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An Exploration Of Reasoning Biases In Delusions

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ABSTRACT

Delusions are one of the most prominent and important symptoms of psychosis. Recent attempts to understand delusions from a psychological framework have gathered momentum, and there is evidence that people with delusions show a 'jump to conclusions' reasoning bias, making decisions on the basis of less evidence. Further work has proposed that this is due to a bias in data-gathering. The current study aimed to clarify whether the reasoning biases are related to a tendency towards early cognitive closure or an inability to integrate information.

A between-subjects design study compared the reasoning styles of four groups: two groups of psychotic inpatients (one group with delusions, the other group with no current delusions), and two groups from the normal population (one high on a measure of delusion-proneness, the other low on this measure). Finding evidence for reasoning biases in those in the normal population who are prone to delusional ideation would provide support that these biases are involved in delusion formation, as well as delusion maintenance. A non-deluded psychiatric control group was also used to clarify whether the reasoning biases were related to delusions or the experience of psychosis itself. Five tasks were used to explore the differences in reasoning styles between the groups, and also to further explore the exact nature of the reasoning biases exhibited by delusional individuals.

Results showed some evidence that those with delusions demonstrated a 'jump to conclusions' tendency. The evidence gave some support for the hypothesis that this was due to an inability to integrate information. There was no evidence of a general cognitive deficit in those with delusions. Evidence that the biases were due to the presence of delusions rather than psychosis was inconclusive. Also, the subtlety of differences between those high and low in delusion-proneness did not enable conclusions to be drawn on the role of reasoning biases on delusion formation.

Implications of these findings for the formation and maintenance of delusional beliefs are discussed. Delusions are seen as being a person's interpretations of their experiences. It is suggested that having an inability to integrate information would lead to interpretations of events that relies only on immediate information, rather than an interpretation that is able to use past information to give context. In this way, the interpretation is more likely to be a false one. Clinical implications for the practice of cognitive behaviour therapy are also discussed.

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INTRODUCTION

Delusions are one of the most prominent and important symptoms in psychosis, representing the feature that epitomises madness (Garety & Hemsley, 1994). Although delusions occur in many clinical conditions, they are regarded as marker symptoms for the presence of psychosis, in particular schizophrenia (Cutting, 1985).

Delusions are described by DSM-IV (A.P.A., 1995) as:

> ***"A false belief based on incorrect inference about external reality that is firmly sustained despite what almost everyone else believes and despite what constitutes incontrovertible and obvious proof of evidence to the contrary. The belief is not one ordinarily accepted by other members of the person's culture or sub-culture."***

Several defining features are mentioned within this quote. Delusions are viewed as beliefs, formed by some sort of irrational reasoning, that are characteristically incorrigible and unchangeable. However, this definition is not without controversy, and problems with it are discussed later.

Delusions are usually studied in the context of schizophrenia, and this is understandable due to the high frequency of delusions within the disorder. Delusions of persecution, of reference and control were found in 54%, 67% and 48%, respectively, of a sample of schizophrenic patients (WHO, 1973). However, it can be argued that delusions also merit exploration in their own right (Persons, 1986). One reason for this is that delusions are often preoccupying and distressing (Garety & Hemsley, 1987). Understanding more about the properties of delusional beliefs and how to alter them, may lead to further practical interventions to alleviate this distress, such as cognitive-behavioural interventions (Chadwick & Lowe, 1990). In addition, although the extent to which they influence action is variable (Wessely *et al.,* 1993), there has been empirical and anecdotal evidence that delusions are directly related to violent or self-harming behaviour (Link & Stueve, 1994; Swanson *et al.*, 1996).

Knowledge on the aetiology of delusions is very limited (Garety, 1991). Theories attempting to explain the aetiology and maintenance of delusions have approached the subject from a number of different perspectives, including biological, cognitive (Bentall *et al.,* 1994; Garety & Hemsley, 1994), and neuropsychological (Frith, 1987; Ellis & Young, 1990).

Recently, attempts to understand delusions from a psychological framework have gathered momentum. This chapter aims to address a number of issues that have arisen from this perspective. Firstly, it will review evidence for psychological models of how delusions are formed and maintained, and raise questions about their usefulness. Within the psychological framework, a number of different models have developed which give varying, and often opposing, theories as to the causal factors in delusions. Early theorists, such as Maher (1974) propose perceptual abnormalities play a causal role, others suggest 'theory of mind' deficits (Frith, 1987), and other suggest attributional biases (Bentall, Kaney & Dewey, 1991). These theories have been found to be plausible, yet potentially applicable to only a sub-set of patients. Secondly, this chapter will focus on ideas that reasoning biases play a role in delusions (Garety *et al.,* 1991), and explore work previous studies that have explored the nature of these reasoning biases and their implications. Thirdly, it will explore work that suggests delusions lie on a continuum with other beliefs, and the implications that this has for the formation of delusions. This is done in the context of looking at the work done on investigating whether the reasoning biases found in people with delusions also exist in people who are prone to delusional ideas. Finally, it will identify questions raised by the above topics that this current study will further explore.

1. Models Of Delusions

i) Delusions As Explanations Of Unusual Experiences

Maher (1974) is the main proponent of the theory of delusions as disturbances of perception. He proposed that delusions arose as an individual's explanation of unusual perceptual experiences, mainly biological in nature (such as hallucinations). He believed that the feeling of relief that the individual experienced by arriving at an explanation, even a delusional one, served to reinforce and maintain the delusional beliefs. Maher (1974; 1988) asserted that the implications of his model are that delusional beliefs are formed and maintained using the same reasoning processes as any other strong belief, and argued that there is an absence of evidence for any impairment of reasoning ability. His argument was that it is the experience that is unusual rather than the interpretation of it.

This theory was supported by evidence that delusions occur in a large number of medical and psychological conditions (Maher & Ross, 1984). There are also studies that demonstrate that irrational beliefs and paranoia can occur in environments where there is sensory loss, such as hearing loss in the elderly (Cooper *et al.*, 1974), or be promoted where hearing loss is hypnotically induced (Zimbardo *et al.,* 1981).

However, Maher's account has been criticised on a number of levels. Chapman & Chapman (1988) argue that delusions can often occur in the absence of unusual perceptual experiences. There is also evidence to suggest that hallucination formation is not as *passive* a process as Maher suggested, but rather that the cognitive style of the person influences whether they occur (Slade & Bentall, 1988). There is also some evidence to suggest that delusional beliefs sometimes influence abnormal experiences, rather than the other way round (Bentall, 1990b). Chapman & Chapman (1988) also reasoned that, *"If delusions are reasonable interpretations of anomalous experiences, subjects with similar experiences should have similar beliefs"*. However, they found that similar perceptual experiences were interpreted by different subjects in many different ways, ranging from the delusional to the normal. In addition, people reported delusions or unusual beliefs that had no relationship to any unusual experiences.

Maher's assertion that there is no evidence for any impairment of reasoning ability is also questioned. Garety & Freeman (1999) found that there is ample evidence of reasoning biases, which are discussed in detail later in the chapter. It seems plausible that the experience of unusual perceptions may play a role in the formation of *some* delusions, but are not sufficient or even necessary conditions for *all* delusions. Whereas Garety (1992) accepted that it is possible that delusions may be maintained through normal reasoning processes, she argued that Maher's views are less convincing in terms of the formation of delusions.

ii) Delusions As Theory Of Mind Deficits

Frith (1992) has proposed a cognitive neuropsychological account of delusions. He suggested that delusions are a result of a basic underlying dysfunctional cognitive process, that is, abnormalities in the representation of mental states.

Frith (1987) proposed that delusions of a paranoid type arise from an inability to infer and interpret the beliefs, thoughts and intentions of other people, hence are deficits of 'theory of mind'. He also proposed that delusions of thought insertion and withdrawal resulted from a deficit in monitoring one's own thoughts and actions. If there is a difficulty in distinguishing between internally-generated and externally-generated thoughts and actions, this may lead to the experience of thoughts or actions being initiated without any awareness of the intention to initiate them. The individual's explanation of this could be to believe that he is not in control of his own thoughts and actions, but that other forces are responsible.

Garety & Freeman (1999) reviewed evidence for 'theory of mind' deficits. Corcoran *et al.* (1995) and Frith & Corcoran (1996) found evidence for impairments in both first order tasks, which require appreciation of another person's beliefs about the world, and second order tasks, which require inferences about a person's beliefs about another person's beliefs. This would seem to provide some evidence for Frith's theory. However, the groups were not matched for IQ (which is an important confounding variable in 'theory of mind' tasks).

It is questionable as to whether the 'theory of mind' deficits found are related to delusions or is more a consequence of wider cognitive dysfunction accompanying psychosis. Garety & Freeman (1999) conclude in their review article that there is only preliminary evidence to support this model.

iii) Delusions As A Defence Against Low Self-Esteem

Bentall, Kaney, & Dewey (1991) have proposed a motivational account of persecutory delusions, drawing on attribution theory. Attributions are causal explanations that individuals give for their own behaviour or that of others (Fiske & Taylor, 1991). Kaney & Bentall (1989) found that deluded patients made excessively external attributions (blaming other or the situation) for negative events, but excessively internal attributions (asserting that they themselves were responsible) for positive events. There is evidence that this 'self-serving' attributional style is found in people with persecutory delusions when measured directly, but when measured implicitly, by disguising the attribution task as a memory task, then those same individuals show a depressed, self-blaming attributional style (Bentall *et al,* 1991; Bentall *et al.,* 1994; Kinderman & Bentall, 1996a). This model concludes that persecutory delusions function as a defence against underlying feelings of low self-esteem by minimising the discrepancies between actual self and ideal self, and increasing the discrepancy between self and other (Bentall *et al.,* 1991).

Although Kaney & Bentall (1989) indicate that deluded patients make abnormal attributions, the cause of this abnormality remains uncertain. Bentall *et al.* (1991) put forward the possibility that deluded patients fail to make use of appropriate contextual information when attempting to make sense of social interactions, and that this may leave a person vulnerable to developing a paranoid way of thinking.

Whereas Bentall's model proposes a potential explanation of persecutory delusions, it does not provide evidence that this attributional bias is shown in people with other types of delusions. Peters, Day & Garety (1998), using patients who demonstrated a range of delusions, found that although such patients showed a self-serving bias, they were not significantly different from normals. Sharp *et al.* (1997) also found that patients with non-persecutory delusions did not differ from normal subjects in their attributional style, suggesting that the attributional bias influences delusional *content* rather than *form*.

In addition, the protective function of this attributional style is questioned. There is little evidence for correlations over time between levels of self-esteem and degree of conviction in persecutory delusions (Freeman *et al.,* 1998). Birchwood & Iqbal (1998) found that during acute psychosis dysphoria, loss of self-esteem actually increases, and 'follows the same course' as delusional thinking. It would also be predicted that, if delusions acted as a defence, those with delusions would have average or high self-esteem. However, Freeman *et al.* (1998) found that three quarters of those with persecutory delusions had low self-esteem. Measures of self-esteem correlated with measures of social functioning, but not with delusional conviction. Thus the authors argued that for the majority of this group, low self-esteem is best understood in terms of the processes identified in depression, for example, hopelessness or illness severity. Only in a small sub-group with *normal* levels of self-esteem, rather than high, does the delusion appear to maintain self-esteem. In a review, Blackwood *et al.* (2000) argued that if the delusion is a defence it is at best a poor one. Birchwood (1999) argued that persecutory delusions do not conceal impaired self-concept, but render it visible.

In conclusion, there is only correlational evidence in support of this model, and its application seems limited to persecutory delusions. Garety & Hemsley (1994) suggested attributions may play a role in reinforcing delusions by anxiety reduction, but their role in the formation of delusions is unclear and unsubstantiated.

iv) Delusions And Probabilistic Reasoning Biases

There has been a growth in literature which seems to suggest that abnormal reasoning might be implicated in delusions (Huq *et al.,* 1988; Garety *et al.,* 1991; Dudley *et al.,* 1997a). This conflicts with Maher's assertion that delusions are the product of normal reasoning about an abnormal experience. The following section explores the evidence for abnormal reasoning, and the implications for the formation and maintenance of delusions.

2. Reasoning Biases And Delusions

"Human beings may well be rational in some circumstances, but not in others".

Johnson-Laird (1982)

Why Study Reasoning Biases?

A number of definitions of delusions propose their 'irrationality' and 'incorrigibility' as defining characteristics, that they are *"not amenable to reason or modifiable by experience"* (Mullen, 1979). However, it has also been proposed that strong beliefs held by non-deluded individuals can often be maintained with little evidence to support them (Alloy & Tabachnick, 1984). It is interesting to explore whether there are definable differences between delusions and strong beliefs. Garety & Hemsley (1994) assert that *"considering the models of rationality and normal reasoning....helps us to clarify the concepts of incorrigibility and faulty judgements in delusions."*

Normal Reasoning

The study of reasoning biases with delusions often struggles with the definition of 'normal' reasoning, and there is evidence that human beings do not always follow 'logical norms' (Wason & Johnson-Laird, 1972). Reasoning is not restricted to logic, but instead people use a number of heuristics and biases in making decisions, some of which can lead to errors. One common bias found is termed the 'confirmation bias' (Ross & Anderson, 1982), which is used to preserve and protect existent beliefs. This asserts that we attend to, interpret and store information which confirms our existing beliefs, and give less weight to or disregard information that is contradictory to these beliefs. There are many studies providing evidence for this bias (Wason & Johnson-Laird, 1972; Lord *et al.,* 1979; Estes, 1976). People also tend to use confirmatory strategies when *forming* hypotheses, looking for cases that would make a hypothesis true, rather than using the more 'logical' strategy of attempting to disconfirm a hypothesis. Another pervasive finding is that people are notoriously inaccurate at probability judgements (Kahneman & Tversky, 1973), and show a tendency to make probability predictions on the basis of frequencies rather than probabilities (Estes, 1976).

In conclusion, normal reasoning is subject to a number of errors, as Kihlstrom & Hoyt (1988) state, *"human judgements and inferences are not always logical and rational, and certain errors creep into the process".* Given these errors and biases, the implication is that delusional incorrigibility and irrationality are not as abnormal as the definitions suggest, but instead may represent a quantitative rather than a qualitative difference. Chapman & Chapman (1988) argue that deluded patients, *"do not show a qualitatively unique kind of error, but instead accentuate a normal* *tendency to the point of gross deviancy"*. These findings imply that it is possible for a delusion to be maintained in the absence of an underlying abnormality. Evidence around this issue is explored later.

Although the concept of 'normal reasoning' is ambiguous, a normative model, such as Bayes Theorem of probabilistic inference (Fischoff & Beyth-Marom, 1983), is needed to provide a framework for investigating probabilistic reasoning. Bayesian models specify whether a subject's confidence in a current belief should be revised according to the value of the new evidence received. Hemsley & Garety (1986) argue that this approach can be usefully applied to the study of deluded individuals. Bayesian procedures provide a model of different stages of the formation and evaluation of a hypothesis (Huq, Garety & Hemsley, 1988),[1] and allows for categorisation of deviation from the model.

Evidence For Reasoning Biases In People With Delusions

Recently, there have been a number of studies providing evidence for reasoning biases in people with delusions. Although some use tasks and material thought to be relevant to delusions (Brennan & Hemsley, 1984), many use material thought to be unrelated or neutral. Using neutral material has the advantage of being able to reflect a more generalised or fundamental reasoning abnormality, if differences are found (Garety & Hemsley, 1994). One formative study using neutral material, and also

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[1] Bayes Thoerem is described by Huq *et al* (1988) as following these stages:

1. "The identification of the data sources that are most useful for discriminating between competing hypothesis."
2. "The assessment of the implications of an observed datum vis-à-vis the truth of competing hypotheses."
3. "An aggregation of the implications of different data with an overall appraisal of the relative likelihood of the truth of the hypothesis."
4. "The selection, based on that appraisal, of the appropriate course of action."

using Bayes model as a framework is that by Huq, Garety & Hemsley (1988). The study compared a deluded schizophrenic group, a non-deluded psychiatric control group of various diagnoses (mainly affective or anxiety disorders), and a normal control group, in a probabilistic reasoning task.

This study used a task which involved two jars of beads, each containing beads of two different colours in equal and opposite proportions (85:15). The jars were hidden from view, and the experimenter drew beads from one jar and showed them to the participant (the colours are actually read from a list that had the same ratio as the chosen jar). The participants were given two cards, a 'continue' card ("More items please") and a 'stop' card ("No more items, I have decided"), and asked to choose which one to hold up after each bead was shown. It was then recorded how many beads the participant needed to see before making a decision about which jar was being used.

The second part of this study was a condition which again used the beads. This time, ten beads were drawn from a jar, but instead of asking the participant to indicate when they had made a decision, after each draw subjects were required to indicate the probability of the draw coming from one of the two jars, using a response board. Dependent variables included how many beads they used to reach certainty, and how certain they had been after the first bead.

The deluded group came to their decision on the basis of significantly less beads than the control groups, on both tasks. It was proposed that this style of 'jumping to conclusions', requiring less information for beliefs to be formed, would be likely to lead to a false belief and therefore contribute to the formation and maintenance of abnormal beliefs. The deluded group also had a tendency to display a higher degree of certainty about their decision after the first bead than the control groups. This was seen as further evidence of delusional participants 'jumping to conclusions'. Huq *et al.* (1988) noted that the deluded population made very few errors, therefore argued that these findings should not be interpreted as evidence of an inability to reason probabilistically, but rather a bias in early acceptance of hypotheses. Huq *et al.* (1988) propose that, using Bayes Theorem, the deluded group could be argued to have reached their decision at an objectively 'rational' point, and that the two control groups were somewhat overcautious. This 'better' performance by the deluded group suggests that the results did not reflect a generalised performance deficit, but a more specific reasoning bias.

However, Huq *et al.* (1988) acknowledged considerable variability within the experimental group, which was obscured by group means. About half of the deluded sample (47%) responded in an 'extreme fashion' on both tasks by making their decision on the very first draw, compared to only 4% of the controls. However, they found no clear differences between 'extreme' responders and the rest of the deluded group. They proposed that further work needed to be done to determine whether there is a particular sub-group within the deluded group, to which the reasoning abnormalities may be confined. They concluded by stating that some, but not all, deluded individuals have a reasoning bias characterised by rapid and over-confident responding. As this was demonstrated in a 'neutral' task, it infers that the tendency to 'jump to conclusions' is an underlying reasoning bias rather than specific to material relevant to delusional beliefs.

There are a number of difficulties with Huq *et al.'s* (1988) study. Firstly, it used fairly small numbers, and did not take account of any potential differences in the symptomatic state or the IQ of the patients. Secondly, although Huq *et al.* (1988) argued that their results are not simply characteristic of the 'psychiatric patienthood', the non-deluded psychiatric control group differed from the experimental group on a number of factors other than the absence of delusions, therefore the differences cannot validly be attributed to delusions. Thirdly, the study analysed the 'number of draws to decision' for both tasks together, thus obscuring any differences there may have been between the two tasks. Lastly, the study only tested aspects of hypothesis formation, not of belief maintenance or change.

Garety, Hemsley & Wessely (1991) carried out a study to extend the study by Huq *et al.* (1988), and to redress some of the methodological flaws. They used four subject groups, two of which were deluded subjects, (one group with delusional disorder or paranoia and one with schizophrenia with delusions) and two control groups (one anxious control group and one normal control group). By repeating the first part of the original task, their study confirmed Huq *et al.'s* (1988) findings that the two deluded groups requested fewer items of information before making a decision. This style of responding was not more characteristic of subjects with delusional disorder compared to those with schizophrenia.

Garety *et al.* (1991) also found great variability within this group, with a majority of deluded respondents performing normally, but 41% of the deluded group showing an 'extreme' response style and reaching a decision after only one piece of information, compared with only one normal subject, and no anxious subjects. Garety *et al.* (1991)

found the 'extreme responders' scored lower on the Mill Hill Vocabulary Test than other deluded subjects, were more likely to express higher conviction about their own beliefs, and were also more likely to have been experiencing hallucinations.

Garety *et al.* (1991) also extended the second part of the study, the probabilistic response condition where the participant gave estimates of the probability that the bead had come from a particular jar after each draw. Their findings on 'initial certainty' and 'number of beads to decision' did not replicate the findings of Huq *et al.* (1988) in that there were no significant differences found between groups. This may reflect a difference in the responses people with delusions give when presented with information, compared to having to gather information themselves. This led on to further studies by Dudley *et al.* (1997a) that are described later.

An additional part of this condition was that the proportion of beads shown for the first half of the twenty beads shown supported one hypothesis, but then, after ten beads, changed to favour the alternative hypothesis. In determining the subject's response to contrary evidence in this way, the study aimed to explore belief maintenance as well as formation. By calculating the change in estimate between the third bead, a colour favouring the dominant hypothesis, and the fourth bead, of the opposite colour, it was found that the deluded group were more likely to reduce their confidence in their decision in the light of the 'disconfirmatory evidence' than the control groups. The control groups either made little change in estimates, or increased their estimates slightly to continue to affirm their initial hypotheses. In addition, 15% of the deluded subjects made estimate changes of more than 50%, compared with no estimate changes of this magnitude within the control groups. Also, following the first ten beads, when the beads begin to follow the alternative hypothesis, the deluded group showed a (non-significant) tendency towards changing their estimates rapidly. This evidence suggests that deluded individuals show a tendency towards shifting hypotheses on the basis of one item.

There are several interesting conclusions to be drawn from this study. One is that a large proportion of deluded subjects show evidence of a 'jump to conclusions' reasoning bias, reaching conclusions using fewer data, and appearing more ready to change their hypotheses. However, the majority reason normally. Secondly, deluded subjects are not characteristically incorrigible, in that they are not clinging tenaciously to their hypotheses but rapidly changing them. This creates an interesting perspective on the notion of 'incorrigibility' in delusions, seen to be a defining characteristic. Whereas rapid and extreme judgements appear to be characteristic of reasoning in some deluded patients, incorrigibility appears not to be. It is likely that the difficulty in shifting delusions may not be a result of any general or global reasoning abnormality, but is specific to the delusional belief, representing a normal tendency to cling to strongly held beliefs. Thirdly, contrary to Maher's theory that delusions are a normal response to abnormal experiences, those who experienced more hallucinations exhibited greater reasoning biases. Garety *et al.* (1991) proposed that one possibility for this was that both abnormal experiences and abnormal probabilistic inferences may arise from a common cause: a failure to make use of past information when processing new stimuli. This is consistent with other studies that have shown that schizophrenics give greater influence to the immediate environmental stimuli compared with the effects of prior learning (Hemsley, 1987). It would also appear to give some support for Garety's (1992) observations that a delusional person demonstrates a loss of the benefit of accumulated life experience, accounting for a failure to reject delusional beliefs as unrealistic.

Like the study by Huq *et al.* (1988), Garety *et al.* (1991) used a psychiatric control group that differed in many features from the deluded groups. This raises the question as to whether the bias described was related to the experience of delusions, or the experience of schizophrenia or psychosis. Few studies have compared psychotic inpatients with and without delusions to investigate whether the biases are related to psychosis or the delusions themselves. Mortimer *et al.* (1996) suggested probabilistic reasoning bias is a consequence of having schizophrenia rather than delusions. They looked at probabilistic reasoning biases in schizophrenic patients and concluded that the 'jump to conclusion' reasoning bias did not appear to correlate with any specific symptoms, or the severity of delusions. However, there are criticisms of how this study actually measured delusions. Rather than taking a global measure of delusion severity, or a separate measure of conviction, Mortimer *et al.* (1996) used an index of the 'volume' of the delusion, which was more related to the *number* of delusions. The participants were also drawn from a rehabilitation population, rather then an inpatient group, which may have meant they were less symptomatic than other groups studied. Further work, with tighter psychiatric control groups, is needed to establish whether reasoning biases are related to psychosis or the presence of delusions.

Further evidence that people with delusions do have the ability to change their hypotheses is provided by Young & Bentall (1997b). They did a study, using neutral material, investigating the extent to which subjects with persecutory delusions were prepared to change their attributional judgements following additional information.

They found that the deluded subjects altered their attributions in the direction predicted by Kelley's (1967) attribution theory, and this did not differ from the two matched control groups (depressed group and normal group). There was no evidence that people with delusions were unwilling or unable to shift their judgements under these conditions.

Garety & Hemsley's Model of Delusion Formation And Maintenance

Based on these findings, Garety & Hemsley (1994) set out a multi-factorial model of delusion formation and maintenance. This model describes the role of reasoning biases in the formation and maintenance of a belief, and a representation of this is shown in Figure 1. A person's prior expectations determine whether current information is processed or not. The belief results from an interaction between the information and the processing style. They propose that the information-processing style of deluded individuals is characterised by a failure to make use of learned regularities, and a focus on prominent current stimuli, which can lead to inaccurate inferences. The belief is then maintained and reinforced by anxiety reduction, and further influences the search for confirmatory evidence. Garety & Hemsley (1994) suggest the same reasoning style involved in information processing also plays a role in maintaining the belief, on the basis of very little support. They add that maintenance processes may be similar to normal reasoning in that the individual seeks out confirmatory evidence and ignores disconfirmatory evidence, but that these processes are exaggerated. Garety & Hemsley (1994) argue that delusions are unlikely to share a common cause, and propose that different parts of this model will contribute to differing degrees within different people.

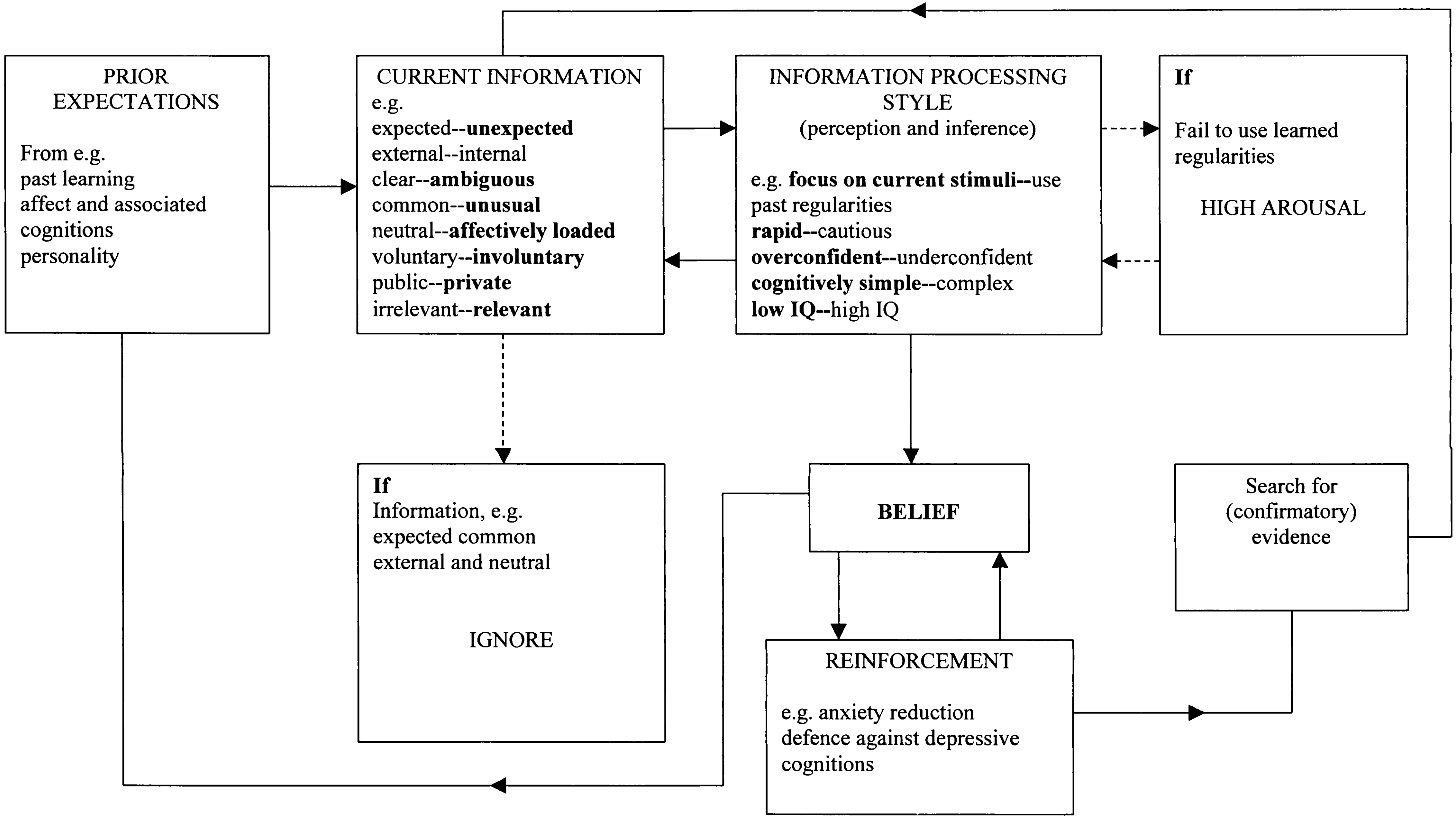

Figure 1: Garety & Hemsley's (1994) model of belief formation (with factors implicated in delusion formation in bold)

Many other studies have found a tendency for those with delusions to make judgements on the basis of less information. For example, Abroms *et al.* (1966) found that when they showed those with paranoid delusions pictures of ambiguous images and asked them to identify them, they found that, compared to controls, they were more likely to make inaccurate judgements than suspend judgements.

This finding that people with delusions have a tendency to 'jump to conclusions' and make decisions on the basis of less evidence is one that has been replicated in a number of studies (Garety & Freeman (1999) cite as examples: Kemp *et al.*, 1997; Young & Bentall, 1995; and John & Dodgson, 1994). However, there is a need to explore the impact that delusion-relevant material would have on the biases, and also assess whether the biases are a result of a more global cognitive deficit.

The Effect Of Relevant Or Emotional Information On Reasoning Biases

Finding reasoning biases using neutral tasks provides evidence towards an underlying or pervasive reasoning bias that could impact upon the formation or maintenance of delusional beliefs. However, Simpson *et al.* (1998) argue against generalising people's performance in these relatively neutral and abstract tasks, and suggest that many researchers ignore the impact that emotional salience and personal relevance has on performance. A possible argument could be that these neutral studies challenge only a recently held and relatively neutral belief, and not one that has emotional content or relevance to the person. Some studies have aimed to address this issue to explore the impact personal relevance has on reasoning biases.

Dudley *et al.* (1997b) compared the amount of information requested by deluded, depressed and normal samples, in two types of task following the beads paradigm. One task was a realistic but neutral task, using boys' and girls' names in place of beads, and requesting participants to decide whether they were taken from a mainly boy's or mainly girl's school. The second task was a personally-relevant task, which used positive and negative personality characteristics about a person similar to the participant. The participant had to decide whether the person was generally liked or disliked. They found deluded participants requested less information prior to making the decision on both tasks, compared to controls, and all groups used less information on the personally-relevant task. They concluded that the fact that this hasty style was heightened by emotional content could lead to more errors in reasoning, and hence could lead to delusions.

Young & Bentall (1997a) also investigated the impact of meaningful material on reasoning biases. They used the probabilistic response part of the beads paradigm, and compared it to a condition that employed personality characteristics in place of beads. The participants were asked to indicate how certain they were that these characteristics were describing one of two individuals. The group differences found in the neutral task were replicated, with deluded participants showing greater magnitude of reduction in certainty following disconfirmatory information. These differences were more pronounced in the meaningful conditions. The authors propose that these results were due to participants giving more weight to recently presented information in personal conditions. They argue that such information is more readily accessible, as human beings have such well-developed schema on people and relationships. Therefore it appears that the reasoning biases shown in these 'neutral' tasks, actually become accentuated when more emotionally salient or relevant tasks are used.

Does This Bias Reflect A Global Inability To Reason Logically?

There has also been a debate as to whether this reasoning bias is reflective of a more general cognitive deficit, or is indicative of a specific bias. Early theorists such as Von Domarus (1944) proposed that delusions arise from a global failure in logic. However, experimental studies have not supported this (Nims, 1959).

Kemp *et al.* (1997) made the point that deluded people are not deluded about everything or apparently at random, which points away from a global deficit in reasoning. They attempted to explore formal logic ability in people with delusions by examining syllogistic, conditional and probabilistic reasoning. They made a comparison of deluded patients and normal volunteers using conditional statements (if..then statements), syllogisms (no A are C, some B are C, some C are not A), and probability judgements. These tasks were manipulated by using both neutral and emotionally salient material. Both normal and deluded subjects commonly made logical errors. Using conditional statements, the deluded group had a slight tendency towards making invalid inferences, which was accentuated in the emotionally salient task. The deluded group showed no significant differences from normals in terms of syllogistic reasoning. In probabilistic tasks, the deluded group showed only a very slight trend towards being less influenced by context or existing schema than normals. Thus the deluded group were slightly less able to make use of past information.

They concluded that the differences between deluded individuals and normals were surprisingly small, and that there was only a mild weakness in formal logic in people with delusions. They proposed that this may reflect one link in the chain towards developing delusions. They also concluded that emotional salience influences reasoning in deluded people. However, overall, they found that people with delusions were subject to the same errors of logic than non-deluded individuals.

Further evidence that people with delusions do have some capacity to reason normally is provided by Bentall & Young (1996). They suggest that a lack of sensible strategies for testing hypotheses might be expected to lead to unusual beliefs. Using 'sensible hypothesis generation and testing' they found no evidence of abnormal hypothesis testing in typical everyday situations in people with persecutory delusions. Participants were presented with descriptions of typical everyday situations with positive and negative outcomes and required to select from given strategies to prove one of three variables was responsible for outcome. Both groups performed in a manner consistent with research into sensible reasoning (Tschirgi, 1980), where subjects employed the disconfirmation strategy more when the outcome was negative, and employed the confirmation strategy more when the outcome was positive. No differences were found between deluded and normal controls. Bentall & Young (1996) concluded that deluded subjects do not have a difficulty in using information to test hypotheses. They also argued that previous studies that have indicated poor hypothesis testing in deluded patients have used tasks which involved information presented sequentially, and thus deficits shown may reflect an inability to integrate information over time rather than a general reasoning deficit.

In addition, Dudley *et al.* (1997a) carried out a study to see whether the reasoning biases exhibited were a product of a failure to reason probabilistically. The study involved a coin-tossing task (Griffin & Tversky, 1992). The participants were presented with a set of results that they were told come from spinning a coin, and were asked to estimate the chance the coin was biased. The deluded participants were found to reason in the same way as depressed and normal controls, being influenced by the *strength* of evidence (the proportion) but not taking account of *weight* (sample size). This indicated that deluded subjects are able to make use of probabilistic information, and make similar probability judgements with similar biases to normal subjects.

In conclusion, there is strong evidence that the reasoning biases exhibited by people with delusions are not as a result of a general cognitive deficit, but appear to be more specific biases that differ from the biases exhibited by non-deluded individuals. Further work has begun to explore the nature of these biases.

What Are The Nature Of These Reasoning Biases?

Data-Gathering Bias

In the study by Garety *et al.* (1991) it is interesting to note that the tendency to make rapid judgements was more prominent in the first part of the study, where subjects chose how many beads to use, compared to when all beads were viewed. Dudley, John, Young & Over (1997a) investigated this further. They looked more specifically at whether the 'jump to conclusions' bias found was due to deluded patients *using* the data given in probabilistic task differently to controls, or whether the bias was one in actually *gathering* the data.

They also used the beads paradigm, involving the two conditions as used in previous tasks. In the first condition, the participants chose the amount of evidence seen before they made their decision. In the second condition, the experimenter decides how many beads are seen, and all participants make a decision on which jar was being used based on the same amount of evidence (ten beads). When the participants were free to determine the amount of evidence seen, those with delusions made their decisions based on less evidence than the normal and depressed control groups, hence were said to have a tendency to 'jump to conclusions'. However, when the experimenter determined the number of beads seen, the deluded group did not differ in their probability judgements from the normal controls.

Dudley *et al.* (1997a) also repeated another part of Garety *et al.* (1991) study, where the first ten beads presented appeared to support one hypothesis, and the following ten beads appeared to contradict this hypothesis. Whereas Garety *et al.* (1991) found a non-significant trend towards the deluded group showing more willingness to change hypotheses following the first ten beads, Dudley *et al.* (1997a) found no differences. Dudley *et al.* (1997a) concluded that the deluded group were *as* willing to change as the control groups, but not *more so*. However, they acknowledged that this difference may be due to a difference in testing, as previous studies that have shown a bias have used change in confidence as a measure, whereas this study used complete reversal of direction. In addition, Dudley *et al.* (1997a) did not explore the response to contradictory evidence within the first ten beads.

Dudley *et al.* (1997a) propose that people with delusions are able to reason in a similar way to non-deluded comparison groups when provided with the same amount of evidence. They argue that deluded individuals do not have a general reasoning deficit *per se*, but a more specific deficit in data gathering. They seek less information before making a decision and weight the information differently. However, a major flaw in the study was that 'normal reasoning' on the second task was determined by the participant choosing the correct jar after seeing ten beads. This was subject to a large ceiling effect, with very few participants making errors, which challenges the validity of comparing it to the participant- determined task.

Further evidence of a bias or difficulty in data-gathering is provided by Young & Bentall (1995). They compared the hypothesis testing skills of patients with persecutory delusions with those of depressed and normal individuals. Subjects were required to solve a series of visual discrimination problems, and had to generate potentially correct solutions to each problem, by progressively narrowing down the set of possible correct solutions on the basis of feedback from the examiner. The groups did not differ in the range or total number of hypotheses generated. However, the deluded subjects showed less evidence of 'focusing' down their hypotheses to an overall correct solution. Thus they were able to formulate hypotheses correctly but had a bias in gathering data to test them. The authors proposed that this may be due to the deluded subjects having more specific cognitive deficits, perhaps in the ability to make use of sequential information.

Another study that also observed that delusional individuals have a data-gathering bias is that of John & Dodgson (1994). They found evidence that patients with delusions were found to request less information and make more incorrect guesses in inductive reasoning tasks, such as 20 questions, leading to poorer judgements. The deluded participants showed a decreased ability to 'focus' their questions, and narrow down their hypotheses.

The presence of a data-gathering bias would seem to fit with other previous studies as an explanation of the 'jump to conclusions' style. However, understanding of why this bias occurs is still unclear. The next part explores evidence for a number of differing ideas as to the origin of the data-gathering bias.

Explanations Of Data-Gathering Bias

a) Confirmation Bias

Dudley *et al.* (1997a) proposed two explanations for their findings. One of these was that a hasty style could be an extreme version of the 'confirmation bias' described earlier in relation to normal reasoning biases. Thus deluded individuals may form a hypothesis early but be less able to consider alternatives to it, therefore view further searches as redundant. This fits with evidence from Brett-Jones, Garety & Hemsley (1987), who found people with delusions did not search for disconfirmatory evidence as much as normal controls. As seen earlier in the discussion of normal reasoning biases, an extreme confirmation bias could theoretically be involved in forming a delusional belief, as the individual searches out and attends to only information that confirms a belief, rather than disconfirms it. It could also be involved in maintaining the belief, by interpreting any ambiguous information in a way to support the delusional belief, whilst ignoring contradictory information.

However, this idea does not fit with evidence shown earlier that people with delusions do rapidly change their hypotheses in the face of contradictory evidence, rather than ignoring such evidence (Garety *et al.,* 1991; Young & Bentall, 1997b). This is clearly an area that needs clarification.

b) Cognitive Closure

Another explanation provided by Dudley *et al.* (1997a) for the data-gathering bias was that people with delusions have a reasoning style towards imposing an answer quickly in order to reduce cognitive demands. This is known as the need for cognitive closure. Cognitive closure is described by Kruglanski (1990b) as 'the need for an answer...., any answer....compared to confusion and ambiguity.' Webster & Kruglanski (1994) suggest that need for closure may vary as a function of the situation, but also view it as a dispositional construct. They have developed measures to determine individual differences in this construct within the population (Need For Closure Scale: Kruglanski, Webster & Klem, 1993).

Using this idea, having a personal bias towards a high need for cognitive closure would predispose a person towards sticking with an unusual or delusional belief rather than seeking out information to disconfirm it. Using the model by Garety & Hemsley (1994), cognitive closure could also play a role in maintaining delusional beliefs by reducing anxiety.

At first glance, this idea would seem to contradict findings that deluded individuals change hypotheses rapidly. However, it could be argued that if those with delusions did have a bias caused by a high need for cognitive closure, the ambiguity caused when faced with contradictory evidence may lead them to completely change their minds towards that alternative hypothesis, to avoid discomfort.

c) Inability To Integrate Past Information

The earlier study by Garety *et al.* (1991) suggested that one explanation of the 'jump to conclusions' bias could be an inability to use or integrate past information in making decisions, but instead only being influenced by immediate, moment-to-moment information. This would account for a data-gathering bias, as if a person were unable to use past information they may view immediate present information as the only relevant information, and hence be convinced that further searching was unnecessary. This would also fit with the evidence that people with delusions change hypotheses rapidly, according to what information has just been presented (such as Young & Bentall, 1995). Salzinger (1984) terms this the 'immediacy hypothesis', where behaviour is controlled by stimuli immediate in the environment. He argues that responding to such immediate information is responding to information in isolation, whereas it is the context that gives it meaning.

Fitting this explanation into the experience of delusions, Garety & Hemsley (1994) suggest that an information-processing style characterised by an inability to use past information, or integrate past regularities about the world, could lead to incorrect inferences, in turn leading to the formation of delusions.

There have been a number of studies providing evidence that people with delusions do not make use of past information or context. Corcoran & Frith (2000) did a study using five different versions of the Thematic Selection Task, which is similar to Wason's Selection Task. This is a task used to examine people's logical reasoning ability and is usually in the form of an abstract syllogism. They used five versions of this task to determine if providing a contextual setting to the task, using a familiar content, or using a social setting made any difference to the difficulty of the task. Results showed that those with paranoid delusions markedly failed to show facilitation with stories of a social nature even if this examined a rule of a highly familiar nature. Corcoran & Frith (2000) suggest that this may be due to an inability to use similar experiences from their own memory to improve their reasoning on current tasks. However, the task is also dependent on memory, which has been shown to be impaired in some people with schizophrenia (McKenna *et al.*, 1994; Shallice *et al.*, 1991). It is possible that this task may reflect a semantic or episodic memory problem, thus people are less able to relate current events to past experience.

In conclusion, evidence would suggest that the 'extreme confirmation bias' suggested by Dudley *et al.* (1997a) as a possible mechanism behind data-gathering biases, has much evidence to refute it. This leaves two other potential explanations of the bias. One is that it is due to a personal tendency or bias towards a need for cognitive closure, to impose a quick answer on a decision. The other is that it is due to an inability to integrate information, leading to an over-reliance on immediate information present, and a neglect of context or past information. The focus of the current study is to further investigate these possibilities to determine the nature of these reasoning biases.

Personal Bias Or Specific Inability?

The two potential explanations described would lead to different predictions that could be tested experimentally. Although both are able to incorporate results found on the 'jump to conclusions' tendency, and on the ability to change hypotheses rapidly in people with delusions, it is predicted that they would respond differently according to the difficulty of the task. If the data-gathering bias is a result of a high need for cognitive closure, deluded individuals would be expected to respond in a similarly rapid way, regardless of the level of difficulty. However, if the bias is a reflection of an inability to integrate information, deluded individuals would be expected to show this type of response only at higher levels of difficulty, with a greater amount of information to integrate.

Both Young & Bentall (1997a) and Dudley *et al.* (1997a) carried out variations of the beads task using a variety of beads ratios. They argued that the closer the ratio, the more difficult the task. Dudley *et al.* (1997a), used the dependent variable of 'number of draws to decision'. They found that when they used beads in the ratio of 60:40 the deluded sample still made their decision on the basis of less evidence than controls, but took account of the change in base rate and delayed their decision accordingly. Dudley *et al.* (1997a) argued that the data-gathering bias was therefore not a result of impulsiveness. Young & Bentall (1997a) repeated the probability response part of the beads task, where participants rated how likely it was that the beads had come from a particular jar. They used conditions of three different ratios. Like Dudley *et al.* (1997a) and Garety *et al.* (1991), they found no significant differences between deluded subjects and normal or depressed controls on the number of draws to reach certainty. However, the effect of condition was significant, with all groups reaching certainty quicker on easier conditions.

Findings that deluded participants do respond to the difficulty of the task would appear to argue against the idea of cognitive closure, which would predict rapid response at all levels. However, although Young & Bentall (1997a) found that deluded participants made more errors at greater levels of difficulty, all groups did, so it does not give conclusive evidence towards the hypothesis that the bias is due to an inability to integrate information either.

One study that aimed to directly examine whether 'jump to conclusion' reasoning biases were related to a need for cognitive closure or an inability to integrate information over time was that by Colbert & Peters (2000). One disadvantage of this study is that it did not use deluded people, but members of the general population which were divided into two groups: one group who scored highly in measures of delusional ideation, and the other who scored low on such measures.

They used a task called the 'Flats Task'. Participants were given a hypothetical task where they had to determine the amount of information they would want to use in selecting a flat. There were four parts to the task, which differed in difficulty by increasing the number of possible items of information. They predicted that if the data-gathering bias was related to a tendency towards cognitive closure then the high delusion-prone group would select less information than the low delusion-prone group, at all levels of difficulty. However, if the reasoning biases were related to an inability to integrate information, the high delusion-prone group would select less information only at high levels of difficulty. It was found that both groups increased the amount of information looked at and used as the amount available increased, but there was no significant difference between groups. There was little significant evidence for either hypotheses, but this may have been related to the use of normal participants rather than people with delusions, as the differences between the groups may have been to subtle. One finding was that people high in delusion-proneness had a greater tendency towards cognitive closure, than those low in delusion-proneness, as measured by the Need For Closure Scale (NFCS: Kruglanski *et al.*, 1993).

The nature of the data-gathering bias shown by people with delusions remains unclear. This current study focuses on directly examining the usefulness of the two potential explanations described, extending this work to include both clinical and non-clinical participants.

3. The Continuum Hypothesis

Concept Of Schizotypy

There is a growing amount of literature that gives evidence for a continuum between 'normality' and psychosis (Claridge, 1994). Part of that evidence involves findings that there are individuals within the normal population who have traits that resemble psychotic symptoms, but remain psychologically healthy (Meehl, 1962). This is the concept of 'schizotypy'. Work has been done to develop self-report scales to measure schizotypy and identify populations that are high 'schizotypes' (e.g. Delusions Symptom-State Inventory (DSSI): Foulds & Bedford, 1975). 'High schizotypes' are found to resemble schizophrenics on a number of levels (Linney, Peters & Ayton, 1998), which provides some support for the validity of the concept (Peters, Day, McKenna & Orbach, 1999a). It has also been found that the structure of schizotypy parallels the multi-dimensionality of schizophrenia (Bentall *et al.,* 1989).

High Schizotypy Groups

First degree relatives of schizophrenics have been found to show an increased frequency of schizotypal personality disorders (Varma & Sharma, 1993). Also those who believe in the paranormal (Thalbourne, 1994), or have out of body experiences (McCreery & Claridge, 1995), or have had profound religious experiences (Jackson,

1997) or are members of certain new religious movements (Day & Peters, 1999) have been found to score highly on schizotypal measures.

Members of New Religious Movements (NRMs), such as Druids and Hare Krishnas, have been found to show higher rates of schizotypy than conventional religious and non-religious control groups (Day & Peters, 1999). A study by Day & Peters (1999) suggested that there is an overlap of experience between NRMs and psychosis, but this is confined to positive symptomatology rather than the broad spectrum of symptoms in psychosis. Despite this overlap in symptoms, the overwhelming evidence from studies are that generally NRMs do not differ significantly from the rest of the population in terms of mental health and adjustment (Richardson, 1995), and remain functioning members of society. McCreery & Claridge (1995) coined the term 'happy schizotype', highlighting evidence that schizotypy is not a 'malignant' personality trait in itself, and may be beneficial to the individual.

Delusions Also On A Continuum

Delusions too are thought to lie on a continuum (Chapman & Chapman, 1980). They are no longer viewed as all-or-nothing false beliefs (Peters *et al.,* 1999a; Chadwick, 1992), but instead are viewed as multi-dimensional, varying in aspects such as belief strength, distress, obtrusiveness and concern (Garety & Hemsley, 1987).

Close examination of the delusional beliefs of psychiatric patients suggests broad similarities between their content and the content of beliefs widely held in the population, such as beliefs in hypnosis, telepathy, and spiritual influences (see Kingdon & Turkington, 1994, for a review). Large sub-groups within the population report unusual experiences with high frequency, such as déjà vu, visual and auditory hallucinations, and odd perceptions (Chapman & Chapman, 1988; Romme & Escher, 1989). In a poll of unusual beliefs in the USA, one in four believed they had had telepathic experiences, one in seven claimed to have seen a UFO, and one in ten believed they had talked to the devil (Gallup & Newport, 1991).

High Delusion-Proneness

There have been scales developed to measure the concept of 'delusion-proneness', such as the Peters *et al.* Delusion Inventory (PDI: Peters, Joseph & Garety, 1999b). This adopts a multi-dimensional approach with the dimensions of conviction, preoccupation and distress. The continuum hypothesis was supported by evidence that there was an overlap on scores between normal population and psychotic inpatient group. Peters *et al.* (1999b) found that 10% of a normal sample, with no psychiatric history, had PDI scores that exceeded the mean score of a psychiatric inpatient group.

Peters, Day, McKenna & Orbach (1999a) used the PDI to measure delusional ideation in NRMs, specifically Hare Krishnas and Druids, in comparison with two control groups (non-religious and Christian), and a psychotic inpatient group. The NRM groups endorsed significantly more items on the PDI than the two control groups. They also scored higher on levels of conviction than both controls, and significantly higher on levels of preoccupation than the non-religious groups, but not the Christian groups. When comparing with the deluded group, the NRMs showed similar numbers of endorsed items on the PDI, and similar levels of conviction. However, they were significantly less distressed and preoccupied by their experiences. This highlighted similarities and differences between the NRM groups and the experience of psychosis.

This study provided evidence for the continuum between normality and psychosis, with 'normal' individuals at one end of the continuum, the deluded individuals at the other end, and the NRMs at the intersection. However, there was a considerable overlap on PDI scores between groups, indicating that this classification is over-simplified. In addition, the study gave evidence for the multi-dimensionality of beliefs, as NRMs could be distinguished from psychotics by using the dimension scores of distress and preoccupation, but not conviction. Therefore, the difference between NRMs and psychotic patients was not just quantitative, but qualitative.

Peters, Day, McKenna & Orbach (1999a) conclude that whether or not one becomes overtly deluded is not just determined by the content of the belief, but the extent to which it is believed, how much it interferes with the person's life, and its emotional impact. They suggest that it is not *what* is believed, but *how* it is believed that is important.

Continuum And Reasoning

One limitation of the studies on reasoning biases described earlier in this chapter is that they are cross-sectional and demonstrate associations rather than cause. Thus studies using longitudinal methodology would be useful in mapping the relationship of cognitive processes to delusions over time. If reasoning biases were found in people who later developed delusions, this would provide support for the suggestion that the biases are implicated not only in the maintenance of delusions, but in their formation. No such studies have been found, but one study that attempts to address this by investigating reasoning biases in people who show high delusion-proneness is that by Linney, Peters & Ayton (1998). They divided a normal sample into high and low delusion-proneness using the PDI (Peters *et al.,* 1999b), and used a number of tasks in order to determine if there were any reasoning biases.

They found that those with high delusion-proneness were more likely to 'jump to conclusions' on a task which required participants to gather data to generate and test hypotheses about a number rule (Wason's 2-4-6 Task, Gorman, Stafford & Gorman, 1987). Looking at the errors made, they concluded that the 'jump-to-conclusions' style exhibited in this task could be due to differences in gathering feedback information. In addition, group differences were found in the coin-tossing task, described earlier. The high delusion-prone group were found to be less likely to take account of varying sample sizes in a coin-tossing task, which may indicate a lack of sensitivity to the effects of random variation. They propose that an individual who is insensitive to random variation may be less likely to realise that a larger sample is more representative, and this may lead them to 'jump to conclusions' and terminate data gathering early. These findings contradict those by Dudley *et al.* (1997a). This may be related to the difference in populations, but may also be due to differences in measurement. Dudley *et al.* (1997a) looked at the effect of sample size relative to the strength (proportion of heads to tails), where as Linney *et al.* (1998) kept strength constant and assessed the effect of sample size alone.

Blackmore & Troscianko (1985) also investigated the probability judgement of those with paranormal beliefs, known to be high in delusion-proneness, using the coin-tossing task. They used the same instructions as Dudley *et al.* (1997a) and found all subjects performed badly at this task. However, those with paranormal beliefs were significantly worse in responding to changes in sample size in this task than nonbelievers. Therefore the sensitivity to effects of random variation in deluded and delusion-prone individuals is in need of clarification.

The finding that delusion-prone individuals exhibit the same 'jump to conclusions' reasoning biases as delusional individuals provides evidence to support the theory that such biases may be implicated in the formation of delusions. Although similar biases were found, the study did not compare reasoning biases of those high in delusional ideation directly with people with delusions. The current study aims to determine the extent of the similarities in reasoning biases between those high in delusional ideation and those who are actively deluded.

4. Research Questions

This literature raises a number of questions to be addressed in this study:

1) What is the exact nature of this reasoning bias?

a) Is there evidence of a data-gathering bias?

There is clear evidence for a 'jump to conclusions' style of reasoning in people with delusions, but the nature of this bias is still unclear. This study aims to further test Dudley *et al.*'s (1997a) proposal that this is due to a data-gathering bias, as opposed to a general deficit in hypothesis testing. It is hypothesised that this data-gathering bias will be demonstrated in the deluded group, and leads to the following predictions:

i. People with delusions will demonstrate a style of 'jumping to conclusions', in a participant-determined task that involves data gathering to test hypotheses (Wason's 2-4-6 Task; Gorman, Stafford & Gorman, 1987), leading to a greater number of errors.

ii. People with delusions will demonstrate a tendency to request less information before making a decision, compared to normal controls in an participant-determined probability judgement task (Beads Task – Part 1: Huq, Garety & Hemsley, 1988). However, it is not predicted that this will increase the error rate, compared to controls.

iii. Those with delusions will show a similar amount of information seen before reaching certainty compared to normal controls on a experimenter-determined probability task, that does not involve data-gathering (Beads Task – Part 2: Huq *et al.,* 1988).

b) What is the effect of disconfirmatory evidence on certainty?

The second part of the Beads Task (Huq *et al.,* 1988) also aimed to determine the effect of disconfirmatory evidence on the participant's hypothesis, and their ability to use sequential information. It is proposed that dramatic swings in probability estimates in response to different coloured beads would give evidence towards the proposal that an individual is responding only to immediate stimuli. This could be a result of either an inability to use cumulative, sequential information to inform their hypothesis, or as a result of a bias towards cognitive closure.

c) Is the data-gathering bias due to inability to integrate information or due to an increased need for cognitive closure?

This study will also further explore the nature of the proposed data-gathering bias, and test whether this is a consequence of a deficit in the ability to integrate information over time, or a difference in the need for cognitive closure. A two-tailed hypothesis is used, and the results will allow discrimination between two models. Two tasks are used to examine this: Wason's 2-4-6 Task (Gorman *et al.,* 1987), and The Flats Task (Colbert & Peters, 2000), which are replicated with a deluded population.

In Wason's 2-4-6 Task, if the data-gathering bias is related to a *tendency towards early cognitive closure,* the deluded group would make decisions made on minimal information. Thus errors made would be due to participants making a final decision without attempting to explore the boundaries of the two rules. However, if the data-gathering bias is related to an inability to use past or sequential information, errors made would be due to the participant neglecting to use all the feedback given in making their judgement. Thus the participant would only using the trials immediately preceding their decision to inform their decision, ignoring previous contradictory evidence against this hypothesis.

In the Flats Task, if the data-gathering bias is related to a *tendency towards early cognitive closure*, the delusional inpatient group will use less information, compared to normal controls, at *all levels of difficulty.* The difficulty variable will not influence performance of the delusional group, and they will perform similarly in each condition. In addition, it would be predicted that the deluded group would have a lesser amount of information looked at but not used compared to controls, a faster response time, and higher levels of certainty of decision, at all levels of difficulty. However, if the reasoning biases are related to *an inability to use sequential information*, the delusional inpatient group will use less information, compared to normal controls, *only at high levels of difficulty.* It would also be predicted that deluded groups would have a similar amount of information looked at but not used, in all conditions. It is predicted that those with delusions would make faster responses, and show less certainty, compared to controls, only at greater levels of difficulty.

It is also hypothesised that if the data-gathering bias is related to a high need for cognitive closure, the deluded group will show higher levels on this measure, using the Need For Closure Scale (NFCS: Kruglanski, Webster & Klem, 1993), compared to normal controls.

d) Is the data-gathering bias a reflection of a more general reasoning bias?

This study also aims to confirm that the reasoning biases found are a result of a specific bias, rather than more general probability deficits. Thus it is hypothesised that people with delusions will perform similarly to normals in a task that measures a general hypothesis testing bias rather than a specific data-gathering bias (Wason Selection Task: Platt & Griggs, 1987).

The role of a general insensitivity to random variation in reasoning biases is unclear. This study also aims to compare the ability to judge randomness of those with delusions to normal participants in an experimenter-determined probability judgement task (Coin-Tossing Task: Blackmore & Troscianko, 1985), with a two-tailed hypothesis.

2) What is the relationship between the diagnosis of psychotic illness and reasoning biases?

Many studies have found people with delusions demonstrate reasoning biases, but few studies have attempted to determine whether this is a function of the presence of a delusion or the experience of psychosis. By using a clinical control group that has similar diagnoses to a delusional group, but does not have delusions, allows us to further clarify this issue. It is hypothesised that the reasoning biases are related to delusions, and not due to the psychotic illness itself. Thus it is predicted that the reasoning biases will be demonstrated in the clinical delusional group but ***not*** in psychotic patients without delusions.

3) Do high delusion-prone individuals in the normal population demonstrate similar reasoning biases to patients with delusions?

This study aims to compare the reasoning biases of delusion-prone normal individuals with deluded inpatients. It is hypothesised that high delusion-proneness lies on a continuum between normality and delusions. As found in previous studies (Linney *et al.,* 1997), it is predicted that a group high in delusional ideation will demonstrate similar reasoning biases to those shown in deluded individuals, compared to those low in delusional ideation. This would provide evidence that reasoning biases are involved in the formation as well as maintenance of delusions.

METHOD

Overview

Seventy-eight individuals were interviewed from four different participant groups. Two of these were clinical groups (a deluded psychiatric group and a non-deluded psychiatric control group), and two groups were recruited from the normal population (a high delusion-prone control group and a low delusion-prone control group). Measures of their delusional ideation, their need for 'cognitive closure', their levels of anxiety and depression, and their IQ were administered. Five tasks were used to determine the participants' general reasoning biases, probability judgements, and their data-gathering style. Two of those tasks were also used to explore whether data-gathering biases were related to a need for 'cognitive closure' or an inability to make use of sequential information.

Design

The design was a between-subjects design, apart from with the Flats Task, where a within subjects comparison was added. All participants were interviewed only once, and their results used to compare the performances of the different groups. Membership to one of the four groups described was used as an independent variable for the between-subjects analysis. Dependent variables are described under each task described in the Materials Section.

Participants

Only participants aged between eighteen and sixty-five years, and fluent in the English language were included. Participants were excluded if they had any known organic brain damage. However, no participants were excluded on this basis.

Clinical Groups

Participants in the clinical groups were recruited from inpatient wards at Maudsley Hospital, Bethlem Hospital and St Mary's Hospital, London. Inpatients were considered suitable if diagnosed by a consultant psychiatrist as having a current psychotic illness. Clinical participants were excluded if they had a primary diagnosis of alcohol or drug abuse. Advice was given by Registrars on individual wards as to possible appropriate patients. Prior to approaching patients, medical case notes were inspected to check inclusion and exclusion criteria, and to note any history of prior known delusions. Those considered appropriate were then invited to attend an interview session.

At the start of the interview session, a semi-structured interview was administered (The Scale for the Assessment of Positive Symptoms (SAPS): Andreasen, 1984). This is a diagnostic measure used to assess the existence and extent of patients' current delusions, as well as their level of positive symptomatology. A score of three on the 'global delusion measure' was used as a cut-off point to determine in which clinical group the patient would be placed. Those with a score of three and above on this item, indicating high levels of delusions, were allocated to the deluded psychiatric group; and those with a score of less than three, indicating delusions either low or absent, were allocated to the non-deluded psychiatric control group. The Registrars were also asked to complete the Manchester Scale (Krawiecka, Goldberg & Vaughan, 1977) for the patients interviewed, to confirm diagnosis and reliability of the researcher's findings with the SAPS.

In total, thirty-five inpatients were interviewed. Of these, twenty-one were allocated to the deluded psychiatric group, and fourteen to the non-deluded psychiatric control group. In addition, due to difficulty in recruiting non-deluded inpatients, two recently discharged non-deluded outpatients were interviewed, who matched all the inclusion criteria. This made a total of sixteen participants in the non-deluded psychiatric group. The deluded and clinical non-deluded groups ranged in diagnosis (Table 2).

Additional demographic information was collected from each participant including their age, ethnicity, years of education past age sixteen, and employment (or employment prior to admission for clinical participants). An IQ Test (The Quick Test: Ammons & Ammons, 1962) was administered to give a brief overview of the participant's verbal intelligence. In addition, information was collected from the clinical groups in terms of diagnosis, length of current admission, number of admissions, total time spent in hospital and current medication. These were mainly obtained from the individual's medical notes. The information collected from the clinical group is shown in Tables 1, 2 and 3. Information was also collected for the clinical non-deluded participants as to whether they were ever known to have had delusions in the past. Of the sixteen interviewed from this group, five were known to have had delusions on previous admissions, five were known to have never expressed delusions, and information about this was not known for six participants.

TABLE 1: DEMOGRAPHIC INFORMATION FOR CLINICAL GROUPS.

		CLINICAL DELUDED (N=21)	CLINICAL NON-DELUDED (N=16)
DEMOGRAPHIC INFORMATION			
Gender	*Males*	13 (61.9%)	9 (56.3%)
	Females	8 (38.1%)	7 (43.8%)
Age	*Mean (sd)*	34.86 (8.21)	34.69 (13.86)
Ethnicity	*White UK/Other*	8 (38.1%)	7 (43.8%)
	Black Afro-Caribbean	10 (47.6%)	8 (50.0%)
	Asian	3 (14.3%)	0 (0.0%)
	Other	0 (0.0%)	1 (6.2%)
Years of further education[a]	*Mean (sd)*	1.26 (1.76)	1.14 (1.70)
IQ	*Mean (sd)*	88.14 (9.03)	90.38 (15.93)
Social class based on occupation[b]	*I (Professional Occupations)*	1 (4.8%)	1 (6.3%)
	II (Managerial & Technical)	4 (19.0%)	0 (0.0%)
	IIIN (Skilled non-manual)	3 (14.3%)	1 (6.3%)
	IIIM (Skilled manual)	3 (14.3%)	0 (0.0%)
	V (Unskilled)	1 (4.8%)	1 (6.3%)
	Long-Term Unemployed	9 (42.9%)	13 (81.3%)

[a] Information on years of education is missing for four participants – two from the deluded group, and two from the clinical non-deluded group.

[b] Social class based on occupation (prior to entering hospital) was found using the Office of Population Census & Surveys (1990) Standard Occupational Classification (SOC)

TABLE 2: DIAGNOSTIC INFORMATION FOR CLINICAL GROUPS

			CLINICAL DELUDED (N=21)	CLINICAL NON-DELUDED (N=16)
DIAGNOSTIC & ADMISSIONS INFORMATION				
Diagnosis[c]	*Schizophrenia*		14 (66.7%)	8 (50.0%)
	Bipolar affective disorder		2 (9.5%)	4 (25.0%)
	Psychotic Illness (unspecified)		2 (9.5%)	2 (12.5%)
	Schizoaffective disorder		1 (4.8%)	0 (0.0%)
	Bipolar affective/ schizoaffective disorder		0 (0.0%)	1 (6.3%)
	Borderline personality disorder with psychosis		0 (0.0%)	1 (6.3%)
Length of current admission (in days)[d]		*Mean (sd)*	84.65 (75.15)	49.25 (42.27)[e]
Number of admissions[f]		*Mean (sd)*	6.65 (7.41)	7.33 (10.05)
Total time spent in hospital (in weeks)[g]		*Mean (sd)*	59.38 (64.15)	62.71 (77.36)
MEDICATION TAKEN				
Daily dose of anti-psychotic medication[h]	*Mean (sd)*		491.21mg (643.35)[i]	536.29mg (628.99)
	Anti-depressant medication		3 (14.3%)	2 (10.0%)
	Lithium medication		3 (14.3%)	3 (18.8%)

[c] Information on diagnosis was missing from the records of two participants from the deluded group.
[d] Information on length of current admission was missing for four of the non-deluded participants, and three of the clinical non-deluded participants.
[e] An outlier (more than 3 standard deviations away from the mean) of 586 days was removed from this calculation.
[f] Information on number of admissions was missing for one of the deluded group, and two of the clinical non-deluded group.
[g] Information on total time spent in hospital was missing for two of the clinical non-deluded group.
[h] Standardised to equivalent of mg of chlorpromazine. Medication information missing for three participants – one from the deluded group, and two from the clinical non-deluded group.
[i] An outlier (>3 sd from the mean) of 4000mg was removed from this calculation.

TABLE 3: SCORES ON THE SAPS AND THE HADS, FOR CLINICAL GROUPS

		CLINICAL DELUDED (N=21)	CLINICAL NON-DELUDED (N=16)
SCORES ON THE SCALE FOR THE ASSESSMENT OF POSITIVE SYMPTOMS (SAPS)			
Global Hallucination Score	*Mean (sd)*	2.14 (1.88)	2.50 (1.75)
Global Delusion Score	*Mean (sd)*	3.76 (0.62)	1.06 (0.68)
Global Bizarre Behaviour	*Mean (sd)*	1.00 (1.26)	0.75 (1.13)
Global Thought Disorder Score	*Mean (sd)*	0.90 (1.41)	1.00 (1.15)
SCORE ON THE HOSPITAL ANXIETY & DEPRESSION SCALE (HADS)			
Overall Score	*Mean (sd)*	13.14 (8.98)	16.31 (7.10)
Depression Score	*Mean (sd)*	6.10 (4.76)	8.88 (4.30)
Anxiety Score	*Mean (sd)*	7.05 (4.63)	7.44 (4.23)

Non-Clinical Groups

In total, forty-one participants from the normal population were recruited. The study aimed to recruit individuals who differed in their level of delusion-proneness, with the aim of dividing the participants into two groups: one group high on a measure of delusion-proneness, and one group low on such a measure. Previous studies have shown that members of New Religious Movements (such as Hare Krishna and Druids) and also those who have psychic or paranormal beliefs are especially high on these measures (Thalbourne, 1994; Peters, Day, McKenna & Orbach, 1999a). Persons with a known history of hospitalised psychiatric illness were to be excluded. However, no participants approached were excluded on these grounds.

Local agencies of the Hare Krishna Movement in Central London and Watford were contacted, and a request made for volunteers. Ten members of this group agreed to participate. Also, eight volunteers were recruited from the College of Psychic Studies in London following advertisements for people with 'psychic beliefs and/or experiences' (see Appendix A). Two participants with psychic/paranormal beliefs who did not attend the college also volunteered to participate. In total, twenty participants from groups thought to be high in delusion-proneness were interviewed.

Twenty-one participants from the normal population who were not members of these groups were recruited and interviewed, with the aim of having a sample of people who scored lower on measures of delusion-proneness. These were recruited via colleagues or acquaintances of the researcher. In order to reduce the risk of a biased sample, only participants who were not mental health or psychology professionals were invited to take part. The background information collected is shown in Table 4.

TABLE 4: DEMOGRAPHIC INFORMATION, SCORES ON THE HADS AND GROUP OF RECRUITMENT, FOR NON-CLINICAL GROUPS.

		NORMAL HIGH DELUSION-PRONE (N=21)	NORMAL LOW DELUSION-PRONE (N=20)
DEMOGRAPHIC INFORMATION			
Gender	*Males*	11 (52.4%)	11 (55.0%)
	Females	10 (47.6%)	9 (45.0%)
Age	*Mean (sd)*	34.86 (10.63)	32.55 (9.03)
Ethnicity	*White UK/Irish*	16 (76.2%)	20 (100.0%)
	Black Afro-Caribbean	0 (0.0%)	0 (0.0%)
	Asian	2 (9.5%)	0 (0.0%)
	Other	3 (14.3%)	0 (0.0%)
Years of further education	*Mean (sd)*	3.95 (2.09)	2.85 (2.94)
IQ	*Mean (sd)*	95.00 (8.52)	99.80 (6.99)
Social class based on occupation	*I (Professional)*	4 (19.0%)	2 (10.0%)
	II (Managerial & Technical)	15 (71.4%)	13 (65.0%)
	IIIN (Skilled non-manual)	1 (4.8%)	4 (20.0%)
	IIIM (Skilled manual)	1 (4.8%)	0 (0.0%)
	Long-Term Unemployed	0 (0.0%)	1 (5.0%)
SCORE ON HOSPITAL ANXIETY & DEPRESSION SCALE			
Overall score	*Mean (sd)*	9.52 (3.70)	7.20 (4.25)
Depression scale	*Mean (sd)*	3.33 (1.93)	2.40 (2.23)
Anxiety scale	*Mean (sd)*	6.19 (2.75)	4.80 (2.67)
GROUP OF RECRUITMENT			
	Hare Krishna Movement	10 (47.6%)	0 (0.0%)
	Psychic College	6 (28.6%)	2 (10.0%)
	Paranormal Beliefs	0 (0.0%)	2 (10.0%)
	Rest of population	5 (23.8%)	16 (80.0%)

When all non-clinical participants had been interviewed, they were divided into two groups on the basis of their scores on the Peters *et al.* Delusional Ideation Scale (PDI: Peters, Joseph & Garety, 1999b). This was done by adding the total scores for each dimension of the PDI (distress, preoccupation and conviction) to the total score on the PDI, and finding the overall median score for the non-clinical group. The median was calculated to be forty-two. Those who scored on or above the median (42 and over) were allocated to the high delusion-prone group (21 participants), and those who scored below the median (41 and under) were allocated to the low delusion-prone group (20 participants). In total, 80% of the participants taken from the groups thought to be high in delusion-proneness (Hare Krishna Movement, Psychic College members or those with paranormal beliefs) remained within that group after they had been divided using the PDI scores, and 20% were found to lie in the low PDI group.

Differences Between Groups

Comparing All Groups

There were no significant differences between the four groups in terms of gender (χ^2 (3) = 0.413, p = 0.938[j]) or age (χ^2 (3) = 1.839, p = 0.606[k]). However, there were significant differences between the four groups in terms of ethnicity[l] (χ^2 (3) = 21.890, p = 0.001), years of education past age 16 (F (3, 70) = 7.075, p < 0.001[m]), IQ scores (F (3, 74) = 5.047, p = 0.003), social class based on occupation[n] (χ^2 (6) = 47.557, p <

[j] Pearson's chi-square was used throughout the analysis, unless otherwise stated.

[k] Using Kruskall Wallis non-parametric test, as age was substantially skewed in the low PDI group. Where possible, when data were skewed, transformations were attempted using square roots or logarithms. However, in instances where these failed, non-parametric tests were used.

[l] As all the participants in the low PDI group were white, the ethnicity group was collapsed into white vs. other, to reduce the number of cells in the chi-square with an expected count less than 5.

[m] Using One-way ANOVA on data transformed using square root, as years of education was substantially skewed for both clinical groups.

[n] The categories were collapsed into 'I & II', 'III, IV & V', and 'Unemployed', in order to reduce the number of cells with expected counts less than 5 in the chi-square analysis.

0.001) and HADS scores, including total HADS scores ($F (3, 74) = 7.238$, $p < 0.001$), HADS depression scores ($F (3, 74) = 8.463$, $p < 0.001$) and HADS anxiety scores ($F (3, 74) = 3.853$, $p = 0.013$).

For ethnicity, these differences were found between the deluded group and both the high PDI and the low PDI non-clinical groups ($\chi^2 (1) = 6.222$, $p = 0.013$, $\chi^2 (1) = 18.129$, $p < 0.001$, respectively) and between the non-deluded group and both the high and low PDI groups ($\chi^2 (1) = 4.063$, $p = 0.044$; $\chi^2 (1) = 15.000$, $p < 0.001$, respectively). This is believed to be due to the broader ethnic mix of the clinical groups, whereas for the non-clinical groups, the participants were mainly white. There were no significant differences in ethnicity between the two clinical groups ($\chi^2 (1) = 0.120$, $p = 0.729$). However, there were significant differences between the two non-clinical groups (using Fisher's Exact Test, $p = 0.048$[o]).

With regards to years of education past the age of sixteen, post-hoc Bonferroni tests on pair-wise comparisons revealed that the high PDI group had significantly more years of further education than both the deluded and non-deluded clinical groups ($p = 0.001$; $p = 0.002$ respectively). There were no significant differences between the low PDI group and any other group. There were also no significant differences between the two clinical groups, or between the two non-clinical groups in terms of years of further education.

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[o] Fisher's Exact Test was used as cells in the chi-square had counts less than 5, which violates the assumptions of the chi-square test.

In terms of IQ, post-hoc Bonferroni tests on pair-wise comparisons revealed that the low PDI group had a significantly higher IQ (as rated on the Quick Test) than both the deluded and non-deluded clinical groups ($p = 0.003$; $p = 0.047$, respectively). No other significant differences were found.

The differences in social class based on occupation can be seen to be due to the large numbers of long-term unemployed people in the clinical groups, and the greater number of people in the non-clinical groups with occupations in the social class bracket of I or II. There were significant differences between the deluded group and both the high and low PDI non-clinical groups (χ^2 (2) = 19.944, $p < 0.001$; χ^2 (2) = 12.201, $p = 0.002$, respectively), and between the non-deluded group and both the high and low PDI groups (χ^2 (2) = 29.055, $p < 0.001$;χ^2 (2) = 23.042, $p < 0.001$, respectively). There were no significant differences between the two clinical groups (χ^2 (2) = 5.598, $p = 0.061$), or between the high and low PDI groups (χ^2 (2) = 2.114, $p = 0.347$).

On HADS total scores, the clinical groups can be seen to have higher overall HADS scores, and anxiety and depression scores than the non-clinical population. Post-hoc Bonferroni tests revealed that the low PDI group had significantly lower overall scores than both deluded and non-deluded clinical groups ($p = 0.022$; $p < 0.001$ respectively) and the high PDI group had significantly lower scores than the clinical non-deluded group ($p = 0.011$). These differences were also reflected in the HADS depression scores, with again significant differences between low PDI and both deluded and non-deluded clinical groups ($p = 0.006$, $p < 0.001$ respectively) and between high PDI group and the clinical non-deluded group ($p = 0.004$). With the

HADS anxiety scores, the low PDI group were found to have significantly lower scores than the clinical non-deluded group ($p = 0.008$). There were no significant differences between the two clinical groups, or between the two non-clinical groups in terms of HADS total scores, or anxiety or depression scores.

Differences Between Clinical Groups

The two clinical groups do not differ significantly from each other in terms of length of current admission when interviewed ($t(27) = 1.471$, $p = 0.153$), number of admissions ($t(31) = 0.598$, $p = 0.554$[p]), or total length of time in hospital ($t(33) = 0.274$, $p = 0.223$[q]). The two groups also did not differ in daily dosage of anti-psychotic medication (Mann-Whitney $U = 123.0$, $p = 0.733$), or in anti-depressant medication (Fisher's Exact Test = 1.000), or lithium medication ($\chi^2 (1) = 0.234$, $p = 0.672$). As would be expected, the groups did differ significantly in terms of global ratings of delusions on the SAPS ($t(35) = 12.532$ $p < 0.001$). However, they did not differ in terms of other global ratings on the SAPS: hallucinations ($t(35) = 0.590$, $p = 0.559$); bizarre behaviour ($t(35) = 0.622$, $p = 0.535$[r]); or thought disorder ($t(35) = 0.593$, $p = 0.557$[s]).

Ethical Considerations

Ethical approval for the study was given by the Joint UCL/UCLH Committees on the Ethics of Human Research, and also by St Mary's Local Research Ethics Committee,

[p] Number of admissions was transformed by logarithm, as the data was skewed for both deluded and clinical non-deluded groups.

[q] Total time spent in hospital was transformed by logarithm, as the data was skewed for both deluded and clinical non-deluded groups.

[r] Global ratings of bizarre behaviour using the SAPS were transformed by square root, as data was skewed for the clinical non-deluded group.

[s] Global ratings of thought disorder using the SAPS were transformed by square root, as data was skewed for the deluded group.

and The Bethlem & Maudsley NHS Trust Ethics Committee. The letters of approval are shown in Appendices B, C and D.

For the clinical population groups, written permission from the appropriate Consultant was obtained to allow the researcher to approach patients and also to look at their medical notes. All participants read an information sheet before they agreed whether or not to take part (see Appendix E). This sheet gave an outline of the research and its purposes. It stated that participation was voluntary and that they could withdraw at any time, and assured confidentiality and anonymity. Clinical participants were informed that their participation would not affect their care in any way, and informed them that their medical notes would be looked at. Prior to starting the interview and testing process, any queries they had about the research and the process were clarified, and written consent was obtained from all patients (see Appendix F).

Researchers

Sixty-eight of the participant interviews were carried out by a Clinical Psychologist in Training, and ten were carried out by a Research Psychologist. Both were supervised and trained on administration of the tasks by the main project supervisor.

Measures

Diagnostic Measures

Manchester Scale (Krawiecka, Goldberg & Vaughan, 1977)

This is a brief scale, designed to provide an indication of symptoms observed. This scale was used in order to assess the reliability of the researcher's measures of symptoms using the SAPS. It has been found to have a high level of inter-rater reliability (Kendall's Coefficient of Concordance (W) ranging from 0.58 to 0.87, with a significance of $p < 0.01$ for all items).

Raters are asked to rate the patient's behaviour, as measured on eight items, over the last week. Four of those items are rated using the patient's replies to questions (depression, anxiety, coherently expressed delusions and hallucinations) and four are rated according to the rater's observations of the patient (incoherence and irrelevance of speech, poverty of speech, flattened incongruous affect and psychomotor retardation). Each item is rated on a scale of 0 to 4 of increasing severity, according to instructions provided with the scale.

Scale for the Assessment of Positive Symptoms (SAPS: Andreasen, 1984)

This is a standardised structured interview consisting of thirty-five items, measuring positive symptoms. The items fall under five scales, which were used to assess the extent of hallucinations (seven items), delusions (thirteen items), bizarre behaviour (five items), positive formal thought disorder (nine items) and inappropriate affect (one item). Inter-rater reliability for items are high (r = from 0.56 to 0.99). Internal consistency is slightly less for the scale as a whole (Cronbach's $\alpha = 0.48$).

A standardised clinical interview was used to evaluate the respondent's symptoms, as assessed for each item. Possible prompt questions are provided. For each item, the participant was assessed by the rater on a scale of 0 to 5 of increasing severity. Descriptions of what would be necessary to achieve each score are described in the manual. The last item on each scale is an overall global rating for each group of symptoms, taking into account the nature and severity of symptoms, again on a scale of 0 to 5.

Inter-rater reliabilities

The researchers were trained in the administration and scoring of the SAPS by an experienced psychiatrist, using three patients. Inter-rater reliability was established by joint rating between the trainer and the main researcher with two participants (Cohen's Kappa = 0.729), between the trainer and the second researcher for three participants ($\kappa = 0.572$), and between the two researchers for six participants ($\kappa = 0.605$).

Reliability of SAPS against Manchester Scale

The Manchester Scale was completed by the Registrars for eighteen of the clinical participants. The researcher's ratings of global measure of hallucinations using the SAPS were found to correlate highly with the Registrar's global ratings of hallucinations, using the Manchester Scale ($r = 0.698$, $p = 0.001$), as did the two measures of delusions ($r = 0.739$, $p < 0.001$). The global measure of thought disorder on the SAPS was measured against the Incoherence score on the Manchester Scale, and found to correlate significantly ($r = 0.685$, $p = 0.002$).

Self-Report Questionnaires

The Peters *et al.* Delusional Ideation Scale: (PDI: Peters, Joseph & Garety, 1999b)

The PDI is based on the Present State Examination (Wing, Cooper & Sartorious, 1974). It has twenty-one items designed to measure delusional ideation in the normal population, and has been found to be a reliable and valid measure (Peters *et al.*, 1999b). The items have high internal consistency (Cronbach's $\alpha = 0.82$), and the measure has good concurrent validity[t] (Spearman's $r = 0.65$, $p < 0.001$) and criterion validity. It consists of eleven 'factors': religiosity, persecution, grandiosity, paranormal beliefs, thought disturbances, suspiciousness, paranoid ideation, negative self, depersonalisation, catastrophic ideation and thought broadcast, and ideation of reference and influence. Each factor was measured using two items (apart from the depersonalisation factor, with only one). Each item asks about the participant's belief or experience to which the participant answers either yes or no. For example:

> *"Do you ever feel as if people seem to drop hints about you or say things with a double meaning?"*

Each question also has three additional dimensions, which are completed for the endorsed items only. These dimensions measure levels of distress, preoccupation and conviction for the affirmed belief, rated by the participant on a five-point Likert scales.

A number of different scores can be obtained from the PDI: a total PDI score, comprising of the total number of items endorsed (ranging from 0 to 21); a total distress score, calculated from the sum of the distress ratings from each item (ranging from 0 to 105); a total preoccupation score, calculated from the sum of the preoccupation rating for each item (ranging from 0 to 105); and a total conviction score, calculated from the sum of the conviction ratings for each item (ranging from 0

[t] Concurrent validity measured against the Delusions Symptom-State Inventory (DSSI, Foulds & Bedford, 1975).

to 105). The sum of the total distress, preoccupation and conviction scores added to the total number endorsed can also be calculated (ranging from 0 to 336).

The Hospital Anxiety & Depression Scale (HADS: Zigmond & Snaith, 1983)

This is a well-used clinical tool, designed to measure a respondent's level of anxiety and depression. It has been found to be a valid and reliable measure, with high internal consistency (Spearman's correlations ranging from 0.60-0.30 for depression items, all significant beyond $p < 0.02$, and Spearman's correlations from 0.76-0.41 for anxiety items, all significant at $p < 0.01$). It has also been shown to have significant concurrent validity (Spearman's correlations of scores with psychiatric rating: $r = 0.70$ for depression; $r = 0.74$ for anxiety, both significant at $p < 0.001$). It had also been shown to be able to distinguish between depression and anxiety.

It consists of fourteen items, half of which relate to anxiety and half to depression. Each item has four potential responses on a scale of 0 to 3. The depression scores range from 0 to 21, and the anxiety scores range from 0 to 21. These scores are combined to give a total HADS score, thus total HADS scores range from 0 to 42.

The Need For Closure Scale (NFC: Kruglanski, Webster & Klem, 1993): Modified Version

This original version of the NFC is a forty-two item questionnaire designed to measure a person's need for 'cognitive closure'. As described in the Introduction chapter, the concept of 'cognitive closure' is viewed as a dispositional construct towards imposing an early answer on a task or situation to avoid confusion and ambiguity (Kruglanski, 1990). In the original version, participants indicated the extent to which they endorse an item by responding on a six-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. This measure was found to be a reliable and valid instrument in measuring individual differences of cognitive closure. Studies indicate satisfactory internal consistency (Cronbach's $\alpha = 0.84$) as well as high test-retest reliability ($r = 0.8611$). It also possesses acceptable discriminant[u] and convergent validity.

This version has been modified for use with a psychiatric population. Nine items were removed, as they related to work or studies, which were thought to be inappropriate for use with an inpatient population. In addition, the Likert scale was altered to a yes/no format to increase ease and speed of completion (see Appendix G).

The remaining thirty-three items fall into five factors which the authors proposed to broadly represent the construct: preference for order and structure (three items), discomfort with ambiguity (nine items), decisiveness of judgement (seven items), desire for predictability (six items), and close-mindedness (eight items).

IQ Test

Quick Test (Ammons & Ammons, 1962)

This is a valid and reliable rapid measure of a person's current verbal IQ. Single forms and combination forms have been found to be highly reliable ($\alpha = 0.66$ to 0.95), and have good validity estimates ($r = 0.77$ to 0.96) for correlations with revised Stanford-Binet and Weschler scales. The participant is shown four line drawings and

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[u] One example of where the Need For Closure Scale's discriminant validity was shown was in a study where individuals with relatively high (vs. low) NFC scores exhibited greater primacy effects in impression formation (Webster & Kruglanski, 1994).

is read fifty test words, which they must relate to one of the drawings. The participant's answers are scored according to an objective list of correct answers, provided to the scorer. The participant's overall score is then converted to a Weschler-type IQ score using a conversion chart. This measure was used to take account of any differences in intellectual ability.

Reasoning Tasks

Wason's 2-4-6 Task (Gorman, Stafford & Gorman, 1987): Modified Version

A modified version of the Wason (1960) 2-4-6 Task was used, described by Gorman *et al.* (1987). Gorman *et al.* (1987) found that instructing the participants that they were looking for two rules (a 'dax' and a 'med'), rather than just one rule where feedback was either correct or incorrect, improved performance from 21% correct to 88% correct. In the version used in this study, participants were told that they were to look for two mutually exclusive rules (labelled the Dax rule & the Med rule) that accept some number triples and reject others. Unknown to the participants, the Dax rule is where any three numbers are different, and the Med rule is the opposite: where two or more numbers are the same. The participants were initially given an example of the Dax rule (2-4-6). They were then asked to generate their own number triples, and were given feedback on each one as to which rule it follows. The task ended when the participants believed that they knew the two rules (see Appendix H for instructions given).

The dependent variables in this task were: whether the answer is correct or incorrect; type of error made; time taken; number of triples to first 'med'; total number of 'meds'; and total number of 'daxes' following the first 'med'. The type of error made was predicted from work by Linney *et al.* (1998). One common type of error they found was the participant 'not exploring boundaries' (indicating a tendency towards cognitive closure). Another was 'using only most recent information' (indicating an inability to use sequential information).

The Beads Task (Huq, Garety & Hemsley, 1988): Part 1

Two parts of this task were used, similar to the design by Huq *et al.* (1988). In the first part, the participants were shown two jars, labelled A & B, containing beads of two different colours, yellow and black, in equal and opposite proportions. Jar A had 85 yellow beads and 15 black beads, and Jar B had 85 black beads and 15 yellow beads. These jars were then hidden from the participant's view, and the experimenter informed them that she would be drawing beads from only one jar. The participants were asked to inform the experimenter when he or she believed that they were certain from which jar the beads were being drawn (see Appendix I for instructions given). The experimenter drew beads from the chosen jar one at a time, replacing them each time. The order of beads actually drawn were determined from a pre-set list which corresponded to the actual proportions in Jar A, to ensure standardisation. The order of beads shown was as follows:

Y Y Y B Y Y Y Y Y B B Y Y Y Y Y Y Y Y B

When the participants announced their decision, the experimenter stopped, and recorded how many beads the participants saw before making their decision. The participants were then asked which jar they believed the beads were being drawn from.

Dependent variables for this task were: whether the answer given is correct or incorrect; and number of beads to certainty.

The Beads Task (Huq, Garety & Hemsley, 1988): Part 2

In this second part, the participants were shown two different jars of beads, again labelled Jars A and B, each containing beads of two different colours (red and green) in equal and opposite proportions. Jar A had 85 red beads and 15 green beads, and Jar B had 85 green beads and 15 red beads. Again these jars are hidden from the participant's view, and they were informed that the experimenter would be drawing ten beads from one jar only, one at a time. The participants were given ten identical lines, each exactly 100mm in length, corresponding to each one of the beads, which were on separate pages, labelled according to the bead number. The left end of the line was labelled 'Jar A definitely has not been chosen' and the right end was labelled 'Jar A definitely has been chosen'. The mid-point was labelled 'equally likely' (see Appendix J). The participants were asked to indicate how likely they believed it was that Jar A has been chosen, as opposed to Jar B, after seeing each bead shown, by putting a mark on the line given. Again the order of beads was predetermined according to the proportions of Jar A, as following:

R R R B R R R R B R

The point marked by the participant was measured from the left side in millimetres, representing a probability rating from 0 to 100.

Dependent variables on this task were:

1. Number of beads to certainty (certainty being represented by a probability rating of 100% or a rating of more than 85% for two beads)

2. Effect of contradictory evidence (calculated as the probability rating after the third bead minus that after the fourth bead, added to the probability rating of the eighth bead minus that of the ninth bead)

The Flats Task (Colbert & Peters, 2000)

This task was devised by Colbert & Peters (2000) as a way of differentiating whether data-gathering bias was a result of cognitive closure or an individual's inability to integrate information. The version used had been slightly modified to increase ease of use with a psychiatric population, by reducing the amount of information in each condition. The amended items were piloted so that the items were equally balanced. Chi-squares for all but the easiest condition showed no significant differences between groups. Steps were taken to address the balance for Condition 1. However, this was not piloted (see Appendix K for flat contents).

In the Flats Task, participants were given information about four different flats and asked to decide which they prefer (see Appendix L for instructions). The task was manipulated by increasing the amount of information available for each flat in each condition, the amount of information across the conditions being 2, 4, 8 and 16. Two types of information were given to examine whether people use different types of information to make their decision: information thought to be relevant to making a decision on the flat (i.e. rent, size, noise level, furniture quality, distance from work, cleanliness, cupboard storage space, brightness of room, and landlord/landlady attitude) and information that was thought to be less relevant, or 'idiosyncratic information' (i.e. day of the week rubbish is collected, colour of front door and availability of ornamental birdcage). A previous study using this task found no differences between groups in the use of idiosyncratic information, however, the participants were from the normal population. Other studies have shown that schizophrenic patients are more idiosyncratic in their responses in word association tasks than the normal population (Johnson, Weiss & Zelhart, 1964).

The task is timed. When the participants announced their decision of which flat they preferred, the total number of pieces of information looked at was noted, and the participants were asked which pieces of information they had *used* to inform their decision, to determine number of pieces of information actually used. From this, the number of items of information *'looked at but not used'* was also calculated. The participants were asked the certainty of their decision, on a scale from 0 to 100. After all four conditions, the participants were asked which condition they found easiest.

The dependent variables for the between-groups analysis for this task were: choice of flat for each condition; time taken for each condition; certainty of choice for each condition; number of flats used for each condition; total amount of information used; amount of information looked but not used; and amount of idiosyncratic information used for each condition. A within-groups design was then used to explore the effect of increasing difficulty of task by using the four conditions, and to explore any interactions between group and condition.

Wason's Selection Task (Platt & Griggs, 1987): Modified Version

The Wason's Selection Task is a form of deductive reasoning task normally used to examine formal logic and an individual's ability to test a given hypothesis. Wason & Johnson-Laird (1972) found that in the original abstract version of the task, less than

10% of subjects solved the problem. However, people were much more able to solve it when it was couched in a familiar context (Wason & Shapiro, 1971). A modified version of this task, using a concrete, familiar context was used (see Appendix M).

In this task, the participants were asked to put themselves in the position of being a 'quality controller' in a company that manufactures hot and cold taps, where some of the taps have been labelled incorrectly (using red and blue dots). They were then given a rule: "If the tap is hot it must be marked with a red dot" and then presented with four cards, each with the colour of the dot on one face, and whether the tap is hot or cold on the other. They were presented so that one hot tap, one cold tap, one blue dot and one red dot are visible to the participants. The participants were asked to decide which cards they would need to turn over to test this rule. The correct answer involves using the disconfirmatory strategy of the hot tap plus the blue dot.

The dependent variables for this task were: whether the answer given is correct or incorrect; time taken; the participant's certainty of their decision; and number of cards looked at. The answers were also converted into a 'logic index' described by Platt & Griggs (1993), which involved giving one point for each correct card selected, and subtracting a point for each incorrect card selected. In this way the possible scores ranged from –2 to +2.

The Coin-Tossing Task (Blackmore & Troscianko, 1985)

In this task, the participants were presented with eight examples of hypothetical coin-tossing. For example:

"I spin a coin 12 times and get 'heads' 6 times."

The eight examples given differ in the proportions of heads to tails (strength): half had proportions of heads to tails of 50:50, and half had proportions of 75: 25. They also differed in number of tosses (weight), there being two examples of each of the following number of coin tosses: 4, 12, 20 and 60. These examples were presented in pseudo-random fixed order. The participants were asked to estimate to what extent the coin was biased or unfair on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair (see Appendix N for instructions and order presented).

Bayes Theorem suggests that, of the examples where ratios are 50:50, an increase in the number of tosses should result in a decrease in ratings of unfairness. Of those examples where the ratio is 75:25, an increase in the number of tosses should lead to an increase in ratings of unfairness. For those where ratios are 50:50, a score of one is given each time the ratings decreased with increasing number of tosses, minus one each time the ratings increased with increasing number of tosses, and a score of zero each time they remained the same with increasing tosses. For those where ratios are 75:25, a score of one is given each time the ratings increased with increasing number of tosses, minus one each time the ratings decreased with increasing number of tosses, and a score of zero each time they remained the same. The scores for these two ratios were added, thus there was a potential range of scores from –6 to +6. These scores were normalised to range from 0 to 100.

The dependent variables in this task were: score for when coin is 'fair'; score for when coin is 'unfair'; and total coin score.

Procedure

Each interview session consisted of the three self-report questionnaires, an IQ assessment task, and the five reasoning tasks. In addition, a diagnostic semi-structured questionnaire was used for the clinical groups. The total time taken to complete the questionnaires and tasks was between one and two hours for each participant.

Initially, the SAPS was administered to determine the clinical group. Following this, the participants were asked to complete the three self-report questionnaires described earlier. The order in which the participants were asked to complete these was randomised across participants to avoid potentially confounding order effects.

After this, the IQ Test (The Quick Test: Ammons & Ammons, 1962), together with the five reasoning tasks, were administered to the participants. The Quick Test was included in with the reasoning tasks in order to disguise the fact that it was an IQ Test. These tasks were also randomised into six possible orders to ensure that practice or order effects did not impact on overall results.

Setting

Interviews for clinical inpatient participants were conducted in a quiet room on the participant's ward. For non-clinical participants and the two outpatients, interviews were conducted either at interview rooms at the Institute of Psychiatry, or University College London, or in the participant's home. For the participants from the Hare Krishna movement, a room was made available at their temple in Watford. Although participants were informed initially that they could take breaks if they required, none did.

Planned Statistical Analysis

The data collected was entered onto a database in SPSS (Version 9.0). Planned analyses on continuous data included determining group differences using one-way analysis of variance, with additional post-hoc Bonferroni tests to complete pair-wise comparisons, while still accounting for Type 1 error. Kruskall Wallis tests were also planned where data were found not to be normally distributed and could not be successfully transformed, followed by additional Mann-Whitney tests when differences between groups were predicted. Pearson's chi-square was also planned where data were categorical.

For the Flats Task, Repeated Measures Analysis of Variance was planned, with group and condition as independent variables, and amount of information used, or looked at but not used as dependent variables. Scores on the Need For Closure Scale were also used as independent variables for both the Flats Task and the Wason's 2-4-6 Task.

RESULTS

Screening the Data

Due to the significant group differences in IQ, years of education and scores on the HADS, univariate analyses of covariances (ANCOVAs) and logistic regressions were carried out on the dependent variables, to determine the impact of these differences on task scores. These results are reported in the results section where significant effects of covariates occur. Homogeneity of regression was also checked for each of these analyses, by checking for any significant interactions between the covariates and impact of group effects. Where no significant effects of covariates were found, one-way analysis of variances (ANOVAs) are reported. Kruskall Wallis tests and Pearson's chi-squared are also reported when data was not normally distributed, or categorical.

Scores on the Peters *et al.* Delusional Inventory Scale

One-way ANOVAs were used to determine any differences in the PDI scores and dimensions (distress, preoccupation and conviction). The non-clinical samples were grouped on the basis of PDI scores, therefore it would be expected that the low PDI group would differ from the high PDI group and the clinical groups in dimensions, as well as total scores. The aim of the analyses was to confirm this, but also to determine whether the two clinical groups and the high PDI group differed in aspects of PDI scores. Table 5 describes the mean and standard deviations for PDI scores.

TABLE 5: SCORES ON THE PETERS *ET AL.* DELUSIONAL INVENTORY, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 20)[a]	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Total score (range: 0-21)	8.05 (3.87)	8.00 (3.65)	8.95 (3.63)	3.35 (1.57)
DIMENSIONS				
Distress score (range: 0-105)	22.05 (17.34)	22.63 (10.75)	17.10 (11.43)	5.15 (3.34)
Preoccupation score (range: 0-105)	20.05 (14.95)	21.25 (10.58)	19.43 (12.59)	5.10 (2.24)
Conviction score (range: 0-105)	28.01 (15.14)	29.06 (14.84)	30.48 (12.25)	8.55 (4.49)
Sum of dimensions and total score (range: 0-336)	78.25 (48.77)	80.94 (28.24)	75.95 (37.54)	22.15 (9.49)

[a] One member of the deluded group failed to complete the PDI.

For each of the scoring methods (total number of items answered affirmatively and the sum of the dimensions scores for each item added to that total score), and the PDI dimensions individually, there were significant moderating effects of HADS scores (all significant at the 5% level). Appendix O describes the estimated marginal means and standard errors for these scores, when controlling for HADS scores. When accounting for this covariate, using an analysis of covariance (ANCOVA), as would be expected, there were significant differences between the groups in terms of total PDI scores ($F(3, 72) = 9.500$, $p < 0.001$), distress scores ($F(3, 72) = 14.897$, $p < 0.001$[b]), preoccupation scores ($F(3, 72) = 12.686$, $p < 0.001$[c]), conviction scores ($F(3, 72) = 10.995$, $p < 0.001$), and the sum of dimensions added to the total score ($F(3, 72) = 8.974$, $p < 0.001$). Post-hoc Bonferroni tests confirmed that this was due to significantly lower scores within the low PDI group, compared to each of the other three groups (all at the 1% level). There were no differences found in scores between the other three groups. Information on the mean scores of the individual factors making up the PDI are described in Appendix P, but were not thought to be relevant to discussion in the main results.

Need For Closure Scale Scores

As there were no significant effects of covariates, one-way ANOVAs were used to determine any differences in the groups in terms of total NFCS scores, and factor scores. The mean and standard deviations of these variables are shown in Table 6.

[b] Distress scores were transformed by logarithm, as scores for the deluded group were significantly skewed.

[c] Preoccupation scores were transformed by logarithm, as scores for the deluded group and high PDI group were significantly skewed.

TABLE 6: SCORES ON THE NEED FOR CLOSURE SCALE, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 20)[d]	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Total Need For Closure Scale score (range: 0-33)	19.45 (4.85)	18.87 (2.66)	16.38 (5.50)	15.95 (5.91)
FACTORS				
Closed Mindedness (range: 0-8)	3.20 (1.47)	2.75 (2.05)	2.05 (1.40)	3.00 (2.18)
Discomfort with Ambiguity (range 0-9)	6.30 (2.05)	5.56 (2.19)	5.33 (2.29)	4.50 (2.19)
Decisiveness (range: 0-7)	3.90 (2.07)	4.06 (1.98)	4.33 (2.20)	3.85 (1.84)
Preference for Order (range: 0-3)	2.15 (0.88)	2.25 (0.93)	1.57 (1.08)	1.15 (1.18)
Preference for Predictability (range: 0-6)	3.90 (1.59)	4.25 (1.34)	3.10 (1.89)	3.45 (1.63)

[d] One member of the deluded group failed to complete the NFCS.

Total NFCS Score

It was predicted that people with delusions would score higher on the NFCS if the reasoning biases found in earlier studies were due to a high need for cognitive closure. Looking at the total NFCS scores, the differences between the groups approached significance ($F(3, 73) = 2.404$, $p = 0.074$). However, this significance disappeared ($F(3, 72) = 0.780$, $p = 0.503$) when controlling for a significant covarying effect of years of education ($F(1, 72) = 6.686$, $p = 0.012$). Thus results found do not support this hypothesis.

NFCS Factors

There were no significant differences between groups in terms of the factors of Closed Mindedness ($F(3, 73) = 1.634$, $p = 0.189$) and Preference For Predictability ($F(3, 73) = 1.756$, $p = 0.163$). The differences between groups on the Discomfort With Ambiguity factor approached significance ($F(3, 73) = 2.302$, $p = 0.084$), but this effect disappeared ($F(3, 72) = 1.191$, $p = 0.319$) with the significant covarying effect of HADS scores ($F(1, 72) = 8.886$, $p = 0.004$). The factor of Decisiveness also was significantly moderated by HADS scores ($F(1, 72) = 4.270$, $p = 0.042$), and there were no significant differences between groups in terms of this factor ($F(3, 72) = 0.582$, $p = 0.629$). The Estimated Marginal Means when controlling for significant effects of covariates are shown in Appendix Q. There were, however, significant differences between groups in terms of Preference For Order factor ($F(3, 73) = 4.747$, $p = 0.004$). Post-hoc Bonferroni tests revealed that this was due to significantly lower scores for the low PDI group, compared to both the deluded group ($p = 0.018$) and the non-deluded group ($p = 0.013$). There were no differences in this factor between the low and high PDI groups ($p = 1.000$), or between the two clinical groups ($p = 1.000$).

Wason's 2-4-6 Task

Correct Answer Given

The scores for the dependent variables for this task are shown in Table 7. It was predicted that the deluded group would make a greater number of errors on this task, due to a tendency to 'jump to conclusions'. Only one participant (4.8%) in the deluded group, and none in the clinical non-deluded group, gave the correct answer on the Wason's 2-4-6 Task, whereas eight (38.1%) from the high PDI group and ten (50.0%) from the low PDI group gave the correct answer. Using Pearson's chi-square, it was found that this difference between the four groups was significant (χ^2 (6) = 24.791, p < 0.001). Using a logistic regression, there was found to be a significant covarying effect of years of education (β = 0.340, Wald = 8.817, p = 0.003). However, even with this controlled for, there remained a significant group effect (χ^2 (3) = 15.753, p = 0.001). It was found that the high PDI group answered correctly significantly more than both the deluded and clinical non-deluded groups (χ^2 (2) = 7.816, p = 0.020; χ^2 (2) = 12.481, p = 0.002, respectively), as did the low PDI group (χ^2 (2) = 11.010, p = 0.004; χ^2 (2) = 11.548, p = 0.003). There were no significant differences between the two clinical groups (χ^2 (2) = 3.160, p = 0.206), or between the high and low PDI groups (χ^2 (2) = 2.515, p = 0.284).

Ability To Finish The Task

Ability to finish the task, time taken and number of triples to the first 'med' are proposed to give some indication of general *ability* to form hypotheses. There was a significant difference in the number of participants being unable to finish the task (χ^2 (3) = 9.524, p = 0.026). All such participants gave up as they did not generate any examples of the 'med' rule. Using 2 x 2 chi-squared, this was found to be due to significantly more participants unable to complete the task in the clinical non-deluded group compared to the high PDI group (Fisher's Exact Test = 0.012). The greater number in the clinical non-deluded group unable to complete compared to the low PDI group approached significance (χ^2 (3) = 3.662, p = 0.056). There were no significant differences between the deluded group and any other group, or between the two non-clinical groups.

Time Taken

Although from Table 7 it can be seen that the differences in time taken seem quite large, using a one-way ANOVA[e], these differences were not found to be significant (F (3, 52) = 1.486, p = 0.229).

Number of Triples To The First 'Med'

Using a one-way ANOVA[f], there were no significant differences between the groups that completed the task in terms of how many triples they propose until they reached their first 'med' (F (3, 57) = 0.190, p = 0.903). This indicated that there was no difference in the ability of groups to find a 'med', giving evidence against a deficit in forming hypotheses. The results from the time taken and number of triples to reach the first 'med' provide evidence against any deficit in *forming* hypotheses for those with delusions. However, the results for the clinical non-deluded group must be taken in the context of significantly less of this group being able to finish the task at all, indicating that the clinical non-deluded group *do* show a difficulty in forming hypotheses.

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[e] One-way ANOVA was used on time taken transformed by logarithm, as data for the high PDI and deluded groups were significantly skewed.
[f] Data on 'number of triples to first 'med'' was transformed by logarithm, as the high PDI group were significantly skewed.

TABLE 7: DEPENDENT VARIABLES ON THE WASON'S 2-4-6 TASK, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 21)	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Correct answer given	1 (4.8%)	0 (0.0%)	8 (38.1%)	10 (50.0%)
Error made				
Jumping to conclusions	12 (57.1%)	4 (25.0%)	8 (38.1%)	3 (15.0%)
By not exploring boundaries	5 (23.8%)	2 (12.5%)	0 (0.0%)	0 (0.0%)
Using only recent information	7 (33.3%)	2 (12.5%)	8 (38.1%)	3 (15.0%)
Used confirmatory strategies only	2 (9.5%)	3 (18.8%)	4 (19.0%)	4 (25.0%)
Made logical error	2 (9.5%)	2 (12.5%)	0 (0.0%)	0 (0.0%)
Could not complete task	4 (19.0%)	7 (43.8%)	1 (4.8%)	3 (15.0%)
Time taken (in seconds)[g]	401.33 (384.94)	459.75 (207.46)	354.10 (249.16)	261.19 (149.88)
Number of triples to first 'med'	9.53 (6.04)[h]	11.22 (8.79)	9.79 (4.65)	8.76 (4.29)
Total number of 'meds'	4.81 (3.78)	4.78 (2.28)	3.26 (1.33)	5.18 (3.86)
Total number of 'daxes' after first 'med'	2.53 (2.29)	6.00 (7.43)	1.05 (1.31)[i]	0.94 (1.60)

[g] Information on time taken was missing for nine of the deluded group, eight of the non-deluded group, one of the high PDI group and four of the low PDI group.

[h] An outlier (>3 sd from the mean) of 62 within the 'total number of meds' was removed from these calculations, and from 'number of triples after first med' and 'total number of meds'.

[i] An outlier (>3 sd from the mean) of 15 in 'total number of triples after the first med' was removed from the these calculations, and those of 'total number of triples' and 'number of triples to first med'.

Actual Answer Given

The errors made were explored and categorised into four groups, as this was the most interesting aspect of the task. A large proportion made errors as they were thought to 'jump to conclusions', making decisions by using minimal information. These were split into two groups. One group was those that 'jumped to conclusions' as they did not explore the boundaries of the 'med' rule, making erroneous decisions based on less than the median number of 'meds' for the normal groups (median = 4). An example of this was when a participant found an example of the 'med' rule, but made a decision almost immediately, leading to a logical, but incorrect inference (e.g. *"meds are all numbers the same").* The second group were those who generated an appropriate number of both 'meds' and 'daxes' but made their decision by using only the last pieces of information to inform their answer, ignoring earlier information that contradicted that answer. An example of this was when a participant generated a number of 'meds' (for example, '3-3-1', '2-6-2' and '7-14-7') and made the decision the 'med' rule was, *"all meds are with a seven at the beginning and the end",* based on only the last triple. Further errors were those who came to the wrong decision due to only used confirmatory strategies to generate further 'meds'. These participants made erroneous decisions based on a number of 'meds' equal to or more than the median number of 'meds' for the normal groups. A further category were those who seemed unable to do the task, and gave answers that were either idiosyncratic (for example, *"meds are types of cars"),* or contradicted both early and recent triples.

It was predicted that the deluded group would show an increased number of errors made due to 'jumping to conclusions'. When the number of participants who *'jumped to conclusions'* were taken as a proportion of the answers given, there was a significant difference between groups (χ^2 (3) = 8.875, p = 0.031). Using pair-wise chi-squared, there were found to be a significantly higher frequency *of 'jump to conclusions'* answers given in the deluded group compared to the low PDI group (χ^2 (1) = 7.842, p = 0.005) and the clinical non-deluded group (χ^2 (1) = 3.823, p = 0.050). There were no significant differences between the deluded group and the high PDI group (χ^2 (1) = 1.527, p = 0.217). There were also no significant differences between the clinical non-deluded group and either the high or low PDI groups (χ^2 (1) = 0.711, p = 0.399; χ^2 (1) = 0.567, p = 0.451), or between the two non-clinical groups (χ^2 (1) = 2.83, p = 0.095). These findings supports the hypothesis that people with delusions have a tendency to 'jump to conclusions' when forming decisions in a data-gathering task, compared to both a normal control group and a non-deluded psychiatric control.

It was also hypothesised in the introduction that if the data-gathering bias were due to an increased need for cognitive closure, the deluded group would show a greater number of errors due to not exploring the boundaries of the 'med' rule. However, if the bias were due to an inability to integrate information, the deluded group would show a greater number of errors due to only using the most recent information. When these two 'jump to conclusions' types of errors were analysed separately, a greater number of participants overall made errors due to 'not exploring boundaries'. However, with the number of participants who *'jumped to conclusions due to not exploring boundaries'* taken as a proportion of the total answers given, there were no significant differences between the groups (χ^2 (3) = 4.997, p = 0.172), using Pearson's chi-square. When the type of error made of *'jumping to conclusions due to only using recent information*' was considered in terms of the proportion of answers given, there were a significantly higher proportion of participants in the deluded group giving such answers, compared to low PDI group (Fisher's Exact Test = 0.048) and high PDI (Fisher's Exact Test = 0.048). There were no other significant differences between groups on this measure.

The results support the hypothesis that deluded individuals show an inability to use past information, compared to normal controls. However, this must be taken in the context of the finding that all participants show a greater tendency towards errors due to 'not exploring boundaries', despite the lack of group differences. It is also of interest to note that, although those who were high in delusion-prone in the normal population did not differ significantly from those in the low delusion-prone group in terms of 'jump to conclusions' errors, they also failed to differ significantly from those with delusions. This gives some weight to the hypothesis that those who are high in delusion-proneness in the normal population show similar reasoning biases to those with delusions.

A logistic regression was carried out to explore whether a high need for closure would predict a *'jump to conclusions'* answer. Results found there was no significant effect of NFCS scores (β = 0.175, Wald = 0.1358, p = 0.713). It also did not predict an answer of *'jumping to conclusions due to not exploring boundaries'* (β = -0.0003, Wald = 0.000, p = 0.9957). This provides further evidence against the involvement of an increased need for closure in the 'jump to conclusions' bias.

Total Number of 'Meds'

Calculating the number of 'meds' generated provided a measure of how many pieces of information the participant chose to gather before making their decision. Using only a few number of 'meds' would indicate using 'jump to conclusions' reasoning biases. Using a one-way ANOVA[j], there were no significant differences between groups in terms of total number of 'meds' generated ($F (3, 57) = 1.003$, $p = 0.398$).

In the study by Garety *et al.* (1991), the majority of the deluded sample were found to reason normally, whereas 41% were found to be 'extreme responders', making decisions on the basis of only one piece of evidence, obscuring group means. The possibility of a sub-group within the sample in the current study was explored within this task. Of the deluded group, three participants (14.3%) made their decision based on only one 'med', compared to none in the clinical non-deluded group, and one each in the high and low PDI groups (4.8% and 5.0%, respectively). All these participants came to an incorrect answer. However, this difference was not significant (χ^2 (3) = 3.510, $p = 0.319$).

A logistic regression was carried out to determine if a higher number of 'meds' was predictive of a correct answer. After controlling for the significant effect of Group (χ^2 (3) = 18.484, $p < 0.001$), there was no significant predictive effect of the number of 'meds' (χ^2 (1) = 1.209, $p = 0.272$). A logistic regression was carried out to determine if a higher number of 'daxes' after the first 'med' was predictive of a correct answer. After controlling for the significant effect of Group (χ^2 (3) = 17.911, $p = 0.001$), there was no significant predictive effect of the number of 'daxes' (χ^2 (1) = 0.521, $p = 0.471$). This suggests that the significantly higher number of correct answers given by the non-clinical groups was not dependent on the number of 'meds' generated, or the number of 'daxes' after the first 'med'.

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[j] Data on 'total number of 'meds'' was transformed by square root, as the low PDI group was

Beads Task: Part 1

Answer Correct

As can be seen in Table 8, over 90% of the participants correctly judged which jar was being used in Part 1 of the Beads Task. Using Pearson's chi-square, there were no significant differences between groups in terms of this variable (χ^2 (3) = 2.810, p = 0.422). Whether a participant correctly answered did not appear to depend on the number of beads they had seen, and in fact those who were incorrect had seen a higher mean number of beads than those who were correct (*Mean* = 11.0, (*sd* = 5.89) compared to *Mean* = 8.21 (*sd* = 5.98)). However, using an independent t-test[k], these differences were not significant (t (76) = 1.54, p = 0.128).

Number of Beads to Decision

It was hypothesised that the deluded group would request less information in this task prior to making a decision, compared to controls. Using a one-way ANOVA[l], there were no significant differences between the groups in number of beads requested before making a decision on the jar (F (3, 74) = 1.991, p = 0.123). Due to a large degree of variance within the groups, it is more valid to observe the medians, which are shown in Table 8.

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significantly skewed.

[k] The number of beads seen was transformed using logarithm, as data were significantly skewed in the correct group.

[l] Data on the number of beads requested before decision was significantly skewed for the clinical non-deluded group and the low PDI group, and therefore was transformed using logarithm.

TABLE 8: SCORES ON THE BEADS TASK: PART 1, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 21)	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Answer correct	20 (95.2%)	13 (81.3%)	20 (95.2%)	18 (90.0%)
Number of beads to decision[m]	8.43 (6.65)	10.88 (6.32)	8.52 (5.61)	6.50 (5.01)
Median	5.00	8.00	7.00	5.00
Range	1 - 21	3 - 21	3 - 20	3 – 20

[m] Those who requested over 20 beads were set to the value of 21. There were two participants who did this, one from the deluded group (who requested 25) and one from the clinical non-deluded group (who requested 35).

It is interesting to note that the median scores for the non-clinical groups appear to be in the opposite direction to the hypotheses made about this task. The high PDI group have a higher median score than the low PDI group, and the low PDI have a similar median score to the deluded group. It is also interesting to note the large proportion of the deluded group who made their decisions based on an over-large number of beads. Seven of the deluded group (33.3%) waited until they had seen over ten beads, compared to six in the clinical non-deluded group (37.5%), five in the high PDI group (23.8%), and three in the low PDI group (15.0%). However, these differences were not significant (χ^2 (3) = 2.897, p = 0.408).

Garety *et al.* (1991) found 47% of their deluded group were classified as 'extreme' responders who made their decision on just one bead. In this study only three participants from the deluded group (14.3%) made their decision on this basis. None of the responders in the other groups used less than three beads to inform their decision. Using Pearson's chi-square, this difference was found to be significant (χ^2 (3) = 8.469, p = 0.037). However, caution must be taken in interpreting these results as there was a large number of cells in the chi-square with counts less than five.

Beads Task: Part 2

Number of Beads To Certainty

Scores for the dependent variables for the second part of the Beads Task are shown in Table 9, and Figure 2 shows the means scores for each bead, for the four groups. A large proportion of the deluded, clinical non-deluded and high PDI groups never reached certainty (100% estimate, or over 85% for two beads), throughout the task. However, using Pearson's chi-square, there were no significant differences between groups on this variable (χ^2 (3) = 4.126, p = 0.248). Those who did not reach certainty were coded as 11, and the amended scores seen in Table 9 show these means. However, using a one-way ANOVA, there were no significant differences between the groups on this measure (F (3, 74) = 0.636, p = 0.594). This is in line with the hypothesis that when presented with information, as opposed to having to gather it, deluded people reason normally.

Three of the deluded reached certainty after seeing only one bead (14.3%), as did one from the clinical non-deluded group (6.3%) and one from the low PDI group (5.0%). Using Pearson's chi-square, there were no significant differences on this measure (χ^2 (3) = 3.676, p = 0.299).

Effect of Disconfirmatory Evidence

It was hypothesised that the deluded group would have a greater response to single items of disconfirmatory evidence, by making large reductions in their certainty estimates. The effect of the fourth and the ninth bead (both of which are the opposite colour to the dominant colour presented) on certainty estimates were added together to give an overall effect of contradictory evidence. Despite what look like large differences in this variable on Figure 2, using Kruskall Wallis Test[n] the difference between the groups in overall effect of disconfirmatory evidence approached significance (χ^2 (3) = 6.546, p = 0.088). There were no significant differences between groups in terms of the separate effect of the fourth bead (χ^2 (3) = 4.088, p = 0.252). However, the difference between groups in the effect of the ninth bead on

[n] The data for the effect of disconfirmatory evidence for both bead 4 and bead 9, as well as overall effect, were significantly skewed to the right for both the high and low PDI groups. The skewness was not amenable to transformation by either logarithm or square root.

certainty estimates was found to approach significance (χ^2 (3) = 7.520, p = 0.057). Separate Mann Whitney pair-wise comparisons revealed that this was due to the disconfirmatory evidence having a significantly greater impact on the clinical non-deluded group compared to the high PDI and low PDI groups (U = 79.0, p = 0.006[o]; U = 96.0, p = 0.042[p], respectively). There was no significant difference between the deluded group and either the high or low PDI groups (U = 175.5, p = 0.246; U = 195.5, p = 0.699), between the two clinical groups (U = 127.5, p = 0.217), or between the high and low PDI groups (U = 183.0, p = 0.463).

A large proportion of participants reduced their certainty in response to seeing the fourth bead. Seven of the deluded group (33.3%) reduced their certainty by 50% or more in response to the fourth bead, compared to four in the clinical non-deluded group (25%), two in the high PDI group (9.6%), and one in the low PDI group (5.0%). Using Pearson's chi-square, the differences between groups on this measure approached significance (χ^2 (3) = 7.253, p = 0.064). Using further 2 x 2 chi-squares, a significantly greater proportion of the deluded group were found to have this extreme response, compared to the low PDI group (Fisher's Exact Test = 0.045). The difference between the deluded group and the high PDI group was not significant (Fisher's Exact Test = 0.130). There were no other significant differences. This supports the hypothesis that those with delusions show greater effects in response to disconfirmatory evidence compared to normal controls.

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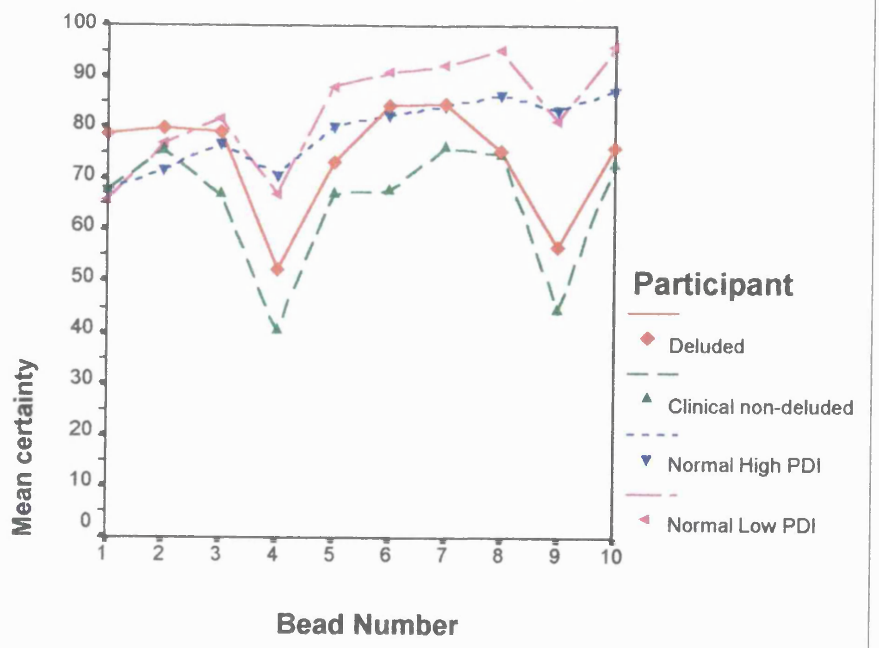
[o] Exact significance given (2* (1-tailed significance)

[p] Exact significance given (2* (1-tailed significance)

TABLE 9: SCORES ON THE BEADS TASK: PART 2, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 21)	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Number of beads to certainty	5.38 (4.27)	6.19 (4.00)	6.52 (3.71)	5.10 (2.91)
Median	3.00	6.00	6.00	4.50
Range	1 - 11	1 - 11	2 – 11	1 - 11
Certainty after first 3 beads	79.16 (16.34)	69.98 (25.68)	71.97 (17.66)	74.70 (14.99)
Effect of disconfirmatory evidence	-45.81 (70.72)	-56.75 (77.08)	-8.90 (22.49)	-28.50 (57.22)
After Bead 4	-27.00 (48.00)	-26.38 (43.24)	-6.00 (14.14)	-14.70 (27.32)
After Bead 9	-18.81 (34.45)	-30.38 (47.73)	-2.90 (11.52)	-13.80 (32.13)

Figure 2: Mean Certainty in Beads Task (Part Two)



Looking at the response to the ninth bead, at how many of those reductions in certainty were of the magnitude of 50% or more, four of the deluded group (19.0%) made such reductions, compared to five in the clinical non-deluded group (31.2%), none in the high PDI group and three in the low PDI group (15.0%). Again this difference approached significance (χ^2 (3) = 7.131, p = 0.068). However, when a significant effect of years of education (β = -0.4392, Wald = 4.2272, p = 0.040) was controlled for, this significance reduced (χ^2 (3) = 5.428, p = 0.143). This indicates that, with a greater amount of evidence provided for one hypothesis, the deluded group were less likely to make such drastic changes in certainty when presented with potentially disconfirmatory evidence.

Flats Task

Flat Chosen

Although efforts were made to weight the attractiveness of the flats equally within each condition, for Conditions 1 and 2 there was one flat that overall was significantly more popular than the other three. In Condition 1, Flat Y was significantly more popular than W, X and Z, for all groups (using chi-square, this was significant at the 5% level for all groups). In Condition 2, Flat C was consistently chosen as significantly more popular for all groups (using chi-square, this was significant at the 5% level for all groups). However, in Condition 3, Flat G was considered significantly more popular by the deluded group (χ^2 (3) = 9.286, p = 0.026), but there was no consistent favourite with the other groups. Similarly, for Condition 4, Flat K was considered significantly more popular with the low PDI group (χ^2 (3) = 16.400, p = 0.001), but there was no consistent favourite with the other three groups. The actual frequencies of flats chosen are found in Appendix R.

Time Taken

Figure 3 demonstrates the mean time taken to complete the task, for each group, across the four conditions of increasing difficulty (tables of the actual means and standard deviations of time taken, certainty of decision and number of flats used are found in Appendix S). It was predicted that the deluded group would be quicker in the Flats Task than the control groups, due to a tendency to use less information in making a decision. It was hypothesised that this difference would be significant at all levels if the bias were due to a need for cognitive closure, but only at high levels if the bias were due to an inability to integrate information. Using a Repeated Measures 4 x 4 ANOVA[q], there was found to be a significant main effect of Condition ($F (3, 67) = 55.717$, $p < 0.001$[r]), but there was no significant main effect of Group overall ($F (3, 69) = 0.048$, $p = 0.986$). However, there was a significant interaction between Group and Condition ($F (9, 207) = 1.969$, $p = 0.044$). However, when a significant covarying effect of years of education ($F (1, 68) = 6.489$, $p = 0.013$) was accounted for, this interaction was no longer significant ($F (9, 204) = 1.584$, $p = 0.122$). The significant effect of Condition remained ($F (3, 63) = 18.210$, $p < 0.001$), as did the non-significant effect of Group ($F (3, 68) = 0.350$, $p = 0.789$). This would seem to provide evidence against the hypothesis of a 'jump to conclusions' tendency.

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[q] Data for time taken in Condition 1 is transformed by square root, as scores were significantly skewed for the deluded & non-deluded groups.

[r] Pillai's Trace is used for reporting repeated measures effects, unless stated.

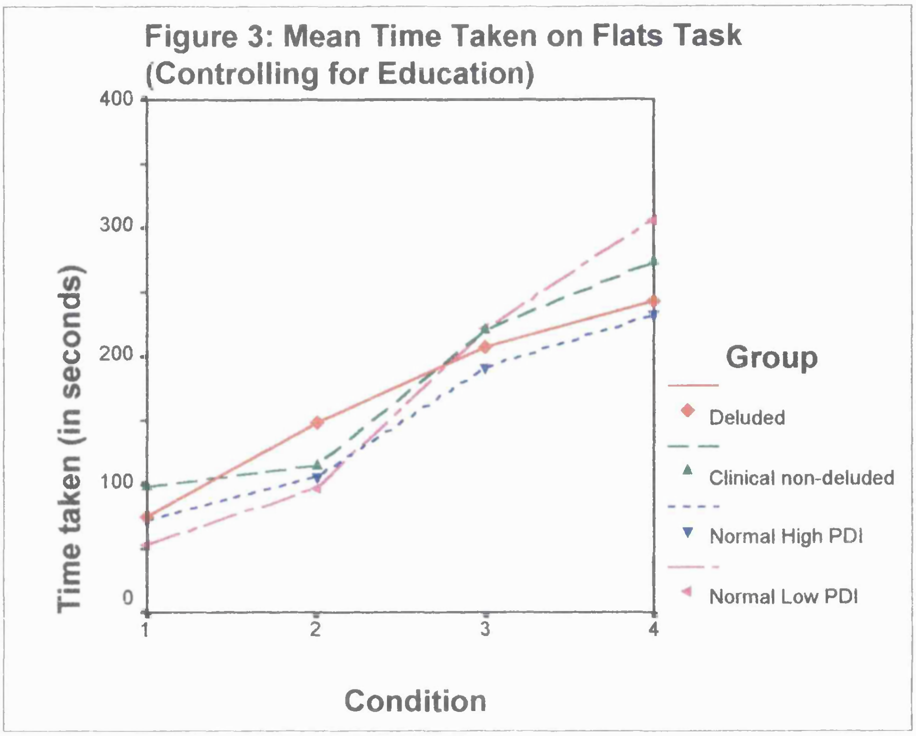


Figure 3: Mean Time Taken on Flats Task
(Controlling for Education)
400
300
200
100
0
Time taken (in seconds)
1
2
3
4
Condition
Group
Deluded
Clinical non-deluded
Normal High PDI
Normal Low PDI

Certainty of Decision

Figure 4 demonstrates the change in participants' certainty of decision across conditions for all of the four groups. Again, using the two-tailed hypothesis, it was predicted the deluded group would show a higher level of certainty compared to controls all conditions if the bias were due to a high need for cognitive closure. However, if it were related to an inability to integrate information, the level of certainty would be lower than controls, but only at high levels of difficulty. Using Repeated Measures 4 x 4 ANOVA^{s}, there were no significant effects of Condition (F (3, 67) = 0.617, p = 0.606), and no significant main effects of Group (F (3, 69) = 1.197, p = 0.317). There were also no significant interactions between group and condition (F (9, 207) = 0.848, p = 0.573). Again this would provide evidence against the hypothesis of a 'jump to conclusions' tendency.

Number of Flats Used

The number of flats used does not refer to the amount of information used, but how many of the four flats provided were opened. This is a post-hoc hypothesis, based on observations through testing that a number of participants appeared to arrive at decisions after only looking at one or two flats. It is proposed that looking at less than the four flats provided is further evidence of a data-gathering bias. Figure 5 shows the mean number of flats used for each condition. All participants in the low PDI group used all four flats in making their decision, in all conditions. A small number of the high PDI group used less than four flats, contributing to a slightly lower mean number of flats overall. For the two clinical groups, however, there were still a lower mean number of flats looked at over all conditions, compared to the non-clinical groups.

Figure 4: Mean Certainty in Flats Task

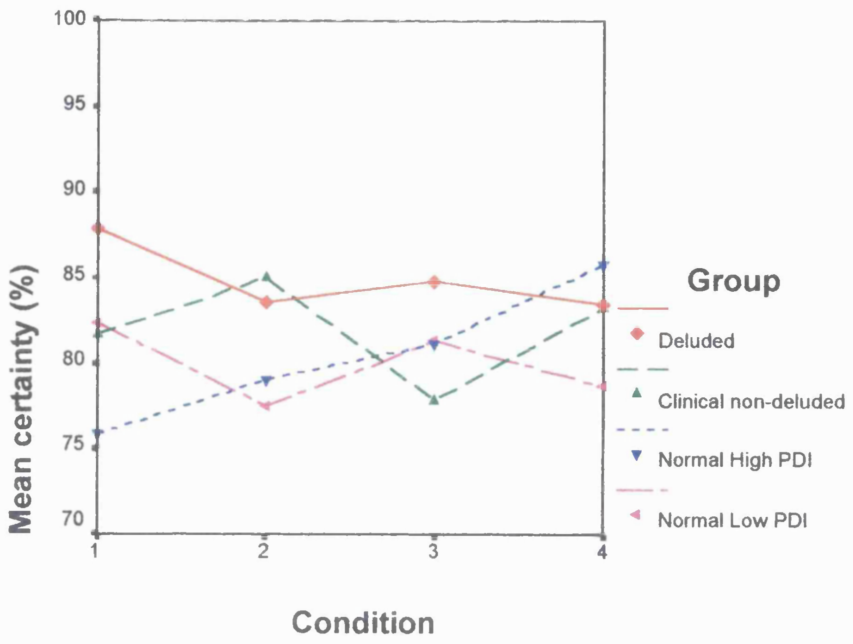
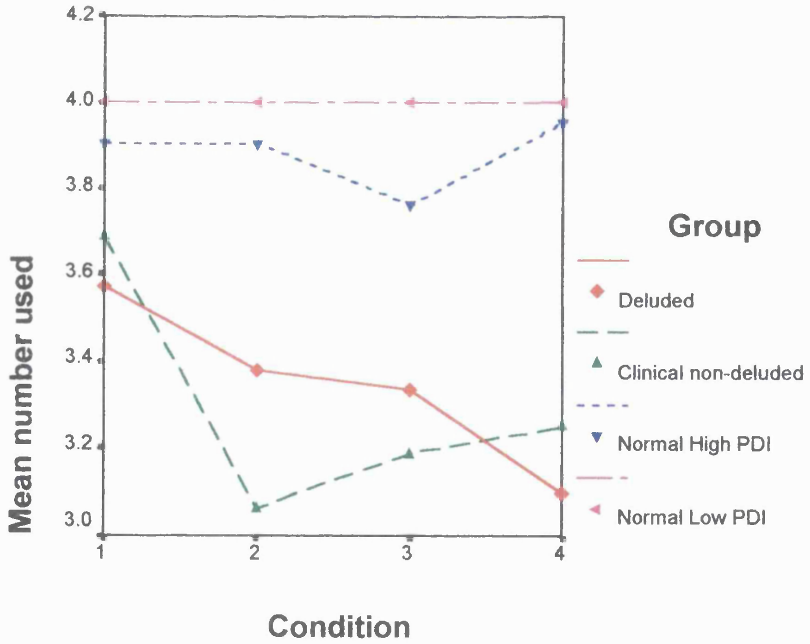


Figure 5: Mean Number Of Flats Used In Flats Task



[5] The certainty of decision was transformed using square root as data is skewed for each Condition in the deluded group, Conditions 1, 2 & 4 for the clinical non-deluded group, Conditions 3 & 4 for the high PDI group, and Condition 1 for the low PDI group.

Using Pearson's chi-square[t], there were no significant differences between groups in the proportion using less than four flats in Condition 1 (χ^2 (3) = 5.280, p = 0.152). However, there were significant differences between the four groups in Condition 2 (χ^2 (3) = 13.286, p = 0.004). Logistic regression revealed a significant effect of IQ (β = 0.0872, Wald = 7.5701, p = 0.006), but there remained a significant Group difference even when accounting for this covariate (χ^2 (3) = 9.859, p = 0.020). The deluded group were found to have a significantly greater proportion of participants using less than all the flats, compared to the low PDI group (Fisher's Exact Test = 0.021). Also the clinical non-deluded group had a significantly greater proportion using less than all flats compared to both high and low PDI groups (Fisher's Exact Test = 0.029; Fisher's Exact Test = 0.004, respectively). There were also significant differences between groups for Condition 3 (χ^2 (3) = 11.149, p = 0.011), but when significant effect of IQ (β = 0.084, Wald = 6.092, p = 0.014) and years of education (β = 0.510, Wald = 4.098, p = 0.429) were included, this effect disappeared (χ^2 (3) = 5.668, p = 0.129). Finally, there were also significant differences between groups for Condition 4 (χ^2 (3) = 16.627, p = 0.001). When significant effects of IQ (β = 0.0741, Wald = 5.259, p = 0.022) and years of education (β = 0.8524, Wald = 5.8562, p = 0.0155) were included, this effect slightly reduced (χ^2 (3) = 7.807, p = 0.050), but remained significant. The deluded group were found to have a significantly greater proportion of people using less than four flats than both the high and low PDI group (χ^2 (1) = 8.400, p = 0.004; Fisher's Exact Test = 0.001, respectively). The clinical non-deluded group also had a significantly greater proportion using less than four flats compared to the low PDI group (Fisher's Exact Test = 0.007), and a greater

[t] Data were collapsed into categories of 'used 4 flats' vs. 'used less than 4 flats', to reduce the number of expected cells with counts less than 5, and to enable exploration of covariate effects.

proportion that approached significance compared to the high PDI group (Fisher's Exact Test = 0.066). These findings would seem to provide evidence to support the hypothesis of a bias in data-gathering in those with delusions.

It was hypothesised that if there was a data-gathering bias related to a need for cognitive closure, the deluded group would use a similar amount of minimal data throughout all conditions, which would be significantly less than the normal control group in all conditions. They would also have a minimal amount of information looked at but not used, across all conditions. In comparison, the normal control group would have little information looked at but not used in early conditions, but more in more difficult conditions. In this way, it would be predicted that, for the deluded group, there would be less information looked at but not used, compared to controls, in later conditions. However, if the bias were due to an inability to integrate information, the deluded group would use less information than controls, but only at high levels of difficulty. In addition, they would increase their amount of information looked at but not used as difficulty increases. In this way, the level of information looked at but not used would be similar to controls, in all conditions.

Amount of Information Used

Figure 6 shows the mean amount of information used across the conditions, for each group. Using a Repeated Measures 4 x 4 ANOVA, there was a significant effect of Condition ($F (3, 70) = 19.991$, $p < 0.001$), as well as a significant effect of Group ($F (3, 72) = 7.586$, $p < 0.001$). There was also a significant interaction of Group and Condition ($F (9, 216) = 216.00$, $p < 0.001$).

Figure 6: Amount Of Information Used In Flats Task

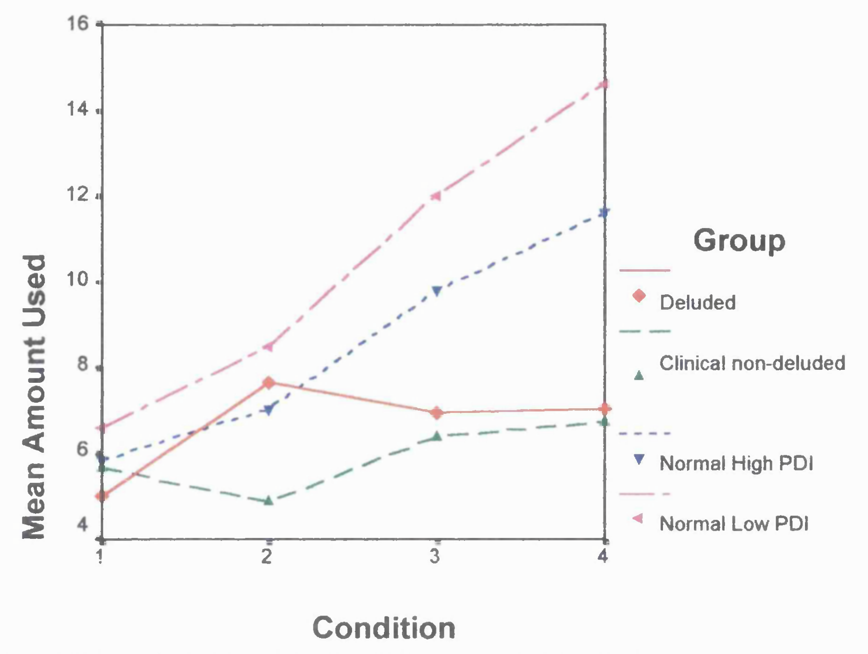
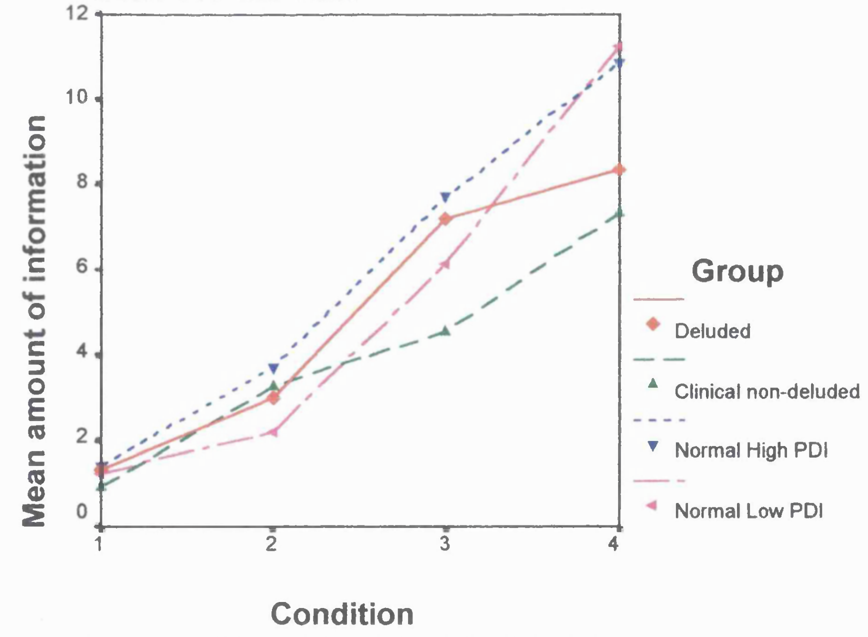


Figure 7: Amount Of Information Looked At But Not Used In Flats Task



Using simple effects, there were no significant differences between groups in Condition 1 (F (3, 72) = 1.706, p = 0.173). However, there were significant differences between the groups in Conditions 2, 3 and 4 (F (3, 73) = 3.622, p = 0.017; F (3, 72) = 5.761, p = 0.001; F (3, 72) = 9.096, p < 0.001). Pair-wise (Sidak) comparisons revealed that in Condition 2 these differences were due to the low PDI group using significantly more information than the clinical non-deluded group (p = 0.012), and in Conditions 3 and 4, due to the low PDI group using significantly more information than both the deluded (p = 0.006, p < 0.001) and clinical non-deluded groups (p = 0.005, p < 0.001). There were no significant differences between the high PDI group and the two clinical groups in any of the Conditions, or between the low and high PDI groups at any point.

Using multivariate tests, there were significant increases in amount of information used over the four conditions for the deluded, high PDI and low PDI groups (F (3, 70) = 6.466, p = 0.001; F (3, 70) = 9.938, p < 0.001; F (3, 70) = 18.841, p < 0.001, respectively). There were no differences across conditions for the clinical non-deluded group (F (3, 70) = 0.972, p = 0.411). Looking more closely at the increases made for the deluded group, using Sidak pair-wise comparisons, there were significant increases in amount of information used between Condition 1 and 2 (p < 0.001), but not between Conditions 2 and 3, or 3 and 4, as the amount of information used levelled off. For the high PDI group, the significant increase in information used across conditions was due to a change approaching significance between Conditions 2 and 3 (p = 0.058). The increases between the other Condition points were not significant. For the low PDI group, there was an increase in amount of information used between all Conditions (p = 0.019; p = 0.008; p = 0.041).

These results show that the deluded group used similar amounts of information to the normal control group for the first two Conditions, then levelled off and used significantly less information in the two most difficult Conditions. This gives support to the hypothesis that the data-gathering bias was shown only at high levels of difficulty, indicating an inability to integrate information. Interestingly, the clinical non-deluded group used the same minimal amount of information across all Conditions, which was significantly lower than the normal control group in the latter three Conditions. This type of pattern is more related to a need for cognitive closure.

Amount Of Information Looked At But Not Used

Figure 7 shows the mean amount of information looked at but not used across conditions, for each group. (A table of the mean amount of information used, and amount looked at but not used, is shown in Appendix T). As would be expected, there was a significant effect of Condition on the amount of information looked but not used ($F(3, 70) = 21.864$, $p < 0.001$), but there was no significant main effect of Group ($F(3, 72) = 1.117$, $p = 0.348$). There was also no significant interaction between Group and Condition ($F(9, 216) = 0.950$, $p = 0.482$) (see Figure 7). This again supports the predictions made about the reasoning bias being related to an inability to integrate information.

Effects of Need For Closure Scale Scores

It was predicted that, if the data-gathering bias were due to a high need for cognitive closure, those who selected and used less data would have greater scores on the NFCS. The NFCS scores were added to the Repeated Measures ANOVA as a covariate, to explore any moderating effects it may have. When looking at the *'amount of information looked at'*, there was no significant effect of NFCS scores (F (1, 71) = 0.468, p = 0.496), or any interaction effects (F (3, 69) = 0.443, p = 0.723). Similarly, when looking at *'amount of information used'*, there were no significant effects of NFCS scores (F (1, 71) = 0.000, p = 0.985), or any interaction effects (F (3, 69) = 0.239, p = 0.869). This provides evidence against the need for closure hypothesis.

Idiosyncratic Information

The amount of idiosyncratic information used by participants was collapsed across conditions into a variable considering the total amount of such information used. The mean scores and standard deviations of this measure are shown in Table 10. This variable was used to determine if the deluded group used different *type* of information in making decisions about the flats, as well as different amounts. The amount of idiosyncratic information used was then further collapsed into the categories 'used' vs. 'not used' due to a high proportion of participants not using any idiosyncratic information, and significant skewness in all groups. Pearson's chi-square revealed a significant difference between groups as to the proportion of participants that had used idiosyncratic information in making their decision (χ^2 (3) = 15.977, p = 0.001). Using logistic regression, a significant effect of IQ was found (β = -0.080, Wald = 7.980, p = 0.005). With the effect controlled for, the significant effect of group remained (χ^2 (3) = 20.291, p = 0.014). There was found to be a significantly higher proportion of participants in the deluded group using such information compared to both the high and low PDI groups (χ^2 (1) = 11.667, p = 0.001; χ^2 (1) = 8.497, p = 0.004). There were no significant differences between the clinical non-deluded group and the two non-clinical groups (Fisher's Exact Test = 0.066, Fisher's Exact = 0.204).

TABLE 10: AMOUNT OF IDIOSYNCRATIC INFORMATION USED & LOOKED AT BUT NOT USED, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 21)	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Amount of Idiosyncratic Information Used	1.14 (1.42)	1.25 (2.27)	0.05 (0.22)	0.20 (0.62)
Number of participants using idiosyncratic information	11 (52.4%)	5 (31.3%)	1 (4.8%)	2 (10.0%)
Amount of Idiosyncratic Information Looked At But Not Used	5.24 (6.80)	3.94 (5.09)	4.48 (6.33)	4.35 (6.13)
Number of participants looking at but not using idiosyncratic information	14 (66.7%)	13 (81.3%)	12 (57.1%)	8 (40.0%)

When exploring whether idiosyncratic information was *looked at and not used*, using Pearson's chi-square[u], again by collapsing data from all conditions, there were no significant differences between groups (χ^2 (3) = 6.817, p = 0.078). There were no significant covariant effects. This result was backed up by findings using a Kruskall-Wallis Test, that there were also no significant differences in the total amount of idiosyncratic information looked at but not used (χ^2 (3) = 1.292, p = 0.731). These results suggest that there are differences between these groups in the type of information actually used, but not in the type of information looked at but not used.

Wason Selection Task

Correct Answer Given

It was predicted that there would be no group differences in this task, as it was testing the presence of a more general reasoning deficit. As can be seen in Table 11, only four participants (5.1%) correctly answered the Selection Task, using the disconfirmatory strategy of '*hot tap, blue dot*': one from the deluded group, one from the high PDI group and two from the low PDI group. Using Pearson's chi-squared, it was found there were no significant differences between the four groups on this variable (χ^2 (3) = 1.852, p = 0.604). Using a logistic regression, it was found that there was a significant effect of education (β = 0.59, Wald = 5.36, p = 0.021), but with this accounted for, there was still no significant effect of group (χ^2 (3) = 1.853, p = 0.604). Of the answers actually given, the majority for each group used the confirmatory strategy of '*hot tap, red dot*' (39.7% overall). The second most popular choice for all groups, apart from the low PDI group, was to turn over all four cards

[u] Idiosyncratic information looked at but not used was collapsed into 'looked at and not used' vs. 'non looked at and not used' due to a high number of participants looking at no pieces of idiosyncratic

(20.5% overall). The answers were also converted into a 'logic index' described in the methods section. This was used to determine if there were any differences between groups in logical ability on this task. Using a one-way ANOVA, there were no significant differences between the groups on this measure (F (3, 74) = 1.398, p = 0.250). This would appear to support the hypothesis that any reasoning biases found in people with delusions are not as a result of a global cognitive deficits. However, this may be a result of a large floor effect, as so few participants answered correctly.

Additional Variables

Using a one-way ANOVA, there were no significant differences between groups in the mean number of cards turned over, (F (3, 74) = 0.690, p = 0.561), in time taken to complete the task (F (3, 63) = 1.701, p = 0.176), and, using Kruskall Wallis test[v], there were no significant differences in certainty of decision on this task (χ^2 (3) = 2.726, p = 0.436). The three above results also argue against a *general* reasoning bias, or deficit in logical reasoning, in deluded individuals, compared to normals.

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information.

[v] Non-parametric Kruskall Wallis test was used as certainty was significantly skewed for all groups.

TABLE 11: DEPENDENT VARIABLES ON THE WASON'S SELECTION TASK, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS)

	Clinical Groups		Non-Clinical Groups	
	Deluded (N = 21)	**Non-Deluded (N = 16)**	**High Delusion-Prone (N = 21)**	**Low Delusion-Prone (N = 20)**
Correct answer	1 (4.8%)	0 (0.0%)	1 (4.8%)	2 (10.0%)
Time taken (in seconds)[w]	37.73 (41.20)	18.71 (12.47)[x]	47.28 (46.98)	35.40 (30.01)
Certainty of decision (%)[y]	96.26 (8.29)	92.42 (14.74)[z]	86.19 (19.74)	85.68 (23.64)
Number of cards turned over	2.33 (1.02)	2.50 (1.03)	2.48 (1.08)	2.10 (0.72)
Logic Index (range: -2 to +2)	-0.05 (0.74)	-0.13 (0.50)	0.10 (0.62)	0.30 (0.80)
Answer given:				
Hot tap, red dot	6 (28.6%)	7 (43.8%)	8 (38.1%)	10 (50.0%)
All four cards	5 (23.8%)	4 (25.0%)	6 (28.6%)	1 (5.0%)
Hot tap only	1 (4.8%)	0 (0.0%)	2 (9.5%)	3 (15.0%)
Red dot only	2 (9.5%)	2 (12.5%)	1 (4.8%)	0 (0.0%)
Hot tap, red dot, cold tap	0 (0.0%)	1 (6.3%)	1 (4.8%)	2 (10.0%)
Hot tap, cold tap	3 (14.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Red dot, blue dot	2 (9.5%)	0 (0.0%)	1 (4.8%)	0 (0.0%)
Cold tap, blue dot	0 (0.0%)	1 (6.3%)	1 (4.8%)	1 (5.0%)
Hot tap, red dot, blue dot	0 (0.0%)	1 (6.3%)	0 (0.0%)	1 (5.0%)
Red dot, cold tap	1 (4.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

[w] Information on time taken was not recorded for six members of the deluded group, one member of the non-deluded group, and three members of the high PDI group.
[x] An outlier (>3 sd from the mean) of 246 seconds was removed from the calculations.
[y] Information on certainty of decision was not given for two members of the deluded group, one from the non-deluded group, and one from the low PDI group.
[z] An outlier (>3 sd from the mean) of 0% was removed from the calculations.

Coin-Tossing Task

Table 12 shows the scores for the Coin Task (shown pictorially in Figure 8). The total scores on the Coin Task were normalised to range from 0 to 100[aa]. The scores from when the coin was 'unfair' (ratio of 75:25), and when the coin was 'fair' (ratio of 50:50) were also calculated, and similarly normalised from 0 to 100. Thus a score of 50 on all of these scales represented no change in estimated probabilities with changing coin weights. A score over 50 represented increasingly accurate predictions as to changes in estimated probabilities with changing weight, according to Bayesian theories, and a score below 50 represented increasingly inaccurate predictions.

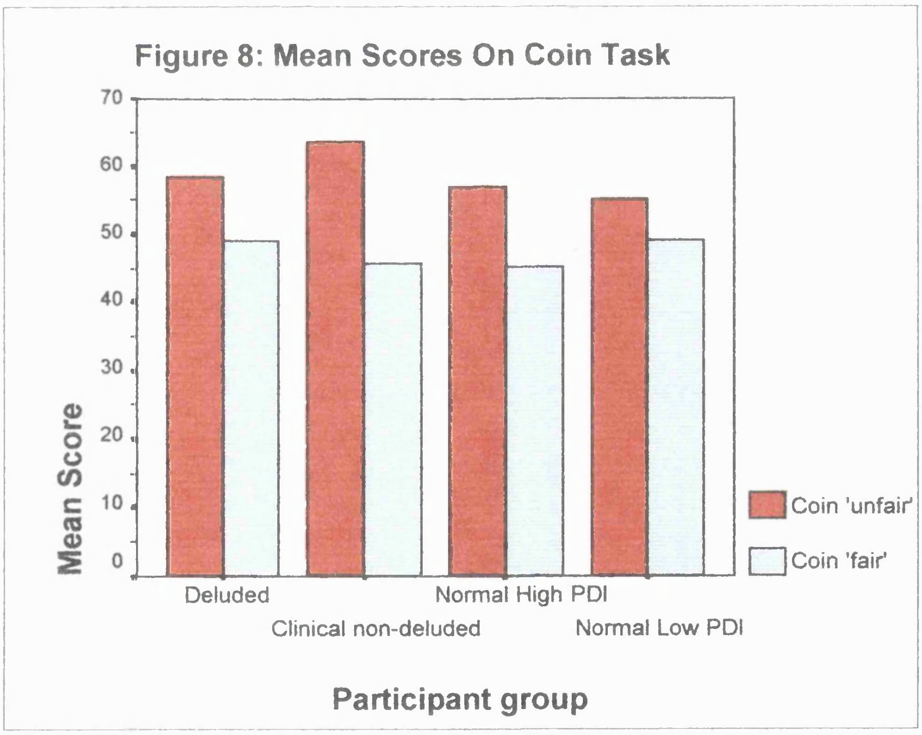
All groups were fairly inaccurate at judging these probabilities overall, with mean total coin scores just over 50. Using a one-way ANOVA, there were no significant differences between groups in these scores ($F (3, 73) = 0.504$, $p = 0.681$).

The scores for when the coin was 'fair' or 'unfair' were examined separately. Using a one-way ANOVA there were no differences between groups when the coin was 'unfair' ($F (3, 73) = 0.762$, $p = 0.519$). Using Kruskall Wallis, there were also no significant differences between groups in score when the coin was 'fair' ($\chi^2 (3) = 1.530$, $p = 0.675$). In order to allow checks on the data for effects of covariates, the data for this variable was collapsed into two groups: '50 and over' and 'under 50'. There were no significant effects of covariates using a logistic regression, and using Pearson's chi-square, there were also no significant differences between groups when the coin was 'fair' ($\chi^2 (3) = 4.720$, $p = 0.193$[bb]).

[aa] This was done by adding 6 to the score then multiplying by 100/12.

TABLE 12: SCORES ON THE COIN-TOSSING TASK, FOR ALL GROUPS (MEANS & STANDARD DEVIATIONS) SCORES NORMALISED FROM 0 – 100.

	CLINICAL GROUPS		NON-CLINICAL GROUPS	
	DELUDED (N = 20)[cc]	NON-DELUDED (N = 16)	HIGH DELUSION-PRONE (N = 21)	LOW DELUSION-PRONE (N = 20)
Total Coin Score	53.75 (9.16)	54.69 (9.61)	51.19 (10.30)	52.08 (9.32)
Coin Score When Ratio is 50:50	49.17 (8.51)	45.83 (12.91)	45.24 (15.94)	49.17 (13.76)
Coin Score When Ratio is 75.25	58.33 (15.77)	63.54 (17.45)	57.14 (19.42)	55.00 (16.31)



[cc] Data on the coin-tossing task is not available for one member of the deluded group, who failed to complete the task.

Participants appeared to display higher mean scores (indicating more accurate estimates) when the coin was 'unfair' (i.e. they *increase* their estimated likelihood of 'unfairness' with increasing number of coins), but lower mean scores (indicating less accurate estimates) when the coin is 'fair' (i.e. they do not *decrease* their estimated likelihood of 'unfairness' with increasing number of coins). Using a Wilcoxon Signed Ranks Test, this difference was found to be significant ($Z = -3.810$, $p < 0.001$). This indicates that participants were responding to the strength of the coins (ratio) rather than the weight of the coins (sample size).

These results do not support the hypothesis that people with delusions have a difficulty in judging the effects of random variation, compared to normal controls. In fact, they show similar biases to those in the normal population.

DISCUSSION

This discussion initially presents a summary of the main results, then interprets them within the context of the hypotheses and the relevant literature, proposing implications for the understanding of delusions. Next, the methodological limitations and directions for future research are examined. Finally, the implications of the findings on clinical practice are considered.

Summary of Results

Need For Closure Scale Scores

There were no differences between groups in NFCS scores. The only difference found was that the low PDI control group scored lower on the Preference For Order sub-scale, compared to the two clinical groups.

Wason's 2-4-6 Task

A greater proportion of both the normal control groups were able to give correct answers to this task, compared to both the clinical groups. There were no differences between groups in terms of time taken or ability to generate an example of a 'med' rule. However, this was within the context of finding that fewer participants from the psychiatric control group were able to finish the task. However, the deluded group did not differ from the normal controls on this measure.

Looking at the type of answer given, overall the deluded group showed a greater frequency of *'jump to conclusions'* errors, compared to both the psychiatric control group and the low delusion-prone control group, but not compared to the high delusion-prone group. The *'jump to conclusions'* errors were separated into those *'not exploring boundaries'* and *'only using recent information'* to allow discrimination between high need for closure and an inability to integrate information. Although there were a greater number of participants overall giving answers that indicated they were 'not exploring boundaries', there were no differences between groups in the frequency of participants giving such an answer. Fewer participants gave their answer based on 'only using recent information', but there was a higher proportion of the deluded group giving this style of answer compared to the low delusion-prone control group. In addition, there were no correlational relationships found between any of these styles of answering and Need For Closure Scale scores.

There were no differences between groups in the total number of 'meds' generated before decision, or any significant evidence of a sub-group of 'extreme' responders. Neither the total number of 'meds', or 'daxes' after the first 'med', were predictive of a correct answer when controlling for the effect of group.

Beads Task

In Part One of the Beads Task, where participants determined how much information they saw prior to reaching a decision, there was a low error rate. There were no differences between groups in terms of number of beads seen, or number of correct responses. Only three of the deluded group showed 'extreme' responses based on only one item of information, compared to none in the other three groups.

In Part Two of this task, where the participants were asked to provide probability estimates on a fixed amount of information, there were again no differences between groups in terms of number of beads to reach certainty, nor number of 'extreme' responses to early information. However, there was evidence that a greater proportion of the deluded group responded in an 'extreme' manner to an early piece of potentially disconfirmatory evidence (the fourth bead) compared to the low delusion-prone group. There were no group differences in such a response to a later piece of disconfirmatory evidence (the ninth bead) or with these two changes combined.

Flats Task

All groups took longer time to complete the task with increasing levels of difficulty, but there were no group differences in this variable, nor in certainty of decision. In Conditions 2 and 4, there were a greater number of the deluded group and the psychiatric control group using less than the four flats provided compared to the low delusion-prone control group.

The deluded group increased the amount of information they used over the first two easier conditions, in line with the normal control group, but then levelled off and used less information compared to the low delusion-prone group in the last two conditions only. The psychiatric control group, however, did not increase the amount used with increasing amount available, and used less information compared to low delusion-prone group in all but the first condition. In addition, the low delusion-prone group increased the amount of information used across all conditions, whereas the high delusion-prone group only increased their amount of information between the last two conditions. There was no effect of NFCS scores on amount of information used. There were no differences between groups in the amount of information *looked at but* *not used*, though there was an overall increase in this variable with increasing difficulty.

The deluded group was also found to use significantly more idiosyncratic information compared to both the normal control groups. However, the psychiatric control group did not differ from the normal control groups on this measure. There were no differences between groups in the amount of such information looked at but not used.

Coin Task

All groups showed a bias on this task towards using information associated with coin strength (the ratio of heads to tails) while neglecting the effect of weight (the sample size). There were no group differences in the tendency to do this, or ability to judge random variation.

Wason's Selection Task

Very few participants correctly answered this task. There were no differences between groups in terms of the correct answer, type of answer given, number of cards turned over, time taken or certainty of decision.

Meaning of Results

This section discusses the results within the context of the hypotheses and wider literature.

1) What is the exact nature of the reasoning bias in people with delusions?

a) Is there evidence of a data-gathering bias?

The hypothesis predicted that the tasks would show that people with delusions demonstrate a bias in data-gathering. This was assessed using Wason's 2-4-6 Task and the Beads Task.

Results on the type of error made on the Wason's 2-4-6 Task supported the proposal by Garety *et al.* (1991) that those with delusions show a 'jump to conclusions' tendency when selecting information to test a hypothesis, compared to normal controls. This led to an increased error rate. The deluded group showed a similar ability to generate an example of the 'med' rule, and took a similar amount of time compared to normal controls, suggesting that the errors made do not reflect an inability to *form* hypotheses, but a difference in the strategies used to *test* them. The study by Bentall & Young (1996) into 'sensible hypothesis generation and testing' found that deluded subjects have no difficulty in using information to test hypotheses when provided with sufficient information. The current results show that a bias in hypothesis testing did emerge, however, when participants had to generate their own information.

This task showed that people with delusions demonstrated a 'jump to conclusions' bias in two main ways. The most prominent strategy they used was by generating only a small amount of information and basing a decision on that limited information (not exploring boundaries). However, this did not differ in frequency to normal control groups. The other, less-used strategy was by generating appropriate amounts of information, but only *using* the last items in making their decision. The deluded group were found to use this strategy significantly more than the normal control groups. Results also showed that there were no group differences in amount of information collected overall.

From this evidence, it can be concluded that the deluded group *used* less information than normals in making a decision, supporting the proposal that they 'jump to conclusions'. However, it cannot conclusively be said that the deluded group *gathered* less information, which would seem to be against the idea of a data-gathering bias. Studies such as Dudley *et al.* (1997a) proposed such a bias based on findings that a deluded sample select less information in making a decision on the Beads Task. However, the error rate on this task was extremely low, and a potential answer (right or wrong) was very simple – either Jar A or B. However, in the 2-4-6 Task, a potential answer may not have been apparent from seeing the first 'med'. Participants may not have automatically recognised the difference between the previous triples they had generated, and their first 'med'. It is possible, therefore, that the data-gathering bias may only become evident when an answer seems apparent, and only at this point would the person see no further need to seek more information to back-up their answer. This fits with evidence from John & Dodgson (1994) and Young & Bentall (1995) that deluded people show less evidence of 'focusing down' their hypotheses.

Results from the Beads Task (Part One), which studied the formation of beliefs, failed to demonstrate any evidence of a data-gathering bias. This goes against other studies discussed in the introduction (Huq *et al.,* 1988; Garety *et al.*, 1991; Dudley *et al.,* 1997a) that present fairly robust findings that those with delusions select less information in making a decision.

There could be a number of explanations for these discrepant findings. One explanation could be that the instructions given, asking participants to be 'absolutely certain', may have led some participants to request more information than they needed. In the current study, some participants, from both normal and clinical groups, reported waiting until they had seen fifteen dominant beads before expressing a decision, as they reasoned that this would make it a probabilistic certainty. In the Huq *et al.* (1988) study, practice sessions were used with the response board, which may have acclimatised participants to thinking probabilistically. A few other participants voiced suspicions that the experimenter was choosing the colour of the beads deliberately (which was, of course, true!). The use of a computer may have reduced suspiciousness and avoided participants' concerns about being 'caught out'. Also, changing the wording of the instructions to 'be as certain as you can be' may have enabled the participants to express their decisions at a more realistic time.

Another explanation of these findings could be the large variation in amount of information requested. In the Beads Task, the current study found far greater overall means and much greater variances of number of items of information requested, for all groups (deluded group: *mean* = 8.43, *sd* = 6.65; low PDI group: *mean* = 6.50, *sd* = 5.01), compared to the study by Garety *et al.* (1991) (deluded schizophrenic group: *mean* = 2.38, *sd* = 1.94; normal control group: *mean* = 5.38, *sd* = 3.15). Also in this current study, the deluded sample appeared to show a binomial distribution, with roughly a quarter of the participants (23.8%) making rapid decisions (in three beads or less), and a third (33.3%) basing their decisions on an over-large number of beads (ten beads or over). These large distributions may have obscured group differences.

A further explanation for these results could be that only a small sub-group of the deluded sample showed a data-gathering bias. Garety *et al.* (1991) found that the difference in amount of information requested in their study was a result of a large minority (41%) in the deluded group showing an 'extreme' response, making decisions on the basis of one item of information only. In the current study, only three deluded individuals (14.3%) showed such a response. It is possible that the sample selected only contained a small sub-group of deluded participants that showed an 'extreme' responding style of data-gathering.

In conclusion, therefore, Wason's 2-4-6 Task gives evidence that those with delusions show a 'jump to conclusions' bias compared to controls, but that the idea of a data-gathering bias is more complex than simply collecting less information. It is proposed that the data-gathering bias is affected by the difficulty of a task. However, evidence from Part One of the Beads Task, does not support evidence of a data-gathering bias, but this may be due to differences in the administration of the task.

b) What is the effect of disconfirmatory evidence on certainty?

The results from Part Two of the Beads Task showed that those with delusions do have a tendency to respond to disconfirmatory evidence in a more extreme way. However, similar to the findings by Garety *et al.* (1991), those with delusions only made these types of responses early in the task, in response to the fourth bead, but not later in the task, in response to the ninth bead. Garety *et al.* (1991) found that later on in the task, even when an accumulative number of beads indicated an alternative hypothesis, the deluded group were as likely, but not more likely, than the control group to alter their decision. The findings imply that this type of extreme response to contradictory evidence occurs during belief formation but not in belief maintenance.

c) Is the data-gathering bias due to inability to integrate information or due to an increased need for cognitive closure?

Overall, findings indicated no differences between groups in terms of NFCS scores. This provides evidence against the proposal that the data-gathering bias shown by people with delusions is due to a high need for cognitive closure. These results differed from findings by Colbert & Peters (2000), who found that those high in delusion-proneness scored higher on this measure than those low in delusion-proneness, indicating some relationship between these two constructs. The current results may be related to difficulties with the NFCS measure. Unlike the study by Colbert & Peters (2000), the scale was adapted for ease of use with the psychiatric population, but these adaptations were not piloted or checked for reliability or validity. This may have limited the use of this measure.

Both the Wason's 2-4-6 Task and the Flats Task were designed to discriminate between need for closure and inability to integrate information as explanations of the data-gathering bias. In the 2-4-6 Task, it was originally hypothesised that if the reasoning biases found in deluded samples were due to a need for cognitive closure, this group would make more errors due to not exploring the boundaries of the 'med' rule. However, if it were due to an inability to integrate information, it was predicted that the deluded group would make more errors due to only making use of recent information, ignoring earlier evidence that contradicts the answer. The actual results showed that the deluded group made both types of errors. However, only the 'only using recent information' was significantly higher in the deluded groups. It is proposed therefore that both deluded and normal participants 'jump to conclusions' by not exploring boundaries, but the difference between the two groups is that the deluded group have a higher tendency towards using only recent information in their decisions. In this way, the 2-4-6 Task provides more evidence for the hypothesis that the data-gathering bias is due to an inability to integrate information. This is supported by findings that the NFCS did not correlate with the 'jump to conclusions' errors.

There was further and more compelling evidence towards the inability to integrate information hypothesis provided by the Flats Task. This hypothesis predicted that the deluded sample would be influenced by the difficulty of a task. In easier conditions, those with delusions would use similar amounts of information to normals, but as the task increases in difficulty, they would use much less information as they are increasingly unable to integrate it to make a decision. However, if the bias were due to a high need for cognitive closure, it would be expected that the deluded group would not be affected by the difficulty of the task. It would be predicted that those with delusions would base all decisions on minimal data, therefore use a similar amount of limited information even when more information is available, and hence use less than normals in all conditions.

Results showed that the deluded group used less information than controls only in the two most difficult conditions. The fact that the deluded group did respond to increasing amounts of information by using less data supports the idea that they have an inability to integrate greater amounts of information. The fact that there was no difference in time taken indicates that it took as long for deluded people to form a decision on much less information, as it did for controls to use much more information. This would again point towards a difficulty in being able to mentally organise information to make a decision.

These findings fit with evidence from Young & Bentall (1997a) and Dudley *et al.* (1997a) that people with delusions do respond to the difficulty of a task. The evidence supports the studies discussed in the introduction that proposed that people with delusions are not able to make use of past information and context (Corcoran & Frith, 2000). McCormick & Broekema (1978) compared deluded and non-deluded paranoid schizophrenics with alcoholic controls on a task of perceptual recognition. They found that deluded patients rarely showed sequential learning and suggested that they *"responded to each stimulus as if it is new, neither integrating information from earlier studies to facilitate performance, nor showing the debilitating effects of earlier incorrect responding."*

These two tasks provide evidence in support of the hypothesis that a data-gathering bias in those with delusions is due to an inability to integrate information, rather than a personal bias towards cognitive closure. Those with delusions tend to make decisions based on only immediate information, and have difficulty making use of past information to inform these decisions. In addition, people with delusions *are* able to make use of small amounts of information. However, when there is a larger amount of information available which they cannot integrate, they gather less information on which to base a decision, and thus make decisions earlier than controls.

Colbert & Peters (2000) suggested that inability to integrate information may underlie both the 'jump to conclusion' style and the need for cognitive closure. If a person is unable to integrate information, it may lead to discomfort with ambiguous information, and being more decisive to eliminate this discomfort. However, the findings in both that study and in the current study do not suggest a correlation between amount of information looked at and need for closure, so this suggestion is not really supported.

Another interesting finding was that, despite using less information overall, those with delusions used significantly more idiosyncratic information than normal controls. This would suggest that those with delusions also differ in the type of information they use in decisions, as well as the amount.

d) Is the data-gathering bias a reflection of a more general reasoning bias?

Results from the logic index in the Wason Selection Task indicated that those with delusions have a similar ability to reason logically to normal controls. However, all groups showed a tendency towards using confirmatory strategies to test a hypothesis rather than disconfirmatory strategies. This is in accord with findings by Bentall & Young (1996) that deluded people and normals show no difference in their use of disconfirmatory strategies to test hypotheses.

There were some practical and methodological flaws with this task. With so few participants answering correctly, the validity of these results as evidence against a global reasoning deficit is limited, as the similarities may be due to a floor effect. It was hoped that couching the task in a familiar context would aid facilitation, but this was not the case. Platt & Griggs (1993) found that a number of strategies improved response rate. One strategy involved providing a statement to draw attention to the other cards, such as "if the tap is hot it must be marked with a red dot, but if it is cold, it can be marked with either a red or a blue dot". Another involved asking participants to provide reasons for their answer, and giving instructions to choose cards on the basis of "whether or not they violate the rule". Changing the instructions to incorporate one or more of these additions may have led to a higher response rate, and allowed differences to have been observed.

Results from the Coin Task provided more valid evidence that those with delusions do not have a general reasoning bias, compared to normals. There was a tendency for participants to be influenced more by the strength of the coins (the different ratios) rather than the weight (the sample size). This fits with evidence from Dudley *et al.* (1997a), that deluded people are subject to similar biases as normals, and when presented with information, have the ability to reason normally. However, it is counter to evidence from Linney *et al.* (1998) and Blackmore & Troscianko (1985) that those high in delusional ideation show less sensitivity to the effects of varying sample size compared to those who are low in delusional ideation. Linney *et al.* (1998) proposed that this indicated a lack of awareness of the effects of random variation, and could lead to a premature termination of data-gathering. This study provides evidence against that proposal, and concludes that there is no global reasoning deficit in those with delusions.

2) What is the relationship between the diagnosis of psychotic illness and reasoning biases?

When comparing the deluded group and the psychiatric control group directly, there were few differences in the responses given. The only direct piece of evidence for differences between the deluded group and the psychiatric control group was in the 2-4-6 Task. The psychiatric control group showed significantly less 'jump to conclusions' style answers than the deluded group. However, there were differences in the *pattern* of responses in the other tasks, in that there were differences between the deluded group and the low delusion-prone group that were not shown between the psychiatric control group and the low delusion-prone group, and vice versa.

The psychiatric control group, like the deluded group, showed no difference in general reasoning ability when compared with normal control groups, as evidenced by scores on the Wason Selection Task and the Coin-Tossing Task. However, this group, unlike the deluded group, were less likely to finish Wason's 2-4-6 Task compared to the normal control groups. The psychiatric control group also showed no difference from normal low delusion-prone group in the frequency of giving answers due to 'only using recent information', unlike the deluded group.

In the Flats Task, the psychiatric control group also showed a different pattern of responding. Whereas the response of the deluded group differed from the low delusion-prone group only at high levels of difficulty, the psychiatric control group used similar amounts of information across all conditions, and used less information compared to the low delusion-prone control group in all but the first condition. These results would seem to coincide more with the need for closure hypothesis, that they use less information regardless of task difficulty.

In conclusion, the psychiatric control group showed greater evidence of a more general inability to form and test hypotheses, whereas the deluded group had a specific bias towards 'jumping to conclusions'. It is believed that, within this context, the style of responding on the Flats Task in the psychiatric control group is not reflective of a data-gathering bias due to a high need for cognitive closure, but is more reflective of a general inability to use information. The reasons why this group would show such a global deficit is unclear. There were no differences between the two clinical groups in terms of positive symptoms as measured by the SAPS. However, it is possible that the groups differed in terms of negative symptoms, which were not measured.

This leads to a dilemma in interpreting the results of the bias within the deluded group. For all findings, except the 'jump to conclusions' bias in the 2-4-6 Task, it is impossible to conclude that the reasoning biases shown were due to the presence of delusions rather than the experience of psychosis. It is possible the differences seen were related to illness severity, with some of the clinical non-deluded group at a different stage in their illness where negative symptoms are more prominent. It is further complicated by difficulties with the psychiatric control group. The study endeavoured to find a population as similar to the deluded group as possible, with the only difference being the absence of delusions. The current study had the strength of using stricter criteria for inclusion into the psychiatric control group than any other studies discussed, who have mainly used non-psychotic psychiatric groups, such as anxious or depressed groups. However, although it was ensured that none of the psychiatric control group had been delusional on their current admission, checks from the patient's notes indicated that five were known to have been delusional on previous episodes. Although differences between the two groups are inconclusive, the implications are further limited by these findings. The flaw in the psychiatric control group does not enable us to compare those who have never been delusional but are psychotic, with deluded patients. However, given this limitation, it is possible to attribute similarities between the two clinical groups to a tendency to experience delusions at one stage in life. Therefore, it is tentatively suggested that these similarities in reasoning style may be due to having a vulnerability to delusions, rather than being actively delusional.

3) Do high delusion-prone individuals in the normal population demonstrate similar reasoning biases to patients with delusions?

It was predicted that the high delusion-prone group would show similar biases to those with delusions, which would be significantly different from those who are low delusion-prone. This would have provided evidence towards reasoning biases being implicated in the formation of delusions. However, in a similar way to the above findings about the deluded and the psychiatric control group, there were no *direct* differences between the low and high delusion-prone groups. A difference in the pattern of responding can be inferred from where the low delusion-prone groups differed from the deluded group, and the high delusion-prone group did not. This provides some evidence of a continuum, with those high in delusional ideation in the centre.

In Wason's 2-4-6 Task, the high delusion-prone group showed a similar ability to come to a correct answer as the low delusion-prone group. However, in type of answer given, the low PDI group differed from the deluded group in frequency of 'jump to conclusions' errors, but the high PDI did not. In addition, the deluded group did not differ from the high PDI in number of errors due to 'only responding to recent information', whereas there was a difference between the deluded group and low PDI. Linney *et al.* (1998) found direct differences in their study of reasoning biases in high and low delusion-prone individuals.

In the Flats Task, the deluded group used less information than the low PDI group at higher levels of difficulty, but neither the low PDI or the deluded group differed from the high PDI group on these measures. Like the study by Colbert & Peters (2000), the high and low PDI groups did not differ in terms of number of beads to decision in the Beads Task (Part One), or in number of beads to certainty in the Beads Task (Part Two). However, the high PDI group did not differ from the deluded or non-deluded group in greater proportion of errors made, whereas the low PDI group did. In addition, the high PDI group did not differ from the deluded group in extreme response to disconfirmatory evidence, whereas the low PDI did.

The differences between the two normal control groups are inconclusive. This may be due to the relatively low PDI score in the normal control population (before they were split into the two groups), compared to that of Linney *et al.* (1998), so the differences between the two normal groups may have been too subtle. The median score of the normal population in the current study was 42, whereas in the group used by Linney *et al.* (1998) the median was 61. A proportion of those selected from groups thought to be high in delusion-proneness had PDI scores that fell into the low delusion-prone group. This discrepancy appears to come from the psychic and paranormal groups, who may not be as delusion-prone as predicted.

Evidence that a proportion of the high PDI group appeared to show similar biases to the deluded group does lend some weight to the proposal that delusions lie on a continuum, from normal beliefs to delusional beliefs, with the high PDI group in the centre. However, the subtlety of these differences does not enable us to establish this conclusively.

Theoretical Implications of Results

Drawing all the findings together, what implications do they have for the understanding of delusions? The findings support proposals that those with delusions do not demonstrate a *general* reasoning deficit, and use some biases in probabilistic reasoning that are similar to the biases seen in normals. However, there is evidence to support a more specific bias, that of basing decisions on less information. The evidence suggests that people with delusions use less information, but the evidence for an actual bias in data-gathering is less conclusive, and mediated by the difficulty of the task. The results from this current study suggest that an inability to integrate information lies behind the 'jump to conclusions' bias. There is also evidence to suggest that this inability to integrate information leads to people with delusions using only immediate stimuli, at the neglect of earlier, possibly disconfirmatory information. In a task where information is presented, rather than gathered, it is suggested that this inability also lies behind a style of changing hypotheses rapidly when faced with disconfirmatory evidence, early on in belief formation. This type of responding does not occur later on when the belief is formed.

It is possible to speculate how this data-gathering bias, characterised by an inability to integrate information, could be involved in both formation and maintenance of delusions.

Delusion Formation

Looking firstly at delusion formation, most psychological models of psychosis view delusions as an individual's way of making sense of their experiences. A delusion is seen as just one possible interpretation of events, the self or experiences (Garety, 1992). The reasoning biases found may be used to explain some features of delusion development that studies describe, and also may be implicated in what leads an interpretation to be a delusional one.

Firstly, one important feature of delusion development that has been observed is that the person shows a 'loss of the benefits of accumulated life experience', accounting for a failure to reject delusional beliefs as unrealistic (Chapman & Chapman, 1988). Whereas it is acknowledged that most people ignore some information in forming hypotheses, deluded people appear to ignore facts of physical reality that they and others have experienced throughout their lives. Linked to this is the idea that the deluded person appears not to use context when making sense of information. This would connect with the ideas by Salzinger (1984) who argues that it is the context that gives information meaning. Deluded individuals show a failure to initiate a comparison with stored knowledge, even though that knowledge exists (David &

Howard, 1994). When faced with an unusual experience, a non-deluded person considers more information about the world than just the experience itself in making an interpretation, while the deluded person '*responds to the experience as if it were the only data available*' (Garety & Hemsley, 1994).

Having an inability to integrate information may be involved in these features. When processing information about an event, such an inability could lead to beliefs being formed on the basis of very little information, even single occurrences. An inability to integrate information could also affect the person's ability to put the event or idea into context, even the context of well-established physical regularities, as they are unable to integrate past information to create a context. An inability to integrate information would lead to an over-reliance on information that is immediate, strong, or personally relevant. This fits with findings from the current study that those with delusions use more idiosyncratic information in making their decisions. It also corresponds with suggestions by McCormick & Broekema (1978) that those with delusions have an over-response to temporally immediate stimuli. Chapman & Chapman (1988) provide an example of a patient who had the experience of hearing their mother's voice coming from the drain, and formed the belief that their mother was trapped there, ignoring the physical reality that people cannot fit into drain pipes, and failing to consider alternative explanations such as the voice coming from elsewhere. An inability to integrate information would mean that the person was only able to make use of the immediate information, that of hearing the voice, and was unable to use weaker evidence, such as the physical limitations, that may have led to the search for alternative explanations. By affecting data-gathering, the inability to integrate information would be more likely to lead to an interpretation of an event that is false and relies only on the information immediately present, rather than an interpretation that is able to use past information to give context, and hence is more likely to be realistic.

Another feature of delusion development is the relationships that people with delusions see between concepts. They *'entertain the possibility that events which....cannot have a causal relationship with each other, might nonetheless do so'* (Meehl, 1964). This is a similar idea to that of 'illusory correlations' (Brennan & Hemsley, 1984), where people with delusions have a greater tendency to make connections between stimuli that are not, in reality, connected. An example of this is when a person notices on one occasion that traffic lights change when he thinks about them, and concludes that his thoughts control traffic lights. Being unable to integrate information would again lead to the person to focus only on the information in front of them that coincide together, and being unable to use other information that suggests there is no causal relationship. Brennan & Hemsley (1984) suggest that illusory correlations are formed due to the deluded person rigidly imposing schema when processing information, using 'top-down' processing. Our evidence would suggest that some illusory correlations may instead be due to extreme 'bottom-up' processing, coming solely from the immediate information.

The finding from the Beads Task (Part Two) that deluded people rapidly change hypotheses can also be explained by the inability to integrate information. The deluded person is unable to use the accumulating information, but instead is influenced by the immediate information in making a decision. This style of responding, however, seems contrary to clinical experience of delusions, which do not rapidly change from moment to moment. However, results on this task, and from other studies (Garety *et al.,* 1991), suggest that this type of responding only occurs in the early stages of belief formation, not in belief maintenance. Once the belief is formed, and strengthened, more confirmatory biases are exhibited.

The speculation that the inability to integrate information is involved in delusion formation in these ways must be moderated by the inconclusive findings about reasoning biases in high delusion-prone individuals in the normal population. If the delusion-prone group had shown similar data-gathering biases to the deluded group, it would have provided more weight to the argument that such biases are involved in delusion formation. Although the delusion-prone group did show a pattern of responding similar to that of the deluded group, the results were not conclusive. However, in a similar way that, using a cognitive model (Beck *et al.,* 1979), a style of negatively interpreting events is activated by a critical incident, it is possible that the reasoning biases described are only activated when the person is trying to make sense of stressful experiences. This would fit into the vulnerability-stress framework (e.g. Strauss & Carpenter, 1981), that suggests a person can have an underlying vulnerability to psychosis, but that symptoms themselves are only experienced when triggered by forms of extreme stress for the individual. This supports ideas that delusions do not occur in a vacuum, but occur in the context of extreme psychological distress and emotional difficulties (Fowler *et al.,* 1998).

Belief Maintenance

The findings from this study relate mainly to the involvement of reasoning biases in the formation of beliefs. Garety & Hemsley (1994) suggest in their model that biases that occur in forming a delusion are also active in delusion maintenance. However, it is also possible to speculate how an inability to integrate information may be implicated in delusion maintenance. There are three aspects to delusion maintenance that are explored using this idea: whether further information is sought about the belief; the type of information sought; and the interpretation of information provided.

The evidence from the current study suggests that an inability to integrate information lies behind a bias towards gathering and using less information when forming a belief, for deluded individuals. It is proposed that this bias would not only prevent past or contextual information from being integrated, but maintain delusions by preventing the search for further information. However, there is evidence to suggest the failure of individuals to search for further evidence about their belief is also a bias shown in normals (Alloy & Tabachnick, 1984).

It has also been found that if a search for further evidence does occur, in people with delusions, only confirmatory evidence is sought (Garety & Hemsley, 1994). The reasoning biases described were found to be influenced by the difficulty of a task, thus it may be that it is easier to integrate information that fits with the existing belief, but it is harder to integrate contradictory evidence. It is possible that the inability to integrate information would, in this way, influence the type of information sought. Brett-Jones *et al.* (1987) suggested that those with delusions are more likely to be aware of hallucinatory evidence that confirms the belief, rather than objective experience that is disconfirmatory. However, again this type of 'confirmatory bias' is also seen in non-deluded individuals (Ross & Anderson, 1982).

As well as influencing the search for information about the belief, it is also suggested that the inability to integrate information may be involved in the interpretation of information provided about the belief. Garety & Hemsley (1994) studied the reaction of deluded patients to hypothetical contradictions to their delusions. Of those studied 11/14 stated that they would reject or ignore such information, or distort it to fit with their delusional system, whilst only 2/14 reported that they would reduce their conviction or dismiss their belief. However, this was not measured against reaction to such information in normal individuals.

The biases used to maintain delusions described above are also all evident in normal reasoning about strong beliefs. This current study does not provide more information as to whether those with delusions show qualitatively or quantitatively different reasoning biases from normal in delusion maintenance. A reasonable suggestion is that delusions are maintained using similar biases to normals, but that this maintenance may be facilitated or accentuated by an inability to integrate information.

Methodological Limitations

The results of this study should be taken in the context of a number of methodological limitations and difficulties. One was the use of the psychiatric control group which was described earlier. Also, the study should have measured the participant's level of negative symptoms as well as positive ones, to ensure that this was not a confounding variable.

Another difficulty was the lack of difference in PDI scores between the deluded group and both the psychiatric control group and the high PDI control group, despite the two clinical groups showing significant differences in the presence of delusions (as measured by the SAPS). The PDI is designed to measure delusion-proneness, as a trait, and it would be expected that the high PDI group would answer similar number of items affirmatively to the deluded group. Given that the clinical non-deluded group also consists of some individuals who have had at one time experienced delusions, they would also be expected to score similarly on this measure. What would be anticipated would be a difference in scores from the dimensions. Peters *et al.* (1999a) found that NRMs showed similar levels of conviction to those with delusions, but lower levels of preoccupation and distress. The current study found no differences in any of the dimensions between these three groups. However, the group used in the current study showed lower levels of delusional distress and preoccupation, compared to the Peters *et al.* (1999a) sample. Unlike the sample from Peters *et al.* (1999a), the deluded group did not differ from the high PDI group and the clinical non-deluded group in terms of levels of anxiety and depression, as measured by the HADS. It is possible that the similar levels of preoccupation and distress may be reflecting the underlying similar levels of depression and anxiety among these three groups, rather than specific preoccupation and distress about the belief itself. It is also possible that, despite high scores on the SAPS, the deluded group may have been less deluded than samples in other studies, reflected in the comparatively low PDI scores.

Other methodological difficulties involved the use of the tasks themselves. As described earlier, using facilitation instructions with Wason's Selection Task may have reduced the floor effect and allowed a more valid interpretation of the results. The validity of the results on the Flats Task may have been strengthened by tests of inter-rater reliability as to what information was used and not used. In this task, participants were asked, after they announced their decision, what information they had actually used. Asking the participants to describe their decision-making processes as they were carrying them out would have been more useful, and may have enabled the experimenter to determine if they were using confirmatory or disconfirmatory strategies in making their decision. Also, it is unclear if the unequal weighting of the flats made a difference to results.

One strength of the Flats Task was that it investigated styles of cognitive processing and decision making, and was not evaluating the number of errors made. Garety *et al.* (1991) suggests that in schizophrenia research, tasks that simply generate more errors in the psychiatric participants are subject to problems of interpretation. However, it was unclear what role memory had on this task. It is possible that the deluded group were using less information due to greater memory difficulties. The instructions allowed participants to take cards out to refer to, but only a small proportion were observed to do this, and in more difficult tasks it was quite cumbersome. A computer version of this task, where participants could uncover what information they needed, and also specify what they used, may be an interesting and useful development.

Further Research

There are two directions in which further research could be developed from this current study. One direction is to further clarify the current findings by improving the methodology and filling the gaps this study fails to cover. The other direction is in generating further questions from the findings that may extend the understanding of delusions.

With regard to improving methodology, amendments made to the tasks as suggested in the previous section would give further validity to the conclusions. In particular, the role of memory on the reasoning biases found in the Flats Task needs clarification. Improvements to the selection of control groups would also have provided more complete answers to the research questions.

The difficulties described with the psychiatric control group prevented conclusions being drawn as to whether the reasoning biases found were related to the presence of delusions, or an underlying delusion-prone trait. Further studies could use a psychiatric control group who had never been deluded. Similarly, the limitations of the high delusion-prone group did not allow for clarification of the role of reasoning biases in delusion formation. Ideally, longitudinal work assessing the development of reasoning biases at different points in delusion formation, maintenance and recovery would provide a better picture of how such biases may be implicated at each stage. There has been some interesting work done on prodromal stages of delusions (Bentall, 1996), and work is needed to determine whether reasoning biases are involved in this stage. One question raised from this study is whether the biases found are part of a delusion-prone vulnerability, and are evident in reasoning even when the individual is not deluded, or whether the biases are not exhibited normally but are activated during the early stages of delusion development.

With regard to further questions generated from the study, there is a need to explore the role of emotion, particularly anxiety, in the reasoning biases found. Although other studies (e.g. Young & Bentall, 1997a; Dudley *et al.*, 1997b) have explored the impact that personal relevance of a task has on reasoning biases, the emotional impact of these variations has not been assessed. It is possible that the inability to integrate information is mediated by the effects of anxiety at high levels of task difficulty. Future work could explore the impact that emotionally relevant material has on the inability to integrate information.

Another area not explored by this study is the presence of a sub-group of deluded individuals who show 'jump to conclusions' biases (as suggested by Garety *et al.*, 1991) and the properties of such a sub-group. An important clinical question generated from this would be whether having such biases affects recovery from delusions, or somehow mediates the response to therapeutic intervention. If so, this would suggest that assessment of such biases is needed as part of assessment for intervention, and that modification of such biases could be effective as a treatment component.

Clinical Implications

The current study proposes ideas as to how reasoning biases may be involved in the formation and maintenance of delusional belief, based on the findings of the nature of these biases. This final section considers how these ideas may impact on clinical practice, with reference to cognitive therapy as a treatment for psychosis.

There is growing consensus on the usefulness and effectiveness of psychological approaches to delusions, particular cognitive-behavioural interventions, from single case studies (Fowler, 1992) to randomised controlled trials (Kuipers *et al.*, 1997; 1998). Such interventions have been found to have an impact on delusional conviction, and also on the distress levels associated with delusions (Kuipers *et al.*, 1997). It is believed that a greater understanding of the mechanisms underlying delusions will enhance the efficacy of cognitive treatments.

As mentioned earlier, cognitive models view delusions as a person's attempts to make sense of their experiences. It is proposed that reasoning biases are involved in the formation and maintenance of delusional interpretation by constricting the evidence used in making the interpretation, and in the misinterpretation of day to day events. In line with ideas of delusions on a continuum with normal beliefs, it is proposed that biases used to maintain delusions are also on a continuum with biases used to maintain other dysfunctional beliefs. Like other psychological difficulties (such as anxiety disorders), cognitive models propose an individual case formulation approach, which considers not only the nature of delusion, but the individual's life history and the context in which the symptoms arose, to formulate a new understanding that is less distressing. Delusional interpretation is reinforcing in removing the person's sense of bewilderment and confusion, but has a cost in terms of distress and disturbance (Chadwick *et al.*, 1996). In weakening the delusional interpretation and enabling the person to use an alternative understanding of their experiences, the distress is also weakened.

Chadwick *et al.* (1996) proposed four elements involved in weakening delusions in cognitive therapy. These involve challenging the belief, questioning the plausibility of the delusional system, reformulating the delusion as an understandable response to specific experiences and finally, constructing a meaningful alternative. The findings from this study impact upon how these elements of therapy might be implemented.

One way that they impact is in the recognition that the cognitive distortions leading to the misinterpretation of events, seen in cognitive therapy with all clients (Beck *et al.,* 1979), are accentuated in people with delusions. Though there have been findings that reasoning biases are not a predictor of poor outcome (Garety *et al.,* 1997), a formulation of difficulties could incorporate an assessment of the extent of the individual's reasoning biases, with the aim of modifying them in therapy.

Another consideration is in the challenge of delusional beliefs by providing evidence against them. Having an inability to integrate information would have an impact on the type of evidence the person can make use of. The implication is that people with delusions respond to small pieces of information that are immediate and strong, rather than to accumulative information that they find harder to integrate. It would seem reasonable for the therapist to assess what piece of information would be influential in disconfirming the belief, rather than collecting many different items of disconfirmatory evidence.

These reasoning biases would also have implications for the use of reality testing. Reality testing is often a useful tool in cognitive therapy where a behavioural experiment is set up to directly test a premise of the delusion. As mentioned earlier when interpreting the results, one possible reason for the confirmatory bias that maintains delusions is that disconfirmatory information is harder to integrate. By establishing an alternative conceptual framework prior to reality testing, it is proposed that a deluded person would find it easier to integrate the outcome of the test, as they would have an alternative explanation available. This would back up suggestions made by other theorists (such as Chadwick *et al.,* 1996; Kuipers *et al.,* 1996) that an alternative explanation needs to be set up prior to reality testing delusions.

Linked to this is the generation of these alternatives. In cognitive-behavioural therapy with non-psychotic clients, the client is usually asked to generate their own alternative interpretations to situations rather than the therapist supplying one. Generating alternative explanations to accommodate all their experiences would require the integration of immediate, past and contextual information, which delusional patients would struggle to do. This provides support for Chadwick *et al.'s* (1996) suggestion that it may be more effective to construct a meaningful alternative with the client.

There is no single pathway to developing delusions. Reasoning biases are only one element in delusional formation and maintenance, and different elements are more prominent for different individuals. Nevertheless, further understanding of the role of reasoning biases in delusions could guide efforts towards enabling the individual to formulate a new understanding, and alleviate the distress such beliefs cause.

References

Abroms, G.M., Taintor, Z.C. & Lhamon, W.T. (1966) Percept assimilation and paranoid severity. Archives of General Psychiatry, **14**, 491-496.

Alloy, L.B. & Tabachnick, N. (1984) Assessment of covariation by humans and animals: the joint influence of prior expectations and current situational information. Psychological Review, **91**, 112-149.

American Psychiatric Association (1995) Diagnostic and Statistical Manual of Mental Disorders (4th Edition). APA: Washington.

Ammons, R.B. & Ammons, C.R. (1962) The Quick Test (QT: Provisional manual). Psychological Reports, **11**, 111-161.

Andreasen, N. (1984) Scale For The Assessment Of Positive Symptoms (SAPS). Department of Psychiatry: Iowa.

Beck, A.T., Rush, A.J., Shaw, B.F. & Emery, G. (1979) Cognitive Therapy of Depression. Guilford Press: New York.

Bentall, R.P. & Young, H.F. (1996) Sensible hypothesis testing in deluded, depressed and normal subjects. British Journal of Psychiatry, **168**, 372-375.

Bentall, R.P. (1990) The illusion of reality: a review and integration of psychological research on hallucinations. Psychological Bulletin, **107**, 82-95.

Bentall, R.P. (1996) From cognitive studies of psychosis to cognitive behaivour therapy for psychotic symptoms. In, G. Haddock & P. Slade (eds) Cognitive Behavioural Intervention With Psychotic Disorders. Routledge: London.

Bentall, R.P., Claridge, G.S. & Slade, P.D. (1989) The multi dimensional nature of psychotic traits: a factor analytic study with normal subjects. British Journal of Clinical Psychology, **28**, 363-375.

Bentall, R.P., Kaney, S. & Dewey, M.E. (1991) Paranoia & social reasoning: An attribution theory analysis. British Journal of Clinical Psychology, **30**, 13-23.

Bentall, R.P., Kinderman, P. & Kaney, S. (1994) The self, attributional and abnormal beliefs, Towards a model of persecutory delusions. Behaviour Research & Therapy, **32**, 331-341.

Birchwood, M. & Iqbal, Z. (1998) Depression and suicidal thinking in psychosis: a cognitive approach. In, T. Wykes, N. Tarrier & S. Lewis (eds) Outcome & Innovation in Psychological Treatment of Schizophrenia. Wiley: Chichester.

Birchwood, M. (1999) Commentary on Garety & Freeman I: 'Cognitive approaches to delusions – A critical review of theories and evidence'. British Journal of Clinical Psychology, **38**, 315-318.

Blackmore, S. & Troscianko, T. (1985) Belief in the paranormal: Paranormal judgements, illusory control and the 'chance baseline shift'. British Journal of Psychology, **76**, 459-468.

Blackwood, N.J., Howard, R.J., Bentall R.P. & Murray, R.M. (2000) Cognitive neuropsychiatric models of persecutory delusions. Submitted.

Brennan, J.H. & Hemsley, D.R. (1984) Illusory correlations in paranoid and non-paranoid schizophrenia. British Journal of Clinical Psychology, **23**, 225-226.

Brett-Jones, J., Garety, P.A. & Hemsley, D. (1987) Measuring delusional experiences: its method and application. British Journal of Clinical Psychology, **26**, 257-265.

Brown, W.A. & Herz, L.R. (1989) Response to neuroleptic drugs as a devise for classifying schizophrenia. Schizophrenia Bulletin, **15**, 123-129.

Chadwick, P. & Lowe, C. (1990) The measurement and modification of delusional beliefs. Journal of Consulting & Clinical Psychology, **58**, 225-232.

Chadwick, P. (1992) Borderline: A Psychological Study of Paranoia & Delusional Thinking. Routledge: London.

Chadwick, P., Birchwood, M. & Trower, P. (1996) Cognitive Therapy For Delusions, Voices & Paranoia. Wiley: Chichester.

Chadwick, P.D.J. & Lowe, C.F. (1990) Measurement and modification of delusional beliefs. Journal of Consulting & Clinical Psychology, **58,** 225-232.

Chadwick, P.D.J. & Lowe, C.F. (1994) A cognitive approach to measuring delusions. Behaviour Research & Therapy, **32,** 355-367.

Chapman, L.J. & Chapman, J.P. (1980) Scales for rating psychotic and psychotic-like experiences as continua. Schizophrenia Bulletin, **6,** 476-489.

Chapman, L.J. & Chapman, J.P. (1988) The genesis of delusions. In, T.F. Ottmanns & B.A. Maher (eds) Delusional Beliefs. Wiley: New York.

Claridge, G. (1994) Single indicator at risk for schizophrenia: Probable fact or likely myth? Schizophrenia Bulletin, **20,** 151-168.

Claridge, G.A. & Broks, P. (1984) Schizotypy and hemisphere function. I. Theoretical considerations and measurement of schizotypy. Personality & Individual Differences, **5, 6,** 633-648.

Colbert, S. & Peters, E. (2000) Reasoning style and delusional ideation: Need for closure or an inability to integrate information over time? Submitted to, British Journal of Clinical Psychology.

Cooper, A.F., Kay, D.W.K., Curry, A.R., Garside, R.F. & Roth, M. (1974) Hearing loss in paranoid an affective disorders of the elderly. Lancet, **2,** 851-854.

Corcoran, R. & Frith, C. (2000) Conditioning reasoning and 'theory of mind': The case of schizophrenia. Submitted to, British Journal of Psychology.

Corcoran, R. Mercer, G. & Frith, C. (1995) Schizophrenia, symptomatology and social inference: investigating 'theory of mind' in people with schizophrenia. Schizophrenia Research, **17**, 5-13.

Cutting, J. (1985) The Psychology of Schizophrenia. Churchill Livingstone: Edinburgh.

David, A. & Howard, R. (1994) An experimental phenomenological approach to delusional memory in schizophrenia and late paraphrenia. Psychological Medicine, **24**, 515-524.

Day, S. & Peters, E. (1999) The incidence of schizotypy in new religious movements. Personality & Individual Differences, **27**, 55-67.

Dudley, R., John, C.H., Young, A.W. & Over, D.E. (1997a) Normal and abnormal reasoning in people with delusions. British Journal of Clinical Psychology, **36**, 243-258.

Dudley, R., John, C.H., Young, A.W. & Over, D.E. (1997b) The effect of self-referent material on the reasoning of people with delusions. British Journal of Clinical Psychology, **36**, 575-584.

Ellis, H.D. & Young, A.W. (1990) Accounting for delusional misidentifications. British Journal of Psychiatry, **157**, 239-248.

Estes, W.K. (1976) The cognitive side of probability learning. Psychological Review, **83**, 37-64.

Finn, S.E., Bailey, J.M., Schultz, R.T. & Faber, R. (1990) Subjective utility ratings of neuroleptics in treating schizophrenia. Psychological Medicine, **35**, 843-848.

Fischhoff, B. & Beyth-Marom, R. (1983) Hypothesis evaluation from a Bayesian perspective. Psychological Review, **90**, 239-260.

Fiske, S.T. & Taylor, S.E. (1991) Social Cognition. McGraw-Hill International Editions.

Foulds, G.A. & Bedford, A. (1975) Hierarchy of classes of personal illness. Psychological Medicine, **5**, 181-192.

Fowler, D. (1992) Cognitive behaviour therapy in management of patients with schizophrenia: preliminary studies. In, A. Werbart & J. Culberg (eds) Psychotherapy of Schizophrenia: Facilitating & Obstructive Factors. Scandinavia University Press: Oslo.

Fowler, D., Garety, P. & Kuipers, E. (1998) Understanding the inexplicable: an individually formulated approach to delusional beliefs. In, C. Perris & P.D. McGorry (eds) Cognitive Psychotherapy of Psychiatric & Personality Disorders: Handbook of Theory & Practice. Wiley: Chichester.

Freeman, D., Garety, P., Fowler, D, Kuipers, E., Dunn, G., Bebbington, P. & Hadley, C. (1998) The London-East Anglia randomised controlled trial of cognitive-behavioural therapy for psychosis IV: self-esteem and persecutory delusions. British Journal of Clinical Psychology, **37**, 415-430.

Frith, C.D. & Corcoran, R. (1996) Exploring 'theory of mind' in people with schizophrenia. Psychological Medicine, **26**, 521-530.

Frith, C.D. (1987) The positive and negative symptoms of schizophrenia reflect impairments in the perception and initiation of action. Psychological Medicine, **17**, 631-648.

Frith, C.D. (1992) The Cognitive Neuropsychology of Schizophrenia. Lawrence: Hove.

Gallup, G.H. & Newport, F. (1991) Belief in paranormal phenomena among adult Americans. Sceptical Inquirer, **15**, 137-146.

Garety, P. & Freeman, D. (1999) Cognitive approaches to delusions: A critical review of theories and evidence. British Journal of Clinical Psychology, **38**, 11-154.

Garety, P., Fowler, D., Kuipers, E., Freeman, D., Dunn, G., Bebbington, P., Hadley, C. & Jones, F. (1997) The London East Anglia randomised controlled trial of cognitive behavioural therapy for psychosis: II: Predictors of outcome. British Journal of Psychiatry, **171,** 420-426.

Garety, P. & Hemsley, D.R. (1994) Delusions: Investigations Into The Psychology of Delusional Reasoning. Oxford University Press: Hove.

Garety, P. (1991) Reasoning and delusions. British Journal of Psychiatry, **159 (supplement 14),** 14-18.

Garety, P. A., Hemsley, D.R. & Wessely, S. (1991) Reasoning in deluded schizophrenic and paranoid patients: Biases in performance on a probabilistic inference task. Journal of Nervous and Mental Disease, **179, 4,** 194-201.

Garety, P.A. & Hemsley, D.R. (1987) Characteristics of delusional experience. European Archives of Psychiatry & Neurological Sciences, **236,** 294-298.

Garety, P.A. (1992) Making sense of delusions. Psychiatry: Journal for the Study of Interpersonal Processes, **55,** 282-291.

Gorman, M.E, Stafford, A. & Gorman, M.E. (1987) Disconfirmation and dual hypotheses on a more difficult version of Wason's 2-4-6 task. The Quarterly Journal of Experimental Psychology, **39, A,** 1-28.

Griffin, D. & Tversky, A. (1992) The weighting of evidence and the determinants of confidence. Cognitive Psychology, **24**, 431-435.

Hansson, L., Bjorkman, T. & Svensson, J. (1995) The assessment of needs in psychiatric patients. Acta Psychiatrica Scandinavia, **92**, 285-293.

Hemsley, D.R. & Garety, P.A. (1986) Formation and maintenance of delusions: a Bayesian analysis. British Journal of Psychiatry, **149**, 51-56.

Hemsley, D.R. (1987) An experimental psychological model for schizophrenia. In, H. Haffner, W.F. Gattaz & W. Janzarik (eds) Search for the Causes of Schizophrenia. Springer: Heidelberg.

Huq, S.F. Garety, P.A. & Hemsley, D.R. (1988) Probabilistic judgements in deluded and non-deluded subjects. Quarterly Journal of Experimental Psychology, **40, A**, 801-812.

Jackson, M.C. (1997) Benign schizotypy? The case of spiritual experience. In, .S. Claridge (ed.) Schizotypy: Relations to Illness & Health. Oxford University Press: Oxford.

John, C.H. & Dodgson, G. (1994) Inductive reasoning in delusional thinking Journal of Mental Health, **3**, 31-49.

Johnson, R.C., Weiss, R.L. & Zelhart, P.F. (1964) Similarities and differences between normal and psychotic subjects in response to verbal stimuli. Journal of Abnormal & Social Psychology, **58**, 221-226.

Johnson-Laird, P.N. (1982) Thinking as a skill. Quarterly Journal of Experimental Psychology, **34A**, 1-29.

Kahneman, D. & Tversky, A. (1973) On the psychology of prediction. Psychological Review, **80**, 287-292.

Kaney, S. & Bentall, R. (1989) Persecutory delusions and attributional style. British Journal of Medical Psychology, **62**, 191-198.

Kelley, H.H. (1967) Attribution theory in social psychology. In, D. Levine (ed.) Nebraska Symposium on Motivation. University of Nebraska Press: Lincoln.

Kemp, R., Chua, S., McKenna, P. & David, A. (1997) Reasoning in delusions. British Journal of Psychiatry, **170**, 389-405.

Kihlstrom, J.F. & Hoyt, I.P. (1988) Hypnosis and the psychology of delusions. In, T.F. Ottmanns & B.A. Maher (eds) Delusional Beliefs. Wiley: New York.

Kinderman, P. & Bentall, R.P. (1996) Self-discrepancies and persecutory delusions: evidence for a model of paranoid ideation. Journal of Abnormal Psychology, **105**, 106-113.

Kingdon, D.G. & Turkington, D. (1994) Cognitive Behaviour Therapy Of Schizophrenia. Wiley: Chichester.

Krawiecka, M., Goldberg, D. & Vaughan, M. (1977) A standardised psychiatric assessment scale for rating chronic psychotic patients. Acta Psychiatrica Scandinavia, **55**, 299-308.

Kruglanski, A.W. (1990) Motivations for judging and knowing: implications for causal attribution. In, E.T. Higgins & R.M. Sorrentino (eds) The Handbook of Motivation & Cognition: Foundations of Social Behaviour, Volume 2. Guilford Press: New York.

Kruglanski, A.W., Webster, D.M. & Klem, A. (1993) Motivated resistance and openness to persuasion in the presence or absence of prior information. Journal of Personality & Social Psychology, **65, 5**, 861-876.

Kuipers, E., Fowler, D., Garety, P., Dunn, G., Bebbington, P., Freeman, D. & Hadley, C. (1998) The London East Anglia randomised controlled trial of cognitive behavioural therapy for psychosis: III: Follow-up and economic evaluation at eighteen months. British Journal of Psychiatry, **173**, 61-68.

Kuipers, E., Garety, P. & Fowler, D. (1996) An outcome study of cognitive behavioural treatment of psychosis. In, G. Haddock & P. Slade (eds) Cognitive Behavioural Intervention With Psychotic Disorders. Routledge: London.

Kuipers, E., Garety, P., Fowler, D., Dunn, G., Bebbington, P., Freeman, D. & Hadley, C. (1997) The London East Anglia randomised controlled trial of cognitive behavioural therapy for psychosis: I: Effect of the treatment phase. British Journal of Psychiatry, **171**, 319-327.

Link, B.G. & Stueve, A. (1994) Psychotic symptoms and violent/illegal behaviour of mental patients compared to community controls. In, J. Monahan & H. Steadman (eds) Violence & Mental Disorder: Developments in Risk Assessment. University of Chicago Press: Chicago, Illinois.

Linney, Y., Peters, E. & Ayton, P. (1998) Reasoning biases in delusion-prone individuals. British Journal of Clinical Psychology, **37**, 285-302.

Lord, C., Lepper, M.R. & Ross, L. (1979) Biased assimilation and attitude polarisation: the effects of prior theories on subsequently considered evidence. Journal of Personality & Social Psychology, **37**, 2098-2110.

Maher, B. & Ross, J.S. (1984) Delusions. In, H.E. Adams & P. Sutker (eds) Comprehensive Handbook of Psychopathology. Plethum: New York.

Maher, B.A. (1974) Delusional thinking and perceptual disorder. Journal of Individual Psychology, **30**, 98-113.

Maher, B.A. (1988) Anomalous experience and delusional thinking: the logic of explanations. In, T.F. Ottmanns & B.A. Maher (eds) Delusional Beliefs. Wiley: New York.

McCormick, D.J. & Broekema, V.J. (1978) Size estimation, perceptual recognition and cardiac response rate in cute paranoid and non-paranoid schizophrenics. Journal of Abnormal Psychology, **87**, 385-398.

McCreery, C.A.S. & Claridge, G.A. (1995) Out-of-body experiences and personality. Journal of the Society for Psychical Research, **60**, 129-148.

McKenna, P.J., Mortimer, A.M. & Hodges, J.R. (1994) Semantic memory and schizophrenia. In, A.S. David & J.C. Cutting (eds) The Neuropsychology of Schizophrenia. Lawrence Erlbaum: Hove.

Meehl, P. (1962) Schizotaxia, schizotypy, schizophrenia. American Psychologist, **17**, 827-838.

Mortimer, A.M., Bentham, P., McKay, A.P., Quemada, I., Clare, L., Eastwood, N. & McKenna, P.J. (1996) Delusions in schizophrenia: A phenomenological and psychological exploration. Cognitive Neuropsychiatry, **1, 4**, 289-303.

Mullen, P. (1979) Phenomenology of disordered mental function. In, P. Hill, R. Murray & G. Thorley (eds) Essentials of Post-Graduate Psychiatry. Academic: London.

Nims, J.P. (1959) Logical reasoning in schizophrenia: the Von Domarus principle. Unpublished doctoral dissertation. University of Southern California.

Persons, J.B. (1986) The advantages of studying psychological phenomenon rather than psychiatric diagnosis. American Psychologist, **41**, 1252-1260.

Peters, E., Day, S. & Garety, P. (1997) From preconscious to conscious processing: Where does the abnormality lie in delusions? Schizophrenia Research, **24**, 120.

Peters, E., Day, S., McKenna, J. & Orbach, G. (1999a) Delusional Ideation in psychotic and religious populations. British Journal of Clinical Psychology, **38**, 83-96.

Peters, E., Joseph, S. & Garety, P. (1999b) The measurement of delusional ideation in the normal population: Introducing the PDI (Peters *et al.* Delusions Inventory). Schizophrenia Bulletin, **25**, **3**, 553-576.

Platt, R.D. & Griggs, R.A. (1993) Facilitation in the abstract selection task: The effects of attentional and instructional factors. The Quarterly Journal of Experimental Psychology, **46A**, **4**, 591-613.

Richardson, J.T. (1995) Cult definitions: From sociological-technical to popular-negative. Review of Religious Research, **34**, 348-356.

Romme, M.A.J. & Escher, A. (1989) Hearing voices. Schizophrenia Bulletin, **15**, 209-216.

Ross, L. & Anderson, C.A. (1982) Shortcomings in the attribution process: on the origins and maintenance of erroneous social assessment. In, K. Kahneman, P. Slovic, & A. Tversky (eds) Judgement Under Uncertainty: Heuristics And Biases. Cambridge University Press: New York.

Salzinger, K. (1984) The immediacy hypothesis in a theory of schizophrenia. In, W.D. Spalding & J.K. Cole (eds) Theories of Schizophrenia and Psychosis: Nebraska Symposium on Motivation. University of Nebraska Press: Lincoln.

Shallice, T., Burgess, P.W. & Frith, C.D. (1991) Can the neuropsychological case study approach be applied to schizophrenia? Psychological Medicine, **21**, 661-673.

Sharp, H.M., Fear, C.F. & Healy, D. (1997) Attributional style and delusions: an investigation based on delusional content. European Psychiatry, **12**, 1-7.

Sharp, H.M., Fear, C.F., Williams, J.M.G., Healy, D., Lowe, C.F., Yeadon, H. & Holden, R. (1996) Delusional phenomenology: dimensions of change. Behaviour Research & Therapy, 34, 123-142.

Simpson, J., Done, J. & Vallee-Tourangeau, F. (1998) An unreasoned approach: A critique of research on reasoning and delusions. Cognitive Neuropsychiatry, **3**, **1**, 1-20.

Slade, P.D. & Bentall, R.P. (1988) Sensory Perception: A Specific Analysis of Hallucination. Croom Helm: London.

Strauss, J.S. & Carpenter, W.T. (1981) Schizophrenia. Plenum: New York.

Swanson, J.W., Borum, R., Swartz M. et al (1996) Psychotic symptoms and disorders and the risk of violent behaviour in the community. Criminal Behaviour & Mental Health, **6**, 309-329.

Thalbourne, M.A. (1994) Belief in the paranormal and its relationship to schizophrenia-relevant measures: A confirmatory study. British Journal of Clinical Psychology, **33**, 78-80.

Tschirgi, J.E. (1980) Sensible reasoning: a hypothesis about hypothesis. Child Development, **51**, 1-10.

Varma, S.L. & Sharma, I. (1993) Psychiatric morbidity in the first degree relatives of schizophrenic patients. British Journal of Medical Psychology, **34**, 151-155.

Von Domarus, E. (1944) The specific laws of logic in schizophrenia. In, J. Kasanin (ed.) Language & Thought in Schizophrenia. University of California Press: Berkeley, California.

Wason, P.C. (1960) On the failure to eliminate hypotheses in a conceptual task. Quartley Journal of Experimental Psychology, **12**, 129-140.

Wason, P.C. & Johnson-Laird, P.N. (1972) Psychology of Reasoning: Structure & Content. Batsford: London.

Wason, P.C. & Shapiro, D (1971) Natural and contrived experience in a reasoning problem. Quarterly Journal of Experimental Psychology, **23**, 63-71.

Webster, D.M. & Kruglanski, A.W. (1994) Individual differences in need for cognitive closure. Journal of Personality and Social Psychology, **67, 6**, 1049-1062.

Wessely, S., Buchanan, A., Reed, A., Everitt, N., Garety, P., Cutting, J. & Taylor, P. (1993) Acting on delusions (I): Prevalence. British Journal of Psychiatry, **163**, 69-76.

Wing, J.K., Cooper, J.E. & Sartorious, N. (1974) The Measurement And Classification Of Psychiatric Syndromes. Cambridge University Press: Cambridge.

World Health Organisation (1973) The International Pilot Study of Schizophrenia. WHO: Geneva.

Young, H.F. & Bentall, R.P. (1995) Hypothesis testing in patients with persecutory delusions: comparison with depressed and normal subjects. British Journal of Clinical Psychology, **34**, 353-369.

Young, H.F. & Bentall, R.P. (1997a) Probabilistic reasoning in deluded, depressed and normal subjects: effects of task difficulty and meaningful versus non-meaningful material. Psychological Medicine, **27**, 455-465.

Young, H.F. & Bentall, R.P. (1997b) Social reasoning in individuals with persecutory delusions: The effects of additional information on attributions for the observed behaviours of others. British Journal of Clinical Psychology, **36**, 569-573.

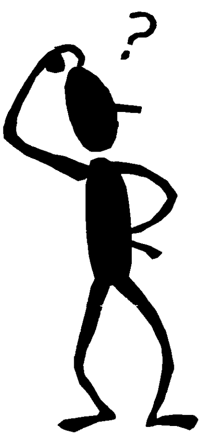
Zigmond, A.S. & Snaith, R.P. (1983) The hospital anxiety and depression scale. Acta Psychiatrica Scandinavia, **67**, 361-370.

Zimbardo, P.G., Anderson, S.M. & Kabat, L.G. (1981) Induced hearing deficit generates experimental paranoia. Science, **212**, 1529-1531.

APPENDICES

Appendix A: Advertisement for Volunteers From Psychic College

VOLUNTEERS NEEDED



I am looking for volunteers, who have psychic beliefs or have had psychic experiences, to take part in a study that is looking at the relationship between people's beliefs and the way that they solve problems and make decisions.

I am investigating the idea that people who have a high degree of open-mindedness solve problems in a different way from those who have not.

If you decide to take part in the study you will be given a number of simple problem-solving tasks and you will be asked to fill in some questionnaires about your views on life, and the way you make decisions, all of which would take just over an hour. I am able to pay people £10 for their time. All interviews will be anonymous and entirely confidential.

If you are interested please contact:

Patricia Thornton, Clinical Psychologist in Training, Sub-department of Clinical Health Psychology, University College London, Gower Street, London, WC1E 6BT. Tel. **07957 326 399**, or **0171 6095836** or email: **pat@thornton99.fsnet.co.uk**

Appendix B: Letter of Permission From UCL/UCLH Ethics Committee

UCL
HOSPITALS

The University College London Hospitals

The Joint UCL/UCLH Committees on the Ethics of Human Research

Committee Alpha Chairman: Professor André McLean

Please address all correspondence to:
Mrs Iwona Nowicka
Research & Development Directorate
9th Floor, St Martin's House
140 Tottenham Court Road, LONDON W1P 9LN
Tel. 0171- 380 9579 Fax 0171-380 9937
e-mail: i.nowicka@academic.uclh.nthames.nhs.uk

Dr E Peters
Lecturer
Sub-Department of Clinical Health Psychology
UCL
Gower Street

31-Mar-99

Dear Dr Peters

Study No: **99/0074** *(Please quote in all correspondence)*
Title: **The relationship between reasoning & thinking styles.**

I have reviewed the above application and agreed it by Chairman's Action. You may go ahead with your research.

Please note that it is important that you notify the Committee of any adverse events or changes (name of investigator etc) relating to this project. You should also notify the Committee on completion of the project, or indeed if the project is abandoned. **Please remember to quote the above number in any correspondence.**

Yours sincerely

I. Nowicka

pp. Richard Rawles
Vice Chairman

The Maudsley
Advancing mental health care

Appendix C: Letter of Permission From Bethlem and Maudsley Ethical Committee

The Bethlem *and* Maudsley NHS Trust

ETHICAL COMMITTEE (RESEARCH)

Tel: (0171 919) 2892

22 October, 1998

Prof R Murray
Dept. of Psychological Medicine
Institute of Psychiatry

Maudsley Hospital
Denmark Hill
London SE5 8AZ
Telephone 0171 703 6333
Fax 0171 919 2171

Dear Prof Murray

Re: An investigation of reasoning abnormalities in people with delusions (146/98)

The Ethical Committee (Research) considered and approved the above study at its meeting on 16 October 1998.

Initial approval is given for one year. This will be extended automatically only on completion of annual progress reports on the study when requested by the EC(R). Please note that as Principal Investigator you are responsible for ensuring these reports are sent to us.

Please note that projects which have not commenced within two years of original approval must be re-submitted to the EC(R).

Please let me know if you would like to nominate a specific contact person for future correspondence about this study.

Any serious adverse events which occur in connection with this study should be reported to the Committee using the attached form.

Please quote Study No. 146/98 in all future correspondence.

Yours sincerely,

Margaret M Chambers

Margaret M Chambers
Research Ethics Coordinator

The Bethlem and Maudsley NHS Trust
Registered address
Bethlem Royal Hospital
Monks Orchard Road
Beckenham, Kent BH3 3BX
Patron: HRH Princess Alexandra
The Hon. Lady Ogilvy, GCVO

Working in association with
Institute of Psychiatry

93
8.9.99

RESEARCH AND DEVELOPMENT OFFICE

(Mailbox 121) 2nd Floor, Mint Wing, St Mary's Hospital, Praed Street, London W2 1NY

Direct Line R&D: 0171-886 1330/2014 Ethics: 0171-886 6514 Fax: 0171-886 1529

Appendix D: Letter of Permission From St Mary's Local Research Ethics Committee

September 27, 1999

Patricia Thornton
34b Witherington Road
Highbury
London
N5 1PP

Dear Ms Thornton

99/X0092 The relationship between reasoning and thinking styles.
R&D NUMBER MUST BE USED IN ALL COMMUNICATIONS

On behalf of the members I am pleased to say that the above project has now been approved by the St Mary's Local Research Ethics Committee (LREC). This approval is given on the understanding that the research team will observe strict confidentiality over the medical and personal records of the participants. It is suggested that this be achieved by avoidance of the subject's name or initials in the communication data. In the case of hospital patients, this can be done by using the hospital record number and in general practice, the National Insurance number or a code agreed with the relevant GP.

It should be noted:

- The Committee's decision does not cover any resource implications which may be involved in your project.

- The LREC should be informed of any untoward development, amendments or changes in protocol that may occur during the course of your investigations, quoting the above R&D number in any correspondence.

Research documents approved	Date of circulation	Date of approval
LREC Application form	8.9.99	27-Sep-99
Consent form and information sheet	8.9.99	27-Sep-99

Chairman's initials

The St Mary's NHS Trust comprises:
St Mary's Hospital, the Western Eye Hospital, and acute services at St Charles Hospital

99/X0092 The relationship between reasoning and thinking styles.
Dr Peters, Patricia Thornton, and Yvonne Linney, Psychologists ...

- Where research involves computer data, this may be subject to the Data Protection Act.

- The GPs of any volunteers taking part in research projects should be aware of their patients' participation.

- Every care should be taken to obtain the volunteers' informed consent to participate in the research project with the necessary help being provided for volunteers with language difficulties.

The Research & Development Office will be monitoring your project frequently. If you have need to contact us further regarding your project, please quote the R&D number as specified in the heading.

Yours sincerely

Dr Rodney Rivers
Chairman

Appendix E: Participant Information Sheet

INFORMATION SHEET:

TITLE OF STUDY: THE RELATIONSHIP BETWEEN REASONING & THINKING STYLE

I am inviting you to take part in a research study looking at the relationship between the way that you think about things and reasoning. If you decide to take part in the study you will be given a number of problem solving/reasoning tasks and you will be asked some questions about your views on life. This should not take any longer than two hours and you will be able to divide this up and do it on separate occasions if you want to. We will also be asking your doctor for permission to look at your medical records. If you decide to take part in this study you will be paid an honorarium of £10 which you will receive when the testing is finished.

All information that you give us will remain strictly confidential. When the information is stored on computer and when the results are written up your name will not be included.

You do not have to take part in the study if you do not want to. If you decide to take part you may withdraw at any time without having to give a reason. Your decision whether to take part will not affect your care and management in any way.

Please ask if there is anything you do not understand or if you would like more information. You may contact either:

- **Patricia Thornton**, Clinical Psychologist in Training, Sub-department of Clinical Health Psychology, University College London, Gower Street, London, WC1E 6BT. Tel. 07957 326 399

  OR
- **Dr Emmanuelle Peters,** Department of Psychology, Institute of Psychiatry, De Crespigny Park, London, SE5 8AF. Tel. 0171-919-3415

Appendix F: Participant Consent Form

CONSENT FORM:

TITLE OF STUDY: THE RELATIONSHIP BETWEEN REASONING & THINKING STYLE

Before signing the consent form please ensure you have read and answered the following questions:

- Have you read the information sheet about this study? Y/N
- Have you had an opportunity to ask questions and discuss this study? Y/N
- Have you received satisfactory answers to all your questions? Y/N
- Have you received enough information about this study? Y/N
- Which researcher have you spoken to about this study?________________
- Do you understand that you are free to withdraw:
    - * at any time
    - * without giving a reason for withdrawing
    - * without affecting your future medical care? Y/N
- Do you agree to take part in this study? Y/N

I agree to take part in this study outlined in the information sheet:

Signed: ______________________ Date: __________________

Print Name: ______________________

Signature of staff member obtaining consent:______________________

Print Name: ______________________

- **Patricia Thornton**, Clinical Psychologist in Training, Sub-department of Clinical Health Psychology, University College London, Gower Street, London, WC1E 6BT. Tel. 07957 326 399

  OR
- **Dr Emmanuelle Peters,** Department of Psychology, Institute of Psychiatry, De Crespigny Park, London, SE5 8AF. Tel. 0171-919-3415

Appendix G: Modified Need For Closure Scale

N. F. C.

1. Even after I've made up my mind about something, I am always eager to consider a different opinion. *YES/NO*
2. I don't like situations that are uncertain. *YES/NO*
3. I dislike questions that could be answered in many different ways. *YES/NO*
4. I like to have friends who are unpredictable. *YES/NO*
5. I feel uncomfortable when I don't understand the reason why an event occurred in my life. *YES/NO*
6. I feel irritated when one person disagrees with what everybody else in a group believes. *YES/NO*
7. I hate to change my plans at the last minute. *YES/NO*
8. I don't like to go into a situation without knowing what I can expect from it. *YES/NO*
9. When I go shopping, I have difficulty deciding exactly what it is that I want. *YES/NO*
10. When faced with a problem I usually see the one best solution very quickly. *YES/NO*
11. When I am confused about an important issue, I feel very upset. *YES/NO*
12. I tend to put off making important decisions until the last possible moment. *YES/NO*
13. I usually make important decisions quickly and confidently. *YES/NO*
14. I would describe myself as indecisive *YES/NO*
15. I think it is fun to change my plans at the last minute. *YES/NO*
16. I enjoy the uncertainty of going into a new situation without knowing what might happen. *YES/NO*
17. In most social conflicts, I can easily see which side is right and which is wrong. *YES/NO*
18. I tend to struggle with most decisions. *YES/NO*
19. When considering most conflict situations, I can usually see how both sides could be right. *YES/NO*
20. I prefer to socialise with familiar friends because I know what to expect from them. *YES/NO*
21. When thinking about a problem, I consider as many different opinions on the issue as possible. *YES/NO*
22. I like to know what people are thinking all the time. *YES/NO*
23. I dislike it when a person's statement could mean many different things. *YES/NO*
24. It's annoying to listen to someone who cannot seem to make up his or her mind. *YES/NO*
25. I find that establishing a consistent routine enables me to enjoy life more. *YES/NO*
26. I prefer interacting with people whose opinions are very different from mine. *YES/NO*
27. I like to have a place for everything and everything in its place. *YES/NO*
28. I feel uncomfortable when someone's meaning or intention is unclear

to me. *YES/NO*

29. When trying to solve a problem I often see so many possible options that it's confusing. *YES/NO*

30. I always see many possible solutions to problems I face. *YES/NO*

31. I'd rather know bad news than stay in a state of uncertainty. *YES/NO*

32. I do not usually consult many different opinions before forming my own view. *YES/NO*

33. I dislike unpredictable situations. *YES/NO*

Appendix H: Instructions for Wason's 2-4-6 Task: Modified Version

"The problem you are going to do now involves trying to guess two rules that govern number principles. One rule will be referred to as the "Dax" rule; the other will be referred to as the "Med" rule. The number triple 2, 4, 6 is an example of the Dax rule. Please write it down in the column marked "Triple" on the sheet in front of you, and in the far right hand columns marked "Dax or Med?" put a tick in the Dax column on the same line as 2, 4, 6."

"To discover the two rules, write down as many other number triples as you like. In each case, predict whether the rule will be Dax or Med by writing either Dax or Med in the centre, "Your prediction?" column on the sheet in front of you. Then I will indicate whether the triple really is Dax or Med by putting a tick under either the Dax or Med column on the far right."

"When you have a guess about either rule, simply stop proposing triples and write the guess on the sheet under the last triple you proposed. I will not tell you whether any of your guesses are correct until the task is over; it is up to you to decide whether you have correctly guessed the Dax and Med rules or not. You may make as many guesses as you like and you may continue proposing triples to test your written guesses until you are sure one of them is correct. I will also be timing you while you are doing this task, but this is not important. Take as long as you like and let me know when you think you know what the rules are."

Appendix I: Instructions for the Beads Task: Part 1

"Jar A has 85 yellow beads and 15 black beads. Jar B has 85 black beads and 15 yellow beads. I am going to hide the jars from you and choose one of them to use. I will not use the other jar at all. I will show you the beads from the jar I have chosen. I will show you one bead at a time and then put it back and choose another one. I want you to tell me when you have decided which jar I have picked. You can see as many beads as you like before you make your decision. I want you to be absolutely certain."

Appendix J: Instructions for the Beads Task: Part 2

"Jar A has 85 red beads and 15 green beads. Jar B has 85 green beads and 15 red beads. I am going to hide the jars from you and pick one to use. I will not use the other jar at all. Again, I am going to show you beads from the chosen jar one at a time, putting each bead back after I have shown it, and picking another one. However, this time I want you to indicate on the scale how likely you think it is that Jar A has been chosen as opposed to Jar B. I want you to do this each time I show you a bead. (This time I will show you 10 beads only)."

How likely is it that Jar A has been chosen?

(Jar A is mainly red beads)

Bead 1:

JAR A HAS DEFINITELY **NOT BEEN** CHOSEN	equally likely	JAR A HAS DEFINITELY **BEEN** CHOSEN

Appendix K: Contents of Flats Envelopes

2 Conditions

	W	**X**	**Y**	**Z**
Rent	70	40	70	55
Size of living & dining rooms	Medium	Small	Large	Small

4 Conditions

	A	**B**	**C**	**D**
Rent	40	55	70	40
Size of living & dining rooms	Medium	Large	Medium	Small
Noise level	High	High	Low	Moderate
Day of the week rubbish collected	*Wednesday*	*Thursday*	*Monday*	*Tuesday*

8 Conditions

	E	**F**	**G**	**H**
Rent	40	40	70	70
Size of living & dining rooms	Medium	Medium	Medium	Medium
Noise level	High	High	Low	Low
Day of the week rubbish collected	*Thursday*	*Wednesday*	*Monday*	*Tuesday*
Colour of front door	*Green*	*Brown*	*Green*	*Black*
Furniture Quality	Average	Average	Below average	Average
Distance from work	45 minutes	10 minutes	30 minutes	10 minutes
Cleanliness	Good	Poor	Good	Poor

12 Conditions

	I	**J**	**K**	**L**
Rent	40	70	70	40
Size of living & dining rooms	Large	Medium	Medium	Large
Noise level	High	Low	Low	High
Day of the week rubbish collected	*Tuesday*	*Wednesday*	*Thursday*	*Monday*
Colour of front door	*Green*	*Blue*	*Brown*	*Green*
Furniture Quality	Average	Below average	Average	Above average
Distance from work	45 minutes	10 minutes	45 minutes	30 minutes
Cleanliness	Fair	Fair	Good	Fair
Cupboard storage space	Average	Above average	Below average	Below average
Brightness of room	Poor	Fair	Fair	Fair
Landlady/landlord attitude	Good	Poor	Good	Poor
Availability of ornamental birdcage	*Negotiable*	*Not available*	*Negotiable*	*Available*

Appendix L: Instructions for Flats Task

These envelopes represent four one-bedroomed furnished flats. In the envelopes is a card which gives the information that appears on the outside of the envelope, for example the card in the envelope labelled "rent" will tell you how much per week the flat costs. What I want you to do is decide which flat you would prefer for yourself. You can look at as many or as few envelopes as you like, and you can do whatever you want with the envelopes. You can take the cards out and put the envelopes to one side, or leave them in the envelopes, it doesn't matter. The envelopes don't have to stay in this order, you can mix them up and move the around if you want. I am going to be timing you, but it is not important. I just want to know how long the task takes, so don't rush, work at your own pace and tell me when you have decided which flat you prefer.

Appendix M: Instructions for Wason's Selection Task: Modified Version

"I'm going to read out a story to you where you have to imagine yourself in the situation described. In the story you have to try and make sure that certain rules are being followed. When I have read the story out, I will ask you a question about the rule in the story. I'm going to start reading the story out now so concentrate carefully."

"You are a quality controller employed by a company that manufactures and fits hot and cold water taps to sinks. Recently the company have had a number of complaints from customers saying that both of their taps had blue dots on them. You have asked all recent customers to return information cards to you. Here are four cards recently returned to you. On one side is a red or blue dot while on the other is the word 'hot tap' or 'cold tap'. You have to check that the following rule has been strictly followed. The rule is: **"if the tap is hot it must be marked with a red dot."**

"I will be timing you on this task but this is not important. You can take as long as you want. Don't rush and just let me know when you have decided which cards you want to turn over."

The displayed sides of the cards are: coloured red dot, coloured blue dot, hot tap and cold tap.

"You should now show me the card or cards which you think you would definitely need to turn over to see whether the rule has been broken or not."

"Please say how certain you are about this decision on a scale of 0 to 100, where 0 is not at all certain and 100 is totally certain."

Appendix N: Instructions for the Coin-Tossing Task

"Imagine you are spinning a coin, and recording how often it lands on heads and how often it lands on tails. For each of these examples, please say to what extent you think the coin is not a fair coin."

"I spin a coin 12 times and get "heads" 6 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 4 times and get "heads" 2 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 60 times and get "heads" 30 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 12 times and get "heads" 9 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 4 times and get "heads" 3 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 60 times and get "heads" 45 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 20 times and get "heads" 15 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

"I spin a coin 20 times and get "heads" 10 times. To what extent would you say this is not a fair coin? Please indicate how fair you think this coin is on a scale of 0 to 100, where 0 is totally fair and 100 is totally unfair."

Your answer__________

Appendix O: Scores on the Peters et al. Delusional Inventory, For All Groups, When Controlling For HADS Scores (Estimated Marginal Means & Standard Error Score)

	Clinical Groups		Non-Clinical Groups	
	Deluded (N = 20)[1]	**Non-Deluded (N = 16)**	**High Delusion-Prone (N = 21)**	**Low Delusion-Prone (N = 20)**
Total Score	7.77 (0.72)	7.27 (0.85)	9.21 (0.70)	3.95 (0.75)
Dimensions				
Distress Score	15.24 (1.15)	16.71 (1.18)	15.28 (1.15)	4.97 (1.16)
Preoccupation Score	14.92 (1.17)	17.34 (1.20)	15.10 (1.16)	5.01 (1.17)
Conviction Score	27.25 (2.73)	26.82 (3.21)	31.26 (2.66)	10.37 (2.84)
Sum Of Dimensions And Total Score	74.05 (7.19)	69.91 (8.67)	79.81 (7.01)	31.11 (7.49)

[1] One member of the deluded group failed to complete the PDI.

Appendix P: Information on Results of Differences Between Groups on PDI Factors

	Clinical Groups		Non-Clinical Groups	
	Deluded (N = 20)[2]	Non-Deluded (N = 16)	High Delusion-Prone (N = 21)	Low Delusion-Prone (N = 20)
Factors				
Religiosity (range: 0-2)	0.71 (0.85)	1.25 (0.93)	1.14 (0.79)	0.15 (0.37)
Persecution (range: 0-2)	0.86 (0.86)	0.81 (0.91)	0.43 (0.60)	0.20 (0.52)
Grandiosity (range: 0-2)	0.86 (0.96)	0.88 (0.89)	1.10 (0.77)	0.15 (0.49)
Paranormal beliefs (range: 0-2)	1.00 (0.77)	1.06 (0.77)	1.67 (0.58)	0.65 (0.81)
Thought disturbances (range: 0-2)	0.67 (0.66)	0.63 (0.72)	0.67 (0.86)	0.20 (0.41)
Suspiciousness (range: 0-2)	1.19 (0.68)	1.13 (0.72)	1.48 (0.60)	1.25 (0.55)
Catastrophic Ideation & Thought Broadcast (range: 0-2)	0.38 (0.59)	0.44 (0.63)	0.38 (0.59)	0.00 (0.00)
Negative Self (range: 0-2)	0.29 (0.56)	0.25 (0.45)	0.24 (0.54)	0.05 (0.22)
Paranoid Ideation (range: 0-2)	0.62 (0.67)	0.50 (0.52)	0.76 (0.77)	0.15 (0.37)
Ideation of Reference & Influence (range: 0-2)	0.86 (0.65)	0.63 (0.62)	0.86 (0.85)	0.35 (0.49)
Depersonalisation (range: 0-2)	0.33 (0.48)	0.44 (0.51)	0.24 (0.44)	0.20 (0.41)

[2] One member of the deluded group failed to complete the PDI.

Appendix Q: Scores on the Need For Closure Scale, For All Groups, When Controlling For Significant Covariate Effects of HADS or Years of Education (Estimated Marginal Means & Standard Error Score)

	CLINICAL GROUPS		**NON-CLINICAL GROUPS**	
	DELUDED (N = 20)[3]	**NON-DELUDED (N = 16)**	**HIGH DELUSION -PRONE (N = 21)**	**LOW DELUSION -PRONE (N = 20)**
Total Need For Closure Scale score (controlling for education)	18.65 (1.12)	18.06 (1.24)	17.45 (1.30)	16.28 (1.08)
FACTORS				
Discomfort with Ambiguity (controlling for HADS)	6.07 (0.47)	5.00 (0.55)	5.54 (0.46)	4.97 (0.49)
Decisiveness (controlling for HADS)	4.06 (0.45)	4.44 (0.53)	4.20 (0.44)	3.54 (0.47)

[3] One member of the deluded group failed to complete the NFCS.

Appendix R: Flat Chosen For Each Condition, For All Groups (Means & Standard Deviations)

	Clinical Groups		Non-Clinical Groups		
	Deluded (N = 21)	Non-Deluded (N = 16)	High Delusion-Prone (N = 21)	Low Delusion-Prone (N = 20)	Total (N = 78)
Condition 1:					
Flat W	4 (19.0%)	2 (12.5%)	2 (9.5%)	3 (15.0%)	11 (14.1%)
Flat X	4 (19.0%)	3 (18.8%)	7 (33.3%)	4 (20.0%)	18 (23.1%)
Flat Y	11 (52.4%)	10 (62.5%)	11 (52.4%)	13 (65.0%)	45 (57.7%)
Flat Z	2 (9.5%)	1 (6.3%)	1 (4.8%)	0 (0.0%)	4 (5.1%)
Condition 2:					
Flat A	2 (9.5%)	1 (6.3%)	1 (4.8%)	1 (5.0%)	5 (6.4%)
Flat B	5 (23.8%)	6 (37.5%)	2 (9.5%)	2 (10.0%)	15 (19.2%)
Flat C	12 (57.1%)	8 (50.0%)	13 (61.9%)	15 (75.0%)	48 (61.5%)
Flat D	2 (9.5%)	1 (6.3%)	5 (23.8%)	2 (10.0%)	10 (12.8%)
Condition 3:					
Flat E	7 (33.3%)	3 (18.8%)	3 (14.3%)	6 (30.0%)	19 (24.4%)
Flat F	1 (4.8%)	5 (31.3%)	3 (14.3%)	3 (15.0%)	12 (15.4%)
Flat G	10 (47.6%)	5 (31.3%)	5 (23.8%)	8 (40.0%)	28 (35.9%)
Flat H	3 (14.3%)	3 (18.8%)	10 (47.6%)	3 (15.0%)	19 (24.4%)
Condition 4:					
Flat I	4 (19.0%)	4 (25.0%)	5 (23.8%)	1 (5.0%)	14 (17.9%)
Flat J	5 (23.8%)	4 (25.0%)	6 (28.6%)	1 (5.0%)	16 (20.5%)
Flat K	10 (47.6%)	5 (31.3%)	10 (47.6%)	12 (60.0%)	37 (47.4%)
Flat L	2 (9.5%)	3 (18.8%)	0 (0.0%)	6 (30.0%)	11 (14.1%)

Appendix S: Time Taken to Complete Flats Task, Certainty of Decision & Number of Flats Used For Each Condition, For All Groups (Means & Standard Deviations)

	Clinical Groups		Non-Clinical Groups	
	Deluded (N = 21)	**Non-Deluded (N = 16)**	**High Delusion-Prone (N = 21)**	**Low Delusion-Prone (N = 20)**
Time Taken (in seconds)				
Condition 1 (2 items)	77.00	98.60	73.67	52.70
	(38.33)[4]	(71.04)[5]	(28.44)	(16.56)
Condition 2 (4 items)	148.75	110.50	110.25	98.90
	(128.67)[6]	(65.33)	(57.96)[7]	(38.54)
Condition 3 (8 items)	204.38	200.69	218.52	227.10
	(141.06)	(111.58)	(142.46)	(142.02)
Condition 4 (12 items)[8]	264.25	252.06	279.81	317.10
	(176.45)	(212.82)	(157.23)	(180.70)
Certainty (%)				
Condition 1 (2 items)[9]	88.50	82.75	75.86	82.37
	(17.85)	(25.12)	(21.48)	(20.44)
Condition 2 (4 items)[10]	83.15	79.60	79.05	77.47
	(20.78)	(27.93)	(18.28)	(18.41)
Condition 3 (8 items)[11]	85.50	78.00	81.14	82.25
	(20.96)	(24.48)	(21.11)	(15.06)
Condition 4 (12 items)[12]	83.42	83.00	85.76	79.75
	(23.57)	(26.03)	(12.86)	(16.97)
Number of Flats Used (1-4)				
Condition 1 (8 items)	3.57 (0.98)	3.69 (0.87)	3.90 (0.44)	4.00 (0.00)
Condition 2 (16 items)	3.38 (1.15)	3.06 (1.34)	3.90 (0.44)	4.00 (0.00)
Condition 3 (32 items)	3.33 (1.15)	3.19 (1.22)	3.76 (0.77)	4.00 (0.00)
Condition 4 (48 items)	3.10 (1.22)	3.25 (1.24)	3.95 (0.22)	4.00 (0.00)

[4] An outlier (>3 sd from the mean) of 600 seconds was removed from calculations for Condition 1.
[5] An outlier (>3 sd from the mean) of 485 seconds was removed from calculations for Condition 1.
[6] An outlier (>3 sd from the mean) of 600 seconds was removed from calculations for Condition 2.
[7] An outlier (>3 sd from the mean) of 420 seconds was removed from calculations for Condition 2.
[8] Information on time taken was missing for one member of the deluded group for Condition 4.
[9] Information on certainty was missing for one member of the deluded group, and one low PDI participant on Condition 1.
[10] Information on certainty was missing for one member of the deluded group, one from the clinical non-deluded group, and one low PDI participant on Condition 2.
[11] Information on certainty was missing for one member of the deluded group, and one from the clinical non-deluded group for Condition 3.
[12] Information on certainty was missing for two members of the deluded group, and one from the clinical non-deluded group for Condition 4.

Appendix T: Amount of Information Used & Looked At But Not Used, Over Each Condition, For All Groups (Means & Standard Deviations)

	Clinical Groups		Non-Clinical Groups	
	Deluded (N = 20)[13]	**Non-Deluded (N = 15)**[14]	**High Delusion-Prone (N = 21)**	**Low Delusion-Prone (N = 20)**
Amount of Information Used				
Condition 1 (8 items)	5.00 (2.47)	5.67 (2.32)	5.86 (2.24)	6.60 (1.96)
Condition 2 (16 items)	7.65 (4.69)	4.87 (2.64)	7.05 (2.27)	8.50 (3.03)
Condition 3 (32 items)	6.95 (4.64)	6.40 (4.27)	9.81 (4.18)	12.05 (5.58)
Condition 4 (48 items)	7.05 (4.86)	6.73 (3.77)	11.62 (3.71)	14.65 (8.05)
Amount of Information Looked At But Not Used				
Condition 1 (8 items)	1.40 (1.60)	1.00 (1.56)	1.43 (1.91)	1.25 (1.86)
Condition 2 (16 items)	3.15 (3.41)	2.67 (3.72)	3.71 (3.58)	2.20 (2.38)
Condition 3 (32 items)	7.55 (8.79)	4.40 (6.09)	7.71 (6.71)	6.15 (6.52)
Condition 4 (48 items)	8.55 (11.85)	6.73 (10.61)	10.86 (9.63)	11.25 (10.60)

[13] An outlier (>3 sd from the mean) of 36 items of information used in Condition 4 was removed from calculations for 'amount of information used', 'amount of information locked at but not used (including low priority)' and 'amount of information looked at' for all conditions

[14] An outlier (>3 sd from the mean) of 32 items of information used in Condition 4 was removed from calculations for 'amount of information used', 'amount of information locked at but not used (including low priority)' and 'amount of information looked at' for all conditions