

**HOW ARE INDIVIDUAL DIFFERENCES IN SCHIZOTYPY RELATED  
TO TYPE 1 (AUTOMATIC/HEURISTIC) AND TYPE 2  
(REFLECTIVE/EFFORTFUL) THINKING PROCESSES?**

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## ABSTRACT

**Background:** Human reasoning is often conceptualised within ‘dual process’ frameworks, comprising Type 1 (automatic/heuristic) and Type 2 (reflective/effortful) processes, as well as ‘thinking styles’. These processes have not yet been comprehensively investigated in relation to schizotypy; a continuum of normal variability of psychosis-like characteristics and experiences. This could provide insights into thinking processes associated with psychosis-related phenomena, bypassing the limitations of psychiatric diagnosis and the confounding factors associated with clinical populations.

**Aims:** This study sought to investigate whether individual differences in schizotypy (‘unusual experiences’ and ‘introvertive anhedonia’) were related to thinking processes and thinking styles. Another aim was to examine how schizotypy, thinking processes and thinking styles were related to cognitive reflection, informed by dual process theories.

**Method:** The study employed a cross-sectional design and data was collected through an online survey. A large sample ( $n = 1,512$ ) completed several measures pertaining to personality and reasoning. Correlations examined the association between schizotypy and reasoning processes. Regression analysis was used to further examine predictors of cognitive reflection, and multiple mediation models tested whether thinking styles and processes mediated the association between schizotypy and cognitive reflection.

**Results:** Schizotypy was associated with greater reliance on intuitive thinking, less reliance on deliberative thinking, as well as a hastier, less reflective reasoning style. Unusual experiences, thinking processes and thinking style were independent predictors of cognitive reflection, and schizotypy contributed to significant additional variance in reflection over other predictor variables. Thinking processes and thinking style had a small mediating effect on the relationship between schizotypy and cognitive reflection.

**Conclusion:** These findings add novel and meaningful contributions to the literature on schizotypy and decision making, and potentially allude to similar reasoning processes to those reported in psychosis. Clinical implications include potential useful targets for therapy, and several promising avenues for future research are suggested.

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# CHAPTER ONE

## INTRODUCTION

### 1.1. Chapter Overview

This study sought to investigate how individual differences in schizotypy are related to Type 1 (automatic/heuristic) and Type 2 (reflective/effortful) thinking processes. This chapter will first set the scene by providing a general overview of dual process theories of reasoning. This will include reference to terminology, theoretical variations, the current evidence base related to dual process models, as well as areas of controversy and critiques. The concept of schizotypy will be introduced, and contextualised in relation to continuum models of psychosis-like characteristics and experiences. The current research into psychosis and reasoning will then be discussed and appraised in a narrative review. This will be followed by a systematic review of the evidence base relating schizotypy to various aspects of reasoning in the context of dual process models (including Type 1 and Type 2 thinking processes, thinking style, cognitive inhibition and cognitive biases). The chapter will conclude by outlining the aims, rationale and research questions of the present study.

### 1.2. Dual Process Theories of Reasoning

#### 1.2.1. Overview

It is important that theories of reasoning and decision making are first outlined more generally in order that specific predictions can be made regarding the relationship between thinking processes and schizotypy. Dominant models of reasoning tend to come under the umbrella term of 'dual-process' theories of higher cognition. Such dual process theories have become ubiquitous within the field of cognitive psychology and have become influential in theories of social cognition, learning and memory (Evans & Frankish, 2009). While terminology and definitions can vary across theories (Stanovich, 2012), these theories generally posit that decisions, thoughts and judgments are the consequence of two types of processing. This includes 'Type 1 processing', thought to be fast, intuitive and automatic, and 'Type 2 processing', which is considered to be slow, reflective and effortful (Evans, 2003, 2010). Type 1 processing is thought to rely on heuristics (based on prior beliefs, intuition and gut feelings; Tversky & Kahneman, 1975), while Type 2 processes are thought to encompass logical and rational reasoning (Evans, 2008). While Type 2

processing can be thought of as supporting explicit or 'conscious' processing, given that definitions of 'consciousness' are somewhat ambiguous (Evans & Frankish, 2009), it may in fact be more accurate to define Type 2 processes as a set of interacting processes, including a flow of information through 'working memory' (Evans & Over, 1996). Type 2 processing can therefore be purported to be slower, more deliberative than Type 1, and correlated with cognitive capacity (or working memory; Evans, 2010). Dual process models have recently been popularised as 'fast and slow thinking', most notably by Daniel Kahneman (Kahneman, 2011).

Earlier versions of dual process theories asserted that Type 1 and Type 2 processes are each supported by distinct and localised neural architecture, which can be termed 'System 1' and 'System 2' (e.g. Evans, 2003; Stanovich, 2005). By these accounts, neural correlates of System 1 are generally thought to be evolutionarily ancient and ubiquitous across animals, supporting implicit, unconscious, or preconscious cognition. System 2, on the other hand, is considered to have developed relatively recently in our human evolutionary history, supporting the higher level and abstract logical reasoning that only humans are capable of (Evans & Frankish, 2009).

Theorists supporting System 1/System 2 terminology also concede that System 1 may in fact refer to a multiplicity of different neural systems all supporting more general Type 1 cognitive processes (Evans, 2008), while System 2 may rely on working memory processes to support hypothetical thinking or 'cognitive decoupling' (Evans & Stanovich, 2013). Therefore the functional and regional specialisation assumed by the term 'system' (particularly in the case of System 1) may be misleading. This is further complicated as the terms Type 1/Type 2 and System 1/System 2 often appear to be (erroneously) used interchangeably throughout the reasoning literature. Keith Stanovich, one of the theorists who initially coined the terms System 1 and System 2, concedes himself that the terms should be abandoned for these reasons (Evans & Stanovich, 2013). Therefore, for the sake of clarity, throughout this thesis only the terms 'Type 1' and 'Type 2' will be used, referring to intuitive/automatic and reflective/deliberative processes respectively.

### 1.2.2. Evidence for Dual Process Theories

Dual process theories of reasoning originally emerged from an observation of conflict between non-logical intuitive biases and logical processes on tasks where people were carrying out deductive logical reasoning tasks (Evans, 1977). Indeed, pre-existing beliefs have consistently been reported to interfere with the ability to reason logically (using Type 2 processes), giving rise to increased errors on such tasks (Evans, Barston, & Pollard, 1983; Klauer, Musch, & Naumer, 2000). This now well-replicated finding is known as the ‘belief bias effect’ (Evans & Curtis-Holmes, 2005) because our pre-existing heuristic beliefs (Type 1 processes) tend to compete with, and interfere with our higher level reasoning processes (Type 2 processes), leading to biased incorrect responses.

The syllogistic reasoning task is a seminal task in which the ‘belief bias effect’ has been clearly demonstrated. Syllogisms involve applying deductive reasoning to arrive at a logical conclusion following two (or more) statements (known as ‘premises’) that are asserted to be true. The conclusion can be logically *valid* or *invalid* (that is, either objectively correct or incorrect), but crucially can also be either *believable* or *unbelievable*. For example, through effortful and deliberative reasoning it may become clear that the statements “all flowers have petals” and “roses have petals” do *not* logically lead to the conclusion “roses are flowers” (Markovits & Nantel, 1989), despite the conclusion sentence being semantically *believable* according to our pre-existing knowledge of the world. However, evidence suggests that people are more likely to endorse conclusions on these reasoning tasks when they are *believable* (even when they are not logically correct), than when they are *unbelievable*. This appears to be a robust effect, that has been reported across several behavioural studies (e.g. Evans, Barston, & Pollard, 1983; Evans & Curtis-Holmes, 2005; Klauer, Musch, & Naumer, 2000; Morley, Evans, & Handley, 2004; Neys, 2006; Revlin, Leirer, Yopp, & Yopp, 1980). Interestingly, the belief bias effect has been reported to be less prominent in people with higher cognitive ability (Stanovich & West, 1997), but only if they are motivated or instructed explicitly to ignore believability of the problem (Evans, Handley, Neilens, Bacon, & Over, 2010).

Neuroimaging studies have also reported neural and functional correlates of inhibitory control during syllogistic reasoning within the brain. Increased activity in the

right inferior frontal cortex (IFC) has been reported in people who perform better on syllogistic reasoning problems where prior beliefs and logic conflict (Tsuji & Watanabe, 2009, 2010). Furthermore, repetitive transcranial magnetic stimulation (rTMS) of the right IFC, which is thought to temporarily disrupt brain activity in targeted areas, has been found to *enhance* the belief bias effect (Tsuji, Masuda, Akiyama, & Watanabe, 2010). This makes sense as the right IFC is known to play a key role in inhibitory cognitive functions (Aron, Robbins, & Poldrack, 2004) and may suggest that rTMS in this area disrupts the ability to inhibit irrelevant semantic information. This indicates that the right IFC may be a crucial neural substrate implicated in the interaction or conflict between Type 1 and Type 2 processes. Another study using event-related brain potentials (ERP) also identified greater P500 electrophysiological activity in central-frontal cortical regions on incongruent belief bias syllogisms than either congruent syllogisms or a baseline condition (Luo et al., 2008). Evidence from psychometrics has also found Type 2 processing to be empirically and strongly linked with cognitive ability, while Type 1 processing has no such association (Evans, 2003). This seems to suggest there are qualitative differences between the two types of processing.

### 1.2.3. Cognitive Inhibition

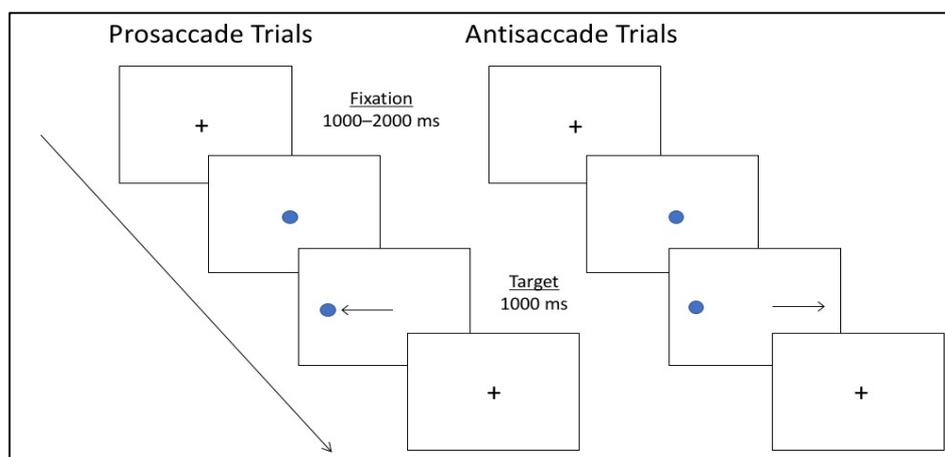
It has been questioned whether cognitive reasoning biases occur through lax monitoring (i.e. simply assuming our intuitions or 'gut feelings' are correct) or whether people in fact realise they are biased (i.e. they are aware of conflict between Type 1 intuition and Type 2 logic), but are not successfully able to block their tempting intuitive beliefs (De Neys, 2010). The latter explanation implies an impaired ability to *inhibit* and over-ride a tempting 'prepotent', dominant or automatic response (Svedholm-Häkkinen, 2015). Application of cognitive inhibitory control is therefore relevant for understanding reasoning in the context of dual process models.

Recent research supports the idea that effortful and deliberative (Type 2) processing is required to over-ride intuitive responses when reasoning. For example, the belief bias effect tends to *increase* under increased time pressure (Evans & Curtis-Holmes, 2005). This may arise through greater constraints being placed on cognitive capacity, which thereby limits the ability to inhibit intuitive biases through active engagement of reflective Type 2 processes. An increased belief bias effect has also

been reported in situations where burden on executive resources has been manipulated through use of a secondary distractor task (De Neys, 2006). Here, the effect was robust enough to be ubiquitous across all participants tested, regardless of their natural working memory capacity or cognitive ability. There is also evidence to suggest that a metacognitive ‘feeling of rightness’ or confidence related to one’s intuitive answers may render one’s Type 2 intervention or inhibition of Type 1 processes less likely (Thompson, Prowse Turner, & Pennycook, 2011). Overall, this suggests that Type 2 processes can be used to exert ‘top-down’ inhibitory control of Type 1 responses, and that this in turn may be linked to working memory demands and levels of subjective confidence in one’s intuition.

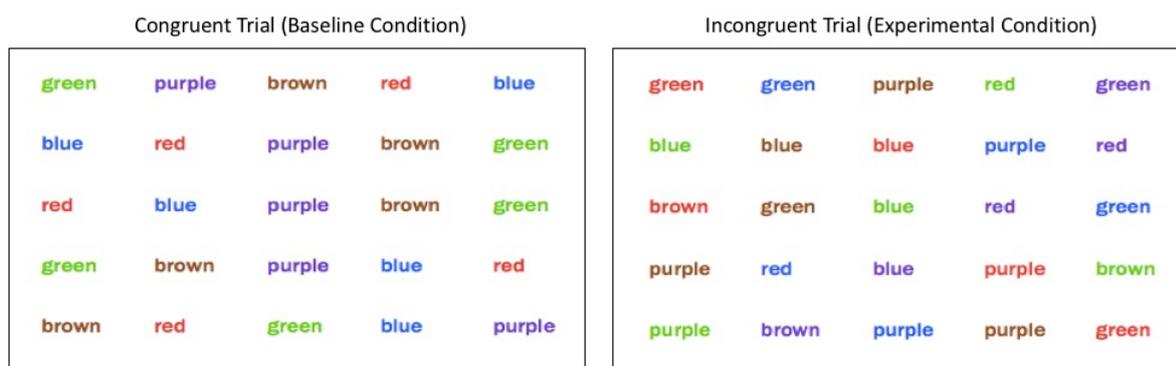
#### 1.2.4. Behavioural Tasks of Type 2 Control over Type 1 Processes

Behavioural tasks, such as the ‘antisaccade task’ can be used to assess the ability to inhibit a dominant or automatic response. The antisaccade task uses eye-tracking software to monitor the ability to inhibit the reflexive response of looking towards a sudden onset target by asking the subject to make a volitional saccade in the opposite direction to (i.e. looking away from) the target (see Figure 1). Performance on antisaccade trials can then be compared to the ‘prosaccades’ of the subject (i.e. their performance when following the target). It is thought to be a reliable, relatively objective, sensitive and direct way of measuring the ability to resolve conflict between volitional (Type 2) and reflexive (Type 1) behavioral responses (Ettinger, Kumari, Crawford, & Davis, 2003) and has been used to assess inhibitory control in both clinical and non-clinical samples (Hutton & Ettinger, 2006).



**Figure 1.** Example of prosaccade and antisaccade conditions on a typical antisaccade eye-tracking task

Other tasks, such as the Stroop test (Stroop, 1935), also provide insights into inhibitory control by similarly tapping into this conflict between Type 1 and Type 2 processing. In a typical Stroop task, colour names are presented in incompatibly coloured ink (e.g. the word 'green' written in blue ink) and participants are asked to name the colour of the ink rather than reading the word itself (see Figure 2). This involves inhibiting the prepotent and automatic response of simply reading the word and having to consciously over-ride it by looking for and naming the colour instead. An 'interference effect' is shown when the time to name the ink colour takes longer than the time taken to read the written word. The straightforward word reading task is therefore administered before the inhibitory task to serve as a baseline level of comparison. Greater interference effects will be identified in people with reduced inhibitory control. Whilst this has been a popular and influential task in cognitive research, it could be argued that the antisaccade task constitutes a purer and more direct measure of inhibition, as it does not tap into language or reading ability, and is also unaffected by colour-blindness.

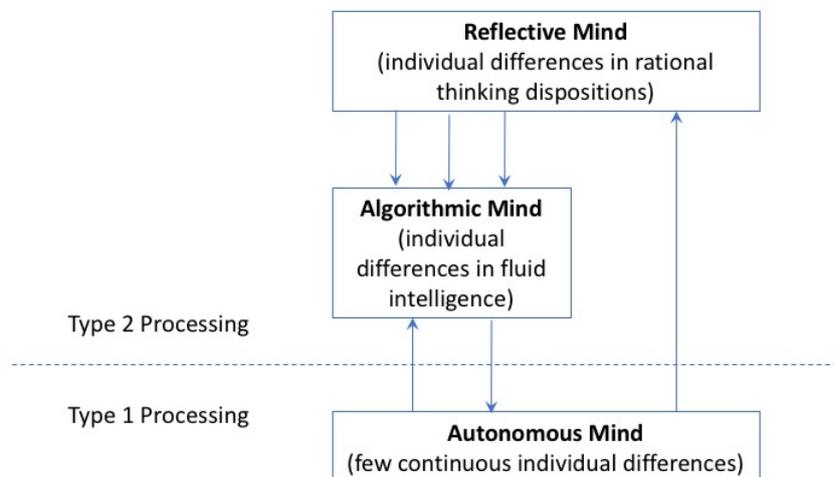


**Figure 2.** Example of baseline and experimental conditions on a typical Stroop test

### 1.2.5. Tripartite Model of the Mind

More recently, Keith Stanovich proposed a 'tripartite' extension of dual process theories to include an additional layer of Type 2 processing, which he called the 'reflective mind' (Evans & Stanovich, 2013) (see Figure 3). Stanovich observed that, whilst intelligence is generally correlated with logical reasoning ability, the capacity to engage in effective logical reasoning *can be* relatively independent of one's cognitive ability (Stanovich, 2012; Stanovich & West, 2008). He therefore proposed that an additional factor, 'thinking style' (or 'reflective mind') can mediate how effectively Type 2 processes over-ride Type 1 processes. This is thought to explain additional

individual differences in reasoning. Despite including an additional third component, the tripartite model still assumes a distinction between Type 1 and Type 2 thinking processes and is therefore still compatible with traditional dual process theories.



**Figure 3.** Stanovich's tripartite model of the mind and related individual differences (based on Evans & Stanovich, 2013)

Stanovich outlined three levels within his tripartite model (Evans & Stanovich, 2013). The 'Autonomous Mind' is responsible for Type 1 processing, while the 'Algorithmic Mind' and the 'Reflective Mind' are both responsible for different levels of Type 2 processing. A hierarchy of control is suggested within the model, where the Reflective Mind controls the Algorithmic Mind, and both in turn exert control over the Autonomous Mind. The reflective mind comprises higher level cognitive styles, thinking dispositions, personal values and attitudes towards forming and changing beliefs. This might include, for example, the degree to which one thinks extensively about problems before they respond, the amount of information they collect before making decisions, whether they integrate others' points of view into their decisions or their tendency to adjust their beliefs by factoring in the quality of evidence available to them. Conversely, cognitive ability (or intelligence) is captured by the 'algorithmic mind'. Variations in intelligence and thinking styles can together exert control over a primed 'Type 1' response to determine whether it is either expressed or inhibited. It follows therefore, that according to the model, people who are both higher in cognitive ability and more motivated due to their thinking disposition will be better placed to generate normatively correct responses (West, Toplak, & Stanovich,

2008). This ability will be depleted when motivation is lacking or when less effortful Type 1 processing is sufficient in order to generate a correct response (Stanovich & West, 1998).

The tripartite model is thought to operate in a 'default interventionist' fashion (Evans, 2007). This means that by default most of our responses are fast and relatively autonomous, and they are then intervened upon by Type 2 processes only when cognitive resources (i.e. working memory), motivation and environmental cues allow it. While Stanovich's model shares attributes with other dual process models (e.g. Kahneman, 2011), there are other theorists who posit that Type 1 and Type 2 processes operate in parallel, known as 'parallel-competitive' structures (Barbey & Sloman, 2007; Sloman, 1996; Smith & DeCoster, 2000). However, these parallel-competitive models arguably fail to account for why some processing is much faster and less effortful, and do not explain why Type 2 processes often seem to *over-ride* a primed Type 1 response.

Individual differences in the reflective mind may allow people to engage preferentially in one system over another. For example, people with a greater *reflective* thinking disposition demonstrate longer response times on reasoning tasks than *low-logic reasoners* who are more subject to the 'belief bias effect' (Stupple et al., 2011). Theories that do not acknowledge the influence of thinking style may therefore fail to adequately explain the intricacies of human reasoning.

#### 1.2.6. The Cognitive Reflection Test

The 'Cognitive Reflection Test' (CRT; Frederick, 2005) is a behavioural measure of cognitive reflection or the 'reflective mind', which also taps into cognitive inhibitory control of Type 2 over Type 1 processes. It consists of a series of reasoning problems that assess a person's ability to inhibit a tempting intuitive (or 'lure') response and then engage in reflective reasoning to calculate an alternative correct response. For example, consider the following problem:

"If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? \_\_\_\_ min"

Here, an incorrect and intuitive answer of '100' is primed, and it requires reflective thinking to override this response with the correct response of '5'. This highlights how humans are 'cognitive misers' in that they default to heuristic processing that is non-demanding and of low computational expense (Toplak, West, & Stanovich, 2014). This may be because Type 2 processing tends to require much greater concentration and can be experienced as aversive or unpleasant due to its interference with other thoughts and actions. A study by Toplak and colleagues (Toplak, West, & Stanovich, 2011) found that the CRT was a predictor of rational thinking performance on a series of heuristics and biases tests, including belief bias syllogisms. Furthermore, the CRT was found to predict rational thinking, *independent* of measures of intelligence, executive functioning or thinking disposition (although the CRT is also thought to tap into aspects of intelligence and thinking disposition). The CRT is empirically useful in that it is relatively easy to administer (as it is in questionnaire format) and is a performance based measure of cognitive reflection, rather than relying on self-report.

#### 1.2.7. Self-Report Measures of Thinking Styles

Self-report attitudinal measures have also been developed to assess individual differences in thinking style (which are thought to contribute to Stanovich's Reflective Mind). A list of such measures with sample items are displayed in Table 1. The validated 'Actively Open-Minded Thinking Scale' (Haran, Ritov, & Mellers, 2013) assesses the personal tendency to engage in open, reflective and flexible thinking. Indeed research suggests that individual differences in actively open-minded thinking are a predictor of a person's ability and tendency to reason about their previously held beliefs (Stanovich & West, 1997). This measure only aims to capture variability in Type 2 processing as it is characterised by flexible cognitive control.

Another measure, the Rational Experiential Inventory (REI; Epstein, Pacini, Denes-Raj, & Heier, 1996) constitutes a validated self-report measure of the preference to engage in logical (rational or Type 2) thinking versus experiential (intuitive or Type 1) thinking. The scale comprises two factors; 'Faith in Intuition' and 'Need for Cognition' (Cacioppo & Petty, 1982). These are based on Epstein's 'Cognitive-Experiential Self Theory' (Epstein, 1998), which posits two information processing systems; one

‘analytical-rational’ and the other ‘intuitive-experiential’ and is therefore broadly analogous to dual process models of Type 1 and Type 2 thinking.

**Table 1.** Self-report measures of thinking styles with sample items

Measure	Factor	Authors	Sample Item
Actively Open-Minded Thinking Scale	Actively Open-Minded Thinking	Haran, Ritov, & Mellers (2013)	Allowing oneself to be convinced by an opposing argument is a sign of good character.
Rational Experiential Inventory	Faith in Intuition Need for Cognition	Epstein et al. (1996)	I believe in trusting my hunches. I prefer to do something that challenges my thinking abilities rather than something that requires little thought.

These scales can be critiqued for failing to clearly delineate *type* of reasoning from *style* of reasoning (Evans & Frankish, 2009). However, this is likely an artefact of the inevitable complexity and overlap between these variables, which arguably cannot be clearly teased apart and distinguished using behavioural or self-report measures. It could also be argued that self-report measures may never truly capture thinking style, as by its very nature cognitive style may be subject to bias and a lack of awareness of one’s own preferences. On the other hand, it could also be counter-argued that these measures are intended to be attitudinal measures of personal preference, implying that they are effective in measuring what they claim to measure.

#### 1.2.8. Critiques of Dual Process Theories

While undoubtedly influential in informing current understandings of reasoning and decision making, dual process theories have nevertheless faced criticism. For example, they have been critiqued for being somewhat vague in their theoretical definitions, lacking conceptual clarity and inadequately evidenced (Keren & Schul, 2009). For example, theories often imply that Type 1 processing is biased and error-prone, while Type 2 processing is accurate, logical and normatively rational (Epstein, 1994). The evidence that Type 2 processes can *also* be subject to biases (e.g. Verschueren & Schaeken, 2005; Weidenfeld, Oberauer, & Hörnig, 2005) seemingly questions the face validity of clear distinctions between the two types of thinking. However, even proponents of dual process theories themselves acknowledge that it is a fallacy to assume that intuitive Type 1 judgments are often incorrect, and

equally, to assume that logical deliberative judgments cannot be prone to errors (Evans, 2007). However, dual process theorists have admitted that the distinction between Type 1 and Type 2 processes is unlikely to be completely categorical and inflexible (Stanovich, 2013). While the two types are purported to embody two qualitatively distinct forms of processing, they are nevertheless thought to each comprise an amalgamation of cognitive and neural processes (Evans & Stanovich, 2013). Additionally, within dual process models there can be legitimate variations in terms of proposed structure (e.g. default interventionist vs. parallel competitive) and their underlying neurocognitive processes.

Other critics argue that dual process theories are unnecessary in explaining human reasoning as the processes can adequately be explained by unified or 'single system' accounts (Kruglanski & Gigerenzer, 2011; Osman, 2004). For example, some theorists posit a continuum of reasoning ranging from intuitive to analytical, without discrete distinctions between the two (e.g. Hammond, 1996). Alternatively, Kruglanski and Gigerenzer (2011) posit that a range of cognitive processes can be described through overarching 'rule based' judgments. For example, they suggest that the widely observed 'belief bias effect' merely provides evidence for conflict of different types of rules, rather than evidence for dual process theories per se. However, it could equally be argued that 'rule' is such a broad and non-specific term, which could encompass any number of reasoning processes, that even the presence of rule based reasoning would not invalidate the existence of two different types of processing. Furthermore, single system accounts fail to account for why different areas of the brain are have been associated with Type 1 and Type 2 processing respectively (Schneider & Chein, 2003).

Some criticisms of dual process models may have arisen because different types of dual process theories have been grouped together in a way that implies they are conceptually similar, when in fact many possess subtle differences. The incorrect assumption of homogeneity between the theories is known as the 'clustering problem' (Evans & Stanovich, 2013). Contrary to what critics may suggest (Kruglanski & Gigerenzer, 2011), the defining features of Type 1 and Type 2 processing do not need to be considered *necessary* and *deterministic*. Rather Type 1 and Type 2 processing can be conceptualised as having respective sets of

*correlated features*, which are more likely to occur alongside one another within one type of processing (Evans & Stanovich, 2013). For example, there appears to be consensus that Type 2 processing is slow, sequential and reliant on working memory, while Type 1 processing is considered fast and relatively automatic (Evans & Stanovich, 2013). Indeed, it could further be argued that within psychology, it is rare that models and theories are considered all-encompassing, deterministic and empirically unfalsifiable, due to the subjective and varied nature of human thought and behaviour. Therefore, this thesis will primarily draw on Stanovich's tripartite dual process model to inform theory related to reasoning and decision making, and how it relates to schizotypy.

### **1.3. Schizotypy**

#### **1.3.1. Schizotypy and Psychosis**

The term 'schizotypy' refers to a continuum of psychosis-like characteristics and experiences, ranging from those characterised as less extreme, to the more extreme states that might be observed in clinical psychosis (Ettinger, Meyhöfer, Steffens, Wagner, & Koutsouleris, 2014). Conceptualising psychosis-like experiences on a continuum contrasts with early theories of psychosis which posited that such experiences were 'all-or nothing', categorical and observable phenomena (Bleuler, 1950), leading to discrete terms and psychiatric diagnoses such as 'schizophrenia'. 'Schizophrenia' is thought to consist of a range of illness-related 'symptoms' that through a checklist approach of assessing the number and combination of symptoms, are used to inform psychiatric diagnosis (American Psychiatric Association, 2013). These include 'positive symptoms' (delusional beliefs and hallucinations), 'negative symptoms' (such as 'anhedonia' or reduced ability to experience pleasure, cognitive difficulties and less interest in other people) and disorganised thoughts and speech (Cowen, Harrison, & Burns, 2012). A diagnostic approach remains very dominant in psychiatry today, despite the questionable validity and ethical implications (e.g. stigma and disempowerment) of the 'schizophrenia' label and diagnosis (Bentall, Jackson, & Pilgrim, 2011; Boyle, 2014; Double, 2002; Rosenhan, 1973). The concept of schizotypy therefore attempts to move away from a diagnostic, symptom based, and 'illness-focused' understanding of experiences, and towards an arguably more normalising, individual differences approach to understanding human thinking and behaviour.

### 1.3.2. Definition of Schizotypy

Schizotypy is thought to encompass a range of human experiences and traits including unusual beliefs and perceptions, magical thinking, anhedonia and introversion (Fisher et al., 2004). It has been linked to creativity and artistic pursuits (Burch, Pavelis, Hemsley, & Corr, 2006; O'Reilly, Dunbar, & Bentall, 2001) as well as mating success (Nettle & Clegg, 2006). Authors have conceptualised the constructs that make up schizotypy in slightly different ways and there has been debate about its latent structure. One study using factor analysis suggested that it comprises four primary factors: 'aberrant perceptions and beliefs', 'cognitive disorganisation', 'introvertive anhedonia' and 'asocial behaviour' (Claridge et al., 1996). Elsewhere, 'introvertive anhedonia' and 'cognitive disorganisation' were acknowledged as two factors, but 'unusual experiences' and 'impulsive non-conformity' were included as the third and fourth factors (Mason, Claridge, & Jackson, 1995). 'Disorganised schizotypy' (or 'cognitive disorganisation') is thought to reflect disorganised thoughts and speech, while 'impulsive non-conformity' refers to disinhibited, impulsive or non-conforming behaviour. Others have conceptualised just two reliable dimensions; 'positive schizotypy' and 'negative schizotypy' (Kwapil, Barrantes-Vidal, & Silvia, 2008). Indeed these do appear to be the most consistently replicated factors (Vollema & van den Bosch, 1995) with a general consensus that schizotypy comprises at least these two dimensions (Fisher et al., 2004). 'Unusual experiences' and 'introvertive anhedonia' can be considered to reflect central aspects of positive and negative schizotypy respectively, which may in turn be related to positive and negative 'symptoms' in clinical psychosis. However, a recent study found that while higher 'negative' and 'disorganised' aspects of schizotypy were predictive of poorer mental health, there was no relation between 'positive' schizotypy and mental health (Ödéhn & Goulding, in press).

### 1.3.3. Measures of Schizotypy

Several psychometric measures have been developed to capture individual differences in schizotypy. In line with variation in the literature, these measures vary in the number and nature of their underlying factors. A selection of some of the most influential measures including sample items for their respective underlying factors are displayed in Table 2.

**Table 2.** Self-report measures of schizotypy with sample items

Measure	Factors	Sample Item
Rust Inventory of Schizotypal Cognitions (Rust, 1989)	Positive schizotypal cognitions	I have, on occasions, tried to reach the very essence of an object with my mind
Schizotypal Trait Assessment (Claridge & Broks, 1984)	Magical ideation	Are you sometimes sure other people can feel what you're thinking?
	Unusual perceptual experiences	Have you ever felt when you looked in a mirror that your face seemed different?
	Paranoid ideation and suspiciousness	Do you feel that you have to be on your guard even with your friends?
Schizotypal Personality Questionnaire (Raine, 1991)	Ideas of reference	Do you sometimes feel that other people are watching you?
	Social anxiety	I get anxious when meeting people for the first time
	Odd beliefs/magical thinking	Have you had experiences with the supernatural?
	Unusual perceptual experiences	Have you often mistaken objects or shadows for people, or noises for voices?
	Eccentric/odd behaviour	I have some eccentric (odd) habits
	No close friends	I have little interest in getting to know other people
	Odd speech	I often ramble on too much when speaking
	Constricted affect	I tend to avoid eye contact when conversing with others
The Oxford-Liverpool Inventory of Feelings and Experiences (Mason, Linney, & Claridge, 2005)	Suspiciousness/paranoid ideation	I often feel that others have it in for me
	Unusual experiences	Have you ever thought that you had special, almost magical powers?
	Introvertive anhedonia	Are there very few things that you have ever enjoyed doing?
	Cognitive disorganisation	Do you often have difficulties in controlling your thoughts?
Multidimensional Schizotypy Scale (Gross, Kwapil, Raulin, Silvia, & Barrantes-Vidal, 2018)	Impulsive non-conformity	Would you like other people to be afraid of you?
	Positive	I have sometimes felt that strangers were reading my mind
	Negative	If given the choice, I would much rather be with another person than alone
	Disorganised	Things slip my mind so often that it's hard to get things done

The O-LIFE was, until recently, based on the largest dataset of schizotypal measures. It is also firmly established as a research tool having been widely used in studies, with favourable psychometric properties (Mason, Linney, & Claridge, 2005). It comprises four factors including Unusual Experiences, Introvertive Anhedonia, Cognitive Disorganisation, and Impulsive Non-Conformity. Very recently and subsequent to data collection in the present study, the 'Multidimensional Schizotypy Scale' was created based on a large online sample ( $n = 6265$ ). The measure taps into positive, negative and disorganised aspects of schizotypy (Gross et al., 2018). This scale also claims to have good psychometric properties, including reliability and high item-scale correlations (Kwapil, Gross, Silvia, Raulin, & Barrantes-Vidal, 2018), but does not yet have an established evidence base.

#### 1.3.4. Why Investigate Schizotypy?

In the reasoning literature, there is a much larger evidence base around 'schizophrenia' and psychosis or particular psychosis-like experiences (e.g. hearing voices or delusional beliefs) than there is in relation to schizotypy. This may be because diagnostic categories and 'symptoms' are considered more 'objective' and the findings seemingly more 'groundbreaking' within the scientific or medical community. However, given the poor validity of psychiatric diagnoses (Boyle, 1990; Kendell & Jablensky, 2003), it may be more useful to take an individual differences or continuum approach to investigating decision making in relation to these types of experiences. Furthermore, by researching schizotypy, it may be possible to bypass the confounding effects of medication and 'acute' psychosis that may be associated with presentations that are severe enough to be diagnosed as 'disorders' within our current frameworks (Ettinger et al., 2014). For example, antipsychotic medication can have global sedative effects on the brain that can greatly impede validity when exploring cognition or thinking processes (Barnes & McPhillips, 1999; Lambert et al., 2004). Furthermore, there is an unequivocal link between trauma and psychosis (Read, Van Os, Morrison, & Ross, 2005), which can confound research findings. Indeed, people who are very distressed by their experiences are by definition more likely to present to mental health services, arguably resulting in a sample with different characteristics and thinking dispositions compared to the non-clinical population. These confounding effects may be less common when exploring schizotypy in a non-clinical context within the general population. Furthermore,

research into schizotypy is arguably better able to capture heterogeneity and multi-dimensional features (Barrantes-Vidal, Grant, & Kwapil, 2015), as opposed to having to fit into a discrete and narrowly-defined diagnostic category.

Nevertheless, one could still argue that the concept of 'schizotypy' also relies on reductionist terminology as a means of capturing rich, unique and individual human experiences. Therefore, it must be acknowledged that there are also limitations of using continuum models of psychosis, and of assuming that schizotypy itself (and its underlying factors) are observable, reliable and valid constructs. While schizotypy has been criticised for being just another means of categorising psychosis-like experiences (Rawlings, Williams, Haslam, & Claridge, 2008), the current study aims to regard schizotypy as an individual difference that varies across the population like any other. It is also hoped that a normalising and continuum view of such experiences will discourage any negative, pathologising or deterministic connotations related to either psychosis or schizotypy.

#### **1.4. Reasoning in Psychosis**

This section will briefly outline some of the key findings, debates and areas of controversy within the psychosis and reasoning literature. Until recently, dual process theories had not been integrated into psychosis-related frameworks. However, this has been attempted more recently, but only in relation to delusional beliefs (Ward & Garety, in press; Ward, Peters, Jackson, Day, & Garety, 2018). In these studies, the authors have posited that a combination of over-reliance on Type 1 reasoning processes alongside a lower propensity to use Type 2 reflective reasoning processes may be implicated in the maintenance of unusual or distressing beliefs. With research overwhelmingly focusing on 'positive symptoms', there appears to be less of an established evidence base into other aspects of psychosis and their relationship with decision making. This section will not discuss research related to schizotypy, as this will be covered in greater depth in the systematic literature review section that follows.

##### **1.4.1. Type 1 Processing**

A large body of research has investigated psychosis in relation to the 'jumping to conclusions' (JTC) bias; a reasoning bias, which refers to the tendency to make

hastier decisions and/or with greater conviction. The JTC bias has typically been assessed using a behavioural task called 'the Beads Task' (Huq, Garety, & Hemsley, 1988). This task requires participants to engage in probabilistic reasoning based on two jars which contain complimentary ratios of coloured beads. After the jars are hidden from view, beads are drawn one-by-one from *one* of the jars. Participants are then required to estimate which of the jars the bead is being drawn from and the task is terminated once a final decision is made. This task can assess the degree of *certainty* with which decisions are made, as well as how *rapidly* a conclusion is reached (i.e. the number of 'draws to a decision'). A higher degree of certainty and greater speed of arriving at a decision is thought to be indicative of a tendency to make decisions based on little evidence, or 'jumping to conclusions'.

Several studies have suggested that people with psychosis demonstrate a greater JTC bias than non-clinical subjects (Garety, Kuipers, & Fowler, 2001; So, Siu, Wong, Chan, & Garety, 2016). In the context of dual process models, this can be considered analogous to making decisions based on intuition or 'gut feeling' i.e. a Type 1 process. Evidence from two independent meta-analyses also suggests that the JTC bias is more prominent in people with psychosis than in controls, with medium to large effect sizes (Hedge's  $g = 0.53$ , Dudley, Taylor, & Wickham, 2015;  $g = 0.71$ , McLean, Mattiske, & Balzan, 2017). These studies also found evidence for small to medium effects of increased JTC bias in people with delusions in psychosis compared with people without delusions in psychosis (Hedge's  $g = 0.29$ , Dudley et al., 2015;  $g = 0.33$ , McLean et al., 2017). Another meta-analysis by Ross and colleagues (Ross, McKay, Coltheart, & Langdon, 2015) found an association between delusions and the JTC bias in 'delusion-prone' samples, with a small effect size ( $r = 0.10$ ). This may indicate that the JTC bias is associated specifically with delusions (rather than psychosis more generally) and that the effect is more pronounced in clinical samples. These findings may further demonstrate a disrupted ability to integrate context with sensory information in delusions. A recent study also found that the JTC bias was more prominent in people with psychotic experiences who receive clinical care, than either controls or people with psychotic experiences without a need for care (Ward et al., 2018). This was assessed through a novel 'in vivo' method of rating intuitive and rational reasoning through interviews. This would suggest that the JTC bias is associated with psychosis that meets clinical thresholds

rather than psychotic experiences that are non-distressing or absent from paranoia. However, another study reported a comparable JTC effect across clinical and non-clinical voice hearers, although clinical voice hearers scored more highly on 'emotional reasoning' than non-clinical voice hearers (Daalman, Sommer, Derks, & Peters, 2013). Notably, Balzan, Delfabbro, Galletly and Woodward (2012) have discussed some limitations related to task comprehension of the 'beads task'. They have suggested that only the 'premature decision' component, but not the 'over-adjustment' component (i.e. radically altering beliefs in the face of little disconfirming evidence) appears to be a genuine feature of psychosis. Nevertheless, the current evidence appears to implicate greater reliance on Type 1 or intuitive reasoning in psychosis.

#### 1.4.2. Type 2 Processing

As might be expected from an apparent increased tendency to engage in intuitive Type 1 processing, the literature seems to indicate that people with psychosis are correspondingly *less* adept at Type 2 processing (e.g. Mujica-Parodi, Greenberg, Bilder, & Malaspina, 2001). For example, people with a diagnosis of 'schizophrenia' (e.g. Garety & Hemsley, 1997) or those with persecutory ideation (Freeman, Evans, & Lister, 2012) have been found to reason less logically than non-clinical controls. Furthermore, poorer performance on deductive reasoning tasks is also reportedly associated with *greater* functional activity in brain areas subserving logical reasoning abilities in medication-naïve participants diagnosed with schizophrenia (Ramsey et al., 2002). This excessive recruitment of reasoning-related brain areas may imply poorer cognitive efficiency when carrying out logical or Type 2 reasoning tasks, potentially suggesting this type of reasoning is more challenging for people with psychosis.

Ward et al. (2018) also reported *lower* levels of rational reasoning in people with clinical psychosis in the context of explaining their psychosis-related experiences through their 'in vivo' interview method. Specifically, clinical subjects were less able to create alternative or less distressing appraisals of their experiences than either a control group, or a non-clinical group with psychosis-like experiences. Interestingly, the non-clinical group were found to be equally rational and reflective in their

reasoning as control subjects, potentially suggesting that Type 2 reasoning (or a more reflective thinking style) may be protective in avoiding distress or paranoia.

On the other hand, Owen, Cutting, & David (2007) interestingly found that theoretical rationality was actually *enhanced* in people diagnosed with schizophrenia compared with controls. Using deductive reasoning problems (belief bias syllogisms), they found that people with psychosis reasoned *more* logically and accurately than controls when logic conflicted with common-sense. However, the sample size of the clinical group was relatively small ( $n = 17$ ) and all participants were taking anti-psychotic medication, potentially confounding the results. Nevertheless, people diagnosed with schizophrenia are also reported to be more likely to misinterpret metaphorical or abstract meanings (e.g. proverbs) according to their concrete or literal meanings (Heinz, 2014). This may imply a *reduced* propensity to be distracted by conflicting contextual information when reasoning in a logical way. These discrepant findings need to be investigated further, whilst also considering the additional influence of inhibitory control, 'cognitive style' or attitudes about thinking, which may complicate the picture.

#### 1.4.3. Inhibitory Control

There appears to be some evidence for reduced cognitive inhibitory control in people with psychosis compared with controls (Ethridge et al., 2018; Peters, Pickering, & Hemsley, 1994). For example, a recent meta-analysis suggests that people with a schizophrenia diagnosis demonstrate poorer performance on the Stroop task than non-clinical participants (Westerhausen, Kompus, & Hugdahl, 2018). It is now also well-established that people with psychosis or a diagnosis of schizophrenia are more likely to make errors on the antisaccade task (Curtis, Calkins, Grove, Feil, & Iacono, 2001; Hutton & Ettinger, 2006; Radant et al., 2018). Although pharmacological treatments have been found to interfere with oculomotor functioning (Reilly, Lencer, Bishop, Keedy, & Sweeney, 2008), increased antisaccade errors appear to be unrelated to specific 'symptoms' or antipsychotic medication (Reilly et al., 2014), potentially alluding to similar processes within schizotypy. Furthermore, poorer antisaccade performance in schizophrenia may be exacerbated by working memory difficulties (Nieman et al., 2000). This makes sense in light of the proposed link between Type 2 processing and working memory (Evans & Over, 1996), in that

reduced working memory capacity (either through natural cognitive ability or increased cognitive 'load') is thought to render Type 2 processing less effective at overriding intuitive responses. A study by Ettinger et al. (2017) reported task-specific cognitive inhibitory impairments in schizophrenia, which were confined to the Stroop and antisaccade tasks. Interestingly, there was no evidence of impairments on other tasks pertaining to cognitive inhibition, potentially alluding to a varied or non-generalised profile of cognitive inhibitory processes in psychosis.

#### 1.4.4. Thinking Style

A study by Freeman and colleagues (Freeman, Lister, & Evans, 2014) used the REI to assess self-reported reasoning styles across people with persecutory delusions ( $n = 30$ ) and a large sample of controls ( $n = 1000$ ). Interestingly, not only were analytic reasoning scores lower in the clinical group (an effect that was expected), but intuitive thinking processes were unexpectedly also found to be lower within this group. The authors posited that this could be an artefact of the self-report nature of the measure, and people potentially not being metacognitively or objectively aware of their own thinking styles or preferences. Furthermore, the clinical group was small and although they were deemed 'medically stable', medication and other mental health difficulties might have confounded the findings. Lastly, persecutory delusions reflects quite a specific aspect of psychosis, and the picture may differ across other aspects of psychosis.

A recent literature review by Ward and Garety (in press) highlighted how, for people with delusional beliefs, there may be a cognitive disposition towards *lower* belief flexibility. Belief flexibility refers to the ability to 'decouple' or distance oneself from one's beliefs in order to reflect on alternatives or the prospect of being mistaken in one's beliefs. This clearly shares similarities with cognitive style or Stanovich's 'Reflective Mind'. Another study consisting of a sample of 41 adults with a schizophrenia diagnosis reported that lower self-reflectivity was associated with less accurate appraisals of one's own work performance (Luedtke et al., 2012).

People with psychosis (Eisenacher & Zink, 2017) and people scoring highly in delusion-proneness (McLean et al., 2017; Woodward, Buchy, Moritz, & Liotti, 2007) have also been reported to demonstrate a cognitive bias against disconfirmatory

evidence (BADE). This refers to a tendency to be less likely to integrate new evidence that disconfirms one's existing beliefs. This finding has also been corroborated in a recent meta-analysis, which identified greater BADE in people with psychosis vs. healthy controls ( $g = 0.33$ ) as well as in people with delusions in psychosis vs. people without delusions in psychosis ( $g = 0.31$ ), with small to medium effect sizes (McLean et al., 2017). This seems to make intuitive sense, as delusions tend to persist even in the light of novel, falsifying or objectively conflicting evidence (Broyd, Balzan, Woodward, & Allen, 2017). While some studies have suggested that BADE is not related to 'negative symptoms' (e.g. Juárez-Ramos et al., 2014), other studies provide preliminary evidence for a potential association (Eisenacher et al., 2016). The BADE seems to draw parallels with aspects of the 'Actively Open-Minded Thinking Scale', which includes items tapping into the propensity to consider and revise one's established beliefs in response to new or conflicting evidence.

### **1.5. Reasoning in Schizotypy**

For the systematic literature review into reasoning processes in schizotypy, a search was carried out according to the Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009). Searches, paper selection and data extraction was performed by the author and verified by the thesis supervisor.

#### **1.5.1. Search Strategy**

The search strategy used to identify relevant literature for the present study is displayed in Table 3. Electronic databases were searched from when online records began up until July 2017. Another keyword search (using the term "schizotypy") was carried out in Scopus in April 2018 to identify any additional recent and relevant articles. Articles published after the initial search were also identified through email alerts created through Ebsco and Scopus based on the search terms specified below.

The literature search included the term "schizotypy" (and related synonyms) along with synonyms for Type 1 and Type 2 processing, thinking style and decision making across the databases. Hand searches of references in relevant articles and key

review articles were also undertaken (see Appendix A for literature search flowchart).

**Table 3.** Search strategy for systematic literature review

Databases	Search Terms	Inclusion Criteria	Exclusion Criteria	Extracted Data
PsycINFO (Ovid) Medline (PubMed) Scopus Science Direct	(“schizotyp*” OR “psychosis-prone*”) AND (“type 1” OR “system 1” OR “intuiti*” OR “heuristic” OR “antisaccade” OR “jumping to conclusion*” OR “bias*”) OR (“type 2” OR “system 2” OR “effortful” OR “rational*” OR “belief bias” OR “syllogism*”) OR (“thinking style” OR “reasoning style” OR “reflective mind” OR “cognitive style”) OR (“Decision*making” OR “thinking” OR “reasoning” OR “judgment” OR “judgement”)	1) Pub- lished in peer- reviewed academic journals. 2) Written in English. 3) All study designs.	1) Studies investigating psychiatric diagnoses (e.g. schizophrenia, schizotypal personality disorder) as well as general psychosis or ‘schizophrenia’. 2) Studies investigating specific psychosis- like experiences in the healthy population (i.e. voices or delusions). 3) Studies examining very ‘early’ attentional processes (e.g. prepulse inhibition and startle response).	Sample characteristics, study design, methodology, experimental tasks involved, type of cognitive process (i.e. Type 1, Type 2, cognitive style), outcome data, conclusions and potential sources of bias.

### 1.5.2. Type 1 Reasoning

Seven studies related to Type 1 processing in schizotypy were eligible for inclusion in this section. Three studies identified a greater ‘false detection’ or ‘jumping to perceptions’ type bias in positive schizotypy (Grant, Balsler, Munk, Linder, & Hennig,

2014; Tsakanikos & Reed, 2005a, 2005b) compared to their low-scoring counterparts. 'Jumping to perceptions' refers to a bias towards believing that ambiguous perceptual experiences are real and external (Colbert, Peters, & Garety, 2010). These studies typically assessed automatic detection of fast moving words (or non-words) presented more quickly than could be captured by a deliberative response bias, and found a higher number of 'false positive' (or false alarm) perceptions in schizotypy. These findings may make intuitive sense in the context of hallucinatory experiences potentially being linked to a stimulus that is perceived in the absence of an objectively experienced stimulus. Another study which assessed reaction time of visual cueing similarly revealed impairments on the jumping to perceptions task both in negative schizotypy (in males) and impulsive non-conformity (more so in females) (Mason, Booth, & Olivers, 2004). This however constitutes a less pure measure of visual attention than eye tracking tasks due to the reliance on motor control and the subject having to make a response on a computer.

Similarly, intuitive thinking (assessed by the REI, Pacini & Epstein, 1999) has also been associated with unusual beliefs (Boden, Berenbaum, & Topper, 2012) as well as both paranormal beliefs and schizotypy (disorganised thinking and cognitive-perceptual domains) in teachers (Genovese, 2005). Another study by Wolfradt et al. (1999) conversely found that the introvertive aspects of schizotypy may be associated with greater reliance on intuitive thinking, while participants with a preference for both intuitive and rational thinking styles scored highly on cognitive-perceptual aspects of schizotypy. However, the study was correlational, had small effect sizes and was based purely on self-report. Nevertheless, there appears to be some evidence that greater reliance on intuitive/automatic (i.e. Type 1) thinking may be more common amongst those with higher schizotypy scores.

### 1.5.3. Cognitive Inhibition

As mentioned above, research into cognitive inhibition can shed light on how effectively Type 2 processes can intervene on automatic and intuitive Type 1 reasoning processes. Difficulties with inhibition may also be indicative of a propensity to engage in a more intuitive or impulsive reasoning style. In addition to antisaccade studies, which are reported separately in the next section, twelve studies related to inhibitory cognitive control were found to be eligible for the review.

Positive schizotypy has been associated with impaired top-down inhibitory processing on a perceptual task (Bullen, Hemsley, & Dixon, 1987) as well as impaired inhibition on a cognitive task (Peters et al., 1994). Using another task tapping into inhibitory control, the 'Cued Letter Comparison Task', Steel, Hemsley, and Pickering (2007) also found that positive schizotypy was associated with *lower* inhibition when responding to unexpected targets in the context of a previous letter cue. Another study by Migo et al. (2006) also reported a negative association between conditioned inhibition and schizotypy in a university sample. However, a study by Kerns (2006) using confirmatory factor analysis found that only 'disorganised' schizotypy (reflecting disorganised thoughts and speech) was associated with impaired pre-potent inhibition assessed through three tasks tapping into cognitive control, including the Stroop task.

In another study using the Stroop paradigm (Stroop, 1935), Louise et al. (2015) found that impulsive non-conformity, cognitive disorganisation and unusual experiences were all related to impairments on the task, while introverted anhedonia was not. Beech, Baylis, Smithson, & Claridge (1989) also reported a significant Stroop effect in higher general schizotypy, but only for items presented for a short duration ( $\leq 100$ ms). Conversely, three other studies reported no association between Stroop interference and general schizotypy (Green & Williams, 1999; Kaplan & Lubow, 2011) and social anhedonia (Martin & Kerns, 2010). These discrepant findings may reflect impaired inhibition only at more automatic stages of information processing, which may suggest that tasks such as the antisaccade task are better able to detect these processes. It may also be that different subtypes of schizotypy (rather than general schizotypy) are related to inhibition. For example, in a recent study by Ettinger et al. (2017), a range of tasks tapping into cognitive inhibition were administered and a variable performance profile was identified across the tasks according to different domains of schizotypy. They found that negative and disorganised schizotypy were both associated with poorer performance on the 'stop signal' task, and disorganised schizotypy was also associated with increased errors on the 'Simon task'. While positive schizotypy was associated with poorer antisaccade performance, there were no significant associations between any dimensions of schizotypy and the Stroop task, as well as two other tasks tapping into

cognitive inhibition (the 'flanker' and 'go/no-go' task). However, a recent meta-analysis found no evidence of cognitive inhibition in either positive, negative or overall schizotypy (Steffens, Meyhöfer, Fassbender, Ettinger, & Kambeitz, in press).

#### 1.5.4. Antisaccades

Sixteen papers investigating antisaccades in relation to schizotypy met criteria for inclusion in the review. Antisaccade tasks assess the ability to apply inhibitory cognitive control, by requiring participants to make a saccade in the *opposite* direction to a visual target, when the temptation is to visually follow the target. A recent study by Koychev et al. (2016) investigated antisaccades in those with low, medium and high schizotypy scores and found a graded performance between high schizotypy (with the most impaired performance) and low schizotypy (with the least impaired performance). This graded performance suggests that antisaccade errors may be directly related to individual differences in schizotypy and related inhibitory processes.

A study by Schmechtig et al. (2013) also reported impaired antisaccade performance in schizotypy. While the study did not investigate different features of schizotypy separately, several other studies have reported an association between positive schizotypy and antisaccades (Aichert, Williams, Möller, Kumari, & Ettinger, 2012; Ettinger et al., 2005, 2017; Gooding, 1999; Holahan & O'Driscoll, 2005; Larrison, Ferrante, Briand, & Sereno, 2000; O'Driscoll, Lenzenweger, & Holzman, 1998). Ettinger et al. (2005) found no evidence of antisaccade deficits in negative schizotypy and two other studies reported no association between high schizotypy and antisaccade errors (Klein, Brügger, Foerster, Müller, & Schweickhardt, 2000; Meyhöfer et al., 2017).

Gooding, Shea, & Matts (2005) on the other hand, reported antisaccade deficits in negative schizotypy (social anhedonia) and no effect in positive schizotypy. Gooding (1999) reported increased antisaccade errors in both positive and negative schizotypy, although a more robust effect was reported for positive schizotypy ( $p < .01$  compared with  $p < .05$  for negative schizotypy). Another study by Smyrnis et al. (2003) found a negligible effect of schizotypy (assessed through the Schizotypal Personality Questionnaire) on antisaccade performance in a large sample of

conscripts of the Greek Air Force. Different outcomes across studies could reflect use of different questionnaire measures of schizotypy, as well as different study designs, including correlational measures versus testing those at either extreme of the schizotypy spectrum.

On balance, it seems that impaired antisaccade performance (indicative of inhibitory deficits) may be a genuine feature of schizotypy, perhaps most notably for positive schizotypy. In addition, evidence suggests that saccadic performance appears *not* to be confounded by mood (i.e. anxiety, depression or neuroticism) (Ettinger et al., 2005; Smyrnis et al., 2004), making it more likely that it taps into schizotypy directly. Furthermore, behavioural antisaccade deficits appear to have underlying neurobiological correlates including reduced function of the thalamus, cerebellum, visual cortex and putamen; areas which are thought to also be affected in people diagnosed with 'schizophrenia' (Aichert et al., 2012). Further, Gooding and colleagues (2005) reported temporal stability of antisaccade performance over time, in a relatively large sample of 121 participants, suggesting that, at the more extreme end, it may potentially identify a trait association with psychosis.

A recent systematic review by Myles and colleagues (2017) appraised the existing evidence base regarding eye movements in both people high in schizotypy and biological relatives of people with a 'schizophrenia' diagnosis. They found a robust behavioural effect for increased anti-saccade errors in high schizotypy, although effect sizes generally appeared to be smaller than in first-degree relatives. Along with another narrative review by Wan and colleagues (Wan, Thomas, Pisipati, Jarvis, & Boutros, 2017), this lends further support to the hypothesis that increased antisaccade error rates, indicative of impaired inhibitory control, may be a feature of schizotypy.

#### 1.5.5. Jumping to Conclusions

Eight studies investigating a JTC type data gathering bias were considered eligible for inclusion in the review. Several studies have reported a significant JTC bias effect in high compared with low schizotypy (Brugger & Graves, 1997; Moritz et al., 2017; Moritz, Van Quaquebeke, & Lincoln, 2012; Sellen, Oaksford, & Gray, 2005). Despite

the aforementioned methodological limitations related to the classic beads task, such as issues around task miscomprehension and reliability (Balzan et al., 2012), comparable outcomes have been reported on variations of the task. For example, Moritz et al. (2017) recently identified a JTC bias on both a variant of the classic beads task as well as a similar but arguably more straightforward task, 'the box task'. The box task (Andreou et al., 2015; Clark, Robbins, Ersche, & Sahakian, 2006) requires subjects to estimate which of two colours of balls will be displayed more frequently in a matrix of grey boxes. Participants are told that one colour is always in the majority, and that they are free to make their decision after clicking as many boxes as they wish, serving to reveal the colours of the balls beneath. This approach ensures that the total amount of available evidence is clear to the participant as they can see the number of remaining boxes in the matrix. This differs from the 'bead task', in which the remaining beads are always hidden from the subject's view, thereby increasing potential ambiguity of whether it is the evidence related to the *current* bead or the *sequence* of beads that the participant should evaluate.

Highly 'psychosis-prone' individuals showed a particularly strong JTC bias (as evidenced by decreased decision thresholds) on the box task relative to low scorers (Moritz et al., 2017). The authors suggested that this appears to support a 'liberal acceptance' account of reasoning, whereby lower thresholds for making decisions (i.e. making decisions based on less evidence) causes the reasoner to feel overconfident in their judgment. The study design involved a large population based approach, thereby providing evidence for the JTC bias via a mechanism of liberal acceptance in a large sample of 80 high schizotypy scorers and 1,150 low schizotypy scorers, which was not drawn from a university sample as is often the case. This JTC bias was also found to be exaggerated in a similar version with added time pressure. Furthermore, the box task appeared to produce a more robust effect than the classic variation of the beads task, suggesting that the box task may be a more sensitive measure of JTC type biases. Furthermore, no such JTC bias effect was identified when comparing people who scored high vs. low on depression or 'negative symptoms'. This suggests that the JTC bias may be a feature of reasoning that is specifically related to the positive dimension of schizotypy.

Moritz et al., (2012) also reported an association between JTC bias and paranoia within another large sample of 1899 participants from the general population. While paranoia may draw parallels with positive schizotypy, it could be argued it constitutes quite a specific form of positive schizotypy, and may therefore tap into delusion-like phenomenology rather than schizotypy per se. Indeed, the study found that hasty decision making was associated with paranoia specifically, but was not associated with general 'suspiciousness'. Brugger and Graves (1997) found that people scoring highly in paranormal beliefs (assessed through the Magical Ideation Scale) tested fewer hypotheses during a problem-solving task and endorsed hypotheses more readily than low scorers, which seems consistent with a 'liberal acceptance' account of reasoning.

Another study by Sellen et al. (2005) administered the O-LIFE questionnaire to participants and investigated the JTC bias in relation to the four underlying schizotypy dimensions (unusual experiences, introvertive anhedonia, impulsive nonconformity, and cognitive disorganisation). A regression analysis revealed a significant JTC effect for those with high scores in impulsive non-conformity, while there was no significant effect for the other dimensions. As this seemingly conflicts with findings from other studies, this could be an artifact of the study design, in which participants were not selected on the basis of having schizotypy scores at extreme ends of the continuum, meaning that differences may not have been prominent enough to be detected. However, a study by Juárez-Ramos et al. (2014) that adopted this approach, also reported no significant differences between high and low schizotypy across a number of measures including JTC, BADE and feedback sensitivity (whether someone is able to use information to change an incorrect interpretation). However the study included just 15 participants per group, and may therefore have been underpowered to detect modest effect sizes.

#### 1.5.6. Bias Against Disconfirmatory Evidence

With regards to BADE (a bias in which people are less willing to integrate evidence that disconfirms their hypotheses and interpretations; Balzan, Delfabbro, Galletly, & Woodward, 2013a, 2013b), two studies looked specifically into how this relates to schizotypy. Buchy et al. (2007) identified a significant BADE effect in high vs. low schizotypy. In a typical BADE task, participants are required to rate and update the

plausibility of four interpretations of a scenario as more evidence is progressively revealed to produce a 'mini story'. Participants with high scores in schizotypy were found to be more resistant to revising their beliefs in the light of new disambiguating evidence. A more recent study in a Spanish sample (Orenes, Navarrete, Beltrán, & Santamaría, 2012) reported no significant BADE effect in a traditional picture-based version of the task (Moritz & Woodward, 2006), but did identify an effect in a more sensitive version in which reaction times were the outcome measure of interest, as opposed to plausibility ratings. This may reflect the need to utilise more sensitive measures in schizotypy compared with psychosis or clinical samples, in which the effect sizes are likely to be larger and more detectable. Furthermore, the scores in the 'Unusual Experiences' domain which are often examined and reported within schizotypy research were relatively low in the present sample, and should therefore be interpreted cautiously.

#### 1.5.7. Hypersalience of Evidence-Hypothesis Matches

There is also preliminary evidence to suggest that another confirmation bias, named a 'hypersalience of evidence-hypothesis matches' may be a feature of schizotypy. Specifically, people with delusions or 'delusion-prone' people have found to assign excessive weight to evidence which matches their existing hypotheses (Balzan et al., 2013a, 2013b), while considering non-matching information in a similar way to controls. However, this bias has not yet been investigated in relation to schizotypy more generally, and may tap into reasoning related to delusions specifically.

On balance, there is some evidence for the presence of data-gathering biases, such as JTC, BADE and hypersalience of evidence-hypothesis matches in schizotypy, potentially indicating greater reliance on intuitive Type 1 thinking processes (JTC) or a less flexible, open-minded reasoning style (BADE and hypersalience of evidence-hypothesis matches). However, as might be expected, it appears the effects are less extreme than in people with psychosis or clinical samples. Therefore these effects may not be identified without sufficiently large samples or sensitive tasks.

#### 1.5.8. Logical Reasoning

Studies investigating logical reasoning are thought to tap into Type 2 processing, and may incorporate reasoning tasks such as belief bias syllogisms. The literature

search identified five relevant papers, across which the findings were somewhat mixed. In a large sample of 254 participants, Dagnall, Denovan, Drinkwater, Parker, & Clough (2016) found that people with high scores on the schizotypy dimension of Unusual Experiences performed more poorly on reasoning problems involving statistical bias (perception of randomness and conjunction fallacy). However, the association was relatively weak and the relationship was found to be mediated by paranormal beliefs. This finding was confirmed more recently by the same research group who found that schizotypy had a negligible effect on reasoning performance using the same problems, perception of randomness and conjunction fallacy (Denovan, Dagnall, Drinkwater, & Parker, 2018). Lower levels of paranormal beliefs, however, were associated with superior performance on perception of randomness problems, but not conjunction problems. This suggests that presence of paranormal beliefs, as opposed to schizotypy, may be associated with poorer reasoning on such statistical bias reasoning problems.

Conversely, a study by Karimi, Windmann, Güntürkün, & Abraham (2007) interestingly reported *enhanced* reasoning in people with higher scores in schizotypy. The study looked at two different types of reasoning; 'incremental thinking' (involving incremental and goal-related thinking), and what the authors termed 'insight problem solving' (where the solutions relied on creative or divergent thinking). As predicted by the research team, those with higher scores in general schizotypy were found to be better at insight or creative problem solving than their lower scoring counterparts, but were no better on solving focused 'incremental' problems. This ability to acquire new or original perspectives may indicate that people high in schizotypy are less biased by context when reasoning and more able to think laterally and creatively. This may suggest that high schizotypy scorers may show variation in their reasoning profile that cannot simply be categorised into Type 1 and Type 2 processes. However, this finding may require further investigation as a more recent study reported no evidence for an association between insight problem solving and schizotypy (Webb, Little, Cropper, & Roze, 2017).

A study by Young and Mason (2007) found no relation between schizotypy and the ability to make Type 2 conditional inferences. However this contradicts findings from another study (Sellen et al., 2005) in which greater impulsive nonconformity was

found to be associated with impaired ability to make conditional inferences. No effects were found for the remaining schizotypy dimensions of introvertive anhedonia, unusual experiences and cognitive disorganisation. Conversely, in a relatively large sample of 205 college students, Tsakanikos (2004) found that *all* four O-LIFE domains were associated with impairments when performing logical reasoning problems, although only negative schizotypy (introvertive anhedonia) was found to be significant after correcting for random guessing. These discrepancies may reflect variation in reasoning tasks, samples and schizotypy measures.

#### 1.5.9. Context

Seven studies investigating contextual processing in schizotypy were deemed to be eligible for inclusion in this review. Four studies investigated the ability to integrate contextual semantic information in a top-down way in schizotypy. For example, using an Event Related Potential (ERP) approach, Del Goleto, Kostova, & Blanchet (2015) found that high schizotypy scorers did *not* make efficient use of semantic context while they were read mini stories ending with either a literal, ironic or incompatible statement. Unlike their low schizotypy-scoring counterparts, they did not show the changes in N400 or P600 amplitudes indicative of incompatible or ironic endings respectively. This echoes the findings of another ERP study by Kiang and Kutas, (2005) in which N400 amplitudes in overall schizotypy similarly suggested a *reduced* tendency to use context to inhibit unrelated information. Another study by de Loye, Beaucousin, Bohec, Blanchet and Kostova (2013) found that people with higher general schizotypy scores showed less ‘surprise’ as demonstrated through the N400 amplitude when a semantically unexpected word was used to complete a sentence. However, another study by Humphrey, Bryson, and Grimshaw (2010) found no relation between positive schizotypy (the only dimension they looked at) and metaphor processing in a behavioural task. Perhaps this is because behavioural measures are less sensitive to capturing these differences than neuroimaging measures.

Three other studies highlighted a more *elemental* processing style in schizotypy, as opposed to a more holistic and configural style of processing. Haddon et al. (2014) found that people scoring highly only on the Introvertive Anhedonia schizotypy dimension were more likely to make decisions based on an individual element on a

discrimination task. Bressan and Kramer (2013) also investigated contextual integration in schizotypy using the Ebbinghaus optical illusion. In the illusion, people generally perceive a circle surrounded by smaller circles as larger than an identically sized circle surrounded by larger circles. They found that the illusion decreased in line with increasing cognitive-perceptual schizotypy traits. This was a robust effect, that indicates a more detail-oriented or elemental processing style in schizotypy. Conversely, Tsakanikos and Reed (2003) reported impaired performance only in negative schizotypy (Introvertive Anhedonia) on the Hidden Figures Test (Ekstrom, Dermen, & Harman, 1976). This visuo-spatial task requires participants to identify which one of five simple figures is hidden in a series of 32 complex figures, and requires the ability to utilise top-down contextual cues. While results have been mixed, these findings may suggest a lower tendency to integrate contextual surrounding information when processing information in schizotypy. In some cases this appears to be related to more accurate perception and greater attention to detail.

#### 1.5.10. Reflective Mind

A study by Wolfradt et al. (1999) investigated the 'reflective mind' (whether there was a preference for an intuitive 'Type 1' or rational 'Type 2' thinking style) using the Rational Experiential Inventory in a university sample of 374 students. Interestingly, cognitive-perceptual aspects of schizotypy were found to be correlated with a preference for *both* rational and intuitive thinking. Interpersonal schizotypy features were associated with a preference for intuitive thinking alone. However, the study did not control for religiosity or intelligence, which could have confounded the findings, particularly as they were correlational in nature. Another study by Li and colleagues (2016) found that people with schizotypal personality features tended to value delayed or future rewards *less* than their counterparts scoring lower in schizotypy. This may be indicative of a preference for more experiential, intuitive or 'in the moment' type decision making as opposed to logical or rational reasoning.

#### 1.5.11. Summary of Reasoning in Schizotypy

Overall, the research into schizotypy and decision making suggests that there may be greater reliance on intuitive reasoning processes and a poorer performance on Type 2 logical reasoning tasks. Higher schizotypy may also be associated with a more elemental processing style, which may indicate a lower propensity to be

distracted by competing or irrelevant contextual information which can in some cases lead to more accurate perception and lower susceptibility to optical illusions. There is also some evidence to suggest that schizotypy may be positively associated with divergent or creative thinking. Antisaccade performance deficits seem to be a genuine feature of positive schizotypy, although the evidence base is somewhat ambiguous across other tasks tapping into cognitive inhibition. There is some evidence for a hastier and more intuitive reasoning style in schizotypy, which is also reflected through data-gathering biases such as the JTC bias and the BADE. However, the findings seem to be variable with conflicting outcomes reported across tasks, schizotypy measures and domains of schizotypy. This suggests that further research is warranted to clarify and reconcile these discrepancies in the literature.

### **1.6. Research Aims and Rationale**

This study aims to investigate how individual differences in schizotypy are related to Type 1 (automatic/heuristic), Type 2 (reflective/effortful) thinking processes, cognitive reflection and thinking style. As far as the author is aware, thinking processes and styles have not been comprehensively investigated in relation to schizotypy and to date, these processes tend to have been examined in isolation. Furthermore, studies to date have not adequately considered the possible influence of cognitive reflection on decision making in schizotypy. Given that Stanovich's tripartite extension of dual process models presents a compelling and evidence-based theoretical conceptualisation of decision making processes, it seems a timely and worthwhile endeavor to examine this model in relation to personality and individual differences, including schizotypy.

Investigating schizotypy in the non-clinical population should help to control for confounding factors manifesting across studies, participants and research contexts, allowing for a more rigorous and comprehensive understanding of different levels of reasoning within schizotypy. Examining thinking processes across the schizotypy continuum could potentially aid theoretical understandings of the causes and maintenance of psychosis-related phenomena (e.g. hearing voices, unusual beliefs) in a sample less likely to be confounded by medication, trauma, distress or other factors associated with clinical presentations. It also has potentially important clinical implications, as psychological interventions could be developed or refined towards

modifying cognitive processes or altering trajectories that might lead to distressing experiences or transition to clinical psychosis. This is particularly relevant given that psychosis-like experiences are relatively common in the general population, and for many do not need to be associated with distress, stigma or clinical intervention (Van Os & Reininghaus, 2016; Verdoux & van Os, 2018).

### **1.7. Research Questions**

Based on the literature review and research aims, the research questions are as follows:

#### **Research Question One:**

- i) How is schizotypy related to Type 1 and Type 2 thinking processes and thinking styles, in the context of dual process frameworks?

#### **Research Question Two:**

- i) How much variance in cognitive reflection is predicted by schizotypy, thinking processes and thinking style?
- ii) Does the addition of schizotypy significantly contribute to the explanation of cognitive reflection over other predictor variables?

#### **Research Question Three:**

- i) Do thinking processes and thinking style mediate the relationship between schizotypy and cognitive reflection?

## CHAPTER TWO

### METHODOLOGY

#### 2.1. Overview

This chapter will first outline the epistemological position adopted in the present study, before providing details of the research design, procedure and materials. The ethical considerations related to designing and conducting the study will then be discussed, and the chapter will conclude by describing approaches to data analysis.

#### 2.2. Epistemology

The methodological approaches related to cognitive psychology and individual differences research seem to position this study epistemologically within a realist scientific framework. Scientific realism assumes that cognitive or brain processes are 'real' and are therefore observable through empirical methods (Bhaskar, 2009). For example, such methods may attempt to measure inhibitory control through eye tracking approaches, measure intelligence using neuropsychological tests or reasoning ability through performance on logical reasoning tasks. Furthermore, by setting out to investigate thinking processes and styles within dual process frameworks, this relies on the assumption that these so-called 'types' and 'styles' are amenable to observation and measurement. Attempting to ascertain information about personality through measuring schizotypy also relies on the idea that this is a 'real' construct and that meaningful conclusions can be drawn by capturing it.

An alternative approach might have been to investigate the phenomenological aspects of decision processes through using qualitative approaches to explore people's subjective experiences of their decision-making. This would tap into a social constructionist epistemological stance, in which the understanding of the world is thought to be co-constructed through social relationships and culture, rather than a reflection of objective 'reality' (Burr, 2015). However, given that type 1 'intuitive' decisions can by their very nature be out of awareness or unconscious (Dijksterhuis, 2004; Newell & Shanks, 2014), this renders a qualitative approach inappropriate for addressing these particular research questions. Furthermore, a social constructionist perspective might question the existence of 'schizotypy' as a construct, making it

inadequate for examining decision processes in the context of individual personality differences.

This study will instead adopt a 'critical realist' epistemological position (Niiniluoto, 1999). Critical realism accounts for the quantitative and realist assumptions inherent in the research design and aims, whilst acknowledging the conceptual limitations and critiques of adopting such an approach. While the data collected will be exclusively quantitative in nature (thereby involving scientifically realist assumptions), a critical stance will be maintained in terms of how the findings are interpreted. Therefore, the existence of a relationship between cognitive and psychometric tests, and underlying cognitive and psychological processes will be assumed, but the shortcomings of drawing empirical conclusions in relation to such approaches will be acknowledged.

### **2.3. Design**

The study employed a cross-sectional quantitative design. Responses were collected and analysed across several questionnaire variables collected through an online survey. Variables of interest included demographics, unusual experiences, introvertive anhedonia, cognitive reflection, thinking style, Type 1 thinking and Type 2 thinking. The outcome variables of interest were unusual experiences and introvertive anhedonia, reflecting aspects of positive and negative schizotypy respectively. Notably, based on existing theory, these variables were positioned as 'antecedent' variables as opposed to 'consequent' variables within the mediation model (Hayes, 2017).

### **2.4. Procedure**

The online survey was created through the Qualtrics survey platform (Qualtrics, 2018) and accessible to participants through an electronic URL, distributed across various platforms. Participants were initially presented with an information sheet and consent form (Appendix B). Participants could only progress to the main survey if they provided their informed consent. The main survey (Appendix C) took approximately 10-15 minutes to complete and participants were free to discontinue at any point during the survey. Upon finishing the survey, participants received some brief, non-pathologising and sensitively worded feedback summaries based on their personality scores for 'Unusual Experiences' and 'Introvertive Anhedonia' (Appendix

D). These were written by the author and were followed by a disclaimer highlighting that the personality feedback was very general, tentative and based on overall scores, rather than responses to specific questions.

Following this, participants were taken to an 'end' screen, which contained de-brief information (Appendix E), including signposting towards further resources or support in case any distress had been caused by any part of the study. Contact information of the researcher was also provided in case participants wished to withdraw their data or had any other queries or concerns about the research.

## **2.5. Participants**

### **2.5.1. Recruitment**

Recruitment took place through both convenience and purposive sampling. Advertisement materials (a poster and electronic flyer) were created using a free poster design website. The adverts contained a brief overview for the study and provided the study link. Participants were also informed that they would receive some general feedback about their personality at the end of the survey. The study was advertised and distributed through personal social media (e.g. Facebook, Instagram and Twitter), through posters placed at the University of East London and via email through personal contacts at other universities (University of Bristol, University College London and King's College London). Adverts were also placed on websites such as Gum Tree, psychology research websites and placed in local community settings (e.g. Cafés, Yoga studios). More purposive advertisement of the study was also undertaken to recruit people likely to have higher schizotypy scores. This involved advertising the study in Facebook groups dedicated to topics such as spirituality, esoteric knowledge, paranormal beliefs, gaming and introversion.

### **2.5.2. Inclusion Criteria**

Participants were required to be 17 years of age or older. They were also required to be able to read and understand English and have access to a computer or device to complete the questionnaire.

### 2.5.3. Exclusion Criteria

Participants were excluded if unable to read and understand English as it would not be possible to provide informed consent or understand the questions in the survey.

## **2.6. Materials**

### 2.6.1. Demographics

Participants recorded their age, gender and highest completed level of education.

### 2.6.2. Schizotypy

The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) short form schizotypy scale (Mason et al., 2005) was used to measure individual differences in schizotypy. The scale comprises four subscales: Unusual Experiences, Introvertive Anhedonia, Cognitive Disorganisation and Impulsive Nonconformity. The scale reflects a 'fully dimensional' understanding of schizotypy in which psychosis-like experiences are thought to be personality traits, which vary on a continuum like other individual differences. The items are therefore not intended to be diagnostic or reflect 'symptoms' or clinical features of psychosis, but rather 'trait' or personality features related to schizotypy (Mason & Claridge, 2006).

The O-LIFE short form is based on the longer original version of the O-LIFE (Mason et al., 1995). The original O-LIFE scale was constructed based on a large and extensive study into schizotypal traits (Claridge et al., 1996), and reported high test-retest reliability (Burch, Giles, Steel, & Hemsley, 1998) as well as high internal consistency (Mason et al., 1995). The 'goodness of fit' of the O-LIFE's four-factor structure was found to be favourable in a confirmatory factor analysis (Mason, 2006). The scale is also well-established as a research tool, having been used across a wide range of studies and translated into several languages (Mason & Claridge, 2006).

The O-LIFE short form is briefer and easier to administer than the original, whilst retaining its favourable psychometric properties including good reliability, content validity, concurrent validity and heritability (Mason et al., 2005). In the present study, only the Unusual Experiences and Introvertive Anhedonia subscales were administered given that these were the variables of interest, tapping into positive and

negative schizotypy respectively. Indeed, it is suggested that schizotypy does comprise reliable and separate individual components and that there is no theoretical or empirical basis for combining scores to generate an *overall* schizotypy score (Mason & Claridge, 2006). Therefore it is considered acceptable to administer particular domains of interest according to the aims of the research, rather than administering the scale in its entirety.

Twelve self-report items on the O-LIFE brief form assess Unusual Experiences (UE) and ten items assess Introvertive Anhedonia (IA). Items are rated as 1 for a 'yes' response and 0 for a 'no' (except for items that are reverse coded), and are summed to provide a total score for each respective dimension of schizotypy.

Sample Items:

*When in the dark do you often see shapes and forms even though there is nothing there? (UE)*

*Do you feel very close to your friends? (IA)*

### 2.6.3. Cognitive Reflection

The combined Cognitive Reflection Test (CRT; Frederick, 2005) was used to measure cognitive reflection, also tapping into cognitive inhibition or 'miserly processing'. The combined-CRT builds on the original three-item CRT by Frederick (2005), incorporating four additional items from Toplak et al. (2014) and four items from Thomson and Oppenheimer (2016). The CRT is a 'performance-based' measure assessing the ability to withhold a tempting intuitive (but incorrect) Type 1 response and engage in reflective Type 2 processing to calculate a correct response. The items therefore prime an 'intuitive' or tempting response, and deliberative reflective thought is required to over-ride this response. The CRT has been found to be negatively correlated with reasoning tendencies such as risk-taking and 'hyperbolic discounting' (the tendency to choose smaller immediate rewards as opposed to larger delayed rewards) (Campitelli & Labollita, 2010; Frederick, 2005). It is also thought to be related (but not analogous) to 'actively open-minded thinking' (Campitelli & Labollita, 2010).

While the original CRT was found to be a strong predictor of performance across a range of rational (Type 2) thinking tasks (Toplak et al., 2011, 2014), it faced some limitations (Haigh, 2016). The small number of items risked ‘floor effects’ and some items (e.g. the ‘bat and ball’ problem) have now become very familiar through psychology classroom demonstrations and mainstream exposure (e.g. Kahneman, 2011). Furthermore, it was also thought that the original CRT relied too much on mathematical ability and therefore may have been tapping into other cognitive processes such as numeracy (Thomson & Oppenheimer, 2016). Toplak and colleagues (2014) therefore extended the test to include four additional less familiar items, and Thomson and Oppenheimer (2016) more recently proposed a further four additional items that are less reliant on numerical skills, which is known as the ‘CRT-2’. As with the original CRT, good psychometric properties including construct validity, internal reliability and predictive validity are reported for the additional items.

The present study incorporated ten items from across the three aforementioned papers. All items proposed across the papers were included, except for the ‘bat and ball’ problem, which was excluded due to concerns with familiarity of the item, which could invalidate responses. A ‘control’ item consisting of a very simple mathematical problem (with no ‘lure’ response) was also embedded amongst the other items, but did not contribute to the CRT performance score. Correct responses were awarded a score of 1, while incorrect responses were awarded 0, with a maximum total score of 10. Higher total scores were indicative of greater ability to think analytically and override heuristic processing.

Sample Item:

*A farmer had 15 sheep and all but 8 died. How many are left?*

[Intuitive answer: 7, Correct answer: 8]

(from CRT-2; Thomson & Oppenheimer, 2016)

Given that item familiarity can artificially inflate performance on the CRT (Toplak et al., 2011), the combined-CRT was modified to include an additional question “have you seen any of the above puzzles before?”. If the answer was yes, participants were asked to specify which ones they were familiar with. Accuracy scores were

then re-calculated for participants who reported item familiarity, based on the proportion of correct responses *only* for previously unseen items. This score was then transformed to a comparable accuracy score out of 10. The aim of this was to ensure that scores were more reliable and comparable across participants, with less likelihood of falsely inflated and unreliable CRT scores.

#### 2.6.4. Thinking Style

Based on the original Actively Open-minded Thinking Scale (AOT; Stanovich & West, 1997), the present study used a shorter 7-item version of the measure to assess thinking style (Haran, Ritov, & Mellers, 2013). The AOT is a self-report measure assessing the tendency to engage in open-minded thinking and weigh up evidence before making a decision. Questionnaire items tap into the propensity to consider evidence that conflicts with a pre-existing belief and the ability to revise one's established beliefs. The short form has good face validity and reliability as well as being quick and straightforward to administer (Haran et al., 2013), making it suitable for online survey use.

The questions are answered on a 7-point scale (ranging from 1: Completely disagree to 7: Completely agree) and are summed to provide an overall score ranging from 7 to 49. Higher total score indicates a more open-minded and flexible thinking style.

Sample Item:

*People should revise their beliefs in response to new information or evidence.*

#### 2.6.5. Type 1 Processing

Although it was not possible to administer a direct *performance* based measure of Type 1 processing due to the survey format of the present study, a self-report measure of reliance on intuitive processing was used instead. Type 1 processing was assessed through the 'Faith in Intuition' (FI) dimension of the 10-item Rational Experiential Inventory (REI-10; Epstein, Pacini, Denes-Raj, & Heier, 1996). The REI-10 comprises two unipolar scales each consisting of five items; 'Faith in Intuition' and 'Need for Cognition'. Both are based on Epstein's Cognitive Experiential Self Theory

(Epstein, 2003), and are thought to tap into Type 1 (intuitive-experiential) and Type 2 (analytic-rational) processing respectively. These items have been condensed from the original 40-item version of the REI (Pacini & Epstein, 1999), which is reported to have good psychometric properties including high internal validity (Cronbach's alphas > 0.85). Responses are rated on a 5-point Likert scale and total scores indicate a tendency to engage in Intuitive or Rational thinking processes respectively. As the Experiential and Rational processing modes are thought to be independent of one another, it is possible for the same person to achieve a high (or low) score across both subscales.

Sample Item:

*My initial impressions of people are almost always right.*  
(Faith in Intuition, REI-10)

#### 2.6.6. Type 2 Processing

The 'Need for Cognition' (NFC) domain of the REI-10 was used as a proxy measure of Type 2 processing. Scoring and psychometric properties are outlined in the above section. The NFC domain reflects a general personality trait reflecting a desire to exert cognitive effort and engage in deliberative processing. As this is a self-report measure of propensity to engage in Type 2 processing, it may also share a degree of overlap with thinking style, but it is considered conceptually distinct from the AOT (Haran et al., 2013). It is also thought to be distinct from CRT, in part because it is a self-report measure as opposed to a behavioural performance-based one (Frederick, 2005).

Sample Item:

*I would prefer complex to simple problems.*  
(Need for Cognition, REI-10)

## **2.7. Ethical Considerations**

### **2.7.1. Informed Consent and Confidentiality**

Ethical approval for the study was granted by the University of East London Ethics Committee (Appendix F). Participants were provided with an information sheet

before completing the survey (Appendix B). This sheet assured participants that they were free to withdraw at any time by emailing the researcher without any disadvantage to themselves or obligation to give a reason. They were also assured that any publication or dissemination of the research would be provided in an aggregated, anonymised format to maintain confidentiality and ensure participants remained non-identifiable. Participants were also told that the data would not be shared with any third parties, would be stored on a password-protected computer and would be destroyed five years after study completion. Participants used a 'yes' or 'no' check-box to indicate their consent and only after providing consent could they proceed to the main survey. At the end of the survey, participants received a detailed de-brief sheet, in which they were directed to sources of support and were provided with contact details for the researcher and Ethics Committee in case they had any queries or concerns (Appendix E).

### 2.7.2. Potential Distress

The study information, main survey and questionnaire feedback avoided any use of the word 'schizotypy' due to potential connotations with schizophrenia, which might cause participants undue distress. Use of the word 'psychosis' as well as other potentially pathologising or distressing language was also avoided throughout the survey. The debrief sheet signposted participants to sources of support (Samaritans, Rethink Mental Illness, NHS Direct and GP) in the unlikely event that they would become distressed by the study. It was also stipulated to participants that the debrief sheet was a generic form provided to all survey respondents and was in no way based on their individual questionnaire scores or personality feedback. It was therefore made clear that the resources and further support would not be relevant to everyone, but was provided in case it was useful.

## **2.8. Data Analysis**

### 2.8.1. Approach to Analysis

The data were exported directly from the survey platform (Qualtrics) into Microsoft Excel. An initial phase of data cleaning took place in Excel before the dataset was imported into SPSS version 24.0 (IBM Corp, 2016) for further cleaning and analysis. Descriptive statistics were carried out across all variables of interest. T-tests (for gender which was transformed to create the binary variable 'sex') and correlation

analyses (for all other continuous variables) were then performed across the variables, with particular attention paid to the associations between schizotypy (Unusual Experiences and Introvertive Anhedonia) and the remaining variables. While schizotypy remained the central focus of the present study, for theoretical reasons CRT was chosen as the outcome (or dependent) variable for the regression analysis and the 'consequent' variable for the mediation analysis. This meant that a hierarchical multiple-linear regression was performed with CRT as the outcome variable. This approach facilitated inclusion of variables sequentially, according to their theoretical significance (Field, 2013), and provided insights into the specific contribution of schizotypy through its addition in the final step.

Guided by the regression analysis and the existing literature, variables were then selected for inclusion in two multiple mediation models. These models sought to further establish the relationship between schizotypy and cognitive reflection (CRT), whilst considering the potential influences of thinking processes and thinking style as mediating variables. The two models incorporated Unusual Experiences and Introvertive Anhedonia respectively to facilitate investigation of the separate contribution of each of the variables. The mediation analyses were carried out using the Process macro for SPSS (Version 3.0; Hayes, 2017).

### 2.8.2. Power Analysis

A power calculation for the multiple linear regression was performed using G\*POWER for Macintosh version 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). This was a conservative calculation that was carried out before data collection based on all the above variables being entered as potential predictors, with CRT as the outcome variable. Using an alpha of 0.05 and a power of 0.80, the analysis revealed that a sample size of 159 was required to detect a small effect size ( $f^2=0.10$ ). The sample in the present study greatly exceeded the required sample size, suggesting that the study was sufficiently powered to detect any effects.

## **CHAPTER THREE**

### **RESULTS**

#### **3.1. Overview**

This chapter provides details of the results and analyses conducted for the present study. First, the characteristics and descriptive statistics of the sample, as well as approaches used in handling the data, are outlined. The associations between the variables of interest are then described and the analyses related to each of the research questions are reported in turn.

#### **3.2. Sample Characteristics and Demographics**

##### **3.2.1. Sample Size**

At the close of the study, the survey database included a total of 1,732 cases. Five cases were subsequently removed due to comments entered in the survey that the data should be voided (e.g. due to being used for student class examples). A further 171 cases were removed as they had started the survey process but no data had yet been entered. Data for respondents reporting themselves as age 16 years and under ( $n = 44$ ) were also excluded from the analysis due to a lack of ethical approval extending to this age group. This left a final sample size of 1,512 participants, of which 1,348 had completed the survey in its entirety. Descriptive statistics for the final sample are reported in Table 4.

The overall study sample was very large. This provided high power for the analyses, but also meant that small effect sizes could more readily achieve statistical significance. The majority of respondents were female (76.9%) and age was found to span a wide range (17-78 years). The highest level of completed education was also well spread, with decent representation from those who had not completed higher education beyond school (15.0%), those who had completed sixth form (20.4%), vocational qualifications (9.7%) undergraduate degrees (28.4%), postgraduate degrees (22.0%) and doctoral degrees (4.0%).

**Table 4.** Sample characteristics

Variable	Mean (SD) OR n(%)
Age (years); Mean (SD); (min-max)	34.19 (13.36); (17-78)
Sex, n(%)	
Male	338 (22.4)
Female	1162 (76.9)
Highest Education, n(%)	
School	227 (15.0)
College or Sixth Form	309 (20.4)
Vocational Qualification	146 (9.7)
Bachelor's Degree (BSc/BA)	429 (28.4)
Postgraduate Diploma	74 (4.9)
Master's Degree (MSc/MA)	258 (17.1)
Doctorate or PhD	61 (4.0)
Total questionnaire scores, M(SD)	
Unusual Experiences	5.06 (3.03)
Introvertive Anhedonia	3.10 (2.33)
Cognitive Reflection Test	4.04 (2.55)
Actively Open-Minded Thinking Scale	36.21 (6.53)
Faith in Intuition	18.11 (3.73)
Need for Cognition	18.53 (3.41)

### 3.2.2. Missing Data

Data for participants with incomplete survey responses were retained in the dataset to maximise power for the completed variables. The rest of the missing data was generally at the scale level rather than the item level, suggesting that the quality of the data for incomplete survey responses was similar to that of complete responses. All cases were included in the analysis where possible through pairwise deletion. In the few instances where there was one-off item-level data missing amongst an otherwise complete set of scale responses, these were subject to a 'mean imputation' approach (Kalton & Kasprzyk, 1986). This involved establishing the mean for a particular item across the whole dataset and entering the mean value in the place of a missing response. This clearly was not appropriate for missing demographic information or for scale level missing data. However, mean imputation is considered an acceptable method of dealing with missing data where the proportion of missing data is less than 10%, and is thought to perform similarly to other approaches (Shrive, Stuart, Quan, & Ghali, 2006). Furthermore, this approach

is arguably a conservative method for dealing with missing data as it increases the tendency towards the mean, thereby reducing the likelihood for extreme or inflated results. Mean imputation was only required for seven individual items on the AOT (0.0007% of the data for this variable) and for ten individual items on the REI-10 (also 0.0007% of data for this scale), meaning it was a very small proportion of data that was subject to mean imputation, falling well within the acceptable recommended limits.

### 3.2.3. Outliers

Visual inspection and descriptive statistics revealed that outliers were virtually absent from the dataset for quantitative variables. Exporting the data directly from the survey platform into Excel and SPSS eliminated the risk of researcher data entry errors. Furthermore, as most survey items were multiple choice, this eliminated the potential for outliers based on participant responses. However, for erroneous or nonsense responses in free text fields, these were either corrected if the intended response was clear, or the item was entered as 'missing' if the intended response was evidently incorrect or ambiguous (e.g. age entered as '2').

### 3.2.4. Data Distribution

For larger datasets of 200 cases or more, Field (2013) recommends visual inspection of distributions as the optimal method of assessing whether assumptions of normality have been met. Histograms and Q-Q plots were therefore created for all continuous variables of interest, which strongly suggested that the variables were normally distributed (Appendix G). Significance tests of skewness and kurtosis were not performed due to this being an inappropriate criterion to use in very large samples. This is because, in large samples such tests can generate a significant result, even in the context of very minor deviations from normality (Field, 2013). Nevertheless, the *absolute* values of skewness and kurtosis for all continuous variables were found to be within acceptable limits (see Table 5). According to Kim (2013), an acceptable threshold for the assumption of normality in larger sample sizes of 300 or more is an absolute value of <2 for skewness and <7 for kurtosis.

**Table 5.** Values of skewness and kurtosis for continuous variables

Variable	Skewness	Kurtosis
Age	.88	.09
Unusual Experiences	.22	-.73
Introvertive Anhedonia	.57	-.40
Cognitive Reflection Test	.39	-.72
Actively-Open Minded Thinking	-.63	.38
Faith in Intuition	-.33	-.06
Need for Cognition	-.38	.22

### 3.3. Associations between Variables

Pairwise independent samples t-tests were performed between sex and all continuous variables of interest. The results are displayed in Table 6. Homogeneity of variance as assessed by Levene's Test was found *not* to be violated for any variables, except for CRT. Therefore, statistics for *unassumed* equal variances are reported for CRT, while the reported statistics for the remaining variables use assumed equal variances.

Cognitive Reflection, Introvertive Anhedonia, Actively Open-Minded Thinking and Need for Cognition were all found to be significantly higher in males than females. Conversely, Unusual Experiences and Faith in Intuition were both found to be significantly higher in females than males. Effect sizes (*r*) were calculated across all significant t-tests and were generally found to be in the small range (CRT = .24, UE = .08, IA = .07, AOT = .11, NFC = .10, FI = .07).

**Table 6.** T-tests for schizotypy, thinking processes and thinking styles by sex

Variable	Male		Female		<i>t</i>	Sig. (Two-tailed)
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>		
Age	34.47	13.94	34.15	13.17	-.40	.692
Cognitive Reflection Test	4.75	2.74	3.82	2.46	-5.19	<.001***
Unusual Experiences	4.61	2.97	5.17	3.02	3.02	.003**
Introvertive Anhedonia	3.42	2.30	3.01	2.33	-2.77	.006**
AOT	37.56	6.64	35.81	6.43	-4.15	<.001***
Faith in Intuition	17.65	3.83	18.24	3.69	2.45	.014*
Need for Cognition	19.14	3.39	18.35	3.40	-3.56	<.001***

Note: AOT = actively open-minded thinking. \**p* <.05, \*\**p* <.01, \*\*\**p* <.001

Pairwise Pearson’s correlation coefficients were also performed between all continuous variables of interest. The results of these are displayed in Table 7.

**Table 7.** Correlation coefficients between all continuous variables

	Age	CRT	UE	IA	AOT	FI	NFC
Age	-						
CRT	.02	-					
UE	-.09**	-.22***	-				
IA	-.01	-.11***	.26***	-			
AOT	.03	.39***	-.21***	-.11***	-		
FI	.06*	-.22***	.32***	.07**	-.29***	-	
NFC	.05	.25***	-.07**	-.12***	.30***	-.07**	-

Note: CRT = cognitive reflection test; UE = unusual experiences; IA = introvertive anhedonia; AOT = actively open-minded thinking; FI = faith in intuition; NFC = need for cognition. All tests two-tailed.

\*\*  $p < .01$ , \*\*\*  $p < .001$

### 3.4. Research Question One: How is schizotypy related to Type 1 and Type 2 thinking processes and thinking styles, in the context of dual process frameworks?

The association between schizotypy scores and thinking processes and styles is displayed above in Table 7. Unusual Experiences was found to be positively associated with Faith in Intuition ( $r = .32, p < .001$ ), and negatively associated with Cognitive Reflection ( $r = -.22, p < .001$ ), Actively Open-Minded Thinking ( $r = -.21, p < .001$ ) and Need for Cognition ( $r = -.07, p = .006$ ).

Similarly, for Introvertive Anhedonia, this was also positively associated with Faith in Intuition ( $r = .07, p = .009$ ) and negatively associated with Cognitive Reflection ( $r = -.11, p < .001$ ), Actively Open-Minded Thinking ( $r = -.11, p < .001$ ) and Need for Cognition ( $r = -.12, p < .001$ ).

All associations between schizotypy and types of thinking appeared to demonstrate small to medium effect sizes. Field (2013) posits that small effects are around  $r = .10$

and medium effects are around  $r = .30$ , which are each thought to contribute to 1% and 9% of the total variance in the outcome variable respectively.

### **3.5. Research Question Two: Do thinking processes, thinking styles and schizotypy predict cognitive reflection?**

This research question specifically sought to assess both i) how much variance in cognitive reflection is predicted by schizotypy, thinking processes and thinking style, and ii) whether the addition of schizotypy significantly contributes to the explanation of cognitive reflection over other predictor variables.

#### **3.5.1. Linear Regression**

A hierarchical linear regression analysis was used to investigate how much variance in Cognitive Reflection was predicted by various thinking processes (Actively Open-Minded Thinking, Faith in Intuition and Need for Cognition) and schizotypy (Unusual Experiences and Introvertive Anhedonia). Schizotypy was added into the final step of the regression to ascertain its unique additional contribution to the model over the other predictor variables.

Variables that were significantly associated with Cognitive Reflection at the level  $p < .01$  were included in the model. These were entered hierarchically, based on the literature and research questions (Field, 2013). As a demographic variable, sex was entered into the first step. The second step included thinking processes and thinking style (Faith in Intuition, Need for Cognition and Actively-Open Minded Thinking) and the third and final step included schizotypy (Unusual Experiences and Introvertive Anhedonia). The results of the regression analysis are displayed in Table 8.

**Table 8.** Hierarchical multiple regression with Cognitive Reflection as outcome variable

Predictors Entered	B	Beta ( $\beta$ )	<i>t</i>	Sig.	R	R <sup>2</sup>	$\Delta R^2$
Step One					.046	.002	.002
Constant	4.03	-	57.15***	<.001			
Sex	.01	.05	1.70	.090			
Step Two					.430	.185	.183***
Constant	-.90	-	-1.48	.138			
Sex	.01	.05	1.82	.068			
AOT	.12	.05	11.22***	<.001			
FI	-.08	-.12	-4.74***	<.001			
NFC	.12	.15	5.93***	<.001			
Step Three					.444	.197	.012***
Constant	-.49	-	-.79	.432			
Sex	.02	.05	1.99*	.047			
AOT	.11	.29	10.70***	<.001			
FI	-.06	-.09	-3.41**	.001			
NFC	.11	.15	5.78***	<.001			
UE	-.10	-.11	-4.09***	<.001			
IA	-.03	-.02	-.86	.391			

Note: UE = unusual experiences; IA = introvertive anhedonia; AOT = actively open-minded thinking; FI = faith in intuition; NFC = need for cognition.  $n = 1334$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Step one of the hierarchical multiple regression analysis revealed that sex was not a significant independent predictor of cognitive reflection. This initial step accounted for just 0.2% of the variance in cognitive reflection,  $F(1,1332) = 2.88$ ,  $p = .090$ . However, the addition of thinking processes (Faith in Intuition, Need for Cognition and Actively Open-Minded Thinking) in the second step accounted for an additional 18.3% of the variance,  $F(4,1329) = 75.27$ ,  $p < .001$ . This significant  $R^2$  change indicates that the second step was a significantly better model for explaining the data than the first step alone.

In the third and final step, in which Unusual Experiences and Introvertive Anhedonia were added to the model, the final model accounted for an additional 1.2% of the variance,  $F(6, 1327) = 54.30$ ,  $p < .001$ . Again, this suggests that the third step demonstrated a significant change in the proportion of variance in cognitive reflection accounted for over the second step. This final model accounted for a total of 19.7% of the variance in cognitive reflection. Actively Open-Minded Thinking, Faith in Intuition, Need for Cognition and Unusual Experiences were found to be significant independent predictors of cognitive reflection. Introvertive Anhedonia was not found to be independently related to cognitive reflection, and sex only just fell within a

significance level of  $p < .05$ , potentially suggesting a tenuous association given the large sample size and statistical power.

### 3.5.2. Regression Analysis Assumptions

Casewise diagnostics were used to identify potential outliers and extreme cases. However, standardised residuals indicated no cause for concern, with all values falling within +3.29 and -3.29 and nearly all cases (> 99%) falling between -2.58 and +2.58 (Field, 2013). No single case was found to be unduly influencing the model, as indicated through Cook's distance values all falling far below the problematic threshold of 1 or more (Field, 2013). Leverage values also fell within the 'safe' range of < 0.2 (Huber, 1981). DFBeta statistics also confirmed that no single case was having an undue influence on the regression parameters (< 1 across all variables) (Field, 2013). Based on the above, no single case was deemed to be a statistical outlier, and all cases were retained in the analysis.

Standardised residuals were found to be normally distributed as assessed through visual inspection of a histogram and P-P plot (see Appendix G). A Durbin-Watson test statistic of 1.875 also suggested that the assumption of independent residual errors had been met (Durbin & Watson, 1951). Homoscedasticity was also confirmed through visual inspection of a plot of standardised predicted values against standardised residual values, as well as inspection of partial regression plots. Multicollinearity was not found to be a concern for any of the independent variables. This was indicated by acceptable VIF (all < 1.3, well within the 'acceptable' range of < 10; Myers, 1990) and Tolerance values (all > 0.8, far exceeding the minimum threshold of 0.2 recommended by Menard, 1995). Absence of multicollinearity was further identified through acceptable eigenvalue statistics across predictor variables (Field, 2013). The adjusted  $R^2$  value for the final model (.193) was very similar to the value of  $R^2$  (.197), indicating good generalisability of the model. This was further investigated using Stein's formula (Stevens, 2002), which provided evidence for good cross-validity of the model (adjusted  $R^2 = 0.189$ ).

### **3.6. Research Question Three: Do thinking processes and thinking style mediate the association between schizotypy and cognitive reflection?**

#### **3.6.1. Overview and Approach**

Multiple mediation models were used to investigate whether thinking processes mediated the relationship between schizotypy and cognitive reflection. The SPSS macro 'Process' (Hayes, 2017) was used for analysis, given that it produces virtually identical results to Structural Equation Modelling (SEM) programs for large samples and observed (as opposed to latent) variables (Hayes, Montoya, & Rockwood, 2017), as was the case in the present study. The approach involved specifying models at the outset on theoretical grounds and then testing the model to assess how well they fitted the data (Field, 2013). Model template number 4 was selected in Process to facilitate comparison of multiple parallel mediator variables.

Two models were specified and tested. Both models were identical except one tested Unusual Experiences as the primary 'antecedent' variable (Hayes, 2017) (see Figure 4) and the other tested Introvertive Anhedonia as the primary antecedent variable (see Figure 5). Cognitive reflection was specified as the 'consequent' variable in both models. Actively Open-Minded Thinking, Faith in Intuition and Need for Cognition were also included as antecedent variables, positioned to test their mediating effect between schizotypy and cognitive reflection. As sex was not significant at a threshold of  $p < .01$ , this association was not considered robust enough to be included in the mediation model.

While Introvertive Anhedonia was not found to be a significant independent predictor of Cognitive Reflection in the regression analysis, mediation analysis need not be predicated on a statistically significant association between the independent variable and the dependent variable (Zhao, Lynch, & Chen, 2010). That is, there is still value in exploring any potential mediating or indirect effects acting between two variables, despite there not being evidence for a *direct* effect between them.

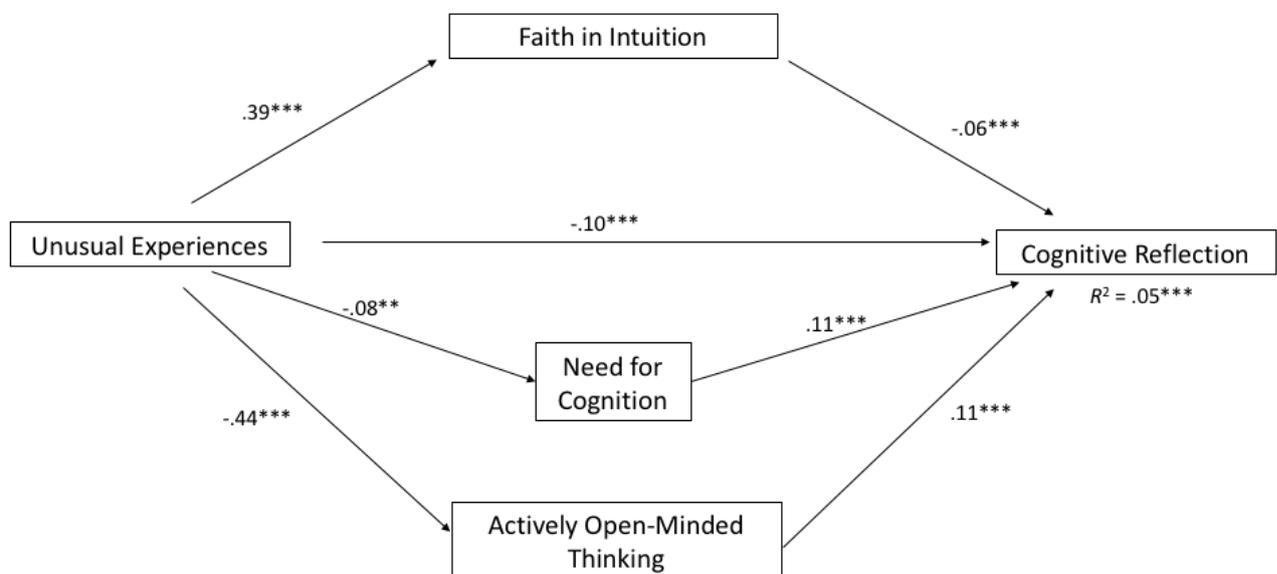
A bias corrected bootstrapping procedure was used to test inferences about indirect effects and their confidence intervals. This is thought to be a more rigorous and highly powered method than the Normal theory based Sobel test (Preacher & Hayes, 2004). The procedure was based on 10,000 bootstrap samples and 95% confidence

intervals. All coefficients and effects are reported in their unstandardised format, as is recommended for the interpretation of mediation models (Hayes, 2017).

### 3.6.2. Mediation Model for Unusual Experiences

The direct effects between variables are represented on the path diagram in Figure 4. The diagram shows that all path effects are statistically significant. This indicates a direct effect between UE and FI ( $b = .39$ ,  $SE = .03$ ,  $p < .001$ ) and from FI to CRT, ( $b = -.06$ ,  $SE = .02$ ,  $p < .001$ ). There was also evidence for a direct effect from UE to NFC ( $b = -.08$ ,  $SE = .03$ ,  $p < .01$ ) and from NFC to CRT ( $b = .11$ ,  $SE = .02$ ,  $p < .001$ ). The association between UE and AOT ( $b = -.44$ ,  $SE = .06$ ,  $p < .001$ ) AOT and CRT ( $b = .11$ ,  $SE = .01$ ,  $p < .001$ ) also indicates direct effects for these pathways.

Approximately 5% of the variance in cognitive reflection was accounted for by all predictors ( $R^2 = .05$ ).



**Figure 4.** A multiple mediation model of unusual experiences and cognitive reflection mediated through thinking processes and thinking style. Unstandardised regression coefficients are provided,  $n = 1334$ ,  $**p < .01$ .  $***p < .001$ .

Table 9 displays the indirect effects in the model. The analyses suggest that Faith in Intuition and Actively Open-Minded Thinking were mediators in the relationship between Unusual Experiences and Cognitive Reflection, as shown by confidence intervals that do not straddle zero (Hayes, 2017). With zero in the confidence

interval, Need for Cognition was *not* found to be a significant mediator. Hayes (2017) suggests that pairwise comparisons can be used to test whether specific indirect effect sizes are statistically different from one another. If both point estimates are of the same sign (as in this case where the indirect effects through Actively Open-Minded Thinking and Faith in Intuition were both *negative*), conclusions can be drawn about the relative strength of the mediators. However, the size of the indirect effects through Actively Open-Minded Thinking and Faith in Intuition were not found to be statistically different from one another as the confidence interval straddled zero ( $b = -.03$ ,  $SE = .01$ ,  $CI = -.05, .00$ ).

As the direct effect between Unusual Experiences and Cognitive Reflection was also statistically significant ( $b = -.10$ ,  $SE = .02$ ,  $p < .001$ ) this provides evidence that thinking processes and style *partially mediate* the association between Unusual Experiences and Cognitive Reflection. This can be described as ‘complementary mediation’ as both the indirect and direct effects are of the same sign (Zhao et al., 2010). Specifically, Unusual Experiences appears to influence Cognitive Reflection both directly and indirectly through Faith in Intuition and Actively Open-Minded Thinking, although the effect sizes were very small. In simple terms, this suggests that people with higher trait Unusual Experiences are less cognitively reflective, and this, can in small part be explained through a greater tendency to reason based on intuition and a lower tendency to engage in open-minded thinking, whilst taking into consideration the small effect sizes.

**Table 9.** Indirect effects of unusual experiences on cognitive reflection

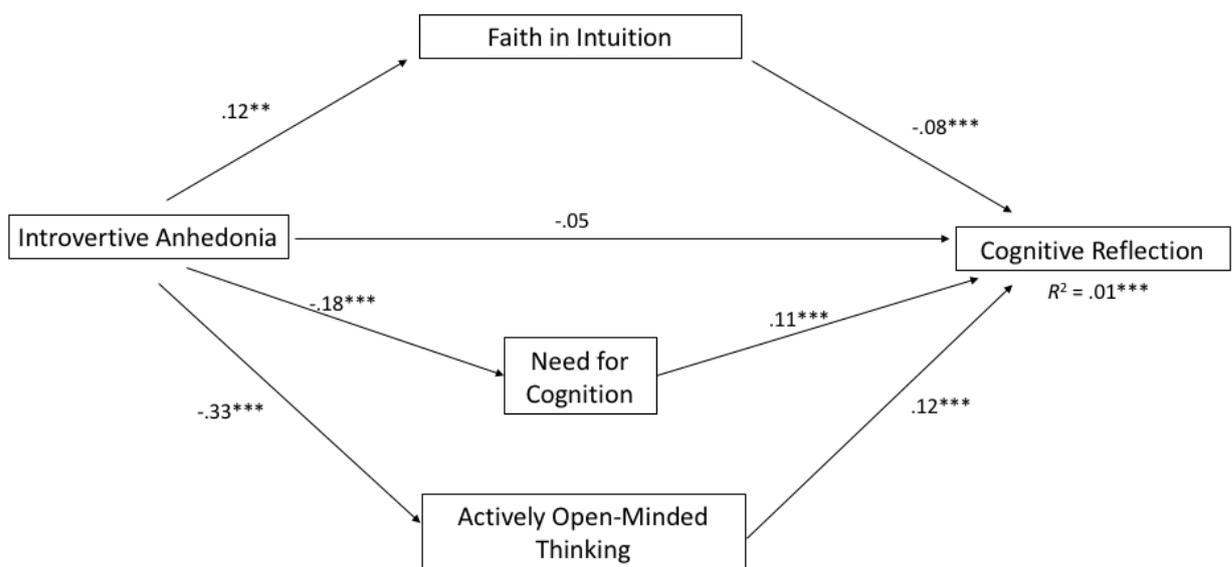
Mediator	Parameter Estimate	SE	95% Bias-corrected confidence interval	
			Lower	Upper
FI	-.02	.01	-.04	-.01*
NFC	-.01	.00	-.02	-.00
AOT	-.05	.01	-.07	-.03*
Total	-.08	.01	-.11	-.06*

*Note:* FI = faith in intuition; NFC = need for cognition; AOT = actively open-minded thinking.

\* $p < .05$  (significant indirect effect).

### 3.6.3. Mediation Model for Introverted Anhedonia

The direct effects between variables in the model are represented in Figure 5. There was found to be a significant direct effect between IA and FI ( $b = .12$ ,  $SE = .04$ ,  $p < .01$ ) and in turn between FI and CRT, ( $b = -.08$ ,  $SE = .02$ ,  $p < .001$ ). Similarly, there was evidence for a direct effect between IA and NFC ( $b = -.18$ ,  $SE = .04$ ,  $p < .001$ ) and from NFC to CRT ( $b = .11$ ,  $SE = .02$ ,  $p < .001$ ). The direct paths from IA to AOT ( $b = -.33$ ,  $SE = .08$ ,  $p < .001$ ) and from AOT to CRT ( $b = .12$ ,  $SE = .01$ ,  $p < .001$ ) were also found to be statistically significant. Only 1% of the variance in cognitive reflection was estimated to be accounted for by all predictors ( $R^2 = .01$ ).



**Figure 5.** A multiple mediation model of introverted anhedonia and cognitive reflection mediated through thinking processes and thinking style. Unstandardised regression coefficients are provided,  $n = 1334$ , \*\* $p < .01$ . \*\*\* $p < .001$ .

Details of the indirect effects between Introverted Anhedonia and Cognitive Reflection are displayed in Table 10. Interpretation of confidence intervals suggested that there were significant indirect effects through Need for Cognition and Actively Open-Minded Thinking, but not for Faith in Intuition. Pairwise comparisons revealed no statistical difference in the size of the indirect effects through Need for Cognition compared with Actively Open-Minded Thinking ( $b = -.02$ ,  $SE = .01$ ,  $CI = -.04, .00$ ). The overall indirect effect was also significant. Again, all indirect effect sizes were

very small and despite meeting statistical significance, need to be interpreted cautiously and their effects not over exaggerated. As the direct effect between Introvertive Anhedonia and Cognitive Reflection did not reach statistical significance ( $b = -.05$ ,  $SE = .03$ ,  $p = .058$ ) this suggests a small 'indirect-only' mediating effect on the association between the two variables through Need for Cognition and Actively Open-Minded Thinking (Zhao et al., 2010). Put more simply, this suggests that people higher in trait Introvertive Anhedonia are less cognitively reflective *only* via an indirect pathway of reduced reliance on rational processes and lower tendency to engage in open-minded thinking, and only to a very small degree.

**Table 10.** Indirect effects of introvertive anhedonia on cognitive reflection

Mediator	Parameter Estimate	SE	95% Bias-corrected confidence interval	
			Lower	Upper
FI	-.01	.00	-.02	.00
NFC	-.02	.01	-.03	-.01*
AOT	-.04	.01	-.06	-.02*
Total	-.07	.01	-.10	-.04*

Note: FI = faith in intuition; NFC = need for cognition; AOT = actively open-minded thinking.

\* $p < .05$  (significant indirect effect).

## **CHAPTER FOUR**

### **DISCUSSION**

#### **4.1. Chapter Overview**

This study sought to investigate how individual differences in schizotypy (unusual experiences and introvertive anhedonia) are related to thinking processes and thinking styles. The aim was to generate a more comprehensive understanding of reasoning and decision making in schizotypy, in the context of dual process models, to build on current theoretical understandings and inform clinical interventions and practical applications. This chapter summarises the key findings of the present study. The results are discussed and appraised in the context of the existing literature, the research questions and study aims. The strengths, limitations and implications of the study will also be discussed. The chapter will conclude with final comments and suggested avenues for future research.

#### **4.2. Sample Characteristics**

Unusual Experiences were found to reduce with increasing age, consistent with findings reported in previous research (Bora & Arabaci, 2009; Fonseca-Pedrero et al., in press; Mason & Claridge, 2006). Sex differences in Unusual Experiences and Introvertive Anhedonia were also in the expected directions based on previous literature (Bora & Arabaci, 2009; Fonseca-Pedrero et al., in press; Mason & Claridge, 2006; Mason et al., 1995; Miettunen & Jääskeläinen, 2010; Raine, 1992), with women reporting significantly higher Unusual Experiences scores than men, and men reporting higher Introvertive Anhedonia scores than women. Furthermore, men were also found to attain higher average scores on the CRT, another finding which mirrors past research (Frederick, 2005). While it is beyond the scope of this thesis to delve into these sex differences in detail, this need not be interpreted as a biological difference in reasoning ability between the sexes. As the CRT relies on numerical ability, this may reflect mathematical interests being developed more in men through greater environmental exposure or women having less confidence with numeracy due to internalised gender stereotypes or less opportunity or encouragement to practice (Fryer & Levitt, 2010).

### 4.3. Results Summary and Overview

A striking finding in the present study was that schizotypy was associated with greater reliance on intuitive processing and less reliance on deliberative processing, as well as a hastier and less reflective reasoning style. Specifically, both Unusual Experiences and Introvertive Anhedonia were associated with higher Faith in Intuition, lower Need for Cognition, lower Actively Open-Minded Thinking and lower Cognitive Reflection. Conversely, cognitive reflection was found to be positively correlated with Need for Cognition and Actively Open-Minded Thinking Style and negatively correlated with Faith in Intuition. Importantly, none of the variables were found to be too highly correlated, with the highest  $r$  being .39 for the association between Cognitive Reflection and Actively Open-Minded Thinking. Furthermore, Need for Cognition and Actively Open-Minded Thinking had an  $r$  of .30 suggesting that despite their conceptual similarities, these measures captured different aspects of thinking disposition. Overall, while some of the variables undoubtedly overlap, they appear to be conceptually distinct, suggesting that meaningful conclusions can be drawn from the analyses.

Unusual Experiences, thinking processes (Need for Cognition and Faith in Intuition) and thinking style (Actively Open-Minded Thinking) were also found to independently predict Cognitive Reflection. Sex was also found to be an independent predictor of Cognitive Reflection, although it achieved a less stringent threshold for significance ( $p < .05$ ). Unusual Experiences, but not Introvertive Anhedonia, contributed to a significant increase in variance in Cognitive Reflection over the other demographic and thinking process variables. Overall, the variables contributed to roughly 20% of the variance in Cognitive Reflection. Mediation models revealed that the association between Unusual Experiences and Cognitive Reflection was partially mediated by the indirect path through increased Faith in Intuition and reduced Actively Open-Minded Thinking. Conversely, for the association between Introvertive Anhedonia and Cognitive Reflection, there was found to be a small, indirect-only mediating effect through reduced Need for Cognition and reduced Actively Open-Minded Thinking.

#### **4.4. Research Question One: How is schizotypy related to Type 1 and Type 2 thinking processes and thinking styles, in the context of dual process frameworks?**

##### **4.4.1. Schizotypy and Type 1 Processing**

The finding related to greater reliance on Type 1 or 'intuitive' reasoning (Faith in Intuition), coupled with a reduced tendency to engage in Type 2 or 'deliberative' processing (Need for Cognition) in schizotypy fits with what was hypothesised based on the literature. Unusual Experiences has previously been associated with impulsivity, and Introvertive Anhedonia with frontal executive difficulties, potentially making intuitive and low effort reasoning an attractive option (Dinn, Harris, Aycicegi, Greene, & Andover, 2002). A higher degree of intuitive thinking assessed through the REI has previously been associated with unusual beliefs (Boden et al., 2012) and introvertive anhedonia (Wolfradt et al., 1999). Furthermore, a profile of increased intuitive thinking and reduced rational reasoning has recently been reported in delusions (Ward & Garety, in press; Ward et al., 2018) as well as in belief in conspiracy theories (Swami, Voracek, Stieger, Tran, & Furnham, 2014). Li et al. (2016) also found that future rewards were given less weight in people with high schizotypy compared to controls, similarly suggesting increased intuitive or 'in the moment' processing in schizotypy. Therefore it appears that this finding extends to the current sample, and suggests a preference for Type 1 processing may be associated with schizotypy as opposed to just the clinical aspects of psychosis.

While the present study did not seek to investigate the JTC bias specifically, the bias appears to share conceptual overlap with Faith in Intuition, used as a measure of Type 1 processing in the present study. To recap, JTC is a data-gathering bias that is thought to be a feature of psychosis (Garety et al., 2001; So et al., 2016) and in particular delusional beliefs (Dudley et al., 2015; Ross et al., 2015) and seems to point at greater reliance on intuitive thinking processes in clinical samples. While the JTC bias has previously been researched in schizotypy (Brugger & Graves, 1997; Steffen Moritz et al., 2017, 2012), the effects have not always been consistent (Juárez-Ramos et al., 2014; Sellen et al., 2005). While firm conclusions in relation to the JTC bias clearly cannot be drawn based the present study given that it was not investigated specifically, the current findings indicate that such data-gathering biases could be a feature of the reasoning profile in the current sample, due to this

increased 'experiential', heuristic or intuitive processing. Indeed, based on the existing literature, it seems to make sense that data-gathering biases (such as JTC, BADE or hypersalience of evidence-hypothesis matches) would be associated with schizotypy, particularly for positive schizotypy. This is because psychosis-like experiences are by definition thought to arise in response to evidence that is not objectively experienced in one's environment and therefore may conceivably arise through greater reliance on "gut" feeling or emotional reasoning.

#### 4.4.2. Schizotypy and Type 2 Processing

The present study found that a preponderance for Type 2 processing (as measured through the Need for Cognition subscale of the REI-10) was lower in both Introvertive Anhedonia and Unusual Beliefs. This mirrors previous research in which logical reasoning has been reported to be poorer in people with higher schizotypy scores, both for unusual experiences (Dagnall et al., 2016) and introvertive anhedonia (Tsakanikos, 2004). Lower rational or Type 2 reasoning has similarly been reported in clinical samples (Garety & Hemsley, 1997; Ward et al., 2018). Overall, the existing research combined with the findings from the present study provide compelling evidence that motivation for rational Type 2 thinking may generally be lower in high schizotypy scorers. However, this may not extend to all types of deliberative thinking. For example, creative thinking has previously been reported to be enhanced in high schizotypy scorers (Karimi et al., 2007). Furthermore, Owen and colleagues (Owen et al., 2007) reported greater rational processing in people with psychosis in situations where common-sense and logic conflicted (belief bias syllogisms). Despite methodological limitations and a small sample size in their study, this perhaps points at superior logical reasoning skills through a mechanism of reduced contextual interference (i.e. being less distracted by irrelevant information). This could be an interesting avenue for further research to elucidate particular sub-processes, as well as strengths and weaknesses related to schizotypy when engaging in logical or Type 2 reasoning.

#### 4.4.3. Schizotypy and Cognitive Reflection

As far as the author is aware, performance on the CRT has not previously been examined in relation to schizotypy. The finding that both Unusual Experiences and Introvertive Anhedonia were inversely related to cognitive reflection is therefore a

novel finding. This finding seems to be consistent with what might be expected based on related theory and literature, given that CRT is also thought to tap into aspects of cognitive inhibition and thinking disposition. For example, research suggests that lower inhibitory control may be a feature of schizotypy, as evidenced through poorer performance on antisaccade tasks (Myles et al., 2017) and the Stroop paradigm (e.g. Louise et al., 2015). Similarly, impaired inhibition and antisaccade performance is a very robust finding in clinical samples (Hutton & Ettinger, 2006; Radant et al., 2018; Westerhausen et al., 2018). As the CRT primes a particular prepotent response, which then requires reflective processing in order for it to be over-ridden, it seems to tap into these difficulties with inhibitory control. This finding may also be associated with a hastier or less reflective reasoning style, and may explain why CRT was also associated with Actively Open-minded Thinking and Need for Cognition. However, it is important to note that the current study did not control for intelligence or numerical ability, which may have been confounding the association between schizotypy and cognitive reflection, as some of the puzzles tap into numeracy skills.

#### 4.4.4. Schizotypy and Thinking Style

This is also the first study to investigate the relationship between schizotypy and actively open-minded thinking style as a measure of thinking disposition. Actively open-minded thinking was found to be negatively associated with both Unusual Experiences and Introvertive Anhedonia. This makes sense given that there were also higher levels of intuitive thinking processes in schizotypy, suggesting high schizotypy may be related to a lower propensity to consider alternative or conflicting evidence when reasoning. The association was stronger between Actively Open-Minded Thinking and Unusual Experiences than it was for Introvertive Anhedonia, suggesting that the finding may be more robust for positive schizotypy. This is consistent with previous research that has identified, perhaps unsurprisingly, that delusional beliefs in clinical samples are associated with lower belief flexibility (Ward & Garety, in press).

Interestingly, Wolfradt et al. (1999) identified a preference for *both* intuitive and rational thinking processes in positive schizotypy, while negative features of schizotypy were associated with a preference for intuitive thinking alone. Notably,

their study used the REI to assess thinking style, which raises the issue of how various cognitive measures can be subject to different and overlapping interpretations (Evans & Frankish, 2009). However, the present study contains a much larger sample and uses the arguably more robust O-LIFE scale to measure schizotypy rather than the Schizotypy Personality Questionnaire. In light of the above, it appears likely that a preference for intuitive and less open-minded thinking may be a genuine feature of schizotypy.

Conceptually, Actively Open-Minded Thinking can be considered to share similarities with BADE, a bias in which people are more likely to disregard evidence that contradicts their existing beliefs. This fits with previous research identifying a significant BADE effect in schizotypy (Buchy et al., 2007; Orenes et al., 2012) as well as a 'hypersalience of evidence-hypothesis matches' bias (assigning excessive weight to evidence that matches one's existing beliefs) in delusion-prone samples (Balzan et al., 2013a, 2013b). Furthermore, high schizotypy scorers have been found to ignore semantic context (Del Goleto et al., 2015) suggesting they may be more likely to stick with their initial choices and less amenable to incorporating relevant alternative information into their beliefs or reasoning processes.

While some other studies investigating the presence of biases such as the JTC and BADE in schizotypy have yielded somewhat conflicting results, this may be related to studies being underpowered to detect small effect sizes in non-clinical samples, or may be an artefact of the slightly different biases and approaches in question. The large sample size and robust effect size in the present study suggests that a less open and flexible thinking style may be a core feature of reasoning in schizotypy, and is likely to be exaggerated in positive compared with negative schizotypy.

#### **4.5. Research Question Two: Do thinking processes, thinking styles and schizotypy predict cognitive reflection?**

This research question sought to assess i) how much variance in cognitive reflection would be predicted by schizotypy, thinking processes and thinking style, and ii) whether the addition of schizotypy would contribute significantly to the explanation of cognitive reflection over other predictor variables.

The final hierarchical regression model, which included sex, Actively Open-Minded Thinking, Faith in Intuition, Need for Cognition, Unusual Experiences and Introvertive Anhedonia accounted for approximately 1/5<sup>th</sup> of the variance in cognitive reflection. Furthermore, the addition of schizotypy in the final step accounted for a significant, but relatively small amount of additional variance in cognitive reflection (1.2%), beyond demographic and cognitive variables. Actively Open-Minded Thinking, Faith in Intuition, Need for Cognition and Unusual Experiences were found to independently predict cognitive reflection. Sex was also found to predict cognitive reflection but only at the less conservative significance level of  $p < .05$ .

These findings seem to support theories related to dual process models and in particular Stanovich's tripartite extension of dual process models (Evans & Stanovich, 2013). To recap, this theory positions reasoning processes in the context of three components: an autonomous mind (responsible for Type 1 processing), as well as an algorithmic mind and a reflective mind (both responsible for Type 2 processing). Similarly in the current study, it appears that cognitive reflection (including inhibitory control) is indeed predicted by intuitive thinking (Faith in Intuition), rational thinking (Need for Cognition) and thinking style (Actively Open-Minded Thinking and Need for Cognition), and crucially in the directions expected based on the theory and literature.

Positive schizotypy may have been a better predictor of cognitive reflection than negative schizotypy in the present study, as it may be more closely related to features of psychosis. Negative schizotypy, on the other hand, may be tapping more into introversion or deriving less pleasure from activities. It makes intuitive sense, given a lower tendency to derive pleasure from activities, that people scoring more highly in Introvertive Anhedonia would gain less satisfaction from engaging in effortful and deliberative thought. Furthermore, positive schizotypy has previously been reported to be a better predictor of antisaccade errors (Ettinger et al., 2005) and performance on the Stroop paradigm (Louise et al., 2015) than negative schizotypy. As both processes tap into cognitive inhibition, this may partially serve to explain the greater influence of Unusual Experiences than Introvertive Anhedonia on cognitive reflection in the present study.

While the regression model did explain a substantial proportion of variance in cognitive reflection, approximately 80% of the variance remained unexplained. It is likely that a diverse range of factors may be contributing to this variance alongside schizotypy and types of processing. Some additional variance may, for example, be accounted for by religious beliefs (White, Joseph, & Neil, 1995), spirituality (Willard & Norenzayan, 2017), mood, mental health difficulties or other personality traits. For example, obsessive-compulsiveness (Enright & Beech, 1993), eating disorders (Claes, Mitchell, & Vandereycken, 2011), impulsivity (Avila & Parcet, 1997), creativity (Benedek, Franz, Heene, & Neubauer, 2012), psychopathy (Sadeh & Verona, 2008) and attention-deficit hyperactivity disorder (Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003) have also been linked to reduced inhibitory control. One study interestingly found that healthy participants who received cortisol (a hormone associated with stress) demonstrated a greater bias towards incorrect intuitive responses on the CRT than participants in the placebo condition (Margittai et al., 2016). This suggests that stress may increase the tendency to reason more hastily and reflexively, which could be an important factor involved in reasoning in schizotypy as well as psychosis, particularly as distress and trauma can often accompany clinical psychosis. Factors such as these could therefore be useful to consider in future investigations into decision making and schizotypy.

As mentioned previously, the CRT seems to rely on numeracy skills in addition to assessing cognitive reflection itself (Sinayev & Peters, 2015). For example, while cognitive reflection is required to reject the primed intuitive response, some items require numerical ability to then be able to calculate the correct response. Therefore individual differences in mathematical ability or intelligence, which were not explicitly assessed in the present study, could have been influencing the association between schizotypy and cognitive reflection. While the present study did assess item familiarity on the CRT and take this into account in the analyses, it seems plausible that even if people are aware of the type of questions asked on the measure they may be more vigilant to primed answers through reading the question through or thinking more carefully on each problem. Furthermore, as with any survey study the effort on the part of the participant may have biased responses. This may have particularly been at risk of affecting the CRT, given that reduced time, distractions or

cognitive capacity could influence the efficiency of which primed responses are overridden through reflective reasoning (De Neys, 2006; Evans & Curtis-Holmes, 2005).

#### **4.6. Research Question Three: Do thinking processes and thinking style mediate the relationship between schizotypy and cognitive reflection?**

The association between Unusual Experiences and Cognitive Reflection was found to be partially mediated by increased Faith in Intuition and reduced Actively Open-Minded Thinking. This is a novel finding in the literature and provides evidence that Unusual Experiences influence Cognitive Reflection both directly and (to a small degree) indirectly through greater reliance on Type 1 processing (Faith in Intuition) and a less flexible thinking style (Actively Open-Minded Thinking). There was no evidence that either of these mediating effects were more powerful or influential than the other. The observed findings are coherent with the idea that people who are less motivated due to their thinking disposition, will be less able to exert control over a primed 'Type 1' response to generate a correct response (West et al., 2008), suggesting that Unusual Experiences may potentially and slightly exaggerate this process.

On the other hand, the direct pathway between Introvertive Anhedonia and Cognitive Reflection was not found to be statistically significant. However, there was evidence for a very small indirect-only mediating effect through reduced Need for Cognition and Actively Open-Minded Thinking. There was no evidence for one of these mediating effects being any more significant or influential than the other. These findings suggest that people higher in trait Introvertive Anhedonia may be less cognitively reflective *only* via a lower tendency to embody a flexible and open-minded thinking style and lower engagement of Type 2 processes (Need for Cognition). This makes sense, as these mediators seem to capture pleasure derived from thinking activities, which seems a likely mechanism accounting for increased cognitive reflection within this personality trait that is characterised by a lower propensity to experience pleasure in general. This is another novel finding in the literature, but again needs to be interpreted cautiously given the small effect sizes.

It should be mentioned that despite the clear directions being specified in the structural pathways of mediation models based on theory, causality can nevertheless

not be inferred with complete confidence (Field, 2000). For example, Zhao and colleagues (2010) caution against assuming that statistical significance of a direct path assumes a direct relationship between two variables, highlighting how this may point at other potential mediators that have not been specified or included in the model. Furthermore, MacCallum (2003) highlights how we cannot ever expect to generate a perfect, correct and parsimonious explanation of psychological phenomena, their relationships and underlying complexities through statistical modelling. However, Hayes (2017) argues that as long as we couch any causal claims based on the data with necessary caveats and cautious theory-based interpretations, meaningful and valuable contributions can nevertheless be drawn from such models. Therefore, while the evidence from the present mediation models adds meaningfully to the literature, they should not necessarily be assumed to be fixed, definitive or without limitations.

#### **4.7. Implications**

Various theoretical and practical implications emerge from the present study. The results lend support to dual process models of reasoning and suggest that, as expected, schizotypy was found to be associated with greater reliance on Type 1 processing, less reliance on Type 2 processing, less cognitive reflection and a less flexible, open-minded thinking style. That only Unusual Experiences, but not Introverted Anhedonia, was independently predictive of cognitive reflection was an interesting finding and is a novel contribution to the literature. This suggests that the reasoning processes examined in relation to cognitive reflection were more relevant to positive schizotypy, than negative, which makes sense given that they are quite different dimensions of schizotypy. Furthermore, the mediating effects of thinking processes and styles had not yet been investigated in relation to schizotypy and cognitive reflection, which constitutes another original contribution to the field. Despite small effect sizes in the mediation analyses, these are nevertheless important results in developing and advancing theories related to personality and thinking processes, pointing at other potential target processes. Furthermore, given that the research took place in a non-clinical sample, it is conceivable that these effects would be further exaggerated in clinical samples, or for those scoring particularly highly in schizotypy.

In addition to these theoretical implications, a number of practical and clinical implications can also be drawn from the present research. The findings point at how thinking styles and processes could be potential treatment targets to increase cognitive reflection for people high in Unusual Experiences, or people potentially at high risk of transition to psychosis. It seems to make sense that increasing people's capacity for cognitive reflection, through encouraging consideration of alternative options or further deliberative reasoning could be useful in some clinical contexts. For example, this may have particular implications for delusional beliefs, which have been associated with several reasoning biases including JTC and BADE (Broyd et al., 2017). Indeed, one study found that eliciting analytic thinking was successful in reducing beliefs in conspiracy theories (Swami et al., 2014). Another study found that Type 2 reasoning was poorer in people with clinical psychosis compared with a non-clinical sample with psychosis-like experiences (Ward et al., 2018). This may indicate that effective rational reasoning may be protective in preventing paranoia or distress associated with psychosis-like experiences. Enhancing cognitive reflection and consideration of alternative choices could therefore potentially serve as a buffer against development or maintenance of paranoid ideation or delusional beliefs.

The current study also suggests that targeting thinking styles and processes could be useful in relation to Introvertive Anhedonia in clinical contexts. However, ameliorating thinking processes related to cognitive reflection may be less relevant in negative schizotypy, Introvertive Anhedonia or in analogous experiences in psychosis. This also appears to make sense given that Introvertive Anhedonia appears to be less directly related to psychosis, and more related to social withdrawal and affective processes. Perhaps instead, it follows that clinical interventions related to negative schizotypy would be better placed to also focus on increasing wellbeing or psychosocial functioning (Greenwood, Landau, & Wykes, 2005; Hunter & Barry, 2018; Lincoln, Mehl, Kesting, & Rief, 2011). For example, such interventions could be tailored towards social integration, social skills training and enhancing social cognition.

Interestingly, increased cognitive flexibility has been found to be a predictor of increased treatment response to Cognitive Behavioural Therapy for Psychosis (Garety et al., 1997; So et al., 2012), one of the recommended treatments for

psychosis (NICE, 2014). This suggests that the benefits of targeting cognitive processes extend to more than merely ameliorating the cognitive processes themselves. Indeed, clinical interventions that target thinking processes have shown promise in treating various aspects of psychosis. For example, metacognitive training programs, which focus on amending reasoning biases have had favourable outcomes for people with psychosis, evidence which has extended to the “gold-standard” of randomised-control trials (Aghotor, Pfueller, Moritz, Weisbrod, & Roesch-Ely, 2010; Briki et al., 2018; Moritz & Woodward, 2007) as well as to group formats (Moritz et al., 2011; Moritz et al., 2018). Notably, the positive effects of this intervention tend to be limited to ‘positive symptoms’, and appear to be particularly effective for delusions, with less of a focus on ‘negative symptoms’. However, ‘Cognitive Enhancement Therapy’, a multidimensional program consisting of neurocognitive training and social cognitive group exercises, has also shown promising results on both social and cognitive measures (Eack et al., 2009; Hogarty et al., 2004). Its focus and benefits in the areas of problem-solving, decision making and cognitive style (cognitive flexibility) may make it a particularly useful approach based on the current research.

Other interventions, that come under the umbrella of ‘Cognitive Remediation Therapy’, aim to improve cognitive flexibility, cognitive functioning and psychosocial functioning. These programs have been found to have positive effects on cognitive and functional outcomes in clinical samples with psychosis (McGurk, Twamley, Sitzer, McHugo, & Mueser, 2007; Wykes, Huddy, Cellard, McGurk, & Czobor, 2011). Perhaps then, programs need to be further refined to take into account cognitive biases and flexibility, psychological wellbeing, social cognition and community participation. This might provide a more comprehensive and parsimonious intervention for psychosis. With the need for cost-effective interventions in the increasingly challenging economic climate of the NHS, aspects of these interventions (e.g. skills training and compensatory strategies) could conceivably be provided through computerised methods, or even through smart phones. Notably, it is not suggested that computerised therapies be offered at the exclusion of face to face therapies. However, such approaches might provide a solution for people who do not have access to services due to being housebound, living in remote or inaccessible areas or for those who do not meet the increasingly unattainable criteria for receiving

psychological input through the NHS. Furthermore, such interventions could also provide some input or comfort for those on long wait lists for face to face therapies, or could serve as an adjunct to build on and consolidate face to face work, for example through helping people to practice and strengthen skills between sessions.

Use of psychological interventions appears to be a favourable alternative to pharmacological interventions in people who are distressed by their experiences. Antipsychotics produce a range of unpleasant side effects (Arana, 2000; Leucht, Pitschel-Walz, Abraham, & Kissling, 2018), their action on the brain is very broad as opposed to targeted and the science behind their mechanisms of action is somewhat unclear (Miyamoto, Duncan, Marx, & Lieberman, 2004; Moncrieff & Cohen, 2005). However, the present study also needs to be interpreted within a broader sociocultural and political context. It seems that compassionate approaches encouraging social inclusion, employment opportunities and reducing stigma would be key in managing distress related to any psychotic experiences, and could also conceivably affect thinking styles and processes through different yet unexplored mechanisms. For example, social trust has been found to increase as a function of economic equality and availability of opportunities (Rothstein & Uslaner, 2005). As psychosis is related to social inequality (Boydell, van Os, McKenzie, & Murray, 2004) and tends to be characterised by a lack of trust (Fett et al., 2012), which is also associated with altered functional brain activation (Gromann et al., 2013), it is conceivable that social context could influence neurocognitive brain processes that lead to or maintain psychosis. This could be an interesting and novel avenue for future research. Furthermore, levels of schizotypy have been found to differ as a function of class and ethnicity (Sharpley & Peters, 1999), highlighting the importance of social context in the formation of what might be assumed to be a rigid and inflexible personality construct.

#### **4.8. Study Limitations and Caveats**

The results and implications of the present study need to be couched in a number of limitations. For example, the 'thinking process' and 'thinking style' variables in the present study are, as with any psychological constructs, not absolute, clear-cut and categorical phenomena. This is reflected in the literature and the multitude of slight variations in dual process theories (Evans & Stanovich, 2013). It is likely that the

constructs in question and measures used to capture them, tap into multiple processes and overlap to a degree. For example, thinking processes inevitably overlap with and are related to thinking styles, and Type 1 processes also appear to be related to Type 2 processes, given that Type 2 processes can exert inhibitory control over Type 1 processes. As such, in hindsight there could have been alternative ways of positioning the variables in the regression and mediation models, which could also have been adequately justified on a theoretical basis. Furthermore, thinking process variables were also significantly correlated with one another, albeit not to such a high level that it became a concern in interpreting the data. Indeed, this is a caveat that applies to all similar studies, and highlights the importance of avoiding claims that cognitive research can ever claim to capture 'pure' or discrete thinking processes.

A related critique, is that the present study adopts a critical realist epistemology, assuming that the 'real world' exists and can be observed and discovered through scientific enquiry. Indeed, this is just one way of approaching research and does not mean that alternative approaches (e.g. qualitative or social constructionist approaches) could not also yield interesting and rich information, which could complement or provide an alternative to quantitative and realist approaches. For example, this might provide interesting insights into the content or types of thoughts related to schizotypy, or people's personal experiences of their intuitive and deliberative thinking processes, and thinking styles. Furthermore, as the present study mainly used self-report measures, this assumes that people are aware of their own propensity to reason using Type 1 or Type 2 processes, or are objectively aware of their own thinking styles. Using future methods which capture thinking processes and styles more 'objectively' (e.g. through capturing reasoning 'in action' through behavioural or interviewer rated methods) could be a useful way to build on or corroborate the current findings.

Another limitation of the present study is that due to the survey-based nature of the study, intelligence or cognitive ability was not explicitly assessed (Toplak et al., 2011). Furthermore, substance misuse, neurological problems or mental health difficulties were not assessed or controlled for in the analyses. Therefore, despite not being intentionally recruited as a clinical sample, it is conceivable that these

unreported factors could nevertheless be present and influencing the findings. For example, low mood or a diagnosis of Autism Spectrum Disorder could conceivably confound Introvertive Anhedonia scores, while a diagnosis of Attention Deficit Hyperactivity Disorder, or indeed unreported psychosis-related presentations could also affect the findings. On the other hand, it could also be counter-argued that this makes the data more representative of 'real' people and the population at large which it is intending to emulate.

Lastly, the concept of schizotypy itself, is not without its criticisms and controversy. For example, its underlying factor structure can vary across studies and some critics have described it as a categorical construct (Rawlings et al., 2008). However, the present study relies on a continuum definition of schizotypy and does not attempt to distinguish 'high' from 'low' schizotypy. Furthermore, evidence suggests that research into schizotypy can draw meaningful comparisons with psychosis and clinical presentations (Cochrane, Petch, & Pickering, 2018). However, this should nevertheless be approached with caution due to potential additional or complicating factors involved in clinical presentations. Nevertheless by examining schizotypy, the present study has attempted to bypass some of these complicating and confounding factors (e.g. trauma, acute distress, antipsychotic medication). Furthermore, whereas research into psychiatric diagnosis can risk promoting the idea of 'abnormality' or 'pathology', carrying out research in non-clinical populations can arguably also promote a more normalising and inclusive view of psychosis-like experiences (Johns & van Os, 2001). Furthermore, as with other personality traits, schizotypy has moderate temporal stability and can therefore vary over time (Venables & Raine, 2015), suggesting it is not necessarily fixed and inflexible.

#### **4.9. Study Strengths**

Despite the above caveats, the present study also has a number of strengths. First of all, the sample size is very large. This means that the study findings are more likely to generalise to other samples as well as the general population at large, and that the study was highly-powered to detect the small effect sizes characteristic of this type of research. There was also good representation across a wide range of ages and education levels, which is often not the case in psychology research in which there tends to be a significant over-representation of younger, and relatively

highly-educated university students. Furthermore, there was decent representation from across the schizotypy continuum, for both Unusual Experiences and Introverted Anhedonia.

The present research is also novel in its approach and adds meaningfully to the literature on schizotypy and decision making. This is the first study to investigate schizotypy in the context of dual process models, whilst taking into consideration thinking style. It is also the first to provide evidence for a negative association between both positive and negative schizotypy and the Actively Open-Minded Thinking Scale. Furthermore, it is also the first to suggest that Unusual Experiences is independently predictive of Cognitive Reflection, as measured through the Cognitive Reflection Test. Importantly, it also took item familiarity into consideration in the administration of the Cognitive Reflection Test, thereby increasing the rigour and validity of the measure. Overall, it provides compelling evidence for greater reliance on Type 1 intuitive processes and reduced engagement of Type 2 processes, as well as a less flexible thinking style in schizotypy, and provides useful insights into the processes and mechanisms involved.

#### **4.10. Reflective Account**

The author has been cautious whilst carrying out this research not to undermine or pathologise experiences that are characteristic of schizotypy. The aim of this research was to discover more about the cognitive processes involved in schizotypy, without implication that schizotypy is a negative personality trait. Furthermore, while the present research draws parallels based on shared features between schizotypy and psychosis, this should not be interpreted as implying a causal or deterministic relationship between the two. Furthermore, the author similarly does not wish to imply that psychosis is an inherently negative or aversive experience. While psychosis can be associated with distress and lower wellbeing (Broyd, Jolley, & Johns, 2016), particularly in the context of persecutory or paranoid ideation (Startup, Freeman, & Garety, 2007), many people in the general population report psychosis-like experiences which cause them no harm or distress (Bak et al., 2003; Johns & van Os, 2001). Indeed, prevalence estimates suggest that subclinical psychotic experiences are present in approximately 5% of the population (Van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam, 2009) and that lifetime prevalence of

hearing voices may be as high as 15% (Tien, 1991). Furthermore, there is evidence to suggest that religious or spiritual experiences are often misconstrued as psychosis (Johnson & Friedman, 2008; Menezes & Moreira-Almeida, 2010), and that psychosis-like experiences vary considerably across cultures (Bauer et al., 2018; Suhail & Cochrane, 2002). Therefore, the suggestions regarding clinical implications needs to be couched in the caveat that psychosis-like experiences are not inherently 'negative' and the author would argue that they only need to be worked with or adjusted if they are experienced as upsetting or distressing. This fits with current cognitive models of psychosis that suggest it is the 'appraisal' rather than the experiences themselves that cause distress (Garety et al., 2001). Furthermore, much of the distress associated with psychosis tends to arise through societal discrimination, 'othering' and stigma (Brohan, Elgie, Sartorius, & Thornicroft, 2018; Rüsck et al., 2014). Similarly, our definitions of 'unusual experiences' or 'delusions' only exist based on normative culturally-shaped assumptions of reality and 'truth' (Harper, 2004), suggesting that they are not categorical or clearly-defined phenomena. Therefore, the author hopes that the present research does not detract from the important part that socio-cultural and political processes can play in understanding psychosis and related distress.

#### **4.11. Future Research**

Based on the findings from the current research and identified gaps in the literature, a number of promising avenues for future research are suggested:

- i) While dual process models have recently been investigated in relation to delusions (Freeman et al., 2014; Ward & Garety, in press), these have not been examined comprehensively in relation to other aspects of psychosis, such as hallucinations or social anhedonia. The present research can therefore be built upon and investigated further in clinical populations and according to particular presentations.
- ii) Research could examine in greater detail how thinking styles and processes are related to schizotypy, and the pathways and interactions (e.g. mediating and moderating influences) between them. For example, SEM could be used to test the hypothesis that a hasty or less flexible reasoning style leads to more intuitive processing, which subsequently

leaves less cognitive capacity for deliberative processing, which is predictive of positive schizotypy scores.

- iii) The findings from the present study suggest that there is room to investigate other variables that might be mediating the relationship between Unusual Experiences and Cognitive Reflection. Examining religious beliefs, creativity or other aspects of personality could be useful starting points in this endeavour.
- iv) Other, more 'objective' methods including in vivo behavioural methods (belief bias syllogisms, antisaccade task), interviewer-rated approaches or neuroimaging methods could be used to supplement or corroborate the current findings. This could also help to further establish the neurobiological processes and neural networks involved in decision making and how this interacts with aspects of personality.
- v) Future research could go into greater depth by exploring different aspects of Type 2 cognitive processes and how they relate to schizotypy. For example, people scoring more highly in positive schizotypy may be more adept at creative or original thinking (Karimi et al., 2007), while negative schizotypy may be related to convergent and systematic thinking. Social or emotional reasoning could also conceivably be poorer in negative schizotypy. Therefore the findings related to logical and deliberative processing reported in the present study may not extend to *all* types of reasoning in schizotypy and could be further investigated and built upon.
- vi) Future research could endeavour to examine the role of relationships, social context and culture in reasoning processes in schizotypy. For example, it is conceivable that reasoning in schizotypy may differ according to factors such as social support, social rank (Cotier & Toulopoulou, 2017), cultural differences or political orientation.
- vii) As in the present study, future research could benefit from investigating reasoning within the context of dual process frameworks. Stanovich's tripartite extension of dual process models seems to be a parsimonious and comprehensive way of conceptualising such processes. Acknowledging and building on these various complementary aspects of decision making will allow for fuller understandings of reasoning

processes, whether more generally or in relation to particular aspects of personality or clinical phenomena.

#### **4.12. Conclusion**

The present study sought to investigate how schizotypy is related to thinking processes and styles, in the context of dual process models of reasoning. The study provides evidence for variation in thinking processes and styles according to trait schizotypy in a very large non-clinical sample. Schizotypy was found to be associated with greater reliance in Type 1 intuitive processing, and lower engagement of Type 2 deliberative processing. This was similarly highlighted through lower cognitive reflection and less open-minded and flexible thinking styles as a function of increased schizotypy, both for Unusual Experiences and Introvertive Anhedonia. Unusual Experiences, but not Introvertive Anhedonia, was an independent predictor of cognitive reflection. In predicting cognitive reflection, schizotypy contributed a significant proportion of additional variance over other predictor variables (Actively Open-Minded Thinking Style, Faith in Intuition and Need for Cognition). Mediation models suggested that the pathway between Unusual Experiences and cognitive reflection was partially mediated by increased Faith in Intuition and reduced Actively Open-minded Thinking, with small effect sizes. There was also evidence for a small indirect-only effect between Introvertive Anhedonia and cognitive reflection through lower Need for Cognition and Actively Open-Minded Thinking. These findings add novel and meaningful contributions to the literature on schizotypy and decision making. They also inform various practical and clinical implications, and provide springboards for further promising research avenues in the area of decision making and personality.

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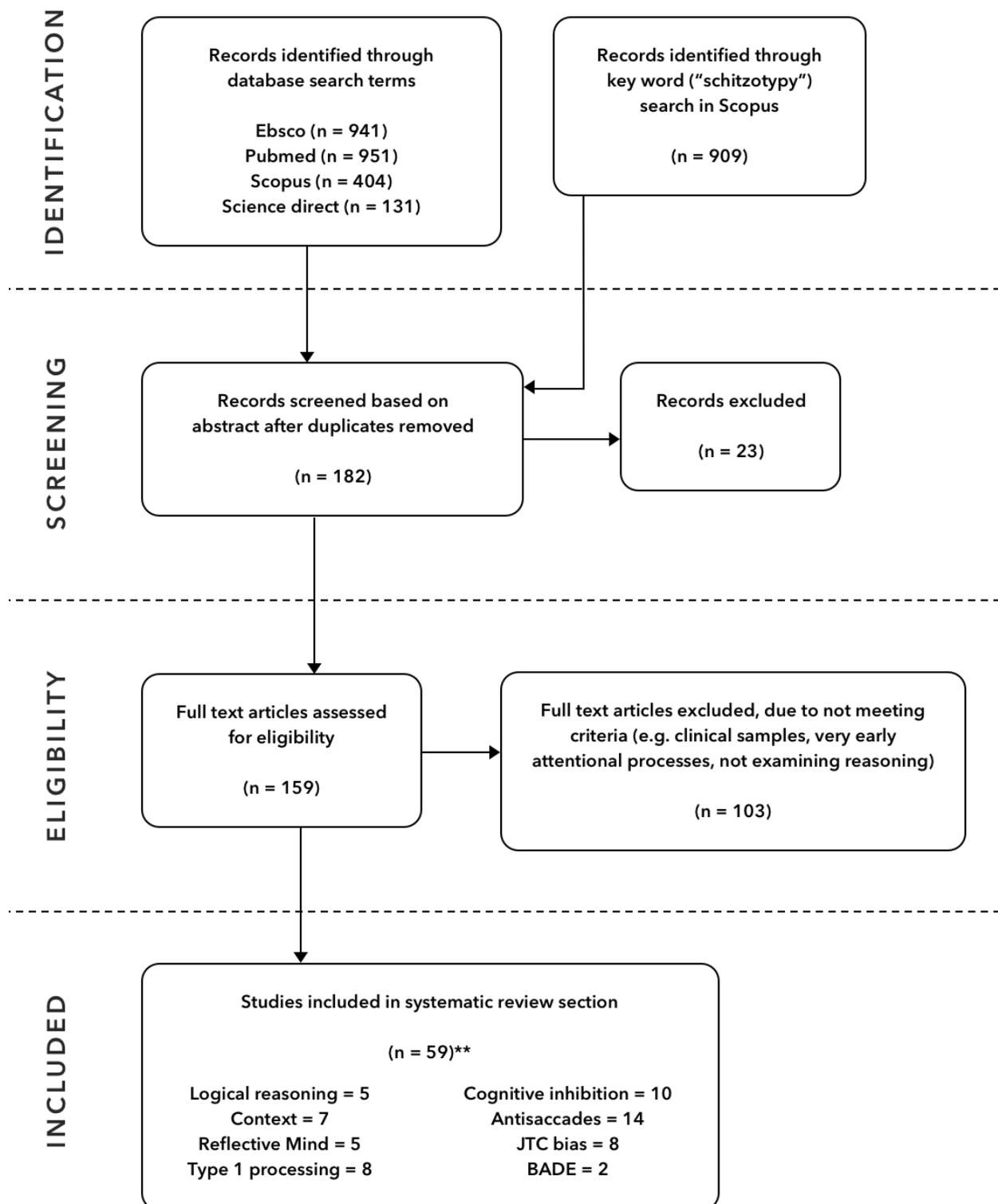
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## 6. APPENDICES

### Appendix A: Literature Search Flowchart



\*\* NB the original literature search took place in July 2017. Hand searches in papers were also carried out. Another keyword search in Scopus was carried out before

thesis submission in April 2018 to identify any additional recent and relevant articles. New articles were also identified through email alerts through Ebsco and Scopus based on the search terms specified within the search strategy.

Additional studies were included in the following sections:

- Logical reasoning ( $n = 2$ )
- Cognitive inhibition ( $n = 2$ )
- Antisaccades ( $n = 2$ )

## **Appendix B: Participant Information and Consent Sheet**

**School of Psychology**  
**University of East London**  
**University Research Ethics Committee**

**Principal Investigators**  
Annabel Broyd (u1524876@uel.ac.uk)  
Professor Ulrich Ettinger  
Professor Paul Allen  
Dr Volker Thoma (v.thoma@uel.ac.uk)

### **PARTICIPANT INFORMATION**

Thank you for taking an interest in participating in this study.

#### **Project Title**

A survey on individual factors related to how people think and make decisions.

#### **Project Description**

The aim of the research is to investigate how people with different personality characteristics process information and think differently. This research could potentially help us to better understand thinking skills or to develop psychological interventions to support various thinking processes.

The study involves answering some questions about personality characteristics, solving a few problems, and providing some demographic information. This should take no longer than ten to fifteen minutes. You'll also get some feedback about your personality characteristics at the end.

#### **Confidentiality of data**

Data will be anonymised and stored on a password-protected computer. Only myself and co-investigators will have access to the data and none of the information will be shared with any other parties. All information will be considered confidential and any dissemination of the findings will be anonymised and free from any identifying information. Data will be stored for 5 years and then destroyed.

#### **Disclaimer**

You are not obliged to take part in this study and are free to withdraw at any time and can do so by emailing Annabel Broyd (u1524876@uel.ac.uk). You may withdraw without disadvantage to yourself and without any obligation to give a reason.

This study has been approved by the University of East London Ethics Committee. If you have any questions or concerns about how the study has been conducted, please contact my supervisor:

Dr Volker Thoma, v.thoma@uel.ac.uk, + 44 (0)2082234438

or

Chair of the School of Psychology Research Ethics Sub-committee: Dr. Mary Spiller, School of Psychology, University of East London, Water Lane, London E15 4LZ.

(Tel: 020 8223 4004. Email: m.j.spiller@uel.ac.uk)

Thank you in anticipation. I hope you find it interesting and enjoy participating!

Yours sincerely,

**Annabel Broyd**  
**Trainee Clinical Psychologist / Principal Investigator**

Do you wish to continue?

Yes

No

## Appendix C: Survey Questionnaires

The following questions ask for some basic demographic information.

Note that we will not share your details with anyone else - all information will be kept anonymous and confidential.

---

### Age

### Gender

Male

Female

Other

Would prefer not to say

### What is your highest completed level of education?

School

College or sixth form

Vocational qualification

Bachelor Degree (BA/BSc)

Postgraduate Diploma

Master's Degree (MA/MSc)

Doctorate or PhD

*The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE) – Short Form Questionnaire (Unusual Experiences and Introvertive Anhedonia subscales)*

**Unusual Experiences (12 items)**

When in the dark do you often see shapes and forms even though there is nothing there?

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

Have you ever thought that you had special, almost magical powers?

Have you sometimes sensed an evil presence around you, even though you could not see it?

Do you think that you could learn to read other's minds if you wanted to?

When you look in the mirror does your face sometimes seem quite different from usual?

Do ideas and insights sometimes come to you so fast that you cannot express them all?

Can some people make you aware of them just by thinking about you?

Does a passing thought ever seem so real it frightens you?

Do you feel that your accidents are caused by mysterious forces?

Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?

Does your sense of smell sometimes become unusually strong?

**Introvertive Anhedonia (10 items)**

Are there very few things that you have ever enjoyed doing?

Are you much too independent to get involved with other people?

Do you love having your back massaged? (a)

Do you find the bright lights of a city exciting to look at? (a)

Do you feel very close to your friends? (a)

Has dancing or the idea of it always seemed dull to you?

Do you like mixing with people? (a)

Is trying new foods something you have always enjoyed? (a)

Have you often felt uncomfortable when your friends touch you?

Do you prefer watching television to going out with people?

*Score 1 for yes, 0 for no.*

*(a) Score 1 for no, 0 for yes.*

*The Combined Cognitive Reflection Test*

The following questions involve solving a few puzzles. Please answer the questions by entering the first answer that comes to mind. Please do all working out in your head.

1) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

..... minutes.

2) A magazine and a banana together cost £2.90. The magazine costs £2. How much does the banana cost? \*\*

.....

3) If you're running a race and you pass the person in second place, what place are you in? ..... place.

4) 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 the lake?

.....days.

5) A farmer had 15 sheep and all but 8 died. How many are left? ..... sheep.

6) If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take them to drink one barrel of water together?

.....days.

7) Jerry received both the 15<sup>th</sup> highest and the 15<sup>th</sup> lowest mark in the class. How many students are in the class?

..... students.

8) Emily's father had three daughters. The first two are named April and May. What is the third daughter's name?

.....

9) A man buys a pig for £60, sells it for £70, buys it back for £80, and sells it finally

for £90. How much has he made?

.....pounds.

10) How many cubic feet of dirt are there in a hole that 3' deep x 3' wide x 3' long?

.....

11) Simon decided to invest £8,000 in the stock market one day early in 2008. Six months after he invested, on July 17, the stocks he had purchased were down 50%. Fortunately for Simon, from July 17 to October 17, the stocks he had purchased went up 75%. At this point, Simon has:

a. broken even in the stock market. b. is ahead of where he began. c. has lost money.

Have you seen any of the above puzzles before?

Yes

No

If yes, please write the question numbers of the puzzles you have seen before:

.....

\*\* indicates control question

*The Actively Open-Minded Thinking Scale – 7-item*

Please rate your agreement or disagreement with each statement on a 1 to 7 scale, where 1 = Completely Disagree, 4 = Neutral, and 7 = Completely Agree.

1. Allowing oneself to be convinced by an opposing argument is a sign of good character.
2. People should take into consideration evidence that goes against their beliefs.
3. People should revise their beliefs in response to new information or evidence.
4. Changing your mind is a sign of weakness.
5. Intuition is the best guide in making decisions.
6. It is important to persevere in your beliefs even when evidence is brought to bear against them.
7. One should disregard evidence that conflicts with one's established beliefs

(Note: Last 4 items should be reverse coded).



## **Appendix D: Personality Summaries**

### *Unusual Experiences – High Range*

Your personality questionnaire scores indicate that you have a high tendency to experience unfamiliar sensations or thoughts that might be considered magical, spiritual or superstitious. You may also hold some beliefs that others might find unusual. You may experience the ability to cross mental boundaries and feel a sense of contact with a force beyond the individual self. These types of experiences have been linked to creative thinking and artistic achievement as well as the ability to create a state of 'flow' in which you can become deeply absorbed, focused and can derive immense pleasure from particular tasks. You are also likely to be able to think flexibly and be open to new ideas and experiences.

### *Unusual Experiences – Medium Range*

Your personality questionnaire scores indicate that you may have some tendencies to experience unfamiliar sensations and thoughts that might be considered magical, spiritual or superstitious. You may find that you hold some beliefs that others find unusual. You may experience the ability to cross mental boundaries and feel a sense of contact with a force beyond the individual self. These types of experiences have been linked to creative thinking and artistic achievement as well as the ability to create a state of 'flow' in which you can become deeply absorbed, focused and can derive immense pleasure from particular tasks. You are also likely to be able to think flexibly and be open to new ideas and experiences.

### *Unusual Experiences – Low Range*

Your personality questionnaire scores indicate that you have a low tendency to experience unfamiliar sensations and thoughts that might be considered magical, spiritual or superstitious. The beliefs you have about the world tend to be shared with others and are generally not considered unusual by others. Generally you feel grounded, connected to reality and show high levels of self-awareness, in both mind and body.

### *Introvertive Anhedonia – High Range*

Your scores also indicate that you have a tendency to prefer quiet and solitary activities compared to socialising with large groups of people. You may also gain less enjoyment from social and physical activities (e.g. exercise, hobbies, music) than others do, due to preferring a quieter and more peaceful external environment. You may find that social activities can be quite draining, and feel more comfortable and energised in reflective or solitary activities or when interacting with close friends. People scoring within this range often make great mathematicians, scientists, engineers, inventors or artists due to their creativity, analytical thinking and ability to reflect.

### *Introvertive Anhedonia – Medium Range*

Your scores also indicate that you tend to enjoy a mix of socialising with others as well as engaging in quiet and solitary activities. You probably have a few good friends, as well as a wide circle of acquaintances. You may enjoy engaging in certain social and physical activities (e.g. exercise, hobbies, music), but also value your peace and quiet. People who score within this range can be flexible and adapt their behaviour to fit in with their work or social contexts. For example, you may find you can switch between being enthusiastic, talkative and assertive, as well as being creative, analytical and reflective.

### *Introvertive Anhedonia – Low Range*

Your scores also indicate that you tend to enjoy socialising with large groups of people compared to quiet and solitary activities. You tend to feel more comfortable and energised around others, thriving off social interaction and stimulating environments. You likely enjoy engaging in a range of social and physical activities, such as exercise, hobbies and music. People scoring within this range may be enthusiastic, talkative and assertive, may have strong relationships with others and tend to work very well in groups.

### *Disclaimer following summaries*

Remember, these are only very general personality summaries – we are all different and our unique experiences and characteristics cannot fit neatly into categories!

## **Appendix E: Debrief Information**

Thank you very much for participating in this study.

Below you will find some general information of services that can provide further support should you feel concerned or distressed by any part of this study.

We give this information to everyone that has participated and it is not related to survey responses. Please ignore the resources if you feel they are not relevant to you.

If you would like to ask any questions or have any concerns please don't hesitate to raise these with me now or later via email on [u1524876@uel.ac.uk](mailto:u1524876@uel.ac.uk).

We would also like to remind you that all data collected will remain confidential and there will not be any identifying information in any publication or dissemination of the research.

### **Useful Contacts and Resources**

**Samaritans - 116 123** – The Samaritans helpline is open 24 hours a day and offers free confidential support for people who are distressed or would like someone to talk to.

**Rethink – 0300 5000 927** – A free confidential helpline offering practical advice and support. Open Monday - Friday 9.30am - 4pm (not including bank holidays).

If you have any concerns you can also make arrangements for local support through your GP, local health provider or call NHS 111.

**In an emergency, please contact your GP or visit your local accident and emergency department.**

## Appendix F: Ethical Approval Letter

### School of Psychology Research Ethics Committee

## NOTICE OF ETHICS REVIEW DECISION

For research involving human participants

BSc/MSc/MA/Professional Doctorates

**REVIEWER:** Lucia Berdondini

**SUPERVISOR:** Volker Thoma

**COURSE:** Professional Doctorate in Clinical Psychology

**STUDENT:** Annabel Broyd

**TITLE OF PROPOSED STUDY:**

### DECISION OPTIONS:

1. **APPROVED:** Ethics approval for the above named research study has been granted from the date of approval (see end of this notice) to the date it is submitted for assessment/examination.
2. **APPROVED, BUT MINOR AMENDMENTS ARE REQUIRED BEFORE THE RESEARCH COMMENCES** (see Minor Amendments box below): In this circumstance, re-submission of an ethics application is not required but the student must confirm with their supervisor that all minor amendments have been made before the research commences. Students are to do this by filling in the confirmation box below when all amendments have been attended to and emailing a copy of this decision notice to her/his supervisor for their records. The supervisor will then forward the student's confirmation to the School for its records.
3. **NOT APPROVED, MAJOR AMENDMENTS AND RE-SUBMISSION REQUIRED** (see Major Amendments box below): In this circumstance, a revised ethics application must be submitted and approved before any research takes place. The revised application will be reviewed by the same reviewer. If in doubt, students should ask their supervisor for support in revising their ethics application.

### DECISION ON THE ABOVE-NAMED PROPOSED RESEARCH STUDY

*(Please indicate the decision according to one of the 3 options above)*

APPROVED

**Minor amendments required** (*for reviewer*):

**Major amendments required** (*for reviewer*):

**ASSESSMENT OF RISK TO RESEARCHER** (*for reviewer*)

If the proposed research could expose the researcher to any of kind of emotional, physical or health and safety hazard? Please rate the degree of risk:

- HIGH
- MEDIUM
- LOW

*Reviewer comments in relation to researcher risk (if any): n/a*

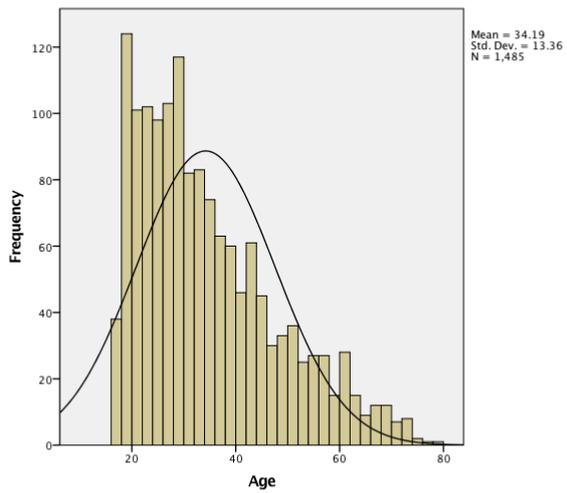
**Reviewer** (*Typed name to act as signature*): Dr Lucia Berdondini

**Date:** 25<sup>th</sup> April 2017

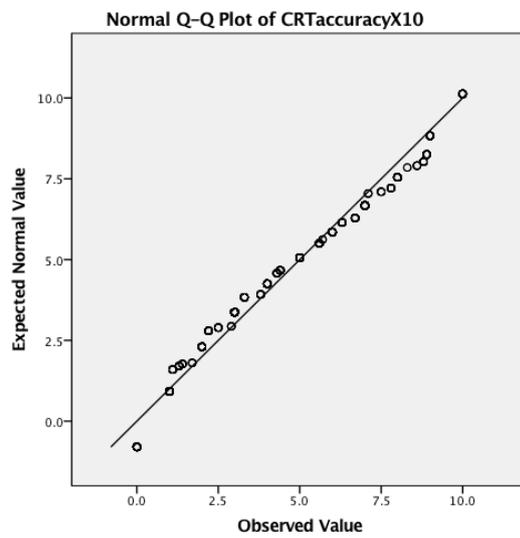
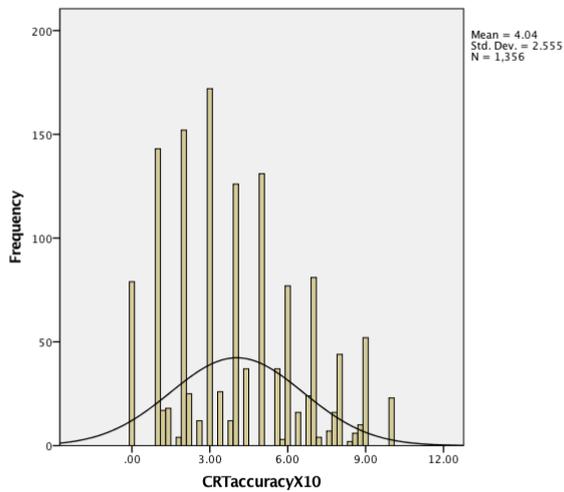
*This reviewer has assessed the ethics application for the named research study on behalf of the School of Psychology Research Ethics Committee*

## Appendix G: Statistical Software Output

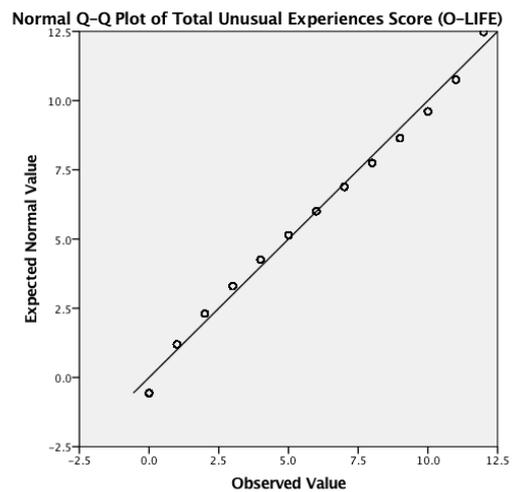
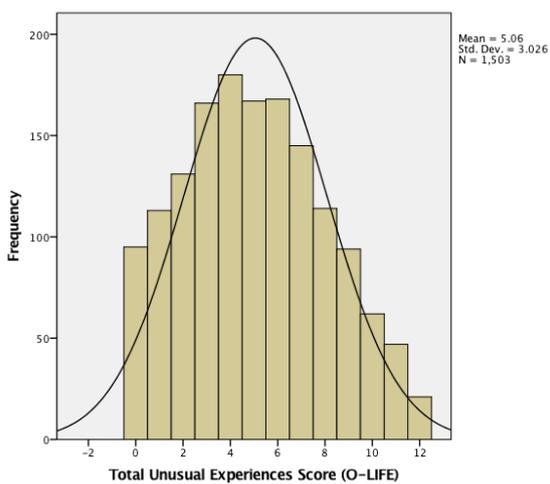
### Histogram and Q-Q Plot for Age



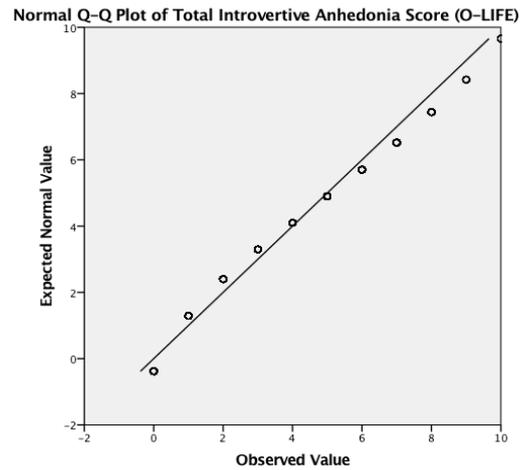
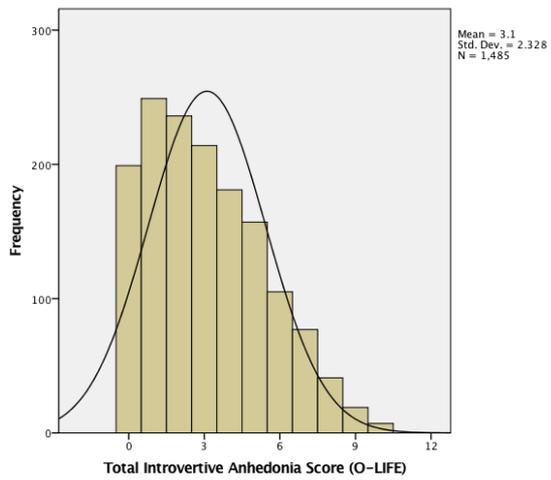
### Histogram and Q-Q Plot for CRT



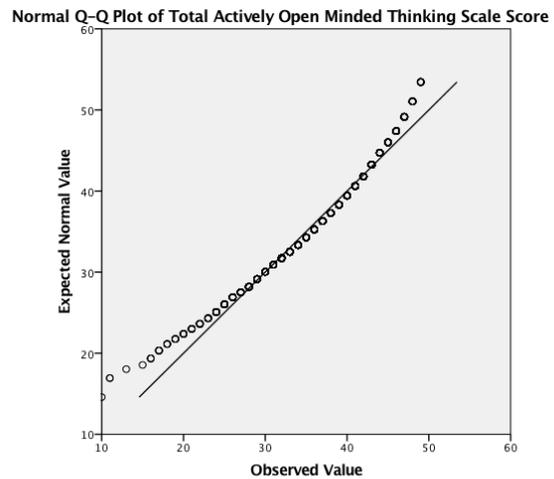
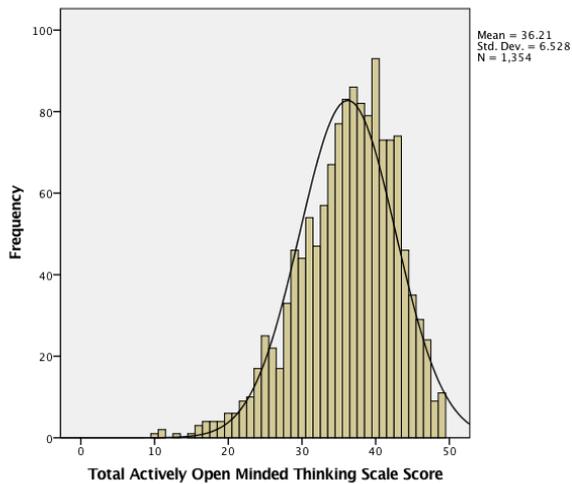
### Histogram and Q-Q Plot for Unusual Experiences



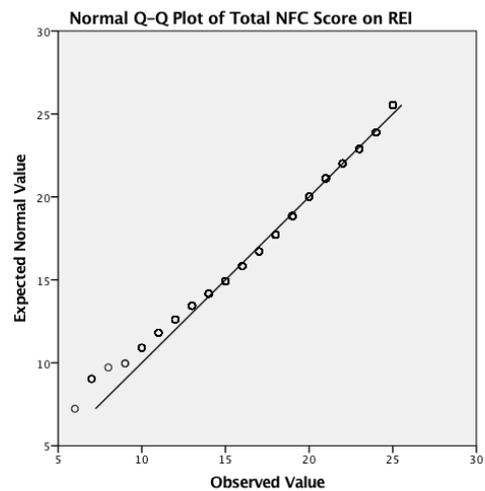
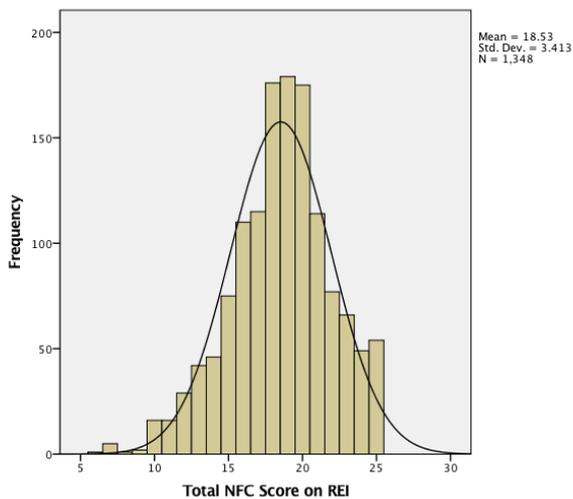
### Histogram and Q-Q Plot for Introverted Anhedonia



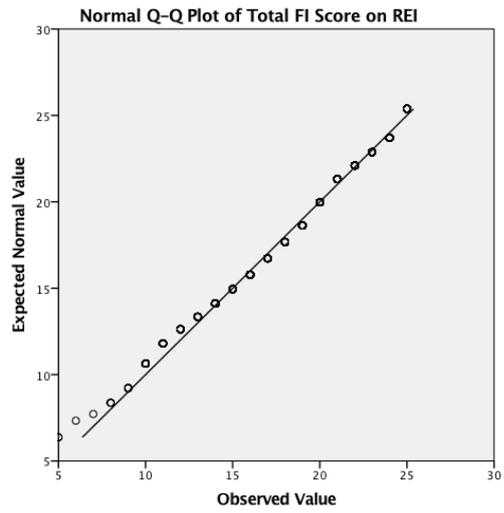
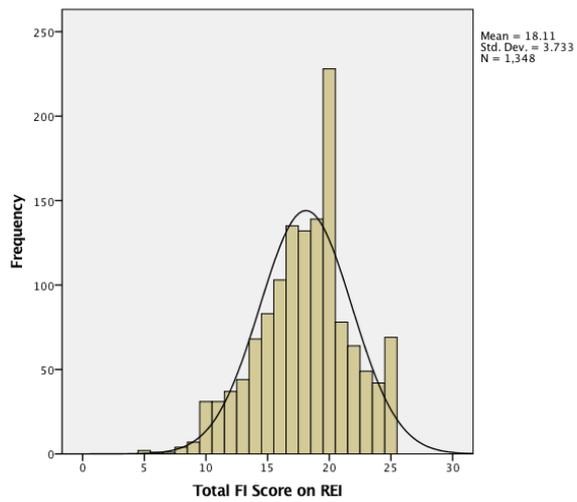
### Histogram and Q-Q Plot for Actively Open-Minded Thinking Scale



### Histogram and Q-Q Plot for Need for Cognition



## Histogram and Q-Q Plot for Faith in Intuition



## Linear Regression Assumptions

