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INDUCTIVE REASONING IN PERSECUTORY DELUSIONAL THOUGHT

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INDUCTIVE REASONING IN PERSECUTORY DELUSIONAL THOUGHT

by

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in partial fulfilment for the degree of

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ABSTRACT

Inductive Reasoning in Persecutory Delusional Thought

by Ian Baker

Delusions are considered to be one of the primary symptoms of psychosis but until recently have received little empirical investigation. One approach has been to examine the extent to which deluded individuals demonstrate cognitive biases which are different from those of normal controls in inductive reasoning tasks. In this study two hypothesis testing tasks were used to investigate cognitive biases in a group of people with persecutory delusions compared to a group whose delusions had remitted and a normal control group. Participants completed two tasks consisting of a series of visual discrimination problems in which they had to choose between pairs of stimuli presented on cards. Condition 1 examined previously reported biases of deluded participants requiring less information before making judgements and being overconfident in their judgements. Positive or negative feedback was given after every card and participants were unconstrained in giving solutions. Condition 2 partially replicated Young and Bentall's (1995) hypothesis testing study and examined participants' ability to process information sequentially and progressively focus down the set of possible correct solutions. Feedback was restricted and participant responding was constrained.

No differences were found between groups in condition 1. In condition 2 deluded participants produced fewer hypothesis and sampled from a smaller range of hypotheses than remitted and control participants. Deluded participants also produced fewer correct hypotheses than the other groups. A trend was found for deluded participants to use fewest sensible responses to feedback, followed by remitted and control groups. The reverse trend was found for use of nonsensical responses to feedback. Limitations of the study, implications for clinical practice and suggestions for future research are considered.

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AUTHOR'S DECLARATION

At no time during the registration for the degree of Doctor of Clinical Psychology has the author been registered for any other University award.

The contents of this volume are identical to the volume submitted for examination in temporary binding except for the amendments requested at the examination.

This study was conducted while the author was a Trainee Clinical Psychologist in the South West Region in East Gloucestershire NHS Trust and Severn NHS Trust. The research was conducted in collaboration with East Gloucestershire NHS Trust.

Signed.....Iws Baker.....

Dated.....10 JULY 1997.....

1.1 Overview

The introduction aims to review a wide range of research about delusions and reasoning in order to produce testable predictions about the cognitive processes of individuals with persecutory delusions. Although delusions are regarded as the hallmark of psychotic disorders surprisingly little is known about the psychological processes involved in their formation and maintenance. It is argued here that the role of cognitive bias is an important factor in delusional thought and that there are similarities to what is known in the much more fully investigated area of reasoning in 'normal' individuals. It is proposed that cognitive biases will be evident in hypothesis testing tasks in deluded participants.

The literature review examines traditional definitions of delusions together with the most influential conceptual issues. An outline of the major classifications of delusions is given. It is argued that traditional psychiatric conceptions are inadequate to account for the complexity of delusional thought and associated problems are discussed.

A number of theories of delusion formation are considered. It is argued that delusional thought is likely to comprise of a number of factors but heuristic judgement and cognitive biases are necessary elements. Studies of reasoning in normal individuals are briefly discussed to provide a context in which to compare reasoning in deluded individuals. This is followed by a review of empirical reasoning studies with deluded participants using inductive reasoning tasks and attribution theory. This provides the rationale for the present study and the resultant experimental hypotheses.

1.2 Definitions and classifications

The definition and concept of delusions have been written about extensively and are often accepted without criticism. Attempts to provide classifications of delusions have also been numerous and fall into two broad categories: quantitative and qualitative. Quantitative classifications (e.g. Wing Cooper and Sartorius (1974) and Spitzer and Endicott (1978)) are descriptive in nature and have sought to identify and measure the content of delusions without considering distinctions in pathology or underlying process. In contrast qualitative classifications (e.g. Bluemel (1950), Jaspers (1963), Mayer-Gross, Slater and Roth (1960) and Schneider (1959)) involve the attempt to distinguish subtypes of delusions on the bases of theoretical explanations of underlying processes.

Jaspers (1963) provides the most influential theoretical account of delusions and his ideas still dominate contemporary psychiatric definitions. Jaspers proposed that delusion is a term that can be applied to all false judgements which are characteristically

- i) held with extraordinary conviction, with an incomparable subjective certainty
- ii) maintained imperviously to other experiences and compelling counter-arguments, and
- iii) have impossible content.

Jaspers argues that a delusion is a primary phenomenon which constitutes a transformation of one's total awareness of reality; it is entirely outside the normal range of experiences and so is impossible to understand and is qualitatively different from any normal

experience. For Jaspers this contrasts with affective disorders of anxiety and depression which are exaggerated forms of normally encountered states.

Jaspers makes the distinction between primary delusions which are psychologically irreducible and result from a pathological experience or personality change and secondary delusions which can be understood in the light of related affect. Jaspers describes three sub-groups of delusions:

- i) delusional perception
- ii) delusional idea or notion, and
- iii) delusional awareness.

Fundamental to Jaspers' understanding of delusions is the incorrigibility of the belief. It is the absolute refusal to alter or modify beliefs despite subsequent reflection or external criticism that contrasts the deluded person with someone merely holding a different view from that of the majority. Although Jasper's work has been criticised it is important to outline his ideas in some detail as he fundamentally influenced the way in which delusions are conceptualised. Current psychiatric understanding of delusions still relies heavily on Jasper's work and recent writing in this area has added little to his ideas. Delusions are commonly defined as absolute, discrete and discontinuous in nature.

1.2.1 Diagnostic interviews and systems

The Present State Examination (PSE) schedule (Wing, Saratorius and Cooper, 1974) is a structured interview containing 22 categories of delusion e.g. reference, persecution, morbid jealousy. Delusions are defined as either primary or secondary and are rated as having partial or full conviction. The Research Diagnostic Criteria (RDC) (Spitzer,

Endicott and Robins, 1978) provides a similar system of descriptive classification to the PSE and provides a list of criteria for 26 categories of delusions.

The Diagnostic and Statistical Manual of Mental Disorders 3rd edition (DSM-III APA, 1987) definition of delusion illustrates the dichotomy made between normal and deluded thought:

Delusion. A false personal belief based on incorrect inference about external reality and firmly sustained in spite of what almost everyone else believes and in spite of what constitutes incontrovertible and obvious proof or evidence to the contrary. The belief is not one ordinarily accepted by other members of the person's subculture (i.e. it is not an article of religious faith).

Delusions are referred to frequently in the ICD-10 Classification of Mental and Behavioural Disorders (World Health Organisation, 1992) particularly in the categories F20-F29 - schizophrenia, schizotypal and delusional disorders. However as Sims (1991) comments the term delusion is not defined at any point and this has potentially serious implications for the effectiveness of this system.

1.2.2 Problems in definition

A number of authors have commented on the problems inherent in the traditional definition and conceptualisation of delusion (Strauss, 1969; Garety, 1985). These difficulties can be grouped into three main themes.

1. A delusion is a false belief or idea

Moor and Tucker (1979) argued that the existing criteria of falsity and deviance of delusional beliefs were inadequate. They note that false beliefs are commonly held and if this were a sufficient condition for being deluded then the vast majority of people would be have to be regarded as deluded. They suggest that false beliefs may signify the presence of delusion but it should not be regarded as a defining condition. Assessing the deviance of a belief is also problematic in that it is difficult to know what 'normal' beliefs should be used for comparison. Cultural relativity is a significant issue in this respect and Moor and Tucker also suggest that if the deviant belief view is accepted, psychiatric diagnosis may be used to repress dissenting political minority views.

2. Delusional beliefs are not amenable to reason or counterargument and are not modifiable by experience.

Until comparatively recently it was generally considered pointless to engage with deluded individuals about their delusional beliefs (Slater and Roth, 1969, cited in John and Dodgson, 1994). However a growing body of research has shown that deluded beliefs can be modified by psychological interventions and that there are valid empirically based reasons for rejecting the view that delusions are never capable of modification (e.g, Watts, Powell and Austin, 1973; Chadwick and Lowe, 1990; Fowler and Morley, 1989; Kingdon and Turkington, 1991).

This type of psychological approach is still in its infancy and its effectiveness and application are still being investigated. The cognitive approach to modifying delusional thought is based on similar assumptions to those in the treatment of depression. A

collaborative approach is emphasised and attempts are made to identify the cognitive schemata serving to maintain beliefs and to access associated emotions. Alternative evidence is considered to explain the phenomena relevant to the delusion and beliefs are challenged with the aim of providing more adaptive interpretations.

3. A delusion is held with absolute conviction

An influential paper by Strauss (1969) based on empirical work showed that many delusions are not held with absolute conviction. He argued that it would be more useful to conceptualise delusions as points on a continuum with normal functioning. Strauss suggests three factors which seem important to distinguish between delusions and self-deception: degree of conviction, time preoccupied with the belief, and implausibility of the claim. When conceptualised in this way delusion becomes a matter of degree. At one end of the spectrum are relatively common beliefs referred to as self-deceptions and at the other end delusional beliefs which are characterised by high levels of conviction, preoccupation and implausibility.

The approach of seeing delusions on a continuum with normal functioning has important implications both theoretically and practically. It implicitly suggests that individuals can move along the continuum towards normally held self-deceptions, and so makes possible techniques that would be discounted with a fixed and discrete view of symptoms. This view has been adopted by a number of researchers (Hole et al., 1979; Chapman and Chapman, 1980; Kendler *et al.*, 1983; Garety, 1985; and Brett-Jones, Garety and Hemsley, 1987).

Garety (1985) and Brett-Jones, Garety and Hemsley (1987) highlight problems inherent in trying to operationalise definitions of delusions and the need to question some previously held assumptions. The latter study devised a questionnaire to evaluate systematically delusional experience and found delusions to be multidimensional in character. Delusions were evaluated in categories of Conviction, Preoccupation, Inference, Reaction to hypothetical contradiction and Accommodation. Delusions were found to be markedly desynchronous and lacking co-variance between the different categories of beliefs.

It therefore appears that traditional psychiatric definitions and conceptualisations are in themselves inadequate to account for delusional thought. Delusions are more accurately seen as multi-dimensional in nature and on a continuum with normality. The definition of delusion in DSM-IV (APA, 1994) reflects this more complex view. Delusional belief is defined 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 or evidence to the contrary. The belief is not one ordinarily accepted by other members of the person's culture or subculture (e.g. it is not an article of religious faith). When a false belief involves a value judgement, it is regarded as a delusion only when the judgement is so extreme as to defy credibility. Delusional conviction occurs on a continuum and can sometimes be inferred from an individual's behaviour. It is often difficult to distinguish between a delusion and an overvalued idea (in which case the individual has an unreasonable belief or idea but does not hold it as firmly as is the case with a delusion).

1.3 Theoretical explanations of delusions

Theories of delusion formation are numerous and have been generated from most psychological perspectives. Very little empirical research however has been carried out to test these theories (Winters and Neale, 1983). Most perspectives do not agree that delusions are psychologically irreducible and see them as secondary to more fundamental abnormalities e.g. of affect, personality, unconscious wishes, perception or judgement or organic impairment.

1.3.1 Disturbance in affect

A few early theorists argued that exaggerated affect was the cause of delusional thinking. Stocker (1940, cited in Arthur, 1964) reasoned that delusions could be traced to four affects - depressive, manic, anxious and suspicious. This and other early theories suggest that certain affective states cause delusional beliefs. Although many theorists regard affect as relevant either to the content of a delusion or to its formation and maintenance very little recent work has examined the direct relationship between affect and delusion.

1.3.2 Psychoanalytic theories

Psychoanalytic writers have provided the most extensive theoretical work about delusions. The most prominent psychoanalytic theory of delusion uses the concept of projection (e.g. Freud, 1915). Delusions are regarded as symptoms which act as projections of personal wishes, conflicts or fears to an external source. Freud argued that delusions of paranoia and grandiosity are the product of repressed homosexual impulses which are striving for expression. Winters and Neale (1983) review a number of studies which attempt to test

Freud's repressed homosexuality theory and concluded that the results are weak and conflicting.

More contemporary psychoanalytic theorists postulate that delusions reflect the memories, affects and the phantasies of the individual before they succumbed to psychosis (Freeman, 1981, 1990; Nelki, 1988). These phantasies existed because anxiety or guilt prevented a satisfactory outlet for instinctual wishes either directly or in sublimated form.

1.3.3 Deficits in perception

Early theorists viewed delusions as the individual making logical inferences about altered body sensations or perception (Winters and Neale, 1983). The modern advocate of this view is Maher (1974, 1988) who proposed that delusions result from a primary perceptual abnormality, which is biological in nature, and that involves vivid and intense sensory input. The individual experiencing these abnormal perceptions then seeks an explanation using normal cognitive mechanisms. In support of this view Maher cites evidence from the study of normal subjects under anomalous environmental conditions which suggests that irrational beliefs can be provoked. Building on earlier reports of an association between hearing loss and paranoid delusions in the elderly (Cooper *et al.*, 1974) and in late onset schizophrenia (Kay *et al.*, 1976), Zimbardo *et al.*, (1981) proposed that a loss of auditory acuity, if unacknowledged, could be interpreted as other people whispering unfavourable things. It has also been proposed that delusions of misidentification result from disorders of facial recognition (Ellis and Young, 1990).

Arthur (1964) notes that many theorists have assumed that some delusions are secondary to the experience of hallucinations and this is the view implicit in much contemporary

psychiatric literature (e.g. DSM-IV). The most comprehensive work investigating hallucinations was carried out by Slade and Bentall (1988) who identified a central process distinguishing between internally (imagined) and externally generated events. They argue that hallucinations result from a failure in the skill of reality discrimination. It is therefore not the perception itself which leads to the experience of hallucinations but an inferential error made on the basis of that information.

Although the abnormal perceptual theory has some appealing features it has been argued that it is essentially incomplete (Bentall, 1994). It is apparent that delusions often develop in the absence of any abnormal perception or experience (Chapman and Chapman, 1980). The theory also fails to explain why a delusional interpretation is offered for an unusual sensory experience when there are other more natural explanations which could easily be considered .

1.3.4 Deficits in attention and consciousness

Some researchers investigating schizophrenia have argued that delusions and other positive symptoms are the result of disorders of attention or consciousness. Hemsley (1993) proposed that the basic psychological dysfunction that characterises schizophrenia is a “weakening of the influences of stored memories of regularities of previous input on current perception”. Individuals with schizophrenia are therefore less able to make use of the redundancy and patterning of sensory input to reduce information processing demands.

Frith (1979) proposed that the symptoms of schizophrenia are the result of a defect in the mechanism that controls and limits the contents of consciousness. This ‘filter’ theory can be understood in terms of excessive self-awareness. Individuals with schizophrenia

become conscious of perceptions that normally would remain preconscious. Frith argues that this initiates an attempt for explanation of these percepts using normal reasoning. Delusions as well as thought disorder and auditory hallucinations may then result. Delusions may occur on the basis of hallucinatory experiences but also as a result of attention being captured by incidental details of the environment.

Frith's (1987, 1992) more recent accounts of the positive symptoms of schizophrenic psychopathology centre on the hypothesis that willed intentions are not monitored correctly. Frith argues that there are two mechanisms involved in a central monitoring system. The first is operated by an external stimulus and in consultation with long-term memory, a stimulus intention is formed that can lead to an appropriate action. In Frith's formulation this process is not disturbed in schizophrenia.

In the second route to action current goals or plans in conjunction with long-term memory form a willed intention. Frith argues that a failure to monitor intentions to act would result in delusions of control, thought insertion and thought control. This results from a disruption of intentionality, where thinking without awareness occurs, and so thoughts are interpreted as alien and having been inserted into the mind. Similarly if an individual is unable to distinguish between events caused by their own actions and those generated externally then confusion in attributing the source of events is likely to occur. One result of this error may be the experience of auditory hallucinations in which the person hears a voice not recognised to be their own.

Morris (1997) linked the concept of cognitive monitoring and intentionality to the idea of locus of control. The paper extends the idea of faulty monitoring to a wide range of abnormal experiences. Morris proposes that internally initiated behaviour which is

monitored as unintentional may explain passivity symptoms such as conversion disorder, somatisation disorder, delusion of control and depersonalisation. Conversely where monitoring signals behaviour to be internally initiated and controlled, but in reality it is externally controlled, it is argued that this may account for among other things, delusional guilt and delusions of grandiosity and persecution. Morris concludes that the most serious implication of viewing delusions in this way is that they would be amenable to treatment by psychological intervention. He suggests possible treatment may include providing discrimination training, counselling individuals to avoid situations which avoid faulty monitoring and the use of cognitive therapy to change beliefs arising from faulty monitoring.

1.3.5 Neuropsychological theories

Delusions have been associated with a fairly wide spectrum of cerebral disorders. Cutting (1985) argues that in some cases of schizophrenia, delusions may be caused by damage to right or left parietal lobe. He discusses statistical findings that there is evidence of an association between individuals with paranoid delusions and delusions of reference and lesions to the left temporal lobe (Toone *et al.*, 1982). Cutting developed ideas about right parietal lobe damage and delusion formation caused by problems in perception. He uses the examples of Capgras syndrome and anosognosia. Capgras syndrome is the delusional belief that a familiar person has been replaced by a double. Anosognosia is the belief that an obvious physical disability that is present in the person does not exist. Cutting argues that a link exists between these disorders and visual agnosia caused by organic brain damage so inferring an underlying perceptual disorder.

McKenna (1987, 1991) argues that delusions are the result of an organic brain dysfunction impairing long term memory. He reasons that delusions are the consequence of dysfunction in the neural correlates implicated in memory. He cites studies implicating the hippocampus and related structures of the limbic system and the prefrontal cortex (e.g. Squire, 1987; Baddeley and Wilson, 1987) which are involved in the formation and storage of long term memory. These neuroanatomical structures believed to be implicated have come to form a well defined complex known as the septo-hippocampal system (SHS). The most comprehensive formulation of the SHS and its basis for a theoretical model of schizophrenia was produced by Gray, Feldon, Rawlins, Hemsley and Smith (1991). McKenna (1991) extended the work by Gray *et al* (1991) to speculate how the SHS might be involved specifically in delusional thought.

A large number of experimental animal studies have concluded that the SHS has no simple motor, sensory, learning or emotion function. It appears that in a general way the SHS facilitates efficiency and flexibility in learning. Animals with damaged SHSs display complex behavioural changes with increased tendency to perseveration and disinhibition. The animals still maintain the ability to learn and unlearn but the process is slower and more insensitive. Gray *et al* (1991) propose that the function of the SHS is to compare actual sensory data with expected predictions of what should be the case based on past experience. If actual and expected match the SHS has a passive role allowing current motor responses to occur as planned. If there is a mismatch between actual and expected the SHS takes over active control of behaviour and the engaged motor plan is inhibited, arousal sharply increases and alternative behaviours are instigated to attempt to resolve the discrepancy. In a less clear way the system also acts in the storage and updating of information about the relationships between events and their consequences.

McKenna (1991) argues that a neglected aspect of Gray *et al's* (1991) account is a consideration of the behavioural consequences of the SHS becoming damaged by excessive dopaminergic activity and becoming abnormally biased to its passive match function. He argues that this would be consistent with the subjective experience of delusions. Neutral stimuli would be erroneously identified as important and so acquire abnormal significance; there would be a tendency for expected to be falsely judged as matching actual and so predictions would be erroneously verified as correct; falsely matched information would be passed on and stored so altering the stored regularities used to make future predictions and plans for motor behaviour would continue to be elaborated although they would be inappropriate for the environmental stimulus.

1.3.6 Abnormal reasoning

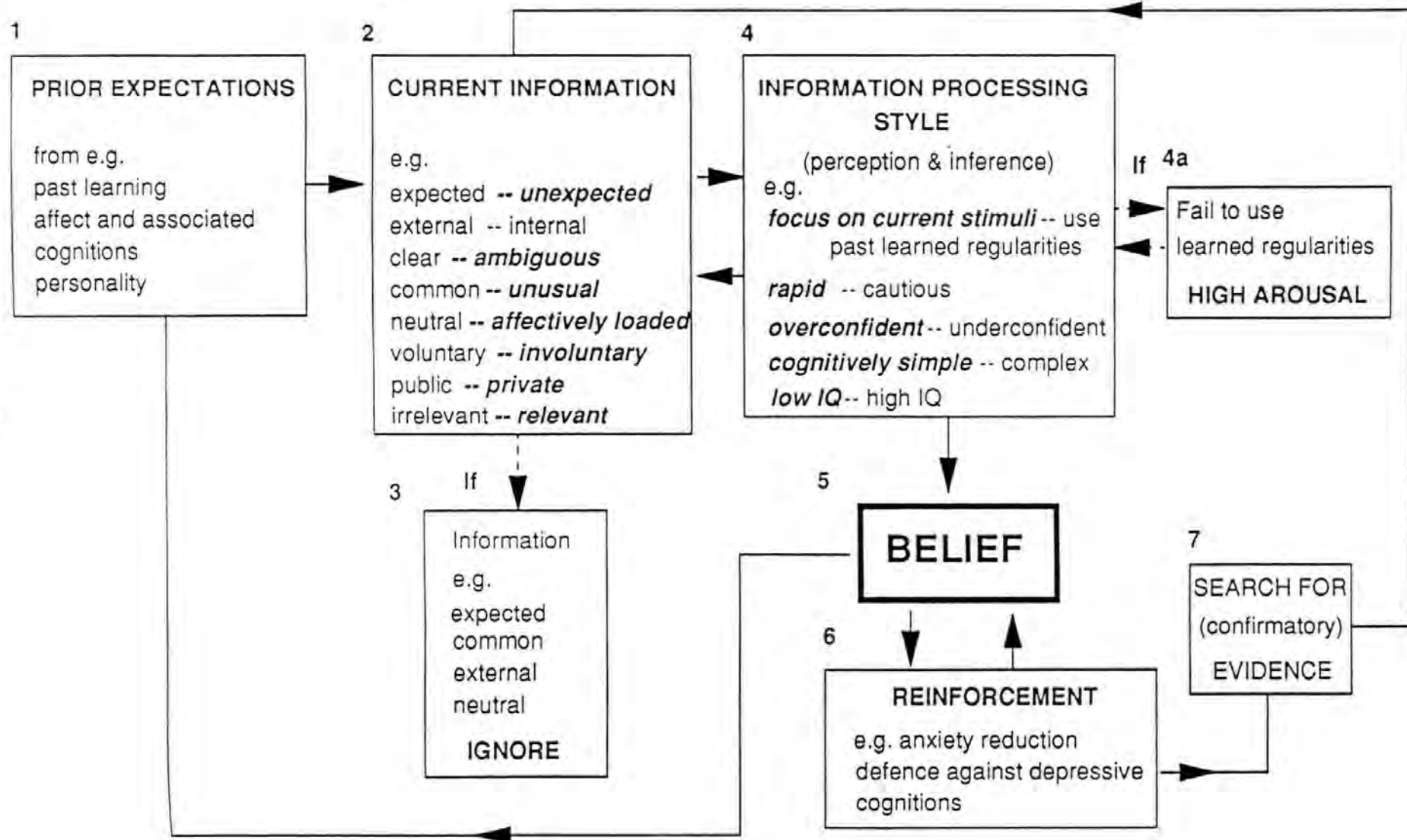
A number of theories have argued that delusions are the product of faulty reasoning. Von Domarius (1944, cited in Garety, 1991) was the first to propose that delusions arise from a failure of deductive reasoning. This theory was abandoned when it was found that non-deluded people were also not very skilled at this type of reasoning. In many ways this theoretical perspective has evolved through the gaps in the abnormal perception theory to account convincingly for delusional thought and the important part judgement and reasoning plays in normal subjects. Reasoning biases are implicated in delusions because not all subjects under the same conditions develop delusional beliefs and because delusions do not appear to arise necessarily from abnormal perceptual experiences. Chapman and Chapman (1988) examined the relationship of beliefs to experience in a large group of students and found that subjects responded to similar experiences with beliefs which ranged from the normal to the fully delusional.

The most contemporary cognitive models of delusional thought are provided by Bentall (1994) and Garety (1991). Both authors stress the provisional nature of their ideas. Bentall proposed an outline model in which beliefs arise from perceived data in the world, inferences are made and a belief is generated. An information search may or may not occur to corroborate or refute these beliefs. Bentall argues that delusions reflect abnormalities at one or more of these stages, although additional factors may contribute to delusion formation.

Garety's (1991) model is illustrated in Figure 1. Box 1 represents the cognitive state of the individual before a delusional belief has been formed. This influences the information that is detected and selected. If the material is expected and neutral in content, it is ignored. More salient material continues to be processed and is dependent on the judgmental style of the individual and results in the formation of a belief. Garety suggested that perceptual abnormalities will account for some delusions where the type of information processed is unusual e.g. in a drug induced psychosis and in some neurological impairments. However where the perceptual system is not so disrupted, judgmental processes will be the decisive factor in delusion formation so that in some cases there will be no abnormal perception. Reinforcement and searches for confirmatory evidence serve to maintain the delusional thought.

Both models are in the early stages of development and more work is needed to specify the perceptual and reasoning biases that are thought to be involved in delusion formation. The role of emotion in the models also remains to be investigated.

Figure 1. Garety's Model of Belief Formation (factors implicated in delusion formation in bold)



An obvious difficulty that emerges in exploring the reasoning of deluded people is absence of a norm for correct or normal reasoning. Fischhoff and Beyth-Marom (1983) proposed that Bayesian inference provides a general framework for evaluating beliefs in the normal population and that it may be used to describe a person's consistency with, or departure from the model. Hemsley and Garety (1986) applied this model to the inferences of deluded individuals and argued that it provided a useful framework for evaluating reasoning.

1.4 State or trait factors

Another interesting but uninvestigated area concerns whether delusions are state or trait factors and whether different types of delusions exhibit different temporal patterns. Some psychiatric disorders are characterised by transient delusional beliefs while others are accompanied by more intractable and stable delusional thought. Many patients suffering from delusions follow a recognised course where they become florid, their symptoms remit and they relapse again into psychosis. Butler and Braff (1991) argue that sensory overload may precipitate the onset of delusions and that the fixity and duration of delusion may relate to whether the underlying sensory dysfunction is fixed or trait related. They reasoned that fixed delusions may be correlated with fixed sensory registration and information processing dysfunctions while less fixed delusional states may reflect more labile sensory and information processing disturbances. It remains a matter of speculation what other factors could be correlated with delusional state.

1.5 Reasoning in normal subjects

One of the evident difficulties with the investigation of cognitive processes leading to

belief formation in delusions is that the rules of normal reasoning are not fully understood. However in contrast to the psychiatric literature there has been extensive empirical investigation of reasoning in normal subjects, based on a large variety of experimental studies conducted within the areas of both cognitive and social psychology. It has been debated whether human thought is rational, irrational or a mixture of the two (Johnson-Laird, 1982), or if it is an issue which experimental psychology can or should address (Evans, 1992). Since the 1970s experimentally derived evidence has been claimed for a large number of biases in reasoning and judgement. These are summarised in Table 1.

Availability biases	A variety of biases attributed to individuals judging event probabilities by the ease with which examples can be brought to mind
Belief in the law of small numbers	Individuals ignore or give insufficient weight to sample size in judging likelihood of means and proportions
Base rate fallacy	Individuals ignore base rate information when assessing posterior possibilities
Illusory correlation	Individuals perceive correlations in random data that accord with prior beliefs
Anchoring biases	Individuals anchor subsequent judgements to initial ones
Conjunction fallacy	Under some circumstances individuals will judge the conjunction of two events to be more probable than one component in isolation
Hindsight biases	Individuals given outcome knowledge overestimate the chance that they could have made a correct prediction
Overconfidence / miscalibration	Individuals systematically overestimate the probability that their judgements are correct
Vividness	Individuals overweight information that is emotionally interesting, image provoking, etc.
Fundamental attribution error	A tendency to attribute behaviour to actor's disposition and ignore situational variables

Table 1. Main judgmental biases and description of beliefs

The impetus for the volume of research in this area arose from the now classic work of Tversky and Kahneman (1974, 1982). In summary this work has shown that people are highly fallible and have a tendency make particular kinds of reasoning errors. Rachman (1983) in his review of irrational thinking and cognitive therapy succinctly summarises much of the findings:

“People are inclined to place disproportionate evidential value on recent events, events of personal salience, vivid events, and events that they feel are representative. They tend to place undue emphasis on information which is easily available (to the neglect of equally or more important information that is not immediately accessible). People tend to neglect statistical data, to ignore base rates and to express and follow inconsistent intuitions. They are capable of holding contradictory views simultaneously.” p68

The major influence of Kahneman and Tversky was to develop the idea that many of these cognitive errors are caused by the use of “judgmental heuristics” which serve to reduce the difficulties of assessing probabilities and of predicting outcomes. The idea of heuristics was taken from other areas of problem solving and is a set of ‘rule of thumb’ strategies which lead to quick answers but are prone to errors. Kahneman and Tversky proposed a number of heuristics but the most significant and influential are representativeness, availability and anchoring.

1.5.1 Biases in reasoning

It is possible to select some of these biases in normal human reasoning which have important implications for the way in which delusions are defined and conceptualised. A

widely researched reasoning bias has been labelled the confirmation bias. This is the tendency for individuals to test hypotheses in biased manner such as to avoid finding disconfirming evidence. Wason (1960) developed an inductive reasoning task known as the '2 4 6' problem in which participants have to guess a rule that the experimenter has in mind which can be used to classify sets of three numbers. Participants have to generate three numbers of their own and are told by the experimenter whether the set conforms or not with the experimenter's rule. 2 4 6 is given as an example but the rule is 'any ascending sequence'. Results show that participants tend to generate more complex hypotheses of the rule and give many examples which confirm their hypothesis and become convinced that their rule is correct. Wason found that a significant proportion of participants did not correct their initial responses even when all the relevant information was made available to them to show that they were wrong. Making comment on this striking effect not to defend their evidently false reasoning Wason states "the most salient feature of performance is the participants' incorrigible conviction that they are right when they are, in fact, wrong" (p.365).

Belief bias is another robustly demonstrated cognitive tendency in which a bias is evident in the evaluation of evidence (Evans, Barston and Pollard, 1983). It is proposed that in deductive reasoning tasks participants' ability to generate or evaluate a conclusion as valid (whether it logically and necessarily follows from the premises) is impaired when they hold relevant prior beliefs. Thus believable conclusions are more likely to be judged valid than unbelievable conclusions. Ross and Anderson (1982) argue that it is highly likely that our beliefs influence the process by which we seek out, store and interpret relevant information. Pollard (1982) argues that believable conclusions may be more 'available' and that belief bias may reflect a rational strategy in everyday reasoning.

The literature of reasoning in normal subjects clearly demonstrates that subjects are not logical, rational beings; indeed they are fallible and prone to reasoning errors. The dichotomy between deluded and normal reasoning appears not to be as clear as originally thought. It seems more likely that the delusional thought represents a quantitative rather than qualitative difference from normal performance and that maintaining an already strongly held belief in the face of contradictory evidence is not in itself abnormal.

1.6 Abnormalities of deluded reasoning

There have been a large number of studies examining reasoning and cognitive disorders in people with a diagnosis of schizophrenia (e.g. McReynolds et al., 1964; Abroms et al., 1966 and McCormick and Broekema, 1978). Recent research has identified specific information processing deficits that include (a) problems with elementary functions such as selective attention towards relevant stimuli and sustained attentions over long periods of time (Oltmanns and Neale, 1975; Neuchterline, 1977); (b) problems with complex functions such as encoding and recognition of familiar cues, storing information for future retrieval or deductive or analagous conclusions from available information (Broga and Neufeld, 1981; Neuchterline and Dawson, 1984); and (c) problems with executive functions and response selection (Broen and Storms, 1967, Weinburger *et al.*, 1986, 1988). However, there are substantially fewer studies which specifically examine reasoning in deluded subjects. It has been suggested that this is because for the 20 years following the mid-sixties researchers in this area focused their attention almost solely on the syndrome of schizophrenia (Persons, 1986).

More recently delusions and other symptoms of psychosis have been studied as isolated phenomenon because of their intrinsic interest and because of doubts about the validity of

the diagnostic categories for schizophrenia (Bentall, Jackson and Pilgrim, 1988). Reasoning biases in deluded people predominantly have been examined from two main perspectives: attribution theory and inductive reasoning tasks.

1.6.1 Studies based on attribution theory

One approach to investigate reasoning in delusional thought is provided by attribution theory which offers a framework for understanding the explanation that individuals give for their own behaviour and for the behaviour of others. Attribution theory is concerned with how individuals perceive and make use of information to arrive at causal explanations of social events. It has been argued that this perspective is particularly appropriate as many of the delusions experienced by psychotic subjects seem to concern the patient's place in the social world and his or her beliefs about the intentions of others (Bentall, 1994).

The first investigation of attributional style was conducted on individuals specifically selected for the presence of persecutory delusions (Kaney and Bentall, 1989). The experimental group (n=17) was matched with a psychiatric control group of clinically depressed participants (n=16) and a normal control group (n=17) with no known psychiatric history. The study used the Attribution Style Questionnaire (ASQ) which required participants to generate possible causes for hypothetical positive and negative events. Participants rated their own causes on scales of internality, stability and globalness. Results showed that both deluded and depressed participants had excessively internal, stable and global attributions for negative events. However in contrast to depressed participants the deluded group also made excessively internal, global and stable attributions for positive events. Put simply, the experimental group showed a systematic bias to blame others if something went wrong and conversely an equally systematic and excessive

tendency to credit themselves if something went right. Kaney and Bentall suggested that such an attributional style would leave individuals vulnerable to making both persecutory and grandiose interpretations of life events.

These findings were consolidated by Candido and Romney (1990) who studied non depressed paranoids, depressed non-paranoids and a control group of patients who were both paranoid and depressed using the ASQ. The paranoid group showed the opposite attributional style to the depressed group in attributing good events to themselves and bad events to others or to chance. The observation that participants with persecutory delusions have exactly the opposite attributional bias to that of depressed participants was explained by assuming that they have an exaggerated “self-serving bias”. It has been argued that the purpose of this attributional style is to maintain self-esteem (Hewstone, 1989).

The self-serving bias in deluded participants was investigated further in patients with persecutory delusions (n=14) and depressed (n=14) and normal controls (n=14) by Kaney and Bentall (1992). Participants were asked to play two computer games in which they had to make choices between stimuli presented on a screen. Incorrect choices led to loss of points and correct choices added points to the participant’s score. Without the participant’s knowledge the games were pre-programmed so that the outcome of the game was predetermined with one game (the lose game) leading to a net loss of points and one game (the win game) leading to a gain of points. After each game participants were asked to rate their control over the outcome of the score. Deluded participants showed a strong self-serving bias in that they perceived greater control over outcomes in the win condition compared to depressed and normal controls.

Lyon, Kaney and Bentall (1994) devised a study using subjects with persecutory delusions, depressed and normal controls to further test the theory that persecutory delusions serve the function of defending against low self-esteem. A method of accessing defended feelings of low self-esteem was devised in the Pragmatic Inference Task (PIT). Performance on this measure was compared with the open assessment of attributions using the ASQ. Lyon *et al* found that on the open ASQ where participants were aware of being tested, deluded participants demonstrated external attribution for negative events (blamed others). On the opaque PIT which camouflaged questions in a memory task and subjects were unaware that their attributions were being examined deluded participants displayed an internal attribution (self blame) for negative events and an external attribution for positive events. The authors concluded that persecutory delusions serve to defend the individual against deeply held feelings of low self-esteem and camouflage a depressive attributional style.

A different aspect of the attributions made by individuals with persecutory delusions was studied by Bentall, Kaney and Dewey (1991) who looked at explanations made by deluded participants for the social behaviour of others. Using Kelley's (1967) theory of social attribution the choice of person, circumstance and stimulus attributions for a series of social vignettes describing interactions between two persons were examined. The study used all but one of the participants who took part in Kaney and Bentall's (1989) research. Participants were asked to rate how certain they were in their choice ranging from very certain to very uncertain on a five point scale. It was found that the deluded individuals made excessive person attributions for negative events. They also were excessively certain about their judgements compared to the depressed controls. As in Kaney and Bentall (1989) and Candido and Romney (1990) where deluded participants showed a bias not to attribute negative events in which they were involved to themselves, in this study they showed a similar bias of not blaming the victim in negatively valued social interaction in

which they were not involved. When asked about the accuracy of their judgements deluded participants were relatively overconfident, a finding consistent with that of Huq *et al.*, (1988).

In an attempt to replicate findings using individuals with persecutory delusions Fear, Sharp and Healy (1996) examined cognitive processes in individuals (n=29) diagnosed with delusional disorder. The research aimed to test the ideas that delusions represents a single conceptual entity regardless of the different sub-types of delusion. Among other things the study compared levels of depression and attributional style in individuals with persecutory and non-persecutory delusions and normal controls. The study replicated previous attributional findings of deluded participants (Kaney and Bentall, 1989; Candido and Romney, 1990) and showed excessively external and stable attributions for negative events and excessively internal attributions for good events. In contrast to previous results deluded participants did not show abnormal levels of overt or camouflaged depression. The authors interpreted the results to support the view that delusions represent a unitary concept irrespective of content.

A debatable point concerning all Bentall *et al's* work is the refusal to rely on traditional psychiatric diagnostic classifications for inclusion criteria. Critics may argue that this compromises research design in that experimental and psychiatric control groups contain heterogeneous diagnoses. This may limit the application and acceptance of research findings as classification by diagnostic categories is the most widely used system. In favour of Bentall's approach is that such objections ignore the serious problems of the validity of traditional psychiatric classifications and deny the rationale for this type of study which seeks to investigate symptoms and not syndromes.

1.6.2 Studies based on abstract reasoning tasks

A second although not entirely separate approach to the study of reasoning in people with delusions has been based on abstract reasoning tasks. In an attempt to test Magaro's (1980) cognitive model of paranoia and schizophrenia Brennan and Hemsley (1984) compared paranoid (n=11) and non-paranoid (n=8) schizophrenics on their formation of illusory correlations. An illusory correlation is the report by an observer of a correlation between two events which in reality are not correlated. The paranoid participants were deluded while the non-paranoid group exhibited hallucinations, thought-disorder and incongruity of affect. The authors reported that the paranoid group perceived particularly strong illusory correlations compared with non-paranoid and normal groups on a task involving stimuli relevant to subjects with paranoid delusions.

Using an emotionally neutral probabilistic inference task and Bayes' decision theorem Huq, Garety and Hemsley (1988) investigated inductive reasoning in deluded individuals. The experimental participants were 15 people with a diagnosis of schizophrenia and delusional symptoms; the psychiatric control group consisted of 10 patients with a variety of psychiatric conditions and the normal control group consisted of 15 volunteers with no psychiatric history. The experimental task was to decide which of two jars coloured beads were being selected from, with participants having prior knowledge of the proportions of bead colours in each jar. Very few decision errors were made overall. Deluded participants in comparison to controls were found to request significantly less information before reaching a judgement and expressed higher levels of confidence in their judgements.

Interestingly on these two measures, number of draws to decision and initial certainty, the deluded sample's responses were more rational according to Bayes' theorem, so

theoretically making them more objectively rational than the control groups. There was considerable variability within the experimental group with seven individuals (47%) making a decision after the very first draw. A post hoc analysis did not point to any clear differences between the extreme responders and the other deluded participants. Because normal participants typically perform conservatively compared to Bayes' theorem the authors interpreted this finding as evidence of an abnormal bias in some deluded subjects of drawing on little evidence and being overconfident.

A follow-up of this study reported by Garety, Hemsley and Wessely (1991) used essentially the same neutral probabilistic inference task to examine reasoning in deluded schizophrenic (n=13) and paranoid participants with delusional disorder (n=14). Two control groups were used, one with 14 participants receiving treatment for anxiety disorder and one with no history of psychiatric treatment. Groups were matched for age, gender and intelligence. The study replicated the principal finding of Huq *et al.* (1988) that a proportion of deluded subjects request fewer items of information before reaching a decision. A small number of extreme responders was again evident in the experimental group. It was also found that deluded participants were more likely to change their estimates of the likelihood of an event when confronted with potentially disconfirmatory information. The authors took this finding to support the view that deluded individuals are not characteristically incorrigible. The other finding of Huq *et al.*, that deluded participants express higher levels of certainty after the first item of information is presented was not replicated.

Although the experimental procedure was simplified using two conditions rather than the four used by Huq *et al.* (1988) both studies can be criticised for their complexity and abstract nature. The possibility that some participants did not fully understand what was

required of them was not considered, and provides an alternative explanation for the group of extreme responders found in both studies. In common with the other papers reviewed this study can be criticised for the small numbers used. The inclusion criteria for the experimental group were not rigorous, so allowing a variety of delusional sub-types to be treated as a single psychological entity. Also no data were provided on other aspects of the participants' current symptomatology. Some participants in the psychiatric control group were diagnosed as suffering from manic depression and may have been deluded in the past.

John and Dodgson (1994) extended this area of study and used the "Twenty Questions Game" as a more ecologically valid inductive reasoning task. The study aimed to investigate the strategies that deluded individuals use when testing hypotheses. The study used an experimental group of 11 deluded individuals with a diagnosis of schizophrenia and one with paranoid schizophrenia. The psychiatric control group consisted of 12 depressed participants and the normal control group of 12 volunteers.

The study again found that deluded subjects requested less information, and made guesses more readily than volunteer and psychiatric controls. Deluded participants gathered significantly less information overall compared to control groups, made significantly greater number of incorrect direct guesses, and made significantly fewer responses overall.

The authors concluded that reasoning processes of deluded participants are qualitatively different from those in normal reasoning processes. The functional significance for deluded subjects in this type of reasoning was discussed from a number of perspectives although the authors noted that the study was compromised by the fact that a considerable proportion of both patient groups gave up before completing the task.

Using a different type of inductive reasoning task Young and Bentall (1995) studied the hypothesis testing skills of patients with persecutory delusions using a visual discrimination task adapted from Levine (1966). Participants were required to complete a series of problems in which they had to choose between pairs of stimuli presented on cards. Following positive or negative feedback from the experimenter participants' ability to progressively narrow down the set of possible correct solutions was assessed. No differences were found between the deluded and control groups in the range or number of hypotheses generated. Deluded participants were less inclined than controls to stick to hypotheses when given positive information and were more inclined to stick to their hypotheses following negative feedback. They also showed less evidence of 'focusing' down their hypothesis to an overall correct solution in response to successive feedback.

Young and Bentall interpreted this last finding as directly conflicting with the findings of Huq *et al* (1988) and Garety *et al.*, (1990), that deluded participants reached decisions more rapidly than controls. Young and Bentall proposed that there exist basic deficits in the ability of deluded participants to make use of sequential information. This was defined as being able to generate a set of potentially correct solutions to a problem, testing hypotheses and progressively narrowing down the set of possibly correct answers on the basis of feedback. The authors proposed that a difficulty in integrating information over time would be likely to lead to early responding in tasks where participants were free to respond and so avoid making judgements on the basis of a sequence of information.

1.7. Summary

Delusions in their own right have received little experimental attention until recently. However, the small number of studies investigating cognitive bias in deluded subjects

appear to show some consistent findings. Studies using tasks based on social attribution theory indicate that subjects with persecutory delusions make excessively external, stable and global attributions for negative events and excessively internal, stable and global attributions for positive events. In assessing the social behaviour of others it appears that these subjects are as unwilling to attribute negative events to victims as to themselves. These judgements are held relatively over-confidently. In camouflaged assessments of attributions people with persecutory delusions blamed themselves for negative events and made external attributions for positive events. These findings support the theory that persecutory delusions are a camouflaged form of depression and that the delusions fulfil the function of protecting self-esteem.

In unconstrained inductive reasoning studies deluded participants have shown a tendency to jump to conclusions when evaluating evidence, to be relatively over confident in their judgements and contrary to previously widely held assumptions, change their opinions in the face of potentially disconfirmatory evidence. There is some evidence that a cognitive bias is also shown in tasks requiring sequential processing of information by deluded subjects being less able to progressively work to a conclusion.

A serious objection can be made about the interpretation in all the cited studies concerning the causal status of the observed cognitive biases. All that can be demonstrated in studies of this type of cross sectional design is that there is an association between a particular cognitive style and particular type of psychopathology. Most studies can be criticised for the vague criteria that were used in forming experimental groups; only recently have attempts been made to study reasoning biases in a more clearly defined delusional population. It is unlikely that different types of delusion share a common cognitive mechanism and that these are the same in the formation and maintenance of delusions. All

the studies can be criticised for relying on small subject numbers. Very significantly no longitudinal studies have been attempted to investigate changes in reasoning biases with the onset and remission of symptoms.

1.8 Conclusions and introduction to the present study

It has been argued that delusions are complex multi-faceted phenomena with numerous factors involved in their formation and maintenance. Recent studies have provided evidence that traditional definitions are inadequate to account for this complexity and that it is most useful to conceptualise delusional thought as being on a continuum with 'normal' thinking. It has been shown that it is over simplistic to characterise delusional thought as categorically irrational, bizarre and incorrigible. An investigation of reasoning processes in non-psychiatric individuals also shows a lack of logic and rationality, and that 'normal' reasoning contains similar biases attributed to deluded thought.

The study of delusions had primarily been theoretical and a number of these perspectives have been reviewed. It is thought likely that factors such as personality, unconscious wishes, affect, perceptual abnormality, deficits in attention and consciousness, neurological impairment and cognitive bias may all contribute to the formation and maintenance of delusional thought. However it is argued here that a crucial factor is that perception cannot be separate from inference: cognitive biases exist and there is growing evidence that difference biases can be systematically demonstrated in deluded and non-deluded thought. The main findings from experimentally based studies conclude the literature review.

1.8.1 This study

The aim of this study was to further examine the existence of cognitive biases in the inductive reasoning of deluded participants. In line with the majority of recent research it was decided to focus on individuals suffering from persecutory delusions. This acknowledges the complexity and variety of psychological processes that are involved in different categories of delusional thought and makes possible valid comparison with other studies using this deluded sub-group. In general the paranoid sub-type of schizophrenia also typically involves the presence of especially prominent systematised delusions in the absence of thought disorder.

The aim of the study was to examine the contention made in Young and Bentall's study (1995) that the inability of deluded participants to integrate information over time results in early responding in unconstrained inferential reasoning tasks and to inability to focus down efficiently on sequential information processing tasks. It would seem useful to compare performance on a task with conditions likely to demonstrate biases found in unconstrained inductive reasoning tasks with a sequential information processing task using the same participants.

Two experimental conditions couched as games were therefore devised to test this prediction using modified hypothesis testing tasks. Both experimental conditions consisted of a set of visual discrimination problems in which participants had to choose between pairs of stimuli presented on cards. Condition 1 was an evaluative hypothesis testing task in which feedback was given after every response and participants were free to give their solutions to the problem at any point. Condition 2 was a partial replication of Young and Bentall's (1995) study assessing hypothesis testing in a sequential information processing

task in which feedback is limited by the experimenter and participants are not free to terminate the task when they wish. Subjective certainty levels were obtained in both conditions. Levels of depression were also assessed to test Bentall's (1994) theory that the presence of persecutory delusions acts as a camouflaged form of depression.

A further aim of the study was to explore hypothesis testing in individuals whose delusions had remitted. No previous research has examined whether cognitive biases or deficits are a state or trait of delusional thought. As this work is exploratory, no specific hypothesis were made about the performance of remitted participants on either hypothesis testing tasks.

1.8.2 Hypotheses with rationales

The following hypotheses were tested:

Condition 1

1. Remitted participants will have higher levels of depression as measured by the Beck Depression Inventory than deluded participants. (This based on Bentall's (1994) theory that persecutory delusions serve to increase levels of self-esteem.)
2. Deluded participants will make judgements about the rule in fewer trials than controls. (This is based on the experimental findings of Huq *et al.*, (1988), Garety *et al.*, (1991) and John and Dodgson (1994) in which deluded participants were found to request less information before making a judgement.)

3. Deluded participants will express higher certainty levels about their judgements than controls. (This hypothesis seeks to test the findings of Huq *et al.* (1988), and Kaney and Bentall (1989), but it was not replicated in Garety, *et al.*, (1991) that deluded participants are relatively over confident in their judgements.)

4. Deluded participants will make more errors in estimating the rule correctly than controls. (This result was evident in the study of John and Dodgson (1994) but was not found by Huq *et al.*, (1988) or by Garety *et al.*, (1991). The hypothesis testing task used in this study is more similar to that used by John and Dodgson as it is an evaluative task and it is predicted that the consequences of deluded participants not being able to integrate information over time will lead to more errors).

5. In deluded participants there will be a positive correlation between high certainty scores and early responding and in control participants there will be a negative correlation between these variables. The correlation coefficients will be significantly different from each other. (Huq *et al.*, (1988) and Garety *et al.*, (1991) found the first part of the hypothesis to be the case and it is reasonable to suppose that control participants will exhibit the opposite tendency and be more confident in the accuracy of their hypotheses when they have received more information).

Condition 2

6. There will be no significant difference in the number of hypotheses produced by the deluded and control groups. (Hypotheses 6 and 7 are based on the findings of Young and Bentall (1996) although their study predicted deluded participants to produce significantly fewer hypotheses from a smaller range of hypotheses).

7. There will be no significant difference in the range of hypotheses produced by the deluded and control groups.
8. Deluded participants will form fewer correct hypotheses than the control group. (This is to test Young and Bentall's (1995) assertion that deluded participants will be less able to integrate sequential information over time and so will be less accurate in hypothesis formation.)
9. Deluded participants will express lower certainty levels about their judgements than controls. (This is not based on any empirical evidence but on the speculation that lack of confidence will be exhibited by the deluded group when they are not able to respond early.)
10. Deluded participants will be less inclined to stick to hypotheses following positive feedback than controls. (Hypotheses 10 and 11 seek to replicate findings from Young and Bentall, (1995)).
11. Deluded participants will be more likely to stick to hypotheses following negative feedback than controls.
12. Deluded participants will make more errors in estimating the rule correctly than controls. (A consequence of producing fewer correct hypotheses than controls will be for deluded participants to make more errors in estimating the rule for each trial.)
13. Deluded participants will more frequently be unable to form any hypothesis at the end of the task than controls. (From Young and Bentall (1995) that deluded participants will not be able to focus down to a specific solution as well as controls.)

2.1 Selection of participants

Three groups of participants took part in this study with 12 individuals in each group. Attempts were made to match participants for age, sex and years in full-time education. Staff at four community mental health teams and three psychiatric in-patient wards were consulted to suggest potential participants. Criteria for inclusion in the deluded group were that the person had been diagnosed as suffering from persecutory delusions and had no organic brain damage and no history of alcohol or substance abuse. Similar criteria were applied to the remitted group except that their delusions had to have been in remission for a period of one month or longer. The control group consisted of volunteers with no history of psychiatric illness.

Local ethical committee approval was received for the study (Appendix 1) and forty-nine people who were currently deluded or whose delusions had remitted were invited to take part in the study (Appendix 2). Twenty-six people agreed to participate. One remitted and one control participant started the experimental tasks but chose not to complete them.

2.1.1 Deluded group

The deluded group consisted of eight males and four females currently suffering from persecutory delusions and who were receiving psychiatric treatment at the time of testing. The mean age was 34.8 years ($SD=11.8$), range 20-57 years. The mean age on leaving full-time education was 17.8 years ($SD= 3.0$), range 15-22 years. Eleven participants had a diagnosis of paranoid schizophrenia and one had a diagnosis of delusional disorder. Six of

the participants were seen whilst they were psychiatric inpatients. All participants were being prescribed neuroleptic medication at the time of testing. Table 2 lists the main delusional themes for this group.

Participant		Delusional beliefs
P1	Male	Believed friends out to harm him
P2	Female	Believed others trying to give her diseases
P3	Female	Believed neighbours persecuting her. Bullied by police
P4	Male	Believed people in downstairs flat out to get him by sending poisonous fumes through floor
P5	Female	Believed a group of men trying to rape her
P6	Male	Believed other inpatients trying to harm him with needles
P7	Female	Believed people hated her and wanted her to commit suicide
P8	Male	Believed God punishing him for past misdemeanours
P9	Male	Believed others trying to poison his food
P10	Male	Believed men trying to give him AIDS
P11	Male	Believed neighbours bugging his house and could read his thoughts
P12	Male	Believed figures in authority conspiring against him

Table 2. Main persecutory themes for participants in deluded group

2.1.2 Remitted group

This group contained eight males and four females all of whom were outpatients at the time of testing. The mean age of the group was 34.0 years (SD=8.6), range 20-47 years. The mean age of leaving full-time education was 17.3 years (SD=2.6), range 15-21 years. All participants had a diagnosis of paranoid schizophrenia and all were being prescribed neuroleptic medication. Criteria for inclusion in this group were that participants had

experienced persecutory delusions in the past, but that for at least the past month the delusional beliefs had been in remission. Participants were receiving psychiatric treatment either by attending a day centre or were being monitored by a community psychiatric nurse.

2.1.3 Control group

These participants were volunteers drawn from nursing, portering and administrative staff from Delancey Hospital, Cheltenham. Participants were matched for age, sex and years in full time education with the deluded group and consisted of eight males and four females. The mean age of the group was 34.2 years ($SD=10.2$), range 21-55 years with a mean age of 17.3 years in full-time education ($SD=1.7$), range 16-22 years. The criterion for inclusion in this group was having no history of psychiatric illness.

2.2 Materials and procedure

Participants in the deluded and remitted groups were tested individually either in hospital ($n=6$), at a day centre ($n=15$) or at the person's home ($n=3$) by the author. The tasks took between 30 minutes to an hour to complete. Both conditions consisted of a two choice visual discrimination task in which participants were required to discover a rule for making correct choices. To provide continuity between the tasks and to facilitate comprehension the task were couched in terms of a game.

In both conditions each problem was represented by a set of 16 laminated cards, 12cm x 12cm, each containing one of two shapes (circles, 2cm diameter or cross, 2cm x 2cm) that differed along dimensions of colour (red or blue), number (two or four shapes) and position

(left or right on the card). There were therefore two levels of each dimension making a total of eight possible stimulus combinations. For example within a given problem each stimulus might either be a circle or cross, blue or red, be two or four in number and be positioned on either the right or left of the card. This set of combinations has the property of being internally orthogonal so that both levels of every dimension appear exactly twice with both properties of every other dimension. Both conditions consisted of three trials.

2.2.1 Condition 1

Condition 1 formed an evaluative hypothesis testing task devised to correspond with certain experimental conditions found in the studies of Huq *et al* (1988) and Garety *et al* (1991). These were that feedback was given after every response and that participants were free to give their solution when they chose. After giving their answer for each trial participants were asked to rate how certain they were that they had solved the problem correctly on a five point Likert scale (Appendix 4).

2.2.2 Condition 2

Condition 2 was a modified version of the focusing task originally devised by Levine (1966) and that was replicated using deluded participants by Young and Bentall (1995). The materials and aim of the task were the same as in condition 1 except that participants received feedback only on trials 1, 6 and 11, which were the designated feedback trials. The remaining trials were non-feedback trials where no response was given by the experimenter. Also participants were not free to give a solution until all 16 cards had been presented. When a participant gave a solution they were again asked to rate how certain

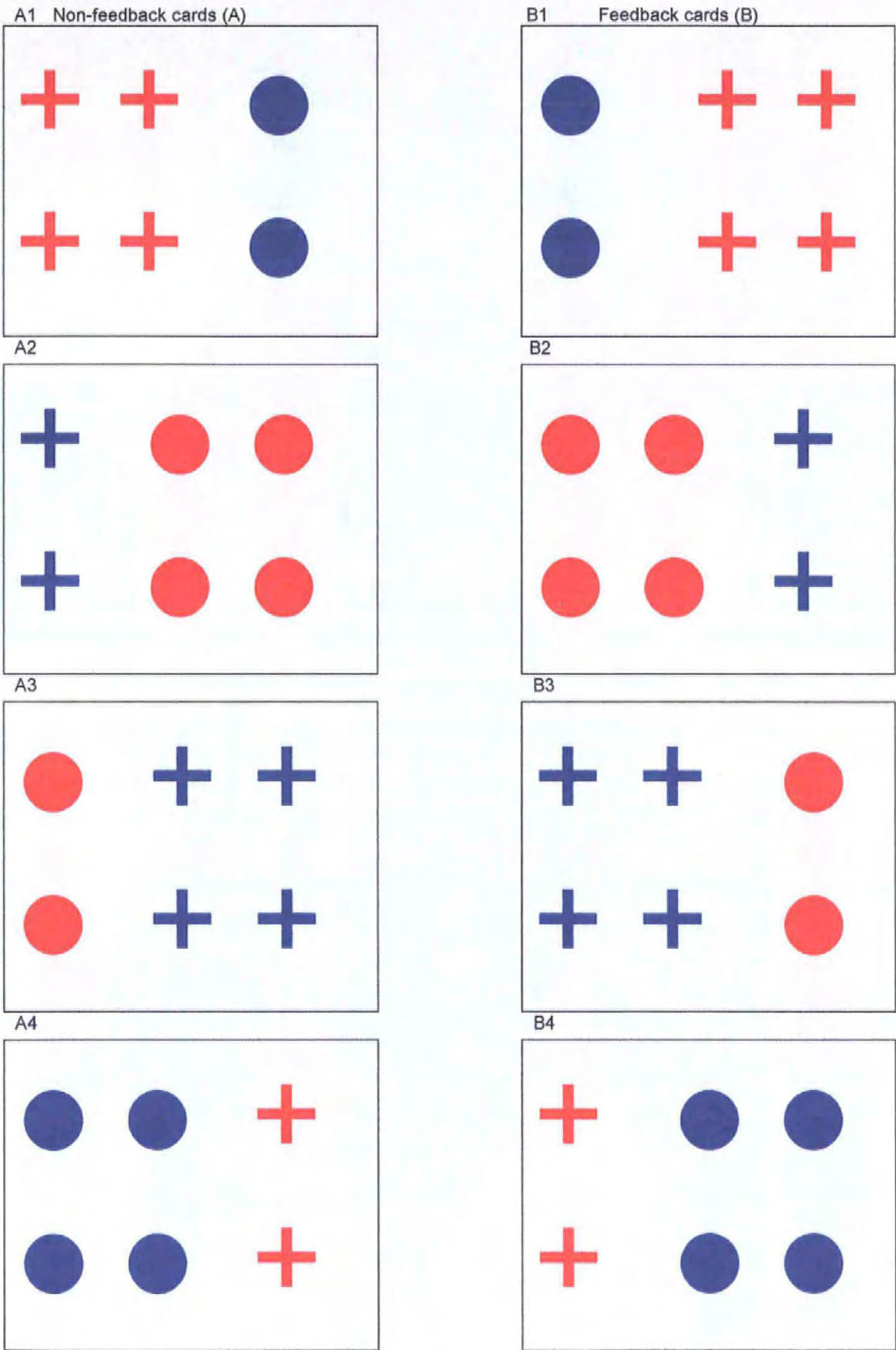
they were that they had provided the correct solution. The order of presentation of cards in both conditions were randomised within trials and between groups (Appendix 5).

An example of stimulus cards for condition 2 is shown in Figure 2. The A cards shown on the left of Figure 2 were allocated to the non-feedback presentations. The remaining B cards were allocated to feedback trials. Thus feedback using B cards was always separated by presentation of each of the four A non-feedback cards. A consequence of the stimulus combinations being internally orthogonal is that participants' hypotheses can be inferred from the four non feedback presentations. Some sequences of A cards are consistent with the formation of a specific hypothesis whereas some are inconsistent with a definite hypotheses (see Table 3).

Response pattern	Hypothesis
LLLL	Left
LLRR	Cross
LRLR	Red
LRRL	Four
RRRR	Right
RRLl	Circle
RLRL	Blue
RLLR	Two
LLLR	No hypothesis
RLLL	No hypothesis
LRLl	No hypothesis
LLRL	No hypothesis
RRRL	No hypothesis
RLRR	No hypothesis
RRLR	No hypothesis
LRRR	No hypothesis

Table 3. Determination of participants' hypotheses by pattern of response over non-feedback presentations (adapted from Silberman *et al.*, 1983). The hypotheses shown are correct in relation to the non-feedback series shown in Figure 2.

Figure 2. Example of stimulus material used in condition 2



Features for each problem were randomly selected in advance and feedback given dependent on the participants' choice of card. Because of the internally orthogonal construction of the cards feedback always resulted in just one possible correct answer for each problem by the time that the final sequence of four B cards was presented. At the start of any problem the participant is faced with a choice of eight possible hypotheses. After presentation of the first feedback card (trial 1) the number of possible hypotheses is reduced to four. After the presentation of the second feedback card (trial 6) the perfectly logical participant should have the option of two hypotheses remaining. After the third feedback card (trial 11) only one possible hypothesis should remain. As detailed earlier, it is possible to work out participants' formation of hypotheses from the sets of non-feedback cards.

2.2.3 Instructions to participants.

The instructions to participants were adapted from those described by Levine (1966) and were as follows:

"In this game I will show you a series of cards like this one. Each card has a number of features. Each card will have a circle and a cross and they will be either red or blue. You can see that there are either two or four of the shapes and that of course one is on the right and one is on the left of the card. For each game one of the features of the card has been chosen in advance. This chosen feature will not change as we go through the game. The aim of the game is for you to work out which feature has been chosen and to tell me which shape shows it and I'll tell you whether you are right or wrong. In this way you can work out if the chosen feature is the colour, the shape, the number or the position on the card. Try to work out the chosen feature as quickly as possible so you can choose correctly as

often as possible. I will ask you how sure you are that you have worked out the chosen feature correctly" (participant showed Likert rating scale).

After one sequence of 10 practice cards in which 'blue' responses were given positive feedback the participant was asked "*What was the chosen feature?*". If the participant gave an over elaborate answer the experimenter replied "*The problem is not as complicated as that. In this practice game one of the shapes, colours, numbers or positions has been chosen and is always correct. Let's try again*". No participant was allowed to begin the test problems until he or she demonstrated an understanding of the task by successfully determining the solution to a 10 card practice game.

Condition 1 was run and instructions were:

"After each card in this game I will tell you whether your choice was correct and you can either ask for another card or you can stop the game and tell me what feature you think had been chosen. You can ask for up to 16 cards. Make a guess as soon as you think you know what the chosen feature is."

After each trial the experimenter said:

"Now we will do the same again. Bear in mind that the chosen feature may have changed."

Instructions for condition 2 were:

"In the last game I said right or wrong after each card. For this next game I will give you fewer clues and will not always tell you whether you are right or wrong. After some cards I will say nothing. Don't let that worry you. Try and concentrate and to be correct each

time. This game will last for 16 cards and at the end I will ask you if you think you know what the chosen feature was. Again I will ask you to rate how certain you are that you are correct."

2.3. Piloting

As both conditions contained alterations from previous studies a small pilot study was carried out on two deluded people and two people without psychiatric problems. The results indicated that the tasks were quickly understood and that they could be administered and scored relatively easily.

The process initiated several changes in wording to make the tasks more easily comprehensible. The main alteration was to half the number of trials in both conditions from six to three. The deluded subjects found it difficult to keep their attention on task and found six trials of each task too repetitious and demanding.

2.4 The Beck Depression Inventory

The Beck Depression Inventory (BDI) was completed by the participant after completion of the reasoning tasks. The BDI is a 21 item self-rating scale which is commonly used to assess the severity of depression in psychiatrically diagnosed patients (BDI; Beck Ward, Mendelsohn, Mock and Erbaugh, 1961). Reliability studies (Beck *et al.*, 1988) have shown a high degree of internal consistency, in that all item scores correlate highly with total score and high split-half reliability has also been found. Independent validation studies have shown a range of usually high correlations of BDI scores with other measures of depression (Beck *et al.*, 1988).

3.1 Description of the methods of data analysis

Data was analysed using SPSS and Statistica computer software. Descriptive data of each variable were analysed for measures of central tendency and displayed as frequency distributions. In general and as group sample sizes were equal for all comparisons it was considered that the use of parametric statistics (ANOVA and Pearson Product Moment Correlation) was justified. Where assumptions of normality and homogeneity of variance were violated it was judged that parametric statistics were sufficiently robust to produce only minor effects on results.

Randomised block design ANOVAs were used as participants were matched. Tukey HSD tests were used for post-hoc analysis of statistically significant ANOVA results. This is the most conservative type of test for planned comparisons of between three and five group means (Howell, 1992). Where means were converted into proportions non-parametric Friedman tests were used.

3.2 Description of sample

A total of 36 participants took part in the study, 24 males and 12 females. The mean age and years in education of the participants are shown in Table 4.

	Deluded	Remitted	Controls
Age			
Mean	34.8	34.0	34.2
(Standard deviation)	(11.8)	(8.6)	(10.2)
Range	20-57	20-47	21-55
Years in education			
Mean	17.8	17.3	17.3
(Standard deviation)	(3.0)	(2.6)	(1.7)
Range	15-22	15-21	16-22

Table 4. Means (standard deviation) and range of age and years in education of participants.

One way ANOVAs showed no significant differences between groups for age ($F(2,22)=.208$, $p= .81$) and years in education ($F(2,22)=.167$, $p= .85$).

Analysis of the distribution of sexes in the sample using the chi-square test showed that there was no difference in the composition of males and females between groups ($X^2=.00$, $df=2$, $p=1.0$) but there were significantly more men than women ($X^2=4.0$, $df=1$, $p= .045$). This is a reflection of the higher prevalence of schizophrenic type disorders in men than women.

Participants were matched by years in education as a rough measure of intelligence. To test how well this controlled intelligence years in education was correlated with the three measures of correct problem solving in the two conditions. A significant but modest correlation existed between years in education and number of trials correctly solved in

condition 2 ($r = .30$, $p = .041$, 1 tailed test), but not between education and number of trials correctly solved in condition 1 ($r = 0.003$, $p > .05$, 1 tailed test) or the number of hypothesis correctly formed in condition 2 ($r = -1.0$, $p = 2.9$, 1 tailed). It therefore appears equivocal that years in education acted as a satisfactory control for intelligence in this study. It is possible that a cohort effect existed for younger and older participants in that the mean age for leaving full time education has increased in the past few decades irrespective of intelligence.

3.3 Condition 1

Hypothesis 1 stated that remitted participants will have higher levels of depression as measured on the Beck Depression Inventory than deluded participants. The mean scores obtained from the Beck Depression Inventory are given in Table 5.

Group	Deluded	Remitted	Control
Mean	18.8	13.5	6.5
(Standard deviation)	(12.8)	(8.5)	(4.2)
Range	7-41	4-26	0-14

Table 5. Means (standard deviations) and ranges of Beck Depression Inventory scores

A one way ANOVA showed that there was a significant difference in depression scores between groups ($F(2,22) = 6.76$, $p = .005$). Tukey HSD tests indicated that the deluded group had significantly higher scores of depression than the control group ($p = .003$) but not than the remitted group ($p = .213$). There was no significant difference between the remitted and the control groups ($p = .117$).

Hypothesis 2 stated that deluded participants will make judgements about the rule in fewer trials than controls. The maximum number of trials for a judgement to be made was 16. The mean scores for numbers of trials to make a judgement about the rule are given in Table 6.

Group	Deluded	Remitted	Control
Mean	3.3	3.3	3.8
(Standard deviation)	(1.5)	(1.0)	(1.0)
Range	1-7	2-7	2-6

Table 6. Means (standard deviation) and ranges of scores for number of trials to make a judgement about the rule.

A one way ANOVA showed there was no significant difference between groups on the number of trials taken to reach a judgement in this condition ($F(2,22) = .954$, $p = .40$).

Hypothesis 3 stated that deluded participants will express higher certainty ratings about their judgements than controls and hypothesis 4 that deluded participants will make more errors in estimating the rule than controls. Table 7 shows means, standard deviations and ranges of certainty ratings and correctly solved rules for the three groups.

Group	Deluded	Remitted	Control
Certainty			
Mean	4.0	3.8	4.3
(Standard deviation)	(1.0)	(1.0)	(0.7)
Range	1-5	1-5	2-5
No correct			
Mean	2.1	2.4	2.5
(standard deviation)	(1.0)	(.67)	(.67)
Range	0-3	1-3	1-3

Table 7. Means (standard deviations) and range of certainty ratings and number of correctly solved rules.

One way ANOVAs showed that there were no significant differences in judgement certainty levels between groups ($F_{92,22}= 1.27$, $p= .30$) nor in the number of correctly solved rules ($F_{2,22}= .906$, $p=.42$).

Hypothesis 5 stated that in deluded participants there will be a positive correlation between high certainty scores and early responding and in control participants there will be a negative correlation between these variables. The correlation coefficients were also hypothesised to be significantly different from each other.

The number of trials taken to reach a judgement and the certainty rating for the judgement were analysed for each group using Pearson's Product Moment Correlation. The correlation coefficient and the probability levels for these variables are given in Table 8.

Group	Deluded	Remitted	Control
Correlation	-.46	-.43	-.45
Probability level	.064	.083	.066

Table 8. Correlation coefficients and probability levels (1 tailed test) for number of trials taken to reach a judgement and certainty rating.

All three groups show negative correlations between number of trials taken to make a decision and judgement certainty levels. However none of the correlations reached a level of statistical significance and did not differ from each other ($Z = -.71$, 2-tailed, $p = >.05$).

3.4 Condition 2

A series of analyses were carried out on the participant's hypothesis testing skills in condition 2. Hypotheses 6 and 7 stated that there will be no significant difference in the number or range of hypotheses produced between deluded and control groups. The maximum number of hypotheses that could be generated by participants during testing on the three trials was nine and the maximum range of hypotheses to be drawn from was eight. Hypothesis 8 stated that deluded participants will make more errors in correctly estimating the rule than controls. A hypothesis was deemed correct if it was consistent with the total information available at the at the last point at which feedback was given. The means, standard deviations and ranges of the total number, range and correctly estimated hypotheses formed are shown in Table 9.

Group	Deluded	Remitted	Control
Total (Max=9)			
Mean	5.6	5.8	7.5
(Standard deviation)	(1.83)	(1.99)	(1.38)
Range	3-8	2-9	5-9
Range (Max=8)			
Mean	2.9	3.5	4.5
(Standard deviation)	.90	1.0	1.2
Range	2-5	2-5	3-6
Correct			
Mean	2.8	4.3	5.3
(Standard deviation)	1.6	1.7	2.4
Range	0-7	1-7	2-9

Table 9. Means (standard deviation) and range of number, range and correct hypotheses formed by groups.

A one way ANOVA indicated that there was a significant difference between groups in the number of hypotheses formed ($F(2,22)= 3.841$, $p= .037$). Further post-hoc comparisons showed that the control group produced significantly more hypotheses than the deluded group ($p= .046$) but not more than the remitted group ($p= .090$). There was no significant difference between the deluded and remitted groups on this measure ($p= .941$). The result indicates that the deluded group formed significantly fewer hypotheses than the control group during the task.

A one way ANOVA also showed a significant difference between groups on the range of hypotheses used ($F(2,22)= 8.27, p= .002$). Post-hoc analysis found the deluded group to use a significantly smaller range than controls ($p=.001$) but not than the remitted group ($p= .225$). There was no significant difference in the range of hypotheses used by remitted and control groups ($p=.070$). The result indicates that the deluded group selected their hypotheses from a significantly smaller range of hypotheses than control subjects.

Consistent with hypothesis 8 a further one way ANOVA showed a significant difference between groups on the number of correct hypotheses generated ($F(2,22)=5.10, p= .015$). A priori planned comparisons found the deluded group produced significantly fewer correct hypotheses than both the remitted group ($t=1.91, df=11, p= .041$) and the control group ($t=3.41, df=11, p= .003$). There was no significant difference in means between the remitted and control groups ($t=1.19, df=11, p= .131$).

Hypothesis 9 stated that deluded participants will express lower certainty levels about having solved the rule correctly than controls. The means (standard deviation) and range of certainty levels are shown in Table 10.

Group	Deluded	Remitted	Control
Mean	3.5	3.0	4.1
(Standard deviation)	(1.6)	(1.8)	(1.2)
Range	0-5	0-5	0-5

Table 10. Means (standard deviation) and range of certainty judgements.

A one way ANOVA showed no significant difference between the groups on this measure ($F(2,22)= 2.22, p= .13$). Therefore although deluded participants made significantly more errors than the control group there was no difference in certainty of having solved the rule correctly. This may support the hypotheses that deluded participants are over confident in their judgements compared to non-deluded controls.

Hypotheses 10 and 11 stated that deluded participants will be less inclined to stick to hypotheses following positive feedback and more inclined to stick to hypotheses following negative feedback. Participants responses following positive and negative feedback were analysed. Logically it is more reasonable to stick to an existing hypothesis following positive feedback and to change hypotheses following negative feedback. As feedback was dependent on the participants' choice of card this resulted in unequal proportions of positive and negative feedback between groups. However analysis using the chi-square test showed no significant difference in frequency of positive and negative feedback between groups ($X^2= 1.26, df= 2, p=>.05$).

Participant's responses over the four non-feedback cards following each presentation of feedback were classified in 'stick', 'change' or 'no hypothesis'. The proportion of hypotheses from each group classified as 'stick' and 'change' after presentations of positive and negative feedback are shown in Figures 3 and 4. This shows that there is a tendency in all groups to stick following positive feedback and to change following negative feedback.

Using a Friedman test the proportions of the number of hypotheses stuck to after positive feedback between groups were analysed. There was no significant difference between groups on this measure ($X^2= 3.81, df=2, p= .15$). Similarly the proportions of hypotheses

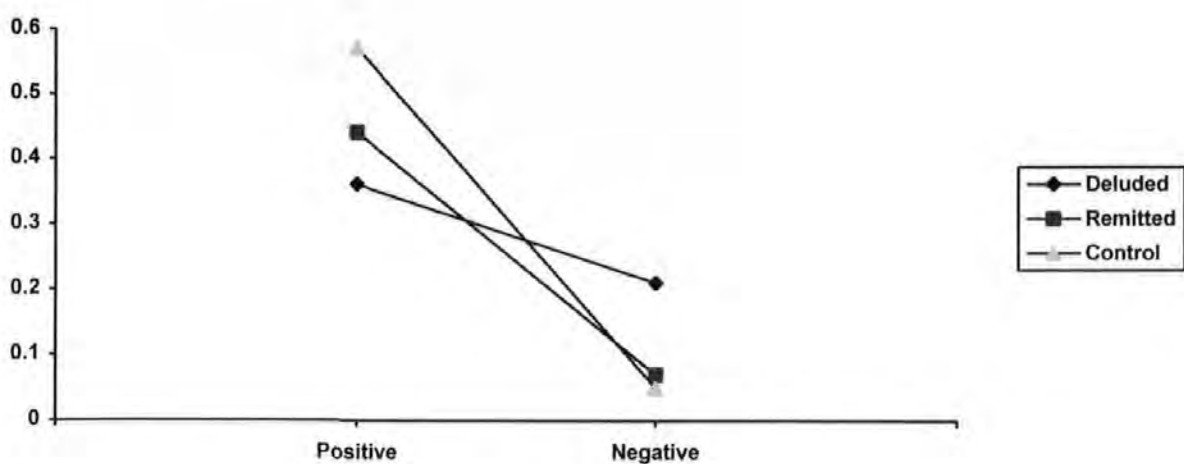


Figure 3. Proportion of unchanged (stick) hypotheses following positive and negative feedback

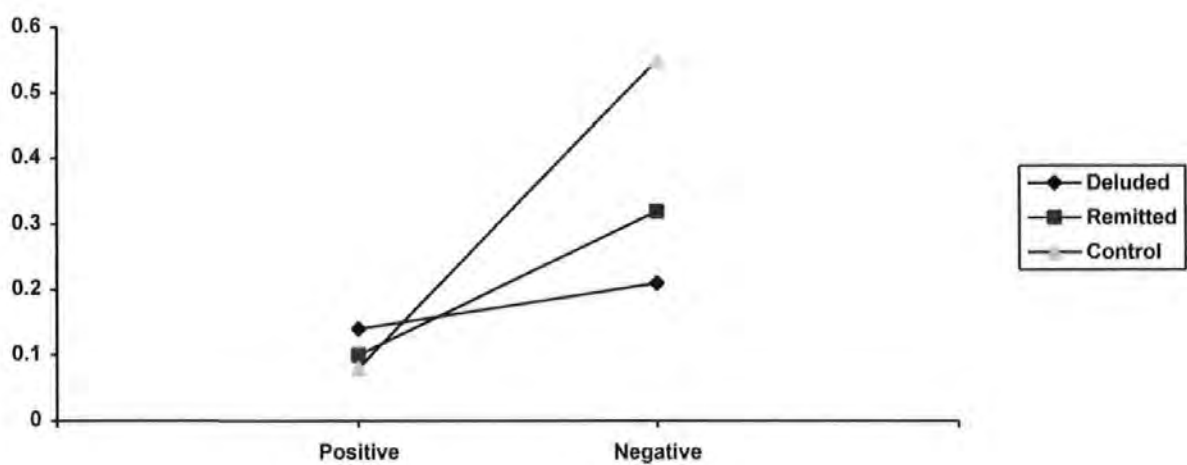


Figure 4. Proportion of changed hypotheses following positive and negative feedback

changed after receiving negative feedback did not differ significantly between groups ($X^2=4.29$, $df=2$, $p=.12$).

The relationship of logical responses to feedback was further analysed by calculating 'sensible' and 'nonsensical' responses to feedback. 'Sensible' responses were calculated by adding the number of hypothesis stuck to following positive feedback to the number of hypotheses changed following negative feedback for each group. The proportion of 'nonsensical' responses were calculated by adding the number of hypotheses changed following positive feedback to the number of hypotheses stuck to following negative feedback. Figure 5 shows the proportion of sensible and nonsensical responses for the different groups. This shows a clear interaction between group and response to feedback. The trend is for deluded subjects to use the fewest sensible strategies and the most nonsensical strategies following feedback with the control group utilising the most logical responses, and the remitted group falling between deluded and control groups for both types of response.

A Friedman test showed a significant difference between groups for use of 'sensible' responses to feedback ($X^2=8.79$, $df=2$, $p=.012$). Further analysis using Page's L Trend Test showed there was a significant trend in the predicted direction ($L=153$, $n=12$, $p<.05$) with the deluded group using least, followed by the remitted group and the control group using the largest number of sensible responses to feedback.

A Friedman Test on the use of nonsensical responses to feedback also showed a significant difference between groups ($X^2=6.17$, $df=2$, $p=.046$). Use of Page's L Trend Test showed a significant predicted trend ($L=155$, $n=12$, $p<.05$) with the deluded group showing the

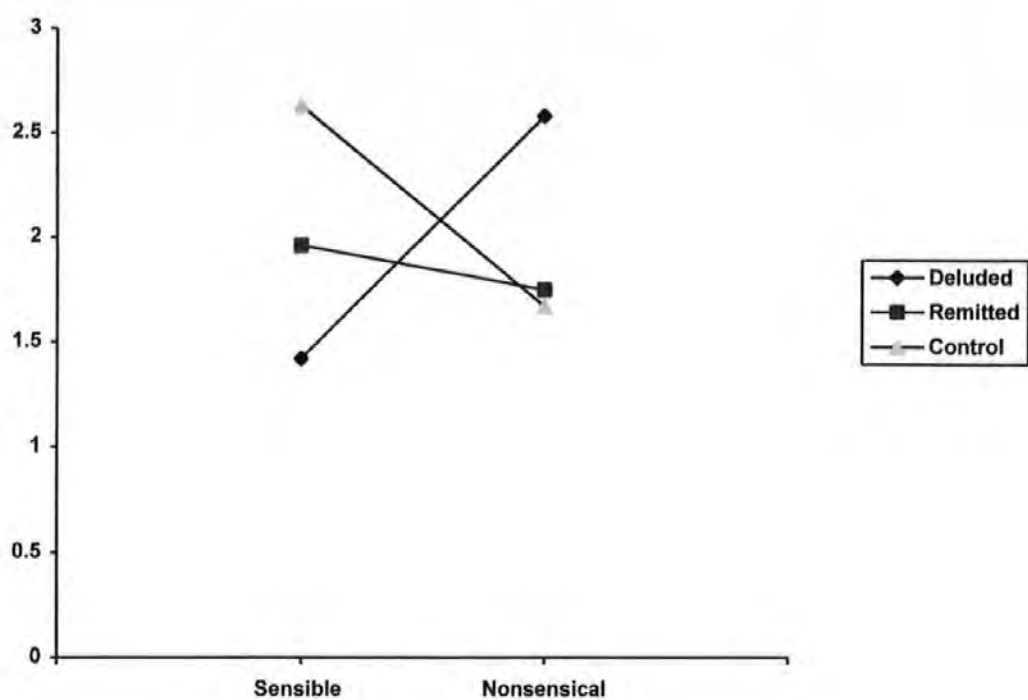


Figure 5. Ranked means of sensible and nonsensical responses to feedback for deluded, remitted and control groups

largest number of nonsensical responses, followed by the remitted group and then the control group.

At the end of each trial participants were asked if they had an idea of which feature had been chosen. Hypothesis 12 stated that deluded participants will make more errors in estimating the rule than controls. Hypothesis 13 stated that deluded participants will more frequently be unable to form any hypothesis at the end of trials than controls. This was an attempt to assess whether deluded participants found it more difficult to focus down to a solution than controls.. Table 11 shows the means (standard deviations) and range of number of final hypotheses formed and numbers of correctly solved rules for each group.

Group	Deluded	Remitted	Control
Final No			
Mean	2.7	2.4	2.8
(Standard deviation)	(.50)	(1.0)	(.56)
Range	0-2	0-3	1-3
No correct			
Mean	1.4	1.6	2.3
(Standard deviation)	(1.1)	(1.3)	(1.1)
Range	0-3	0-3	0-3

Table 11. Means (standard deviation) and range for final number of hypotheses and correctly solved rules

One way ANOVAs showed that there was no difference between groups on both measures of numbers of final hypotheses formed ($F(2,22)=.853, p= .44$) and number of correctly solved trials ($F(2,22)=1.79, 0= .19$).

As the deluded group scored significantly more highly on the BDI this measure was correlated with the dependent variables in which significant differences between groups had been observed. This was to investigate the possibility that the deluded participants' poorer performance was associated with and potentially caused by depressed mood. Table 12 shows correlations between BDI, number and range of hypotheses and number of correct hypotheses.

Measure	BDI
Number of hypotheses	-0.122 (n s)
Range of hypotheses	-0.232 (n s)
Correct hypotheses	-0.240 (n s)

Table 12. Pearson correlations (2 tailed test) between BDI and number, range and correct hypotheses

The correlation coefficients between the three variables were all negative but did not reach statistical significance. This indicates that a higher level of depression was not associated with deficits in hypothesis testing skills and so did not act as a confounding variable.

4.1 Summary of results

This study investigated the inductive reasoning skills of people suffering from persecutory delusions in comparison to a group whose delusions had remitted and a volunteer control group using two types of hypothesis testing tasks. Both experimental conditions consisted of a set of visual discrimination problems in which participants had to choose between pairs of stimuli presented on cards. Condition 1 was a hypothesis testing task in which participants were unconstrained and feedback was given after every response. Condition 2 was a sequential information processing task in which participants were required to focus down to an overall solution by logically testing a series of self-generated hypotheses. Feedback was limited and participants were not free to terminate the task at will.

The results obtained give some specific support to the theory that different cognitive biases are evident in people with persecutory delusions compared to normal controls. Evidence was obtained to support the prediction that the inability of deluded participants to integrate information over time results in an inability to focus down efficiently on a sequential information processing tasks. Cognitive deficits were demonstrated in the deluded group who formed fewer hypotheses, from a smaller range and produced a smaller number of correct hypotheses than controls. There was also a difference in the number of rational and irrational responses to feedback between groups. Deluded participants used the fewest number of sensible responses, followed by the remitted group, with the control group using the largest number. The opposite was observed for use of nonsensical responses to feedback. This is important as it demonstrates a dissociation effect of cognitive bias in

deluded participants which cannot be accounted for purely in terms of generalised impairment.

No support was obtained for the prediction that biases exist which lead deluded participants to early responding in an unconstrained inferential reasoning task and the study failed to replicate any of the predicted findings in condition one.

4.2 Condition 1

The deluded group scored as significantly more depressed than both the remitted and control group. This measure was included to test Bentall's (1994) theory that persecutory delusions serve to increase self esteem and to camouflage depression. The findings do not apparently support this theory in that if a simple linear relationship existed between mood and the presence of persecutory delusions it would be expected that the remitted group would present with higher levels of depressive symptomatology than the deluded group. A comparison of the BDI scores in deluded participants shows a very similar moderate level of depression in this study and in those reported by Bentall and Kaney (1989) and Bentall, Kaney and Dewey (1991). The significantly higher level of depression in the deluded group in this study is consistent with the finding of Chadwick and Lowe's (1990) study of cognitive therapy in delusional patients where in some individuals a decrease in delusional intensity was accompanied by a lowering of BDI score.

In condition 1 none of the hypotheses related to the experimental task were supported and no significant differences were found between groups on any of the dependent variables. Specifically there were no differences in the number of trials taken to make a judgement on the task which conflicts with the findings of Huq *et al.*, (1988), Garety *et al.*, (1991) and

John and Dodgson (1994) in which deluded subjects were found to request less information than controls before making a judgement. Deluded participants did not therefore demonstrate a bias of jumping to conclusions. Similarly there was no difference between groups in their level of certainty about their judgement. This conflicts with the findings of Huq *et al.* (1988) and Bentall, Kaney and Dewey (1991) in which deluded participants were found to be overconfident, but is concordant with the findings of Garety *et al.*, (1991).

Few errors were made in correctly estimating the rule and this did not differ between groups. This indicates that in this task the hypothesis testing abilities of deluded subjects are comparable to that of remitted participants and non-deluded controls and supports the contention that all participants understood the task similarly. No associations between certainty levels and number of cards drawn were found: in deluded participants early responses were not correlated with higher certainty scores and in control subjects later responding was not correlated with higher certainty scores. There was no difference between the correlation coefficients for these variables for the two groups.

There are a number of possible explanations for these findings. An initial consideration is the type of experimental task used. An important distinction can be made between the cognitive strategies required in evaluation and estimation tasks (Hogarth and Einhorn, 1992). In evaluation tasks evidence is encoded as positive or negative relative to the hypothesis under consideration. In contrast, estimation tasks involve assessing some kind of "moving average" that reflects the position of each new piece of evidence relative to the opinion currently held. This condition used a neutral evaluative hypothesis testing task which has not previously been reported in the literature. The studies by Huq *et al.* (1988) and Garety *et al.* (1991) used a neutral probabilistic inference task. A possible explanation

for the different findings in the present study is that the different tasks require different reasoning strategies and so may reveal different reasoning biases.

A problem with this line of argument is that John and Dodgson (1994) found the predicted reasoning biases in deluded participants using an evaluative hypothesis testing task. However the properties of the tasks used by Garety *et al.* and John and Dodgson are notably different. The Twenty Questions task used by John and Dodgson is less restricted in general task requirements and has the scope to detect a larger range of errors than the tasks used by Huq *et al.* and Garety *et al.* The current study very closely replicated the experimental conditions of the latter studies and provided similar opportunities to demonstrate the predicted biases.

Another possible explanation for the difference in results is that both the studies of Huq *et al.* and Garety *et al.* concluded that the reasoning abnormalities looked for in condition 1 may be confined to a subgroup of deluded individuals. The latter study investigated the factors associated with extreme responding but failed to identify specific characteristics of those patients using abnormal reasoning. The difference in findings may be due to the selection criteria of participants. In this study participants were chosen because of the presence of persecutory delusions whereas in the other studies broader inclusion criteria were used.

One problem with the results of Huq *et al.* and Garety *et al.* is that it is not clear precisely how the findings should be interpreted. It may be that participants were responding impulsively to the most recent information with which they had been presented. This may be connected with difficulty in selective attention. It could also be that deluded participants were exhibiting abnormal Bayesian reasoning (Hemsley and Garety, 1986) in

which information was being weighted differently from control participants. As pointed out by Garety *et al* (1991) tasks that result simply in more errors in experimental participants are problematic to interpret clearly.. It is therefore more useful to use tasks that investigate styles of cognitive processing rather than general deficits.

4.2.1 Implications of findings of condition 1

Although the findings did not support any of the experimental hypotheses several things can be inferred from the results. Firstly it is clear that providing the conditions of an unconstrained hypothesis testing task are in themselves insufficient to demonstrate any differentiation in cognitive biases that might exist between deluded and non-deluded participants. The features of unconstrained responding and immediate feedback are also not directly associated with demonstration of these biases. It can also be inferred that the presence of persecutory delusions is not a feature of participants associated with the predicted cognitive biases. From this it can be concluded that the biases shown in previous studies are not particularly robust. This is anticipated by Huq *et al.*, (1988) who are cautious about the reliability of their findings. It remains a matter for future research to more specifically examine the extent to which the biases can be demonstrated and to identify the characteristics of participants and reasoning tasks which are associated with them.

4.3 Condition 2

Condition 2 assessed the ability of participants to process information sequentially and focus down to a correct solution using a hypothesis testing strategy. Results indicate that deluded participants demonstrated a deficit in reasoning strategies on this task. Contrary to

hypotheses 6 it was found that the deluded group formed a significantly smaller number of hypotheses during this task than the control group. For each set of four non-feedback cards it is possible to choose an order which is either consistent or inconsistent with one definite hypothesis. To form a hypothesis requires a degree of logical tenacity and patience and the recognition that no information is gained by changing the choice of hypothesis before feedback is received.

Hypothesis 7 was also not supported and deluded participants selected hypotheses from a significantly smaller range of hypotheses than the control group. Deluded participants were therefore making a selection from a significantly smaller pool of information. This may be because deluded participants have a reduced information processing capacity and so are restricted in the scale of hypotheses which they test. An alternative reason for this may be that deluded participants are demonstrating a strong belief bias. As outlined in the introduction this is the tendency for reasoning to be influenced by relevant prior beliefs. It may be that deluded participants are more heavily influenced by previous feedback and prior expectations and so restrict the range of hypotheses they test.

The deluded group also produced significantly fewer correct hypotheses than remitted and control groups. For a hypothesis to be judged correct requires not only the responses to feedback over the four consecutive feedback trials to be consistent with one hypothesis, but also the hypothesis to be consistent with the information that is known at that point. This is a direct measure of the ability to focus down to one correct overall hypothesis and to integrate information over trials and formed the most cognitively complex element of this study. This last finding partially supports Young and Bentall's (1995) result in which a significant one way ANOVA was obtained indicating a trend for deluded participants to

make fewer correct hypotheses than controls. However in their study this difference was not supported by further post-hoc comparisons.

The finding that deluded participants produced fewer correct hypotheses than remitted participants is significant as this identifies a cognitive deficit specifically associated with the presence of delusions or possibly some other factor correlated with this group e.g medication. The process of producing a correct hypothesis depends primarily on logical processing. It is possible that the inability to marshal memory capacity in the context of logical processing is involved in this deficit. However a number of alternative explanations also exist for these findings. It is likely that the deluded group were generally less physically and mentally active than the other groups. The opportunity for effortful mental exertion may therefore be more limited and deluded participants less accustomed to periods of mental concentration. The cognitive deficits may be the result of general cognitive inactivity.

The reasoning deficits may also be artefacts of impaired memory, attention or organisational capacities. Although no independent measures of these factors were assessed some inferences about them can be made. The information processing demands are deliberately kept low on the task. Silberman *et al.*, (1983) estimated that four items have to be held in memory for approximately 15 seconds in order to be able to solve the problem. Simple memory failure alone is therefore unlikely to account for the poorer performance of deluded participants on this task. Specific attentional deficits however may also contribute to poorer focusing ability.

Another possibility is that neuroleptic medication may lead to bradyphrenia and contribute to the impaired cognitive performance. Although levels of medication were not quantified,

all participants in the remitted group were also being prescribed similar medicine at the time of testing. The effect of neuroleptic medication on cognition is not known and is discussed more fully later in the study.

Contrary to hypotheses 10 and 11 analysis of responses following positive and negative feedback showed that there was a tendency for all groups to retain hypotheses following positive feedback and to shift hypotheses following negative feedback (Figures 3 and 4) and there was no difference between groups on these measures. This contrasts with the findings of Young and Bentall (1995) who found that deluded subjects in comparison to controls were less inclined to stick to their hypotheses following positive feedback and more likely to stick to hypotheses following negative feedback. Deluded participants in this study therefore responded more appropriately to feedback than in the original study.

Combining responses following positive and negative feedback to produce proportions of sensible and nonsensical responding showed a significant difference between groups. A significant difference was found in which deluded participants used the least number of sensible strategies, followed by the remitted group with the control group using the greatest number. The opposite effect was found in the use of nonsensical responses to feedback resulting in a clear interaction effect (Figure 5). The results do not show that deluded participants have more difficulty responding to positive or negative feedback *per se* but that there is a composite deficit in the absence of sensible strategies and the use of nonsensical strategies. This effect is less strong in the remitted group but still significantly different from the performance of normal controls.

These results imply that in deluded participants not only are there core abstract reasoning deficits in the production of hypothesis but also deficits exist in how these hypotheses are

modified in response to feedback. In this task deluded participants were less able to evaluate information and respond to feedback appropriately than remitted and control groups. The study therefore showed a dissociation in cognitive performance by deluded participants between conditions 1 and 2. This is important because had the deluded group shown poorer performance on both hypothesis testing tasks it could have been argued that all that was being demonstrated was a global cognitive deficit leading to impaired performance. The dissociation gives specific information about the experimental conditions which demonstrate cognitive bias and how they are shown.

On the more global measure of the ability to focus down to a final hypothesis no difference was observed between groups in the number of final hypotheses formed at the end of the task and there was no difference between groups on the numbers of correctly solved rules for each group. This suggests that although deluded participants were not reasoning as efficiently and used a more limited set of hypotheses, they were still able to perform equally on the general task of working out which feature had been chosen in advance. This may have been the product of guesswork because even if all information had been disregarded except feedback on the final trial, the participant is left with a 1 in 4 chance of correctly finding the solution.

Contrary to hypothesis 9 there was no difference between groups on subjective ratings of certainty about having solved the task correctly. In this task all three groups expressed the same levels of certainty and performed similarly well in terms of solving the tasks. This is consistent with the results obtained in condition 1.

4.3.1 Implications of findings from condition 2

Some of the main findings of this study are at variance with the conclusions of Young and Bentall (1995). This study demonstrated the main effects that Young and Bentall predicted but did not find in their study that deluded participants formed fewer hypotheses, from a smaller range and with a fewer number of correct hypotheses. It is important to try and determine why this smaller study found differences not observed in the original study. The most obvious difference between the two studies was the number of trials used in the task. Young and Bentall ran 16 trials and this study ran three trials for both conditions 1 and 2. A comparison of data is to some extent possible by prorating scores obtained in this study on the different dependent variables over 16 trials. The prorated data for this study and for Young and Bentall (1995) showing the mean total number, range and number of correct hypotheses are given in Table 13.

	Young and Bentall (1995)			This study		
	Deluded	Depressed	Control	Deluded	Remitted	Control
Total Mean	37.81	39.75	40.56	29.68	31.90	39.75
Range Mean	6.00	6.69	6.88	2.9	3.5	4.5
Correct Mean	18.31	23.75	24.87	14.84	22.79	28.09

Table 13. Comparison between prorated results in Young and Bentall (1995) and this study for means of total number, range and number of correct hypotheses.

The table shows that very similar numbers of hypotheses were produced by the two control groups and that deluded participants in this study produced substantially fewer hypotheses than in Young and Bentall's study. All three groups in this study used a smaller range of hypotheses than in Young and Bentall's study. This variable cannot be prorated and it is probable that the differences are a result of the smaller number of trials used in this study and the range would increase in proportion to the total number of trials in the task. A bigger range of correct hypotheses was obtained in this study although the results are broadly comparable.

One explanation for the different results between studies is that the hypothesis testing deficits of deluded participants in Young and Bentall's study were concealed by learning effects in the deluded group over a substantially longer series of trials. As outlined above individuals with a diagnosis of schizophrenia are likely to have a range of impaired information processing resources. It is possible that the additional number of trials in Young and Bentall's study enabled deluded participants to improve their hypothesis testing skills to levels comparable with the normal control group. To verify this it would be necessary to examine their raw data and compare the relevant dependent variable scores across trials.

Another possibility which may have produced the difference in results is that the severity of psychopathology in the deluded groups in the two studies may have been different. Neither studied quantified severity of delusional or other psychiatric symptoms. Even a rough measure such as the number of participants who were tested while psychiatric inpatients is not available as Young and Bentall do not give this figure. However similar criteria for inclusion in the deluded groups were used and there are no obvious reasons why a significant difference between groups should exist.

4.4 General considerations relating to the study

A number of other factors need to be discussed in considering the findings of this study. A basic issue is whether participants understood both experimental tasks. The practice task ensured that all participants had a certain level of understanding of what was required and no pressure was put on them to start before they expressed confidence in knowing what they had to do. Care was taken to ensure all participants had the same level of understanding of the tasks. Couching the tasks in terms of games enabled this to be done fairly simply and provided good face validity for the study. The high levels of correctly solved rules in both conditions supports the contention that participants did understand the tasks.

A second basic issue that applies to all research in this area is whether performance in reasoning tasks can directly be attributed to cognitive deficits or biases or whether they can equally well be explained by other factors. Motivational influences have not been given a great deal of consideration in the literature but they provide a powerful source of explanation for patterns in problem solving, particularly in people with persecutory delusions. For example it is possible that the bias of jumping to conclusions is the result of wanting to end the task as quickly as possible in order to leave the test conditions. Further research is necessary to investigate the extent of motivational influences on task performance and the degree to which this affects cognitive judgement.

An exploratory aspect of the present study was to investigate the hypothesis testing abilities of a group who had recovered from their delusional symptoms. The consistent finding was that remitted group's scores fell between the deluded and control group's on almost every measure. On hypothesis 8 the remitted group scored significantly differently

from the deluded group in forming more correct hypotheses. A significant difference was found in the use of sensible and nonsensical responses to feedback with the remitted group falling between the deluded and control groups. These findings seem intuitively valid and potentially provide hard empirical support for the view outlined in the introduction that delusional thought is best conceptualised as being on a continuum with 'normal' thought. However it is also possible that qualitative differences do exist in delusional cognitive processes but a continuum exists in the probability of the dysfunctional processes operating, with deluded participants using dysfunctional process more often.

4.5 Reliability and validity of findings

The results found in this study need to be interpreted with caution. The small number of participants in the study limits the representativeness of the results and use of an experimental methodology also restricts how widely the results can be applied to reasoning in everyday situations. The need for a conservative attitude has clearly been shown in follow-up problem solving studies with non-psychiatric participants. Different wording of the experimental tasks has consistently failed to replicate original studies. Evans (1992) comments "The answer you get depends critically upon what particular question you ask and in what form you ask it". The external validity of these experimental studies is therefore uncertain. The fact that experimental results are so dependent upon the framing of questions means that simple generalisations are invalid. The most that can be claimed from such studies is that biases can reliably occur under certain standardised conditions and may lead to serious reasoning errors in everyday situations.

4.6 Limitations of the study

This study can be criticised in a number of ways. Participants were allocated to the patient groups not principally on the basis of broad psychiatric diagnosis such as schizophrenia but rather according to the presence of persecutory delusions. Although a number of authors have argued for the validity of this type of approach which targets specific symptoms in research (Bentall, 1990a, 1990b; Bentall, Jackson and Pilgrim, 1988, Persons, 1986) it would be important to see if the present findings generalise to other psychiatric disorders. As previously mentioned the small sample size of the study limits the representativeness and generalisability of the results.

The criteria for inclusion in the remitted group was based on the clinical judgement of the community teams. The reliability and validity of the inclusion criteria for this group would have been strengthened had an independent assessment of psychiatric symptoms been conducted, specifically examining the presence or absence of delusional thought. It was felt that this was not feasible in a study of this size as participants were drawn from teams throughout East Gloucestershire NHS Trust and under the medical care of four different consultant psychiatrists.

In common with all other published studies in this subject area the use of a cross-sectional design does not permit any causal inference to be drawn between persecutory delusions and reasoning deficits; at best only an association between a type of reasoning deficit and a specific psychopathology can be demonstrated. An attempt to address this issue was made with the inclusion of a group whose delusions had remitted. Optimally however a longitudinal study would be required to investigate the course of reasoning biases and correlates of psychopathology.

A confounding factor was that all participants in the deluded and the remitted groups were prescribed neuroleptic medication at the time of testing. Many of the participants were also taking additional types of medication. Individuals had been taking different medications for different periods of time and in different amounts. It is also known that non-compliance is common with rates estimated to be at least 50% (Bebbington, 1995).

The effect of medication on cognition is known to be complex and it is impossible to be certain of its impact in this type of study. For a review of the effects of neuroleptic and anticholinergic medication on cognitive functioning in schizophrenia the reader is referred to Spohn and Strauss (1989). The main conclusions from this review are that medication acts to normalise disordered thinking and attention/information processing dysfunctions. This effect may be limited to the dysfunction that occurs in acute psychotic episodes. Certain memory functions may be disrupted by the use of anticholinergic medication. Spohn and Strauss (1989) are at pains to point out the limitations of these conclusions and the limits of their generalisability.

It is possible to argue that the effects of neuroleptic medication may reduce any cognitive deficits and minimise group differences by improving attention and information processing. It is also highly plausible that the side effects and intolerance of this type of medication cause increased sedation and slow speed of information processing. It is not possible to be certain about the effect of neuroleptic medication on this reasoning task and it remains a subject for future research.

In order to standardise the administration of the experiment and to optimise a similar level of understanding between participants condition 1 was always preceded condition 2. It was felt that this offered the most logical transition from practice task to experimental task and

that if the order of conditions were randomised this would significantly affect understanding of the tasks. A penalty for this was that it is possible that learning and fatigue effects confounded the effects of cognitive bias. However it was also thought that the relatively small number of trials in each condition meant that the demands made on participants were not sufficient for these to be significant factors.

It was shown that matching groups for years spent in full time education was at best a very rough attempt to control for intelligence levels between groups. It is possible that group differences are purely the result of individuals in one group being more intelligent and therefore better problem solvers. The use of the NART or a sub-test from the WAIS-R may have offered a more accurate assessment of intelligence and enabled a better between group matching. However Young and Bentall (1995) used the Picture Completion task and found no correlation between this and hypothesis testing skills.

4.7 Implications for clinical interventions

The evidence is growing that cognitive-behavioural interventions can help deluded patients construe their experiences and symptoms in non-psychotic terms. However the precise way in which this can be achieved is still largely unknown and the reported intervention studies are essentially exploratory (Chadwick and Birchwood, 1994). The clinical relevance of studies like the present one is to increase knowledge of the reasoning processes in delusional thought which can be used to inform intervention methods.

It will be valuable for therapists engaged with clients in evaluating the rational evidence supporting beliefs to be aware that deluded participants have particular difficulty in integrating information over time and may exhibit deficits in hypothesis testing of

sequential information. This has particular relevance in certain aspects of cognitive therapy in which abstract and hypothetical concepts are referred to and inferences are drawn about the contents of beliefs e.g. such techniques as reaction to hypothetical contradiction. Guidelines to therapists may be to check a shared understanding of the work and to explore the inferences formed at regular intervals. From the results obtained from the remitted group it is likely that hypothesis testing skills improve as delusional systems weaken.

4.8 Future research

Little empirical work has been carried out in this area and many aspects remain that could fruitfully be investigated. Further investigation is generally needed to clarify the extent of cognitive bias in delusional thought and the experimental circumstances in which this can be demonstrated. Other hypothesis testing tasks could be used to help determine this. The only type of hypothesis testing tasks that presently have been used have employed emotionally neutral stimuli. It would be interesting to evaluate the effect of emotionally salient material on hypothesis testing and it would be possible to integrate the emotional content of the material with the types of abnormal beliefs held by deluded participants and to examine their interaction.

Research is also needed to advance what is known about cognitive bias in types of delusions other than persecutory thought e.g. manic depression. A longitudinal study investigating reasoning and cognitive style in deluded participants would be valuable in overcoming the methodological weaknesses of present studies.

Reasoning studies in normal participants have progressed to attempts at eliminating or reducing robust biases by giving instructions in problems solving tasks (e.g. Evans, Newstead, Allen and Pollard, 1994). Attempts to debias deluded participants may provide a useful starting point and give more specific information for cognitive interventions for modifying delusional beliefs.

4.9 Conclusions

The experimental results support the theory that different cognitive biases are evident in deluded participants compared to normal controls in certain types of hypothesis testing tasks, specifically in a sequential information processing task. In an unconstrained hypothesis testing task in which feedback was given after every response deluded participants' performance was equal to that of remitted and control groups on all measures. In a sequential information processing task deluded participants formed fewer hypotheses, from a smaller range of hypotheses and formed a smaller number of correct hypotheses than controls.

Deluded participants also used information about hypotheses they had formed less rationally than both remitted and control participants. Although these results may be explained by cognitive impairments in deluded participants the production of a greater number of nonsensical responses to feedback and the equal performance in condition 1 provides evidence of specific cognitive bias. A dissociation effect was produced between the two experimental conditions and in the use of sensible and nonsensical use of feedback suggesting that specific cognitive biases are evident in the inductive reasoning skills of deluded participants.

The need for caution in interpreting the results and the generalisations that are valid about the inductive reasoning skills of deluded individuals in everyday situations were made. For increased reliability the reasoning of deluded individuals needs further investigation, using different research methodologies and using different reasoning tasks with different delusional subtypes.

Appendix 1

Approval for from East Gloucestershire NHS Trust Ethics Committee



**GLOUCESTERSHIRE
HEALTH AUTHORITY**

**VICTORIA WAREHOUSE
THE DOCKS
GLOUCESTER GL1 2EL**

**TEL: (01452) 300222
FAX: (01452) 318800
TEL: (Direct)
(01452)
FAX: (Direct)
(01452)**

Our Ref:

Please ask for:

Beryl Elliott Clerk to the East Gloucestershire Ethics Committee

23rd May 1996

Mr Ian Baker
Trainee Clinical Psychologist
Department of Clinical Psychology
Delancey Hospital
Charlton Lane
Cheltenham Glos GL53 9DU

Dear Ian

RE: 96/16 - INDUCTIVE REASONING IN DELUSIONAL THOUGHT

Many thanks for your excellent proposal and for attending to clear up any difficult points. I can confirm that the Committee have approved your application and wish you well in its application. We will, of course, require that you update us in one year's time as to whether the trial is finished and its outcome, or whether it is continuing.

Good Luck.

Yours sincerely

MIKE RICHARDS
Chairman - East Glos LREC

APPENDIX 2

PARTICIPANT INFORMATION SHEET

You have been invited to participate in a study looking at how people solve problems. It is known that different people solve problems in different ways and researchers are interested in the various types of strategies that are used. This study may be beneficial in providing information about the ways in which people reason. This is helpful in certain types of clinical treatment.

This study involves two tasks using a set of patterned cards. The aim of the task is to work out a rule which the researcher is using to sort cards into a category. The task will take about 30 minutes to complete.

You may decline to participate in the study or having given consent you may withdraw at any time without giving any reason. No displeasure or penalty will be incurred for non-participation.

If you require any further information about the study please contact:

Ian Baker
Department of Clinical Psychology
Delancey Hospital
Charlton Lane
Cheltenham
Glos. GL53 9DU
Tel: 01242 272183

April 1996.

Appendix 3

CONSENT FORM

Study title: Inductive Reasoning in Persecutory Delusional Thought

Have you read the Participant Information Sheet?	Yes/No
Have you had an opportunity to ask questions and discuss this study?	Yes/No
Have you received satisfactory answers to all your questions?	Yes/No
Have you received enough information about the study?	Yes/No

Who have you spoken to?

.....

Do you understand that you are free to withdraw from the study:

- | | |
|---|--------|
| <ul style="list-style-type: none">• At any time• Without having to give a reason for withdrawing• And without affecting your future medical care? | Yes/No |
|---|--------|

Do you agree to take part in this study?	Yes/No
--	--------

Signed.....

Date.....

(Name in block letters)

.....

Parent/Guardian/Carer

Date.....

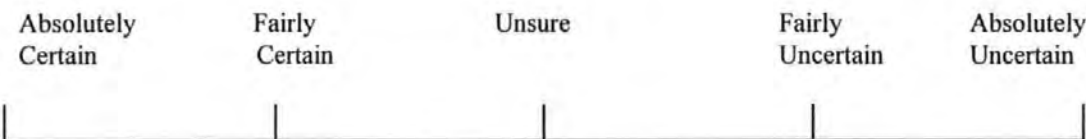
(Name in block letters)

.....

Signed (Researcher) Date.....

Appendix 4

Certainty Rating Scale



Appendix 5

Experiment Randomisation Schedule

Three sets (1, 2 &3) of 16 stimulus cards were produced with feedback and non-feedback cards randomised within each set. Two features (A and B) were randomly chosen for each set giving six solutions to be determined. Each featured was given to each group twice and randomised within and between groups. The randomisation for each group is shown below.

participant	Group					
	Deluded		Remitted		Control	
	Condition 1	Condition2	Condition 1	Condition2	Condition 1	Condition2
P1	1B 3B.2B	2B 3B 1A	1B 2A 3A	3B 1A 2A	1B 2A 3B	1A 3A 2A
P2	1A 2B 3B	3A 1A 2B	2A 3B 1A	2A 1B 3B	3B 2A 1A	2A 3B 1A
P3	2A 3B 1A	3A 2A 1B	1A 3A 2B	3A 2B 1A	1A 2A 3B	2B 3A 1B
P4	1A 2B 3A	3B 1A 2A	2B 3A 1A	1A 3B 2B	2B 3A 1A	1A 2A 3B
P5	2A 1A 3A	1A 3B 2A	2A 3B 1B	2A 1A 3A	1B 2A 3B	2B 1A 3A
P6	2A 3A 1B	2B 1B 3B	2B 3A 1B	2B 3A 1B	3A 1B 2B	3B 1B 2A
P7	2A 3A 1B	2A 3A 1B	3B 2B 1B	1A 2A 3A	2B 3B 1A	2B 3A 1A
P8	1A 3B 2B	1A 2B 3A	1A 2A 3B	2B 1A 3B	1B 3B 2A	1B 2A 3B
P9	1A 2B 3A	2A 1B 3B	2B 1A 3A	2A 3B 1B	1B.3A 2A	2B 1A 3A
P10	2A 1B 3B	1B 2B 3B	3B 2B 1A	3B 2B 1B	2B 1A 3A	1B 3B 2A
P11	1B 3B 2B	3A 2A 1A	1B 2A 3A	3A 2A 1B	1B 2B 3A	2B 3B 1B
P12	1B 2A 3A	1B 2B 3A	2A 3B 1B	1B 3A 2B	2B 1A 3A	1B 2B 3A

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