AQ) scores and the scores on the Positive scale of the Schizotypal Personality Questionnaire (SPQ_POS).

Reasoning Style and Psychosis and Autism

Regression Analysis

A series of multiple linear regression analyses were conducted to further explore the relationships between psychosis, autism, the PAB and reasoning style. For each of the regression analyses, the SPQ_POS and AQ were entered as the first predictors, followed by both WMC and NVIQ. These variables were added to confirm that any significant relationships observed between the predictors and dependent variables were not mediated by degrees of cognitive ability. As neither of the impulsivity scores showed any association with self-report or performance measures of reasoning, and there was no age or gender effects, the independent variables here were confined to SPQ_POS and the AQ. Parallel to Study 1 in Chapter 4, and to test the relationship between the PAB and reasoning style, the above analysis was re-run, but replacing the AQ and SPQ_POS as predictors for the PAB in isolation.

Psychosis and Autism Traits as Predictors of Reasoning Style

As presented in Table 5.3, the AQ score was a significant negative predictor of CRT_INT, although SPQ_POS was not. The relationship between AQ and CRT_INT remained significant when it was simultaneously entered with WMC and NVIQ, which, in turn, were not significant predictors of CRT_INT. The AQ score was also a positive and significant predictor of CRT_DEL, although SPQ_POS was not. The association between AQ and CRT_DEL held when it was simultaneously entered with WMC and NVIQ. Both WMC and NVIQ were positive predictors of CRT_DEL.

The AQ score was a negative significant predictor of REI_INT, but SPQ_POS was not. The relationship between AQ and REI_INT held when it was simultaneously entered with WMC and NVIQ. WMC and NVIQ were non-significant predictors of REI_INT (both $p > .05$). The AQ score was a significant positive predictor of REI_DEL, although SPQ_POS was not. The relationship between AQ and REI_DEL held when it was simultaneously entered with WMC and NVIQ. WMC was not a significant predictor of REI_DEL, but NVIQ was.

AQ was a significant positive predictor of incongruent syllogistic reasoning score along with SPQ_POS. The relationship between AQ and SPQ_POS scores on incongruent reasoning held when it was simultaneously entered with WMC and NVIQ. Both AQ and SPQ_POS remained significant predictors. WMC was not a significant predictor ($p > .05$), but NVIQ was.

Psychosis-Autism Bias scores as predictor of reasoning style

As presented in Table 5.4, the PAB was unable to predict the performance measure of reasoning style using the CRT. However, the PAB was a positive predictor of self-report intuitive reasoning. The relationship between PAB and scores on REI_INT held when it was simultaneously entered with WMC and NVIQ. The PAB in isolation, and when the PAB was included in the same model as WMC and NVIQ, were all non-significant predictors of congruent scores (both $p > .05$). Table 5.4 also reveals how the PAB was a significant negative predictor of incongruent reasoning score. The relationship between PAB and scores on incongruent reasoning held when it was simultaneously entered with WMC and NVIQ. NVIQ was a significant positive predictor of incongruent reasoning, but WMC was not ($p > .05$).

Table 5.3

SPQ_POS and AQ scores as predictors of measures of reasoning style (N=95)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	SPQ_POS	.008	.014	.05
	AQ	-.04	.012	**-.38**
Model 2	SPQ_POS	-.005	.015	-.03
	AQ	-.037	.012	**-.35**
	WMC	.014	.008	.17
	NVIQ	-.039	.021	-.19
CRT_DEL				
Model 1	SPQ_POS	-.014	.016	-10
	AQ	.042	.010	**.46**
Model 2	SPQ_POS	.004	.016	.03
	AQ	.037	.012	**.33**
	WMC	-.016	.008	.19
	NVIQ	.062	.022	**.29**
REI_INT				
Model 1	SPQ_POS	.012	.007	.16
	AQ	-.40	.006	**-.67**
Model 2	SPQ_POS	.006	.007	.08
	AQ	-.039	.006	**-.65**
	WMC	.005	.004	.10
	NVIQ	-.020	.010	-.17
REI_DEL				
Model 1	SPQ_POS	-.007	.008	-.09
	AQ	.023	.006	**.39**
Model 2	SPQ_POS	.005	.008	.06
	AQ	.019	.006	**.33**
	WMC	-.002	.004	-.03
	NVIQ	.045	.011	**.39**
Incongruent				
Model 1	SPQ_POS	-.038	.012	**-.33**
	AQ	.042	.010	**.46**
Model 2	SPQ_POS	-.028	.013	**-.25**
	AQ	.039	.010	**.42**
	WMC	.002	.007	.03
	NVIQ	.041	.018	**.23**

Table 5.4

Regression Models for Reasoning Style using PAB score as Predictor (N = 95)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	PAB	.164	.119	.14
Model 2	PAB	.111	.123	.09
	WMC	.010	.008	.12
	NVIQ	-.030	.022	-.15
CRT_DEL				
Model 1	PAB	-.202	.127	-.16
Model 2	PAB	-.144	.129	-.09
	WMC	-.012	.008	-.14
	NVIQ	.053	.023	**.24**
REI_INT				
Model 1	PAB	.174	.066	**.26**
Model 2	PAB	.151	.069	**.22**
	WMC	.002	.005	.03
	NVIQ	-.014	.012	-.12
REI_DEL				
Model 1	PAB	-.089	.067	-.13
Model 2	PAB	-.030	.065	-.04
	WMC	.000	.004	.01
	NVIQ	.040	.011	**.35**
Incongruent				
Model 1	PAB	-.423	.096	**-.41**
Model 2	PAB	-.374	.098	**-.36**
	WMC	.004	.006	.06
	NVIQ	.036	.017	**.20**

Note. Bold indicates $p < .05$

Reasoning Style and Subscales of Psychosis and Autism Traits

Regression analyses was carried out to assess whether there were any significant associations between certain subscales of the SPQ_POS and AQ and measures of reasoning style. Parallel to previous regression analyses, all subscales for both the SPQ_POS and AQ were entered simultaneously.

Table 5.5 shows that the SPQ_POS_IoR was a significant and positive predictor of intuitive responses on the CRT, but SPQ_POS_Un was a significant negative predictor of intuitive responses on the CRT. The remaining facets of the SPQ_POS revealed no relationship with intuitive responses on the CRT (all $p > .05$). AQ_AS was a significant positive predictor of intuitive responses on the CRT, but AQ_Comm score was a negative significant predictor of intuitive responses on the CRT. The remaining facets of the AQ were unrelated to intuitive responses on the CRT. Table 5.5 further yielded that all facets of the SPQ_POS were significant negative predictors of deliberative responses on the CRT (all $p < .05$). However, it was the SPQ_POS_Un that was a positive predictor of deliberative responses on the CRT. Only AQ_Comm was a positive predictor of deliberative responses on the CRT, while AQ_AS was a negative predictor of deliberative responses on the CRT. The remaining facets of the AQ were unrelated to deliberative responses on the CRT. Turning to self-report measures, no individual facet of the SPQ_POS or AQ was associated with self-report intuitive reasoning style. However, AQ_ATD was a significant positive predictor of self-report deliberative reasoning. The remaining facets of both the SPQ_POS and AQ were unrelated to reasoning style (all $p > .05$). The findings outlined in Table 5.5 did not change significantly when WMC and NVIQ were added to the model.

Table 5.5

Regression Models of Reasoning Style using subscales of the SPQ_POS and AQ (N = 95)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	SPQ_POS_IoR	.148	.062	**.33**
	SPQ_POS_MT	.119	.081	.17
	SPQ_POS_UN	-.189	.071	**-.37**
	SPQ_POS_SuS	.038	.069	.08
	AQ_ATD	.053	.047	.12
	AQ_AS	.148	.065	**.35**
	AQ_SS	-.058	.060	-.18
	AQ_COMM	-.192	.070	**-.52**
	AQ_IMA	-.034	.059	-.08
CRT_DEL				
Model 1	SPQ_POS_IoR	-.127	.066	**-.27**
	SPQ_POS_MT	-.180	.087	**-.24**
	SPQ_POS_UN	.194	.076	**.35**
	SPQ_POS_SuS	-.065	.074	**-.12**
	AQ_ATD	-.054	.051	-.11
	AQ_AS	-.197	.070	**-.44**
	AQ_SS	.101	.065	.29
	AQ_COMM	.198	.075	**.50**
	AQ_IMA	.019	.063	**.04**
REI_INT				
Model 1	SPQ_POS_IoR	.032	.036	.12
	SPQ_POS_MT	-.047	.047	-.11
	SPQ_POS_UN	.052	.041	.17
	SPQ_POS_SuS	-.021	.040	-.07
	AQ_ATD	.011	.027	.04
	AQ_AS	-.012	.038	-.05
	AQ_SS	-.055	.035	-.29
	AQ_COMM	-.042	.040	-.19
	AQ_IMA	-.012	.034	-.04
REI_DEL				
Model 1	SPQ_POS_IoR	-.035	.036	-.14
	SPQ_POS_MT	-.071	.048	-.18
	SPQ_POS_UN	.049	.042	.17
	SPQ_POS_SuS	-.017	.041	-.06
	AQ_ATD	.063	.028	**.26**
	AQ_AS	-.068	.038	**-.29**
	AQ_SS	.042	.035	.23
	AQ_COMM	.030	.041	.14
	AQ_IMA	.015	.035	.06

Note. Bold indicates $p < .05$

SPQ_POS_MT was a significant negative predictor of INCONG score. Nonetheless, the remaining facets of the SPQ_POS were unrelated to INCONG scores (all $p > .05$). Finally, only AQ_Comm positively predicted INCONG scores. The findings did not change when NVIQ and WMC were included in the model.

Table 5.6

Regression Models of Syllogistic reasoning using subscales of the SPQ_POS and AQ (N = 95)

Regression Model	Predictor	B	SE	β
INCONG				
Model 1	SPQ_POS_IoR	-.050	.054	-.12
	SPQ_POS_MT	-.193	.071	**-.32**
	SPQ_POS_UN	-.041	.062	-.09
	SPQ_POS_SuS	.000	.060	.01
	AQ_ATD	-.002	.041	-.00
	AQ_AS	-.082	.057	-.22
	AQ_SS	.075	.053	.26
	AQ_COMM	.130	.061	**.40**
	AQ_IMA	.000	.051	-.00

Note. Bold indicates $p < .05$.

Discussion

The purpose of the current study was to test the aims and hypotheses of Study 1 in Chapter 4 using the full versions of the Autism Quotient (AQ; Baron-Cohen et al., 2001) and the positive dimension of the Schizotypal Personality Questionnaire (SPQ_POS; Raine, 1996). Further to this, the current study extended Study 1 by including more general cognitive measures, including nonverbal IQ and WMC, to test the specificity of the relationship between autism and psychosis traits and reasoning style. Lastly, the performance measure of reasoning style was extended to include a syllogistic reasoning task to further examine expressions of intuitive and deliberative reasoning style beyond a single performance measure of reasoning style.

The main findings revealed that autism traits were positively associated with a more deliberative style of reasoning as indexed by increased deliberative responses on the CRT, higher scores on self-report deliberative reasoning, and an increased performance on both congruent and incongruent syllogistic reasoning tasks. Autism traits were found to be negatively associated with intuitive reasoning across both self-report and performance measures of reasoning using the CRT and REI. These findings held when controlling for cognitive ability. Taken together, the findings support the outline hypotheses that autism traits reflect a more deliberative relative to intuitive style of reasoning. Psychosis traits were not positively associated with all measures of intuitive reasoning style, but psychosis traits were found to be were negatively associated with incongruent syllogisms and were unrelated to congruent syllogisms, suggesting that, in the context of syllogistic reasoning, psychosis traits reflected a susceptibility to belief bias responding. Contrary to what was expected, the PAB was unrelated to the majority of reasoning style measures; however, the PAB was found to be negatively associated with incongruent syllogism accuracy.

The relationships between autism traits and reasoning style suggest a profile characteristic of more deliberative relative to an intuitive style of reasoning across the autism continuum. These findings are supportive of, and extend earlier, research

findings by De Marito et al. (2009) and Brosnan, Ashwin and Gamble (2013), whereby the authors observed that people with ASD were found to display a style of reasoning that reflected a more 'deliberative' as opposed to intuitive style of reasoning towards a variety of reasoning tasks. Indeed, such findings held when cognitive ability was controlled for. This suggests that a deliberative style of reasoning was not simply mediated by higher degrees of general intelligence or working memory capacity. Comparable to Study 1 in Chapter 4, the observed relationships between autism traits and CRT performance support Brosnan, Hollinworth, and Antoniadou (2014). Using the CRT as a measure of reasoning style, Brosnan et al. found that participants with ASD provided more deliberative as opposed to intuitive responses, thus conceptualising ASD as being associated with a more deliberative and less intuitive reasoning style. Nevertheless, these data must be interpreted with caution because Study 1 found that the AQ_Short was only negatively related to self-report intuition, whereas the remainder of the relationships observed in the current study were absent. Perhaps the differing results may stem from using the full as opposed to the short versions of the AQ. A particularly insightful finding and was that autism traits were positively associated with syllogistic reasoning performance. More importantly, autism traits were positively associated with incongruent syllogistic reasoning performance. This association suggests that, when existing beliefs conflicted with logic, increasing degrees of autism traits reflected higher scores, suggesting a more deliberative style of reasoning. Indeed, such findings further extend the notion that the ASD continuum may reflect a more deliberative as opposed to intuitive style of reasoning, which extends beyond the CRT and REI.

The current findings are supportive of McKenzie, Evans and Handley (2012). McKenzie et al. observed how, relative to a matched Control group, participants with ASD were less influenced by the context of reasoning statements, thus displaying less susceptibility to the context of incoming information, which is often associated with intuitive reasoning (Evans & Stanovich, 2013). The current findings between the autism personality traits and incongruent reasoning complement this finding, suggesting that

individuals with increasing degrees of autism traits are less likely to contextualise incoming information. Consequently, autism traits may be associated with a more de-contextualised form of reasoning. However, a note of uncertainty is whether increasing degrees of autism traits reflect impaired intuitive mechanisms, whereby such individuals have difficulty contextualising information, or intuitive mechanisms are intact but dominated by deliberative reasoning. This assertion would need to be tested within a clinical group of participants with ASD and a matched Control group to fully explore the issue.

In contrast to Study 1 in Chapter 4, psychosis traits were not associated with intuitive responses on the CRT. Analogous to Study 1, psychosis traits were unrelated to self-report measures of intuitive and deliberative reasoning. Indeed, when looking at the individual subscales of the SPQ_POS, there were no consistent relationships between a single facet of the SPQ_POS and reasoning style measures. This is contrast to Freeman, Evans and Lister (2012), who propose the idea that it was the 'paranoid / suspiciousness' subscale of the SPQ_POS that was more readily related to intuitive reasoning style. Together, the findings provide no evidence for psychosis traits, reflecting a tendency to engage in a more intuitive over deliberative style of reasoning. The discrepancy between Study 1 and the current study may be attributed to the different measures used, although this is unlikely, as the positive subscale of the SPQ_Brief has been found to correlate with the full positive subscale of the SPQ (Compton, Chiien & Bollini, 2007). Perhaps an obvious difference between the findings between the current study and Study 1 resides in the design of the study. For the current study, participants came to the Psychology Laboratories at the University of Bath to complete all measures, as a result of this design, and participants met the researcher. From this viewpoint, it could be that a social desirability bias was accentuated in this particular study design, as opposed to Study 1, whereby all measures were completed online. Indeed, social desirability for the positive dimension of the SPQ has been found to occur, particularly when participants attain high scores on psychosis traits, which may have lowered total SPQ_POS scores in the current study (Abbott & Byrne, 2013; Mealey et al., 2014).

In accordance with the dual process theory, the absence of a relationship between the psychosis traits and CRT performance suggests that endorsing positive psychosis traits does not reflect a more exaggerated form of intuitive reasoning. Instead, it could be argued that endorsing psychosis traits makes someone no less susceptible to exhibiting a more intuitive style of reasoning than someone who endorses little to no psychosis traits. Notwithstanding this, in support of our initial hypothesis, psychosis trait scores were found to be negatively associated with incongruent reasoning scores, thus providing evidence for a more 'belief biased' form of responding, which implies a more intuitive style of reasoning (Denes-Raj & Epstein, 1994; Evans, 2008; Stanovich & West, 2000). The number of psychosis traits did impact on syllogism performance when the content of the syllogism was in conflict with everyday knowledge or beliefs. These findings provide support for belief bias responding, being accentuated in expressions of psychosis traits. From a dual process perspective, this finding suggests that psychosis traits may be explicitly associated with a higher tendency to contextualise all incoming information (Evans, 2011). This may explain why people with clinical levels of psychosis traits have difficulty dismissing their delusional/unusual beliefs, even when presented with evidence to the contrary. In support of Toplak (2011) and Campitelli and Gerrans (2014), however, intuitive responses in the CRT were moderately and negatively correlated with both congruent and incongruent syllogistic reasoning performance. This suggests that both syllogisms and CRT performance measures were potentially examining the same phenomena conceptualised as an intuitive style of reasoning.

The PAB was unrelated to the CRT. Consequently, comparable to Study 1 in Chapter 4, the discrepancy between psychosis and autism traits was unable to predict performance-based intuitive reasoning. However, the PAB was predictive of self-report intuitive reasoning. Nevertheless, the PAB was unrelated to self-report measures of reasoning style. This suggests that the dominance of psychosis relative to autism traits has little value in further predicting reasoning style when using the full measures of the SPQ and AQ. These findings are in contrast to Brosnan et al. (2010) and Abu-Akel et al. (2015), whereby the discrepancy in scores between different indices of hyper-

mentalising and hypo-mentalising were more important at predicting cognition than individual scores. The relationship between the PAB and intuitive reasoning style is thus not clear from the results of these two studies. The disparity in results across the studies was not particularly surprising, though, given that the PAB was only able to explain marginally more variance than the individual scores of SPQ_POS and AQ; this suggests that the PAB did not show the strongest association with reasoning behaviour due to the limited amount of variance it could explain. However, since these two studies used different versions of psychosis and autism traits, but the same reasoning measures to assess reasoning style, it is possible to propose that the PAB is only informative when the short as opposed to the long versions of the SPQ_POS and AQ were used.

Finally, the PAB was able to predict incongruent syllogistic reasoning performance. This relationship held when measures of cognitive ability and control variables were added to the model. This finding suggests that a dominance of psychosis relative to autism traits may imply an over-reliance on intuitive reasoning within certain reasoning contexts. As there was no relationship between the PAB and congruent reasoning, this further suggests that the PAB was not simply a reflection of worse logical reasoning or a general reasoning deficit per se. These findings are in line with previous research findings (Abu-Akel et al., 2015; Dinsdale et al., 2013; Del Guidice et al., 2014; Brosnan, Ashwin & Gamble, 2013), whereby the discrepancy between measures of psychosis and autism predicts opposing cognition, thus providing support for the diametric disorders hypothesis. However, given the correlations between incongruent reasoning scores and CRT_INT scores, it is difficult to explain why the PAB was unrelated to the CRT_INT but predictive of incongruent reasoning. It could be that PAB scores are sensitive to the context of the reasoning task.

With regards to the relationship between psychosis and autism traits, total autism trait scores were positively related to total psychosis trait scores. This is consistent with Study 1 and shows an overlapping relationship between psychosis and ASD. The current positive relationship between autism and psychosis traits is fitting with clinical observations, whereby people with a diagnosis of a psychotic disorder have been

reported to endorse significantly higher scores on autism trait measures in contrast to Control groups (Esterberg et al., 2008; Lugnegård, Hallerbäck, & Gillberg, 2010; Matsuo et al., 2015). Moreover, such relationships provide no support for Spek and Wouters' (2010) claim, in that discriminating between autism and psychosis can be established by the assessment of the presence of positive psychosis traits. However, the subscales of both the SPQ_POS and AQ were not all significantly correlated with each other. This suggests that, although total psychosis and autism trait scores may demonstrate a positive relationship with one another, there are some subscales related to psychosis traits that are independent from autism traits. For example, Attention to Detail and Attention Switching were two subscales of the AQ that were not significantly related to all subscales of the SPQ_POS. This may suggest a point of demarcation between the two continua.

Overall, the positive relationship between total psychosis traits and autism trait scores supports previous research studies (Hurst et al., 2007; Tordjman, 2008; Rawlings & Locarnini, 2008; Kanai et al., 2011) that propose autism and psychosis exist on a single overlapping continuum. However, despite the positive relationship between autism and psychosis, they were still differentially related to measures of reasoning style. This suggests that there must be some differences in terms of relation or variation between the measures that impact on reasoning style. On the other hand, there are alternative explanations that may account for the positive relationship between psychosis and autism traits. Firstly, the SPQ_POS may not be subtle enough to differentiate between psychosis and autism traits. As stated in the discussion section of Study 1, this may stem from the wording of the items in the questionnaire. In relationship to the diametric disorders hypothesis, it could simply be that hyper/hypo-mentalising and mechanistic cognition are not captured by positive psychosis or autism traits using the SPQ_POS and AQ. Secondly, the positive correlation between the AQ and SPQ_POS could be a product of using a non-clinical population. As suggested by Nylander, Lugnegård and Hallerbäck (2008), perhaps the boundaries between autism and psychosis become increasingly unclear as the expression of these disorders becomes weaker. The mean group score of

the SPQ_POS in the current study was considerably lower than previous studies using non-clinical populations of a similar sample size (Mealey, Abbott, Byrne, & McGillivray, 2014; Van't Wout et al., 2004). In order to confirm this supposition, such measures should be applied to people who reside further along the psychosis and ASD continua.

In line with the final hypothesis (3b), the relationships between psychosis traits, autism traits, and the PAB with reasoning style all held after controlling for individual differences in NVIQ and WMC. In regard to the dual process theory, NVIQ and WMC are considered to positively related to deliberative but not intuitive reasoning style (Newstead et al., 2004; Stanovich & West, 1999, 2000). The fact that such relationships held after controlling for measures of cognitive ability further supports the proposal that psychosis and autism traits may be related to dual process variables specifically, rather than individual differences in cognitive ability.

A number of limitations of the current study must be acknowledged. Firstly, this was a student sample at one university in the UK, so may not be representative of the general population and not easily relatable to samples in other studies. Secondly, as discussed earlier, the mean scores on the SPQ_POS measure were lower in contrast to previous studies, suggesting that the present sample reflected the lower end of the psychosis continuum. Therefore, matching the limitation of Study 1 in Chapter 4, our current sample was not representative of people residing on the upper end of the psychosis continuum. It could, therefore, be that psychosis traits do impinge on reasoning style, but the restricted dispersion in scores on the SPQ_POS did not allow for any significant associations to be identified. The implications for these findings could have impacted on why the PAB was unable to predict reasoning style for many of the reasoning style measures.

The present findings suggest a number of avenues for future research. Firstly, despite initial findings from Study 1 and earlier research findings outlined in the literature review in Chapter 2, there was some evidence to suggest that psychosis traits predict an over-reliance on intuitive reasoning or an under-reliance on deliberative

reasoning. Collectively, this finding is supportive of Abu-Akel et al. (2015), who proposed that the association between psychosis traits and cognition is a 'dose-dependent' relationship, suggesting that certain expressions of psychosis traits (i.e. higher numbers of endorsed psychosis traits) can impact on reasoning style, yet the scores on the current measure of the SPQ_POS did not reach a threshold that may have influenced reasoning style. One way to assess this would be to recruit participants with higher levels of psychosis traits. On the other hand, autism traits scores clearly demonstrated a pattern of deliberative as opposed to intuitive reasoning. In order to verify this further, comparing a clinical ASD group to a non-ASD group would allow for more concrete conclusions to be drawn. Finally, support for the interaction between psychosis and autism traits was only found for syllogistic reasoning, but was unrelated to all other reasoning style measures. More research will be needed to resolve this incongruity and to clarify the implications that high psychosis relative to autism traits have for different styles of reasoning. Of course, if future studies are unable to support the connection between the PAB and reasoning style, then the implications the interaction of psychosis and autism have on reasoning style need to be revised or partially rejected. It would be especially useful to replicate the present study, but to use difference measures to capture hyper-mentalising, such as the Community Assessment of Psychic Experiences Questionnaire (Stefanis et al., 2002). This may result in a negative association between hyper-mentalising and mechanistic cognition, which may consequently have implications for reasoning style.

CHAPTER 6: The Use of Intuitive and Deliberative Reasoning amongst participants with a High Degree of Psychosis Traits

Introduction

The purpose of the current study is to examine reasoning style in a sample of participants who may reside towards the higher end of the psychosis continuum and compare their performance to a matched Control group. That is, a group of participants who have significantly fewer psychosis traits than the experimental group. Directly comparing such groups of participants will allow me to investigate if the results, consistent with the diametric disorders hypothesis, are found within a high psychosis group. In addition, such a comparison will further inform the relationship between the psychosis continuum and reasoning style.

The results of the first two experimental chapters showed that higher psychosis traits were related to higher intuitive reasoning as assessed by the Cognitive Reflective Test (CRT; Frederick, 2005), and that higher psychosis traits were related to incongruent syllogisms, which suggests that psychosis traits may reflect a susceptibility to more intuitive over deliberative reasoning style. However, not all the results were consistent with the hypotheses, as psychosis traits were unrelated to the CRT and self-report measures of intuitive and deliberative reasoning style in Study 2 Chapter 5. These inconsistent results may have been due to the samples being from the general population. For example, the evidence in clinical populations demonstrates that people with a psychotic disorder (e.g. schizophrenia) are compared to a matched Control group, particularly with performance on syllogistic reasoning (Mujica-Parodi et al., 2000; Williams, 1964; Goel et al., 2004; Corcoran, 2003; Gottesman and Chapman, 1960). Collectively, these studies have demonstrated that people with a psychotic disorder tend to exhibit a more intuitive pattern of responding when completing syllogisms. These findings have also been found to extend beyond syllogistic reasoning. For example, Balzan et al. (2012) administered a series of reasoning tasks to participants

with schizophrenia, as well as to a matched healthy Control group who reported no positive psychosis traits. Similar to the CRT, each of the reasoning tasks had an 'intuitive' response that would come to mind quickly and effortlessly but was incorrect, and a more normative and correct response that could be reached after more effortful thinking. Balzan and colleagues observed that the schizophrenia group were found to provide the more rapid responses to the reasoning tasks, whereas the healthy Control group were more likely to provide the more effortful and slower responses. These findings suggest that individuals residing on the higher end of the psychosis continuum exhibited a more rapid mode of responding. However, these findings must be interpreted with caution because the reasoning tasks used may not have been an adequate reflection of reasoning per se. Balzan et al. employed reasoning tasks extracted from Tversky and Kahnemann (1973), which included the 'Coin-Toss task', 'Letter frequency availability task', and the 'Famous-names availability task'. Performance on these tasks is predicated on an understanding of probability and frequency estimation. As a result of this, incorrect performance on these tasks may not have necessarily reflected a more intuitive style of reasoning; conversely, the results may have simply signified absence of experience and understanding of handling problems and tasks based on probability. Indeed, such tasks may simply be a reflection of whether participants have the relevant knowledge of probability to complete the task in the first place (Evans & Stanovich, 2013). As a result of these findings and results from Studies 1 and 2, further research is needed that employs a series of reasoning tasks hypothesised to assess intuitive and deliberative reasoning styles in a population sample considered to reside further along the psychosis continuum.

Turning our attention to autism trait scores, autism trait scores in Study 2 Chapter 5 were found to significantly predict deliberative reasoning style and negatively predict intuitive reasoning within a non-clinical population sample. The predictive validity of AQ scores held after controlling for measures of cognitive ability and other relevant demographic characteristics that may have mediated reasoning style. These findings were supportive of earlier research with clinical populations of participants with

ASD reflecting a more deliberative relative to intuitive reasoning style (Brosnan, Ashwin, & Gamble, 2013; Brosnan, Hollinworth, & Antoniadou, 2014; De Marito et al., 2008; Morsanyi, Handley, & Evans, 2009). Given that several studies have revealed moderate to large correlations between psychosis and autism trait scores using measures such as the SPQ and AQ in people with a clinical diagnosis of a psychotic disorder (Spek & Wouters, 2010; Barneveld et al., 2011; Esterberg et al., 2008), it is important to consider whether reasoning style amongst people with high levels of psychosis traits impacts on reasoning style when they endorse moderate to high degree of autism traits co-currently. Drawing on the diametric disorders hypothesis (Crespi & Badcock, 2008) if people with psychosis report a low amount of autism traits, any effects on reasoning style should be predominantly driven by psychosis traits as there will be a higher discrepancy between psychosis relative to autism traits. However, if the variance of the autism trait scores encompasses a wide range, then any effect of psychosis trait scores on reasoning style is expected to be modulated by the relative expression of the AQ scores.

In separate studies, both Ross, Freeman, Dunn and Garety (2011) and Moritz et al. (2015) found that, when participants with a psychotic disorder were encouraged to 'slow their thinking down', and were educated about how rapid responding can lead to biases in their reasoning, participants were less susceptible to reasoning biases at post-assessment. Indeed, this manipulation in reasoning has been administered to typical general populations, with many research findings demonstrating that decreasing the time a participant has to respond to a reasoning task incites more intuitive and less deliberative responses, whereas increasing the time participants have to respond has the opposite effect (Roberts & Newton, 2001; Evans & Curtis-Homes, 2005; Finucane et al., 2000; Schroyens, Schaeken, & Handley, 2003; Tsujii & Watanabe, 2010). However, all of these cited studies failed to index the severity of symptoms of psychosis; it could be that relationships between such constructs will be more evident in individuals who acquire higher scores on psychosis trait measures. In order to test this hypothesis, it was deemed appropriate to recruit participants who may reside on the higher end of the

continuum. It would have been appropriate to recruit participants within an inpatient setting. However, as extensively discussed in Chapter 3, clinical populations are difficult to reach and require an extensive ethical assessment and approval from organisations like the National Health Service. In addition, given that antipsychotic medication is the first point of call for people who experience psychosis (see Chapter 1), the consumption of medication may be associated with confounds of active symptomatology which, in turn, can impact on both self-report and performance measures of reasoning style. Consequently, individuals who may reside further along the psychosis continuum, but are not actively experiencing psychosis, were recruited for this study. All of the studies reviewed here support the notion that people who endorse a degree of psychosis traits will exhibit a more intuitive relative to deliberative style of reasoning.

In view of all that has been mentioned so far, and in line with previous research findings, the following study therefore sets out to explore the following aims:

Aims and hypotheses

The aim of the current study is to investigate whether an intuitive relative to deliberative style of reasoning, in the form of both self-report and performance measures of reasoning style, is more evident in individuals who may reside further along the psychosis continuum in contrast to a general population sample. Also, to explore potential links reasoning style measures have with psychosis, autism and the discrepancy between psychosis and autism traits.

a) Participants in the high psychosis group will provide more intuitive responses and less deliberative responses on the CRT compared to the Control group.

b) Participants in the high psychosis group will self-report a preference for more intuitive relative to deliberative reasoning style, as measured by the REI compared to the Control group.

c) Participants with high psychosis traits will have worse performance on incongruent syllogisms, but not congruent syllogisms compared to the Control group.

d) Relative to the Control group, in the high psychosis group only, intuitive reasoning style measures (CRT_INT, REI_INT) will be associated with increased psychosis traits and negatively associated autism traits. Performance on incongruent syllogisms will be negatively associated with psychosis traits, but not congruent performance.

e) Relative to the Control group, in the high psychosis group only, deliberative reasoning style measures (CRT_DEL, REI_DEL) will be associated with increased autism traits and negatively associated with psychosis traits. Performance on incongruent syllogisms will be positively associated with autism traits, but not congruent syllogisms.

f) Relative to the Control group, in the high psychosis group only, the Psychosis-Autism Bias (PAB) will be positively associated with (CRT_INT, REI_INT) and negatively associated with (CRT_DEL, REI_DEL and Incongruent syllogisms).

Method

Participants

The participants comprised 30 people who self-reported being in remission from a diagnosis of a psychotic disorder (17 male, 13 female; Mean age = 32.23. SD = 4.92), who were recruited through online mental health charities Rethink and the Hearing Voices Network. These participants formed the high psychosis group. In addition, 26 controls with no known clinical diagnoses (11 male and 15 female; Mean age = 26.00. SD = 5.99) were recruited through various advertisements around the University of Bath. The study was also advertised via social media communication (Facebook and Twitter).

As indicated in Table 6.0, the proportion of males and females did not significantly differ between the two groups ($X^2(1) = .53$, ns), but the difference in age was significant (t (54) = 4.44, $p < .01$). The difference in SPQ_POS scores was significantly different between the two groups (t (54) = 3.95, $p < .001$). Participants in the high psychosis group attained significantly higher scores on the AQ than the Control group (t (54) = 2.97, $p = .004$). There were no significant differences in NVIQ. All participants had a raw score of at least 30 on the Full Ravens Progressive Matrices, which is considered to reflect at least average intelligence (Jensen, Saccuzzo, & Larson, 1988). Further to this, there was no significant difference in the number of years participants spent in education between the two groups.

Table 6.0

Demographic characteristics of both participatory groups

	Control group (N = 26)	Psychosis Group (N = 30)
Characteristic	Mean (SD)	Mean (SD)
Gender (M:F)	15:11	53:32
Education (years)	16.86 (1.83)	15.14 (2.36)
SPQ_POS	17.65 (3.97)	26.13 (4.81)
AQ	27.37 (5.60)	32.65 (7.41)
NVIQ Scores	40.67 (11.10)	44.54 (8.43)

In order to verify that participants were residing towards the upper-end of the psychosis continuum, participants in the psychosis group had to obtain a cut-off score of 20 on the SPQ_POS measure. This is consistent with previous studies that have found similar scores on the SPQ_POS in clinical populations (Brosey & Woodward, 2015) and people in remission from a psychotic disorder (Moreno-Izco et al., 2015). All participants reported being in formal education for a minimum of eight years and all reported English as their native language. No participant reported being diagnosed with another psychological disorder. To clarify whether participants were not actively experiencing psychosis, the Psychosis Screening Questionnaire (PSQ; Bebbington & Nayani, 1995), a self-report measure of psychosis, was employed. This was a five-item questionnaire that directly asked about active symptoms of psychosis over the last month. Scores could range from 5 (low psychosis) to 20 (high psychosis). Participants who obtained a score of 10 were excluded from the study (N = 2). This is in line with previous studies that utilise such a measure for screening participants for active psychotic symptomology (Johns et al., 2004).

Materials

All measures reported in Study 2 were employed in the current study.

Procedure

Participants who reported being in remission from a psychotic disorder were recruited through advertisements delivered through flyers and email bulletins to local South West mental health charities including Mind, Rethink and the Hearing Voices Network. Advertisement involved recruiting individuals with a psychotic disorder (defined by DSM-IV-TR, ICD-10, or DSM-5 criteria) who had not reported an active psychotic episode within the last month, and were not currently registered as an inpatient or outpatient with any mental health services. This was to confirm that participants were not intermittently experiencing episodes of psychosis that could impact on self-report or performance measures of reasoning. Furthermore, advertisement for the study specifically requested participants who had formally received a diagnosis of a psychotic disorder from a mental health professional such as Psychiatrist or Clinical Psychologist, but were living independently within the community. Prospective participants were encouraged to contact the author and clarify through email that they were suitable for the study. If confirmation was obtained, they were provided with the study link. The Control group was an opportunity sample of male and female University students and individuals in full-time employment (N = 11). This group was recruited through advertisements through campus.

Data preparation and analysis

All data was analysed using SPSS for Windows, version 20 (SPSS, 2005). Initial screening and cleaning of the data has been described in Study 1. In the first stage of the analysis, descriptive statistics were calculated for all variables. A series of independent t-tests were then used to examine between groups differences between people in the Psychosis Group versus the Control Group.

Partial correlation analysis was then conducted controlling for Age and Gender. This allowed for the exploration of how the reasoning style measures related to one another. A single partial correlation was employed controlling for Group to explore the relationship between total SPQ_POS and AQ scores.

Finally, using the Psychosis Group only, multiple linear regression was conducted to explore how expressions of psychosis and autism traits were associated with different styles of reasoning. Parallel to the previous two studies, individual measures of cognitive ability were included in order to test the specificity between psychosis and autism and reasoning style.

Results

For both groups, mean scores, standard deviations, t-values and effect sizes for all measures are presented in Table 6.1. As illustrated in Table 6.1, there were many significant differences between the two groups.

Correlations among the dependent variables are presented in Table 6.2. Equivalent to Study 2, correlational analysis was carried out to examine the relationships between all measures of reasoning style for the entire sample. Due to the number of correlations conducted (15), Bonferroni-corrected significance levels were employed and alpha set at p = .003 (i.e. .05/15). As significant differences were expected between the two groups, partial correlations were conducted, controlling for Age and Group.

As demonstrated in Table 6.2, CRT_INT was negatively associated with CRT_DEL. CRT_INT was negatively correlated with incongruent accuracy scores, but was not significantly correlated with congruent accuracy scores. Lastly, CRT_DEL was positively correlated with incongruent accuracy scores and positively correlated with congruent accuracy scores. Congruent syllogisms scores were unrelated to incongruent syllogism scores. REI_INT was negatively associated with CRT_DEL and incongruent syllogisms. The REI_DEL was positively associated with incongruent syllogisms.

Table 6.1

Means, standard deviations (SD), t-values and effect sizes of measures used in Study 3 (N = 56)

	Psychosis Group (N = 30) Mean *(SD)*	Control group (N = 26) Means (*SD*)	t-value	Cohens d
AGE	32.23 (4.92)	26.00 (5.99)	4.25**	1.13
AQ	27.37 (5.60)	30.65 (7.41)	-2.97*	.49
SPQ_POS	26.13 (4.81)	17.65 (9.97)	3.95**	1.08
PAB	-.03 (1.32)	-.24 (1.29)	5.17**	.16
REI_INT	3.42 (.38)	2.69 (.70)	4.74**	1.29
REI_DEL	3.48 (.41)	3.79 (.66)	-2.06	.56
CRT_INT	1.43 (.82)	.65 (.75)	3.73**	.99
CRT_DEL	.97 (.93)	2.23 (.86)	-5.27**	-1.40
CONG	3.03 (1.03)	3.50 (.81)	-1.89**	-.50
INCONG	1.73 (.83)	2.81 (1.23)	-3.79**	-.01
IMPULS	72.03 (12.27)	62.31 (11.97)	2.99*	.80
WMC	38.93 (9.42)	45.65 (7.35)	-1.45	-.79
NVIQ	40.67 (11.10)	44.54 (8.43)	-1.48	-.39

AQ = Autism Quotient Score; SPQ_POS = Positive psychosis trait Score; PAB = Psychosis-Autism Bias; REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogisms; IMPULS = Barratt Impulsivity Score. WMC = Working Memory Capacity Score (OSPAN); NVIQ = Non-verbal IQ (Ravens Progressive Matrices) * $p < .05$; **$p < .001$

Table 6.2

Partial correlations for dependent variables assessing reasoning style (N = 56)

	REI_DEL	CRT_INT	CRT_DEL	CONG	INCONG
REI_INT	-.29	.25	-.45*	-.22	-.42*
REI_DEL		-.22	.20	-.03	.43*
CRT_INT			-.82*	-.24	-.53*
CRT_DEL				.53*	.47*
CONG					.02

Note. Controlling for Age and Group. REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogism. * p <.003

Correlation Analysis between SPQ_POS and AQ

A partial correlation was employed controlling for the group and revealed that SPQ_POS scores were unrelated to AQ scores (r = .013, p > .05).

Multiple Linear Regression predicting Reasoning Style

Following on from Studies 1 and 2, the current study set out to determine whether expressions of psychosis and autism traits in people who may reside further along the psychosis continuum impacted on different styles of reasoning. Replicating the previous analysis, for the psychosis group only (N = 30) the SPQ_POS and AQ were entered as the first predictors, followed by both WMC and NVIQ. These variables were added to confirm that any significant relationships observed between the predictors and dependent variables were not mediated by degrees of cognitive ability. As neither

impulsivity scores showed any association with self-report or performance measures of reasoning, and there was no age or gender effects, the independent variables here were confined to SPQ_POS and the AQ. Afterwards, the SPQ_POS and AQ were replaced with the PAB and the models were re-run again.

Psychosis and autism traits scores and Reasoning Style

As illustrated in Table 6.3, AQ and SPQ_POS scores were unrelated to CRT_INT (both p > .05). AQ was, however, positively predictive of CRT_DEL. However, the relationship between AQ and CRT_DEL became non-significant when it was simultaneously entered with WMC and NVIQ. REI_INT was negatively predicted by AQ. However, these findings did not hold when measures WMC and NVIQ were added to the model.

Neither the AQ nor SPQ_POS were able to predict scores on the REI_DEL (all *p* >.05). As shown in Table 6.3, SPQ_POS and AQ scores were unrelated to incongruent syllogistic reasoning scores (both *p* > .05). However, both SPQ_POS and AQ scores were predictive of congruent syllogistic reasoning. SPQ_POS scores were negatively predictive of congruent syllogistic scores, whereas AQ scores were positively predictive of congruent syllogistic reasoning scores. However, these predictors became non-significant when WMC and NVIQ were added to the model, SPQ_POS and AQ.

Psychosis-Autism Bias Score on Reasoning Style

As illustrated in Table 6.4, the PAB score was unrelated to CRT_INT (*p* > .05), but was a significant negative predictor of CRT_DEL. However, this finding did not hold when WMC and NVIQ were added. The PAB significantly predicted REI_INT scores. This became non-significant when WMC and NVIQ were added to the model. The PAB was not a significant predictor of REI_DEL (*p* > .05). PAB scores were unrelated to incongruent syllogistic reasoning scores (*p* > .05).

Table 6.3 AQ and SPQ_POS as predictors of Reasoning Style (N = 30)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	SPQ_POS	-.008	.032	-.04
	AQ	-.031	.028	-.21
Model 2	SPQ_POS	.005	.036	.03
	AQ	-.047	.034	-.32
	WMC	-.005	.018	-.06
	NVIQ	.015	.018	.20
CRT_DEL				
Model 1	SPQ_POS	-.023	.031	-.12
	AQ	.092	.027	**.53**
Model 2	SPQ_POS	.005	.033	.02
	AQ	.057	.031	**.**34
	WMC	-.013	.016	-.12
	NVIQ	.033	.016	.39
REI_INT				
Model 1	SPQ_POS	.027	.013	.33
	AQ	-.030	.011	**-.43**
Model 2	SPQ_POS	.015	.014	.18
	AQ	-.016	.013	-.23
	WMC	.009	.007	.21
	NVIQ	-.013	.007	-.37
REI_DEL				
Model 1	SPQ_POS	.034	.015	**.39**
	AQ	.003	.013	.04
Model 2	SPQ_POS	.024	.016	.27
	AQ	.017	.015	.22
	WMC	.001	.008	.02
	NVIQ	-.013	.008	-.35
Incongruent				
Model 1	SPQ_POS	.022	.033	.12
	AQ	.002	.028	.01
Model 2	SPQ_POS	-.007	.035	-.03
	AQ	.040	.033	.26
	WMC	.007	.017	.08
	NVIQ	.035	.017	**.47**

Note. Bold font indicates p < .05

Table 6.4 PAB score as predictor of Reasoning Style (N = 30)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	PAB	.093	.116	.15
Model 2	PAB	.171	.149	.27
	WMC	-.007	.018	-.07
	NVIQ	.015	.018	.20
CRT_DEL				
Model 1	PAB	-.358	.114	**-.50**
Model 2	PAB	-.187	.139	-.26
	WMC	-.011	.016	-.10
	NVIQ	.033	.017	**.39**
REI_INT				
Model 1	PAB	. 1 5	.047	**.51**
Model 2	PAB	.081	.057	.27
	WMC	.009	.007	.21
	NVIQ	-.013	.007	-.37
REI_DEL				
Model 1	PAB	.051	.058	.16
Model 2	PAB	-.016	.072	-.05
	WMC	.003	.009	.05
	NVIQ	-.013	.009	-.35
Incongruent				
Model 1	PAB	.032	.118	.05
Model 2	PAB	-.149	.143	-.23
	WMC	.008	.017	.09
	NVIQ	-.035	.017	**-.47**

Note. Bold font indicates significant at p < .05

Discussion

The current study set out to further explore whether people who may reside further along the psychosis continuum would exhibit a profile of displaying a more intuitive relative to deliberative reasoning style when compared to a healthy Control group. Further to this, the study was interested in examining the relationship between individual scores of the SPQ_POS, AQ and the PAB with reasoning style within such a sample of participants. In line with the first set of hypotheses, and in comparison to the Control group, people in the high psychosis group self-reported a more intuitive and less deliberative style of reasoning, along with providing more intuitive responses on the CRT and worse performance on incongruent, but not with congruent syllogisms. Collectively, such findings suggest that participants within the high psychosis group can be conceptualised as being more intuitive and less deliberative in comparison to participants who acquire fewer scores on measures of psychosis traits. However, independent scores of psychosis, autism, and the PAB were unrelated to reasoning style measures.

In light of the first set of hypotheses, there was consistent evidence for people in the high psychosis group to exhibit a more intuitive behavioural pattern of reasoning relative to a matched Control group. Indeed, these findings held after controlling for various demographic and control variables (e.g. WMC, IQ, impulsivity), thus, challenging the idea that such findings were simply being driven by the psychosis group having lower cognitive ability or having higher impulsive tendencies (Johnson-Selfridge & Zalewski, 2001; Kao & Liu, 2010). These findings are in line with previous findings that suggest people along the psychosis continuum have a more intuitive relative to deliberative style of reasoning (Speechley et al., 2010; Holt et al., 2010). As far as the author is aware, this is the first time such an investigation has been reported which involved employing multiple measures of reasoning style. Firstly, the psychosis group were found to provide significantly more intuitive responses and significantly fewer deliberative responses on the CRT in comparison to the Control group. These findings reflect the opposite pattern of performance to those people with ASD (Brosnan et al., 2016, Study 2). Indeed, such

opposing patterns of responding on the CRT provide indirect support for Crespi and Badcock's (2008) diametric disorders hypothesis, whereby Brosnan et al. found ASD participants provided significantly more deliberative as opposed to intuitive responses on the CRT in comparison to a Control group. Considered together, diametric cognition between reasoning style and autism and psychosis continua appears to exist at the higher end of the continua. The group differences in CRT performance in the current study are particularly fruitful, as they suggest that people who may reside further along the psychosis continuum are more vulnerable to allowing their intuitive response to dominate their reasoning style. From this position, and in line with dual process theory, people residing on the psychosis continuum are unlikely to allow their initial intuitive response to be intervened with a secondary, more deliberative, style of reasoning. As a result, people on the psychosis continuum may forego more effortful and slower analysis. This may suggest that, within such population samples, the core symptoms of psychosis such as unusual experiences, persecutory ideas/odd beliefs, magical thinking, etc., are less likely to be reflected upon deliberatively, which may result in alternative interpretations. Consequently, a failure to reflect deliberatively on incoming information may result in reasoning biases, such as indexed by Jumping to Conclusion task (Fine et al., 2007). Beyond the CRT, people with psychosis reported a preference for a more intuitive and less deliberative style of reasoning in comparison to the Control group. This finding is supportive of Freeman et al. (2014), who found that, relative to a matched Control group, a group of patients with schizophrenia reported significantly lower levels of deliberative reasoning as indexed by the REI. In contrast to Freeman et al., who found people with schizophrenia reporting lower levels of intuitive reasoning, the present findings suggested that the psychosis group reported being significantly more intuitive relative to the Control group. A potential explanation for the discrepancies in these findings is that Freeman et al. used clinical samples who were actively experiencing psychotic symptoms; therefore, it could be that patients with active psychosis were less aware of their reasoning style. Indeed, the findings in the current study showed that correlational analysis indicated that self-report preferences for intuitive reasoning were

negatively associated with deliberative responses on the CRT and scores on incongruent syllogisms, thus demonstrating that such a group may have been more aware of their reasoning style. Nonetheless, given the inconsistency in findings between self-report and behavioural measures of reasoning (Pennycook et al., 2015; Liberali et al., 2012; Thoma et al., 2015), this explanation needs to be interpreted with caution.

It was found that people in the high psychosis group performed significantly worse on incongruent but not congruent syllogisms. This suggests that people within the high psychosis group did not have difficulty with syllogistic reasoning per se, but had difficulty with syllogisms, whereby there was a conflict between logic and semantic knowledge. In contrast to Revsbech et al. (2015) and Mirian et al. (2011), the current group differences held after controlling for cognitive ability. This suggest that such an over-reliance on intuitive reasoning as evidenced by lower scores on incongruent but not congruent reasoning may characterise the psychosis continuum. Furthermore, the current findings argue that people on the psychosis continuum do not have a generalised cognitive deficit per se, as they were able to score on similar levels on congruent reasoning as the Control group. Indeed, these findings are in line with previous research studies that used clinical groups (Goel, Bartolo, Clair, & Venneri, 2004; Gottesman & Chapman, 1960; Speechley et al; 2010), which demonstrated reduced overall syllogistic reasoning performance than controls. However, it should be acknowledged that Goel et al. found that patients were equally impaired in both congruent and incongruent syllogisms, while the matched Control group demonstrated decreased performance for the incongruent condition relative to the congruent syllogisms. Therefore, although Goel et al. demonstrated difficulty with syllogistic reasoning, there was no evidence to suggest that people with schizophrenia were, in fact, responding based on an over-reliance on intuitive reasoning; or whether the participants found the task too demanding, thus resulting in a floor effect, which is why patients in Goel et al.'s study performed equally poorly for both the congruent and incongruent syllogisms. Overall, the findings stemming from the first set of hypotheses provide a selection of evidence

to suggest that people on the psychosis continuum do have a drive for a more intuitive relative to deliberative thinking style.

For the sake of consistency, and in line with previous studies, individual scores of psychosis, autism and the PAB were analysed in relation to measures of intuitive and deliberative reasoning style. It was expected that such trait scores would be related to their respective styles of reasoning. This analysis revealed that individual scores of such measures were unrelated to all measures of intuitive and deliberative reasoning style. In other words, there was no evidence to suggest that psychosis traits, autism traits or the PAB were specifically the product of an over-reliance on intuitive reasoning or an under-reliance on deliberative reasoning. This, together with the finding of intuitive relative to deliberative styles of reasoning occurring in the high psychosis group relative to the Control group, suggests that the underlying reasoning style that either precipitates or perpetuates psychosis traits may be part of the vulnerability to psychosis traits, but also may only have a mediating role in actual psychosis trait formation. However, it should be noted that the effect sizes of the beta coefficients reported in Table 6.3 and 6.4 were at least equal, and in some cases higher, than the beta coefficients reported in Study 2. Consequently, it could be suggested that although the relationships between reasoning style and psychosis and autism traits did not reach significance, they still went in the expected direction. With this in mind it could simply be that the current sample did not have significant power to reach a significant result. Indeed, this is supportive of Wilson, VanVoorhis and Morgan (2007) who proposed that a minimum sample of 50 should be used for multiple regression in order to increase the probability of detecting a medium effect size. As a result, caution should be exercised with prospective research recruiting a larger sample size.

Despite these unexpected findings, other studies have reported similar patterns of results. For example, to determine whether there was any correlation between delusion severity as measured by the Signs and Symptoms of Psychotic Illness scale (SSPI; Liddle et al., 2002) and incongruent reasoning score, Speechley et al. (2010)

reported no relationship between these two measures, despite reporting a significant difference in incongruent reasoning between a schizophrenia and a Control group. Our findings are, therefore, in line with Speechley et al., who suggest that severity of psychosis traits does not necessarily relate to measures of reasoning style per se. However, it is possible that no association was found because of the relatively small sample size. On the other hand, perhaps the absence of relationships between independent measures of autism, psychosis, the PAB, and reasoning style is not surprising, given the samples included people recruited specifically to be high in psychosis and were, therefore, not 'typical' participants.

Finally, for the first time, total SPQ_POS scores were unrelated to AQ scores. This finding can be supportive of Del Guidice et al.'s (2010) view that psychosis and autism traits are orthogonal. From this perspective, SPQ_POS scores in a sample of participants with a history of psychosis may be useful for screening psychosis from ASD. In contrast to Studies 1 and 2, there was no evidence of an overlapping relationship between the two continua. Instead, such scores remained unrelated to one another, suggesting an independent as opposed to overlapping or diametric relationship between the two continua. Such findings are in line with previous studies that have recruited clinical samples of people with psychosis (Gadow, 2013; Shietman et al., 2004). Furthermore, there was no negative relationship between SPQ_POS and AQ. This finding provides no support for the diametric disorders hypothesis, which suggests that autism and psychosis traits should be diametrically opposing. However, it can be argued that Crespi and Badcock do recommend that only milder variants of SPQ_POS and AQ scores can be used to reveal a diametric relationship, given the cut-off scores for the psychosis group were on par with clinical samples (Brosey & Woodward, 2015; Moreno-Izco et al., 2015), though it may not necessarily be a surprise that no negative relationship occurred.

Some potential limitations of the study may be mentioned. Firstly, although the study set out to test people who resided towards the higher end of the psychosis continuum, there may still be differences between the current sample and clinical

population samples. For instance, people who are actively experiencing psychosis may exhibit worse insight into their reasoning style and, therefore, may be more or less intuitive/deliberative when responding to reasoning tasks (Aleman et al., 2006). From this notion, it may be that the findings are specific to people with psychosis in remission as opposed to people who are actively psychotic. Nonetheless, recent findings in other areas of cognition have yielded how inpatients and people in the community in remission with a psychotic disorder display similar cognitive patterns, but to a lesser degree (Underwood, Kumari, & Peters, 2016). These findings, therefore, not only highlight the usefulness and value of examining such a group, but also further support the continuum model of psychosis (van OS et al., 2009).

In sum, the current study found evidence that people residing higher up on the psychosis continuum (as indexed by SPQ_POS scores) had a reasoning profile that reflected a more intuitive relative to deliberative style of reasoning. These findings are pertinent for a number of different reasons. Firstly, an intuitive style of reasoning further extends the literature about the underlying mechanisms that may contribute to explaining why people with psychotic disorders and people with high psychosis traits exhibit reasoning biases, such jump-to-conclusions and gather less information before making a decision (Moritz & Woodward, 2005; Peters, Thornton, Siksou, Linney, & MacCabe, 2008). These biases are known to play a causal role in the maintenance and development of delusions, ideas of reference, magical thinking, etc. Therefore, conceptualising such biases from a dual process framework may be useful for explaining how these reasoning biases develop in the first place. As a result, such exaggerated styles of reasoning may present as an opportunity to encourage more deliberative as opposed to intuitive reasoning.

CHAPTER 7: The Use of Intuitive and Deliberative Reasoning styles by People With and Without an Autism Spectrum Disorder

Introduction

Thus far, various expressions of psychosis and autism traits have been examined across non-clinical populations and across the higher end of the psychosis continuum using a multitude of measures considered to measure reasoning style. In keeping with the main aims of the thesis and to broaden our understanding of reasoning style and the relationship between autism and psychosis, the current study continues this investigation by examining reasoning style within a group of participants with and without a clinical diagnosis of ASD. Parallel to the previous study, the current study sets out to explore two central aims. Firstly, the study is interested in directly comparing a matched Control group with people with a clinical diagnosis of ASD across all measures of reasoning style. A direct comparison of the two groups would allow for further inferences to be drawn about reasoning style across the ASD continuum. A secondary aim of the study is to examine whether scores on measures of psychosis, autism and the psychosis-autism bias can be meaningful in predicting reasoning style in a sample of participants with ASD.

As reviewed in Chapter 2, people with ASD appear to display a more deliberative approach to reasoning (De Martino et al., 2008; Luke et al., 2012). For example, those diagnosed with ASD require more information prior to making decisions when compared to typically developing controls (Brosnan et al., 2016; Study 2). People with ASD have also been found to provide more deliberative as opposed to intuitive responses on the CRT. Brosnan et al. administered the CRT to participants with ASD and a matched Control group. The authors found that the ASD group provided more deliberative as opposed to intuitive answers in contrast to the matched Control group. Furthermore, people with ASD are less likely to contextualise incoming information, which has conceptualised as a product of intuitive but not deliberative reasoning (Morsanyi, Handley and Evans, 2010;

De Marito et al., 2008). Nonetheless, these findings have not always been consistent (Levin et al., 2015). Levin et al. found that participants in the ASD group demonstrated less engagement than a matched Control group for an intuitive reasoning style as indexed by the Rational Experiential Inventory (REI; Pacini & Epstein, 1999). No differences were found in preferences for deliberative reasoning. This set of results suggests that people with ASD are less likely to make decisions based on intuition, but not less likely to make decisions based on deliberations and calculations. These findings have also extended into performance measures of reasoning style. Using a series of reasoning tasks that each had both a 'heuristic' and 'logical answer', which are considered to reflect intuitive and deliberative reasoning styles respectively, Morsanyi et al. (2010) found that, although participants were less likely to provide the heuristic responses, they were not more logical than a matched Control group. These findings further support the notion that, although people with ASD have a tendency to be less susceptible to relying on intuitive reasoning, they were not necessarily more deliberative with their reasoning style. Although the evidence is mixed, there clearly appears to be support for people with ASD displaying less inclination towards intuitive reasoning relative to Control groups. However, precisely what accounts for this reasoning bias has yet to be investigated. Brosnan et al. proposed multiple reasons why people with ASD engage in such a reasoning style. One potential explanation was that people with ASD have difficulty employing an intuitive style of reasoning, which is generally considered to be a rapid and automatic process for people without ASD. Alternatively, it could be that intuitive processes are in intact, but their deliberative response is dominant. This may explain why people with ASD spend longer making decisions and responding to their environment (Luke et al., 2012; Behrmann et al., 2005; Capps et al., 1992; McPartland et al., 2004). The exaggerated time of responding may be a reflection of a person with ASD defaulting to a deliberative style of reasoning, which is conceptualised as being slower and more effortful (Evans, 2004). Alternatively, it could be that people with ASD still exhibit intuitive reasoning to a typical extent as people without ASD, but certain contextual cues trigger deliberative reasoning in those with ASD and high autism

traits. This may be particularly pertinent when processing social information and making decisions based within a social environment.

With regard to syllogistic reasoning, it can be predicted that people with ASD are less likely to respond intuitively to the syllogisms, because intuitive reasoning is based on the links between the task and a particular response option, and people with ASD are less sensitive to contextual cues as evidenced by a weak central coherence (see Chapter 2). However, it should be acknowledged that, although people with ASD are conceptualised as having a more local form of processing, research by Happé and Frith (2006) found that people with ASD could engage in a more global form of processing if instructed to. Indeed, as outlined in Chapter 2, if reasoning style has relationships with local and global processing styles, then it gives credence to the notion that people with ASD can utilise both intuitive and deliberative reasoning styles willingly. Certainly, this may explain the inconsistency in research findings with some studies that reported enhanced deliberative reasoning (De Martino et al., 2008), whilst others have not (Levin et al., 2015). The current study sets out to explore these potential explanations by employing multiple measures of reasoning style. This will allow for a more conclusive inspection of the type of reasoning pattern people with ASD engage in across different types of reasoning task contexts.

The relationship between psychosis traits within ASD is noteworthy of discussion. Firstly, as reviewed in Chapter 1, people with a clinical diagnosis of ASD have consistently shown to report significantly more positive psychosis symptoms when compared to a matched Control group (Barneveld et al., 2011; Blackshaw et al., 2001). Many theorists have argued that people with ASD who endorse positive psychosis traits do so for different reasons. For example, Frith (2004) claimed that individuals with ASD are susceptible to suspicion and paranoid ideas due to the restrictions in their ability to appreciate multiple perspectives. From this viewpoint, people who report experiencing suspiciousness and persecutory ideation may do so as a consequent of negative social experience. Furthermore, some of the behaviours observed in ASD may be misinterpreted as psychosis. For example, it is not uncommon for people with ASD to

verbalise their thoughts out loud or to demonstrate other language oddities, which could be misconstrued as auditory hallucinations (Fitzgerald & Corvin, 2001). Nonetheless, despite the potential explanations for the endorsement of such traits, whether such traits reflect tendencies towards specific styles of reasoning has yet to be fully evaluated. Notably, however, Jänsch and Hare (2014) found that degrees of paranoid ideation as indexed by the Paranoid Thought Scales (PTS; Green et al., 2008) in a sample of adolescents with ASD were associated with a jumping-to-conclusion bias as assessed by the traditional beads task (Garety et al., 2005). This suggests that, regardless of the underlying reason why people with ASD endorse psychosis traits, such traits are still reflective of a specific style of rapid reasoning. Interestingly, Study 3 revealed a trend for autism traits to be associated with deliberative as opposed to intuitive reasoning measures in people with a history of psychosis, but these findings did not hold once measures of cognitive ability were controlled for. This suggests that cognitive ability (mainly NVIQ) mediated the relation between autism traits and measures of deliberative and intuitive reasoning style within such a population.

The diametric disorders hypothesis (Crespi & Badcock, 2008) predicts those with ASD should demonstrate a more deliberative reasoning style as shown by providing more deliberative responses on the CRT, self-reporting a more deliberative as opposed to intuitive style of reasoning, and exhibiting higher scores on congruent and incongruent reasoning. The upper end of the psychosis continuum revealed how psychosis and autism traits were unrelated to one another. The current study will explore the opposite end of the continuum, whereby the relationship between autism and psychosis traits will be assessed.

Aims and Hypothesis

The aim of the current study was to investigate whether there were any differences in intuitive and deliberative style of reasoning, in the form of both self-report and performance measures of reasoning style, between individuals further along the ASD continuum in contrast to a Control group. Secondly, the study set out to explore the relationship between psychosis, autism and the discrepancy between psychosis and autism traits and reasoning style. It was predicted that:

a) Participants with ASD will provide more deliberative responses and less intuitive responses on the CRT than participants in the Control group.

b) Participants with ASD would self-report a preference for more deliberative relative to intuitive reasoning style as measured by the REI than the Control group.

c) Participants with ASD have higher accuracy scores on the congruent and incongruent syllogisms relative to the Control group.

d) Focusing on the ASD group only, intuitive reasoning style measures (CRT_INT, REI_INT) will be associated with increased psychosis traits and negatively associated autism traits. Performance on incongruent syllogisms will be negatively associated with psychosis traits.

e) Focusing on the ASD group only, deliberative reasoning style measures (CRT_DEL, REI_DEL) will be associated with increased autism traits and negatively associated psychosis traits. Performance on incongruent syllogisms will be positively associated with autism traits.

f) Focusing on the ASD group only, the Psychosis-Autism Bias will be positively associated with (CRT_INT, REI_INT) and negatively associated with (CRT_DEL, REI_DEL and incongruent syllogisms), but unrelated to congruent score.

Method

Participants

The participants comprised 26 individuals with ASD (17 male) and 22 typically developing participants without ASD (11 male) who served as the Control group. The ASD group had a mean age of 18.3 years (range 16-21; s.d. = 2.22) and the Control group had a mean age of 17.9 years (range 17-18; s.d. = 2.9; the difference in age between groups did not reach statistical significance (t (31) = 1.94, ns; see Table 7.1). The proportion of males and females did not significantly differ between the two groups ($X^2(1) = .33$, ns). The research was approved by the Psychology Departmental Research Ethics Committee at the University of Bath, which implements the ethical guidelines of the British Psychological Society.

The ASD Group comprised of participants attending a University Summer School for students on the autism spectrum focused on providing an insight into university life (N = 18). On application to the summer school, students provided evidence of clinical diagnosis of ASD using international criteria (DSM-IV, APA, 1994; ICD-10, WHO, 1992) by a qualified professional. Further measures were employed to index the degree of autism traits. The Social Communication Questionnaire (SCQ-Lifetime; Rutter et al., 2003), a 40-item parent report measure and the Autism Quotient (Baron-Cohen et al., 2001; see Chapter 3 for review). Scores on the SCQ measures were significantly above the clinical cut-offs (Mean SCQ score = 16.35, s.d. = 3.02, range = 13-27; t (17) = 3.79, $p = .002$). The mean score on the AQ for the group was 29.42, which is considered reflective of clinical levels of ASD (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005; Ruzich et al., 2015). Due to participants only having an allotted time slot in which to complete the study as part of the Summer School, a short version of the Ravens Progressive Matrices was employed as a measure of non-verbal IQ.

The remaining eight participants were recruited from the Student Disability service at the University of Bath. An email advertising the study was sent to the service actively recruiting people with ASD for a study on reasoning. Eight people responded

and were encouraged to come to the Psychology laboratories at the University of Bath to complete the study. Scores on the SCQ were not available for this subset of data. All participants for this did attain a score on the AQ of at least 26. The Control group (N = 22) was an opportunity sample of male and female students commencing their first year at the same university.

Measures

The majority of the measures used in the current study have been described in Chapter 5. However, due to the participant sample, a few amendments were made. Firstly, due to the length of time needed to administer the Operation Span Task, this measure was omitted from the current study. In addition, a short version of the Ravens Progressive Matrices was administered instead of the full measure that has been used throughout Studies 1-3 (described below). Again, this was due to the restrictions of the allotted time slot to test the group.

Short Ravens Progressive Matrices

A short version of the Raven Advanced Progressive Matrices (APM-SF; Arthur & Day, 1994) was administered. This version involves 12 items selected from the 36 items of the APM-Set II (Raven, 1962). Participants have to select the correct response out of eight possible options. This version of the Ravens has been found to be highly predictive of the full version of the Raven Progressive Matrices (Chiesi, Ciancaleoni, Galli, & Primi, 2012).

Procedure

Participants completed all tasks and questionnaires in the Psychology laboratories at the University of Bath. Participants were debriefed with a debriefing sheet after successful completion of the study. After taking part in a session of a wider summer school, participants were tested simultaneously. Control participants and participants from the Disability Service arranged to take part in the study on a different day.

Data preparation and analysis

All data was analysed using SPSS for Windows, version 20 (SPSS, 2009). Initial screening and cleaning of the data has been described in Study 1. In the first stage of the analysis, descriptive statistics were calculated for all variables. A series of independent t-tests were then used to examine between groups differences between people in the ASD versus the Control Group.

Partial correlation analysis was then conducted controlling for Age and Gender. This allowed for the exploration of how the reasoning style measures related to one another. A single partial correlation was employed controlling for Group to explore the relationship between total SPQ_POS and AQ scores.

Given the number of significant differences between the two groups on a number of key variables including impulsivity, a series of ANCOVAs were conducted that allowed to explore between Group differences between ASD and controls.

Finally, using the ASD Group only, multiple linear regression was conducted to explore how expressions of psychosis and autism traits were associated with different styles of reasoning. Parallel to the previous two studies, individual measures of cognitive ability were included in order to test the specificity between psychosis and autism and reasoning style within such a sample.

Results

For both groups' mean scores, standard deviations and effect sizes for all scales are presented in Table 7.1. Parallel to Studies 1 and 2, a series of independent sample t-tests were conducted using gender as the independent variable to test for gender differences across the variables under investigation for the whole group. There were no significant gender differences amongst any of the measures used throughout the study (all $p > .05$).

Correlations among the dependent variables are presented in Table 7.2. Correlational analysis was carried out to examine the relationships between all measures of reasoning style for the entire sample. Due to the number of correlations conducted (15), Bonferroni-corrected significance levels were employed and alpha set at p = .003 (i.e. .05/15). As significant differences were expected between the two groups, partial correlations were conducted, controlling for Group. As determined in Table 7.2, CRT_INT was negatively associated with CRT_DEL. CRT_INT was negatively correlated with congruent accuracy scores. CRT_DEL was positively correlated with incongruent accuracy scores and positively correlated with congruent accuracy scores. REI_INT was negatively associated with congruent accuracy scores. The remainder of the relationships did not reach significance (all $p > .003$).

	ASD Group (N = 26)	Control group (N = 22)	t-value	Cohens d
	Mean *(SD)*	Means (*SD*)		
AGE	18.65 (*1.85*)	17.91 (*.29*)	2.01*	.55
AQ	29.42 (*5.84*)	14.73 (*4.91*)	9.79*	2.72
SPQ_POS	14.73 (*7.54*)	7.45 (*5.11*)	3.96**	1.13
PAB	-.13 (*1.10*)	.16 (*.69*)	-1.01	-.31
REI_INT	3.58 (*.39*)	3.47 (*.31*)	1.17	.31
REI_DEL	4.07 (*.35*)	3.93 (*.32*)	1.40	.41
CRT_INT	.54 (*.71*)	1.14 (*1.04*)	-2.29*	-.67
CRT_DEL	1.38 (*.85*)	1.82 (*1.10*)	-1.50	-.44
CONG	2.96 (*1.15*)	3.09 (*.92*)	-.433	.12
INCONG	2.50 (*1.45*)	2.68 (*.89*)	-.531	-.14
IMPULS	82.18 (*8.82*)	78.95 (*4.32*)	4.98**	.46
NVIQ_Short	9.58 (*1.72*)	9.91 (*1.44*)	-.726	-.20

Table 7.1 *Means, standard deviations (SD) and effect sizes of measures used*

AQ = Autism Quotient Score; SPQ_POS = Positive psychosis trait Score; PAB = Psychosis Autism Bias; REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent

syllogisms; INCONG = Conflicting accuracy for Incongruent syllogisms; IMPULS = Barratt Impulsivity Score. NVIQ_Short = Short version of the Ravens Progressive Matrices. * p <.05, ** p <.001

Table 7.2

Bivariate correlations for dependent variables assessing reasoning style (N = 48)

	REI_DEL	CRT-INT	CRT_DEL	CONG	INCONG
REI_INT	-.04	-.05	-.02	-.52**	-.07
REI_DEL		.00	.08	.03	.23
CRT_INT			-.65**	-.30**	-.12
CRT_DEL				.34*	.30*
CONG					.25

Note. Controlling for age. REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogism. ** p <.001 * p <.003

ASD versus Control group across Reasoning Style Measures

To explore the differences between the ASD and Control groups on reasoning style measures, multivariate analysis was conducted which involved running a one-way MANCOVA. The covariates were Age, Gender, NVIQ_Short and Impulsivity. Initial analysis revealed that there were no multivariate outliers in the data, as assessed by the Mahalanobis distance (p > .001). Homoscedasticity of the samples was confirmed by Box-M (p < .001). The analysis yielded a statistically significant MANOVA effect (Pillai's Trace = .52, F (6, 41) = 7.61, p <. 001, η_p^2 = .52). A series of ANCOVAs to test each one of the dependent variables (REI_INT, REI_DEL, CRT_INT, CRT_DEL, Incongruent, and Congruent) was conducted. Bonferroni adjustments were made (.05/6) to control for multiple comparisons. This analysis revealed significant differences between the ASD and Control groups on the CRT_INT (F (1, 46) = 5.59, p <. 001, η_p^2 = .10). However, there

were no other significant differences between the ASD and Control group across the other measures (all $p > .008$).

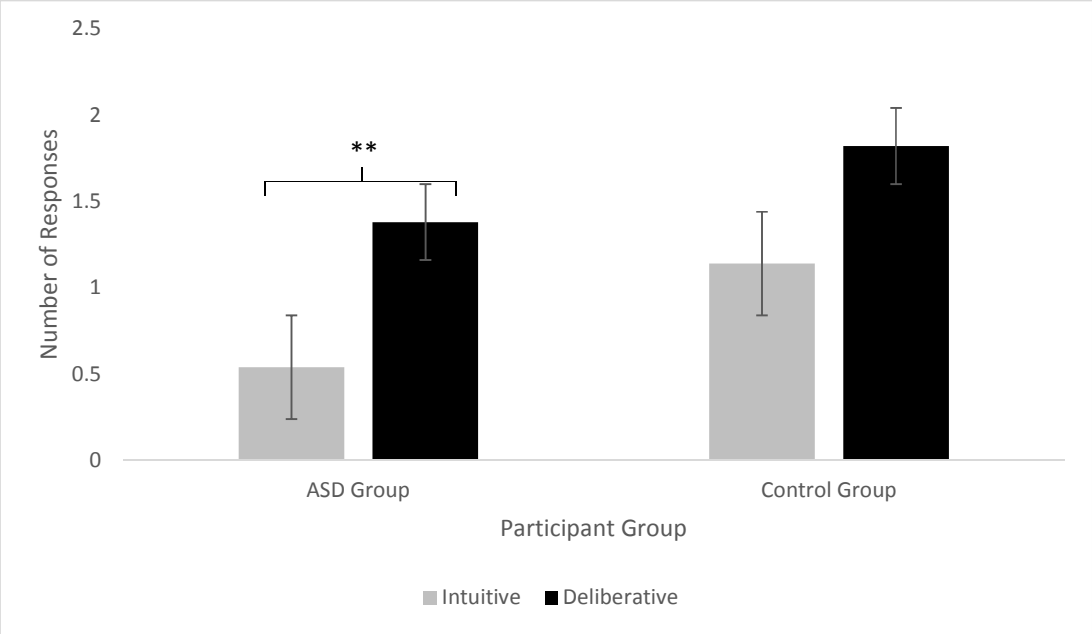


Figure 1: The mean number of intuitive and deliberative responses on the CRT between the ASD Group (N = 26) and the Control group (N = 22).

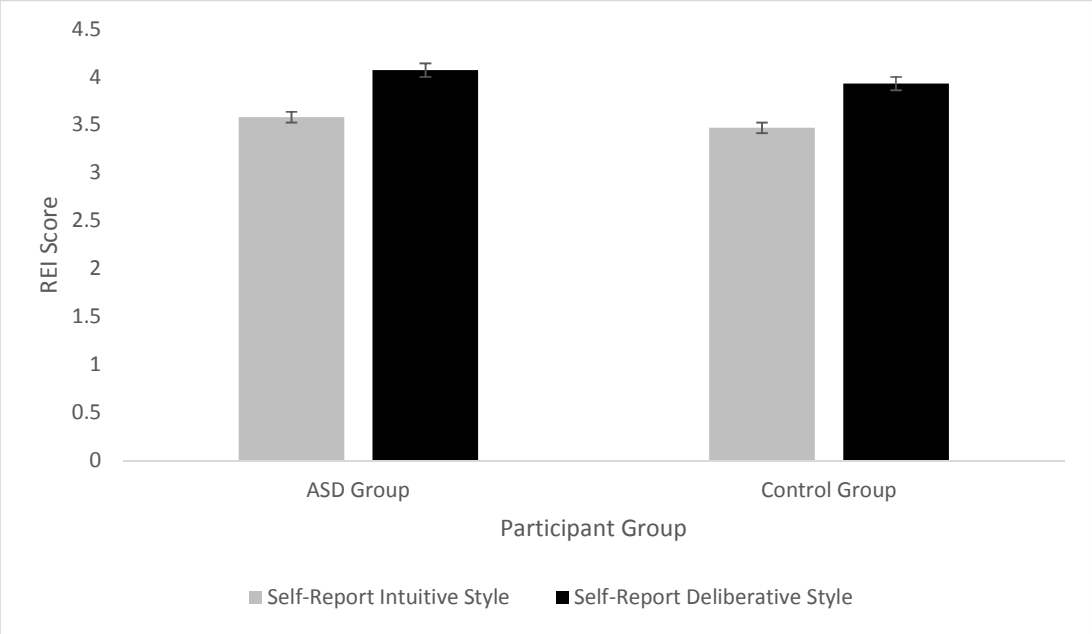


Figure 2: The mean scores of the intuitive and deliberative REI subscales between the ASD Group (N = 26) and the Control group (N = 22).

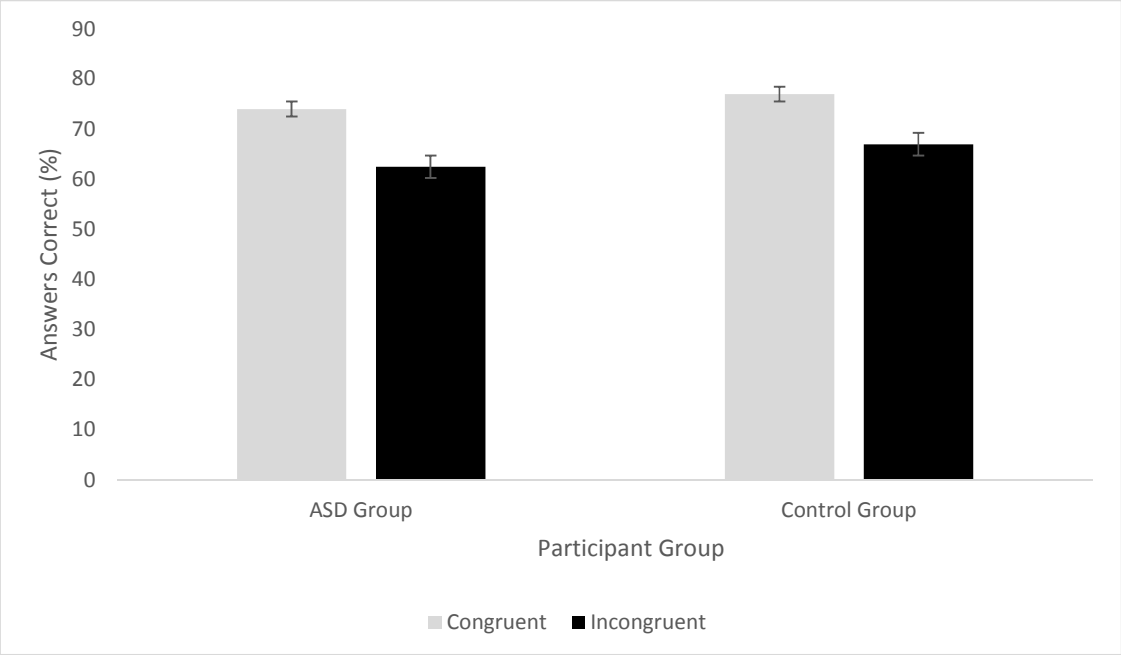


Figure 3: The mean percentage of correct responses for the Control group (n = 22) and ASD group (n = 26) when assessing the logical validity of syllogisms in which the premises conflicted with everyday knowledge (i.e. incongruent) or did not conflict with everyday knowledge (i.e. congruent).

Correlation Analysis

A partial correlation was employed controlling for group and revealed that SPQ_POS scores were unrelated to AQ scores (r = .18, $p > .05$).

Multiple Linear Regression predicting Reasoning Style

Following on from previous studies, the current study set out to determine whether expressions of psychosis and autism traits in people who may reside further along the autism continuum impacted on different styles of reasoning. Replicating the previous analysis, but for the ASD group only (N = 26), the SPQ_POS and AQ were entered as the first predictors, followed by NVIQ. These variables were added to confirm that any significant relationships observed between the predictors and dependent variables were not mediated by degrees of cognitive ability. Parallel to Study 3,

Impulsivity scores did not show any association with self-report or performance measures of reasoning and there were no age or gender effects. Therefore, the independent variables here were confined to SPQ_POS and the AQ. Afterwards, the SPQ_POS and AQ were replaced with the PAB and the models were re-run again.

Psychosis and autism traits and Reasoning Style

As indicated in Table 7.3, AQ and SPQ_POS scores were unrelated to intuitive responses on the CRT_INT (both p > .05). Both SPQ_POS and AQ scores were also unrelated to deliberative responses on the CRT_DEL (both p > .05). SPQ_POS was positive predictive of REI_INT and AQ was negatively predictive of REI_INT. However, when NVIQ was added to the model, only SPQ_POS remained a positive predictor of REI_INT. SPQ_POS scores were negatively related to congruent reasoning. This finding held when NVIQ was added to the model. AQ and SPQ_POS were unrelated to incongruent syllogistic reasoning (both *p* > .05).

PAB scores and Reasoning Style

Table 7.4 reveals that the PAB was strongly related to self-report measures of reasoning. PAB was positively associated with REI_INT. This finding held when accounting for NVIQ. Additionally, the PAB was negatively associated with REI_DEL. Again, this finding held after controlling for NVIQ. The PAB was unrelated to all other measures of reasoning style (all *p* > .05).

Table 7.3

AQ and SPQ_POS as predictors of Reasoning Style in ASD sample (N = 26)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	SPQ_POS	.008	.020	.08
	AQ	.001	.027	.00
Model 2	SPQ_POS	.021	.020	.22
	AQ	.000	.026	.01
	NVIQ	.153	.087	.37
CRT_DEL				
Model 1	SPQ_POS	-.036	.023	-.31
	AQ	.005	.031	.03
Model 2	SPQ_POS	-.038	.025	-.34
	AQ	.005	.032	.03
	NVIQ	-.030	.107	-.06
REI_INT				
Model 1	SPQ_POS	.040	.007	**.77**
	AQ	-.029	.009	**-.39**
Model 2	SPQ_POS	.039	.007	**.74**
	AQ	-.028	.009	-.39
	NVIQ	-.015	.031	-.067
REI_DEL				
Model 1	SPQ_POS	-.013	.009	-.28
	AQ	.012	.013	.18
Model 2	SPQ_POS	-.013	.010	-.28
	AQ	.012	.013	.18
	NVIQ	-.001	.044	-.00
Incongruent				
Model 1	SPQ_POS	-.030	.040	-.15
	AQ	-.009	.055	-.03
Model 2	SPQ_POS	-.006	.042	-.03
	AQ	-.010	.053	-.03
	NVIQ	.292	.179	.34

Note. Bold font indicates significant at p < .05

Table 7.4

PAB predictor of Reasoning Style in ASD Sample (N = 26)

Regression Model	Predictor	B	SE	β
CRT_INT				
Model 1	PAB	.047	.131	.07
Model 2	PAB	.097	.130	.15
	NVIQ	.134	.083	.32
CRT_DEL				
Model 1	PAB	-.283	.148	-.36
Model 2	PAB	-.288	.155	-.37
	NVIQ	-.013	.099	-.02
REI_INT				
Model 1	PAB	.250	.053	**.69**
Model 2	PAB	.236	.054	**.65**
	NVIQ	-.037	.034	-.16
REI_DEL				
Model 1	PAB	-.132	.060	**-.41**
Model 2	PAB	-.133	.063	**-.41**
	NVIQ	-.002	.040	-.09
Incongruent				
Model 1	PAB	-.227	.266	-.17
Model 2	PAB	-.122	.263	-.09
	NVIQ	.284	.167	.33

Note. Bold font indicates significant at p < .05

Discussion

Two overarching ideas lay behind the study reported here. Firstly, it was expected that people with ASD would exhibit a reasoning profile that was characterised by higher levels of deliberative reasoning relative to intuitive reasoning in contrast to people without ASD. Secondly, the specific relationships between autism, psychosis and the psychosis-autism bias and reasoning style were examined in order to investigate whether such independent factors influence reasoning style in an ASD sample. It was expected that such traits would be uniquely associated with different styles of reasoning.

Contrary to the expected hypotheses, the present findings revealed that participants in the ASD group did not demonstrate a more deliberative relative to intuitive style of reasoning. However, participants in the ASD group did provide significantly less intuitive responses than participants in the Control group on the CRT. When examining the individual scores of psychosis, autism, and the PAB, there was no significant relationship between these measures and reasoning styles. These findings were inconsistent with the initial hypotheses.

The current findings are mainly inconsistent with the diametric disorders hypothesis, which proposes that cognitive functioning in ASD is at the opposite end to psychosis within a cognitive spectrum comprised of mentalising and mechanistic dimensions. The results show that ASD is not associated with an over-reliance on deliberative relative to intuitive reasoning style. To the best of the author's knowledge, this is the first time that a group of people with ASD compared to a Control group have not exhibited a pattern that reflected enhanced deliberative relative to intuitive reasoning. With reference to the first aim of the study, the strongest observation was that, for the majority of the reasoning measures under investigation, there were no significant differences in reasoning style between people with ASD and the Control group. The absence of findings in the current study is inconsistent with previous research

findings that have demonstrated that people with ASD engage in a more deliberative relative to intuitive style of reasoning (De Martino et al., 2008; Luke et al., 2012; Brosnan, Ashwin, & Chapman, 2014). Indeed, many studies using different tasks on reasoning, judgement and decision-making have found that, when ASD participants were compared to a matched Control group, participants with ASD appear to engage in a manner of reasoning that is considered to more deliberative.

Drawing on other theories of ASD, it should be acknowledged that, although people with ASD are conceptualised as having a more local form of perceptual processing, that is, a style of processing which involves focusing on the specific details of incoming stimuli and is considered to be a slow and effortful process, research by Happé and Frith (2006) found that people with ASD could engage in a more global form of processing if instructed to do so. Indeed, as outlined in Chapter 2, if reasoning style has relationships with local and global processing styles, as some research findings have found (Dijkstra et al., 2012), then it gives credence to the notion that people with ASD can utilise both intuitive and deliberative reasoning styles willingly. Certainly, this may explain the inconsistency in the current and previous research findings, whereby some studies reported enhanced deliberative reasoning (De Martino et al., 2008) in ASD, whilst others have not (Levin et al., 2015). The current study set out to explore these potential explanations by employing multiple measures of reasoning style. This allowed for a more conclusive inspection of the type of reasoning pattern people with ASD engage in across different types of reasoning style assessments.

People in the ASD group did provide significant, less intuitive, responses than deliberative responses on the CRT in comparison to a matched control. It could, therefore, be that the content of the reasoning task is more important than the reasoning task itself. For example, the CRT is considered to have an active 'salient lure' as evidenced by many people providing the default intuitive response. Although this response is incorrect, the single intuitive response is pre-specified and dominant among all the possible wrong answers. From a dual process perspective, it could be that people with ASD do not automatically default to this intuitive reasoning style when compared

to typically developing individuals. Based on this observation, it could be hypothesised that people with ASD have a deficit in defaulting to intuitive reasoning. One way to assess this would be to examine whether such findings hold when through experimental manipulation (e.g. encouraging participants to respond quickly or slowly when completing reasoning tasks).

It was surprising that participants with ASD did not provide significantly more deliberative responses on the CRT compared to the Control group. Given that both groups were matched for non-verbal IQ, it is reasonable to rule out that group differences were not mediated by variances in general intelligence. It could also be that the items within the CRT have quite arbitrary content; thus, accurate responses were not dependent on pre-existing knowledge, which has been implicated as one of the reasons why people with ASD do perform more logically on a series of logical reasoning tasks that require the ability to refrain from existing knowledge (Morsanyi & Handley, 2012). Furthermore, it is important to acknowledge that the items in the CRT do have numerical content; consequently, participants with ASD and controls may have been evenly matched on their levels of numeracy, and not just on their NVIQ. For example, Moranyi et al. (2011) found large differences between psychology and medical students on performance with the CRT, with psychology students exhibiting significantly more deliberative as opposed to intuitive responses.

Contrary to the initial hypothesis, people with ASD did not report a preference for more deliberative relative to intuitive reasoning in comparison to the Control group. These findings were contrary to both Levin et al. (2015) and Luke et al. (2012), who found that people with ASD had an inclination to avoid reasoning intuitively. Additionally, Brosnan et al. (2016) found that people with high autism traits reported a propensity to engage in deliberative relative to intuitive reasoning on the REI. The current findings suggest that people with ASD exhibited a similar profile of self-report preferences for intuitive and deliberative reasoning as the matched Control group. It was predicted that deliberative reasoning scores would be higher, but it was unexpected that intuitive reasoning style would be high, too. There are several potential explanations for this.

Firstly, analogous to people with clinical levels of psychosis, it could be that findings in the current study could reflect that people with clinical levels of ASD are less aware of their reasoning style processes, or are perhaps unsure of their reasoning style. Secondly, it could be that people with ASD dislike relying on intuitive reasoning when reasoning within a social context, but consider themselves to utilise intuitive reasoning when engaging in non-social situations, i.e. completing the Intuitive Physics Task (Baron-Cohen et al., 2001), whereby superior performance in this task appears to come automatically and with little thought with people with ASD (Happé, 1999). From this viewpoint, reasoning style amongst people with ASD may not be as fixed as previously reported and people with ASD may have a preference for either intuitive or deliberative reasoning, depending on the context they think about reasoning during completion of the questionnaire. For example, the REI reflects open statements about preferences and enjoyment for using intuitive and deliberative reasoning and does not specifically refer to situations of a social nature. This could potentially explain why the current research findings contradict previous research studies.

Finally, there was no significant differences in congruent and incongruent syllogism accuracy scores between the two groups. This latter finding suggests that people in the ASD group are not necessarily better at assessing the validity of syllogisms, despite evidence from previous studies suggesting they are less influenced by their prior knowledge and experience (Pellicano & Burr, 2012; De Martino et al., 2008). Notably, participants with ASD performed at similar levels on congruent and incongruent syllogisms. This suggests that participants with ASD appeared to draw on existing knowledge and beliefs as much as the Control group. Indeed, this finding is in line with Hirschfeld et al. (2007), who also found that participants with ASD relied on existing knowledge when solving syllogisms as much as a typically developing Control group. Consequently, it could be suggested that contextualisation occurs as much in ASD as in the Control group. These findings are contrary to the initial hypothesis and inconsistent with previous research findings, which have demonstrated people with ASD are less susceptible to the content of the reasoning task (De Martino et al., 2008; Morsanyi et

al., 2010). In contrast, the findings are in line with earlier research by Leevers and Harris (2000), who found no significant difference between syllogistic reasoning performance (for congruent and incongruent) syllogisms in participants with and without ASD. However, it should be noted that Leevers and Harris recruited children with and without ASD and, therefore, may not have had the necessary skills or knowledge to utilise in order to correctly assess the accuracy of the presented syllogisms.

Although these findings are inconsistent with previous research findings, there are several explanations that may have accounted for these discrepancies. Firstly, as the study was part of a wider day of activities, all participants were restricted in the time they had to complete the study and respective tasks. It could, therefore, be that participants with ASD did not have time to utilise the reasoning strategy they would have liked to engage in and, therefore, resorted to simply guessing. Given the evidence that suggests people with ASD prefer to take their time reasoning and report difficulties in switching attention (Luke et al., 2012; Ames & Fletcher-Watson, 2010), this explanation may account for the current findings.

Turning to the individual measures of autism, psychosis and the discrepancy between the autism and psychosis scores, the findings are fruitful. Firstly, AQ scores were negatively associated with self-report intuitive reasoning, which is supportive of earlier studies (Luke et al., 2012; Levin et al., 2015). Additionally, these findings were consistent with Studies 1, 2 and the main sample of psychosis participants in Study 3. Collectively, these findings suggest that autism traits are associated with lower self-report preferences for intuitive reasoning. Potential explanations for this observation are wide-ranging. For instance, perhaps people with a high expression of autism traits refrain from engaging in intuitive reasoning as a consequence of having a genuine dislike towards such a style of reasoning. Alternatively, it can be argued that the measure used to index intuitive reasoning used items that related to more 'social' orientated situations, e.g. "When it comes to trusting people, I can usually rely on my gut feelings." It could, therefore, be that people with higher autism traits were responding negatively to items relating to social situations. Nonetheless, AQ scores were not associated with

any performance measures of reasoning style. Notwithstanding, parallel to Study 3, the beta coefficients were significantly higher than those outline in Study 2 between autism traits and behavioural measures of reasoning style. This suggests that although the relationship between autism traits and performance measures of reasoning style did not reach significance, the strength between autism traits and reasoning style supports the notion that autism traits are at least directionally related to a profile of less intuition and more deliberation. However, a larger sample would be needed to verify this. This suggests that, although autism traits may reflect a partiality away from intuitive reasoning, this does extend to behavioural measures of reasoning. On the other hand, SPQ_POS scores were found to be positively predictive of self-report intuitive reasoning, which is in line with Freeman, Evans and Lister (2012). Additionally, such findings extended Jänsch and Hare's (2014) findings, who found that degrees of paranoia in an ASD sample were found to predict a jumping-to-conclusion bias. Indeed, such findings further suggest that psychotic experiences in ASD reflect a tendency for rapid reasoning. SPQ_POS was also found to be a negative predictor of congruent reasoning. Although these findings are in line with previous studies (Speechley et al., 2009), it was unexpected that SPQ_POS negatively predicted congruent but not incongruent reasoning. This suggests that such traits were not associated with difficulty over-riding syllogisms, whereby the premises conflicted with everyday knowledge, but were associated with worse performances when the syllogisms were supportive of everyday knowledge. This finding is surprising, given that many studies have demonstrated that people are better judging syllogisms that were consistent with reality (Reverberi et al., 2009). The Psychosis-Autism Bias was also found to predict worse congruent reasoning. That is, participants with ASD who reported higher psychosis relative to autism traits were found to exhibit worse performance on syllogistic reasoning, when the content of the syllogism was congruent with everyday beliefs and knowledge. Interestingly, this did not extend to incongruent reasoning. This suggests that such bias scores reflected some form of atypicality in reasoning style, yet this may not have reflected an over-reliance on intuitive reasoning per se. Drawing on Abu-Akel et al.'s (2015) research findings, it

could be that hyper-mentalising relative to hypo-mentalising within an ASD sample may have had an interactive effect which results in general reasoning difficulties.

Finally, copying the absence of association between the AQ and SPQ_POS, there was no positive association between autism and psychosis traits within an ASD population. In contrast to typical Control groups, people with ASD are not likely to reveal increasing tendencies for psychosis and autism traits collectively, which may suggest a point of delineation for people residing further along the ASD continuum. However, there clearly were substantial differences between reported psychosis traits between the two groups, with people with ASD endorsing significantly higher psychosis traits in contrast to the Control group. These findings are in line with early research findings, which have revealed that people with ASD are likely to exhibit more significant psychosis traits than people without ASD (Barneveld et al., 2011; Pinkham et al., 2012; Blackshaw et al., 2001). This observation further suggests that psychosis and ASD may share some underlying mechanisms that are related to both ASD and psychotic disorders to exhibit clinical levels of the opposing traits. From this perspective, psychosis and ASD may have more in common than they do apart.

There are, however, several limitations of the study that need to be acknowledged. First and foremost, the sample of participants were considered to have high functioning ASD. That is, individuals with ASD within this sample had at least average intelligence, therefore the findings within the study may not be applicable to the ASD populations as a whole. Nonetheless, previous studies have used similar samples and have found significant differences between reasoning styles between ASD and Control groups. Therefore, these results are still informative of understanding the type of reasoning style people with ASD may engage in. However, it should be noted that both adolescents and adult participants were included in the study; therefore, there may be differences in development and brain maturity between participants at differing ages in the different groups.

Secondly, the methodological setup of the current study was different to previous studies. Participants were all tested as one whole group, which may have altered the way they responded by being distracted, anxious or nervous about being surrounded by so many people. Anxiety has been known to alter performance across a broad range of cognitive tasks in people with ASD (Kushki et al., 2013). One way to potentially avoid this would be for participants to complete such measures online in an environment they feel comfortable in. This may alleviate or dramatically reduce any anxiety and allow participants to respond to the reasoning tasks in a manner that they feel comfortable in.

Thirdly, the majority of participants with ASD were thinking of going to University. In contrast, the Control group were already at University and engaged in an undergraduate course. It could be argued that such a group comparison may be limited, given the participants at University may have already been taught to alter their thinking and studying habits, perhaps training themselves to think in a more effortful and deliberative manner. Indeed, previous research has shown how people who considered themselves to be intuitive reasoners can be trained to think more 'deliberatively' (Neilens, 2005). This training may have occurred when they started on their course and became engaged in their studies.

CHAPTER 8: Study 5: Reasoning Style Using Social and Non-Social Variants of Reasoning Stimuli across the Autism and Psychosis Continua

Introduction

Up until now, within this thesis the content of the reasoning tasks used throughout Studies 1-4 has been presented in the typical format. This typical format generally reflects abstract or neutral content, which is absent of any social substance. Under these circumstances, there has been mixed and inconsistent evidence of precisely how various intensities of autism and psychosis traits are associated with different styles of reasoning. Although the typical format and presentation of syllogisms is appropriate for accurately assessing different styles of reasoning, there is an accumulative body of evidence that suggests the content of the reasoning tasks can impact and influence reasoning style. Such an interference is particularly noticeable when people reason with highly believable or personally relevant content (Vroling & De Jong, 2009). For instance, in contrast to a matched Control group, Blanchette and Campbell (2012) found that war veterans were more accurate at solving syllogisms when the content reflected combat and war-related materials. Indeed, these participants were less likely to exhibit belief bias responding with combat/war content as opposed to typically presented syllogisms. In addition, Goel and Vartanian (2011) demonstrated that administering syllogisms with politically incorrect evocative content (e.g. the justification of rape) reduced belief-bias responding in a sample of undergraduate students. Further to this, several studies yielded that patients with different mental health conditions were more accurate at reasoning about syllogisms, whereby the content of the premises related to their condition in contrast to typical topics (Gangemi, Mancini, & Johnson-Laird, 2013; Johnson-Laird, Mancini, & Gangemi, 2006). Finally, survivors of adverse childhood experiences showed higher accuracy scores on syllogisms, whereby the content

reflected abuse-related material (Blanchette & Caparos, 2013). Indeed, such findings imply that the more meaningful and relevant the content is to someone, the more accurate their reasoning is. However, these findings have not always been consistent. For example, other studies that involved evaluating participants' reasoning about emotional and abstract content (Blanchette & Richards, 2004; Kemp, Chua, McKenna, & David, 1997) found that participants were more likely to provide logically invalid responses when reasoning about emotional compared to abstract content. For instance, Kempt et al. (1997) found that, relative to a matched Control group, people with delusions were found to endorse more invalid syllogisms when the content was emotive in contrast to when it was neutral. Collectively, such findings suggest that the content of syllogisms appears to have a bearing on reasoning style amongst different population samples.

One explanation that could account for discrepancies in syllogistic reasoning of varied content could be that participants are more accurate at reasoning about content related to their own emotional and personal. One explanation for this is that people are more interested in examining content that they can relate to, thus they engage in more effortful and deliberative reasoning, which consequently results in a more logical and accurate style of reasoning. Support for this position was found by Schaeken, Van der Henst & Schroyens (2007), who found that participants paid more attention to relevant as opposed to irrelevant syllogisms, hence providing better accuracy performance on the relevant as opposed to irrelevant syllogisms. Contrary to this premise, however, existing knowledge of the content presented in the syllogism has also been found to worsen performance and induce more belief bias responding. Evidence for this assertion has been found in developmental studies, whereby children have been found to outperform adults on syllogistic reasoning when the content reflects stereotypical information (de Neys & Vanderputte, 2011). From this viewpoint, when children are considered to have a lack of stereotypical knowledge, they are more likely to reason logically as there is no conflict between their personal beliefs and the logical structure of the syllogism. This suggests that children engage in a more deliberative style of

reasoning as there are no intuitive beliefs or experiences to draw upon. Markovits (1995) explains this phenomenon by suggesting that the content embedded within a reasoning task functions as a 'cognitive filter'. This premise suggests that, when people are presented with unfamiliar or unrecognised content, they do not need to effortfully prevent the retrieval of their relevant knowledge as none currently exists (i.e. suppress an intuitive response). Indeed, Markovits' theory is consistent with the default interventionist model of dual process theory. This implies that people are better at syllogistic reasoning and, perhaps, deductive reasoning in general when processing unfamiliar content. Sustenance for this premise has been found in studies whereby children exhibit higher accuracy rates on syllogistic reasoning tasks when the content reflects fantasy or make-believe material (Daniel and Klaczynski, 2006; Vadeboncoeur & Markovits, 1999). In view of all that has been mentioned so far, the content of the reasoning tasks appears to have some form of impact on reasoning style, although the evidence remains mixed as to whether this effect can have an enhancing or diminishing effect on reasoning style. It is, therefore, important to consider how manipulating the content of reasoning tasks impacts on reasoning style when accounting for various expressions of autism and psychosis traits.

Psychosis and ASD are considered to reflect various manifestations of mentalising and mechanistic cognition, which are thought of as examples of hyper and hypo developed social and non-social cognition (Crespi & Badcock, 2008; Baron-Cohen et al., 2009; Baron-Cohen et al., 2009). A key question, then, is whether reasoning style changes amongst people who exhibit various degrees of psychosis and autism traits, when the content of the reasoning tasks relates to social as opposed to abstract content (e.g. animals and objects). For instance, people with ASD have been observed to have persevered or enhanced non-social skills, but typically display worse performance when assessed on tasks considered to examine various aspects of social functioning (see Chapter 1). Also, it could be argued that like typically developing children, people with ASD may not have any social intuitive responses to draw upon. From this position, people residing along the ASD continuum may be less accurate at assessing the validity

of syllogisms when the content is social. On the other hand, the drive for mechanistic cognition suggests that people with ASD are more familiar and, perhaps, comfortable with dealing with non-social phenomena, thus they may demonstrate higher accuracy rates. However, in the previous chapter there appeared to be no difference in reasoning style between an ASD sample and a control sample when the content of the syllogisms reflected typical (non-social) material. So, these findings may suggest that people with ASD may not necessarily engage in a distinctive style of reasoning in contrast to people without ASD.

Comparatively, people residing further along the psychosis continuum may have less difficulty deliberating over social content, as hyper-mentalising reflects exaggerated inferences of social behaviour. Indeed, as several studies have illustrated, this is particularly exaggerated in social contexts (Blakemore, Sarfati, Bazin, & Decety, 2003; Russell, Reynaud, Herba, Morris, & Corcoran, 2006). In addition, people residing on the psychosis continuum appear to demonstrate diminished mechanistic cognition. From this perspective, people with psychosis may be less accurate at reasoning about non-social content (as revealed in Chapter 5). The extent to which such behaviour extends into the context of reasoning has yet to be examined. Although no studies have been published that have sought to investigate such hypotheses, drawing on previous research on reasoning across the autism and psychosis continua may allow for certain predictions to be formulated about how such traits are associated with reasoning style, when the content is social in contrast to non-social.

From the diametric disorders hypothesis, psychosis traits (and psychotic disorders) are conceptualised as poor mechanistic cognition coupled with hyper-developed mentalising cognition. This may suggest that people with high psychosis traits may exhibit better performance on syllogisms, whereby the content reflects social content. Furthermore, whether such findings extend to social syllogisms remains an unchartered but interesting avenue to explore. As far as I am aware, no published studies have specifically examined how social content integrated into syllogisms impacts on people with a high expression of psychosis traits.

With regards to the Cognitive Reflection Test, as far as the author is aware, no published studies have attempted to manipulate the content of the questions to reflect social content. However, some researchers have attempted to replace the content of the items (e.g. bat and ball) with different objects in the hope of guarding against knowledge-based effects (Thomson & Oppenheimer, 2016; Baron et al., 2015; Primi, Morsanyi, Donati, Chiesi, & Hamilton, 2015). For example, Thomson and Oppenheimer (2016) composed an alternate version of the CRT, which replaced the content of the existing items with different topics. For instance, as opposed to asking participants about the number of days a lake takes to develop, the authors use the question: "A farmer had 15 sheep and all but 8 died. How many are left?" Such questions are considered to test a participant's ability to suppress an intuitive response in favour of a more deliberative response. Indeed, in a large population sample, the author's alternative version of the CRT was found to be highly correlated with the original version of the CRT, in addition to predicting syllogistic reasoning performance. This suggest that the items of the CRT are not specific to reasoning style per se and can be altered and still demonstrate strong predictive capabilities of a person's reasoning style. Indeed, Toplak et al. (2013) extended the CRT to include additional items, but none of the additional items were considered to be social.

Prior to conducting the main study, a new set of materials were required which aimed to highlight social as opposed to non-social content. As far as the author is aware, there is currently no published valid and reliable measure of syllogisms that use social content. In addition, the precise interpretation of social content is ambiguous with no clear definition. With this mind, stimulus development was carried out in an attempt to isolate and define content that can be distinguished from non-social material. What follows is a description of how the stimuli was developed prior to the main study. After the discussion of this development, the report proceeds with the main methodology and results section of the main study.

Aims and hypotheses

1. To examine how psychosis and autism traits relate to reasoning style, when the content of reasoning style relates to social compared to non-social content.

2. To see whether different expressions of autism, psychosis, and the discrepancy between psychosis and autism (Psychosis-Autism Bias) relates to reasoning style.

Based on the background literature and previous studies, the following hypotheses were formulated:

In contrast to the Control group:

1. The Psychosis group will provide more deliberative responses on the social CRT and significantly less intuitive responses on the social CRT. The Psychosis group will have higher accuracy scores for incongruent social syllogisms.

2. The Psychosis group will display a more intuitive style of reasoning as indexed by more intuitive responses on the CRT (non-social version) and significantly less deliberative responses on the CRT. The Psychosis group will also display high preferences for self-report intuitive reasoning and lower self-report preferences for deliberative reasoning. The Psychosis group will exhibit lower accuracy rates of syllogistic reasoning of non-social incongruent, but not congruent syllogisms.

3. People with ASD would exhibit a more deliberative style of reasoning as indexed by more deliberative responses on the CRT and significantly less intuitive responses on the CRT. The ASD group will also exhibit high preferences for self-report deliberative reasoning and lower self-report preferences for intuitive reasoning. Further to this, the ASD group will have higher accuracy rates of incongruent but not congruent syllogisms.

4. The ASD group would provide significantly more intuitive responses on the social CRT and significantly less deliberative responses on the social CRT. The ASD group would have lower accuracy scores of social incongruent syllogisms.

5. SPQ_POS scores would be significantly predictive of all intuitive scores and negatively related with deliberative scores on non-social variants of reasoning style. SPQ_POS would be associated with more deliberative responses on the social CRT and higher accuracy rates on incongruent social syllogisms. AQ scores will independently be predictive of a deliberative reasoning style across all non-social measures, but will be negatively related to deliberative responses on the social CRT and lower accuracy scores on social incongruent syllogisms. Finally, the PAB would be related to a more intuitive relative to deliberative style of reasoning for non-social, but related to higher accuracy on social incongruent syllogisms and more deliberative responses.

Stimuli Development

Design

Participants were administered a questionnaire involving 24 different syllogisms, 12 of which were designed to reflect social content. For all intents and purposes, the concept of 'social content' was used loosely to reflect any content that involved stereotypes or social beliefs about society and the world. The remaining 12 were considered to reflect non-social content (animals and objects). The main aim of the questionnaire was for participants to determine which syllogisms were 'social' and 'non-social' and which ones were considered to be 'believable' and 'unbelievable'. Participants were not expected to assess the logical validity of the syllogisms, as in previous studies; the task was designed to specifically examine whether participants could objectively identify which ones were social/non-social/believable/non-believable. In addition, the traditional version of the CRT was employed, along with an alternative version of the CRT that the author considered to reflect social content. For these six questions, participants were required to rate which questions were social and which were non-social. Participants did not have to provide answers to these questions.

Participants

Eleven participants from the University of Bath, all of whom were undertaking a postgraduate qualification (e.g. Masters or PhD), took part in the pilot study. The ages ranged from 24 to 34 years (M = 27.36; SD = 2.62). All participants were native English speakers. No participant reported ever having been diagnosed with a mental health condition. The research was approved by the Psychology Departmental Research Ethics Committee at the University of Bath, which implements the ethical guidelines of the British Psychological Society.

Materials

The social and non-social syllogisms, along with the CRT and social CRT, was presented to participants in paper and pencil format. All syllogisms and items of the CRT were numbered. Non-social and social syllogisms were presented in a mixed order. Under each syllogism, participants had to check one single box that said “Social / Non-Social / Don’t know”. Furthermore, participants also had to check another box that said “Believable / Unbelievable / Don’t know”. For the CRT questions, participants only had to check a box that said “Social / Non-Social / Don’t know”. Full instructions and disclosure about the pilot study were presented at the top of the sheet. In keeping with the existing structure and administration of syllogisms throughout the current PhD, an equal balance of valid-believable, invalid-believable, valid-unbelievable and invalid-unbelievable syllogisms were created. A total of 24 syllogisms were therefore created, with a view of selecting 16 to be used for the experiment. Examples of social versus non-social syllogisms are presented in Table 8.1.

Table 8.1 – Items used in the Pilot Study

Social	Non-Social
No good friends are rude. Some friends are rude. Therefore, some friends are not good friends	No mobile phones are machines. No computers are mobile phones. Therefore, some machines are not mobile phones.

In order to create a social variant of the CRT, items relating to abstract content (lakes, widgets, bat and ball) were replaced with social-based content. An example of social versus non-social CRT items are presented in Table 8.2.

Table 8.2 – Items used in the Pilot Study for CRT

Social CRT	Non-Social (Traditional)
Together, Chloe and Jack have 110 different Facebook friends in total. Chloe has 100 more Facebook friends than Jack. How many Facebook friends does Jack have?	A bat and a ball cost £1.10 in total. The bat costs £1.00 more than the ball. How much does the ball cost?

Procedure

Participants completed the inventory within their own time limits. All participants were encouraged to complete the questionnaire in a quiet setting.

Results

All 11 questionnaires were completed with no missing data. After manually reviewing participants' responses, a list of social and non-social syllogisms was created predicated on the responses checked by participants. In order for a syllogism to be considered social or non-social, all participant responses had to be unanimous. Furthermore, all participants had to agree on the believability of the statement. Syllogisms where participants had checked 'Don't know', or were at a disagreement either between social and non-social content and believability, were excluded from the study (N = 8). Sixteen syllogisms remained, 8 were considered to be social, whilst the remaining syllogisms were interpreted as representing non-social content. Both social and non-social syllogisms were further broken down in believable-valid (N = 2), unbelievable-invalid (N = 2), believable-invalid (N = 2) and unbelievable-valid (N = 2). This was consistent with previous studies, where participants had to assess the validity of congruent and incongruent syllogisms. In all 11 questionnaires, there was a universal agreement of items from the CRT that reflected social and non-social content.

Discussion

The purpose of stimuli development was to validate whether syllogisms and the CRT could be objectively separated into social and non-social variants. With regards to syllogisms, the validation study was successful insofar that there were many unanimous decisions of which syllogisms and items of the CRT were reflective of social versus non-social categories. This finding suggests that perhaps there is a generalisation of what content can be considered to reflect social and non-social phenomena. More importantly, in most cases, participants unanimously agreed which social syllogisms were believable and unbelievable. This adds to the idea that there are believable and typical assumptions about stereotypes and the social world that many people relate to. The results from the current study clearly highlighted that participants considered the original CRT items separate from the social items of the CRT.

After establishing the differences between social and non-social content, the following study set out to explore how expressions of psychosis and autism traits are associated with different measures of social and non-social reasoning style.

Method for Main Study

Participants

The sample included 40 individuals who self-reported a history of psychosis (20 male, 20 female; Mean age = 26.95. SD = 7.01), 40 participants with a self-reported diagnosis of ASD (20 male, 20 female; Mean age = 25.80. SD = 5.04) and 62 controls from the general population (24 male, 38 female; Mean age = 32.40. SD = 4.13). Basic demographic information about the three groups is presented in Table 8.3.

Table 8.3 – *Means and standard deviations of demographic characteristics across the three groups (N = 142)*

	Psychosis	ASD	Control
Gender (M:F)	18:22	20:20	24:38
NVIQ score	50.80 (*8.70*)	41.43 (*7.67*)	42.63 (*8.20*)
Age	32.40 (*4.13*)	25.80 (*5.04*)	26.95 (*7.01*)
Age range	26-46	18-35	18-38

Note: NVIQ = Full Ravens Progressive Matrices Score

The psychosis group were recruited from the Rethink website. The study was advertised on the Rethink website and was tailored to recruit people with a history of a formal diagnosis of a psychotic disorder (defined by DSM-IV-TR, ICD-10, or DSM-5 criteria) who had not reported an active psychotic episode within the last month, and were not currently registered as an inpatient or outpatient with any mental health services. This was to confirm that participants were not intermittently experiencing episodes of psychosis that could impact on self-report or performance measures of reasoning. Furthermore, advertisement for the study specifically requested participants

who had formally received a diagnosis of a psychotic disorder from a mental health professional, such as Psychiatrist or Clinical Psychologist, but were living independently within the community. All participants in this group obtained a SPQ_POS score of at least 20, which was in line with previous studies using clinical populations. All participants reported being in full-time employment.

The ASD group was recruited from a UK-based online charity called 'Research Autism'. This was a charity run by two clinical psychologists from London who specialised in recruiting participants and families with ASD. All registered participants on Research Autism provided proof of diagnosis during registration to the charity. All participants in this group had an AQ score of 26 or above. Out of the ASD group, 80% reported being in full-time education. The remaining 20% reported being in full-time employment.

The Control group was recruited by advertisements around the University of Bath. The study was also advertised via social media communication (Facebook and Twitter). Out of the control sample, 70% reported studying at the University of Bath, whereas the remaining 30% reported being in full-time employment.

Measures

Many of the measures used in the study are described in Chapter Five. However, there are some notable differences in the current study that need to be outlined. Firstly, a new set of syllogisms, as discussed in the aforementioned previous stimuli development section, were administered. All participants completed these syllogisms instead of the previous syllogisms used throughout Studies 2-4. This was conducted in order to guard against knowledge-based effects of participants, who may have already completed the earlier syllogisms by taking part in earlier studies, as some of the same recruitment methods were used. Moreover, both the traditional and modified social versions of the CRT were employed. These items were randomised and intermixed with syllogisms to prevent order effects. In contrast to the previous study, as there was no allotted time slot to complete the online study, the full version of the Ravens Progressive

Matrices was employed. In addition, due to the number of questionnaires and tasks that needed to be completed, the Barratt Impulsivity Scale (BIS; Barratt, Patton, & Stanford, 1975) was excluded from the current study. This decision was made based on the fact that previous studies had elicited no significant relationships between impulsivity and psychosis or autism traits, nor impulsivity and reasoning style measures.

Syllogistic Reasoning Task

Sixteen syllogisms were employed in the current study, eight of which comprised of social content, while the remaining eight were non-social. Participants had to assess the validity of each of the syllogisms. Consistent with previous administration of the syllogism, an equal combination of congruent and incongruent syllogisms was used. All syllogisms were randomised, mixing social with non-social syllogisms. Responses were coded 1 for correct (indicating a deliberative, logically valid answer) and 0 for incorrect. Independent scores were calculated for 'Congruent', 'Social_Congruent', 'Incongruent' and 'Social_Incongruent'. Cronbach's α for this 16-item measure in the current study was satisfactory at .89.

Cognitive Reflection Test

As described in Chapter 3, the original CRT was employed alongside the social version, which was created through the pilot study. For simplicity, this version was called 'S-CRT'. Consequently, participants could acquire a score of 0-3 for S-CRT_INT and S_CRT_DEL. All questions were presented on the same webpage in an intermixed order. Each question had an intuitive response and a deliberative response.

Procedure

Parallel to previous studies, the self-report questionnaire of SPQ_POS and AQ traits, and reasoning style tasks, were administered as an online survey on the Bristol Online Surveys (see http://www.survey.bris.ac.uk). A link to the site was emailed out to interested participants. Although all participants completed the same questionnaires and tasks, some additional measures were completed by participants, depending on where they heard about the study.

All participants had to respond to the mandatory question as to whether they had ever received a diagnosis of a mental health problem. No participant reported the existence of a previous mental health disorder, thus no participant was excluded for subsequent analysis. Finally, all participants had to be at least 18 years and were reminded that their participation was anonymous and completely voluntary, with withdrawal from the exercise permitted at any time. The need for honesty in responding was stressed. The BOS automatically prevented participation more than once by the same person.

Results

Statistical Analysis Strategy

The main analyses involved examining reasoning style across social and non-social variants of reasoning tasks across the three clinical groups.

Group comparisons were conducted using multivariate analysis of covariance with the factor diagnostic group (Psychosis, ASD, and Control) and the covariate Age and NVIQ due to significant group differences amongst the three groups. Following pairwise comparisons were Bonferroni corrected.

Finally, a series of multiple linear regressions were conducted for the entire sample to see whether individual scores on autism and psychosis were related to reasoning style across social and non-social tasks. Due to the large number of analyses conducted, a summary of the results can be found in Table 8.12.

Descriptive Statistics

Means and standard deviations of reasoning style scores across the three groups are presented in Table 8.4.

Table 8.4

Means, standard deviations (SD) of reasoning style measures across clinical groups (N = 142)

	Psychosis	ASD	Control
REI_INT	5.83 (*.66*)	3.07 (*.28*)	6.50 (*.74*)
REI_DEL	5.66 (*.79*)	6.27 (*.66*)	6.58 (*.83*)
CRT_INT	.78 (*.66*)	1.28 (*1.04*)	.90 (*.92*)
CRT_DEL	2.13 (*.79*)	1.35 (*.98*)	2.02 (*.98*)
S_CRT_INT	.60 (*.78*)	1.13 (*.94*)	1.23 (*.80*)
S_CRT_DEL	2.10 (*.84*)	1.62 (*.98*)	1.77 (*.80*)
CONG	2.20 (*.52*)	.93 (*.83*)	2.74 (*.70*)
INCONG	1.33 (*.80*)	1.23 (*.92*)	1.84 (*1.04*)
S_CONG	1.70 (*.69*)	1.17 (*.81*)	1.24 (*.43*)
S_INCONG	1.25 (*1.21*)	1.05 (*1.11*)	1.50 (*1.22*)

Note: REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test; CRT_DEL = Deliberative responses on Cognitive Reflective Test; S_CRT_INT = Intuitive responses on the social version of the Cognitive Reflection Test; S_CRT_DEL = Deliberative responses on social version of the Cognitive Reflection Test; CONG = Non-conflicting accuracy for congruent syllogisms; INCONG = Conflicting accuracy for Incongruent syllogism; S_CONG = Non-conflicting accuracy for congruent social syllogisms; S_INCOG = Conflicting accuracy for Incongruent social syllogisms.

Correlations among the dependent variables are presented in Table 8.5. Correlational analysis was carried out to examine the relationships between all measures of reasoning style for the entire sample. Such correlational analysis examined whether accuracy for social and non-social reasoning tasks was associated with self-report and non-social based measures of reasoning style. Due to the large number of correlations computed, the alpha level was set conservatively at 0.001 for all analyses in order to minimise Type I error and reduce the likelihood of reporting statistically significant, but inconsequential, relationships.

As indicated in Table 8.5, REI_INT scores were negatively associated with deliberative responses on the CRT and positively associated with congruent syllogisms scores, but were unrelated to the remaining measures of reasoning style (all $p > .001$). REI_DEL scores were not associated to any measure of reasoning style (all $p > .001$). The number of intuitive responses on the CRT were negatively associated with the deliberative responses on the CRT and the deliberative responses on. Furthermore, the intuitive responses on the CRT were positively associated with the intuitive responses on the S_CRT. CRT_DEL responses were positively associated with the deliberative responses on the S_CRT and negatively associated with the intuitive responses on the S_CRT. The intuitive responses on the S_CRT were negatively associated with the deliberative responses on the S_CRT. Incongruent syllogism scores were positively associated with incongruent social syllogisms. Finally, social congruent syllogism scores were positively associated with incongruent social syllogisms. There were no other significant associations between any other measures of reasoning style (all $p > .001$).

Table 8.5

Bivariate correlations for dependent variables assessing reasoning style (N = 94)

	REI_DEL	CRT_INT	CRT_DEL	S_CRT_INT	S_CRT_DEL	CONG	INCONG	S_CONG	S_INCON
REI_INT	.13	.19	-.33**	-.02	.13	.69**	.11	.03	-.05
REI_DEL		-.15	.17	-.02	.12	-.00	.22	-.19	.04
CRT_INT			-.72**	.51**	-.56**	-.18	.14	-.00	.14
CRT_DEL				-.68**	.76**	.24	-.11	.07	-.16
CRT_2_INT					-.88**	.02	.20	-.03	.21
CRT_2_DEL						.05	-.15	.05	-.18
CONG							.21	.08	.03
INCONG								.20	.69**
S_CONG									.31**

** $p < .001$

Turning to the relationship between SPQ_POS and AQ scores, a bivariate correlation revealed a significant positive association between SPQ_POS and AQ scores for the entire group. However, when the groups were considered separately, none of the above relationships remained significant for either the Psychosis group, the ASD group, or the Control group. On examination of scatter plots displaying all groups' data, it appeared that the original correlations observed for the entire sample may have represented group differences rather than actual monotopic relationships.

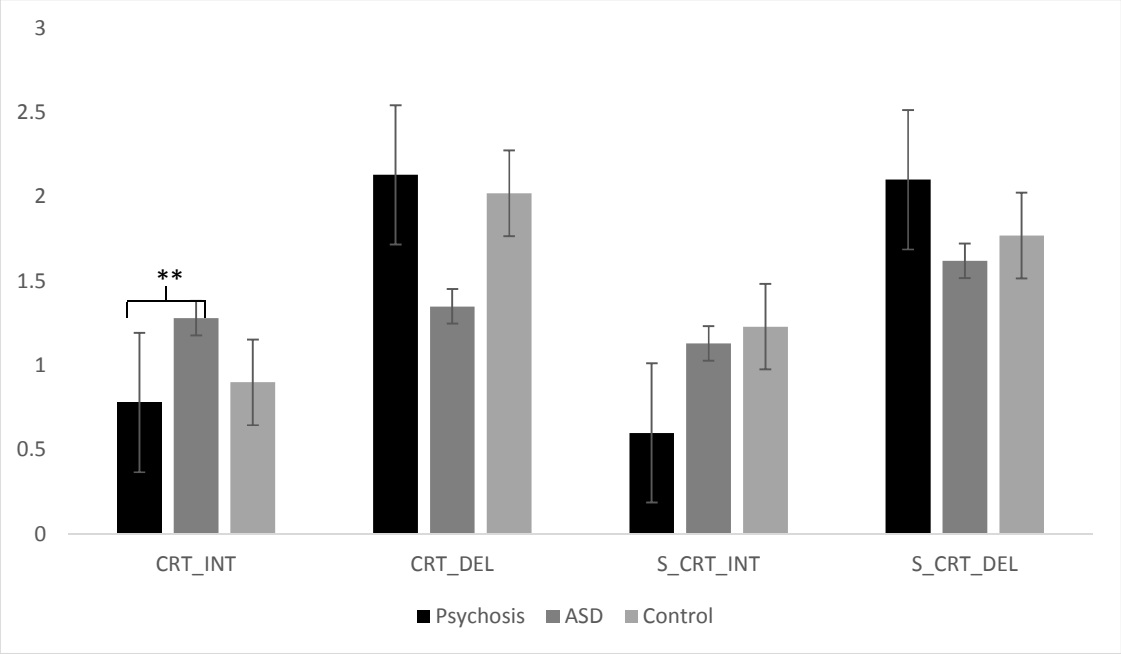
Between Group Analysis of Reasoning Style Measures

To test Hypotheses 1-4, a one-way MANCOVA was conducted to explore whether there were any differences amongst the three groups (Psychosis, ASD, and Control) on the measures of reasoning style. Due to significant differences in Age and NVIQ scores, both of these variables were used as covariates. Prior to the analysis, the data were inspected for univariate outliers, which were conceptualised as scores more than three standard deviations from the corresponding group mean. This was also confirmed by the Mahalanobis distance ($p > .001$), thus no univariate outliers were identified. Homoscedasticity of the samples was confirmed by Box-M ($p < .001$). The analysis yielded a statistically significant MANCOVA effect (*Wilk's* $\Lambda = .059$, F (20, 256) = 39.735, $p < .001$, multivariate $\eta^2 = .75$) between the three groups across measures of reasoning style when controlling for both age and NVIQ. The multivariate $\eta^2 = .75$ indicated that approximately 75% of the multivariate variance of the dependent variables is associated with the group factor.

Bonferroni comparisons were subsequently conducted for each of the significant ANCOVAs to further isolate where the differences between the three groups resided. Bonferroni comparisons showed that, for CRT_INT scores, participants in the Psychosis group had statistically significantly lower mean scores than participants in the ASD group ($p < .005$), but not with the Control group ($p > .005$). There were no significant differences between the ASD and Control group ($p > .005$). For REI_INT scores, Bonferroni comparisons showed that the Control group had statistically significantly higher mean scores than participants from either the Psychosis ($p < .001$) and the ASD group ($p < .001$). The ASD group also had statistically significantly lower mean scores on the REI_INT than the Psychosis group ($p < .001$). Turning to REI_DEL, Bonferroni comparisons yielded that the Control group had statistically significantly higher mean scores than participants from the Psychosis group ($p < .001$), but not the ASD group ($p > .005$). The ASD group did have statistically significantly higher mean scores than participants from the Psychosis group ($p < .001$), but not the Control group ($p > .005$).

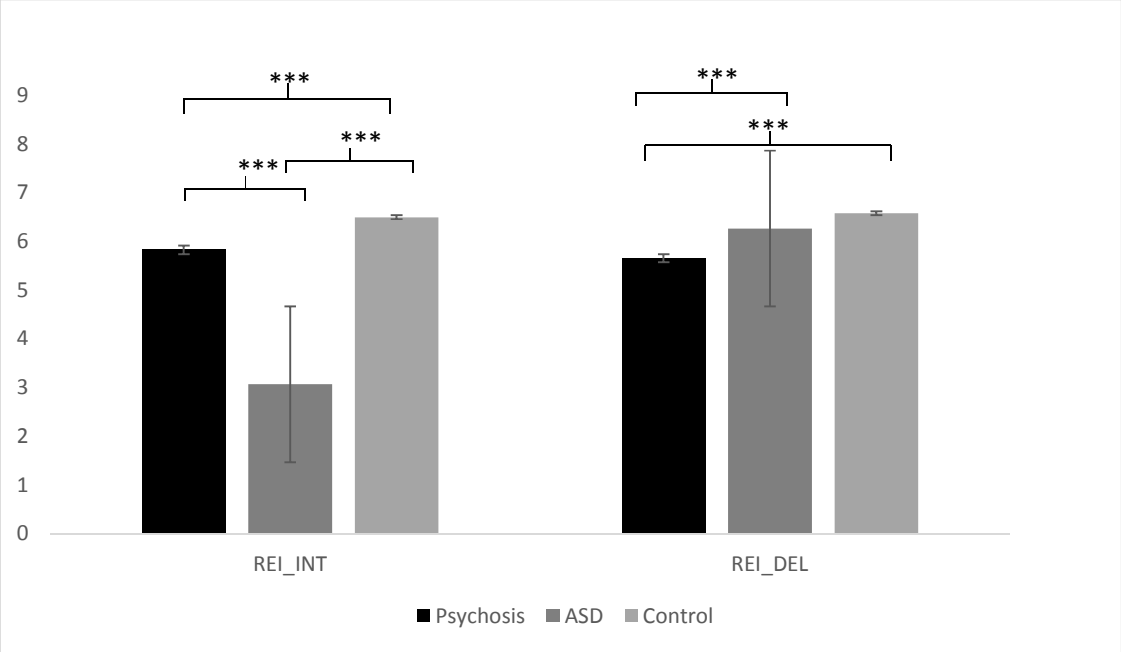
Participants in the Psychosis group had statistically significantly higher mean scores than participants in the ASD group ($p < .005$) and significantly lower mean scores than the Control group on CONG reasoning ($p < .005$). The ASD had a statistically significantly lower mean scores than participants in the Control group on CONG reasoning ($p < .005$). Finally, the Control group had significantly higher mean scores than the ASD group on INCONG reasoning scores ($p < .005$), but not the Psychosis group ($p > .005$). There were no other significant differences between the ASD and the Psychosis groups ($p > .005$). Finally, there was a significant difference between the Psychosis group and ASD group on S_CONG scores ($p < .005$).

For clarity and simplicity, the aforementioned significant relationships are visually presented in the form of error bar graphs in Figures 8.1-8.3.



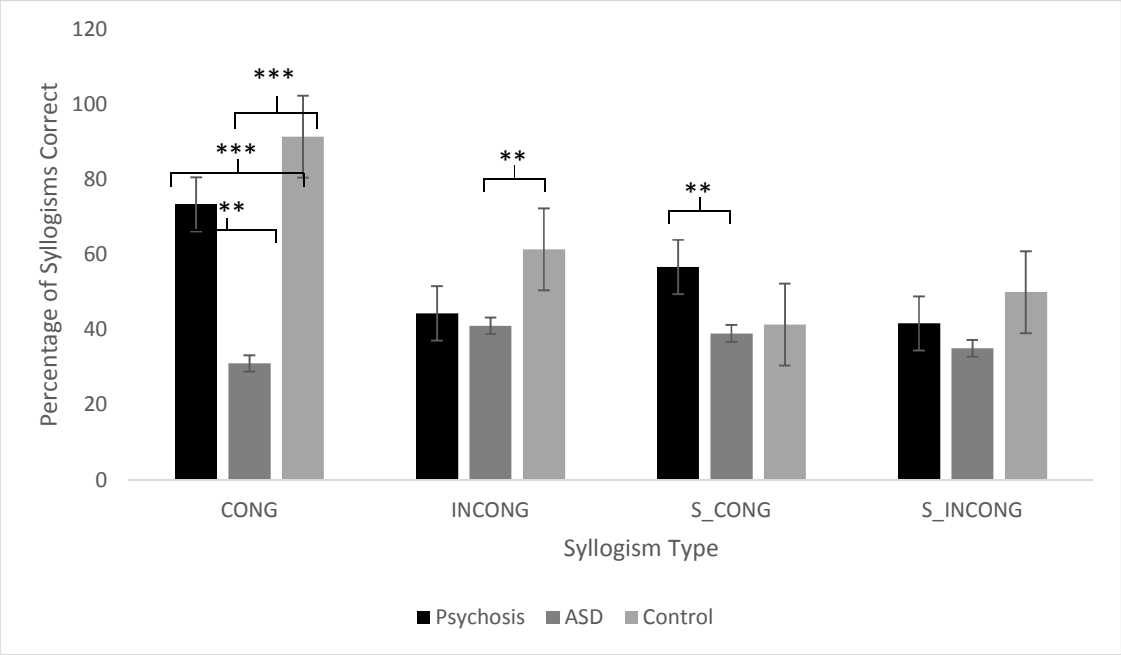
Note. ** = $p < .005$

Figure 8.1: Mean number of intuitive and deliberative responses between the three groups across both the traditional and social version of the CRT. The ASD group provided significantly more intuitive responses than the Psychosis group. There were no other significant differences amongst the three groups.



Note. *** p = < .001

Figure 8.2: The mean scores of self-report measures of intuitive and deliberative reasoning between the three groups. Both the Psychosis and Control groups attained higher self-report scores of intuitive reasoning than the ASD group. The Control group reported higher self-report intuitive scores than the Psychosis group. The Control group also reported higher deliberative reasoning preferences than the Psychosis group. The ASD group reported higher preferences for deliberative reasoning style than the Psychosis group.



Note. ** = $p < .005$, *** $p < .001$

Figure 8.3: The mean percentage of correct responses for all three groups when assessing the logical validity of syllogisms in which the premises conflicted with everyday knowledge (i.e. incongruent) or did not conflict with everyday knowledge (i.e. congruent). In addition, the Figure shows mean percentage of correct responses for all three groups when assessing the logical validity of social syllogisms for both congruent (S_Social) and incongruent (S_INCONG). Both the Psychosis and Control groups had higher mean accuracy scores on the CONG syllogisms than the ASD group. The Control group also had higher mean accuracy scores than the Psychosis group. The Control group had higher mean accuracy scores than the ASD group on INCONG scores. Finally, the Psychosis group had higher mean accuracy scores on social congruent syllogisms than the ASD group.

Hierarchical Regression Analyses

The final stage of the analysis involved a hierarchical multiple regression analysis for the entire sample. Hierarchical multiple regression analyses were conducted in order to investigate the association between reasoning style performance (social and non-social), psychosis traits, autism traits and the discrepancy between autism and psychosis traits (PAB score), whilst controlling for age and NVIQ. Beta estimates for the models and all dependent variables of reasoning style are presented in Tables 8.6-8.11.

For the model predicting intuitive responses on the Cognitive Reflection Test, CRT_INT scores were first regressed onto Age and NVIQ scores (see Table 8.6). The regression model was significant ($R^2_{adj} = .16$, $F_{(2, 139)} = 15.24$, $p < .001$), with the two predictors collectively explaining 16% of the variance in CRT_INT scores. Age (β = -.18, $p = .025$) and NVIQ (β = -.33, $p < .001$) were both negative predictors of CRT_INT scores. At the second step, SPQ_POS and AQ scores were entered. The regression model remained significant ($R^2_{adj} = .21$, $F_{(4, 137)} = 10.73$, $p < .001$), with the four predictors jointly explaining 22% of the variance in CRT_INT scores. AQ (β = -.23, $p = .007$), SPQ_POS (β = .19, $p = .016$) and NVIQ (β = -.32, $p < .001$) scores were uniquely associated with CRT_INT performance, but Age (β = -.11, $p = .167$) was not. The signs of the coefficients suggested that elevated levels of autism traits and higher NVIQ scores were negatively related to intuitive responses on the CRT, whilst higher SPQ_POS scores positively predicted intuitive responses on the CRT.

The same regression sequence was applied to the deliberative responses of the CRT (Table 8.6). At the first step, CRT_DEL scores were regressed onto Age and NVIQ. The regression model was significant ($R^2_{adj} = .30$, $F_{(2, 139)} = 31.77$, $p < .001$), with the two predictors explaining 30% of the variance in CRT_DEL scores. Age (β = .17, $p = .021$) and NVIQ (β = .17, $p = .021$) were both significant predictors of CRT_DEL scores. AQ and SPQ_POS scores were entered at the second step. The regression model was significant (R^2 adj = .09, $F_{(4,137)} = 20.83$, $p < .001$), with the four predictors collectively explaining 36% of the variance in CRT_DEL scores. AQ (β = .22, $p = .003$) and NVIQ (β = .17, $p = .021$)

were uniquely and positively associated with CRT_DEL scores, whilst SPQ_POS scores was negatively associated with CRT_DEL scores (β = -.21, p = .003). Age did not reach significance (β = .10, p = .156).

Turning to self-report measures of reasoning style, the aforementioned regression sequences were again applied to both the REI_INT and REI_DEL scores. Firstly, REI_INT scores were regressed onto Age and NVIQ. The regression model reached significance (R^2_{adj} = .23, $F_{(2, 139)} = 22.46$, $p < .001$), with the two predictors explaining 23% of the variance in REI_INT scores. Age (β = .15, p = .044) and NVIQ (β = .42, $p < .001$) were both significant positive predictors of REI_INT scores. AQ and SPQ_POS were entered as the second step. The regression model remained significant (R^2 adj = .33, $F_{(4,137)}$ = 18.48, p < .001), with the four predictors collectively explaining 33% of the variance in REI_INT scores. SPQ_POS (β = -.29, $p < .001$), Age (β = .21, $p = .006$) and NVIQ (β = .47, p < .001) scores were uniquely and positively associated with REI_INT scores, whilst AQ scores were not (β = -.08, p = .259). When REI_INT was replaced with REI_DEL, REI_DEL was regressed onto Age and NVIQ as the first step. The regression model did not reach significance (R^2 adj = .33, $F_{(2,139)}$ = .368, p = .693). When AQ and SPQ_POS scores were added to the model as a second step, the regression model reached significance (R^2_{adj} = .06, $F_{(4,137)}$ = 3.40, p = .011), with the four predictors explaining 6% of the variance of REI_DEL scores. AQ (β = .21, p = .018) was a significant positive predictor of REI_DEL scores, whereas the SPQ_POS (β = -.28, p = .002) score was negatively associated with REI_DEL scores. Both NVIQ (β = .03, p = .713) and Age (β = .01, p = .855) did not reach significance.

Considering syllogistic reasoning performance, when SPQ_POS and AQ were added to the model as a second step, the regression model was significant (R^2_{adj} = .01, $F_{(4,137)}$ = 15.07, p < .001). Collectively, all four predictors explained 26% of CONG scores. NVIQ (β = .37, p < .001) was a significant positive predictor of CONG scores, whilst SPQ_POS (β = -.41, p < .001) scores were negatively predictive of CONG scores. Age (β = .09, p = .242) and AQ (β = .03, p = .715) were not uniquely associated with CONG scores. Replicating the regression sequence, but regressing Age and NVIQ on INCONG

scores as the first step resulted in the overall model being significant ($R^2_{adj} = .10$, $F_{(2, 139)} = 9.23$, $p < .001$), with the two predictors explaining 11% of the variance in INCONG scores. Age (β = -.35, $p < .001$) was a significant negative predictor of INCONG performance, whereas NVIQ (β = .09, $p = .243$) was unrelated to INCONG scores. Finally, when AQ and SPQ_POS scores were added to the model as a second step, the model remained significant ($R^2_{adj} = .13$, $F_{(4, 137)} = 6.65$, $p < .001$), with all four predictors explaining 14% of the variance of INCONG scores. AQ (β = -.233, $p = .009$) and AGE (β = -.27, $p = .002$) were negatively associated with INCONG reasoning scores, whilst NVIQ (β = .10, $p = .187$) and SPQ_POS (β = .01, $p = .891$) were unrelated to INCONG scores.

Psychosis-Autism Bias and Reasoning Style

In addition to examining associations between reasoning style and participants' raw scores on the SPQ_POS and AQ, the PAB score was also included in the hierarchical regression analyses. The above sequence of regression analyses was repeated, but replacing the SPQ_POS and the AQ with the PAB. In each of these regression models, Age and NVIQ were still entered as step one, while step two involved adding the PAB. The following results describe step 2 of the regression analysis to avoid repetition (Tables 8.8 and 8.9).

For CRT_INT scores, when PAB was entered as the second step, the regression model was significant overall ($R^2_{adj} = .22$, $F_{(3, 138)} = 14.35$, $p < .001$). PAB score (β = .24, $p = .002$) was a positive predictor of CRT_INT scores, whilst NVIQ (β = -.35, $p < .001$) was a negative predictor of CRT_INT scores. Age was unrelated to CRT_INT (β = -.12, $p = .122$). Replacing CRT_INT with CRT_DEL revealed that the overall model remained significant ($R^2_{adj} = .36$, $F_{(3, 138)} = 27.97.35$, $p < .001$). PAB score (β = -.26, $p < .001$) was a negative predictor of CRT_DEL scores, whilst NVIQ (β = .50, $p < .001$) was a positive predictor of CRT_DEL scores and Age (β = .110, $p = .128$) was unrelated to CRT_DEL scores.

Turning to self-report measures, when REI_INT was the dependent variable, second step analysis revealed that the model was significant ($R^2_{adj} = .24$, $F_{(3, 138)} = 16.45$, $p < .001$). However, only NVIQ (β = .43, $p < .001$) was a significant positive predictor of

REI_INT scores. PAB score (β = -.14, p = .060) and Age (β = .12, p = .118) were unrelated to REI_INT scores. When REI_INT was replaced with REI_DEL, the model was significant (R^2_{adj} = .06, $F_{(3, 138)} = 4.45$, p = .005). PAB was the only significant negative predictor (β = -.29, p = .001). Finally, when examining syllogistic reasoning performance, the model was significant when using CONG as the dependent variable (R^2_{adj} = .14, $F_{(3, 138)} = 8.93$, p = .005). PAB score (β = -.24, p = .003) was a negative predictor of CONG performance, while the NVIQ score (β = .32, p < .001) was a positive predictor of CONG performance. Age (β = -.08, p = .118) was unrelated to CONG performance. When CONG performance was replaced with the INCONG model, the model was significant (R^2_{adj} = .11, $F_{(3, 138)} = 7.12$, p = .005). However, Age was a significant predictor (β = -.32, p = .003).

Reasoning Style and Psychosis and Autism traits within Social Content

Lastly, hierarchical regression analyses were run using the same sequence of steps in the aforementioned sections. However, the social variants of the reasoning task were used as the dependent variables (S_CRT_INT, S_CRT_DEL, S_CONG and S_INCONG). For the first set of regression analyses, SPQ_POS and AQ were used as the predictor variables, whilst the second set of regression analyses involved replacing the SPQ_POS and AQ with the PAB. In both sets of analyses, Age and NVIQ were entered as the first step due to the significant differences amongst the three groups.

As illustrated in Table 8.10, neither SPQ_POS nor AQ scores independently contributed significant to intuitive or deliberative responses on the social variant of the CRT.

When S_CONG was used as the dependent variable, overall the model was not significant (R^2_{adj} = .07, $F_{(4, 137)} = 1.53$, p = 196). SPQ_POS or AQ were not significant predictors of S_CONG performance. When S_CONG was replaced with S_INCONG, the model was significant (R^2_{adj} = .07, $F_{(4, 137)} = 7.07$, p < .001). The SPQ_POS score (β = .23, p = .005) was a significant positive predictor of S_INCONG score. The AQ score (β = -.23, p = .008) was a negative predictors of S_INCONG scores.

Reasoning Style and PAB score using Social Content

As shown in Table 8.11, PAB was unrelated to both intuitive and deliberative responses on the social version of the CRT. The PAB score was also unrelated to the S_CONG score. However, when S_INCONG was used as the dependent variable, the overall model was significant ($R^2_{adj} = .08$, $F_{(3, 138)} = 9.50$, $p < .001$), while the PAB score ($\beta = .27$, $p = .008$) was a significant negative predictor of S_INCONG score.

Table 8.6 – *Hierarchical regressions of REI and CRT performance on NVIQ and age (Step 1), Psychosis and autism traits (Step 2)*

Regression Model	Predictor	B	SE	β
CRT_INT				
Step 1	AGE	-.026	.011	**-.18***
	NVIQ	-.028	.007	**.33***
Step 2	AGE	-.016	.012	-.11
	NVIQ	-.029	.006	**-.35***
	SPQ_POS	.020	.008	**.19***
	AQ	-.034	.012	**-.23***
CRT_DEL				
Step 1	AGE	.026	.011	**.17***
	NVIQ	.044	.007	**.48***
Step 2	AGE	.017	.012	.10
	NVIQ	.045	.006	**.50***
	SPQ_POS	-.024	.008	**-.21***
	AQ	.035	.012	**.22***
REI_INT				
Step 1	AGE	.039	.019	**.15**
	NVIQ	.062	.011	**.42***
Step 2	AGE	.053	.019	**.21**
	NVIQ	.069	.010	**.47**
	SPQ_POS	-.05	.013	**-.29**
	AQ	-.022	.020	-.08
REI_DEL				
Step 1	AGE	.010	.012	.07
	NVIQ	.000	.007	.00
Step 2	AGE	.002	.012	.01
	NVIQ	.002	.017	.03
	SPQ	-.027	.008	**-.28**
	AQ	.030	.013	**.21**

Note: Bold is significant at p < .05 Bold* is significant at p < .001

Table 8.7 – *Hierarchical regressions of syllogistic reasoning performance on NVIQ and Age (Step 1), Psychosis and autism traits (Step 2).*

Regression Model	Predictor	B	SE	β
CONG				
Step 1	AGE	.008	.013	.05
	NVIQ	.029	.008	**.30***
Step 2	AGE	.015	.013	.09
	NVIQ	.035	.007	**.37***
	SPQ_POS	-.048	.009	**-.41***
	AQ	-.005	.013	**-.03**
INCONG				
Step 1	AGE	-.055	.013	**-.35**
	NVIQ	.009	.007	.09
Step 2	AGE	-.042	.013	-**.27**
	NVIQ	.010	.007	.10
	SPQ_POS	.001	.009	.01
	AQ	-.036	.014	**-.23**

Note. Bold is significant at $p < .05$; Bold* is significant at $p < .001$

Table 8.8 – *Hierarchical regressions of CONG and INCONG performance with PAB as predictor (Step 2).*

Regression Model	Predictor	B	SE	β
INCONG				
Step 2	AGE	-.050	.013	**-.32***
	NVIQ	.008	.007	.08
	PAB	.110	.067	.13

Note. Bold is significant at p < .05; Bold* is significant at p < .001

Table 8.9 – *Hierarchical regressions of REI and CRT performance with PAB as predictor (step 2).*

Regression Model	Predictor	B	SE	β
CRT_INT				
Step 2	AGE	-.018	.011	-.12
	NVIQ	-.029	.006	**-.35***
	PAB	.191	.059	**.24**
CRT_DEL				
Step 2	AGE	.017	.011	.11
	NVIQ	.045	.006	**.50***
	PAB	-.21	.057	**-.26**
REI_INT				
Step 2	AGE	.031	.019	.12
	NVIQ	.063	.011	**.43***
	PAB	-.191	.101	**-.14**
REI_DEL				
Step 2	AGE	.000	.012	.00
	NVIQ	.002	.007	.02
	PAB	-.215	.061	**-.29**

Note. Bold is significant at $p < .05$; Bold* is significant at $p < .001$

Table 8.10 -Hierarchical regressions of Social reasoning performance using CRT_2, S_CONG and S_INCONG with NVIQ and Age (Step 1), Psychosis and autism traits (Step 2)

Regression Model	Predictor	B	SE	β
S_CRT_INT				
Step 1	AGE	-.029	.011	**-.20**
	NVIQ	-.20	.007	**-.25**
Step 2	AGE	-.026	.012	-.18
	NVIQ	-.109	.007	**-.23**
	SPQ_POS	-.009	.008	-.09
	AQ	-.006	.012	-.04
S_CRT_DEL				
Step 1	AGE	.023	.011	.16
	NVIQ	.028	.006	**.35***
Step 2	AGE	.020	. 0 1	.14
	NVIQ	.029	.006	**.36***
	SPQ_POS	-.010	.008	-.10
	AQ	.013	.012	.09
S_INCONG				
Step 1	AGE	-.073	.019	**-.32**
	NVIQ	.015	.011	.11
Step 2	AGE	-.058	.020	**-.25**
	NVIQ	.012	.011	.09
	SPQ	.039	.014	**.23**
	AQ	-.055	.020	**-.27**

Note. Bold is significant at p < .05; Bold* is significant at p < .001

Table 8.11 -Hierarchical regressions of Social reasoning performance using CRT_2_INT, CRT_2_DEL, S_CONG and S_INCONG

Regression Model	Predictor	B	SE	β
CRT_2_INT				
Step 2	AGE	-.030	.012	**-.21**
	NVIQ	-.020	.007	**-.25**
	PAB	-.027	.060	-.03
CRT_2_DEL				
Step 2	AGE	.019	.011	.14
	NVIQ	.029	.006	.**36***
	PAB	-.086	.058	-.11
S_INCONG				
Step 2	AGE	-.059	.019	**-.25**
	NVIQ	.012	.011	.09
	PAB	.340	.097	**.27**

Note. Bold is significant at p < .05; Bold* is significant at p < .001

Table 8.12

Summary of Results from Hieratical Multiple Linear Regression

Reasoning Style Measure	Age	NVIQ	SPQ_POS	AQ	PAB
REI_INT	+	+	-	ns	-
REI_DEL	ns	ns	-	+	-
CRT_INT	ns	-	+	-	+
CRT_DEL	ns	+	-	+	-
S_CRT_INT	ns	ns	ns	ns	ns
S_CRT_DEL	ns	ns	ns	ns	ns
CONG	ns	+	-	ns	ns
INCONG	-	-	ns	-	ns
S_CONG	ns	ns	ns	ns	ns
S_INCONG	-	ns	+	-	+

Note. Ns = Non-Significant; + = positive association, - = negative association.

Table 8.12 shows a summary of the overall relationships between reasoning style measures and individual scores of SPQ_POS, AQ, NVIQ, AGE, and the PAB.

Discussion

The findings demonstrated that there were no significant differences between the groups for reasoning style when social variants of the CRT (hereafter, S-CRT) and incongruent social syllogisms were employed. There was, however, a significant difference between the Psychosis group and ASD group in terms of higher accuracy scores on social congruent syllogisms. In general, it appeared that changing the content of the reasoning tasks had little impact on groups of participants with a high degree of psychosis and autism traits. Turning to group differences for the non-social variants of the reasoning style tasks, the psychosis group did not provide significantly more intuitive responses than the ASD or the Control group on the standard version of the CRT. Lastly, self-report reasoning style preferences amongst the three groups revealed that it was the Control group that had higher preferences for self-report intuitive reasoning using the Rational Experiential Inventory (hereafter, REI) in contrast to the ASD and Psychosis group. Further to this, the ASD group did report a more deliberative style of reasoning than the Psychosis group.

Contrary to the main hypothesis, people with high psychosis traits did not provide the more deliberative responses on the S-CRT in contrast to the ASD or the Control group. In addition, the ASD group did not provide significantly more intuitive responses on the S-CRT. From this viewpoint, it appeared that changing the content of the original CRT did not impact on reasoning style in people with high psychosis or autism traits. One argument could be that the modification to the CRT to create the S-CRT may have impacted on the initial intuitive 'lure' the original CRT had. However, this seems unlikely, as the intuitive and deliberative responses on the S-CRT positively and significantly correlated with the original intuitive and deliberative responses on the CRT. In addition, individual measures of cognitive ability were positively and significantly correlated with deliberative responses on the S-CRT. The association between measures of cognitive ability and deliberative responses has consistently been found in the original CRT (Toplak, West, & Stanovich, 2011; Shenhav, Rand, Greene, 2012; Pennycook, Cheyne Koehler, & Fugelsang, 2013; Stanovich and West, 2008). Furthermore, parallel

to the original CRT, the intuitive and deliberative responses on the S-CRT were negatively associated with one another. Thus, it is plausible to assume that the CRT and S-CRT were measuring the same underlying processes that were associated with intuitive and deliberative reasoning styles. Another possible explanation could be that completing the CRT twice, albeit a different version, may have had implications for reasoning style performance. For instance, if participants complete some of the items of the CRT, they may become aware of the structure of the questions and may automatically start to question their initial first response, thus engaging in a more deliberative style of reasoning. In other words, performance could have improved through practice-based effects.

In terms of social syllogisms, people in the psychosis group did not display enhanced accuracy on incongruent social syllogisms, but did acquire significantly higher scores on the social congruent syllogisms. This was unexpected, as the structure of congruent syllogisms is predicated on intuitive belief-based responses, which are consistent with the logical structure of the syllogism (Stanovich & West, 2000). In other words, there is no conflict between belief and logic. Given the fact that the Psychosis group did obtain significantly higher scores on these syllogisms in contrast to the control and ASD group, this may demonstrate that people with high degrees of psychosis may have been more accurate at identifying the believability of the premises and conclusion. Overall, when comparing groups of participants with high expressions of psychosis and autism with a matched Control group on social variants of reasoning style tasks, there were limited differences. This, therefore, suggests that modifying the content of the reasoning task did not have an impact on psychosis or autism traits.

Turning to group differences for the non-social variants of the reasoning style tasks, the Psychosis group did not provide significantly more intuitive responses than the ASD or the Control group on the standard version of the CRT. Further to this, the Psychosis group did not provide significantly less deliberative responses in contrast to the ASD or Control group. This finding suggests that participants considered to reside towards the higher end of the psychosis continuum do not have an inclination towards

intuitive relative to a deliberative style of reasoning, as initially hypothesised. However, individual scores on the SPQ_POS were found to be significantly predictive of intuitive responses on the CRT, as well as being negatively associated with deliberative responses on the CRT, thus suggesting that individual trait score was related to behavioural reasoning style as opposed to group differences alone. Surprisingly, the ASD group provided significantly more intuitive responses than the Psychosis group, but not the Control group. This finding is contrary to previous research findings in ASD samples, whereby such individuals have been found to provide significantly *less* intuitive responses than Control groups (Brosnan, Lewton, & Ashwin, 2015; Brosnan, Hollinworth, & Antoniadou, 2014; Lindeman & Lipsanen, 2016). Further to this, such findings suggest that people with ASD provide the intuitive response just as willingly as people without ASD. This may suggest that, as an intuitive response has been provided, deliberative processing may not be as dominant as previously hypothesised in people with ASD. The inconsistent and contradictory results between the current study and previous studies highlight the variation in how people respond when presented with the CRT. One explanation could be that CRT performance across people with and without ASD is actually quite similar. Previous differences that have been reported may, in fact, be the product of better numeracy skills, as some studies have highlighted how performance on such a reasoning style measure is closely related to numeric skills (Welsh, Burns, & Delfabbro, 2013). On the other hand, AQ trait scores were positively predictive of deliberative responses and negatively predictive of intuitive responses on the CRT. This association is in line with the prediction that an increasing expression of autism is characterised by a profile of deliberative relative to intuitive reasoning. Taken together, such findings suggest that it is the trait scores as opposed to diagnostic groups that are more predictive of reasoning style when assessed by the CRT. One explanation for this could perhaps be that participants considered to have ASD, or a diagnosis of psychosis, exhibit overlapping traits, thus group-based analyses may disguise the effects individual traits may have on reasoning style. Interestingly, the PAB was found to be a positive predictive of intuitive responses on the CRT and negatively predictive of

deliberative responses on the CRT. Again, this is in line with the original hypothesis. This association is particularly fruitful, as it further highlights the notion that the discrepancy between psychosis and autism trait scores is also informative of predicting reasoning style. Such findings are complementary to both the diametric disorders hypothesis and Baron-Cohens et al.'s (2002; 2009) extreme male brain theory.

Regarding syllogistic reasoning performance, the Psychosis group attained significantly higher scores on non-social congruent syllogisms, whereby the premises were fitting with existing beliefs in contrast to the ASD group, but not the Control group. This particular finding is in contrast to Mirian et al. (2011), who found no significant differences between a schizophrenia and a control once cognitive ability had been controlled for. One unanticipated finding was that the Control group had significantly higher scores on incongruent syllogisms in contrast to the ASD group. Considered together, this was an unexpected finding as people in the ASD were predicted to have higher accuracy scores on incongruent syllogisms, thus demonstrating a propensity for deliberative as opposed to intuitive reasoning style. Indeed, these findings further support the notion that people with ASD are no more likely to engage in deliberative reasoning compared to people without ASD. In contrast to the author's prediction, AQ traits were negatively associated with incongruent syllogism score, thus suggesting less deliberative reasoning style.

Comparing self-report reasoning style preferences amongst the three groups, it was found that the Psychosis group did not report a higher propensity for intuitive reasoning, as predicted; in fact, it was the Control group that had higher preferences for self-report intuitive reasoning using the REI. Although this finding was unexpected, it is however complementary and consistent with Freeman, Evans and Lister (2014), who also found that it was participants without schizophrenia who reported significantly higher preferences for intuitive reasoning, as measured by the REI. Similarly to Freeman et al., participants in the high psychosis group did report lower preferences for deliberative reasoning style in contrast to both the ASD and Control group. This finding was expected and provides further support for the notion that people residing towards

the higher end of the continuum are less likely to report a preference for engaging in a more deliberative style of reasoning. Notably, less motivation to engage in deliberative reasoning may result in a failure to revise paranoid beliefs or unusual experiences, which consequently may implicate reasoning biases. Indeed, as reviewed in Chapter 2, the most revised reasoning bias in relation to psychosis has been jumping to conclusions, henceforth individuals who are less motivated to reason deliberately may be less motivated to gather more data prior to making a decision. As predicted, however, the ASD group did have significantly lower preferences for engaging in an intuitive style of reasoning. This particular finding is supportive of earlier research studies using ASD samples (Luke et al., 2012; Brosnan, Lewton, & Ashwin, 2016; Koirikivi, 2014; Levin et al., 2015). However, in contrast to these aforementioned studies, the ASD group did not report higher preferences for self-report deliberative reasoning than the Control group. In spite of this, the ASD group did report higher preferences for deliberative reasoning than the Psychosis group. This is a fruitful finding and is consistent with the idea that mechanistic cognition is associated with a more deliberative style of reasoning, in addition to a proclivity for avoiding relying on hunches, gut feelings, automatic thoughts, etc., whilst hyper-mentalising may reflect a deviation away from deliberative reasoning. Moreover, such preferences for deliberative reasoning may be a useful point of demarcation between psychotic and ASDs. However, caution should be exercised here as self-report measures do not always relate to performance-based measures of reasoning style. Consequently, this suggests that participants may self-report a specific style of reasoning, but this is unrelated to actual reasoning style behaviour.

The present conclusions are restricted by a few conditions. Firstly, the samples of participants were wide-ranging. For example, the demographics of each participant were notably different, with an unequal percentage of people in full-time education versus people in employment. As previously discussed, there is some evidence to suggest that students respond differently to the CRT than people who are not in education (Brañas-Garza, Kujal, & Lenkei, 2016). Future research studies should set out to recruit samples that are more representative of the population at large, or perhaps

more equal samples of students versus non-students. Secondly, despite the novel aspect of integrating social syllogisms and a social variant of the CRT, it is difficult to establish whether such items were, in fact, being perceived as social. Indeed, in the validation study, all participants were PhD students and none of them had a diagnosis of a psychotic disorder or ASD. It could, therefore, be argued that people who self-reported a psychotic disorder or an ASD may have interpreted the stimuli differently. Next, although all reasoning style measures were intermixed, it could be that participants became more aware of the structure of the questions due to completing so many similar ones, thus cueing anticipation of a 'conflict' between potential answers. This may have encouraged individuals to shift from being intuitive and investing more time in reasoning deliberatively.

CHAPTER 9 – Pooled Analysis

Introduction

Given the inconsistency in results and various sizes of coefficients between the measures of psychosis and autism traits and reasoning style, it was considered informative and worthwhile to pool all the data from all participant samples collectively from Studies 2, 3, 4 and 5 into a single sample and focus specifically on how autism and psychosis traits are related to CRT, REI and incongruent syllogisms. Analysing such associations in a much larger sample will provide greater power to detect significant associations with reasoning style and autism and psychosis traits. Indeed, although studies 3 and 4 did not show that individual expressions of psychosis and autism traits were associated with reasoning style, the effect sizes were larger for many of the measures. With this in mind, overlapping measures of psychosis, autism and reasoning style from Chapters 4-8 will be collapsed into a single analysis to allow for a closer examination with a larger sample size, of which measures of psychosis and autism are specifically related to measures of reasoning style.

Method

Participants

All data from studies 2-5 were pooled into a single sample. This pool sample comprised of a total of 341 participants. There were 152 males and 189 females. Participants were aged 16-59 years old (mean=26.02, s.d. = 8.02). Within this sample a total of 70 participants self-reported a previous diagnosis of psychosis. 66 participants reported an existing diagnosis of ASD. The remaining participants reported that they had ever been diagnosed with a mental health condition.

Procedure

Datasets from studies 2-5 were exported and transferred to a new dataset. The data in this new dataset was then used to calculate appropriate descriptive and inferential statistics.

Data Preparation and Analysis

All data was exported from the Bristol Online Survey and analysed using the Statistical Package for the Social Sciences (SPSS) version 21. Inspection of the dataset revealed that there was no missing data. Parallel to Study 1, a series of Boxplots were created in order to establish whether there were any outliers for any of the variables under investigation. Visual inspection of the Boxplots revealed that there were no extreme scores on any of the variables under examination. Formal normality tests (Shapiro-Wilk) indicated that all dependent variables did not violate the assumption of normality ($p > .05$).

Descriptive statistics for all variables were calculated. Subsequently a series of Multiple Linear Regressions were conducted using the AQ and the SPQ_POS as the predictors and measures of reasoning style as the dependent variables. Lastly, the AQ and SPQ_POS were replaced with the Psychosis-Autism Bias.

Results

Table 9.0

Means, standard deviations (SD), range of measures used in pooled sample (N = 341)

Measure	Mean (*SD*)	Range
SPQ_POS	15.84 (*9.57*)	0-34
AQ	23.80 (*8.37*)	2-47
PAB	0.00 (*1.09*)	-3.07-3.08
REI_INT	4.03 (*1.44*)	1.75-7.80
REI_DEL	4.56 (*1.42*)	1.80-9.90
CRT_INT	1.07 (*.96*)	0-3
CRT_DEL	1.63 (*1.07*)	0-3
Incongruent	2.02 (*1.33*)	0-4

Note: AQ = Autism Quotient Score; SPQ_POS = Positive psychosis trait Score; PAB = Psychosis-Autism Bias; REI_INT = Rational Experiential Inventory Intuitive subscale; REI_DEL = Rational Experiential Inventory Deliberative subscale; CRT_INT = Intuitive responses on the Cognitive Reflective Test. CRT_DEL = Deliberative responses on Cognitive Reflective Test; INCONG = Conflicting accuracy for Incongruent syllogisms

As illustrated in Table 9.0, Mean scores, standard deviations, and ranges for all measures are reported. When analysing the above sample and controlling for Age, Gender and NVIQ, a partial zero-order correlations revealed a moderate correlation between SPQ_POS and AQ scores ($r = .41$, $p < .001$).

Table 9.1

Summary of Simultaneous Regression Analysis for Variables Predicting Reasoning Style (N = 341).

Regression Model	Predictor	B	SE	β
CRT_INT				
	SPQ_POS	.011	.005	**.11**
	AQ	-.039	.006	**-.34**
CRT_DEL				
	SPQ_POS	-.019	.006	**-.17**
	AQ	.037	.007	**.29**
REI_INT				
	SPQ_POS	-.016	.008	**-.12**
	AQ	-.009	.009	-.05
REI_DEL				
	SPQ_POS	-.034	.008	**-.23**
	AQ	.038	.009	**.22**
Incongruent				
	SPQ_POS	-.002	.008	-.02
	AQ	-.002	.009	-.01

Note. Bold indicates p < .05. All findings hold after controlling for Gender, Age and NVIQ.

As revealed in Table 9.1, SPQ_POS scores were positively related to the intuitive responses on the CRT and negatively related to the deliberative responses on the CRT. Further to this, SPQ_POS scores were negatively associated with self-report intuitive reasoning and negatively associated with deliberative reasoning style. There was no relationship between SPQ_POS and syllogistic reasoning accuracy. Comparatively, AQ scores were positively predictive of deliberative responses on the CRT and negatively predictive of intuitive responses on the CRT. Furthermore, AQ scores were positively

predictive of self-report deliberative reasoning, but were unrelated to self-report preferences for intuitive reasoning. AQ scores were unrelated to syllogistic reasoning performance.

Table 9.2 *Summary of Simultaneous Regression Analysis for the PAB Predicting Reasoning Style (N = 341).*

Regression Model	Predictor	B	SE	β
CRT_INT				
	PAB	.216	.043	**.24**
CRT_DEL				
	PAB	-.250	.048	**-.25**
REI_INT				
	PAB	-.036	.067	-.02
REI_DEL				
	PAB	-.325	.064	**-.24**
Incongruent				
	PAB	-.001	.062	-.00

Note. Bold indicates p < .05. All findings hold after controlling for Gender, Age and NVIQ.

Table 9.2 reveals the relationship between PAB scores and reasoning style. Again, these findings hold when controlling for age, gender and measures of non-verbal IQ. As revealed in Table 9.2, the PAB was a significant positive predictor of intuitive responses on the CRT and was a negative predictor of deliberative responses on the CRT. The PAB was a negative predictor of self-report deliberative reasoning but was unrelated to self-report intuitive reasoning. Finally, the PAB was unrelated to syllogistic reasoning accuracy.

Discussion

From a theoretical perspective, the findings in the combined analysis are in line with the dual process theory of autism (Brosnan, Lewton, & Ashwin, 2016). This data confirms with a much larger sample in which autism traits relate to deliberative processing, which is in line with Luke et al. (2012), who reported that people with ASD have a tendency to engage in more deliberative-style reasoning. Indeed, such association further highlights that people residing on the ASD continuum may have a bias for more effortful and slower reasoning (Brosnan, Ashwin, & Gamble, 2014). Notwithstanding these associations, it is difficult to explain why autism traits are not also related to enhanced performance on syllogisms. One explanation could be that the CRT assesses a propensity to use deliberative or intuitive reasoning, but perhaps not the ability to employ such a reasoning style as indexed by the syllogism accuracy. As a result, someone with high autism traits may be more predisposed to use deliberative reasoning but may not necessarily use it. Given the high negative correlation observed between intuitive responses on the CRT and incongruent accuracy, and the positive correlation between deliberative responses on the CRT and incongruent syllogism accuracy, it can be conjectured that both measures are likely to assess a person's reasoning style (Toplak et al., 2014; Campitelli, 2014). Indeed, many of the studies throughout this thesis have also revealed respective correlations ranging from .06-.07 between CRT responses and incongruent syllogism accuracy. Notwithstanding this, people residing on the ASD continuum are less likely to engage in a more intuitive style of reasoning, which has been found to be associated with more 'global processing' (Sadler-Smith et al., 2011; Dijkstra et al., 2012). The absence of global processing has been associated with enhanced performance on visual-spatial tasks (Almeida et al., 2014; Grinter et al., 2009; Steward et al., 2009).

The aforementioned relationships between reasoning style measures and psychosis traits extend to psychosis traits, which is consistent with Crespi and Badcocks' (2008) diametric disorders hypothesis, which proposes diametrically opposing styles of reasoning. From this position, it could be suggested that higher psychosis traits do indeed reflect a predisposition to intuitive reasoning, which may consequently relate to reasoning biases such as the 'jumping to conclusion' bias.

Turning to the PAB, there appeared to be little evidence to suggest that the discrepancy between psychosis and autism traits is more important than the measures in isolation. While Abel-Akel et al. (2015) contend that autism and psychosis traits are interacting, this interaction may not be present in all domains of cognition. It could, therefore, be argued that such effects are only likely to occur in social cognitive tasks as opposed to more general-based reasoning tasks. Given the inconsistency of the relationships throughout Studies 1 to 5, and the pooled analysis, this is perhaps a likely explanation.

CHAPTER 10 - General Discussion

This thesis set out to explore a number of key aims and hypotheses. One of the central aims of the thesis was to investigate how autism traits, psychosis traits, and the discrepancy between the two measures, were related to different styles of reasoning. In addition, another key aim of the thesis was to further examine whether autism and psychosis traits were overlapping, independent or diametrically opposed as outlined by the diametric disorders hypothesis (Crespi & Badcock, 2008). Further to this, the thesis also set out to examine whether reasoning style changed when dealing with social and non-social content. In this section, each of the main aims outlined at the end of Chapter 2 will be critically appraised in relation to the background literature and the current findings across all the experimental chapters. Subsequently, a review of the wider theoretical and clinical implications will be discussed, along with the methodological limitations of the current research and future research directions.

Reasoning style and its relationship with expressions of autism and psychosis traits

One of the primary objectives of the research was to examine how various expressions of autism and psychosis traits were associated with different styles of reasoning. Based on the background literature outlined in Chapter 2, it was conceived that people who endorse higher levels of psychosis traits were more likely to engage in an intuitive relative to a deliberative style of reasoning. In contrast, people who display higher levels of autism traits were expected to demonstrate a more deliberative as opposed to intuitive style of reasoning. In keeping with the widely held view that such traits reside on a continuum ranging from typicality to disorder, it was expected that increasing expressions of such traits would reflect more exaggeration of the respective reasoning style, henceforth such traits were examined across the autism spectrum disorders (ASD) and psychosis continua. These opposing styles of reasoning were also supportive of the diametric disorders hypothesis (Crespi & Badcock, 2008), which

proposes that diametric cognition exists between psychosis and ASD. From this perspective, the style of reasoning associated with autism traits should be diametrically opposing to that seen in psychosis traits. Nevertheless, as far as the author is aware, this is the first time the diametric disorders hypothesis has been applied to the assessment of different reasoning styles. Previous assessment had predominantly focused on social aspects of cognition such as perspective-taking (Abel-Akel et al., 2016), mentalising abilities (Frith, 2004), and perceptual processing (Russell-Smith, Maybery, & Bayliss, 2010). What follows is a summary and critical appraisal of what the findings through Studies 1-5 (Chapters 4-8) revealed in relation to the relationship between autism and psychosis traits and different reasoning styles.

In Study 1, it was revealed that autism traits were associated with a deviation away from self-reporting an intuitive style of reasoning. However, such association did not relate to performance measures of reasoning style. In addition, there was no support for the proposal that autism traits were associated with a more deliberative style of reasoning, either introspectively or behaviourally. In contrast, psychosis traits were associated with a preference for self-report intuitive reasoning and an increase in the number of intuitive responses provided on the CRT. One conclusion that can be drawn based on the data from Study 1 was that autism traits reflect a general propensity to avoid relying on intuitive reasoning. On the other hand, psychosis traits reflected a motivation to rely on intuitive reasoning in addition to being associated with the absence of inhibiting intuitive reasoning when completing the CRT.

Study 2 built on the findings from Study 1 by employing the full version measures of psychosis and autism traits alongside measures of cognitive ability; this was to confirm the specificity of relationships observed between psychosis and autism traits and reasoning style within Study 1. A second performance measure of reasoning style was employed to extend the findings from Study 1 and to verify such relationships were not task specific. In contrast to Study 1, autism traits were associated with an enhanced deliberative reasoning style and were negatively associated with intuitive reasoning across both self-report and performance-based measures of reasoning style. These

findings held after controlling for measures of cognitive ability. On the other hand, psychosis traits were unrelated to both self-report and intuitive and deliberative performance on the CRT. However, psychosis traits were negatively associated with incongruent reasoning scores on the syllogism tasks, which suggests that psychosis traits reflected a general difficulty for over-riding syllogisms when beliefs conflicted with the logical structure of the syllogism, thus demonstrating more belief-bias responding. This particular finding highlighted that, when beliefs conflict with logic, lower accuracy rates may be associated with increased endorsement of psychosis traits. These findings complement earlier research findings that revealed people with ASD are less likely to exhibit reasoning biases, which are considered a hallmark feature of an intuitive reasoning style (McKenzie, Evans, & Handley, 2010; Morsanyi, Handley, & Evans, 2010; De Martino, Harrison, Knafo, Bird, & Dolan, 2008).

Study 3 sought to examine how psychosis traits were associated with reasoning style using both between group analysis and regression analysis in a sample of participants considered to reside further along the psychosis continuum. In contrast to a matched Control group, participants in the psychosis group displayed a more intuitive relative to a deliberative style of reasoning. Indeed, this finding was consistent across all measures of reasoning style. Such findings revealed that people considered to reside along the upper end of the psychosis continuum were conceptualised as displaying a more intuitive relative to a deliberative style of reasoning when compared to a matched Control group. In addition, such differences held when controlling for individual differences in cognitive ability and impulsivity. These findings provide support for the proposal that people residing towards the higher end of the psychosis continuum do engage in a more intuitive style of reasoning when group comparison analysis is employed. Nonetheless, regression analysis yielded that the trait scores of both autism and psychosis in isolation had no consistent impact on reasoning style. From this viewpoint, analysing independent scores of the SPQ_POS and AQ as opposed to group level analysis provides two different types of results.

Study 4 recruited people with high degrees of autism traits and who all self-reported a formal diagnosis of ASD. A matched Control group was also recruited for group comparisons. Controlling for individual differences in non-verbal IQ, Study 4 revealed that, although participants with ASD were less likely to provide the intuitive responses on the CRT, they were not more likely to provide the deliberative responses than the matched Control group. In addition, the ASD group did not display a more deliberative style of reasoning across any of the other reasoning style measures. In contrast to previous research (Brosnan, Ashwin, & Gamble, 2014), there was no evidence to suggest that people with ASD exhibit a more deliberative relative to intuitive style of reasoning. Indeed, participants with ASD did not have higher accuracy scores on incongruent reasoning than the Control group. This finding implied that, when participants with ASD complete syllogisms, they do necessarily engage in a more deliberative style of reasoning, thus are no less susceptible to belief-bias responding. In contrast to previous studies (Brosnan, Lewton, & Ashwin, 2016; Luke et al., 2012; De Marito et al., 2009), there was no evidence to suggest that participants with ASD have a proclivity for more deliberative as opposed to intuitive reasoning style. Analysing the individual relationship between autism traits and reasoning style did not yield any consistent patterns of reasoning style when behavioural measures were used as the dependent variables. However, AQ scores were found to be negatively associated with self-report intuitive reasoning. This finding is consistent with the idea that AQ traits in isolation reflect a self-reported style away from intuitive reasoning style.

Study 5 explored how various degrees of psychosis and autism traits across three groups of participants were related to social and non-social variants of reasoning task. Focusing on the typical reasoning style measures and contrary to expectations, it was the ASD group that provided significantly more intuitive responses than the psychosis group on the CRT. Indeed, this was the opposite of what was expected and further highlights the inconsistency in reasoning style when the CRT is used to measure intuitive and deliberative reasoning style. Further to this, the ASD group did not provide significantly more deliberative responses on the CRT than the Control group or the

psychosis group. Nonetheless, this was consistent in Study 4 insofar that people with ASD do not necessarily engage in a more deliberative style of reasoning. In fact, the psychosis group did not provide significantly more intuitive responses than the Control group. Indeed, this is particularly surprising given that Study 3 revealed that there were significant differences between the psychosis groups in the number of provided intuitive responses than a matched Control group on the CRT. This difference in performance is difficult to explain, but does further highlight that other characteristics may play a significant role in whether or not people with a high expression of psychosis traits are likely to exhibit an over-reliance on intuitive reasoning, as indexed by intuitive responses on the CRT. Considering self-report measures, the findings remained consistent with previous findings. The ASD were significantly less likely to report a self-preference for an intuitive style of reasoning. The Control group was found to provide both higher levels of self-report intuitive and deliberative reasoning style in contrast to the ASD and psychosis group. Once again, these findings highlight the inconsistency of self-report preferences of reasoning style. Collectively, such amenable findings demonstrate that self-report preferences for reasoning style and intensities of autism and psychosis traits are not specifically associated with an explicit reasoning style profile. Lastly, there were many significant differences among the three groups for congruent reasoning accuracy, with the psychosis group reporting higher accuracy scores than the ASD and the Control group. However, in contrast to the original hypothesis, there were no significant differences between the psychosis group and ASD or Control group and incongruent reasoning. Surprisingly, the Control group obtained significantly higher accuracy scores on the incongruent syllogisms than the ASD group. Although this was unexpected, it is indeed in line with Study 4, which yielded that people with ASD are no less susceptible to belief-bias responding than people without ASD.

Turning to the individual trait scores, many of the relationships between the individual scores were fitting with the original hypothesis. For example, psychosis trait scores reflected more intuitive responses on the CRT and negatively associated with deliberative responses on the CRT. In addition, autism traits were associated with more

deliberative reasoning and negatively related to intuitive responses on the CRT. Further associations were found between AQ scores and self-report preferences for deliberative reasoning style. Finally, psychosis traits were found to be negatively associated with incongruent reasoning accuracy. Further to this, the pooled analysis in Chapter 9 provides further support for the relationship psychosis, autism and specificity of reasoning style. Interestingly, AQ traits were also found to be negatively associated with incongruent reasoning accuracy. Taken together, these findings are quite perplexing and suggest that AQ traits in isolation were actually negatively impacting on incongruent reasoning accuracy.

In summary, the findings of such an investigation were inconsistent with each other, but taken with the pooled analysis, provide support for the main hypotheses outlined in the introductory chapter. Indeed, although the findings did not all reach significant levels, in most cases they went in the expected direction, which was in line and consistent with theories such as the diametric disorders hypothesis. In view of the findings from Studies 1-5, there appears to be some discrepancy between group-based analysis, which reveals different results in contrast to individual expressions of psychosis and autism traits. For example, Study 2 found no relationship between expressions of psychosis traits and intuitive reasoning, yet Study 3 found significant differences in reasoning style between people who were considered to reside further along the psychosis continuum when compared to a matched Control group. However, when individual scores of psychosis traits were analysed, there was no relationship with reasoning style. One explanation for the absence of relationship between these two measures may have reflected an absence of power. Indeed, the pooled analysis in Chapter 9 does provide some credence to this idea. Alternatively, the different findings also suggests that different results occur depending on the type of analysis employed (group versus trait). With this in mind, it could be argued that the relationship between psychosis and reasoning style is not linear and may alter depending on the part of the continua that is assessed. For instance, it could be that the mid-range of the continuum, increasing psychosis relates to increasing intuitive reasoning but after a certain point

this relationship doesn't hold. This suggests that when reasoning style is assessed, researchers need to be aware of the theoretical differences that between categorical versus dimensional approaches to psychosis. Indeed, these inconsistent findings are contrary to what was stated by Freeman et al. (2014), who claimed that "psychosis may be partly driven by rapid gut feeling intuitions that are not then kept in check by the application of effortful logical reasoning" (Freeman et al., p. 454). The absence of consistent relationships is surprising, considering several previous studies had found how paranormal and supernatural beliefs were associated with an intuitive relative to deliberative style of reasoning (Aarnio & Lindeman, 2005; Genovese, 2005). Collectively, the findings in the current study highlight that, despite the similarities between psychosis traits and paranormal\supernatural beliefs, they appear to be phemenologically different to psychosis traits. The difference between these two constructs is, however, difficult to isolate, particularly given the high positive correlation between measures of psychosis traits and measures of supernatural beliefs (Irwin, Dagnall, & Drinkwater, 2012). Perhaps one explanation for the discrepancy in findings may relate to the notion that psychosis traits may reflect a reduced tendency for deliberative reasoning, but may not necessitate a more intuitive style of reasoning.

The Psychosis-Autism Bias and its Relationship with Reasoning Style

An additional novel aspect of the current research involved examining the discrepancy between psychosis and autism trait scores and investigating how this discrepancy score was associated with reasoning style. Indeed, this composite measure was an extension of both Brosnan et al. (2010) and Larson et al.'s (2015) 'empathising bias' and Baron-Cohens' (2009) 'd score', which represents the discrepancy between mentalising and mechanistic cognition, but uses different indices of mentalising and mechanistic cognition compared to the PAB. The current study uses the Autism Quotient to index diminished mentalising (hypo-mentalism) and increased (hyper-mechanism), alongside the positive dimension of the Schizotypal Personality Questionnaire to characterise hyper-mentalising and diminished mechanistic cognition. In accordance with both Baron-Cohen et al.'s (2002; 2009) 'Extreme Male Brain' theory and Crespi and Badcocks' (2008) diametric disorders hypothesis, the discrepancy between psychosis and autism traits can be used to predict cognition that is associated with each disorder. In fact, it has been argued that the discrepancy between the two measures may be more useful and revealing of respective cognition as opposed to the measures in isolation due to trait co-occurrence. With this in mind, it was anticipated that the PAB would be related to measures of intuitive relative to deliberative reasoning style. However, this was the first time such a composite was devised using direct measures of psychosis and autism traits. It was anticipated that, if psychosis traits represented hyper-mentalising and hypo-mechanistic cognition, whereas autism traits reflected the reverse profile, it was expected that the discrepancy between the measures would reflect cognition associated with each disorder. However, as shall be discussed below, support for such a premise was not consistently found.

Study 1 revealed that the PAB was a significant predictor of intuitive responses on the CRT, a negative predictor of the CRT, and positively predictive of self-report

intuitive reasoning. The PAB, therefore, demonstrated more significant relationships with reasoning style than the SPQ_POS and AQ in isolation. However, in Study 2, the PAB was only found to be a significant negative predictor of incongruent reasoning but was unrelated to both the CRT and REI. In Study 3, within a psychosis group, the PAB score was unrelated to all measures of reasoning style when measures of cognitive ability were controlled for. In Study 4, PAB scores were found to be positively related to self-report intuitive reasoning and negatively related to self-report deliberative reasoning. However, no other significant associations were found. In Study 5, PAB scores were found to be unrelated to incongruent syllogistic reasoning but were negative predictors of the REI_DEL and the CRT_DEL. Although the PAB did show some relationships with intuitive and deliberative reasoning in the pooled analysis, the PAB as a single construct was not a better predictor of reasoning style than measures of psychosis and autism traits in isolation. Collectively, such findings do not reveal a consistent relationship with expected measures of reasoning style.

In sum, the present research did not generally support a relationship between PAB and reasoning style. One potential explanation for this could be the result of the moderate positive correlation between the two measures of autism and psychosis. Indeed, Larson et al. (2015) and Brosnan et al. (2010) found that measures of empathising and systemising (mentalising and mechanistic cognition) negatively correlated with one another. Given the SPQ_POS and AQ positively correlated with another, this may have undermined the PAB. In addition, it is important to be aware that the PAB is simply a mathematical construct that assumes some degree of tradeoff between the psychosis and autism, and suggests that the observed behavior is driven by the residual of either condition, once some canceling out has occurred. While theorists such as Brosnan et al. and Larson et al. (2015) propose that autism and psychosis are interacting, this interaction may not be present in all domains of cognition. Perhaps the associations observed throughout the studies between the PAB and reasoning style reflects the opposite effects for autism and psychosis on reasoning style which appears to happen independent of each other.

As shall be discussed in the subsequent section, both student and non-student population samples appear to exhibit both autism and psychosis traits jointly. Although there was no consistent evidence that suggested autism and psychosis traits reflected diametrically opposing reasoning styles, it could still be argued that such traits may reflect opposing cognition across other domains (e.g. local versus global, over- versus under-mentalising abilities). However, in order to understand the PAB further, it is imperative to understand why psychosis and autism traits correlated with one another.

The Relationship between Autism and Positive Psychosis traits throughout the Autism and Psychosis Continua

Previous research has yielded how both typically developing individuals and people with ASD or a psychotic disorder can exhibit co-occurring traits of both psychosis and autism (Woodbury-Smith, Boyd, & Szatmari, 2010; Dossetor, 2007; Abel-Akel et al., 2016; Dinsdale et al., 2013; Del Guidice et al., 2014). Such findings have found mixed evidence for a relationship between total autism and psychosis trait scores. From a theoretical viewpoint, there remains a lively discussion of whether autism and psychosis are overlapping, independent, or diametrically opposing disorders. The findings in the current thesis are, indeed, intriguing and further contribute to this dynamic debate. Taken as whole, the evidence from the current thesis provides evidence for both an independent and overlapping model. However, there was no evidence to suggest a diametric relationship between psychosis and autism traits as postulated by Crespi and Badcock (2008).

Study 1 and Study 2 revealed a positive relationship between psychosis traits and autism trait scores. Together, these findings suggest that, in student and non-clinical populations, psychosis traits share some overlap with autism traits. As discussed in the Discussion section of Chapter Four, it was highlighted that participants endorsed the same items for different underlying reasons. Indeed, theorists such as Del Guidice et al.

(2014) and Dinsdale et al. (2013) suggest that endorsement of both AQ and SPQ items is the consequence of vague item formation. From this perspective, people who respond positively to item questionnaires on the AQ such as 'I am fascinated by numbers', may endorse this item because they believe numbers may have superstitious influences (e.g. the number 13 is unlucky). That being said, a particular strength of the current research was that it was just the positive dimension of the SPQ that was administered throughout the studies in this thesis, it is indeed surprising that participants would report both psychosis and autism traits. For example, using non-clinical populations, several research studies (Nettle, 2006; Wakabayashi et al., 2012; and Dinsdale et al., 2013) have reported how, once the negative traits of psychosis are accounted for, the positive dimension of psychosis is the dimension that can be used to demarcate the two disorders. The findings from Study 1 and 2 are contrary to these hypotheses and provide no support for an independent relationship between the two continua. Indeed, these findings are consistent with Hurst et al. (2007) and Mealey et al. (2014), who also found a significant overlap between positive psychosis traits and autism traits. Given that such trait scores were not negatively associated with one another, there appears to be no evidence for psychosis and autism traits reflecting a diametric relationship.

Turning to Study 3 and 4, there was no significant relationship between autism and psychosis traits. This suggested that autism and psychosis traits were unrelated in groups of participants considered to reside further along the continua of each respective disorder. These findings are supportive of clinical studies involving participants with ASD and schizophrenia, whereby Spek and Wouters (2010) and Barneveld et al. (2011) reported that positive traits of psychosis are the point of demarcation from autism traits. Collectively, such findings support Nylander et al.'s (2008) postulation that the boundaries between psychosis and autism traits are less clear in non-clinical populations, but are less blurred in individuals considered to reside further along the continuum. Notwithstanding this premise, when considering the mean scores of people with psychosis in Study 3 and people with ASD in Study 4, both groups of participants attained significantly higher scores on their opposing measures relative to Control

groups. Such findings suggest that people with a high expression of one dimension of traits are likely to exhibit higher traits on the other. However, these trait scores did not reflect a positive correlation as reported in non-clinical groups. From this position, it can be suggested that people residing along the higher end of the psychosis and autism continua share overlapping features. Considering the findings discussed in the current thesis, it could be suggested that autism and psychosis do not reside at opposite ends of a single continuum, but rather share the same continuum.

Returning to reasoning style, as psychosis traits are associated with CRT_INT, and AQ traits are associated with CRT_DEL (as revealed in Table 9.1), and given that SPQ_POS and AQ are positively correlated, then individuals who are high in both would be expected to provide both an intuitive and deliberative response. Indeed, such associations would make it difficult and challenging to predict what style of reasoning such a person is likely to engage in. Although it is difficult to explain these associations, there are some potential speculative explanations that may help make clear these discrepancies. Firstly, in accordance with the dual process theory, people's proclivity to shift between intuitive and deliberative reasoning styles is predicated on many factors, including: situational (e.g. time pressure), motivation, and available resources such as cognitive ability (Evans & Curtis-Holmes, 2005; Hodgkinson, Langan-Fox, & Sadler-Smith, 2008; see Chapter 2). With this in mind, it could be argued that people high in both psychosis and autism traits are 'balanced', thus there isn't a propensity one way or the other to engage in intuitive or deliberative reasoning, which means that situational factors (e.g. time) become more important for this group of individuals. Indeed, Abel-Akel et al. (2016a; 2016b) reported that participants who have a balanced degree of autism and psychosis traits did not display any signs of perspective-taking difficulties on a task assessing perspective-taking. Whether this applies to dual process reasoning remains to be investigated.

Social variants of Reasoning Style

Previous studies have reported atypicalities in reasoning style amongst people with ASD and psychosis when assessed with a variety of different reasoning style measures (Brosnan, Lewton, & Ashwin, 2016; Freeman, Evans, & Lister, 2012; Garety et al., 2001). For the first time, the content of the performance-based measures of reasoning styles was manipulated to reflect social as opposed to non-social content. This was conducted to assess whether any differences in reasoning style would occur when participants were resolving social as opposed to non-social content. Previous studies on reasoning style had indicated that the content of the reasoning task may have implications for reasoning style (Goel & Vartanian, 2011; Vroling & De Jong, 2009; Owen et al., 2007). For instance, there was some evidence to suggest that the more familiar the content was to someone, the more difficulty they had in over-riding their intuitive beliefs (Blanchette & Caparos, 2013). However, this has not always been a consistent finding, with some studies revealing little to no difference in reasoning style when the content was changed (Blanchette & Richards, 2004).

In accord with Crespi and Badcock (2008), psychosis and autism reside on a single continuum of social cognition. Therefore, it was considered worthwhile to explore whether reasoning styles altered when the content involved social information. This process involved replacing abstract content in the syllogisms and the CRT with more meaningful and relevant social information (e.g. people, social stereotypes, beliefs, etc.). However, as outlined in Study 5 Chapter 8, there was limited evidence to suggest that the content of reasoning tasks impacts on the degree of psychosis and autism traits, at least at the group level.

Although there were no major significant group differences between autism and psychosis groups on the social variant of the CRT, independent psychosis traits were found to have higher accuracy on incongruent social syllogisms, whereas autism traits were found to be negatively related to incongruent social syllogism accuracy. Further to this, the PAB was found to be a negative predictor of incongruent syllogistic reasoning.

This is, indeed, a fruitful finding as it suggests that psychosis traits may not always reflect lower accuracy rates of reasoning. In a previous study by Owen et al. (2007), people with schizophrenia were found to have higher accuracy rates of solving syllogisms, whereby the content of the syllogisms reflected common sense knowledge. One interpretation of this finding was that participants with a psychotic disorder were actually better at reasoning about content that was familiar to them. This provides some evidence for the notion that psychosis traits can override their initial intuitive reasoning style, with a more deliberative reasoning style when the content is familiar to them. However, it is difficult to ascertain precisely why psychosis traits were negatively related to incongruent social syllogisms, but people in the psychosis group did not display worse incongruent social reasoning.

Overall, there was limited evidence to suggest that psychosis and autism traits impact differently on reasoning style, when the content of the reasoning task is changed to social. Perhaps one explanation for this is the fact that, although the content of the reasoning task was changed, the context to which the tasks were completed was not. In other words, the tasks were still being completed in front of a computer screen. Perhaps the effect may have been more pronounced if such reasoning took place within a more social setting (e.g. with other people, in a group setting).

Critical Discussion of the Current Research Studies

Overall, there are several methodological considerations that need to be acknowledged in order for prospective research to develop. The performance measures used to assess reasoning style (as discussed in Chapter 3) have restrictions that may contribute to explaining the inconsistent results observed throughout the thesis. Indeed, there are very few studies that are considered to assess intuitive and deliberative styles of reasoning. Each of these measures will be appraised in light of the current findings.

Subsequently, some of the theoretical assumptions that underpin these measures will be reviewed.

The Cognitive Reflection Test (CFT; Frederick, 2005) is one of the most prevalent measures used throughout the reasoning and decision-making literature. The CRT is designed to assess a person's inclination to override an intuitive, but erroneous, response with a more deliberative correct response. Indeed, intuitive responses on the CRT have been found to predict non-normative responses across a number of different cognitive tasks (Toplak, West, & Stanovich, 2014; Thomson & Oppenheimer, 2016; Hoppe & Kusterer, 2011). Such striking results make it an appropriate and pertinent measure for assessing individual differences in reasoning style. However, a potential limitation to the study is its popularity. In fact, several authors (Baron et al., 2015; Chandler, Mueller, & Paolacci, 2014) have speculated that its reputation has likely resulted in polluted samples, whereby many participants who complete the CRT are already familiar with its structure. Thus, participants may respond differently to what they would have done had they completed the CRT for the first time. With this in mind, it could be argued that any relationships between psychosis or autism traits and reasoning style may be under-reported due to knowledge-based effects. The research studies used throughout this thesis asked participants if they had seen the questions before. However, in each study, participants all reported that they had not seen the questions before. Given the widely-used application of the CRT, it is important to exercise some caution. It is possible participants were concerned about the fact that, if they responded to seeing the questions beforehand, they may have feared they would have been excluded from the study. Given incentives were offered for participation (either financial or course credits), this remains a possibility. Lastly, Pennycook et al. (2015) recently made an argument for the proposal that the CRT may not actually measure intuitive versus deliberative reasoning per se, but simply measures a person's disposition to avoid engaging in intuitive reasoning. However, there are limited measures that are argued to assess such styles of reasoning. Given the primary purpose

of the current research thesis, it can be stipulated that such a measure was both appropriate and suitable for the objectives of the current research.

Another limitation to consider is the population samples that completed the studies. Given that students were assessed in Study 1 and students were then recruited throughout many of the studies in the Control group, the question of external validity needs to be taken into consideration. For example, there have been some reports that students are significantly less likely to provide all the intuitive inaccurate answers on the CRT in comparison to non-students (Falk & Heckman, 2009; Exadaktylos et al., 2013). In a meta-analysis of 118 studies that administered the CRT, it was stated by Brañas-Garza, Kujal, and Lenkei (2016) that one can anticipate the average number of deliberative CRT scores to be higher when using student as opposed to non-student samples. Again, it is rational to consider the inflation of deliberative as opposed to intuitive responses of the CRT, regardless of the individual differences in the expression of autism and psychosis traits. On the other hand, however, several researchers contend that, although strictly not a numeric measure, the CRT is considered to assess some degree of numeric ability (Welsh, Burns, & Delfabbro, 2013). With this mind, some non-students may find such a measure intimidating and refrain from attaining a higher score (e.g. they may rush through the items of the CRT because of the numeric content). Henceforth, recruiting students who may be more familiar with numeric content may be advantageous. Thirdly, and perhaps most importantly, the question of what other individual differences are contributing to performance on the CRT is of grave interest. For example, De Neys, Rossi, and Houdé (2013) reported that people who provided the intuitive response to the bat and ball problem were 83% confident that their response was accurate. In comparison, this was significantly lower than that of the 93% confidence level expressed by the participants who gave the deliberative response. Considered together, this finding highlights the desirability of the intuitive response and suggests this response is accompanied by a high level of self-assurance. With this in mind, it could be argued that individual levels of confidence may have had an impact on CRT performance. Indeed, people with a psychotic disorder have been found to have significantly lower levels of

confidence than participants without a psychotic disorder (Hall & Tarrier, 2003). Finally, the CRT used throughout this study allowed participants to type in a computerised space. Despite this, in almost all cases participants tended to either give the intuitive or deliberative answer for each question. Given the limited amount of 'other' answers, it was not considered appropriate or indeed necessary to examine the other answers. Nonetheless, it is possible that the other answers may be the product of either intuitive or deliberative mechanisms. Larger samples should consider analysing these other answers to assess whether they can be categorised as stemming from either a more intuitive or a more deliberative style of reasoning. Indeed, this may allow for further inferences to be formulated about the relationship between psychosis, autism and reasoning style.

From Study 2 and onwards, syllogisms were employed throughout all studies to assess intuitive and deliberative styles of reasoning. Indeed, incongruent syllogisms in isolation are considered to reflect belief bias responding, whereby lower accuracy rates on incongruent reasoning were considered to be the product of intuitive as opposed to deliberative reasoning. Thus, enhanced accuracy of incongruent reasoning would reflect a more deliberative style of reasoning. However, there are other individual differences that may have played a role in syllogism performance. For example, it could be that the accuracy of a syllogism only plays a partial role in reasoning performance, whereby a person's emotional state may impacts on logicality. Evidence for this assumption has been found in both neuroimaging and behavioural studies (Blanchette, 2006; Blanchette & Richards, 2004; Goel & Dolan, 2003). In such studies, participants in both positive and negative moods have been found to have lower accuracy scores on reasoning tasks. For instance, Oaksford, Morris, Grainger, & Williams (1996) investigated how participants in different moods performed on the Watson Selection Task (Watson, 1966). The authors found that participants in both positive and negative moods were less likely to provide the normatively correct response than participants in a neutral mood. Earlier studies (Channon & Baker, 1994; Radenhausen & Anker, 1988) reported that, when participants were experimentally induced to a depressive state, there was a decrease in their overall

accuracy performance when reasoning about categorical syllogisms. Indeed, Melton (1995) observed that participants who reported a positive mood state prior to completing a syllogism task were less likely to reason more normatively compared to participants who considered themselves to be in a neutral mood. These observations provide support for the notion that the emotional states of participants can hamper syllogistic reasoning performance. Given that none of the participants completed any assessments of mood prior to completing syllogisms, it is possible that a participant's mood may have impacted or contributed to their performance on assessing syllogisms. However, findings between emotional states and syllogistic reasoning performance have not always been consistent, so this is unlikely. In spite of the limitations of the reasoning style measures, both the CRT and syllogisms remain the most widely-used and supportive measures of assessing intuitive and deliberative reasoning styles (Handley & Trippas, 2015; Robison & Unsworth, 2016; see Chapter 2).

Throughout this thesis, a dual process theory was employed as the theoretical framework in order to understand reasoning style. As a result, there are some potential theoretical issues that need to be considered when conceptualising reasoning style to reflect a dual process framework. Evans and Stanovich (2013) propose that, although humans have the ability to engage predominantly in two distinctive styles of reasoning, there are variables and certain conditions that can impact on whether a person engages in one style of reasoning over the other. For instance, the authors propose that sources of individual differences in reasoning style can occur at different stages of the reasoning process (see also Kahneman, 2011). For example, a 'mindware gap' reflects a gap in a person's existing knowledge. In the case of syllogistic reasoning, some people may misinterpret the task and instead judge whether a conclusion is valid or invalid based exclusively on its observable truth. If all people have the relevant mindware (e.g. understanding the objectives of syllogistic reasoning), the next area of individual differences is the ability to detect that the intuitive response must be overridden with a more deliberative response. If people are unable to detect that an override is required, they will produce the intuitive response. In the next stage, a process of decoupling and

de-contextualisation must occur in order to override the intuitive response. Finally, one must have the cognitive capacity to withstand the process of de-contextualisation and endure the override of an intuitive response. An array of evidence accumulated by dual process theorists have indeed demonstrated that individual differences at each of these stages can occur (Evans & Stanovich, 2013; Evans, 2008). With this in mind, it could be that psychosis and autism traits were related to difficulties with different stages of reasoning style. This may explain the discrepancies between traits being associated with different task performances throughout the studies.

Finally, it should be acknowledge that timing participant's responses may shed insight into what reasoning style they engaged in. Therefore a limitation of the current reasoning tasks was that there were no measures of chronometric analysis, such as measuring response latencies and inspection times, to establish whether intuitive or deliberative responses were associated with faster\slower latencies. Due to the setup of the studies (e.g. online survey to host questionnaires), it was not possible to accurately capture such data. Future studies may wish to examine whether the relationships observed in the current study between psychosis, autism, the psychosis-autism bias, and reasoning style, would be associated with faster and slower latencies when assessing reasoning style using performance measures. This would further clarify whether specific traits were associated with different styles of reasoning. Indeed, autism traits would be expected to be associated with slower reasoning times, whereas psychosis traits would be anticipated to be related to faster reasoning times.

Concluding Remarks and Future Directions of Research

Overall, the current research has bridged a gap across multiple areas including reasoning style, autism, psychosis and the relationships between these domains. The research has extended and developed a body of empirical evidence that demonstrates the overlapping relationship between autism and psychosis traits. Indeed, this highlights the need for more suitable self-report measures to be developed that can differentiate between psychosis and autism traits. On the other hand, however, the pooled analysis

clearly indicated a positive and moderate association between the two constructs, which warrants that the positive symptoms of psychosis may not necessarily be enough to demarcate autism from psychosis. With this in mind, future studies that analyse such traits should index both autism and psychosis traits to control for any statistical overlap and derive more meaningful conclusions. Secondly, the research has provided some support for the diametric disorders hypothesis (Crespi & Badcock, 2008), which extends the existing body of research that advocates diametric cognition may also be extended to reasoning style. Thirdly, the research studies in this thesis highlight how individual differences in psychosis and autism traits are associated with different styles of reasoning.

Despite the significant contribution the current research makes, there are some amendments and prospective extensions that can be made for future research. A key position this research adopted was that positive psychosis traits represent hyper-mentalising combined with hypo-mechanistic cognition, whereas autism traits represented the reverse profile. Although there is a strong body of research to support these claims (see Gray et al., 2011; Peyroux et al., 2014; Moore & Pope, 2014; Lahera et al., 2014), the research was limited by using self-report measures to index such individual differences in mentalising and mechanistic cognition. Alternatively, behavioural measures such as the Movie for the Assessment of Social Cognition (MASC; Dziobe et al., 2006) could be an alternative method to capture degrees of mentalising, including hyper-mentalising. In addition, various behavioural tasks could be used to index degrees of mechanistic cognition such as the Intuitive Physics Test (Baron-Cohen, Wheelwright, Spong, Scahill, & Lawson, 2001). This may allow for more accurate measures of hyper-mentalising and mechanistic cognition, as such measures do not depend on self-report methodology. Indeed, the associations between mentalising and mechanistic cognition and reasoning style is still in its infancy, with recent studies only now beginning to explore these associations (Svedholm-Häkkinen, & Lindeman, 2016; Lindeman & Svedholm-Häkkinen, 2016; Vonk & Pitzen, 2016). Employing behavioural measures to assess mentalising and mechanistic cognition would extend the findings in

the current thesis and further determine whether the associations with reasoning style are method specific, or whether they result from different underlying processes.

The entire PhD thesis was predicated on a dual process theory of reasoning (Evans & Stanovich, 2013; Kahneman, 2011; Toplak et al., 2014). As pointed out by many dual process theory critiques (e.g. Gigerenzer & Regier, 1996; Mugg, 2016), such a theory depends entirely on a dichotomous accuracy output (i.e. correct or not) and refrains from focusing on the underlying cognitive processes per se. In other words, normative responses are considered to be the product of deliberative reasoning, whilst the incorrect response is considered the product of intuitive reasoning. From this viewpoint, striking confounds may occur. For instance, if a person provides the 'correct' response (e.g. the deliberative response on the CRT), this may not necessarily imply that such an individual reasoned deliberatively to produce such a response. In fact, they may have reached that correct response through guessing or blind luck. Comparatively, providing the incorrect 'intuitive' response may not necessarily warrant that the individual didn't engage in a more deliberative style of reasoning before reaching their response. As discussed in the previous section, many discrepancies can occur between reasoning and providing a response at different stages (e.g. absence in mindware).

Several other individual differences can also contribute to whether someone engages in one style of reasoning over the other. For example, the 'detection' of extra processing may be a crucial variable. That is the ability to detect that a conflict between intuitive and deliberative reasoning has occurred. Several studies have found how individuals are more likely to engage in a deliberative style of reasoning when they are able to identify (consciously or unconsciously) a conflict in the presented reasoning task (e.g. incongruent syllogisms). Indeed, several studies have found that, when participants are pre-warned about a potential reasoning task having a complex answer, they are more likely to reason deliberatively and produce the correct response in comparison to participants who are not told anything (Epstein et al., 1992; Ferreira et al., 2006; Klaczynski, 2001). Such observations have led to a body of research being developed that focuses specifically on metacognition (Thompson, 2009). Metacognition is

essentially defined as the “subjective assessment of one’s own cognitive processes and knowledge” (Koriat, Ma’ayan, & Nussinson, 2006, p. 38). How metacognition relates to psychosis and autism traits, and the implications such interactions have on reasoning style, is another potential avenue that future research should consider exploring.

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Appendices of Main Measures

The following pages contain the materials that were used throughout the PhD thesis. However, some measures were too large to include (i.e. the Ravens Progressive Matrices). Further details and information about the scoring of items can be found in the Methodology Chapter. All questionnaires were reverse scored and re-coded in line with their original instructions.

It should be acknowledged that all versions of items and questionnaires were initially designed in Paper and Pencil format. As a result, the author converted each questionnaire into an online version by electronically converting it and hosting it on to the Bristol Online Survey. In order to replicate the questionnaires in the original format, Radio buttons, lists, and Electronic Sliding scales and Check Boxes were added to maintain the questionnaires in their original format.

Appendix A – Brief Version of the Schizotypal Personality Questionnaire

Participants were given the following instructions: "*Please answer each question as honestly as possible. Again, there are no trick questions."*

Have you ever had the sense that some person or force is around you, even though you cannot see anyone?

Are you sometimes sure that other people can tell what you are thinking?

Have you ever noticed a common event or object that seemed to be a special sign for you?

Do you often pick up hidden threats or put-downs from what people say or do?

When shopping do you get the feeling that other people are taking notice of you?

Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?

Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?

Do you often have to keep an eye out to stop people from taking advantage of you?

Appendix B – Abridged Version of the Autism Quotient

Below are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by circling your answer (1-4- Strongly Disagree – Strongly Agree, respectively)

I prefer to do things with others rather than on my own
I find social situations easy
I would rather go to a library than to a party
I find myself drawn more strongly to people than to things
I find it hard to make new friends
I enjoy social occasions
I enjoy meeting new people
New situations make me anxious

I prefer to do things the same way over and over again
It does not upset my if my daily routine is disturbed
I enjoy doing things spontaneously
New situations make me anxious

I frequently get strongly absorbed in one thing
I can easily keep track of several different people's conversations
I find it easy to do more than one thing at once
If there is an interruption, I can switch back very quickly

Trying to imagine something, I find it easy to create a picture in my mind
Reading a story, I can easily imagine what the characters might look like
I find making up stories easy
Reading a story, I find it difficult to work out the character's intentions
I find it easy to work out what someone is thinking or feeling
I find it difficult to imagine what it would be like to be someone else
I find it difficult to work out people's intentions
I find it easy to play games with children that involve pretending

I usually notice car number plates or similar strings of information
I am fascinated by dates
I am fascinated by numbers
I notice patterns in things all the time
I like to collect information about categories of things

Appendix C – Rational Experiential Inventory

Please use the following scale to answer these questions:

Completely False to Completely True
1 2 3 4 5

1. _____ I have a logical mind.

2. _____ I prefer complex problems to simple problems.

3. _____ I believe in trusting my hunches.

4. _____ I am not a very analytical thinker.

5. _____ I trust my initial feelings about people.

6. _____ I try to avoid situations that require thinking in depth about something.

7. _____ I like to rely on my intuitive impressions.

8. _____ I don't reason well under pressure.

9. _____ I don't like situations in which I have to rely on intuition.

10. _____ Thinking hard and for a long time about something gives me little satisfaction.

11. _____ Intuition can be a very useful way to solve problems.

12. _____ I would not want to depend on anyone who described himself or herself as intuitive.

13. _____ I am much better at figuring things out logically than most people.

14. _____ I usually have clear, explainable reasons for my decisions.

15. _____ I don't think it is a good idea to rely on one's intuition for important decisions.

16. _____ Thinking is not my idea of an enjoyable activity.

17. _____ I have no problem thinking things through carefully.

18. _____ When it comes to trusting people, I can usually rely on my gut feelings.

19. _____ I can usually feel when a person is right or wring, even if I can't explain how I know.

20. _____ Learning new ways to think would be very appealing to me.

21. _____ I hardly ever go wrong when I listen to my deepest gut feelings to find an answer.

22. _____ I think it is foolish to make important decisions based on feelings.

23. _____ I tend to use my heart as a guide for my actions.

24. _____ I often go by my instincts when deciding on a course of action.

25. _____ I'm not that good at figuring out complicated problems.

26. _____ I enjoy intellectual challenges.

27. _____ Reasoning things out carefully is not one of my strong points.

28. _____ I enjoy thinking in abstract terms.

29. _____ I generally don't depend on my feelings to help me make decisions.

30. _____ Using logic usually works well for me in figuring out problems in my life.

31. _____ I think there are times when one should rely on one's intuition.

32. _____ I don't like to have to do a lot of thinking.

33. _____ Knowing the answer without having to understand the reasoning behind it is good enough for me.

34. _____ Using my gut feelings usually works well for me in figuring out problems in my life.

35. _____ I don't have a very good sense of intuition.

36. _____ If I were to rely on my gut feelings, I would often make mistakes.

37. _____ I suspect my hunches are inaccurate as often as they are accurate.

38. _____ My snap judgements are probably mot as good as most people's.

39. _____ I am not very good at solving problems that require careful logical analysis.

40. _____ I enjoy solving problems that require hard thinking.

Appendix D – Cognitive Reflection Test

A bat and a ball cost £1.10 in total. The bat costs £1.00 more than the ball. How much does the ball cost?

If it takes 5 machines 5 minutes to make 5 widgets, how long would it take100 machines to make 100 widgets?

In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

Appendix E – Barratt Impulsivity Scale

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and select the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

Item	Rarely/Never	Occasionally	Often	Almost always
1 I plan tasks carefully.				
2 I do things without thinking.				
3 I make-up my mind quickly.				
4 I am happy-go-lucky.				
5 I don't "pay attention."				
6 I have "racing" thoughts.				
7 I plan trips well ahead of time.				
8 I am self controlled.				
9 I concentrate easily.				
10 I save regularly.				
11 I "squirm" at plays or lectures.				
12 I am a careful thinker.				
13 I plan for job security.				
14 I say things without thinking.				
15 I like to think about complex problems.				
16 I change jobs.				
17 I act "on impulse."				
18 I get easily bored when solving thought problems.				
19 I act on the spur of the moment.				
20 I am a steady thinker.				
21 I change residences.				
22 I buy things on impulse.				
23 I can only think about one thing at a time.				
24 I change hobbies.				
25 I spend or charge more than I earn.				
26 I often have extraneous thoughts when thinking.				
27 I am more interested in the present than the future.				
28 I am restless at the theater or lectures.				
29 I like puzzles.				
30 I am future oriented.				

Appendix F –Positive Dimension of the Schizotypal Personality Questionnaire

Participants were given the following instructions: *"Please answer each question as honestly as possible. Again, there are no trick questions."*

Ideas of Reference

Do you sometimes feel that things you see on the TV or read in the newspaper have a special meaning for you?

Have you ever noticed a common event or object that seemed to be a special sign for you?

Do you sometimes see special meanings in advertisements, shop windows, or in the way things are arranged around you?

I am aware that people notice me when I go out for a meal or to see a film.

Do some people drop hints about you or say things with a double meaning?

When shopping, do you get the feeling that other people are taking notice of you?

When you see people talking to each other, do you often wonder if they are talking about you?

Do you sometimes feel that other people are watching you?

Do you sometimes feel that people are talking about you?

Odd Beliefs/Magical Thinking

Have you had experiences with the supernatural?

Do you believe in telepathy (mind-reading)?

Are you sometimes sure that other people can tell what you are thinking?

Do you believe in clairvoyance (psychic forces, fortune telling)?

Can other people feel your feelings when they are not there?

Have you had experiences with astrology, seeing the future, UFO's, ESP, or a sixth sense?

Have you ever felt that you are communicating with another person telepathically (by mind-reading)?

Unusual Perceptual Experiences

Have you often mistaken objects or shadows for people, or noises for voices?

Have you ever had the sense that some person or force is around you, even though you cannot see anyone?

When you look at a person or yourself in a mirror, have you ever seen the face change right before your eyes?

I often hear a voice speaking my thoughts aloud.

Have you ever seen things invisible to other people?

Do everyday things seem unusually large or small?

Does your sense of smell sometimes become unusually strong?

Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?

Are your thoughts sometimes so strong that you can almost hear them?

Suspiciousness

I am sure I am being talked about behind my back.

Do you often feel that other people have it in for you?

Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?

I feel I have to be on my guard even with friends.

Do you often pick up hidden threats or put-downs from what people say or do?

Have you found that it is best not to let other people know too much about you?

I often feel that others have it in for me.

Do you often have to keep an eye out to stop people from taking advantage of you?

Appendix G – Full version of the Autism Quotient

How to fill out the questionnaire

Below are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by circling your answer.

DO NOT MISS ANY STATEMENT OUT.

Examples

E1. I am willing to take risks.	definitely agree	slightly agree	slightly disagree	definitely disagree
E2. I like playing board games.	definitely agree	slightly agree	slightly disagree	definitely disagree
E3. I find learning to play musical instruments easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
E4. I am fascinated by other cultures.	definitely agree	slightly agree	slightly disagree	definitely disagree

1. I prefer to do things with others rather than on my own.	definitely agree	slightly agree	slightly disagree	definitely disagree
2. I prefer to do things the same way over and over again.	definitely agree	slightly agree	slightly disagree	definitely disagree
3. If I try to imagine something, I find it very easy to create a picture in my mind.	definitely agree	slightly agree	slightly disagree	definitely disagree
4. I frequently get so strongly absorbed in one thing that I lose sight of other things.	definitely agree	slightly agree	slightly disagree	definitely disagree
5. I often notice small sounds when others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
6. I usually notice car number plates or similar strings of information.	definitely agree	slightly agree	slightly disagree	definitely disagree
7. Other people frequently tell me that what I've said is impolite, even though I think it is polite.	definitely agree	slightly agree	slightly disagree	definitely disagree
8. When I'm reading a story, I can easily imagine what the characters might look like.	definitely agree	slightly agree	slightly disagree	definitely disagree
9. I am fascinated by dates.	definitely agree	slightly agree	slightly disagree	definitely disagree
10. In a social group, I can easily keep track of several different people's conversations.	definitely agree	slightly agree	slightly disagree	definitely disagree
11. I find social situations easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
12. I tend to notice details that others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
13. I would rather go to a library than a party.	definitely agree	slightly agree	slightly disagree	definitely disagree
14. I find making up stories easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
15. I find myself drawn more strongly to people than to things.	definitely agree	slightly agree	slightly disagree	definitely disagree
16. I tend to have very strong interests which I get upset about if I can't pursue.	definitely agree	slightly agree	slightly disagree	definitely disagree
17. I enjoy social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree

18. When I talk, it isn't always easy for others to get a word in edgeways.	definitely agree	slightly agree	slightly disagree	definitely disagree
19. I am fascinated by numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
20. When I'm reading a story, I find it difficult to work out the characters' intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
21. I don't particularly enjoy reading fiction.	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I find it hard to make new friends.	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I notice patterns in things all the time.	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I would rather go to the theatre than a museum.	definitely agree	slightly agree	slightly disagree	definitely disagree
25. It does not upset me if my daily routine is disturbed.	definitely agree	slightly agree	slightly disagree	definitely disagree
26. I frequently find that I don't know how to keep a conversation going.	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I find it easy to "read between the lines" when someone is talking to me.	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I usually concentrate more on the whole picture, rather than the small details.	definitely agree	slightly agree	slightly disagree	definitely disagree
29. I am not very good at remembering phone numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
30. I don't usually notice small changes in a situation, or a person's appearance.	definitely agree	slightly agree	slightly disagree	definitely disagree
31. I know how to tell if someone listening to me is getting bored.	definitely agree	slightly agree	slightly disagree	definitely disagree
32. I find it easy to do more than one thing at once.	definitely agree	slightly agree	slightly disagree	definitely disagree
33. When I talk on the phone, I'm not sure when it's my turn to speak.	definitely agree	slightly agree	slightly disagree	definitely disagree
34. I enjoy doing things spontaneously.	definitely agree	slightly agree	slightly disagree	definitely disagree
35. I am often the last to understand the point of a joke.	definitely agree	slightly agree	slightly disagree	definitely disagree

36. I find it easy to work out what someone is thinking or feeling just by looking at their face.	definitely agree	slightly agree	slightly disagree	definitely disagree
37. If there is an interruption, I can switch back to what I was doing very quickly.	definitely agree	slightly agree	slightly disagree	definitely disagree
38. I am good at social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
39. People often tell me that I keep going on and on about the same thing.	definitely agree	slightly agree	slightly disagree	definitely disagree
40. When I was young, I used to enjoy playing games involving pretending with other children.	definitely agree	slightly agree	slightly disagree	definitely disagree
41. I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	definitely agree	slightly agree	slightly disagree	definitely disagree
42. I find it difficult to imagine what it would be like to be someone else.	definitely agree	slightly agree	slightly disagree	definitely disagree
43. I like to plan any activities I participate in carefully.	definitely agree	slightly agree	slightly disagree	definitely disagree
44. I enjoy social occasions.	definitely agree	slightly agree	slightly disagree	definitely disagree
45. I find it difficult to work out people's intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
46. New situations make me anxious.	definitely agree	slightly agree	slightly disagree	definitely disagree
47. I enjoy meeting new people.	definitely agree	slightly agree	slightly disagree	definitely disagree
48. I am a good diplomat.	definitely agree	slightly agree	slightly disagree	definitely disagree
49. I am not very good at remembering people's date of birth.	definitely agree	slightly agree	slightly disagree	definitely disagree
50. I find it very easy to play games with children that involve pretending.	definitely agree	slightly agree	slightly disagree	definitely disagree

Appendix H – Typical Syllogisms

This is a syllogistic reasoning task, which presents you with an argument (two premises and a conclusion) and asks you to decide whether the conclusion is logically valid or invalid. The idea is to accept that all the statements are true and then decide if the conclusion follows logically.

1. **All calculators are machines.**

   All computers are calculators.

   Therefore, some machines are not computers.

   ☐ Valid ☐ Invalid

2. **No fruits are fungi.**

   All mushrooms are fungi.

   Therefore, some mushrooms are fruits.

   ☐ Valid ☐ Invalid

3. **All African countries are warm**

   Spain is warm

   Therefore, Spain is an African country

   ☐ Valid ☐ Invalid

4. **No harmful substance is natural.**

   All poisons are natural.

   Therefore, no poisons are harmful.

   ☐ Valid ☐ Invalid

5. **5. All flying birds have feathers.**

   No people have feathers.

   Therefore, some people are flying birds.

   ☐ Valid ☐ Invalid

6. **All vehicles have wheels**

   A boat is a vehicle

   Therefore, a boat has wheels

   ☐ Valid ☐ Invalid

7. **All things with an engine need oil**

   Cars need oil

   Therefore, cars have engines

   ☐ Valid ☐ Invalid

8. **All things that are smoked are bad for your health**

   Cigarettes are smoked

   Therefore, cigarettes are bad for your health

   ☐ Valid ☐ Invalid

Appendix I – Social Syllogisms

1. **All good manners are rewarded**

   Being verbally abusive can be rewarded

   Therefore, being verbally abusive is good manners

   ☐ Valid ☐ Invalid

2. **All teenage girls are loving,**

   Teenage girls are caring.

   Therefore, girls are caring because they are loving.

   ☐ Valid ☐ Invalid

3. **All sensitive men are good lovers.**

   Some impotent men are sensitive.

   Therefore, some impotent men are good lovers.

   ☐ Valid ☐ Invalid

4. **No male friend is funny.**

   Some friends are funny

   Therefore some friends are not Male Friends.

   ☐ Valid ☐ Invalid

5. No relationships are loving.

Some marriages are loving.

Therefore, some marriages are not relationships

☐ Valid ☐ Invalid

6. **No good persons are caring.**

Some nurses are caring.

Therefore, some nurses are not good people.

☐ Valid ☐ Invalid

7. If Liz is happy,

Liz will hug Mike. Liz is not hugging Mike.

Therefore, Liz is not happy.

☐ Valid ☐ Invalid

8. All politicians are honest.

Jack is a politician.

Therefore, Jack is honest.

☐ Valid ☐ Invalid

Appendix J – Social Version of the Cognitive Reflection Test

Together, Chloe and Jack have 110 different Facebook friends in total. Chloe has 100 more Facebook friends than Jack. How many Facebook friends does Jack have?

If it takes 5 people 5 minutes to discuss 5 topics, how long would it take 100 people to discuss 100 topics?

Thomas has joined a new school and wants to meet everyone individually in his school. Every day, the number of people he meets doubles in size. If it takes 48 days to meet everyone in his school, how long would it take him to meet half the people in his school?