Logical reasoning in delusion-prone individuals

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June, 2018

Submitted in partial fulfilment of the requirements for the degree of Doctor in Clinical Psychology (DClinPsy), Royal Holloway, University of London

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EXECUTIVE SUMMARY

Research suggests that reasoning biases play a key role in the development and maintenance of paranoia. A number of cognitive interventions have been developed to ameliorate these biases, with the view that this will improve symptoms, functioning and quality of life in individuals with psychosis. Numerous research studies have tested the efficacy of these therapies, and integrating the evidence has important implications for individual, family and service-wide outcomes. The two papers presented in this thesis, a systematic review and an empirical study, aim to contribute to research in the area. The final section, which aims to place the thesis in a wider context, discusses the overall findings, personal reflections on the research process, some limitations of the two studies, and outlines implications for clinical interventions and future research.

Paper One: Systematic review

Background. It is widely acknowledged that reasoning biases contribute to both the development and maintenance of paranoid thinking. Common biases identified in the literature include the jumping to conclusions (JTC) bias and belief inflexibility. In view of the significant impact that these reasoning biases can have on daily functioning, many cognitive interventions have been developed to ameliorate these deficits. Some of these interventions are more broad-based, such as metacognitive training (MCT), whereas others are more targeted and focused treatments, such as video cognitive therapy (VCT) for Theory of Mind (ToM) deficits. The interventions typically utilise skills-based, instructional and experiential techniques to normalise, bring awareness to and ameliorate delusion-relevant cognitive biases. The effect of these interventions on the positive and negative symptoms of psychosis has been studied extensively in the literature. In contrast, the impact of these therapies on reasoning biases, in both the short and the long-term, has received less research attention.

Project aims and method. The study aimed to assess the effectiveness of existing cognitive therapies in alleviating reasoning biases in psychosis. Specifically, the review compared a number of different therapies on their efficacy, as well as exploring whether certain reasoning biases were more or less responsive to treatment. Potential studies were identified using a keyword search of three major online databases: Web of Science, PsycInfo and PubMed. A list of associated terms were generated for the key concepts of 'psychotic disorder', 'cognitive therapy' and 'reasoning biases', and search terms were limited to article title and abstract. Articles identified as potentially relevant were collected and reviewed for appropriateness. Eligible studies were those using a randomised controlled study design (RCT), recruiting adults (18+) diagnosed with a psychotic disorder, and those published in English in peer-reviewed journals. Articles were excluded if they recruited individuals experiencing prodromal or non-clinical psychotic symptoms, or those experiencing psychosis in the context of bipolar disorder or dementia. Therapies could be self-directed, therapist-led, group or individual interventions. Three hundred and thirty-nine studies were screened for suitability and a total of 22 studies were included in the review.

Analysis. A number of descriptive characteristics were extracted from each study, in order to highlight the significant similarities and differences between the studies reviewed. The information retrieved included a) study design features, such as location and setting b) participant characteristics, including diagnosis, ethnicity, gender and number recruited for the study c) both self-report and performance-based measures of reasoning where administered and d) type, format, frequency, duration and mode of delivery of the cognitive therapy delivered. Information regarding the efficacy of each intervention was also extracted. Where studies did not provide effect sizes, or where effect sizes were not reported in terms of Cohens d, this statistic was calculated by the researcher.

Results. One thousand, two hundred and fifty-four participants were included in the final review. Male participants outnumbered female participants, and the sample was comprised of individuals from a range of ethnic and age groups. Most of the studies delivered their intervention using a group format in an outpatient setting, and the interventions were, for the most part, delivered by professional therapists. The review found that targeted treatments were generally more effective than broad-based interventions at improving specific reasoning biases. In general, substantial improvements were reported in belief flexibility and ToM deficits following cognitive therapy. Changes in the JTC and attribution biases were less consistent, though still observed in most cases. In some instances, improvements in reasoning biases occurred during the follow-up period, indicating that changes may require some time to establish before positive effects emerge.

Discussion. A number of factors may limit the generalizability of the review findings. Firstly, most studies applied strict eligibility criteria, which meant that individuals with a variety of co-morbidities, such as substance misuse, were excluded from participation. This limits the extent to which the findings can be applied to typical psychosis patients, who often present with more complex and severe difficulties. The choice of measurement tool used to detect changes in reasoning appeared to influence the findings that were reported. This should be addressed in future research to ensure consistency in the literature. Further, cognitive interventions which have not been tested using an RCT design, will have been excluded from, and thus not represented, in the current review.

Recommendations and clinical implications. The findings suggest that there is promise for the use of cognitive interventions in ameliorating reasoning biases in clinical settings. In general, targeted interventions were more effective in facilitating long-term change in these biases, compared with more broad-based therapies. In light of this, individual needs, current symptoms and therapy goals should also be reviewed when

considering treatment options. The delivery of higher-quality, larger studies evaluating the effectiveness of these therapies in more representative samples would be of interest. In addition, studies with extensive follow-up assessments would be useful to ascertain long-term treatment effects and stability. There is also a need to determine the optimum frequency and duration of treatment for specific reasoning biases, as well as of the cognitive therapy that is delivered. Further research is needed into how effective these treatments are with individuals experiencing prodromal and non-clinical symptoms, where reasoning biases are also prominent. Finally, there is a need for future research studies to measure the effectiveness of these interventions on real-world reasoning processes.

Paper Two: Empirical study

Background. It is widely acknowledged that a number of factors, such as pre-existing beliefs and emotional states, can influence logical reasoning abilities. The interplay between emotion, beliefs and reasoning is of clear relevance to understanding the dysfunctional beliefs characteristic of many psychological disorders. It has been long suggested that these beliefs result from an illogical reasoning style, due to the fact that they are often resistant to change, despite being supported by little evidence in most cases. In light of this, however, a number of theories have been developed which propose that logical reasoning is not impaired in those with psychological illness per se, but instead focus on how beliefs and emotion influence logical reasoning processes.

The belief bias theory suggests that dysfunctional beliefs result from a threat-confirming, fear-based reasoning style. When making decisions regarding their feared beliefs, individuals with psychological disorder are thought to make a quick decision based on their instincts, before considering the logical validity of the conclusion they have drawn. This means that individuals are more likely to accept a conclusion as true or false in line with their beliefs, as opposed to its logical validity. There is debate in the literature as to

whether this enhanced belief bias is applied across all beliefs held by the individual, or whether it is specific to the dysfunctional belief. The dual-process model of reasoning offers a theoretical account of belief bias in deductive reasoning. The model distinguishes between two qualitatively different cognitive processes: Type one 'intuitive' reasoning processes (quick and based on the 'gut-instinct') and Type two 'analytical' reasoning processes (which are more logical and time-consuming). Research suggests that paranoia is positively associated with the presence of Type one thinking and negatively associated with the presence of Type two thinking, however, findings are mixed.

In contrast, the hyper-emotion theory (HET) of psychological illness suggests that emotions of excessive intensity may actually improve logical reasoning over time. The theory hypothesizes that efforts to make sense of intense emotional experiences serve to elaborate and perpetuate these experiences, resulting in enhanced reasoning abilities on topics relevant to the individuals' difficulties. A number of studies assessing logical reasoning in individuals with psychological disorder have found evidence for the HET, dual-process model and belief bias theory. In light of this, the application of these theories to paranoia has received less research attention.

Project aims. The study aimed to further the understanding of reasoning processes associated with paranoid thinking. Specifically, the study assessed logical reasoning and thinking styles in individuals with non-clinical paranoia, as an exploration of the HET, the belief bias theory, and the dual-process model of reasoning. In line with the HET, it was predicted that highly-paranoid (HP) and socially anxious (SA) participants (used as a comparison group and as a second test of the two theories) would reason more accurately on a logical reasoning task when the content was related to their concerns. In contrast, the belief bias theory predicts that HP and SA participants would reason in line with their beliefs, as opposed to the validity of the conclusions presented, when the task content was

related to their concerns. Finally, it was predicted that paranoia would be positively associated with Type one thinking and negatively associated with Type two thinking in the HP group.

Methods. The cross-sectional study recruited 101 undergraduate psychology students to take part in the 30-minute, online study. Participants completed a host of self-report questionnaires (Rational Experiential Inventory (REI-10), Depression, Anxiety and Stress Scale (DASS-21), the Social Phobia Inventory (SPIN) and the Paranoia Scale (PS)) and several experiential tasks (Cognitive Reflection Test (CRT-4) and the Beads task) to assess participants' thinking styles and symptomology. The study used a syllogistic reasoning task to assess logical reasoning abilities. In this task, participants were presented with a series of arguments (comprised of two statements and a conclusion) and were asked to decide whether the conclusion presented was logically valid. The syllogism conclusions varied according to their validity (valid/invalid), their plausibility (plausible/implausible) and their content (paranoia-related, social anxiety-related or non-specific). Participants were divided into three groups, a HP group, a SA group and a control group (L) consisting of participants scoring low on both measures.

Analysis and results. Validity judgements of syllogism conclusions were used to assess logical reasoning abilities. A belief bias effect was found if participants found it easier to judge the validity of valid-believable and invalid-unbelievable syllogisms (i.e., when there was a match between validity and believability) and more difficult to judge the validity of valid-unbelievable and invalid-believable syllogisms. Belief bias summary scores (BB scores) were calculated for each content domain using the following formula: BB = conflict items ((valid-unbelievable + invalid-believable) - congruent items ((valid-believable) + (invalid + unbelievable)). A higher score represented a larger degree of belief bias. Analysis of Variance (ANOVA) tests were used to explore differences between

groups on logical reasoning, according to syllogism content and plausibility. Correlation analyses were then conducted to assess whether paranoia was positively associated with Type one thinking and negatively associated with Type two thinking in the HP group. The study findings did not support the predictions made in line with the HET or the belief bias theory. Interestingly, the study found that paranoia severity was positively associated with Type two thinking, and to some extent Type one thinking, in the HP group.

Discussion and reflections. A number of methodological limitations of the study should be noted. Firstly, the sample was mainly comprised of Caucasian, female, undergraduate students with non-clinical paranoia. This limits the extent to which the findings can be confidently applied to other groups. Further, whilst efforts were made to ensure that the syllogisms contained common, symptom-related concerns, they may not have matched sufficiently to individual beliefs to elicit the corresponding reasoning style described by each theory. Moreover, a lack of power could have meant that smaller differences between groups were not detected. In addition to this, research has shown that the activation of different reasoning styles may depend on the individual being in the feared state or situation, as opposed to being faced with hypothetical scenarios. As previous research has also found no evidence of enhanced reasoning in paranoid individuals with symptom-related content, it may be that paranoia is less easily explained by the HET. Finally, the findings suggest that the simple presence or absence of Type one or Type two thinking may not be sufficient to explain paranoia. The relative use and application of the two systems may be more relevant to understanding delusional beliefs.

Future research and clinical implications. The current study highlights a range of possible avenues for future research. A larger-scale study should be conducted to ensure that more subtle differences in logical reasoning between groups can be detected. Syllogisms should be matched to individual concerns in a meaningful and relevant way in

order to ensure that the hypothesised reasoning styles can be elicited. Future research recruiting participants with clinically severe symptoms, and from a range of socio-demographic backgrounds, would be of interest. Further, it may be clinically relevant to explore the ways by which both analytical and intuitive thinking is applied in anxiety-inducing situations, as well as increasing awareness of the two opposing systems in treatment. Future research should also explore whether therapeutically manipulating thinking style alters the course of delusions. There is also a need to examine how intuitive and analytical thinking styles relate to other delusion-relevant biases. Finally, the inclusion of additional clinical variables such as global functioning and quality of life, to explore the wider impact of different thinking styles, would also be of value.

Paper Three: Impact, integration and dissemination

To summarise, this thesis aimed to further the understanding of reasoning biases across the psychosis continuum. Both studies highlighted the complexity of the various reasoning processes associated with paranoia. Limitations of the research methodology were discussed in both papers, along with ideas for future research and the clinical implications of the study findings. It is anticipated that paper one will be submitted to Clinical Psychology Review for publication. The review findings suggest that there are a number of different cognitive interventions available, and that they are effective in ameliorating reasoning biases in individuals with psychosis. It is anticipated that the study will increase awareness of the different therapies available for use by professionals working with individuals with psychosis. Further, it is also hoped that the review findings will influence the treatment recommendations made for specific reasoning biases, as well as the types of therapies offered by mental health services.

The findings of paper two have been presented to other trainee clinical psychologists and staff members and will be stored in the institution's electronic archives.

Paper two will also be submitted to the Schizophrenia Research journal for publication. The impact of this paper is likely to occur incrementally, in the context of a broader field of research over time, as research exploring logical reasoning in paranoia becomes more prevalent. It is hoped that the current study will inspire the development of future research exploring the HET, the dual-process model and the belief bias theory in relation to paranoia. Further, the findings highlight the importance of assessing, and potentially working therapeutically with, intuitive and analytical reasoning processes in those experiencing paranoid thoughts.

Paper One: Literature Review

Do existing cognitive interventions improve reasoning biases in individuals with psychosis?

ABSTRACT

It is widely acknowledged that reasoning biases play a key role in the development and persistence of delusional beliefs in individuals with psychosis. In light of this, a number of cognitive therapies have been developed and utilised to ameliorate these biases. In order to assess the efficacy of these treatments, a systematic review of studies that empirically tested the effects of a cognitive intervention was conducted. Twenty-two randomised controlled trials (RCT's) met inclusion criteria, and effect sizes were calculated and reported for each study. The majority of the studies reviewed tested the efficacy of broad-based, cognitive interventions such as metacognitive training (MCT). In contrast, several studies tested more focused interventions, such as video cognitive therapy (VCT) for Theory of Mind (ToM) deficits. The review revealed that there are many cognitive interventions available which show promise in improving outcomes. The findings suggest that targeted treatments may be more effective than broad-based interventions at improving specific reasoning biases, though this warrants further research attention. Generally, profound improvements were reported in belief flexibility and theory of mind (ToM) abilities. Changes in the jumping to conclusions (JTC) bias and attribution biases were less consistent, though present in most cases. Conclusions were limited by factors such as a lack of follow-up assessment and differences in measurement tools used across studies. Future research should address these limitations.

INTRODUCTION

Understanding psychosis

Psychosis is a psychological condition whereby an individual's experience of the world around them is disrupted, and those experiencing psychosis are said to be, to some extent, 'out of touch with reality' (Bentall, 2004). Psychotic disorders such as schizophrenia are associated with high rates of co-morbid mental health difficulties such as depression (Dernovsek & Sprah, 2009), increased alcohol and substance use (Gregg, Barrowclough & Haddock, 2007) and a number of physical health problems (Moreno et al., 2013). Following the onset of a psychotic disorder, which typically emerge during early adulthood, the individual experiences a number of psychological changes. These include disruptions to cognitive processes such as attention and perception, which are often associated with symptoms such as hallucinations and delusional beliefs. Interpersonal and occupational functioning can also be impacted by these experiences, as well as by the negative symptoms of psychosis such as apathy, decreased social skills and blunted emotional responses. Research suggests that fewer than 50% of people with non-affective psychosis achieve social recovery, and fewer than 14% of individuals diagnosed with schizophrenia achieve sustained recovery on both symptomatic and functional outcomes (Jääskeläinen et al., 2012).

The possible causes of psychosis are complex, and most researchers now agree that the illness is likely caused by a combination of genetic and environmental factors, as summarised by the stress-vulnerability model (Zubin & Spring, 1977). Family studies have shown that, compared with a lifetime risk for schizophrenia of around 1% in the general population, the risk in siblings of someone with the disorder is around 10%, with this risk increasing as more relatives are affected (Lichtenstein et al., 2009). Other possible causal factors include early childhood abuse (Janssen et al., 2004), recreational drug use

(Arseneault et al., 2002), social isolation or exclusion (Spauwen, Krabbendam, Lieb, Wittchen & van Os, 2004) and trauma (Freeman & Fowler, 2009). Due to this complexity, it has been argued that psychological treatments for psychosis may be more effective when they target individual symptoms such as paranoia (Freeman, Garety, Kuipers, Fowler & Bebbington, 2002). A number of psychological interventions have since been developed to target the mechanisms thought to maintain these experiences (Freeman et al., 2011; Vorontsova, Garety & Freeman, 2013).

Paranoia and persecutory delusions

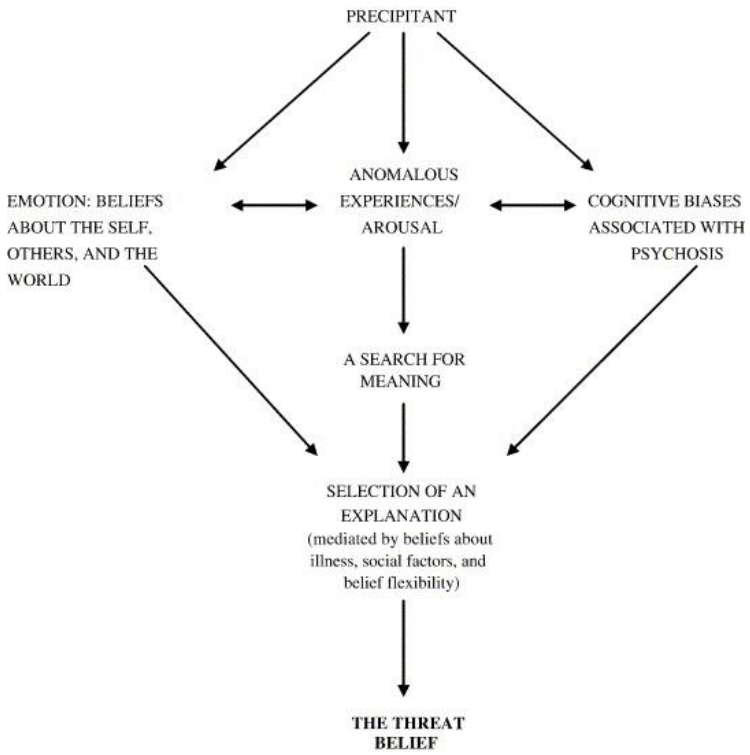
Paranoia is defined as 'the unfounded fear that others intend to cause you harm' (e.g., 'other people are out to get me'; Freeman, Pugh & Garety, 2008) and questionnaire and interview data have found that paranoid thinking occurs in 15–20% of the general population. It has therefore been proposed that there is a continuum of severity of paranoia, and at the extreme end are the persecutory delusions seen in psychotic disorders. These delusional beliefs are thought to be present in over 70% of people with psychosis at first episode (Coid et al., 2013) and are often held with strong conviction, even in the face of contradictory evidence (Dickson, Barsky, Kinderman, King & Taylor, 2016). These strongly held beliefs are often associated with considerable distress for the individual, as well as being linked to an increased risk of hospitalisation, violence and suicide attempts (Freeman & Garety, 2004; Freeman, Pugh, Vorontsova, Antley & Slater, 2010).

Researchers have developed a cognitive model of persecutory delusions in an attempt to better understand how these beliefs may develop (Garety, Kuipers, Fowler & Freeman, 2001; see Figure 1). The model acknowledges that the ways by which an individual interprets and attaches meaning to events will influence how they feel and behave in response. The researchers go onto explain that in the case of psychosis, these interpretations are influenced by a number of factors such as high levels of arousal,

anomalous experiences and pre-existing beliefs about the self, the world and other people. These interpretations may also be influenced by cognitions experienced in the context of co-morbid mental health difficulties such as depression and anxiety. The model also explains that a persecutory belief is more likely to develop if an individual already believes that they are vulnerable, that they deserve to be harmed in some way (Trower & Chadwick, 1995), or if they view other people and the world as a dangerous place on the basis of earlier experiences such as trauma.

Of particular importance here, is that the search for meaning and eventual acceptance of the threat belief is considerably influenced by a number of cognitive reasoning biases associated with psychosis. A large body of research has shown that these biases contribute to both the development and maintenance of delusional beliefs; therefore these biases are often the target of psychological treatments (Waller et al., 2015).

Figure 1. The formation of a persecutory delusion (Garety et al., 2001)



Reasoning biases in Psychosis

Jumping to Conclusions (JTC) bias. The JTC bias is one of the most studied cognitive biases in psychosis research, and is defined as a 'tendency to gather less information compared to controls before making a decision' (Freeman et al., 2007). It is hypothesised that, when present, this bias may lead to the premature acceptance of implausible ideas and prevent the consideration of more realistic, alternative explanations of events (Freeman et al., 2008). Recent research has found that over two-thirds of individuals with delusions display the JTC bias (Van Dael et al., 2005), as well as being observed in patients no longer experiencing delusions (Peters, Day & Garety, 2004), those experiencing non-clinical paranoia, and those at high risk of developing a psychotic disorder (Colbert & Peters, 2002). Further, research has shown that the JTC bias is associated with a poorer treatment response in individuals with psychosis (Menon, Mizrahi & Kapur, 2008).

The JTC bias is the target of many cognitive interventions for individuals with psychosis, in the hope that this may reduce delusional ideation and improve outcomes. In experimental studies, the most common paradigm used to measure JTC is the "beads task" (Ross et al., 2015). This task involves showing individuals two jars of beads in equal but opposite ratios (eg., 60 red beads and 40 blue beads and vice versa). Both jars are then hidden, and the participant is told that individual beads will be drawn consecutively from one jar. The task of the participant is to eventually decide which jar the beads are being drawn from. The main outcome variable is the number of beads drawn before a decision is made, but JTC can also be defined as making a decision after viewing the first, second or third bead shown (Fine, Gardner, Craigie & Gold, 2007).

Belief flexibility. Belief flexibility in the context of paranoia can be defined as 'a metacognitive process involving thinking about one's own delusional beliefs, changing

them in the light of reflection and evidence and generating and considering alternatives' (Colbert, Peters & Garety, 2010). A defining feature of delusional beliefs is their inflexibility. As a result of this, paranoid individuals may hold onto their beliefs with a lot of conviction, even when faced with contradictory information and little supporting evidence. In individuals with psychosis, an inflexible thinking style is thought to be a global trait, as opposed to being specific to the delusional beliefs themselves (Colbert et al., 2010), although research findings are mixed. Clinically, change in delusional conviction is often facilitated by the individual considering that a belief may be mistaken, and through the consideration of alternative explanations for their experiences. Belief flexibility has been found to predict successful response to psychological therapy for psychosis (Garety et al., 1997).

Belief flexibility is often assessed experimentally using the Possibility of Being Mistaken (PM) and Reaction to Hypothetical Contradiction (RTHC) items of the Maudsley Assessment of Delusions Schedule (MADS; Taylor, Garety, Buchanan, Reed & Wessely, 1994). These items assess, in the context of an interview, whether the individual can consider it at all possible that they may be mistaken in their concerns, however unlikely, and also to consider a hypothetical but plausible piece of evidence that might contradict their belief.

Attribution bias. Cognitive models of paranoia have highlighted the role of attribution biases in the development and maintenance of persecutory beliefs (Freeman et al., 2002); however the exact mechanisms by which they operate remain unclear. Bentall and colleagues (Bentall, Corcoran, Howard, Blackwood & Kinderman, 2001) distinguished between an externalizing bias (a tendency for non-self attributions for negative events) and a personalising bias (a tendency to blame other people for negative events). These biases are thought to minimize the discrepancy between the 'real self' and the 'ideal self',

therefore serving a defensive function for the individual's self-esteem (Bentall et al., 2001). Interestingly, there is less evidence to suggest that individuals with psychosis attribute positive events internally (Garety & Freeman, 1999) and several studies have found that these biases do not differ according to event type (McKay, Langdon & Coltheart, 2005; Moritz & Woodward, 2007). These findings have led some researchers to argue that attribution biases may not be purely self-serving in nature (Lincoln, Mehl, Exner, Lindenmeyer & Rief, 2010). Alternatively, this bias may reflect a difficulty in taking a number of situational factors into account in complex social situations (Heinrichs & Zakzanis, 1998).

Experimentally, attribution biases are assessed using both experiential tasks and questionnaire measures such as the Ambiguous Intentions Hostility Questionnaire (AIHQ; Combs, Penn, Wicher & Waldheter, 2007). With this measure, participants read a series of vignettes describing a number of social situations. Following this, individuals are then asked about the intentions of the characters in the vignette, and how the subjects would respond in the given situation.

Theory of Mind. Theory of mind (ToM) refers to 'the cognitive capacity to represent one's own and other persons' mental states, for instance, in terms of thinking, believing, or pretending' (Brune, 2005). Distinctions have been made between first-order ToM, defined as the ability to understand another person's thoughts and emotions, and second-order ToM, the ability to infer what one person thinks about another person's thoughts or emotions (Gregory et al., 2002). Several studies have assessed ToM abilities in individuals with psychosis (Corcoran, Mercer & Smith, 1995; Frith & Corcoran, 1996). Frith and Corcoran (1996) found that psychosis patients performed worse than controls on first-order and second-order false belief ToM tasks (Frith & Corcoran, 1996), whereby participants had difficulties understanding hints, some forms of humour and conversational

rules. Meta-analysis findings suggest that this ToM deficit is a stable trait-characteristic, rather than a consequence of the active phase of psychosis (Sprong, Schothorst, Vos, Hox & Van Engeland, 2007) and is often associated with impaired interpersonal functioning (Couture, Penn & Roberts, 2006). As a result of this, individuals with psychosis may experience a range of negative outcomes, such as unemployment, social isolation and depression (Mancuso, Horan, Kern & Green, 2011; Marwaha & Johnson, 2004).

In experimental research, ToM ability is often measured using tools such as the "Reading the Mind in the Eyes" Test (RMET, Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001). In this task, participants are asked to infer the emotional state of the person that is presented in a given picture, based on that person's facial expression.

The treatment of psychosis

Historically, psychosis was largely viewed as a medical disorder, with treatment focused primarily on hospitalisation and antipsychotic medication. The past twenty years or so, however, has seen the development and utilisation of evidence-based psychological treatments to treat symptoms of psychosis. There are several reasons for this. Firstly, whilst taking antipsychotic medication is no doubt beneficial in many cases, studies have shown that they are only partially effective in relieving symptoms in approximately 40% of patients (Kapur, 2003). Secondly, adherence to antipsychotic medication is generally low, often due to the unpleasant side effects experienced by many who take them (Arana, 2000). Further, whilst antipsychotics have been found to successfully treat positive symptoms, they are thought to be less effective in treating the negative symptoms experienced by patients (Bobes, Arango, Garcia-Garcia & Rejas, 2010). Finally, medication does not typically take into account a wide range of individuals' other concerns about their experiences, and often fails to address a number of other difficulties, particularly those of a social and cognitive nature (Goldberg et al., 2007).

In view of the significant impact that these reasoning biases can have on daily functioning (Langdon, Connors, Still, Ward & Catts, 2014), a number of cognitive interventions have been developed, and utilised clinically, to ameliorate these deficits. Although there is a wealth of literature exploring the impact of such therapies on psychotic symptoms, the short and long-term impact of these interventions on reasoning biases has received less research attention. Further, following an extensive search of the literature, it was concluded that there have been no reviews of this nature conducted to date. In light of this, the current review explored the efficacy of existing cognitive interventions in ameliorating reasoning biases in individuals with psychosis.

METHOD

Inclusion criteria

Eligible studies were those published in peer-reviewed journals in the English language, using a sample of adults (18+) diagnosed with a psychotic disorder. Psychotic disorders included in the review were: schizophrenia, first episode psychosis, schizophreniform disorder, brief psychotic disorder, schizoaffective disorder, delusional disorder and psychotic disorder: not otherwise specified (NOS). Studies could be self-led or therapist-led, and group or individual interventions. Only RCT's were included in the review as they enable the researcher to attribute changes in reasoning biases to the intervention with increased confidence. All included studies reported on a standalone cognitive intervention measuring change in at least one reasoning bias, before and after treatment, to allow for direct comparison. Control groups consisted of either an active control condition, treatment-as-usual or a wait-list control group. Studies which utilised only one control group, in which participants received another cognitive intervention to the one under study, were excluded from the review.

Exclusion criteria

Qualitative studies, conference abstracts or posters, meta-analyses or other reviews, dissertations, book chapters, and studies with a non-RCT design were excluded from the results. Studies were also excluded if they recruited individuals experiencing sub-clinical or prodromal symptoms of psychosis. Studies which recruited participants experiencing psychosis in the context of dementia (or any other neurological condition) or bipolar disorder were also excluded, where this was made explicit to the reader.

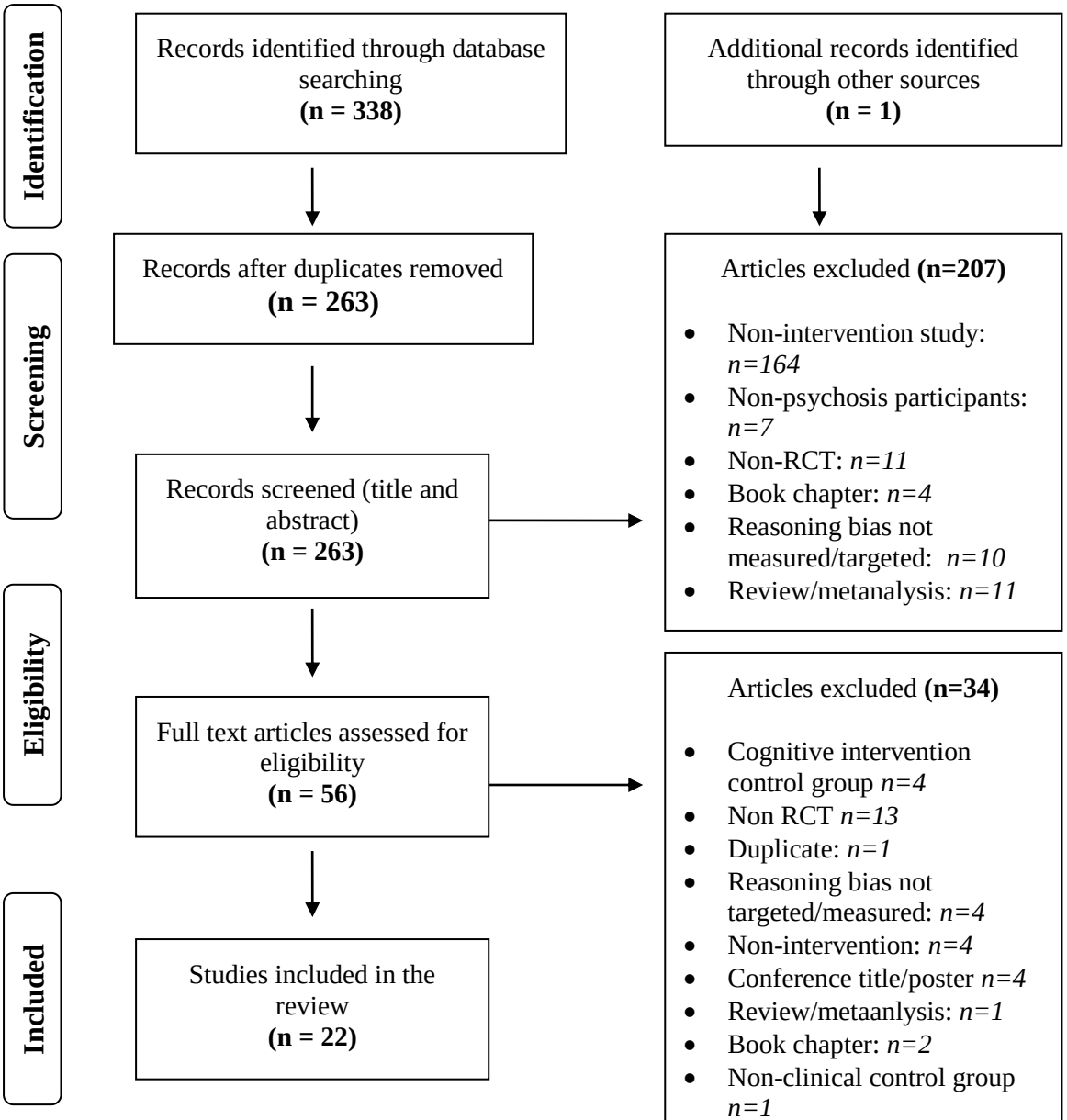
Search strategy

To identify suitable studies to be included in the review, a literature search was conducted on several psychological and social science online databases. The search was conducted on 2nd March 2018. Subsequently, screening of texts was conducted by searching the following electronic databases: Web of Science, PsycInfo and PubMed. The following search string was used within each database: CBT OR cognitive behaviour* therapy OR cognitive OR cognitive behavior* therapy OR cognitive therapy OR cognitive remediation OR metacognitive therapy OR metacognitive training OR training OR cognitive bias modification **AND** 2) reasoning OR attribution OR theory of mind OR jumping to conclusions OR need for closure OR belief flexibility OR cognitive bias OR appraisal OR self-serving bias OR confirmatory bias OR confirmation bias **AND** 3) Schizophren* OR Psychotic OR Psychosis OR delusion* OR Schizotyp* OR Schizoa*. Search was limited to study title, with title/abstract searches carried out on the PubMed database.

The titles and abstracts of the 338 potentially relevant studies were screened for initial assessment of their suitability according to the inclusion and exclusion criteria. Screening of reference lists yielded one further study for assessment. After the removal of 76 duplicates, the abstracts and titles of the remaining 263 studies were screened for eligibility. The screening process identified 56 articles which could potentially meet the

inclusion criteria. The full text versions of these publications were then retrieved and a further 34 articles were excluded from the study. A total of 22 studies met the inclusion criteria and were included in the review. Figure 2 below provides a PRISMA diagram (Moher, Liberati, Tetzlaff & Altman, 2009) which indicates how the papers were selected. Table 1 describes the reviewed studies in detail.

Figure 2. PRISMA diagram of systematic literature review



Data extraction

The following information was extracted from each study where possible: a) study design features, including study location and setting, author name and publication date b) participant characteristics, including diagnosis, number of participants recruited for each study as well as their mean age, gender and ethnicity c) the frequency of both self-report and performance-based measures of reasoning biases where administered and d) type, format, frequency, duration and mode of delivery of the cognitive intervention delivered. Information regarding the efficacy of each intervention was reported where adequate data was available, which included extracting effect sizes for statistically significant results. Where studies did not provide effect sizes, or where effect sizes were not reported in terms of Cohens d, effect sizes were calculated or converted using an online calculator (https://www.psychometrica.de/effect_size.html). Where effect sizes are not described below, this is because the necessary data were not provided.

Method of synthesis

Rationale for a systematic review. A systematic review of the literature was used to integrate and synthesise the relevant studies. The primary aim of a systematic review is to identify, evaluate and synthesize evidence in order to answer a research question (Higgins & Green, 2011). A particular strength of the systematic review process is the transparency and clarity of the methods used, which can then be replicated by others. In addition, a systematic review allows the researcher to take into account a range of findings on a particular topic, which was particularly relevant in this case due to the number of reasoning biases and cognitive interventions considered.

This type of review was chosen over other methods such as a meta-analysis or a narrative review. A meta-analysis was not deemed suitable for this review due to the diversity across studies, in terms of the outcome measures, the methodologies used and the

nature of the interventions. More consistency across studies would allow for a meta-analysis to be conducted in the future. Similarly, there are several disadvantages to conducting a narrative review, including the fact that they can be quite subjective and can often lack a clear and replicable methods section. This in turn could lead to methodological flaws and can bias the conclusions that are drawn by the reviewer (Cronin, Ryan & Coughlan, 2008).

Quality appraisal

The Quality Assessment Tool for Quantitative studies (National Collaborating Centre for Methods and Tools), developed by the Effective Public Health Practice Project (EPHPP) was used to assess the methodological quality of the reviewed studies, in order to guide the interpretation of the results. The EPHPP has been found to have good content and construct validity (Thomas, Ciliska, Dobbins & Micucci, 2004) and inter-rater reliability (Armijo-Olivo, Stiles, Hagen, Biondo & Cummings, 2010). The tool assesses the following six domains: (A) Selection bias, (B) Study design, (C) Confounders, (D) Blinding, (E) Data collection methods and (F) Withdrawals and drop-outs. The intervention integrity and the analysis methods used are also assessed but, according to the EPHPP, these do not contribute to the overall quality rating of the study (though are discussed in the review where relevant). Each domain is rated as 'strong', 'moderate' or 'weak' and a global rating is then given to each study. Each study is rated as either 'strong' (no weak ratings), 'moderate' (one weak rating) or 'weak' (two or more weak ratings) (see Table 2 for overall study ratings and Appendix 7 for individual domain scores).

Table 1. Descriptive statistics of cognitive interventions targeting reasoning biases

Author & Country	**Sample Size Gender Mean age Ethnicity**	**Setting**	**Diagnosis**	**Reasoning Bias**	**Intervention & modality**	**Intervention duration**	**Control group**	**Follow -up**	**Outcome measures**
Aghotor et al. (2010) Germany	N = 30 (12M/14F) 30.75	Inpatient	Schizophrenia	JTC	Group MCT	Twice weekly, 45-minute sessions for four weeks.	Active control (newspaper discussion group)	No	1. BADE
Bechi et al. (2015) Italy	N=75 (43M/32F) 38.54	Not described	Schizophrenia	ToM	Group ToMI	ToMI = twice weekly, one-hour sessions. 18 sessions in total.	Active control (newspaper discussion group)	No	1. PST
					Group SCST	SCST = one weekly, one-hour sessions. 12 sessions in total			
Fernandez-Gonzalo et al. (2015) Spain	N= 53 (34M/19F) 30.46	Outpatient	Schizophrenia Schizoaffective disorder	ToM Attribution biases	Individual SCST in clinic	Twice weekly, one-hour sessions; up to five months.	Active control (non-specific computer training group)	No	1. IPSAQ 2. Eyes task 3. Hinting Task 4. False belief stories

Garety et al. (2015) UK	N= 101 (61M/40F) 41.6 61% White 24% Black African/ Caribbean 15% Asian or other	Inpatient & Outpatient	Schizophrenia Delusional disorder Schizoaffective disorder Psychosis NOS	JTC Belief flexibility	Individual MCT	1.5–3 hour sessions, three meetings	Active control	Yes (two weeks)	1. MADS 2. EoE 3. Beads task
Gaweda et al. (2015) Poland	N= 44 (22M/22F) 51.05	Community	Chronic Schizophrenia	JTC ToM	Group MCT	Eight modules (45–60 minutes each session)	TAU	No	1.CBQp 2. Fish Task
Horan et al. (2009) USA	N= 31 (29M/2F) 48.3 55% African American 29% White	Outpatient	Schizophrenia Schizoaffective disorder	Attribution biases ToM	Group SCST	12, twice-weekly, one-hour sessions.	Active control (illness management and relapse prevention skills)	No	1. AIHQ 2. TASIT

	16% Other								
Horan et al. (2011) USA	N= 80 (30M, 5F in two conditions of interest) 48.05 32% White 14% Hispanic 54% Black	Outpatient & community	Schizophrenia Schizoaffective disorder Delusional disorder Psychosis NOS	Attribution biases ToM	Group SCST	24-sessions	Active control (illness management group)	No	1. AIHQ 2. TASIT
Kayser et al. (2006) France	N= 14 (3F/ 11M) 35.3	Outpatients & one Inpatient	Schizophrenia	ToM	Individual VCT	Two, 1-hour training sessions, over one-week	TAU	No	1. Inference intention task 2. SCD scale
Khazaal et al. (2015) Switzerland France Monaco & Italy	N= 172 (107M/65F) 37.05	Outpatients	Psychotic disorder NOS	Belief flexibility	Group CBT-based training module	Weekly sessions lasting one hour. Mean number of sessions = 12	TAU	Yes (6 month)	1. MADS
Kuokkanen et al. (2014)	N= 20 (20M)	Inpatient	Schizophrenia	JTC	Group MCT	Eight, twice-weekly 45-	TAU	Yes (6 month)	1.Fish task

Finland	43.55					minute sessions.			
Mazza et al. (2010) Italy	N=32 (13F/19M) 24.54	Not specified	Schizophrenia	Attribution biases ToM	Group ETIT	Twice weekly sessions over 12-weeks.	Active control (problem solving training)	No	1. Advanced ToM Scale
Moritz et al. (2011) Germany	N=36 (28M/8F) 32.75	Inpatient & outpatient	Schizophrenia	JTC	Group MCT	Once weekly sessions (maximum of eight sessions)	Wait-list control	No	1. Fish Task
Moritz et al. (2015a) Germany	N= 90 (33M/57F) 40.45	Not specified	Schizophrenia Schizoaffective disorder	JTC	Individual MCT	Online intervention with modules	Waitlist control	Yes (3 month)	1. Fish Task
Moritz et al. (2015b) Germany	N=70 (43F/27M) 40.68	Outpatient & community	Schizophrenia	JTC	Individual CBC	Slides sent out via e-mail weekly for 6 weeks	Waitlist control	No	1. Fish Task
Ochoa et al. (2017) Spain	N=126 (85M/37F) 27.63	Outpatient & community	Schizophrenia Psychosis NOS Delusional disorder Schizoaffective	JTC ToM Attribution bias	Group MCT	Eight, weekly sessions	Active Control (psycho-education)	Yes (6 month)	1. Beads task 2. IPSAQ 3. Hinting task

			disorder Brief psychotic disorder Schizophrenifo-rm disorder						
Pino et al. (2015) Italy	N= 14 (7M/7F) 43.63	Outpatient	Schizophrenia	ToM	Group ETIT	Twice weekly sessions over a 12-week period	Active control (problem solving training)	No	1. Advanced ToM task 2. The eyes task 3. Emotion Attribution Task
Pos et al (2018) Netherlands	N=50 (40M/10F) 23.34	Inpatient & Outpatient	First episode psychosis	JTC	Group MCT	Eight sessions	OT support	No	1. Beads task
Roberts et al. (2014)	N=66 (44M/22F) 39.7 White: 61% African-American: 33% Hispanic: 6%	Outpatient	Schizophrenia Schizoaffective disorder	ToM Attribution biases	Group SCIT	20–24 weekly, hour-long sessions.	TAU	Yes (3 month)	1. TASIT 2. Hinting task 3. AIHQ
So et al. (2015)	N= 44 (24M/20F)	Outpatient	Schizophrenia	JTC	Individual MCT	1 hour sessions,	Waitlist control	Yes (1 month)	1. MADS 2. Beads task

Hong Kong	33.94			Belief flexibility		once a week, over four weeks			
Taylor et al. (2016) UK	N=36 (36M) 39.95	Forensic Inpatient	Schizophrenia	ToM Attribution biases	Group SCIT	16, twice weekly sessions lasting 45-minutes	TAU	No	1. Hinting task 2. AIHQ
Waller at al. (2015) UK	N= 31 (22M/9F) 41.03 White: 41.9% Black Caribbean/ African/Other: 42% Mixed Race: 9.7% Asian: 3.2% Other: 3.2%	Outpatient	Schizophrenia	Belief flexibility	Individual Thinking well intervention (CBT)	Six sessions	TAU	Yes (2 month)	1. EoE 2. MADS
Wang et al. (2013) China	N= 39 (20M/19F) 42.37	Outpatient	Schizophrenia	ToM Attribution biases	Group SCIT	20-week intervention	Wait-list control	Yes (6 month)	1. Eyes task 2. ASQ

Note: JTC: jumping to conclusions; MCT metacognitive therapy; BADE: Bias against disconfirmatory evidence; ToM: theory of mind; SCST: social cognition skills training; ToMI: theory of mind intervention; PST: picture sequencing task; IPSAQ: Internal, Personal and Situational Attributions Questionnaire; MADS: Maudsley Assessment of Delusions Schedule; EoE: explanation of experiences; CBQp: cognitive biases questionnaire; AIHQ: Ambiguous Intentions and Hostility Questionnaire; TASIT: The Awareness of Social Inference Test; TAU: treatment as usual; SCD scale: Schizophrenia Communication Disorder Scale; ETIT: Emotion and ToM Imitation Training; CBC: cognitive bias correction; SCIT:

social cognition and interaction training; CBT: cognitive behavioural therapy; ASQ: attribution style questionnaire; VCT: video cognitive therapy; OT: Occupational Therapy

RESULTS

Overview of included studies

Intervention format and duration. Fifteen studies delivered their intervention in a group setting, with only seven studies offering therapy on an individual basis (Waller et al., 2015; Fernandez-Gonzalo et al., 2015; So et al., 2015; Moritz, Thoering, Kuhn, Willenborg & Westermann, 2015a; Moritz et al., 2015b; Kayser, Sarfati, Besche & Hardy-Baylé, 2006; Garety et al., 2014). Group sessions utilised either one or a combination of the following presentation formats: comic strips and photographs, teaching sessions, experiential activities, computerised tasks, written hand-outs, PowerPoint presentations, videos, card games, written vignettes, discussions or role play exercises. Individual therapy sessions were carried out face-to-face with a therapist (including the use of interactive exercises, film clips, discussions and psychoeducation), using a computerized or online intervention, or through the use of video recordings.

Setting. Twelve studies were conducted at outpatient clinics or in the community (Fernandez-Gonzalo et al., 2015; Wang et al., 2013; Waller et al., 2015; So et al., 2015; Roberts et al., 2014; Pino, Pettinelli, Clementi, Gianfelice & Mazza, 2015; Ochoa et al., 2017; Moritz et al., 2015b; Khazaal et al., 2015; Horan et al., 2011; Horan et al., 2009; Gaweda, Krężołek, Olbryś, Turska & Kokoszka, 2015). Three studies recruited exclusively from inpatient populations (Taylor et al., 2016; Kuokkanen, Lappalainen, Repo-Tiihonen & Tiihonen, 2014; Aghotor, Pfueller, Moritz, Weisbrod & Roesch-Ely, 2010) and four studies recruited from both inpatient and outpatient groups (Moritz et al., 2011; Kayser et al., 2006; Garety et al., 2015; Pos et al., 2018). Three studies did not explicitly specify where they recruited from (Moritz et al., 2015a; Mazza et al., 2010; Bechi et al., 2015).

Therapists or instructors. Nineteen cognitive interventions were delivered by professionals (counsellors, psychiatric nurses, psychiatrists, clinical psychologists,

rehabilitation therapists and trainee clinical psychologists), bachelors levels clinicians or psychology graduates. Three interventions were implemented online or using a computer in a healthcare clinic (Moritz et al., 2015a; Moritz et al., 2015b; Fernandez-Gonzalo et al., 2015).

Review of research methodology

Research design. The studies included in this review were all RCT's and 16 out of the 22 publications included in the review were graded as high quality according to the EPHPP quality assessment tool (see Appendix 7). Nevertheless, descriptions of key areas of methodology were missing in several cases. For example, although all studies reported that participants were randomised to experimental and control groups, not all studies provided an adequate description of the methods used to achieve this (Bechi et al., 2015; Gaweda et al., 2015).

All studies included a baseline and an end-of-treatment assessment. Nine studies conducted follow-up assessments which ranged from two weeks to six-months post-treatment. Thirteen studies utilised either a wait-list or TAU control group, with the remaining nine studies using an active control condition. For example, Garety and colleagues (2015) used a time and format-matched interactive computer task when exploring the efficacy of an individual, computer-based MCT intervention.

Outcome measures. A variety of valid and reliable instruments were employed by researchers to measure reasoning biases (see Table 1). Nine of the 10 studies measuring the JTC bias utilised the beads/fish task (Garety et al., 2015; Gaweda et al., 2015; Kuokkanen et al., 2014; Moritz et al., 2011; Moritz et al., 2015a, Moritz et al., 2015b; Ochoa et al., 2017; Pos et al., 2018; So et al., 2015). Further, all studies used interview-based measures, namely the MADS and the EoE, to assess belief flexibility (Waller et al., 2015; So et al., 2015; Khazaal et al., 2015; Garety et al., 2015). A number of experiential tasks and

questionnaire-based measures were used to assess ToM abilities and attribution biases (Wang et al., 2013; Taylor et al., 2016), including the Ambiguous Intentions and Hostility Questionnaire (AHIQ).

Sample formation. Studies used a variety of recruitment methods and eligibility criteria to form their sample. All studies recruited participants who were diagnosed with a psychotic disorder. Other eligibility criteria included the exclusion of patients experiencing severe thought disorder and suspiciousness (Aghotor et al., 2010), alcohol or substance dependency (Garety et al., 2015) and individuals with intellectual disabilities (Roberts et al., 2014). Recruitment methods included invitation e-mails (Moritz et al., 2015b), referrals from the participants' clinical therapist (Ochoa et al., 2017) and through the systematic reviewing of medical records (Khazaal et al., 2015). Four studies recruited participants according to the phase of their psychosis (Fernandez-Gonzalo et al., 2015; Pos et al., 2018; Gaweda et al., 2015; Ochoa et al., 2017). For example, Pos and colleagues (2018) aimed to explore the efficacy of MCT in early psychosis, and so only recruited individuals experiencing their first psychotic symptoms. Four studies offered financial incentives for those taking part in their research at outcome assessment points (Roberts et al., 2014; Moritz et al., 2011; Khazaal et al., 2015; Horan et al., 2011). Sample sizes varied considerably, ranging from 14 (Pino et al., 2015) to 172 participants (Khazaal et al., 2015).

Participant characteristics. One thousand, two hundred and fifty-four participants from the 22 studies were included in the review. Overall, male participants outnumbered female participants (61% vs. 39%). This is unsurprising given that studies indicate that rates of psychosis are higher in men than in women (Barajas, Ochoa, Obiols & Lalucat-Jo, 2015). The mean age of study participants ranged from 23.3 to 51.1 years. Five studies reported on the ethnicity of their participants and recruited individuals from a range of ethnic groups (Caucasian (M= 45%), African American (M= 42%), Asian (M= 4%),

Hispanic (M= 4%), Mixed race (M=2%) and 'Other racial group' (M= 3%)). Two studies recruited participants from the United States of America, 17 from European countries, two from countries in Asia and one study did not specify where they recruited their participants from.

Analysis of treatment effect

To evaluate treatment effects across RCT's, effect sizes were obtained, or calculated, where possible (Shadish, Robinson, & Lu, 1999). Table 2 depicts either reported or calculated effect sizes from the RCT's included in the review. Effect sizes were interpreted according to Cohen's (1988) definition of an effect size, as follows: d =0.20 as a small effect, around d = 0.50 as a medium effect, and around d =0.80 as a large effect.

Table 2. Effect sizes and methodological quality of included RCT's

			Effect size (d)		
Study & Quality rating	**Bias measured**	**Post treatment**	**1-4 wk**	**1 mo – 3 mo**	**3 mo-6 mo**
Metacognitive training (MCT)					
Aghotor et al. (2010) *Strong*	JTC *(decision after one sentence-BADE)*	-0.31			
Pos et al. (2018) *Strong*	JTC *(decision before two beads; 85:15 ratio)*	-0.25			
Garety et al. (2015) *Moderate*	JTC *(number of beads; 60:40 ratio)*	-0.29	-0.38		
	Belief flexibility *-possibility of being mistaken*	0.19	0.39		
	-alternative explanations	0.44	0.59		
	-hypothetical	0.14	-0.02		

	contradiction			
Gaweda et al (2015) *Moderate*	JTC *(draws to decision; 80:20 ratio)*	-0.18		
	ToM	0.31		
	CBQ	-0.83		
Kuokkanen et al. (2014) *Strong*	JTC *(decision after first fish; 80:20 ratio)*	-0.59	-0.15	0.00
Moritz et al. (2011) *Strong*	JTC *(draws to decision; 80:20 ratio)*	-0.52		
Moritz et al. (2015a) *Moderate*	JTC *(draws to decision; 80:20 ratio)*	-0.41		*n/a*
Ochoa et al. (2017) *Strong*	JTC *(85:15 beads task; decision after one or two beads)*	*n./a (sig.)*		*n/a (non sig.)*
	ToM	0.12		0.34
	Attribution bias (IPSAQ):			
	-Externalizing	-0.07		-0.08
	-personalizing	-0.24		-0.56
So et al. (2015) *Strong*	JTC *(draws to decision; 60:40 ratio)*	-0.02	-0.26	
	Belief flexibility			
	-hypothetical contradiction	>0.8		
	-possibility mistaken	>0.8		
Social Cognitive Skills Training (SCST)				

Horan et al. (2011) (SCST) *Strong*	Attribution bias		
	-hostility	-0.2	
	-aggression	0.00	
	-blame	-0.19	
	ToM	0.19	
Horan et al. (2009) (SCST) *Moderate*	Attribution bias		
	-hostility	-0.11	
	-intention	-0.46	
	-blame	-0.06	
	ToM (TASIT)	0.14	
Fernandez-Gonzalo et al. (2015) (adapted SCST) *Strong*	ToM		
	-eyes task	0.33	
	-hinting task	0.23	
	Attribution bias (IPSAQ)		
	Externalising	-1.09	
	personalising	0.00	
Social Cognition and Interaction Training (SCIT)			
Wang et al. (2013) (SCIT) *Strong*	ToM (affective):		
	Eyes task		
	-mind reading		1.22
	-gender recognition		0.2
	Attribution style (ASQ) positive scores:		
	externality		-0.29
	stability		-0.51
	globality		-0.20
	Negative scores*:*		
	-externality		-0.20
	-stability		-0.35
	-globality		-0.20

Taylor et al. (2016) (SCIT)	ToM	0.59		
Strong	Attribution style			
	-hostility	-0.50		
Roberts et al. (2014) (SCIT)	Cognitive ToM			
Strong	*-hinting task*	0.11	0.24	
	-TASIT	0.01	-0.09	
	Affective ToM			
	-hostility	-0.25	-0.48	
	-aggression	-0.17	-0.15	
Cognitive bias correction programme (CBC)				
Moritz et al. (2015b)	JTC *(80:20 ratio)*			
Strong	*-decision after 1st fish*	-0.63		
	-decision after 1st/2nd fish	-0.51		
Cognitive Behavioural Therapy (CBT)				
Khazaal et al. (2015)	Belief flexibility			
Strong	*-evidence against belief*		0.63	0.89
Waller at al. (2015)	Belief flexibility:		1.01	
Moderate	*-Probability mistaken (MADS)*	0.85	(6w)	
			0.42 (8w)	
Emotion and ToM Imitation training (ETIT)				
Pino et al. (2015) (ETIT)	Cognitive ToM	2.4		
Strong	Social situation task			
	-norm violation	-0.05		
	-extent of violation	-0.04		
	Affective ToM:			
	-Eyes task	0.82		

	-Attribution task	0.97
Mazza et al. (2010) (ETIT) *Moderate*	Cognitive ToM	1.14
	Affective ToM	0.79
Video Cognitive Therapy (VCT)		
Kayser et al. (2006) (VCT) *Weak*	Affective ToM *-attribution errors*	-0.62
Theory of Mind Intervention (ToMI) and SCST		
Bechi et al (2015)		
(ToMI)	ToMI: *ToM*	0.27
(SCST) *Strong*	SCST: *ToM*	0.48

Treatment effect by intervention type

All but three of the studies compared a single treatment modality with a control condition. These included CBT (Khazaal et al, 2015; Waller et al., 2015), SCIT (Wang et al, 2013; Taylor et al., 2016; Roberts et al., 2014) SCST (Horan et al., 2009; Fernandez-Gonzalo et al., 2015), MCT (Aghotor et al., 2010; Pos et al., 2018; So et al., 2015, Ochoa et al., 2017; Moritz et al., 2011, Gaweda et al., 2015; Kuokkanen et al., 2014; Garety et al., 2015), ETIT (Pino et al., 2015; Mazza et al., 2015), CBC (Moritz et al., 2015b) and VCT (Kayser et al., 2006). Three studies used a two-arm intervention design, with one study comparing MCT with a neurocognitive remediation intervention (NR) and a control

condition (Moritz et al., 2015a), the second comparing SCST with a hybrid SCST and NR condition and an illness management group (Horan et al., 2011), and the third comparing SCST and a ToMI with a control group (Bechi et al., 2015). In the first two cases, the cognitive intervention was compared with control intervention only. In the third case, both the SCST and ToMI treatment groups (as stand-alone cognitive interventions) were compared with control participants only.

Intervention types

In all but two cases (Fernandez-Gonzalo et al. 2015; Horan et al., 2011) the treatment group outperformed the control condition across all modalities. Nine interventions produced medium-large effect size across most outcome measures post-intervention (Kayser et al., 2006; Khazaal et al., 2015; Mazza et al., 2010; Pino et al., 2015; Waller at al., 2015; So et al., 2015; Moritz et al., 2011; Kuokkanen et al., 2014; Taylor et al., 2016). The remaining 13 studies reported small-moderate effect sizes across a number of reasoning biases. Effectiveness by intervention type is explored in the section below.

Metacognitive Training (MCT). MCT is a manualized group training program (which can also be delivered individually) for individuals with psychosis (Moritz & Woodward, 2007). The primary aim of MCT is to teach individuals about cognitive distortions and to raise awareness of the dysfunctionality of these biases. The treatment focuses on the cognitive biases involved in the formation and maintenance of psychotic symptoms, such as attribution biases and the JTC bias, as well as targeting negative schemas and dysfunctional coping styles (eg., rumination), which foster depression and impaired social cognition. The MCT exercises aim to provide corrective experiences and teach patients alternative information-processing and coping strategies, in an engaging and experiential manner.

In general, MCT studies reported small-to-medium effect sizes post intervention (ranging from d= -0.02 to d=0.83; Aghotor et al., 2010; Pos et al., 2018; Garety et al., 2015; Gaweda et al., 2015; Kuokkanen et al., 2014; Moritz et al., 2011; Moritz et al., 2015a; Ochoa et al., 2017; So et al., 2015). Small-to-moderate improvements in the JTC bias were generally observed across studies. This bias continued to improve over time in two instances (Garety et al., 2015; So et al., 2015), however, two studies found that these improvements deteriorated during the follow-up period (Kuokkanen et al., 2014; Ochoa et al., 2017). Koukkanen and colleagues (2014) speculated that their eight-session, group MCT intervention was sufficient for short-term improvement in JTC; however a longer-term therapy may be required for longer-lasting change. Where improvements continued during the follow-up period, the researchers adjusted their MCT programme to target reasoning biases more intensively, including personally-relevant material (Garety et al., 2015), as well as delivering their intervention individually rather than in a group (So et al., 2015). As the relevance of psychological treatment to the patient has been found to affect engagement, and consequently outcome (Freeman et al., 2013), it may well be that personalising the interventions leads to longer-lasting improvements, though this warrants further research attention.

Improvements in belief flexibility and attribution biases varied across studies. Ochoa et al (2017) reported slight improvements in the experimental group post-treatment in both externalizing and personalizing attribution biases compared with controls (d=0.07; d=0.24 respectively). Interestingly, the researchers found that the personalizing attribution bias continued to improve during the follow-up period (d= -0.56) whereas the degree of externalizing bias remained the same over time. This finding suggests that certain attribution biases may be differentially responsive to MCT, though further research is needed into this. Where ToM ability was measured, findings were also mixed across

studies (Gaweda et al., 2015; Ochoa et al., 2017), and observed improvements were modest at best (d=0.34; Ochoa et al., 2017). It could be argued that the generalised nature of MCT may not sufficiently address the complex cognitive processes associated with ToM abilities.

Social Cognitive Skills Training (SCST). SCST is an intervention that addresses emotional processing, social perception, attribution biases, and ToM deficits in individuals with psychosis (Horan et al., 2009). During the treatment, participants are taught a number of skills, which gradually increase in their complexity, via a PowerPoint presentation. This is done by breaking down complex social cognitive processes into their component parts, and helping individuals to become more familiar with these skills through repetition and practice. Each session includes a review of previous material, the presentation of new material and interactive training exercises to help consolidate learning.

Treatment outcomes for the SCST interventions were mixed (Horan et al., 2011, Horan et al., 2009; Fernandez-Gonzalo et al., 2015). Two studies utilising longer-term SCST reported improvements in ToM abilities in study participants (Bechi et al., 2015, d=0.48, 18 sessions; Fernandez-Gonzalo et al., 2015, d=0.33, 4-5months of sessions). Interestingly, those treatments that were shorter in duration reported less impressive changes in reasoning biases post-therapy (Horan et al., 2011, d= 0.19, 12 sessions; Horan et al., 2009, d= 0.14, 16 sessions). As stated by Horan and colleagues (2011), it may be that ToM-related concepts are difficult to define and translate into brief, structured training exercises. The researchers highlighted the need for longer-term, more innovative approaches to address these more complex features of social communication. None of the studies reviewed incorporated follow-up assessments, so the longer-term impact of the therapy on ToM deficits cannot be established. The review also found that SCST resulted in some improvements in attribution biases across studies, although findings are mixed.

Small improvements were detected in hostility (d= -0.2; Horan et al., 2011) and blame (d=-0.19; Horan et al., 2011) attributions in the studies reviewed.

Social Cognition and Interaction Training (SCIT). SCIT is an 18-24 session, manual-based, interactive therapy designed to improve social functioning in individuals with psychosis (Roberts, Penn & Combs, 2006). SCIT has shown feasibility and preliminary evidence of efficacy in both inpatient (Penn et al., 2005) and outpatient groups (Roberts & Penn, 2009). The treatment, which is designed to improve emotion perception, attribution biases and ToM abilities, is divided into three phases: emotion training, figuring out situations and integration. During emotion training, the therapist delivers psycho-education around emotions and highlights how they link with thoughts and situations. The aim of the 'figuring out' stage is to teach patients about a number of cognitive biases and highlight how these may be inaccurate and unhelpful. During the final integration phase, the patients put into practice what they have learnt using real-world examples. This is done through discussing and reflecting on troubling interpersonal events, analysing social-cognitive stimuli (eg., videos) or through role-plays with the therapist or other patients.

Compared with SCST, studies delivering SCIT reported more encouraging effect sizes post-treatment on measures of cognitive and affective ToM (Wang et al., 2013, d=1.22; Taylor et al., 2016, d=0.50). Two studies included follow-up assessments up to six-months post treatment, whereby biases continued to improve in some cases (Roberts et al., 2014). This finding suggests that changes in reasoning biases could take some time to establish before they manifest. Further, following SCIT there were larger improvements in attribution biases such as hostility (Taylor et al., 2016; d= -0.5) compared with those reported following the SCST interventions (Horan et al., 2011, d= -0.2; Horan et al., 2009, d= -0.11). In light of these findings, it could be speculated that experiential interventions

(SCIT) are more effective than education-focused treatments (SCST) in ameliorating reasoning biases, though this warrants further research attention.

Cognitive bias correction programme (CBC). The CBC programme is a self-directed, psycho-educational intervention (Moritz et al., 2015b). Rather than specifically addressing the reasoning biases implicated in psychosis, the intervention aims to teach individuals about a wide range of common cognitive biases. The aim of the treatment is to demonstrate to patients the imperfection of human cognition in more general terms and thus plant a seed of doubt for overconfident and biased judgements. The CBC program is organised into six chapters, consisting of 30 exercises, delivered using PowerPoint presentations. During most of the exercises used, participants perform tasks that usually elicit biased responses, are then informed about any mistakes they have made, and are finally instructed on how these errors in thinking can be corrected.

The CBC programme led to moderate improvements in the JTC bias in the experimental group (Moritz et al., 2015b). The researchers used 'decision after 1st fish' (d=-0.63) and decision after 1st or 2nd fish (d=-0.51) to assess change in this bias. A follow-up assessment was not conducted, so the longer-term implications for this treatment are not known. A limitation of this therapy is that it excludes the mention of psychosis and delusion-relevant cognitive biases. Personalising the material could result in larger improvements in reasoning biases, though this warrants further research attention. Finally, the study recruited a higher proportion of males compared with females, and all of the participants were outpatients. In light of this, the findings from the current study should be generalised to other groups with caution.

Cognitive Behavioural Therapy (CBT; 'Michael's Game' and the 'Thinking Well' intervention). Khazaal and colleagues (2015) highlighted that much of the research exploring the efficacy of CBT has focused on interventions delivered in specialized settings

with highly selected participants. A number of preliminary studies have shown, however, that new approaches to treatment, that integrate CBT techniques in game format (Khazaal et al., 2011) or computer-assisted, virtual reality therapies (Freeman et al., 2016) represent promising treatment for patients with psychosis. In light of this, Khazaal and colleagues (2015) devised Michael's Game, a 12-session, group-based hypothetical reasoning training programme devised to promote the dissemination of CBT in clinical settings. The aim of the game is to train individuals to find and consider alternative hypotheses for any given situation, in order to facilitate belief flexibility and thus reduce delusional conviction. This is achieved by encouraging group participants to collectively help the fictive character (Michael) to find alternatives to the conclusions that he draws from situations described on each card. The cards used in Michael's Game contain impersonal information that may reflect the participants' own concerns in order to facilitate generalization.

The 'Thinking Well' programme was developed by Waller and colleagues (2015), and is a six-session intervention with a particular emphasis on reasoning-focused CBT. During the first couple of sessions, participants complete the Maudsley Review Training Programme (MRTP; Waller, Freeman, Jolley, Dunn & Garety, 2011), which is then followed by four individualised sessions of reasoning-focused CBT. The MRTP is a computerised training programme which aims to describe and normalise specific reasoning biases (belief flexibility and JTC) and teaches people how to identify and change these biases through the use of five training tasks. The subsequent CBT sessions are then delivered face-to-face by trained therapists, and are tailored to the individuals' specific delusional belief. Another aim of the therapy is to work towards a selected personal goal. The therapy is delivered individually and was developed to help treat individuals with moderate-to-severe delusions.

CBT-informed treatments were effective at encouraging belief flexibility in psychosis patients (Khazaal et al., 2015; Waller et al., 2015). The impact of the therapy on other reasoning biases was not reported in either study. Khazaal and colleagues (2015) found that post-treatment, the experimental group displayed substantially more belief flexibility compared with control participants (d=.64). In addition, Waller et al (2015) reported that following the 'Thinking Well' intervention, participants in the experimental group were substantially more likely to consider that they were mistaken in their persecutory belief compared with controls (d= .85). In light of this, however, Waller and colleagues used an opportunistic sampling method, whereby they recruited participants from a previous study of theirs who were motivated to engage in research. This may limit the generalisability of the findings to typical patient groups. Interestingly, both studies reported improvements in belief flexibility following the end of treatment (Khazaal et al., 2015, d= .89; Waller et al., 2015; d= 1.01), however these effects were not sustained at longer-term follow-up in Waller et al's study. In response to this, the authors stated that they were planning to extend their therapy programme from four to eight sessions, and that they had consulted participant feedback data in order to refine and improve the intervention (eg., further personalising the therapy exercises).

Theory of Mind (ToM) interventions.

Emotion and ToM Imitation training (ETIT). ETIT is a group-based, 12-week treatment, designed to improve social cognition in individuals with psychosis. Studies have shown that patients with schizophrenia who display ToM deficits also show significant impairments on all imitation tasks. Further, research has shown that imitation errors are significantly associated with reduced social competence and negative symptoms (Mazza et al., 2010). Mazza and colleagues suggested that through observing and imitating other

people's actions, intentions and emotions (whereby the observer experiences the same intention or emotion as the observed, a phenomenon they coined 'embodied simulation'), an individuals' ability to take on another person's perspective is improved. The treatment involves observing others' eye direction, imitating facial expressions, inferring others' mental states and making attributions of intentions based on the actions of others through the use of video clips, pictures and comic strips.

Video Cognitive Therapy (VCT). The VCT intervention (Kayser et al., 2006) is a brief therapy consisting of two, one-hour training sessions delivered over a one-week period. The therapy was designed to help individuals with psychosis to accurately interpret other peoples' mental states and thus develop ToM abilities. During the training sessions, patients are encouraged to be more attentive to the general context of each scene during their analysis of the characters' behaviour and mental state. The intervention utilises movie clips showing two or more people interacting with one another as therapy material. The different mental states depicted by the characters in the clips include hostility, surprise and disappointment. After viewing the clips, the therapist provides a brief description of the general situation shown in the scene. Patients are then encouraged to give a spontaneous description and commentary of what they have seen. Where individuals offered spontaneous interpretations of the characters' behaviour and the mental state that may have motivated it, these interpretations and hypotheses are discussed (eg., through examining the evidence for and against their hypothesis).

Theory of Mind Intervention (ToMI).The ToMI (Bechi et al., 2015) is a group intervention consisting of five modules, delivered over 18, weekly sessions. The intervention uses comic strips and cartoons depicting social interactions as training material. The modules are delivered in increasing order of complexity, with the first three modules focusing on cognitive ToM and the last two on affective ToM. Assuming that

ToM difficulties in schizophrenia are associated with an inability to extract relevant data from the context (Frith & Corcoran, 1996), the intervention trains patients to recognize relevant details, to collect every meaningful piece of information they have seen (for eg., characters' actions and physical features), to read the corresponding verbal part of comic strips and to identify the literal meaning. Patients are then asked to interpret hidden meanings using all the information they have collected and to further hypothesize interpretations, based on expressed emotions, the relationships between characters, the implied motivations and the character's mental state.

In general, larger improvements in ToM were observed following the ToM-specific interventions compared with other, more broad-based interventions (Taylor et al., 2016; Horan et al., 2009). The ETIT intervention was the most effective in improving ToM abilities following therapy. Study participants showed large improvements in both cognitive (Mazza et al., 2010; d=1.14; Pino et al., 2015 d=2.0) and affective (Pino et al., 2015, d= 0.82, 0.97; Mazza et al., 2010, d= 0.78) ToM abilities. In light of this, however, neither study incorporated follow-up assessments so the long-term durability of these improvements cannot be deduced.

In addition to this, participants who received the VCT intervention also demonstrated large improvements in ToM abilities compared with controls (Kayser et al., 2006, d=-0.69). In light of this, however, the studies reviewed had a number of methodological limitations. The VCT intervention is novel and is not manualized, and these findings have not been replicated. Further the researchers in this study were not blind to participant allocation which could have introduced bias. Finally, participants displayed much smaller improvements in ToM following the ToMI intervention (Bechi et al., 2015; d= 0.27). It could be speculated that this may be due to the fact that the ToMI is a slightly

shorter intervention (nine weeks in duration) compared with the 12-week interventions delivered by the other ToM-specific therapies (Mazza et al., 2010; Pino et al., 2015). It may well be individuals need sufficient time to digest and practice the learnt strategies before improvements are visible.

Results by intervention characteristics

Intervention procedure. An examination of the therapy format or setting may help to identify best practices for interventions targeting reasoning biases in individuals with psychosis. Although self-directed, online interventions may be helpful when participants have difficulty accessing outpatient centres, the efficacy of these interventions was somewhat mixed. One study testing the efficacy of a self-directed MCT intervention (Moritz et al., 2015a) reported small changes in the JTC bias immediately after treatment (d= -0.34). These findings could be due to a lack of full adherence to treatment, a lack of motivation but also perhaps due to the lack of follow-up. Interestingly, another study led by the same researcher (Moritz et al., 2011) reported much larger changes in JTC (d= -0.54) when delivering MCT in a therapist-led, face-to-face setting. It could be that face-to-face interventions are more effective, although it is noted that two studies which adopted this intervention style also reported modest effect sizes (Aghotor et al., 2010, d= -0.31; Pos et al., 2018, d= -0.25).

Comparatively, there were no noticeable differences between individually-delivered and group-based interventions. When considering intervention setting (inpatient vs. community), there did not appear to be any significant difference in treatment efficacy across therapies. It is of note, however, that twelve studies recruited their participants from outpatient or community settings. The three studies that recruited from inpatient settings only applied a significant number of exclusion criteria such as significant substance misuse,

co-morbid diagnoses, suspiciousness or thought disorder, or other difficulties that would impair engagement in the group (Taylor et al., 2016; Kuokkanen et al., 2014; Aghotor et al., 2010). This has important implications for the generalisibility of the findings to individuals presenting with more complex and severe symptoms.

Outcome measurements. Interestingly, there were noticeable differences in the changes observed using self-report and performance-based measures of reasoning, indicating that different aspects of reasoning may be captured by these tools. For example, Gaweda and colleagues (2015) reported a large effect size (d= -0.74) when using a self-report measure (CBQ) to detect changes in the JTC bias following MCT. In contrast, when using a performance-based measure of JTC (the "Fish Task") the researchers reported much smaller improvements (d=-0.18). Further, there were differences in the ways by which certain measurement tools were used to assess change in reasoning biases across studies. For example, five studies assessed change in the JTC bias by the number of beads drawn before a decision is made (Moritz et al., 2015a; Garety et al., 2015; Moritz et al., 2011; Gaweda et al., 2015; So et al., 2015), whereas five studies compared the percentage of participants in each group making a decision after the first or second bead/sentence (Aghotor et al., 2010; Kuokkanen et al., 2014; Pos et al., 2018; Ochoa et al., 2017; Moritz et al., 2015b). Furthermore, there were differences across studies in the proportions of different coloured beads in each jar, with two studies using a 60:40 beads ratio (more difficult) (Garety et al., 2015; So et al., 2015), five using an 80:20 ratio (Gaweda et al., 2015; Kuokkanen et al., 2014; Moritz et al., 2011; Moritz et al., 2015a; Moritz et al., 2015b) and two using an 85:15 beads ratio (easier) (Pos et al., 2018; Ochoa et al. (2017).

Follow-up assessment points. Seven of the 22 studies included in the review conducted follow-up analyses. Interestingly, it appears that where studies have included follow-up assessments, belief flexibility scores in particular tended to improve over time.

For example, Khazaal and colleagues (2015), who tested the efficacy of a group, CBT-based intervention, reported larger improvements in belief flexibility after six-months compared with at three-months post treatment. (d= 0.63 vs. d=0.89). Similar effects were described in Garety et al's (2015) MCT study, whereby improvements in belief flexibility continued once the treatment had finished (d= 0.44 post-treatment to d=0.59 at two-week follow-up).

In one case, the length of treatment follow-up made the difference between significant and non-significant results. Waller and colleagues (2015) assessed outcomes immediately after therapy and again at six weeks and eight weeks post-treatment. Large changes in belief flexibility were reported six weeks post treatment (d=1.01), however this improvement started to decline at the eight-week assessment point (d=0.42). This finding highlights the potential need for further intervention (eg., a follow-up, one off 'refresher' session) once treatment is complete in order to maintain treatment gains over time.

DISCUSSION

It is widely acknowledged that reasoning biases contribute to both the development and maintenance of paranoia. In view of the significant impact that these biases can have on daily functioning, many cognitive interventions have been developed to ameliorate these deficits. The impact of these interventions on the positive and negative symptoms of psychosis has been studied at length in the literature. In contrast, the efficacy of these interventions on reasoning biases, both in the short-term and the long-term, has received less research attention. In light of this, the current review compared a number of different cognitive therapies on their efficacy in ameliorating these biases, as well as exploring whether certain biases were more or less responsive to treatment. The review revealed that

there are a number of cognitive interventions available which have shown promise in improving outcomes. Targeted treatments appear to be more effective than broad-based interventions at improving specific reasoning biases, although this warrants further research attention. Generally, robust improvements were reported in belief flexibility and ToM abilities following treatment. Improvements in the JTC and attribution biases were less consistent, though present in most cases. Conclusions were limited by factors such as a lack of follow-up assessments and differences in measurement tools used across studies.

Research design

RCT's are considered the gold standard for testing intervention efficacy (Cook, Campbell & Shadish, 2002). Whilst all of the reviewed studies adopted an RCT design, the quality of the studies varied, and this is likely to influence the confidence with which conclusions can be drawn from the findings. All studies randomly assigned participants to intervention and control groups, in order to reduce allocation bias and to balance known and unknown factors in the assignment of treatments. In light of this, however, in some cases the methods used to do this were not adequately described. Further, in order to ensure that the effects observed are attributable to treatment effect, high-quality trials often include an 'active' control condition, as was implemented by 10 studies in this review. This type of control condition is employed to account for non-specific treatment factors that may account for changes in the outcomes measured, including therapeutic contact or social interaction with other patients. Active comparison conditions may also reduce attrition rates when utilizing RCT's (Da Paz & Wallander, 2017).

In contrast, over half of the studies reviewed included a TAU or wait-list control group. The conditions of these control groups were described as including general psycho-education, computer training, different social activities and individual support. One study which utilised a TAU design reported twice as many drop-outs in the control condition,

with most dropping out for ‘unknown reasons’ and several discontinuing due to a worsening of their psychosis (Khazaal et al., 2015). Further, Wang and colleagues (2013) compared participants receiving a 20-week group SCIT intervention with those placed on a waiting list. Out of the 21 participants on the waiting-list, four of these were lost at follow-up. Two of these participants were hospitalized whilst waiting for the intervention and two participants took up other therapy programmes. In contrast, all 22 participants in the SCIT intervention remained engaged at follow-up. This was not the case in all TAU control designs, however, (Moritz et al., 2015a), and in one case where drop-out rates were much lower, monetary compensation was offered (Moritz et al., 2011). These findings may have important implications for the design of future research studies.

Reporting effect sizes

Of the 22 studies reviewed only 13 reported effects sizes across all assessment points. For the remaining nine studies, effect sizes were calculated from the available information. As research on cognitive interventions for individuals with psychosis becomes more widespread, researchers should routinely report effect sizes for all outcomes studied.

Outcome measurement

The choice of measurement tool used to detect change in reasoning biases could influence the findings that were reported. For example, the JTC bias was assessed using the ‘beads/fish task’ by most researchers; however, studies have shown that the beads task may have significant methodological limitations (Ross, McKay, Colheart & Langdon, 2015). For example, research has shown that the beads task lacks ecological validity, is rarely incentivised and individual motivation might explain some differences in performance (Jacoby, Abramowitz, Buck & Fabricant, 2014). These factors could partly account for the small effect sizes reported in the review. Further, substantial differences were found between self-report and performance-based measures of reasoning (Gaweda et al., 2015).

Whilst it is widely acknowledged that self-report measures are more susceptible to bias, it has also been suggested that performance-based measures could be more sensitive to the functional changes that may follow cognitive interventions (Elliott & Fiszdon, 2014). With regards to the selection of appropriate measures, the findings of this review have important implications for future research studies in this field.

In addition, there were differences in the ways by which measurement tools were used to assess change in reasoning biases across studies, which may limit the extent to which the findings can be compared. For example, some studies measured change in the JTC bias by assessing the number of beads drawn before a decision is made, whereas others compared the percentage of participants in each group making a decision after the first or second bead. Further, there were differences across studies in the proportions of coloured beads present in each jar, with some using a 60:40 beads ratio (more difficult) and others using an 85:15 beads ratio (easier). In the 'higher ratio' instances (when the ratio of beads is 85:15), it could be argued that very few beads need to be drawn for the probability of one of the jars to be very high. Therefore, if a participant asks to see only a small number of beads, participants may not be 'jumping to conclusions on the basis of insufficient evidence'.

Finally, whilst many studies ensured that both patients and clinicians were unaware of which treatment was given until the study was completed in order to limit bias, several studies did not (Garety et al., 2015; Gaweda et al., 2015; Kayser et al., 2006; Waller at al., 2015). Thus, some reported results may be biased by demand characteristics and efforts should be made to ensure that participants and assessors are blinded in future studies.

Sample formation

Researchers used a number of recruitment methods in an attempt to obtain a sample representative of the target population; however, in some cases selection bias may have occurred. For example, several researchers recruited individuals to take part in their

research study who had taken part in a previous study (Waller et al., 2015), had previously explained they were happy to be contacted by researchers to take part in research trials, or were already attending support group programmes (Gaweda et al., 2015). This may have resulted in the inclusion of help-seeking, and perhaps more motivated and insightful participants who were more agreeable to services. Research has shown that cognitive insight is associated with good outcomes in CBT for psychosis (Perivoliotis et al., 2010) and poor insight has been found to be related to low treatment adherence (Rüsch & Corrigan, 2002). It could be hypothesised that less motivated and insightful individuals may not engage as well in the therapy, and thus improvements in reasoning biases may not be observed to as much of an extent.

Additionally, where research was conducted in an inpatient setting, a number of exclusion criteria were applied which may limit the generalizabilty of the findings. For example, Taylor and colleagues (2016) described excluding participants who may find engagement with a group format difficult. This included participants who were on high doses of medication and those who displayed continuous aggressive behaviour. Another inpatient study reported that otherwise eligible participants had to be excluded from the treatment due to an inability to consent (Koukkanen et al., 2016). These findings suggest that patients who were acutely psychotic were not likely to be approached, nor represented, by the population under study. These factors may have implications for the feasibility of the delivery of these interventions in settings such as inpatient units, where patients are frequently detained under section and are often acutely unwell.

Generalizability of results

There are several factors which may limit the extent to which the study findings can be generalized. As with other areas of psychological treatment research, studies recruiting individuals with psychosis often apply strict eligibility criteria which can rule out patients

with a variety of psychiatric and medical co-morbidities. Several studies excluded individuals with co-existing substance misuse and alcohol difficulties (Garety et al., 2015; Horan et al., 2009), mental health difficulties (Bechi et al., 2015), patients showing severe signs of hostility, megalomania, formal thought disorder and suspiciousness (Aghotor et al., 2010) and those with an IQ of less than 70 (Moritz et al., 2011). This limits the extent to which the findings can be generalized to typical psychosis populations in both inpatient and community settings, who may present with more complex and severe difficulties. The exclusion of participants with substance use disorders is particularly significant, since over 40% of psychosis patients are likely to experience substance misuse difficulties at some point (Kavanagh, McGrath, Saunders, Dore & Clark, 2002).

Most of the studies included in the review recruited participants from largely white-majority, western countries. Of particular note, was that a large percentage of the sample was made up of ethnic minority groups (55%), with most of these participants identifying as Black African, Black Caribbean or Black other (42%). These findings are somewhat in line with previous research, reporting high rates of psychosis in ethnic minorities, in particular in those who identify as Black African and Black Caribbean (Veling et al., 2007), with one study reporting a risk between four- and six fold that of the White-British population (Kirkbride et al., 2008). The sizeable percentage of Caucasian individuals recruited (45%) could have been down to chance, or as a result of other factors such as barriers to help-seeking amongst ethnic minorities. Taking these factors into account, the sample partly reflects a 'true' psychosis sample in terms of ethnicity, however; only five of the 22 studies reported on the ethnicity of their participants, so these figures should be interpreted with caution.

Finally, the mean age of study participants ranged from 23.3-51.1 years, with many studies reporting that most of their participants were in the 30-50 years age bracket. In light

of this, generalizing to a more diverse sample may prove difficult. For example, cognitive interventions with older adults may be complicated by factors such as neurodegenerative decline (Folsom et al., 2006). Further, although not explicitly stated, most studies included in this review can be thought of as treating residual, more chronic psychotic symptoms (Cosci & Fava, 2012). In future research, it would be of interest to review studies looking at reasoning interventions across the continuum of psychosis, including those in the general population, and in "at risk" psychosis populations. This could provide insight into the phenomenology and efficacy of the treatment of reasoning biases at different stages of psychosis. Finally, many studies recruited participants with a variety of diagnoses and symptom profiles, introducing the problem of heterogeneity.

Intervention fidelity and process

Generally, researchers put in place a number of measures to ensure treatment fidelity. For example, where therapy was delivered face-to-face, several researchers video-taped sessions and conducted direct observations of those delivering the treatment. Further, a number of studies reported that trial therapists received specialist training in the therapy, or that the therapy was delivered by an expert in the field (So et al., 2015; Wang et al., 2013; Waller et al., 2015). With online, self-directed interventions, it is somewhat harder to ensure that all participants are receiving the intervention as intended. Researchers attempted to ensure treatment fidelity in these cases by, for example, sending out e-mail reminders encouraging participants to use the programme on a regular basis (Moritz et al., 2015b). In light of this, however, for their online CBC intervention, Moritz and colleagues (2015b) reported that just 23 out of the 29 respondents (79%) in the experimental group read all of the treatment modules, with one participant disclosing that they had not read any of the presentations.

It could be speculated that self-directed interventions may be associated with a reduced motivation to engage in treatment. Moritz and colleagues (2015a) gave participants access to their six-week online MCT training programme for up to one year. The researchers started with 30 experimental participants at baseline, this decreased to 20 participants six weeks, post-intervention, and to 14 participants at their three-month follow up. The researchers highlighted that perhaps a lack of motivation, often ameliorated by therapeutic contact, could have had an impact on engagement (Andersson & Titov, 2014). In light of this, however, the same researchers reported a much higher retention rate when testing the effects of an online, six-week CBC intervention on reasoning biases (with 93% of the baseline sample completing the post assessment). Further research is needed to elucidate the factors that encourage engagement in self-directed treatments.

Limitations of Review

A series of scoping exercises were carried out at the start of the review process which indicated that a sufficient number of RCT's matched the proposed inclusion criteria. As such, it was decided that the review would only include studies adhering to this design. These studies typically provide a higher quality of evidence, and would therefore provide more robust findings for synthesis in the review. In light of this, however, it should be noted that cognitive interventions not yet tested using an RCT design likely exist, though were not represented in the review. Employing less-restrictive inclusion criteria might have meant that the findings would have been more representative of the interventions available.

In addition to this, the current review did not consider broader outcomes such as the impact of the change in reasoning biases on other areas such as quality of life, medication use and social functioning. Secondary analyses examining the impact of cognitive interventions on these domains would provide valuable insights into the broader implications of these therapies. Finally, the literature, and therefore the review, may also be

subject to publication biases. Positive findings, as opposed to negative findings, are more likely to be published (Button et al., 2013), yet both are significant when considering how effective an intervention is.

Clinical implications

Although the studies reviewed varied widely in terms of patient characteristics, study design and outcome measurement, several tentative conclusions can be drawn from the findings obtained. The review demonstrated that existing cognitive interventions improve reasoning biases in individuals with psychosis, and that there is promise for the use of these interventions clinically. The findings suggest that where a particular reasoning bias is particularly prominent, a specific and more targeted therapy may be more effective than a broad-based intervention. A thorough assessment of individual symptoms and personal goals would help to determine this. There is also some evidence that personalising the therapy material may lead to improved treatment effects, though this warrants further research attention. Finally, further research is needed to shed light on the feasibility and acceptability of each intervention to individuals with psychosis.

Future research

In light of these points, to ensure that clinical practice is informed by appropriate clinical research findings, and to clarify further how effective cognitive interventions are in treating reasoning biases in psychosis patients, several aims for future research are suggested. The delivery of a large number of high-quality studies, evaluating the effectiveness of cognitive interventions in a representative sample, would be of use. For example, most of the studies included recruited stable participants from outpatient settings, so further research is needed into the efficacy of these interventions in more acutely unwell, inpatient groups. Further, studies with extended follow-up assessments would be useful to

ascertain longer-term treatment effects. There is also a need to determine optimum treatment frequency and duration for specific reasoning biases and cognitive therapies. In addition, further research is especially warranted into the efficacy of these interventions with those in the prodromal stage of psychosis as well as those who are acutely unwell, where reasoning biases are prominent and there is a lack of available interventions (Penn, Waldheter, Perkins, Mueser & Lieberman, 2005). Finally, there is a need for future studies to measure the effectiveness of these interventions on real-world reasoning.

CONCLUSION

The current literature review has found that cognitive interventions targeting reasoning biases in individuals with psychosis are generally effective in achieving outcomes. Some of these improvements were reported immediately after treatment, whilst others appeared to materialize over time. Targeted interventions were comparatively more successful at improving specific reasoning biases compared to more general, broad-based therapies. Interestingly, SCIT was found to be somewhat more effective than SCST in many cases, indicating that an experiential approach could be more valuable than largely psycho-educational treatments, although this warrants further research attention. In summary, these findings help to establish a role for existing psychological interventions in improving reasoning biases, as well as the need for the development of tailored psychological therapies in this group. The field would benefit from the delivery of studies measuring intervention effects on real-world reasoning and studies with follow-up assessments to measure longer-term change.

Chapter two: Empirical study

Reasoning in delusion-prone individuals

ABSTRACT

It is widely acknowledged that a number of factors can influence the way that individuals make decisions. Whilst the impact of emotion and beliefs on reasoning in the general population has been widely studied, the application of these findings to psychopathology has received less research attention. The aim of the current study was to assess logical reasoning in highly-paranoid individuals (HP). HP participants were compared with those high in social anxiety (SA) and those low in both paranoia and social anxiety (L). In line with the hyper-emotion theory (HET), it was predicted that HP and SA participants would reason more logically when the syllogism task content was related to their concerns. In contrast, belief bias predicted that HP and SA participants would reason in line with their beliefs, as opposed to the validity of the conclusions presented, when the task content was related to their concerns. Finally, it was predicted that paranoia severity would be positively associated with an intuitive thinking style and negatively associated with an analytical thinking style, in the HP group. One-hundred and one undergraduate students completed a number of questionnaire and experiential measures to assess symptomology and thinking style, as well as a syllogistic reasoning task to assess logical reasoning abilities. The syllogism conclusions varied according to their content (paranoia-related, social anxiety-related, or non-specific), their plausibility (believable/unbelievable) and their logical validity (valid/invalid) in order to test the various hypotheses. The study findings did not support the predictions made in line with the HET or the belief bias theory. Interestingly, there was some evidence that paranoia severity was positively associated with an analytical, and to some extent an intuitive, thinking style in the HP group. Study limitations, suggestions for future research and the clinical implication of the findings are discussed.

INTRODUCTION

Overview

A large amount of research has explored the impact of pre-existing beliefs on logical reasoning processes (Goel & Dolan, 2003; Goel & Vartanian, 2011). One of the most prominent findings is that individuals have a tendency to view information as valid if it is in line with their beliefs, and are more likely to reject information as false if it is not. This phenomenon is known as the 'belief bias' effect, and is one of the most studied in the reasoning literature (Evans, Over, & Manktelow, 1993). The cognitive dissonance theory offers an explanation for the belief bias phenomenon, stating that we are motivated to not act against our beliefs, as doing so could result in a negative emotional state (Harmon-Jones & Mills, 1999). In everyday life, some degree of belief bias could be considered adaptive. For example, in dangerous situations, when capacities are restricted and time is limited, it makes sense to rely on our 'gut instincts', rather than to stop and consider whether our conclusion meets the standards of formal logic (Eliades, Mansell, Andrew, Stewart & Blanchette, 2012).

Researchers have also explored the ways by which emotion can influence logical reasoning. A number of studies have found that emotion (both negative and positive) often has a detrimental impact on reasoning ability (Goel & Dolan, 2003). Possible explanations for this include the additional load on working memory (thought to limit resources available to reason logically; Baddeley, 2003), the influence of emotion on motivation to solve complex cognitive tasks, as well as emotion influencing how attention is allocated (Gable & Harmon-Jones, 2012). In light of this, however, findings in the literature are mixed. A number of studies have found that individuals reason more logically about emotive, personally-relevant content compared with neutral content. For example, one study looked at logical reasoning in individuals from three different cities shortly after the

London terrorist attacks of July 2005 (Blanchette, Richards, Melnyk & Lavda, 2007). Individuals in London, who reported the highest levels of emotion, as well as a closer proximity to the event, reasoned more logically than participants in Canada when the syllogisms were related to terrorism. Thus, it seems that when participants reason about personally-relevant emotional topics, logical reasoning abilities may be enhanced (Blanchette et al., 2007).

Whilst there has been much research looking at the impact of beliefs and emotion on logical reasoning in healthy individuals, its application to those with psychological difficulties is less well-studied. The interplay between emotion, beliefs and logical reasoning is of clear relevance to better understanding the dysfunctional beliefs characteristic of so many psychological disorders. Historically, it has been understood that individuals with psychological disorder reason illogically (Beck, 1976), and a major focus of many psychological treatments such as Cognitive Behavioural Therapy (CBT) has been to challenge these 'illogical' convictions and to replace these beliefs with more rational alternatives (Clark & Wells, 1995). There is some evidence for logical reasoning deficits in those with psychological difficulties in the literature, although findings are mixed. For instance, research has shown that depressed patients (Channon & Baker, 1994) and individuals with schizophrenia (Goel, Bartolo, St Clair & Venneri, 2004) perform worse than healthy controls on logical reasoning tasks. In contrast, however, one study found no differences in logical reasoning between individuals with OCD and healthy controls (Pélissier & O' Connor, 2002). Further, a recent study found that when confounding variables such as IQ and level of education were controlled for, there were no differences between participants with schizophrenia and healthy controls on reasoning ability (Mirian, Heinrichs & Vaz, 2011). In light of these findings, emerging theories have suggested that

dysfunctional beliefs are not due to illogical thinking per se, and have instead focused on the interplay between emotion, beliefs and reasoning processes (Vroling & de Jong, 2010).

Belief bias and its application to psychological difficulties

Whilst belief bias has been widely studied in healthy individuals (Trippas, Handley & Verde, 2014), its application to psychological difficulties has received less research attention. There is some evidence to suggest that individuals with psychological disorder show a generally-enhanced belief bias compared with healthy controls (De Jong, Weertman, Horselenberg & Van den Hout, 1997). It is hypothesised that the stronger this tendency is, the more likely the individual will fail to correct their prior beliefs. In light of this, a strong belief bias could act as a barrier to revising the dysfunctional beliefs associated with their disorder. In line with this hypothesis, one study found that spider phobics displayed a stronger belief bias regarding commonly-held beliefs than non-phobic controls (De Jong et al., 1997). In view of this, however, subsequent studies have failed to find an association between the strength of the belief bias regarding universal convictions and symptoms of generalised anxiety, social anxiety and depression (Smeets & de Jong, 2005; Vroling & de Jong, 2009).

In contrast, others have suggested that an enhanced belief bias regarding emotionally-relevant rather than global themes may be especially relevant for the development of psychological difficulties (Vroling & de Jong, 2010). The theory explains that the dysfunctional beliefs typical of so many disorders are likely to elicit fear when thought about. It is hypothesised that when individuals are in a situation when a decision regarding their fear has to be made, they make a quick decision based on their intuition and prior beliefs. This fear-based, threat-confirming reasoning style is thought to be a ‘better safe than sorry’ reasoning strategy, whereby the individual neglects the logical validity of the conclusion they draw. This may in turn lead to the formation of stable cognitions and

belief systems which may set an individual at risk of developing a psychological disorder. In conclusion, the tenent of this theory is that individuals with psychological difficulties are not illogical, but may neglect logical reasoning processes in favour of a threat-driven, faith in intuition.

Belief bias is often tested experimentally using syllogistic reasoning tasks (Smeets & de Jong, 2005; Gangemi, Mancini & Johnson-Laird, 2013). When faced with these tasks, participants are asked to judge the logical validity of the syllogisms consisting of two statements, the premise, and a conclusion. In traditional paradigms, there are two types of syllogisms: conflict problems, in which the logical conclusion is inconsistent with one's beliefs (valid–implausible and invalid–plausible) and non-conflict problems in which the logical conclusion is consistent with one's beliefs (valid–plausible and invalid–implausible). Individuals are typically faster and more accurate when making a decision about the validity of a syllogism when there is a match than when there is a mismatch between the validity and believability of the conclusion (Vroling, Glashouwer, Lange, Allart-van Dam & de Jong, 2016).

The dual-process model of reasoning offers a theoretical explanation for the belief bias phenomenon. According to this theory, the human mind utilises two separate reasoning processes when making decisions (Epstein, 1994). Intuitive processes ('Type one' reasoning) are thought to be more implicit, rapid and based on prior knowledge. In contrast, analytical processes ('Type two' reasoning) are thought to be slower, more effortful and rule-based. It is widely acknowledged that emotion can influence both types of reasoning (Blanchette & Richards, 2004). An important assumption of the model is that Type one processes provide default responses that can be altered if Type two processes intervene. Belief bias is therefore observed when there is a reliance on Type one reasoning, and less of an engagement with Type two thinking.

The Hyper-emotion theory (HET) of psychological illness

In contrast, the HET (Johnson-Laird, Mancini & Gangemi, 2006) suggests that emotions of excessive intensity may actually improve logical reasoning over time. The theory states that in any given situation, individuals with mental health difficulties may experience an emotion at a high intensity. The individual does not know why this emotion is being experienced at such intensity, and as emotion directs reasoning, the individual begins to search for answers. A cause is then attributed, based on a number of factors such as the presence of reasoning biases and personal experiences. When this emotion is re-experienced in another situation, the same pattern of reasoning occurs, and through processes such as rumination, an increasing number of possibilities related to this cause are envisioned. Over time, it is hypothesised that individuals with psychological difficulties become 'expert' reasoners about emotional topics related to their difficulties. The authors have also identified characteristic patterns of reasoning associated with certain disorders. For example, the researchers outline a type of extreme confirmation bias in individuals with hypochondria (Johnson-Laird et al., 2006).

Gangemi and colleagues (2013) found evidence for the HET in two of their recent studies. The authors reported that anxious participants drew more valid conclusions that were anxiety-related on a syllogistic reasoning task (75%) than those that were not (38%), and that this difference was larger than the difference for the control participants, which was in-fact nonexistent (33% neutral conclusions vs. 33% anxiety-related conclusions). In the same study, the researchers also compared the impact of emotion and beliefs on logical reasoning in depressed participants and controls, and found similar results. Other studies, using the simulation heuristic to test the HET, have reported mixed findings. Rose et al (in press) found evidence of expert reasoning in individuals with social anxiety, however was unable to replicate this finding in those with paranoia. Additionally, Huddy, Brown, Boyd

and Wykes (2014) found that individuals with clinical paranoia actually produced less coherent simulations compared with matched controls, when the content was related to their concerns, a finding recently replicated by Huddy, Drake and Wykes (2016). In light of these findings, however, the simulation paradigm presumes that reasoning about hypothetical scenarios makes use of imagery and future-based thinking (Raune, MacLeod & Holmes, 2005). It may well be that present-time perceptions with less use of imagery, is more characteristic of paranoia.

The current study

The process of making and revising judgements is of obvious importance to understanding paranoid thinking. There is a wealth of literature exploring reasoning biases in paranoia; however, the role of logical reasoning has received less research attention. The dual-process model of reasoning has also been utilised to better understand thinking styles more generally in individuals with paranoia (Evans, 2003, Kahneman & Frederick, 2002). Previous research has found that higher levels of paranoid thoughts were associated with greater experiential reasoning and less analytic reasoning (Freeman, Evans & Lister, 2012). In light of this, however, research findings are mixed and further research is needed to ascertain how these cognitive styles contribute to paranoid thinking across the continuum. For example, Ward et al (2018) found that individuals with more severe psychotic experiences employed less analytical reasoning during their experimental task. In contrast, the nonclinical group did not differ from controls in rational reasoning abilities.

In addition, the belief bias and the HET have been tested using participants with a range of psychological difficulties including anxiety, depression and phobias. The two theories are yet to be tested with those experiencing paranoid thoughts.

The aim of the current study was to assess logical reasoning abilities in individuals high in non-clinical paranoia. In line with the continuum theory, an exploration of

reasoning ability in non-clinical paranoia is likely to inform the understanding and treatment of clinically severe delusional beliefs (Linscott & van Os, 2013). To test this hypothesis, the study compared the reasoning of highly-paranoid individuals (HP) with those high in social anxiety (SA; as a comparison group, but also as a second test of the belief bias theory and the HET) and a control group (L; participants scoring low on social anxiety and paranoia). It is widely acknowledged that both paranoia and social anxiety involve the expectation of negative responses from others (Tone, Goulding, & Compton, 2011) and symptoms such as a failure to consider or generate alternative explanations for aversive social experiences, are viewed as key features of both persecutory ideation and social anxiety (Freeman & Garety, 2004; Clark & Wells, 1995). It is hoped that as a result, any differences between the two groups on study measures can be more confidently attributed to paranoid cognitions.

Hypotheses:

Hypothesis one: The HET predicts that HP and SA participants will reason more logically (and therefore make fewer errors on the reasoning task) when the task content is related to their concerns, compared to when the content is non-specific. This difference is expected to be greater than the corresponding difference in the L group.

Hypothesis two: Belief bias theory predicts that HP and SA individuals will display a greater belief bias when the syllogisms are related to the participants' concerns, compared to when the content is non-specific. More specifically, HP and SA participants will reason less accurately with conflict syllogism conclusions (implausible-valid and plausible-invalid) and more accurately with non-conflict syllogism conclusions (implausible-invalid and plausible-valid) when the content is related to their concerns, compared to when the content is non-specific. This difference is expected to be greater than the corresponding difference in the L group.

Hypothesis three: In line with previous research with highly paranoid individuals, it is predicted that paranoia severity will be positively associated with an intuitive thinking style and negatively associated with an analytical thinking style in the HP group.

METHOD

Participants

The study was advertised to first year, undergraduate psychology students at Royal Holloway, who could participate to earn course credits (n = 101). Eighty-nine of the participants were female (88%), nine were male (9%), two participants identified with another gender not specified (2%) and one participant did not wish to disclose their gender (1%). The mean overall age of the sample was 18.94 years (SD= 2.76; range = 15-36). Further demographic information is reported in the results section (see Table 4). Participants were divided into three groups; a HP group, a SA group and an L group. Group membership was decided based on the participants' scores on the Paranoia Scale (PS; Fenigstein & Vanable, 1992; see Appendix 4), a measure of sub-clinical paranoia, and the Social Phobia Inventory (SPIN; Connor et al., 2000; see Appendix 4), a widely-used measure of social anxiety.

Thirty-four participants scored above cut-off on the PS (≥ 53) and formed the HP group. Normative data from the student sample used by Fenigstien and Vanable (1992) were used to identify the cut-off score for HP group membership, and a number of other studies have utilized the same approach (Combs, Michael, & Penn, 2006; Combs & Penn, 2004). Importantly, individuals scoring at or above this cut-off score on the PS have been found to display similar social, cognitive, and behavioural biases to those observed in individuals with persecutory beliefs (Combs et al., 2007). The HP group was not required to be low in social anxiety, as research suggests social anxiety is intrinsic to paranoia

(Bebbington et al, 2013), and paranoid thoughts are thought to build upon common social anxieties such as a fear of rejection (Freeman et al., 2005). A number of researchers have reported that a score of 19 on the SPIN distinguishes between participants with and without social phobia (Connor et al., 2000). Thirty-seven participants scored ≥19 on the SPIN but <53 on the PS and formed the SA group. Thirty participants scored below both cut-off points and formed the L group.

Power Analysis

To estimate the sample size needed for the current study, existing research in the area was reviewed. Gangemi and colleagues' (2012) study found that individuals with anxiety reasoned significantly more accurately than controls when the task content was relevant to their concerns (effect size: d= 0.85; Cohen, 1988). A larger effect size in the same direction was reported when researchers compared the reasoning of depressed participants and controls with depression-relevant content (d=2.38). Previous studies exploring logical reasoning in individuals with paranoia have reported more modest differences. One study reported that individuals with delusions showed enhanced logical reasoning with plausible (d=0.82) and implausible (0.54) syllogisms compared with controls (Owen, Cutting & David, 2007).

Taking these effect sizes into account, an expected overall large effect size (d = 0.80) was estimated for the current study. As the planned analyses involved multiple significance tests (both within and between-subjects), a power analysis was calculated based on the sample size needed to detect both of these effects (Greenwald, 1976). Power calculations based on an effect size of d = .80, power at .80 and alpha at .05, indicated a sample of seven participants per condition (21 in total) to detect effects using an ANOVA analyses. In order to test differences between any two groups on measures of interest, a

second power calculation was conducted. This analysis stated that we would need 21 participants in each study group (63 in total) in order to detect the expected effect.

Recruitment

Students interested in taking part in the study were able to read through the information sheet online, which explained that the research aimed to investigate how thoughts about other people, and thinking styles more generally, can influence how people make decisions (see Appendix 3). Students could then sign up to available time-slots online to complete the study, which took around 30-minutes to complete. The only inclusion criteria for the study was having a level of English sufficient to read and understand the information sheet, provide consent, and complete the questionnaires.

Measures

Self report.

The Paranoia Scale (PS; Fenigstein & Vanable, 1992). The PS a 20-item questionnaire used to assess paranoid thinking. Responses are given on a five-point scale, ranging from one (*not at all applicable to me*) to five (*extremely applicable to me*) and example items include*: 'I sometimes feel as if I am being followed'* and *'someone has it in for me'*. Total scores range from 20-100, and higher scores indicate greater levels of paranoia. Fenigstein and Vanable (1992) validated the PS with 581 students, and found that the questionnaire had good internal reliability (a = .84). The PS also demonstrated good test-retest reliability when used with a student sample (a = .70; Fenigstein & Vanable, 1992). In the same study by Fenigstein and Vanable (1992), the scale achieved a Cronbach's alpha of .84, indicating good internal consistency. The authors also reported that the PS was negatively correlated with measures of interpersonal trust ($r(150) = .30$, $p < .01$) and positively correlated with the 'control by powerful others' scale ($r(150) = .34$, $p < .01$), indicating good construct validity.

The Social Phobia Inventory (SPIN; Connor et al., 2000). The SPIN is a 17-item questionnaire, consisting of questions which evaluate fear (eg., people in authority), avoidance (eg., of being the centre of attention), and physiological discomfort (eg., blushing in front of other people). Each of the 17 items is rated on a five-point scale, ranging from zero (not at all) to four (extremely), based on the presence of symptoms over the past week. Total scores range from zero to 68, with higher scores indicating greater distress. The SPIN has been reported to be a reliable and valid measure of social anxiety in non-clinical, student populations. Radomsky and colleagues (2006) reported that the SPIN exhibited good convergent validity, excellent internal consistency ($\alpha = .93$) and test-retest reliability ($r = .86$) in a sample of undergraduate students.

Depression and Anxiety Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The DASS-21 is a 21-item self-report measure of depression, anxiety, and stress. Each subscale is made up of seven items, and each item is rated on a three-point Likert scale (zero = never, three = almost always) based on how individuals have felt over the last week. Responses are added together, with scores on each subscale ranging from zero to 21 (and total scores ranging from zero to 63), with higher scores indicating higher levels of stress, anxiety and depression. Tran, Tran and Fisher (2013) reported that the scale had high internal reliability ($\alpha = .70$) and found significant correlations between DASS scores and other measures including the Beck Anxiety and Depression Scales (r, ranged from 0.58 to 0.78).

Rational Experiential Inventory (REI-10; Norris, Pacini & Epstein, 1998). The REI-10 was designed to assess preferences for information processing, and measures two distinct cognitive styles. The inventory is comprised of two subscales, each consisting of five items. Epstein, Pacini, Denes-Raj and Heier (1996) reported that the correlation between the NFC and FI sub-scales ($r(970) = .08$, $p < .01$), though significant because of

the large sample size, indicated that the two scales were largely independent. The five-item NFC sub-scale has been found to be a reliable measure for assessing an individual's desire to engage in rational thought (α=.73; Epstein, et al., 1996). A sample item is '*I would prefer complex to simple problems*'. Epstein and colleagues (1996) reported positive correlations with measures of action-oriented coping ($r(184) = 0.41$, $p < .01$) and negative correlations with naive optimism ($r(184)=-0.37$, $p=<0.01$), indicating good construct validity. The five-item, FI sub-scale has been found to be a reliable measure of the tendency to engage in and have confidence in one's intuition (α= 0.72; Epstein et al., 1996). A sample item is, '*my initial impressions of people are almost always right*'. Epstein and colleagues (1996) reported positive correlations with naïve optimism ($r(184) = 0.20$, $p < .05$) and esoteric thinking ($r(184)=-0.30$, $p=<0.01$), indicating good construct validity.

Experimental tasks.

Cognitive Reflection Test (CRT-4; Frederick, 2005). The Cognitive Reflection Test (CRT-4) is a four-item inventory designed to measure analytical and/or intuitive thinking. The test consists of four simple mathematical problems that elicit intuitively appealing, but incorrect responses. Engagement with analytical reasoning processes mean that the intuitive response is rejected and further processing ensues, in order to figure out the correct answer. A faith in intuition means that the intuitively appealing response is reported as being correct. Correct responses are totalled to create a CRT score (minimum= zero, maximum = four). The scale has been found to have acceptable internal consistency (α = 0.72; Ross et al., 2015). Performance on the CRT-4 has been found to be positively associated with performance on a measure on actively open-minded thinking (r = 025, $p=<0.05$), and a measure of logical thinking ($r=0.43$, $p=<0.01$; Campitelli & Gerrans,

2014), both of which are proposed to be measured by the test (Toplak, West & Stanovich, 2011). This positive correlation indicates good construct validity.

Probabilistic Reasoning Task ("Beads Task"; Huq, Garety & Hemsley, 1988). The beads task is used to assess the jumping to conclusions (JTC) reasoning style. Participants are shown an image on-screen of two jars of beads, along with task instructions based on those used by Garety and colleagues (2005; See Appendix 5). One jar is labelled as the 'mainly red jar' (and is described and depicted as having 60 red beads and 40 blue beads), and the other jar is labelled as being the 'mainly blue jar' (and is described and depicted as having 40 red beads and 60 blue beads). After the images of the jars are removed from sight, participants are shown a sequence of beads being drawn from one of the jars with replacement. The order in which the beads are drawn is pre-specified and identical for all participants. After each draw, participants are asked if they would like to decide which jar the beads are being drawn from or if they would like to see another bead. Data gathering was operationalized as the number of beads the participant asked to see before making a decision.

Syllogistic reasoning task. A syllogistic reasoning task was used in the current study to assess logical reasoning abilities. Thirty syllogisms were presented to study participants in argument form, consisting of two premises, followed by a conclusion (see Appendix 5). Each syllogism was considered valid if accepting the two premises as true, leads one to also accept the conclusion as true. The syllogisms were presented on screen as a single, sequential list, and participants were instructed to respond to each item by marking each conclusion shown as either valid or invalid. The syllogisms were presented in a fixed, random order to all participants. The majority of the syllogisms used in the study were obtained from researchers who had conducted a similar study (Gangemi et al., 2013).

The social anxiety-related syllogisms were devised by the researcher for the purpose of the study.

Content. Ten of the syllogisms used were paranoia-related, 10 were non-specific, but highly emotive, and the remaining 10 were social anxiety-related. The non-specific syllogisms included were similar to those used by Blanchette and colleagues (2007), who also investigated the impact of emotion and beliefs on reasoning processes. The paranoia related items were devised following a review of the syllogisms used in Kemp, Chua, McKenna and David's (1997) study exploring syllogistic reasoning ability in individuals with delusions. In an attempt to ensure that the social anxiety-related syllogisms were sufficiently relevant to commonly reported concerns, syllogisms were devised following a review of the items making up the Social Phobia Inventory (SPIN) and the Social Phobia Beliefs Questionnaire (SPBQ; as used by Vroling & de Jong, 2009. For example: vulnerability in social situations, feelings of being watched in social situations and appraisals around social skills). The syllogisms were presented from several perspectives: a public self-referent (eg., some people who are self-conscious are tongue-tied) and a private self-referent (eg., every time I walk into a room full of people I feel nervous). This was done as it is unclear in the literature as to whether social anxiety concerns negative public or private self-referent convictions, or both (Mansell & Clark, 1999; Hoffman & Scepkowski, 2006).

Plausibility. In order to test the belief bias hypotheses, the syllogism conclusions varied according to their plausibility. With the non-specific items, the plausibility of the syllogisms varied according to societal norms, commonly-held and less commonly-held universal beliefs. With the paranoia and social-anxiety related syllogisms, the plausibility was varied according to the extent to which the conclusions were congruent with the beliefs

typical of each disorder. With non-conflict trials, the logical response was thought to be consistent with these beliefs. In conflict trials, the logical response was thought to be inconsistent with these beliefs (see Table 3 for an illustration of each combination).

Calculation of belief bias scores

In line with previous research, a belief bias effect is observed when participants find it relatively easy to judge valid-believable and invalid-unbelievable syllogisms (i.e., when there is a match between validity and believability) and relatively difficult to judge the logical validity of valid-unbelievable and invalid-believable syllogisms. As per previous research exploring belief bias in those with social anxiety (Vroling & de Jong, 2010) we computed belief bias summary scores (BB scores) for each content domain. Each BB score was computed by subtracting the number of correct answers from the matched syllogisms from the number of correct scores from the mismatched syllogisms. Therefore: BB = conflict items ((valid-unbelievable + invalid-believable) - congruent items ((valid-believable) + (invalid + unbelievable)). A higher score indicated a larger degree of belief bias. A global belief bias score was then computed by adding together the total BB scores from each domain.

Table 3. Examples of paranoia syllogisms, varying in logical validity and plausibility

	Plausibility	
Logical status	Plausible	Implausible
Valid	(A) Every time I walk down the street, I think I'm being followed. (B) Sometimes, when I walk down	(A) Some of my persecutors are not friends of mine. (B) Everyone who is mad

	the street, I feel I'm in danger. *Does it logically follow that…* (C) …sometimes, when I think I'm being followed, I feel in danger.	at me are friends of mine. *Does it logically follow that…* (C) … some of my persecutors are not mad at me
Invalid	(A) Sometimes, when I'm alone, I start thinking. (B) Sometimes, when I start thinking, I feel people are robbing me of my thoughts. *Does it logically follow that…* (C) …sometimes, when I'm alone, I feel people are robbing me of my thoughts.	(A) Some smart people are not evil. (B) All of my persecutors are smart people *Does it logically follow that…* (C) … some of my persecutors are not evil

Reliability. As the syllogism task was devised for the purpose of this study, it was important to assess the reliability of the scale. Prior to recruitment, a pilot study was conducted to assess inter-rater reliability. Ten participants, all psychology doctoral students, were asked to categorise each syllogism as being "paranoia-related", "social-anxiety related" or "non-specific, but highly emotive". A Fleiss's Kappa was then

calculated to assess the extent of inter-rater agreement. The Kappa statistic obtained was κ=0.60, which is indicative of an 'intermediate-to-good' extent of agreement (Fleiss, 1981).

Prior to conducting the main analyses, it was noticed by the researcher that there were errors in the conclusions of two of the syllogisms devised (items 19 and 28; see Appendix 5). One of these items was non-specific and the other social anxiety-related. In light of this, these items were removed from the dataset, and responses to one paranoia-related syllogism were also removed to ensure an equal number of items across content. In order to determine which paranoia-related item to remove, a reliability analysis was conducted to assess which item contributed the least to the overall reliability of the scale. Item 6 was identified and removed from the dataset.

A reliability analyses was then conducted on the content scales making up the 27-item syllogism set. The reliability of the social anxiety scale was α=0.20, for the paranoia-scale was α=0.56 and for the non-specific scale was α=0.60. It is widely acknowledged that an alpha of 0.8 is acceptable, and that scores substantially lower than this indicate an unreliable scale (Field, 2005). In light of this, however, Kline (1999) highlighted that whilst a Cronbach's alpha of 0.8 is acceptable for cognitive tests such as measures of intelligence, for ability tests a cut-off point of 0.7 is more suitable. As the reliability of the content scales was low, it was deemed appropriate to remove items from each scale where these detracted from alpha. This resulted in three syllogisms being removed from the social anxiety scale (items seven, 20, and 25). Finally, each of the content sub-scales (valid implausible, valid plausible, invalid-implausible, invalid-plausible) were then pro-rated to make up for the deleted items, so that the scores were comparable to those predicted to be found if all items were included. The reliability of the final content scales were: non-specific α = 0.60, paranoia α = 0.56, and social anxiety α = 0.44.

Procedure

All questionnaires were completed online using Qualtrics online survey software and used request-choice questionnaire responses to minimise missing data. The order of presentation of tasks was the same for all participants and was as follows:

1. Information sheet
2. Informed consent form
3. Socio-demographic questionnaire
4. Syllogistic reasoning questionnaire
5. The Cognitive Reflection Test (CRT-4)
6. The beads task
7. DASS-21
8. Paranoia Scale (PS)
9. Social Phobia Inventory (SPIN)
10. Rational Experiential Inventory (REI-10)
11. Debrief form

Ethical considerations

The study was reviewed and received approval from the Royal Holloway Research Ethics Committee (REC ID: 482 see Appendix 1). The procedures were not anticipated to have any negative implications for participants. However, completing questionnaires that ask participants to reflect on paranoia or negative mood may have negative emotional effects. As such, the debrief page included information about relevant sources of emotional support, and participants were encouraged to contact the researcher by email should they have any questions or concerns about any aspect of their participation in the study.

RESULTS

Overview

This section opens with a description of the preliminary statistical procedures employed before hypothesis testing, including those used to screen for and handle missing data, an investigation into the distributions of the data, and managing outliers. Where data were not normally distributed, transformations were conducted so that the data met the assumptions for parametric tests. In addition, descriptive and statistical analyses were carried out to assess whether groups were equivalent at baseline on a number of demographic and other variables. Each hypothesis is then outlined, with details of the statistical procedures used and the results found. All data were processed using the Statistical Package for Social Sciences (SPSS, version 21). Values are reported to two decimal places, apart from percentages which are reported to one decimal place. Conventional levels of statistical significance were used, with the alpha level $p < 0.05$ adopted throughout, unless otherwise stated.

Preliminary Statistical procedure

Data inclusion. One hundred and seven participants completed the consent questions at the start of the study. Of these 107, 105 participants completed the study, with two participants withdrawing their consent before completion. The data set was then screened for missing values. Examination of the data revealed that four participants had consented to the study but did not complete any of the study measures, and so these were removed from the data set. Fourteen data points were missing from the syllogism questionnaire data. In these cases, missing scores were pro-rated by taking an average of the individual participants' performance on syllogisms measuring the same construct measured by the missing data (eg. invalid, implausible SA-related items). A small amount of missing data was found on a number of other questionnaires (three data points) as

responses were not forced. Given the overall low frequency of missing values on these questionnaires, no specific statistical method was chosen to replace this missing data.

Outliers. Outliers are data points that lie well outside the area of variance expected amongst sample scores (High, 2000). Outliers may represent an error in responding, or data recording, but may also represent a genuine extreme value, which occurs because an individual differs from the rest of the sample in a meaningful way (Field, 2013). It is therefore important to identify and examine individual outliers and evaluate the best course of action for managing them in the data set (Field, 2013). Initially, boxplots were inspected to identify univariate outliers, and data points that fell outside of the upper or lower quartiles were examined. For this thesis, data points were investigated as potential outliers if they fell more than three standard deviations above or below the sample mean (Field, 2013). A total of three participants were identified as having extreme high scores on one of the study variables. High scores did not appear to be a systematic effect of group (HP: n = 1; SA: n = 1; L: n = 1). High extreme scores were observed in the data obtained from the beads task. Further inspection indicated that these scores were likely to reflect true data points and therefore represent valid and meaningful variation within the sample. In addition, excluding meaningful data can lead to a loss of power and therefore increase the likelihood of Type one error (Bakker & Wichert, 2014). It was therefore decided to retain these extreme high scores within the dataset.

Distribution of Variance. Normality and homogeneity of variance are both key assumptions for the use of parametric tests. Normality of distribution was initially assessed by visually examining histograms with normal curves for all study variables within each group. After visually examining histograms, each variable was formally assessed for skew and kurtosis using z-scores calculated by the researcher (Tabachnick & Fidell, 2007). Normality was accepted if $z < 3.29$ ($p > .001$), such that a significant score on skew or

kurtosis was taken to indicate significantly non-normal distributions. Histograms with normal curves and skew and kurtosis calculations indicated that the JTC data was positively skewed in the HP group, and the control group. A log-10 transformation successfully normalised this variable in both groups. For comparison purposes, variables that were transformed at any time point or within any condition had the same transformation applied to data at all time points and across all conditions.

Descriptive Statistics

Socio-demographic variables. The sociodemographic characteristics of the sample are presented in Table 4. The sample was made up of predominantly white, female, university students without a formal mental health diagnosis. Prior to the main hypotheses testing, a series of chi-square and one-way Analysis of Variance (ANOVA) tests were computed to assess whether conditions were equivalent across sociodemographic variables. As illustrated in Table 4, there were no significant differences in these variables across study groups.

Study variables at baseline. Scores on symptom measures are presented in Table 5. Differences in scores on the SPIN and the PS reflect differences in group assignment. There were significant differences between study groups on measures of anxiety, stress and depression. Fisher's least significant difference (LSD) tests found that the SA and HP groups did not differ on measures of stress ($t(69)= 0.08$, $p= 0.94$), however, both were significantly more stressed than the control group ($t(65)=4.63$, $p= < 0.01$; $t(62)=4.42$, $p=<0.01$). The SA and HP groups did not differ on measures of anxiety ($t(69)=-0.57$, $p=<0.01$), however both were significantly more anxious than the control participants ($t(58.14)=5.93$, $p=<0.01$; $t(48)=5.69$, $p=<0.01$). Finally, the HP and SA participants did not differ on measures of depression ($t(69)=-0.98$, $p=0.33$) though both were significantly more

depressed than the L group ($t(62) = 5.27$, $p<0.01$; $t(65) = 4.11$, $p=<0.01$). There were no significant differences in the JTC bias between groups ($F(2, 98) = 0.01$, $p = 0.99$).

Table 4. Socio-demographic variables

Sociodemographic variables		Condition				Test Statistic
		Paranoia group *n=34*	Social anxiety group *n=37*	Control group *n=30*	Total Sample *n=101*	
Gender	Female	30	33	26	89	$\chi^2 = 7.78$, p = 0.26
	Male	4	1	4	9	
	Other	0	2	0	2	
	Prefer not to say	0	1	0	1	
Ethnicity	White	19	29	22	70	$\chi^2 = 19.16$, p = 0.09
	Mixed race	1	0	4	5	
	Asian	11	6	3	20	
	Black	1	0	1	2	
	Other	2	2	0	4	
Mental health	Yes	4	4	0	8	$\chi^2 = 3.69$, p =0.16
treatment	No	30	33	30	93	
Age	*M (SD)*	18.5 (0.99)	19.2 (3.11)	19.1 (3.58)	18.94 (2.76)	F(2,98)=0.76,p=0.47

Table 5. Symptom measures by group

	Paranoia *n=34*		Social Anxiety *n=37*		Control group *n=30*		*Test Statistic*
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	
SPIN	36.29	14.55	31.16	8.75	11.73	5.6	F(2, 98) = 48.62, p = <0.01
Depression	8.18	3.93	7.24	4.06	3.73	2.59	F(2,100)= 13.07, p= <0.01
Anxiety	7.82	4.86	7.22	4.09	2.53	2.27	F(2,100)= 16.91, p= <0.01
Stress	10.18	4.90	10.27	4.81	5.43	3.44	F(2,100)= 12.06, p= <0.01
PS	61.47	8.20	39.05	8.34	32.90	8.75	F(2, 98) = 105.25, p = <0.01
JTC	10.24	8.86	10.11	6.85	10.37	6.18	F(2, 98) = 0.01, p = 0.99

Note. SPIN = Social Phobia Inventory. PS = Paranoia Scale;. JTC = jumping to conclusions. Means reported are for untransformed scores; between-group comparisons based on transformed data where required to meet parametric assumptions.

Hypothesis testing

Hypothesis one: The HET. In line with the HET, the first hypothesis predicted that HP and SA participants would reason more accurately when syllogisms were relevant to their concerns compared to when the content was non-specific. This difference was

expected to be greater than the corresponding difference in the L group. In order to test this hypothesis, a 3 X 3 repeated measures ANOVA was computed. Syllogism content (three levels: paranoia-related, social anxiety related, non-specific) was the within-subjects factor. Participant group (three levels: HP, SA, L) was the between-subjects factor. The analyses found a significant main effect of content ($F(2, 194)=21.37$, $p=<0.01$) indicating there were differences in reasoning according to task content across participants. Further exploration of the data found that participants across all groups solved non-specific syllogisms with greatest accuracy, then those which were paranoia-related, followed lastly by those which were social-anxiety related. In contrast to study predictions, the content by group interaction was not significant ($F(4,194)=0.78$, $p=0.54$), indicating reasoning accuracy did not significantly differ across groups according to syllogism content (see Table 6).

Table 6. Correct responses made by socially anxious, paranoid and control participants to syllogism items, by a) content of syllogism b) plausibility of syllogism conclusion

	Group		
Syllogism content	Paranoia	Social Anxiety	Control
	M (SD)	M (SD)	M (SD)
Paranoia	Total = 7.96 (0.41)	Total = 7.81 (0.41)	Total = 7.95 (0.45)
Non-conflict	4.32 (1.53)	4.18 (1.77)	4.35 (1.49)
conflict	3.64 (1.45)	3.63 (1.43)	3.6 (1.37)
Social Anxiety	Total = 6.25 (0.47)	Total = 6.98 (0.45)	Total = 6.56 (0.50)

Non-conflict	3.58 (0.24)	3.95 (0.22)	3.63 (0.25)
Conflict	2.67 (0.34)	3.03 (0.32)	2.93 (0.36)
Non-specific	Total = 7.82 (0.47)	Total = 8.43 (0.45)	Total = 7.86 (0.50)
Non-conflict	4.61 (0.27)	4.70 (0.26)	4.53 (0.29)
Conflict	3.21 (0.31)	3.73 (0.29)	3.33 (0.33)

Hypothesis two: Belief bias theory. In line with the belief bias theory, it was predicted that HP and SA individuals would display a greater belief bias (higher BB scores) when the syllogisms are related to their concerns, compared to when the content is non-specific. This difference was predicted to be greater than the corresponding differences in the L group. A 3 (group) X 3 (content) X 2 (congruency) repeated measures ANOVA was conducted to test this hypothesis. The analyses found a significant main effect of conflict ($F(1,97)= 58.67$, $p=<0.01$). Further exploration of the data found that all participants solved congruent syllogisms more accurately than conflict syllogisms, irrespective of content. This finding supported the more general belief bias theory of reasoning. It was then observed that the interaction between congruency and content within each group was not significant ($F(2,97)=2.13$, $p=0.12$). This indicated that there were no significant differences in belief bias scores within each group according to syllogism content. Finally, there was no significant interaction between content and congruency, according to group membership ($F(4,194)=0.23$, $p=0.92$). This finding indicates that there were no significant differences between groups on belief bias scores according to syllogism content.

Exploratory analyses looked at whether HP and SA individuals were more susceptible to belief bias compared with L participants, irrespective of syllogism content, in

line with some previous research. A one-way ANOVA found that there were no significant difference in belief bias scores overall between groups ($F(2,97)=0.22$, $p=0.81$), indicating that HP and SA individuals were not any more or less susceptible to belief bias across content, compared with L participants.

Hypothesis three: Relationship between thinking styles and paranoia. In line with previous research, it was predicted that paranoia severity would be positively associated with an intuitive thinking style and negatively associated with analytical thinking style in the HP group. This would be reflected in less accurate reasoning on "conflict" syllogisms (i.e. where there is a conflict between the validity and plausibility of the conclusion), fewer beads viewed on the beads task (indicating the presence of the JTC bias), a higher score on the FI sub-scale and a lower score on the NFC sub-scale of the REI and a lower total score on the CRT. A correlation analysis was conducted using all study variables in the HP group (see Appendix 6 for correlation matrix). The analysis found no significant relationship between paranoia severity and performance on conflict syllogisms ($r(34) = -0.06$, $p=0.75$), score on the CRT ($r(34)= -0.17$, $p=0.34$) or performance on the beads task ($r(34)=0.05$, $p=0.80$). Interestingly, a significant positive relationship was reported between paranoia severity and an analytical thinking style, as measured by the REI ($r(34)=0.37$, $p=0.03$) There was a also trend towards a significant positive relationship between paranoia severity and a faith in intuition in this group ($r(34)= 0.29$, $p=0.1$).

DISCUSSION

The current study aimed to further the understanding of reasoning processes associated with paranoid thinking. Specifically, the research explored logical reasoning and thinking styles in individuals with non-clinical paranoia, as a test of the HET, the dual-process model and the belief bias theory. HP individuals were compared with participants

scoring high in social anxiety and those scoring low on both measures. In line with the HET, it was predicted that HP and SA participants would reason more accurately on the logical reasoning task when the content was related to their concerns. In contrast, belief bias theory predicted that HP and SA participants would display an enhanced belief bias when reasoning about content related to their concerns, compared to when the content was non-specific. Neither hypothesis was supported by the study findings. Finally, it was predicted that paranoia severity would be positively associated with an intuitive thinking style, and negatively associated with an analytical thinking style in the HP group. Interestingly, the current study found some evidence that paranoia severity was in fact positively associated with both analytical and intuitive reasoning. In light of this, however, there was no significant association between paranoia severity and other measures of analytical and intuitive reasoning (CRT, conflict syllogisms and the beads task). This section will open with a discussion of the study findings in relation to theory and previous research. The strengths and limitations of the study will then be discussed, before considering future research and possible clinical implications. The findings of the thesis will then be drawn together with conclusions.

Hypothesis one: **The HET**.

A small number of studies have explored reasoning abilities in individuals with clinical (Huddy, Brown, Boyd & Wykes, 2012) and non-clinical paranoia (Rose et al., in press) as a test of the HET. Both studies used simulation methodologies to assess future-directed reasoning in individuals experiencing paranoid thoughts. The research found that enhanced reasoning was not observed in individuals with paranoia when the task content was relevant to their concerns. It was speculated that perhaps paranoia was not significantly associated with the use of imagery-based, future-directed thinking as captured by this methodology. A syllogistic reasoning task was therefore used in the current study to assess

logical reasoning ability, as has been used by other researchers testing the HET and belief bias theories. In light of this, however, the present study added to a growing evidence base suggesting that a preoccupation with paranoid thoughts may not be associated with enhanced reasoning about feared material. Along the same lines, a number of studies have tested the HET using socially anxious individuals. Some research has found evidence of expert reasoning when the task content is disorder-relevant in this group (Rose et al., in press), however other studies have failed to replicate these findings (Vroling et al., 2009). It is not immediately clear why the pattern of reasoning described by the HET was not replicated in the current study. Several hypotheses could be put forward to explain these findings.

Firstly, the HET suggests that underlying patterns of repetitive thinking gradually leads the individual to envisage a wider range of possibilities linked to their feared outcome (Johnson-Laird et al., 2006). Such cyclical patterns of thinking as described by the HET, may not be as typical of paranoia compared with anxiety disorders such as OCD. Research has shown that more cursory thinking tends to be observed in paranoia (Dudley & Over, 2003; Jacobsen, Freeman & Salkovskis, 2012). In addition, the anticipatory nature of the anxiety characteristic of disorders such as phobias may promote this rehearsal of disorder-relevant content as described by the HET. In contrast, research suggests, however, that self-referential ideation, typical of both social anxiety and paranoia, is influenced more by acute fear, the environment, and present time perceptions (e.g., a facial expression; Freeman et al., 2008) that are less anticipatory. Further, there is evidence in the literature that paranoia and social anxiety are partly maintained by a type of post-event, as opposed to pre-event, ruminative processing, which involves the mental replaying of social events after their conclusion (Piccirillo & Heimberg, 2016). Such factors mean that paranoia, and perhaps social anxiety, may be less well explained by the HET.

In addition, a number of methodological limitations of the study should also be addressed. First, whilst efforts were made to ensure that the syllogisms contained common paranoia and social-anxiety related concerns, the pilot data indicated only moderate inter-rater reliability. It may be that the content was not matched sufficiently to individual beliefs to elicit the corresponding reasoning style predicted by the HET. For example, Keen, Brown and Wheatley (2008) reported that when the task content was not personally relevant to an individual's OCD-related concerns, reasoning was less accurate compared to when the task content was personalized. In addition, the internal reliability of the content scales devised for the study was fairly low, indicating that the items may not have adequately measured the variable of interest (Kline, 2000). In light of this, however, it could be argued that the syllogistic reasoning task is an experimental task as opposed to a psychometric measure, in which case the reliability co-efficient may be of less importance here. Future research should address these points.

A number of other extraneous factors could have influenced these findings. Firstly, efforts were made to avoid potential threats to validity in the current study, including participant fatigue. For example, fewer items were included in the logical reasoning task compared with previous research (Gangemi et al., 2013) and the reasoning task was placed at the start of the study. However, it is possible that the cognitive effort required to solve the syllogisms correctly may have caused participants to become tired, dampened their interest and reduced emotional arousal. In light of these factors, participants may have been less motivated to complete the task to the best of their abilities. We may have therefore been unable capture the same cognitive processes that would be activated if the participants were motivated and aroused. Another possibility is that the study lacked sufficient power to detect statistical differences between groups. Previous research exploring the HET has explored the logical reasoning abilities of clinical participants (Gangemi et al., 2013). In

light of this, it may well be that, in line with continuum theories, enhanced logical reasoning is apparent in non-clinical paranoia and less severe social anxiety, albeit to a lesser extent than in individuals with more severe and pervasive beliefs. Although the current study recruited more participants than was indicated by the power analysis, it may be that the current sample was still not large enough to detect more subtle differences in reasoning between groups. Future research should address these study limitations.

Hypothesis two: The belief bias theory

Firstly, the study found that all participants tended to accept congruent conclusions as valid more often than incongruent conclusions, in line with the global belief bias theory (Evans et al., 1993). Next, the current study found that HP and SA individuals did not display an enhanced belief bias when content was related to their concerns in some way. This finding was in contrast with previous research in the area (Vroling & de Jong, 2009; Vroling et al., 2016). A number of factors should be considered when reflecting on this finding. First, as discussed above, the syllogisms may not have captured HP and SA relevant-concerns sufficiently enough to elicit the reasoning style predicted. Again, it may well be that the study lacked sufficient power to detect any findings. Sample size was calculated based on the assumption of large effects (Johnson-Laird et al., 2006), whereas previous studies exploring belief bias in individuals with psychological difficulties have reported small-to-moderate effect sizes (Vroling et al., 2016). It may have been that a significant difference in symptom-specific belief bias would have been evident had we used a larger sample. In addition, some studies exploring belief bias have measured the bias in terms of the time taken to arrive at a conclusion on each item (RT's). It could be argued that reaction time is a more accurate indicator of belief bias, as a measure of the Type one and Type two reasoning processes. However, belief bias is likely to translate into reasoning errors in day-to-day life, as life events typically demand quick-responses as opposed to

having a lot of time to reflect on the logical validity of a conclusion drawn. It could thus be argued that measuring belief bias in terms of reasoning errors made is likely to capture more 'realistic' reasoning processes.

Interestingly, some research has hypothesised that individuals with psychological difficulties display an enhanced reasoning bias more globally, across all of their beliefs. (De Jong et al., 1997; Vroling & de Jong, 2010). The current study did not find evidence of an enhanced belief bias across task content in HP and SA compared with L participants. On review of the literature, it was found that no relationship between a generally enhanced belief bias and psychopathology has been found in observational studies using healthy, analogue and patient samples (Smeets & de Jong, 2005; Vroling & de Jong, 2009). In light of this, however, when using a fear conditioning paradigm as a means of modelling the development of an anxiety disorder, a generally enhanced belief bias was especially marked when participants were in a state of fear (Juth, Lundqvist, Karlsson, & Ohman, 2005; Mansell, Clark, Ehlers, & Chen, 1999). In line with this, it could be that symptom-related belief bias may be more evident during the activation of fear, which perhaps was not elicited using the syllogistic reasoning task. One way to test this assumption would be to induce a state of anxiety/paranoia prior to the presentation of the task (Kirschbaum, Pirke & Hellhammer, 1993). Bringing these results together, it may well be that a generally heightened belief bias itself does not contribute to the development of anxiety disorders, but that heightened belief bias combined with anxiety-inducing learning experiences may well do. If so, it is likely only one of the many factors that contribute to the development and maintenance of anxiety disorders.

Hypothesis three: Relationship between thinking styles and paranoia.

The hypothesis for the current study was made in line with previous research (Freeman, Evans and Lister, 2012), which found that self-reported use of intuitive

reasoning was associated with higher levels of persecutory thinking, whilst analytical thinking was protective. Consistent with these findings, Daalman, Sommer, Derks and Peters (2013) found that healthy voice-hearers showed high levels of 'emotional reasoning' (a bias showing clear overlap with intuitive reasoning). A number of clinical interventions have been developed based on these findings. One example of this is the 'SlowMo' app (Garety et al., 2017), a protocol-driven individual therapy delivered via mobile phone. The intervention aims to reduce paranoia by supporting individuals to notice their upsetting concerns and fast-thinking habits, and then provides them with strategies to slow down, focus on new information, develop safer thoughts and engage more with Type two thinking.

As the findings were in contrast with the literature, it could be hypothesised that the current study findings may be due to a number of factors. First, acquiescence effects, defined as 'the general tendency of an individual to provide affirmative answers to items of a questionnaire, regardless of the content of the items' (Hinz, Michalski, Schwarz & Herzberg, 2007) could have meant that participants seemingly displayed a preference for intuitive and rational thinking on the REI-10. However, correlations between the NFC and FI subscales and other variables (e.g. BB, PS syllogism total) contradict this assumption. Further, another study reported that a preference for both intuitive Type one and Type two thinking styles was associated with stronger paranormal beliefs (Wolfradt, Oubaid, Straube, Bischoff & Mischo, 1999). Instead, this finding could be explained by a complementary relationship between these different forms of information processing systems, as outlined by parallel processing, dual-model theories of reasoning. The predominance of both intuitive and analytical reasoning could also explain why no relationship was found between paranoia severity and other study measures (CRT-4, Beads task & conflict syllogisms), which tap into both reasoning styles simultaneously, as opposed to measuring each reasoning style as separate constructs.

Speechley, Murray, McKay, Munz and Ngan (2010) proposed a Dual-Stream Modulation Failure model hypothesis that could help explain the current study findings. The researchers explained that typically, most situations result in the convergence of Type one and Type two reasoning processes, though it is not uncommon for divergence to occur. The occurrence of diverging outcomes often leads to an internal conflict or sense of dissonance. It is proposed that this conflict has a modulating influence in favour of Type two processing, thus reducing the likelihood of erroneous, intuitive judgments. In delusional ideation, convincing counter-evidence fails to persuade an individual of the inaccuracy of their beliefs. This fundamental error in decision-making may result from a failure to notice or respond to internal conflict generated by the divergence of the two streams. This may cause individuals to apply both reasoning styles in a dysfunctional way, which means that erroneous beliefs are not corrected. Functional imaging data supports this hypothesis, with schizophrenia patients showing reduced activation in conflict detection regions of the brain in response to incongruent stimuli during a Stroop task (Carter, Mintun, Nichols & Cohen, 1997).

Other studies using clinical participants with persecutory delusions have reported somewhat different findings to those discussed above. One study found that a combination of low analytic and low experiential reasoning was associated with the greatest levels of paranoia (Freeman, Lister & Evans, 2014). The reduced engagement with intuitive reasoning processes was an unexpected finding. It was hypothesised by the authors that this may reflect patients with severe paranoia being less aware of their decision-making processes, or being unconfident in their reasoning abilities and hence less able to re-evaluate fearful cognitions. An interesting study by Ward, Peters, Jackson and Garety (2017) explored the dual process model of reasoning across the psychosis continuum. The researchers found that individuals with psychosis associated with a need-for-care, employed

less analytical reasoning on a reasoning task compared with the other groups. In contrast, those with psychosis but without need-for-care, did not differ from controls in analytical reasoning abilities. Interestingly, in line with the current study findings, the non-clinical group also demonstrated high levels of experiential reasoning, with over 60% showing clear evidence of both reasoning processes. These findings suggest that the relative use and application of each thinking style is likely to vary across the psychosis continuum.

Although not an a priori hypothesis, it was noted that individuals with paranoia displayed moderate levels of depression, anxiety and stress. This was in contrast with L participants, who scored in the normal ranges on all three measures. It is widely acknowledged that psychosocial stress is associated with, and can precipitate psychotic symptoms (Corcoran, Mujica-Parodi, Yale, Leitman & Malaspina, 2002). Further, the association between anxiety and paranoia is widely acknowledged, and a number of interventions have been developed to treat these symptoms, with promising results (Freeman & Fowler, 2009). Depression has been found to be a risk factor in the development and maintenance of paranoia (Salokangas et al., 2015) as well as a being a response to experiencing paranoid thoughts. In light of this, however, the mechanisms by which symptoms of depression influences paranoid thinking is less clear. It is hypothesised that depressive ideas about oneself, such as negative self-schemas, directly feed into the content of the paranoid beliefs, and low mood is a key maintenance factor (Vorontsova et al., 2013). Others have highlighted that an interaction between low self-esteem, anxiety and depression puts individuals at risk of developing paranoia (Ben-Zeev, Granholm & Cafri, 2009). Longitudinal studies are needed to assess the relative contribution of depressive symptoms to paranoid thinking in this group. If depression is found to be a risk factor, the effective treatment of the symptoms is likely to alleviate paranoid symptoms and improve interpersonal functioning.

Strengths and Limitations

Design. A number of study design limitations must be discussed. Firstly, as the study was cross-sectional, the associations described could be explained by an unmeasured confounding variable, while the direction of the relationship between thinking styles and paranoia cannot be known. Further, we did not conduct a manipulation check of the believability of the syllogisms used, as was done by other researchers (Gangemi et al., 2013). In light of this, some conclusions described may have been more or less believable than others. This may have influenced the findings of the belief bias test.

In addition to this, a decision was made to explore reasoning and thinking styles in paranoid individuals scoring above the cut off of 52 on the PS. Whilst this method captured the association between reasoning and paranoia at the more severe end, it could be argued that the variability in the ways by which these factors interact with paranoia across the continuum is not adequately captured by grouping participants in this way. Future research should explore thinking styles and paranoia across the continuum, to shed light on the different ways they are implicated in paranoid thinking. Future studies could use regression analyses to explore whether experiential and/or rational thinking predicts paranoia severity.

Sample. Attention should also be drawn to limitations concerning the sample as a whole. The sample used was fairly homogenous, in that most participants were young, white, female, and well-educated undergraduate students. Research has shown that performance on reasoning tasks is associated with cognitive ability (Stanovich & West, 1998) and belief bias scores have been found to decrease with intelligence and with training in analytical reasoning (MacPherson & Stanovich, 2007), both of which are likely to be present in educated groups. These factors may limit the generalizability of the findings. Further, the participants recruited were not from a clinical sample experiencing persecutory beliefs. In line with the continuum theory, non-clinical and clinical paranoia are related

experiences and are hypothesised to be associated with the same cognitive, behavioural and social biases (Freeman et al., 2010). However, differences between clinical and non-clinical experiences have been reported in the literature (Van Os, Linscott, Myin-Germeys, Delespaul & Krabbendam, 2009) so the application of the study findings to clinical samples should be made with caution.

Measures. A strength of the current study is the use of well-validated measures with good psychometric properties. Self-report measures such as those used in the current study have several limitations, however, and can be influenced by a number of factors such as exaggeration, response bias and social desirability biases (Furnham & Henderson, 1982). In light of this however, online studies have been found to be less susceptible to this bias than face-to-face research (Furnham, 1986). In addition to this, the measure of paranoia used in the study could attract some criticism. The PS could be criticised for containing many items that are not clearly persecutory (e.g., 'my parents and family find more fault with me than they should') and does not provide an estimate of the frequency or distress of paranoid thoughts. This may limit the extent to which conclusions can be drawn about the experiences of the participants in relation to their paranoia. This limitation could be addressed in future studies by using a measure such as the Green Paranoid Thoughts Scale (GPTS), which addresses the distress caused by paranoid thoughts, as well as the conviction with which beliefs are held. It could be argued that these items better capture the paranoid experience (Green et al., 2008). Finally, whilst unlikely, it is possible that the rates of paranoia reported by the HP group study were inflated by participants' experience of genuine persecution.

Another limitation was that there were a large number of questionnaires used in the study. This may have impacted negatively on participants due to respondent fatigue. Respondent fatigue is a phenomenon that occurs when participants 'become tired of

completing a questionnaire and the quality of the data they provide begins to worsen' (Lavrakas, 2008). This might have had an impact on the validity of the measures used, but also may have had an emotional impact on the participants in the study, who were already struggling with difficult experiences.

In addition, it could be argued that the syllogistic reasoning task used lacks ecological validity and that the use of a task which mimics every day decision-making processes may have been more suitable. The paranoia-related and non-specific syllogisms were obtained from a colleague in Italy and had been directly translated to English by the authors. The syllogism items then needed paraphrasing and adjusting to ensure that the items made grammatical sense. These changes to the syllogisms meant the questionnaire was not the same as the one which had been successfully used in previous research. Further, as discussed previously, the reliability of the syllogisms was low. Future research should ensure that attention and time is dedicated to the development of a reasoning task due to the importance of a valid and reliable measure in obtaining meaningful results (Kimberlin & Winsterstein, 2008).

Future directions and clinical implications

The current study highlights a range of possible avenues future research. A larger scale study should be conducted to ensure that more subtle differences in reasoning ability between groups can be detected. Future research could replicate the initial study, recruiting participants high in non-clinical paranoia, as well as a sample of clinically paranoid participants, to explore whether evidence for the belief bias theory and the HET are detected at a higher intensity in clinical participants. Syllogisms should be matched to individual concerns in a meaningful and relevant way in order to ensure that the hypothesised corresponding reasoning style can be elicited. It may be clinically relevant to

explore whether inducing a state of fear has any influence on logical reasoning abilities in individuals with psychological difficulties.

Further, it is of note that cognitive therapy generally encourages analytic thinking in order to challenge dysfunctional judgements and moderate the influence of experiential reasoning. The Dual-Stream Modulation Failure model provides a basis to support the development of new metacognitive therapies designed to bring conscious awareness to the divergence of Type one and Type two thinking. Future research studies exploring whether manipulating therapeutically the type of reasoning style alters the course of delusions would be of value (Waller et al., 2011). There are also grounds to examine experiential and rational reasoning styles in relation to other delusion-relevant factors, such as belief flexibility and attribution biases (So et al., 2012). It would also be informative to assess these thinking styles in relation to other clinical variables such as global functioning, to explore the wider impact of different reasoning processes.

CONCLUSION

In summary, the present study did not support the predictions made in line with the HET and belief bias theory. Possible reasons for these findings are discussed, including the need to match content more idiographically to individual concerns and the use of a non-clinical sample. A preference for analytic, and to some extent intuitive, thinking was found to be associated with paranoia severity in the HP group, a finding in contrast to some of the existing findings in the literature. It light of these results, it could be hypothesized that the simple presence or absence of analytical or intuitive reasoning may not be directly related to the maintenance of paranoid beliefs. It may well be the dynamic interaction between the two systems, the conscious modulation of these streams and the ways by which the reasoning styles are applied in certain situations may be more relevant to understanding delusional beliefs (Evans & Stanovich, 2013). Further, the ways by which the two systems

interact appears to vary along the continuum of paranoia, as well as in different situations (eg., in state of fear in social situation vs. conducting a reasoning task online), though this warrants further research attention.

Chapter 3: Integration, Impact and Dissemination

INTEGRATION

This thesis aimed to improve and further the understanding and treatment of reasoning biases across the psychosis continuum. More specifically, the thesis aimed to a) identify and synthesise the literature assessing the efficacy of cognitive interventions targeting reasoning biases in individuals with psychosis and b) explore logical reasoning abilities, as well cognitive style more generally, in delusion-prone individuals. Both papers highlighted the growing interest in the role of reasoning biases in the development and maintenance of psychotic symptoms such as paranoia.

In preparation for the empirical study, I was required to do a great deal of background reading to get to grips with some of the concepts and terminology used in the experimental cognition literature. This involved a thorough exploration of the literature on the Hyper-emotion theory (HET) and the belief bias theory of psychological illness. Both theories have received support through research with individuals with a number of psychological difficulties, and have shown promising trends (Johnson-Laird et al., 2006). It was suggested by several authors that the psychological treatment of psychological symptoms could change if the theories gained enough empirical support. For example, the HET suggests that psychological illnesses are merely transitions from normal life to abnormal emotions. The therapeutic goal would then be to undo the transitions and to undo otherwise expert patterns of inference that strengthen their effects.

The systematic review topic was chosen due to its clear relevance to the empirical study; as I became interested in looking at how effective the current cognitive interventions were at ameliorating reasoning biases such as these. Although research exploring the treatment of reasoning biases in psychosis is rapidly expanding, a review of the literature had not previously been conducted. The review highlighted the wide variety of cognitive interventions available, as well as the range of reasoning biases implicated in psychosis.

Spending the time to absorb the literature in such a way resulted in a greater understanding of the literature, greatly aided the writing of the empirical paper and contributed to a more thorough understanding of some of the cognitive processes associated with psychosis.

It was also of interest to explore whether many treatments targeting logical reasoning in psychosis had been developed and tested. The systematic review did not find any studies testing cognitive interventions targeting logical reasoning in psychosis. This finding highlighted a need within this area for further research with both non-clinical and clinical psychosis populations. However, during the review process it was apparent that many potentially relevant studies had not used controlled methodologies and thus were not amenable for inclusion in the review presented. In light of this, it should also be noted that a wider range of cognitive interventions targeting reasoning biases in psychosis likely exist, although were not represented in the review. Employing less-restrictive inclusion criteria in this regard might have lead to the inclusion of a wider range of interventions and the results may have been more representative of the interventions available.

The empirical study explored logical reasoning abilities in delusion-prone individuals, which was born out of a desire to further understand reasoning processes associated with paranoid experiences. As was recognised through conducting the systematic review, a wide range of reasoning biases are implicated in paranoia, however the role of logical reasoning has received relatively little research attention. Recruitment for the empirical study proved to be extremely fruitful, even though previous research has found that individuals experiencing paranoia may be difficult to recruit for studies (MacKinnon, Newman-Taylor, & Stopa, 2011). The differences between clinical (as represented in the systematic review) and non-clinical participants (as included in the empirical article) should be noted, in particular differences in conviction and distress associated with the delusional beliefs, which are likely to separate clinical and non-clinical presentations (Kiran &

Chadhury, 2009). A major limitation of this study was the selective nature of the sample. For example, study participants were predominantly Caucasian and female, which is in stark contrast to the typical psychosis population (Kirkbride et al., 2008), as represented by many of the studies included in the systematic review. The empirical study did not find any support for the HET or the belief bias theory, however did find a relationship between paranoia severity and intuitive and analytical reasoning processes. The findings suggest that interventions targeting these various reasoning processes would have clinical utility.

IMPACT AND DISSEMINATION

The Economic and Social Research council (ESRC) defines research impact as 'the demonstrable contribution that excellent research makes to society and the economy'. This can involve academic impact, economic and societal impact, or both. It is anticipated that the findings from paper one will be submitted to the Clinical Psychology Review journal for publication. It is hoped that the findings of the systematic review will influence the recommendations made for specific reasoning biases and types of therapy offered by mental health services. Further, it is hoped that there will be an increased awareness of different therapy types available for use by mental health professionals following the dissemination of the review findings. If treatments are to be improved through tailoring interventions according to their efficacy, benefits are likely to be felt across systems. For example, individuals with psychosis are likely to benefit from a better quality of life and emotional wellbeing, which is likely to extend to the psychological well-being of their carers, who frequently experience a number of physical and psychological difficulties (Poon, Curtis, Ward, Loneragan & Lappin, 2018). Further, the economy may benefit from lower rates of unemployment if symptoms, and thus the functioning, of psychosis patients are improved. Further, the NHS could benefit from reduced costs associated with lower

levels of inpatient or emergency admissions, if individuals with psychosis are better able to function in the community. In light of this, however, while advances have been made over recent years, there is still much work needed in the development of effective psychological treatments for psychosis (Jones, Hacker, Cormac, Meaden & Irving, 2012).

The findings from paper two have been presented to other trainee clinical psychologists and staff members at Royal Holloway via a PowerPoint presentation. The thesis will also be disseminated by including a copy in the institution's electronic archives and will be submitted for publication to the Schizophrenia Research journal. As highlighted previously, whilst an expanding field, research into the HET and belief bias theory is in its infancy and the study data is too preliminary and inconclusive to change clinical practice. The impact of this research is likely to occur incrementally, in the context of a broader field of research, over time. It is hoped that the current research will inspire the development of studies testing the HET and belief bias theory in paranoia. Further, the findings highlight the importance of assessing, and potentially working therapeutically with, the application of different reasoning processes in individuals with psychosis (Freeman et al., 2014).

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APPENDICES

Appendix 1: RHUL Ethics Committee Approval

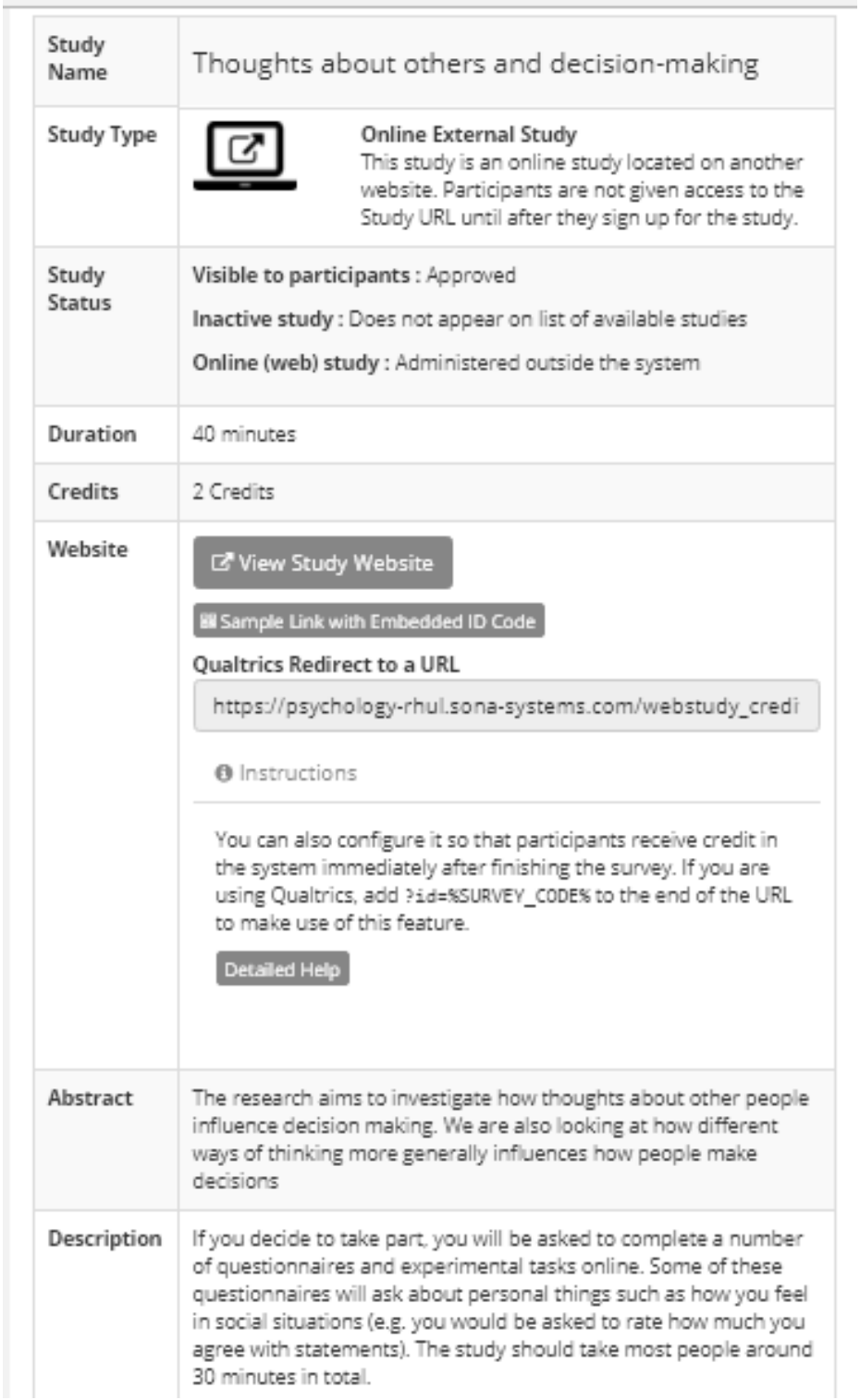
Mon 02/10/2017, 21:09
Deweever, Natalie (2015);
Brown, Gary;
ethics@rhul.ac.uk
Inbox
PI: Gary Brown
Project title: Reasoning in delusion-prone individuals

REC ProjectID: 482

Your application has been approved by the Research Ethics Committee.
Please report any subsequent changes that affect the ethics of the project to the University Research Ethics Committee ethics@rhul.ac.uk

Appendix 2: Advertisement for study

Credit pool study information



Study Name	Thoughts about others and decision-making
Study Type	**Online External Study** This study is an online study located on another website. Participants are not given access to the Study URL until after they sign up for the study.
Study Status	**Visible to participants :** Approved **Inactive study :** Does not appear on list of available studies **Online (web) study :** Administered outside the system
Duration	40 minutes
Credits	2 Credits
Website	View Study Website Sample Link with Embedded ID Code **Qualtrics Redirect to a URL** https://psychology-rhul.sona-systems.com/webstudy_credi Instructions You can also configure it so that participants receive credit in the system immediately after finishing the survey. If you are using Qualtrics, add `?id=%SURVEY_CODE%` to the end of the URL to make use of this feature. Detailed Help
Abstract	The research aims to investigate how thoughts about other people influence decision making. We are also looking at how different ways of thinking more generally influences how people make decisions
Description	If you decide to take part, you will be asked to complete a number of questionnaires and experimental tasks online. Some of these questionnaires will ask about personal things such as how you feel in social situations (e.g. you would be asked to rate how much you agree with statements). The study should take most people around 30 minutes in total.

Appendix 3: Information sheet and consent form

Information sheet

Information sheet

Study title: Thoughts about others and decision making

My name is Natalie DeWeever and I am a Trainee Clinical Psychologist studying at Royal Holloway, University of London. Before you decide whether to participate in this study, I would like you to understand what the research will involve and why the study is being conducted. Below you will find some information about the research. Please read this information carefully. If you have any questions, then please contact me using the email address listed below.

What is the purpose of this study?

The research aims to investigate how thoughts about other people influence decision making. We are also looking at how different ways of thinking more generally influences how people make decisions

Do I have to take part?

No. It is your choice whether you participate or not and your participation is entirely voluntary. If you do decide to take part, then you are free to withdraw from the study at any time and you do not need to give a reason.

What would taking part involve?

If you decide to take part, you will be asked to complete a number of questionnaires and experimental tasks online. Some of these questionnaires will ask about personal things such as how you feel in social situations (e.g. you would be asked to rate how much you agree with statements). The study should take no longer than 30 minutes in total.

Are there any disadvantages or risks to taking part?

We do not anticipate that there will be any disadvantages to taking part, except for the time commitment taken to complete the questionnaires and tasks. Although it

is unlikely, it is possible that you may feel uncomfortable or distressed answering some of the questions you are asked. If this is the case, we have provided some information at the end of the study about seeking support if you are distressed. You are also free to not answer questions which you do not feel comfortable answering.

Are there any benefits to taking part and what will happen to the results?

If you are a first year undergraduate psychology student you will earn 2 course credits for your participation in this study. If you are not, you will be entered into a prize draw to win one of five £20 Amazon vouchers.

Will my information remain confidential?

All information that is collected during the course of the research will be kept confidential. The questionnaire scores and task data will be anonymised and stored securely on a database. Only the researchers will have access to the information you give during the study. The results from the research study will be written up and submitted as part of a Doctoral

Who can I contact about the study?
If you have any questions about the study, please contact me using the following contact details:

Natalie DeWeever, Trainee Clinical Psychologist, Royal Holloway
Natalie.DeWeever.2015@live.rhul.ac.uk

If you have any concerns about how the study is being conducted, you can contact my supervisor using the details below:

Dr Gary Brown
Gary.Brown@rhul.ac.uk

Thank you for considering taking part and/or taking time to read this information.

Consent form

Consent form

Please confirm that you:

Understand the nature of the study proposed, having read and understood the information sheet provided. I have had the opportunity to ask questions (via e-mail to natalie.deweever.2015@live.rhul.ac.uk), and I am satisfied with the answers I received.

Yes
No

Understand that my participation in the study is entirely voluntary and that I am free to withdraw at any time without giving a reason

Yes
No

Agree that if I decide to withdraw from the study then the researchers can continue to use the data and information I have already given them unless I ask for this to be destroyed.

Yes
No

Agree to take part in the study

Yes
No

Appendix 4: Debrief form

Debrief form

Thank you for your participation in this study. If you are a first year undergraduate psychology student you will be awarded 2 course credits. If you are not and you have submitted your contact details before starting, you will now be entered into the prize draw where you will have a chance of winning one of five £20 Amazon vouchers. Your details will be separated from your responses to preserve confidentiality.

What was the purpose of this study?

Many people experience suspicious or worrisome thoughts about other people (Freeman et al, 2005). In this study we are interested in looking at whether these commonly experienced thoughts influence how people make decisions, particularly when the decision is related to these worries in some way. We are also looking at whether different thinking styles more generally (eg. analytical or logical approach to problems) influence how people make decisions. If you are interested in hearing about the results and conclusions of the study, please inform the principal researcher via email (Natalie.DeWeever.2015@live.rhul.ac.uk),

Why is this useful?

Worrisome thoughts are common and distressing so we are seeking to understand the factors that might maintain and reduce them.

Will I be identifiable in this research?

The results of this study will not/cannot include any identifiable information about you.

What can I do if I feel distressed by any part of the study?

We do not expect people to feel worse after completing this study, but if you do feel you would like some support to help with difficult emotions, please contact your GP and inform the principal researcher via email. The university also offers a counselling service, and you may also wish to contact the Samaritans:

Royal Holloway Counselling Service

Website: http://www.rhul.ac.uk/ecampus/welfare/counselling/home.aspx
Telephone: 01784 443 128

Email: counselling@rhul.ac.uk
Location: FW171

Samaritans

Website: http://www.samaritans.org/
Telephone: 08457 90 90 90 (UK) or 1850 60 90 90 (ROI)
Email: jo@samaritans.org

Appendix 5: Empirical study measures

Cognitive Reflection test (CRT-4; Frederick, 2005)

(1) 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

(2) Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class? _____ students

(3) 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? _____ dollars

(4) 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

Social Phobia Inventory (SPIN; Connor et al., 2000)

		0: not at all	1: a little bit	2: some - what	3: very much	4: extre - mely
1	I am afraid of people in authority					
2	I am bothered by blushing in front of					
3	parties and social events scare me					
4	I avoid talking to people I don't know					
5	being criticized scares me a lot					
6	I avoid doing things or speaking to people					
7	sweating in front of people causes me					
8	I avoid going to parties					
9	I avoid activities in which					
10	talking to strangers scares me					
11	I avoid having to give speeches					
12	I would do anything to avoid being					
13	heart palpitations bother me					
14	I am afraid of doing things					
15	being embarrassed or looking stupid are					
16	I avoid speaking to anyone in authority					
17	trembling or shaking in front					

Syllogism questionnaire (with key)

SYLLOGISTIC REASONING QUESTIONNAIRE (S.R.Q.)

In this questionnaire you will be asked to judge whether the conclusions presented are logically valid or not. By logically valid, we mean that the conclusion must be true, after taking into account the information given. Each question has two statements (A and then B) followed by a conclusion (C). Your task is to decide if C (the conclusion) logically follows from the two statements (A and B).

- Choose **YES** if the suggested conclusion (C) *follows logically* from the previous statements (A and B)

- Choose **NO** if the suggested conclusion ***does <u>not</u>*** *follow logically* from the preceding statements.

For example:

(A) No priests are criminals

(B) Some religious people are criminals

Does it logically follow that...

(C) Some religious people are not priests

Given the fact that no priests are criminals and some religious people are criminals, it must be true that some religious people are not priests. So this conclusion is **valid**.

Please work through the problems in order and make sure you do not miss any. If you have any questions please let me know.

1. (A) Sometimes, when my friends don't believe me, I argue with them. (B) Every time my friends don't believe me, I feel they're plotting against me. *Does it logically follow that…* (C) …sometimes, when I argue with my friends, I feel they're plotting against me. P	YES NO
2. (A) Every time I attend a funeral I feel like crying. (B) Sometimes, when I feel like crying, I'm happy. *Does it logically follow that…* (C) …sometimes, when I attend a funeral, I'm happy. HE	YES NO
3. (A) Sometimes, when I'm alone, I start thinking. (B) Sometimes, when I start thinking, I feel people are robbing me of my thoughts. *Does it logically follow that…* (C) …sometimes, when I'm alone, I feel people are robbing me of my thoughts. P	YES NO
4. (A) Every time I walk down the street, I think I'm being followed. (B) Sometimes, when I walk down the street, I feel I'm in danger. *Does it logically follow that…* (C) …sometimes, when I think I'm being followed, I feel in danger. P	YES NO
5. (A) All politicians are corrupt.	

(B) Some of my friends are not corrupt. *Does it logically follow that…* (D) …some of my friends are not politicians. HE	YES NO
6. (A) Some antiabortionists are conservative. (B) All Catholics are antiabortionists. *Does it logically follow that…* (C) … some Catholics are conservative. HE	YES NO
7. (A) All television messages are coded. (B) Some coded messages are harmless. Does it logically follow that… (C) …some television messages are harmless. P	YES NO
8. (A) Some men are not evil. (B) All rapists are men. *Does it logically follow that…* (C) … some rapists are not evil. HE	YES NO
9. (A) Some of my persecutors are not friends of mine. (B) Everyone who is mad at me are friends of mine. *Does it logically follow that…*	

(C) … some of my persecutors are not mad at me. P	YES NO
10. (A) Sometimes, when I get angry, I can't control myself. (B) Sometimes, when I feel insulted, I get angry. *Does it logically follow that…* (C) …sometimes, when I feel insulted, I can't control myself. HE	YES NO
11. (A) Some drug addicts are married. (B) Some married people are happy. *Does it logically follow that…* (C) …some drug addicts are happy. HE	YES NO
12. (A) All alcoholics are violent people (B) Some violent people go to jail. *Does it logically follow that…* (C) … some alcoholics go to jail. HE	YES NO
13. (A) Some priests are pedophiles. (B) All priests are male. *Does it logically follow that…* (C) … some pedophiles are male.	YES

HE	NO
14. (A) Some of the things that are taught by our parents are false. (B) Some of the things I believe, have been taught by my parents. *Does it logically follow that…* (C) … some of the things I believe are false. P	YES NO
15. (A) Some murderers are not evil. (B) All violent people are evil. *Does it logically follow that…* (C) … some murderers are not violent. HE	YES NO
16. (A) Some smart people are not evil. (B) All of my persecutors are smart people *Does it logically follow that…* (C) … some of my persecutors are not evil P	YES NO
17. (A) Every time that I watch TV, there are news reports about violence. (B) Sometimes, when I watch the news on the TV, I feel at peace *Does it logically follow that…* (C) … sometimes, when there are news reports about violence I feel at peace HE	YES NO

18. (A) Some important people are happy. (B) Persecuted people are important people *Does it logically follow that…* (C) … some persecuted people are happy. P	YES NO
19. (A) Everytime I'm in a large crowd of people I hear them talking. (B) Sometimes, when I hear people talking, I think they're talking about me. *Does it logically follow that…* (C) … sometimes, when I'm in a large crowd, I think they're talking about me. P	YES NO
20. (A) Every time I suspect people, I feel safe. (B) Sometimes, when I feel persecuted, I don't feel safe. *Does it logically follow that…* (C) … sometimes, when I feel persecuted, I don't suspect people. P	YES NO
21. (A) Some nervous people are incompetent (B) All nervous people sweat *Does it logically follow that…* (C) … some incompetent people sweat SA	YES NO

22. (A) Every time I interact socially, people judge me (B) Sometimes, when I interact socially, I feel confident *Does it logically follow that…* (C) … sometimes, when people judge me, I feel confident SA	YES NO
23. (A) All easily embarrassed people blush (B) Some of my friends never blush *Does it logically follow that…* (C) … some of my friends are not easily embarrassed SA	YES NO
24. (A) When I am amongst strangers I am being judged (B) Sometimes, when I am judged, I value the feedback *Does it logically follow that…* (C) … Sometimes when I am amongst strangers, I value the feedback SA	YES NO
25. (A) Some nervous people are self conscious (B) All people who are tongue-tied are nervous *Does it logically follow that…* (C) … some people who are self-conscious are tongue tied SA	YES NO
26 (A) When I meet new people I feel confident (B) Sometimes, when I feel confident I speak loudly *Does it logically follow that…*	

(C) … When I amongst new people I speak loudly. SA	YES NO
27. (A) Some people who stutter are confident (B) Confident people enjoy giving speeches. *Does it logically follow that…* (C) … Some people who stutter enjoy giving speeches. SA	YES NO
28. (A) Every time I walk into a room full of people, I feel I nervous. (B) Sometimes when I am being watched, I feel vulnerable. *Does it logically follow that…* (C) … Every time I walk into a room full of people, I feel vulnerable SA	YES NO
29. (A) Every time I meet new people I feel anxious. (B) Sometimes, when I feel anxious, I'm excited *Does it logically follow that…* (C) Every time I meet new people, I'm excited SA	YES NO
30. (A) Every time someone in authority asks to speak to me, I feel scared. (B) Sometimes, when I am scared, I feel determined. *Does it logically follow that…* (C) Sometimes, when someone in authority asks to speak to me, I feel determined. SA	YES NO

Depression and Anxiety Scale (DASS-21; Lovibond & Lovibond, 1995)

DASS21

Name: Date:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

1 (s)	I found it hard to wind down	0	1	2	3
2 (a)	I was aware of dryness of my mouth	0	1	2	3
3 (d)	I couldn't seem to experience any positive feeling at all	0	1	2	3
4 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5 (d)	I found it difficult to work up the initiative to do things	0	1	2	3
6 (s)	I tended to over-react to situations	0	1	2	3
7 (a)	I experienced trembling (e.g. in the hands)	0	1	2	3
8 (s)	I felt that I was using a lot of nervous energy	0	1	2	3
9 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10 (d)	I felt that I had nothing to look forward to	0	1	2	3
11 (s)	I found myself getting agitated	0	1	2	3
12 (s)	I found it difficult to relax	0	1	2	3
13 (d)	I felt down-hearted and blue	0	1	2	3
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15 (a)	I felt I was close to panic	0	1	2	3
16 (d)	I was unable to become enthusiastic about anything	0	1	2	3
17 (d)	I felt I wasn't worth much as a person	0	1	2	3
18 (s)	I felt that I was rather touchy	0	1	2	3
19 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20 (a)	I felt scared without any good reason	0	1	2	3
21 (d)	I felt that life was meaningless	0	1	2	3

REI-0 (Norris, Pacini & Epstein, 1998)

Please use the following scale to answer these questions.

Completely false *Completely true*

1 2 3 4 5

1. _____ I prefer complex to simple problems.
2. _____ I believe in trusting my hunches.
3. _____ I trust my initial feelings about people.
4. _____ I try to avoid situations that require thinking in depth about something.
5. _____ Thinking hard and for a long time about something gives me little satisfaction.
6. _____ When it comes to trusting people, I can usually rely on my "gut feelings."
7. _____ I can usually feel when a person is right or wrong even if I can't explain how I know.
8. _____ I don't like to have to do a lot of thinking.
9. _____ I prefer to do something that challenges my thinking abilities rather than something that requires little thought.
10. _____ My initial impressions of people are almost always right.

Beads task (Huq, Garety & Hemsley, 1988).

Beads Task

PLEASE READ THESE INSTRUCTIONS CAREFULLY:

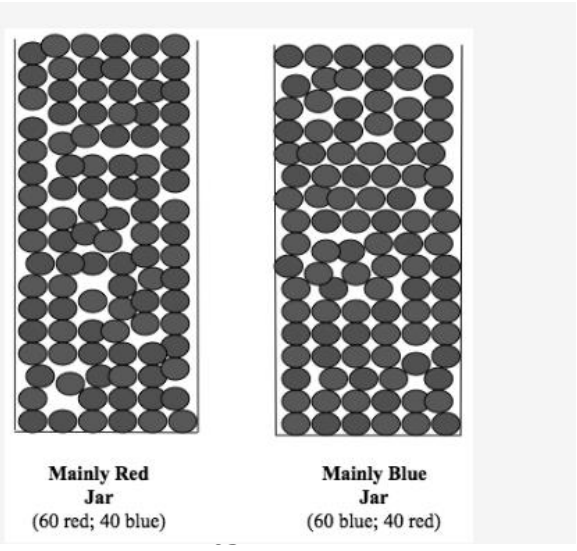
Two jars of beads are shown above. The first jar contains 60 red beads and 40 blue beads; this is the "mainly red jar". The second jar contains 60 blue beads and 40 red beads; this is the "mainly blue jar".

In a moment, the two jars will be out of your view. A series of beads will be automatically selected from ONE of these jars one at a time. Each time a bead is drawn from the jar you will be shown its colour. This bead will then be returned to the SAME jar. The beads will then be shuffled. Importantly, the jars will NEVER be switched but will ALWAYS be drawn from the same jar.

Your task is to stop drawing beads as soon as you feel confident that you can guess which jar the beads are being draw from. Each time a bead is drawn you will be given the option to either "decide now" or "see another bead". If you choose to "decide now" you will be asked to decide whether the beads had been drawn from the mainly red jar OR the mainly blue jar.

Remember a) you can see as many beads as you like before making a decision, and b) you should make your decision as soon as you feel confident that you can guess which jar the beads are being drawn from.

When you are confident that you understand these instructions and are ready to begin the task please move onto the next screen.



The 1st bead is blue. Would you like to decide which jar the beads are being drawn from now or would you like to see another bead?

Decide now

See another bead

<< >>

The 2nd bead is red. Would you like to decide which jar the beads are being drawn from now or would you like to see another bead?

Decide now

See another bead

<< >>

Paranoia scale (Fenigstein & Vanable, 1992)

Paranoia Scale (Fenigstein and Vanable 1992)

Please rate how applicable each belief is to you by selecting a number between 1 (not at all applicable to me) and 5 (extremely applicable to me).

		Not at all applicable to me				Extremely applicable to me
1	Someone has it in for me	1	2	3	4	5
2	I sometimes feel as if I'm being followed	1	2	3	4	5
3	I believe that I have often been punished without cause	1	2	3	4	5
4	Some people have tried to steal my ideas and take credit for them	1	2	3	4	5
5	My parents and family find more fault with me than they should	1	2	3	4	5
6	No one really cares much what happens to you	1	2	3	4	5
7	I am sure I get a raw deal from life	1	2	3	4	5
8	Most people will use somewhat unfair means to gain profit or advantage, rather than lose it	1	2	3	4	5
9	I often wonder what hidden reason another person may have for doing something nice for you	1	2	3	4	5
10	It is safer to trust no one	1	2	3	4	5
11	I have often felt that strangers were looking at me critically	1	2	3	4	5
12	Most people make friends because friends are likely to be useful to them	1	2	3	4	5
13	Someone has been trying to influence my mind	1	2	3	4	5
14	I am sure I have been talked about behind my back	1	2	3	4	5
15	Most people inwardly dislike putting themselves out to help other people	1	2	3	4	5
16	I tend to be on my guard with people who are somewhat more friendly than expected	1	2	3	4	5
17	People have said insulting and unkind things about me	1	2	3	4	5

Appendix 6: Correlation analysis (HP group)

Correlations

		SA_BIAS	PA BIAS	HE_BIAS	TOTAL BIAS	REIFIU total	REINFC total	PSTotal	CRF Total	Beads	Conflict
SA_BIAS	Pearson Correlation	1	-.090	.044	.570**	-.162	-.125	-.232	-.048	-.107	-.293
	Sig. (2-tailed)		.620	.810	.001	.368	.489	.193	.792	.552	.097
	N	33	33	33	33	33	33	33	33	33	33
PA_BIAS	Pearson Correlation	-.090	1	.292	.514**	.246	.137	.084	-.348*	.122	-.208
	Sig. (2-tailed)	.620		.093	.002	.160	.441	.636	.043	.492	.238
	N	33	34	34	33	34	34	34	34	34	34
HE_BIAS	Pearson Correlation	.044	.292	1	.758**	.123	.294	.219	-.317	.081	-.413*
	Sig. (2-tailed)	.810	.093		.000	.488	.092	.213	.067	.647	.015
	N	33	34	34	33	34	34	34	34	34	34
TOTAL BIAS	Pearson Correlation	.570**	.514**	.758**	1	.071	.184	.020	-.359*	.041	-.528**
	Sig. (2-tailed)	.001	.002	.000		.696	.306	.912	.040	.819	.002
	N	33	33	33	33	33	33	33	33	33	33

REIFIU total	Pearson Correlation	-.162	.246	.123	.071	1	.477**	.291	.303	.007	.174
	Sig. (2-tailed)	.368	.160	.488	.696		.004	.095	.081	.969	.326
	N	33	34	34	33	34	34	34	34	34	34
REINFC total	Pearson Correlation	-.125	.137	.294	.184	.477**	1	.373*	.017	.325	-.063
	Sig. (2-tailed)	.489	.441	.092	.306	.004		.030	.923	.060	.722
	N	33	34	34	33	34	34	34	34	34	34
PSTotal	Pearson Correlation	-.232	.084	.219	.020	.291	.373*	1	-.170	.046	-.057
	Sig. (2-tailed)	.193	.636	.213	.912	.095	.030		.338	.795	.749
	N	33	34	34	33	34	34	34	34	34	34
CRFTotal	Pearson Correlation	-.048	-.348*	-.317	-.359*	.303	.017	-.170	1	-.159	.261
	Sig. (2-tailed)	.792	.043	.067	.040	.081	.923	.338		.369	.136
	N	33	34	34	33	34	34	34	34	34	34
Beads	Pearson Correlation	-.107	.122	.081	.041	.007	.325	.046	-.159	1	.232
	Sig. (2-tailed)	.552	.492	.647	.819	.969	.060	.795	.369		.187
	N	33	34	34	33	34	34	34	34	34	34

Conflict	Pearson Correlation	-.293	-.208	-.413*	-.528**	.174	-.063	-.057	.261	.232	1
	Sig. (2-tailed)	.097	.238	.015	.002	.326	.722	.749	.136	.187	
	N	33	34	34	33	34	34	34	34	34	34

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix 7: Methodological assessment of reviewed studies

	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawal/ drop outs	*Intervention integrity*	*Analyses*	Overall Rating
Study									
Aghotor et al., 2010	2	1	2	1	1	1	1	1	**Strong**
Bechi et al., 2015	2	1	1	1	1	1	1	1	**Strong**
Fernandez-Gonzalo et al. (2015)	2	1	1	1	1	1	2	2	**Strong**
Garety et al., 2015	1	1	1	3	1	1	2	1	**Moderate**
Gaweda, 2015	2	1	1	3	1	1	1	1	**Moderate**
Horan et al., 2011	2	1	1	1	1	1	1	1	**Strong**
Horan et al., 2009	2	1	1	1	3	1	1	2	**Moderate**
Kayser et al., 2006	2	1	1	3	3	1	2	1	**Weak**
Khazaal et al., 2015	1	1	1	1	1	1	1	1	**Strong**
Kuokkanen et al., 2014	2	1	2	2	1	1	1	1	**Strong**
Mazza et al., 2010	2	1	1	2	2	1	1	1	**Strong**
Moritz et al., 2011	1	1	1	1	1	1	1	1	**Strong**
Moritz et al., 2015a	3	1	1	1	1	2	1	2	**Moderate**
Ochoa et al., 2017	2	1	1	1	1	2	1	2	**Strong**
Pino et al., 2015	2	1	1	2	2	1	2	2	**Strong**
Pos et al (2018)	2	1	2	1	1	2	1	1	**Strong**
Roberts et al., 2014	2	1	2	1	1	1	2	1	**Strong**
So et al., 2015	2	1	1	1	1	2	1	1	**Strong**
Taylor et al., 2016	2	1	1	1	1	2	1	2	**Strong**
Waller at al., 2015	2	1	1	3	1	1	1	1	**Moderate**
Wang et al., 2013	2	1	1	1	1	1	1	1	**Strong**