Reasoning biases and delusions

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Abstract

We know little about the formation and maintenance of delusional beliefs. Two main approaches have dominated the scant literature. These seek to account for delusions as primarily disturbances of perception (Maher, 1988) or as differences in reasoning (Garety, 1991). The concern here is with reasoning biases. Garety and Hemsley (1994) have proposed a model in which delusions are caused by a "failure to utilise previously acquired information". This leads to people with delusions exhibiting characteristic information processing biases in reasoning (i.e. hastiness and overconfidence). The aim of the present research was to compare the performance on reasoning tasks of people with delusions with that of psychiatric and normal control subjects in order to examine whether these subjects exhibited the proposed characteristics of delusional thought. The reasoning tasks were manipulated in both the form of reasoning (deductive, probabilistic etc.) and in content to examine the effect of reasoning with different types of material (neutral or emotional).

The results of the six studies demonstrated both abnormal and normal reasoning by people with delusions. These people were no more confident than control subjects in the certainty of the correctness of their answers (Experiment 2). Nor were people with delusions excessively swayed by information currently present in the environment (Experiments 1 and 5) which is a supposed consequence of the inability to use past experience. However, people with delusions were shown to be hasty in their decisions relative to comparison subjects (Experiment 5). This hastiness was further exaggerated when the material reasoned with was self referent in content (Experiment 6). In addition, people with delusions were significantly poorer at reasoning on one of the most researched paradigms the Wason Selection Task (Experiments 3 and 4). The relevance of these findings for theories of delusions was examined.

To Joy with love.
To Mum and Dad with love and thanks.

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Declaration

This research was carried out by the author between January 1993 and January 1996 at the University of Durham. I declare that the work contained in this thesis is my own and that no part has been previously submitted in candidature for any other degree.

Statement of Copyright

Table of Contents

List of Tables

Chapter 1

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

List of Figures

Chapter 2

Chapter 5

Chapter 7

Chapter 8

Chapter 9

Chapter 11

1 Diagnosis and definition of Delusions

1.1 A brief introduction to the thesis

Delusions are the hallmark of madness. A person expressing bizarre ideas of persecution or grandiosity would likely be called insane or schizophrenic. Jaspers (1963) stated that "delusion has been taken as the basic characteristic of insanity. To be mad was to be deluded." (p.93). Delusions are usually defined as false beliefs. Unlike other beliefs, surprisingly little is known about how and why delusions are formed. Early clinicians had a great deal to say about the causes of delusions (i.e. Serieux and Capgras, 1909, Freud, 1915). However, the Behaviourist approach considered mental symptoms, like delusions and the study of consciousness, inappropriate to investigate. Recently, cognitive psychologists have regained the confidence to research these previously neglected areas. Now the attempt to understand the nature and function of delusions is one of the most exciting challenges to current psychology.

This thesis reports a number of studies that examined one of the proposed mechanisms for the formation and maintenance of delusional beliefs. Specifically, it has been suggested that people with delusions exhibit biases in reasoning that contribute to the forming and holding of the abnormal belief (Bentall, 1994, Garety and Hemsley, 1994). This theory is more carefully considered in a review of the literature surrounding the nature, definition and theories of delusions. Then this theory is tested in a number of empirical studies.

In this thesis it is contended that delusions are formed and maintained using reasoning processes similar to those used in other non delusional beliefs. Delusions are proposed to exist on a continuum with normal beliefs; they differ in degree rather than in kind. This notion is supported by the demonstration that many normal beliefs are formed using biases in thinking and that delusions also rely on these types of biases, only to a more extreme degree. The specific differences in reasoning form the body of research. Naturally, any discussion of factors leading to the development and maintenance of delusions must necessarily begin with a consideration of what a delusion is.

1.2 Definition

Delusions are disturbances in the content of thought, and not in the thinking process, as in Formal Thought Disorder. To an observer, a delusion appears to be a false belief that is out of keeping with what other people would generally believe. To the person holding the delusional belief, the delusion will be indistinguishable from any other belief held. The decision to determine a belief as being delusional is not made by the person holding that belief. Rather, the judgement is made by an external observer. Typically, the belief will be considered delusional if there is an apparent lack of supporting evidence. For instance, someone may feel that they are being watched by the police because the street lamp outside the room flickers.

The DSM-IIIR (American Psychiatric Association, 1987) is fairly standard in its definition of a delusion. In this case delusions are defined as false personal beliefs that are "based on incorrect inference about external reality and are firmly sustained in spite of what almost everyone else believes, and in spite of what constitutes incontrovertible and obvious proof to the contrary. The belief is not one ordinarily accepted by other members of the persons culture or subculture." Therefore, for a person to be diagnosed as deluded it is required that s/he views the belief as veridical, that it is based on incorrect inference, it is not shared by most other people in his or her culture and that the person maintains the belief in the face of incontrovertible evidence sufficient to disconfirm it.

1.2.1 Problems of Diagnosis of Delusions

Adequate as the DSM-IIIR definition appears to be, as Jaspers (1963) noted "definition will not dispose of the matter". Maher (1992a) discusses the discrepancy between the ideal view of delusions and the reality of actually diagnosing them. In practice, the diagnosis of delusions is made on a different basis to that implied above. Beliefs are defined as delusional not when they have been demonstrated to be false but because they appear to be highly implausible. The assessment of plausibility is made by a clinician on the basis of common sense and not on the basis of evaluation of empirical data on an index of "plausibility". Hence, the occasional situation may arise in which an individual has been regarded as deluded because s/he has held a highly implausible belief that later turned out to be true[1]. The possibility that the belief considered as a delusion is actually true is rarely taken seriously. Mayerhoff, Pelta, Valentino and Chakos (1991) report that a woman considered to be deluded on the basis of her

[1] Maher (1988) refers to this as the Martha Mitchell Effect. This woman was the wife of the Attorney General of the United States. She alleged that illegal activity was taking place in the White House. She was regarded as suffering some form of psychosis until the Watergate affair altered everyone's opinion.

reporting being the victim of threats, actually was being threatened. Similarly, Lemert (1962) on the basis of interviews with paranoid patients concluded that most had been the victims of genuine conspiracy. Of course, without external objective confirmation this high endorsement rate may be a function of a well integrated delusional belief and the effects of being hospitalised and disempowered.

In addition, it is not usually the case that counter evidence is ever presented to the patient. Moor and Tucker (1979) note that conviction in the belief is poorly explored and is usually assumed. Counter argument is rarely used, as it is considered unwise to confront patients with their delusions. Slater and Roth (1969) suggested that it was a waste of time to argue with patients over their delusions. It is true that to dispute the delusion probably would be fruitless, but so it would be with most people with strongly held ideas. A delusional belief must be seen as like any normal belief and that it will not be readily abandoned until it is replaced by a better belief. Therefore, the existence of incorrigibility cannot be considered as indicative of pathology, as this is normal (this will be demonstrated in chapter 3). If one considers that a delusion appeared for a reason and that until an alternative can be supplied that satisfies the original requirement for an explanation, the delusional belief will not be rejected. Thus, it can be seen that the clinical application of the definition is not as simple as it would appear.

1.2.2 Problems in the Definition of Delusions

Besides the problems in diagnosis, Maher (1992a) notes this strict definition of what constitutes a delusional belief holds certain implications. One implication is that the causal pathology most likely lies in a process of incorrect inference i.e. people with delusions have faulty reasoning processes. Additionally, the definition implies that any belief may be categorically classed as either true or false. It assumes there exist criteria by which to determine the falsity or truth of a belief and that there are clear criteria for correct and incorrect inference. Similarly, the assumption is that it is possible to assess the degree to which the available counter evidence is sufficient to disconfirm a belief. Therefore, delusions are assumed to categorically differ from normal beliefs and that this deviation is checked against some external criteria. However, the actual falsity of a belief is not strictly necessary, as in cases of delusional jealousy the partner may actually be unfaithful. In the case of religious delusions based on assumptions of faith, there can be no judgement as to the relative truth or falsity of the belief.

It is apparent that the formal definition of delusions (DSM-IIIR, or now DSM-IV) assumes that the majority of beliefs are non delusional. Presumably then, the majority of beliefs held by the vast majority of people are based on correct inference, are generally held by others, are not demonstrably false, or if so are rapidly modified in the face of counter evidence. This would then cause normal beliefs to be so prevalent in the

population that the existence of an abnormal delusional belief would be immediately apparent and thus, easy to diagnose. Naturally, the existence of such a belief would imply an underlying deviant process in the individuals who hold them, as the beliefs are so distinct from normal.

However, this is not the case. Normal beliefs rarely if ever, fulfil all of the criteria outlined above. This is most obvious when one considers that the formal definition of delusions is inadequate when attempting to distinguish clinically abnormal beliefs from other non pathological, but subjectively important beliefs (i.e. political or religious). In addition, many beliefs are based on incorrect inference and are not formed using prescriptively correct procedures. For instance, Kahneman, Slovic and Tversky (1982) demonstrated that reasoning is often based on heuristics or rules of thumb. Therefore, judgement is based not on logical thought but on biases produced by calling to mind the most readily available information or most representative case. This issue of what constitutes a normal belief will be returned to in chapter 3.

Delusions have been shown to vary in fixity and conviction over time (Garety, 1985). This indicates that the belief is not necessarily fixed, one of the tenets of the definition. Also, the success of cognitive therapy with patients with delusions indicates that their beliefs are not always resistant to counter arguments, if expressed in the right way (Chadwick and Lowe, 1990, Kingdon and Turkington, 1991b).

Therefore, some authors have suggested that delusions can be thought of as being on a continuum of thought running from normal to pathological beliefs (Strauss, 1969). Rather than consider delusions as categorically different, they can be regarded as sharing many of the features of normal beliefs. These dimensional theorists have speculated that delusions are not all or nothing phenomena and this has allowed the recognition that delusion like beliefs appear to be within the realms of normality. Support for this position comes from a number of sources. In the measurement of delusions Garety (1985) and Kendler, Glazer and Morgenstern (1983) demonstrated that delusions are variable in fixity and are multidimensional. Garety and Hemsley (1987) reported four global dimensions that apparently vary in a continuous manner.

1.2.3 Alternative Classification Systems

Rather than view delusions as all or nothing phenomena that have little in common with normal beliefs, it may be best to consider delusions as on a continuum, with normal beliefs. With this in mind an alternative classification scheme is necessary. Oltmanns (1988) suggested a dimensional approach using 7 criteria. Normal beliefs will have some of the features listed below but it is more likely that delusions will have all of them. Naturally, ideas that occupy the middle ground will still be debatable. None of the elements are necessary or sufficient for diagnosis.

A) The balance of evidence for and against the belief is such that others consider it completely incredible.

B) The belief is not shared by others.

C) The belief is held with firm conviction. Statements or behaviours are unresponsive to presentation of evidence contrary to the belief.

D) The subject is preoccupied (or emotionally committed to the belief) and finds it difficult to avoid thinking or talking about it.

E) The belief involves personal reference rather than unconventional religious or scientific or political conviction.

F) The belief is a source of subjective distress or interferes with the person's occupation or social functioning.

G) The person does not report any subjective effort to resist the belief (unlike a person with an obsession).

Naturally, not all of the factors are of the same importance. Hence, the greater number of characteristics does not increase the chance of diagnosis. The elements are not restricted to delusions as non-deluded persons will refuse to abandon certain ideas in the face of contradictory evidence (Maher, 1988, Nisbett and Ross, 1980).

Maher (1988) advocates an alternative to the descriptive content based classification of the DSM-IV(1995). In the field of normal beliefs content is not seen to be important in classification. Rather, there is an emphasis on the explanatory structures employed. Maher cites Southard (1916) who proposed that delusions can be classified according to logical structure in accordance with moods of grammar that the form reflected. There may well be a case for the logical structure of a delusion to have a role in classification. However, this possibility has not been pursued.

1.3 Types of Delusions

Delusions have been reported in over 70 conditions (Manschreck, 1979). These include psychiatric, neurological, metabolic and organic illnesses. Delusions are seen in Parkinson's disease, Alzheimer's disease and other dementing illnesses (Cummings, 1985) as well as in temporal lobe epilepsy, drug and alcohol abuse and HIV infection. Any disease process that affects the brain may well affect cognitive processes, reasoning

and judgement and may ultimately affect beliefs. However, in the dementing diseases the delusions seen are often in a context of general mental decline and are often relatively simple, non elaborated beliefs, that differ from those seen in the much younger people with schizophrenia. Delusions are also seen in association with specific lesions in the brain. For instance, Anosognosia is the denial of the presence of an illness such as hemipariesis and occurs in some subjects after contra lateral damage to the parietal lobe. Delusions are also prevalent in the functional psychoses such as Mania (bipolar disorder), delusional disorder and schizophrenia. In fact, delusions are in many ways the hallmark or defining features of the presence of schizophrenia (Benson and Stuss, 1990).

Delusions are usually classified according to theme and content and some specific contents are associated with specific disorders and these are outlined below. The focus of this thesis is with the specific delusions associated with psychosis.

Delusions are sometimes divided into primary and secondary. Primary delusions or autochthonous delusions are considered to be "native to the soul" (Sims, 1988) and arise directly without external cause. Such beliefs are meant to occur un-understandably (Jaspers, 1963) and do not occur in response to another psychopathological form such as mood disorder. Primary delusions were assumed to be psychologically irreducible and were thought to occur only in schizophrenia. Secondary delusions were meant to be delusion like ideas that were not true delusions as they were understandable given the person's life and history.

This distinction between understandable and un-understandable is not readily accepted in current psychology. These terms were introduced by the early phenomenological psychiatrists who viewed schizophrenia as inexplicable and hence, any symptom of this condition should be equally inexplicable. Spitzer (1992) notes that Jaspers's differentiation between primary and secondary delusions was formulated when the pathogenic agent responsible for schizophrenia was expected to be discovered in the same way the cause of syphilis had been.

As will be detailed later virtually all psychological theories of delusions view them as secondary to another process. Therefore, this distinction will not be used further. However, to an extent this notion of understandability continues in that so called "bizarre" delusions are given greater credence in the diagnosis of schizophrenia. Though what differentiates a bizarre from non bizarre delusion is a difficult issue to resolve and this leads to very low reliability in diagnosis (Fenton, Glashman and Heinssen, 1988, Flaum, Arndt and Andreasen, 1991, Goldman, Hien, Haas, Sweeney, and Frances, 1992).

1.4 Themes of Delusions

Delusions are usually classified according to the theme that the delusion takes. The Present State Examination (PSE, Wing, Cooper and Sartorius, 1974) reports 13 kinds of delusion, whilst the Schedule for Affective Disorders and Schizophrenia (SADS, Spitzer and Endicott, 1977) reports 11 types. Common delusional themes include ideas of importance (Grandiose), ideas of being persecuted, ideas of being loved and many more that are shown in table 1.1.

Also shown in this table are some of the different conditions that delusions can be associated with. Some delusions such as those seen in the delusional misidentification syndromes (DMS) are specific delusional ideas that typically involve the belief that people have been replaced or are not who they appear to be. For instance, the Capgras delusion is the belief that someone like a loved relative is actually an impostor. Such delusions are extremely rare. When they do occur, these delusions are usually associated with a schizophrenia diagnosis. Berson (1983) notes that at least 55% of Capgras patients have a definite diagnosis of schizophrenia. However, recently there has been a great stress on the association of organic impairment in these subjects (Fleminger and Burns, 1993). For instance, the right hemisphere parietal lobe is often implicated in the condition of Reduplicative Paramnesia as well as the other DMS. The Capgras delusion and the other misidentification syndromes are the subject of a great deal of research and debate and this is mentioned briefly in the next chapter. However, this thesis is more concerned with the delusions seen specifically within the context of a psychotic syndrome.

Some delusions are frequently associated with a diagnosis of schizophrenia. The World Health Organisation (International Pilot Study of Schizophrenia, 1973) reported that delusions of reference were found in 67% of schizophrenics, and delusions of persecution were seen in 64%. Delusions of control were present in 48% of the patients with schizophrenia. Only 10% of the patients showed evidence of Formal Thought Disorder. Delusions of Grandeur are very much more frequently associated with Bipolar Disorder (mania). Therefore, delusional beliefs are often associated with specific syndromes. However, delusions are not completely syndrome specific as a person with schizophrenia can have delusions of Grandeur or Guilt. This list (table 1.1) is not exhaustive but merely represents some of the delusional themes and the psychiatric classification associated with them.

Table 1.1: Delusional Themes.

Theme	*Description*	*Classification*
Control	Belief of actions or thoughts being controlled	Schizophrenia
Delusional Mood	Belief that things have changed feelings of unfamiliarity, deja vu, depersonalisation, derealisation	Schizophrenia
Grandeur	Belief of being famous or of having outstanding abilities	Mania Schizophrenia
Guilt	Belief of being guilty of something that may not have done	Depression
Infestation	Belief that body is infested with small macroscopic organisms	Schizophrenia
Jealousy	Belief that partner is unfaithful	Personality Disorder Alcohol abuse
Love	Belief of being loved by someone (especially from a higher social class)	Erotomania De Clerembault's Syndrome
Persecution	Belief of being persecuted by persons or agency	Schizophrenia Delusional Disorder
Reference	Belief that radio and TV broadcasts are directed at the individual	Schizophrenia
Somatic Hypochondriacal	Belief of suffering a physical illness	Depression Schizophrenia
Sin Religion	Belief that have committed terrible sins Belief in extreme religious ideas	Depression Schizophrenia
<u>Misidentification Syndromes</u>		
Impostors	Belief that others have been replaced by impostors	Capgras Syndrome
	Belief that strangers are actually disguised familiar people	Fregoli Syndrome
	Belief that another person is physically transformed into self	Subjective Doubles Doppleganger
	Belief that those around have changed place with each other	Intermetamorphosis
Nihilism	Belief that one is dead or does not exist	Cotard Syndrome
Duplication of location	Belief that current location is also situated in a non adjacent area	Reduplicative Paramnesia
Good Health	Belief that not ill when actually ill Denial of an illness such as hemipariesis	Anosognosia

1.5 Content of Delusions

The actual content of the delusion is determined by the current culture of the experiencer. Therefore, there are differences in the content of delusions across time and across cultures. Persecutory delusions in the USA in the 1950's would often involve communist forces, KGB etc., as they were a powerful agent at the time. The mechanisms of controlling thoughts and actions have also changed from tape recorders to computers. The cross cultural differences are demonstrated by explanations for events given by members of West Indian communities that may involve voodoo or black magic. The explanation given by a European patient may involve X-rays and computers.

1.6 Differentiation of Delusions from other psychiatric symptoms

As has been noted, there are difficulties in defining delusions and distinguishing them from other normal beliefs (see pages 2-4 and chapter 3). In addition, there are considerable difficulties in distinguishing delusions from other abnormal thoughts and experiences.

1.6.1 Differentiation of Delusions from Hallucinations

A hallucination is considered to be "a sensory perception without external stimulation of the relevant sensory organ" (DSM-IIIR, 1987). Therefore, a hallucination is a perceptual experience and a delusion is belief. Thus, delusions and hallucinations apparently have very little in common and one might think that they should be easily distinguished.

Delusions and hallucinations may co-occur in the same subject. A person may have a delusional interpretation of the source of the voices that are heard. For instance, the voices may be accounted for by telepathy or as the voice of God or the devil. However, it would appear that the experience of the voice and the judgement as to its source are different. The hypothesis that hallucinations arise in part from a failure in judgement skills (Slade and Bentall, 1988) has raised the possibility that the two phenomena are not as distinct as was thought (discussed in chapter 2).

There are more complicated distinctions between hallucinations and delusions. One instance in which the distinction is blurred is the case of delusional infestation (see Berrios, 1985 for a review). Here the person develops the delusional conviction that s/he is infected with small organisms such as mites or insects (Morris, 1991). There is a long-standing debate as to whether the cause is a hallucinatory experience that is

delusionally misinterpreted (Bers and Conrad, 1954) or whether the infestation is the result of a primary delusion (Ekbom, 1938, Fish, 1974).

Other classifications are equally difficult, especially when the experience is related to the body. Somatic hallucinations occur when the subject reports abnormal perceptions in the body. Frequently, these are given delusional elaborations. Then it becomes difficult to establish if the hallucinatory experience is still occurring. To some extent it would appear that there is both a hallucinatory and delusional component to these experiences. For example, a person may report that parts of his body talk to him. He may feel movements in his body parts. This may be seen as a somatic hallucination, but the additional interpretation that he is receiving messages or that someone is controlling the body parts may be seen as delusional. The distinction between delusions and hallucinations will be returned to in Chapter 2 when discussing the aetiology of delusions.

1.6.2 Differentiation of Delusions from Overvalued Ideation and Obsessions

Delusions are assumed to differ from these other clinical symptoms essentially by the degree of insight that is preserved in the other conditions. An overvalued idea is seen to be an acceptable, comprehensible idea pursued by the holder beyond the bounds of reason. McKenna (1984) refers to an overvalued idea as a "solitary abnormal belief that is neither delusional nor obsessional in nature but which is preoccupying to the extent that it dominates the sufferer's life" (p579). The background evidence is not usually unreasonable but it may become so important that all other ideas are secondary. Overvalued ideas are more frequently found in people with personality disorders. Examples of overvalued ideas include; Anorexia Nervosa, Hypochondriasis, and Gender Identity Disorder (Transexualism). An overvalued idea is considered to be an isolated notion associated with a strong affect state and abnormal personality.

Overvalued ideas are distinguished from obsessions by not feeling subjectively senseless in the way obsessions are viewed. Obsessions are troubling thoughts that the experiencer finds repetitive and strange and that are not preventable. Obsessional thoughts are meant to have a feeling of subjective compulsion, a resistance to this compulsion and a preservation of insight. Hence, obsessions differ from delusions by the degree of preserved insight into the idea and resistance to it. Oltmanns's (1988) alternative classification of delusions refers to this difference between delusions and obsessions (page 5). However, it appears that not all subjects with obsessions resist their thoughts. Also, subjects with delusions may actually try to resist their ideas (Garety and Hemsley, 1994).

1.6.3 Differentiation of Delusions from Confabulation

Confabulation is a condition that is characterised by the expression of false statements of beliefs. However, unlike delusional beliefs, confabulatory statements are usually very transient, inconsistent and often occur in the context of a memory deficit (McAllister, 1992). It appears that the person forgets that s/he does not remember and may construct false experiences and ideas to compensate.

1.7 Delusions as false beliefs

There is a debate as to whether delusions really are beliefs at all. Sass (1994) has recently remarked on this in relation to the famous Schreber case (1903, 1988). Schreber's delusions according to Sass, were not really delusions at all but attempts at description of what was happening. Therefore, Schreber would say that "it felt like" his stomach had disappeared or it felt "as if" he was turning into a woman. These were then distorted into an apparent delusion by the reporting of them, when in fact they were descriptions (possibly of hallucinatory experiences). Sass notes that people with delusions show a number of characteristics that indicate the delusions are not really beliefs. Firstly, Sass contends that people reporting these experiences often do so with a wry sense of humour or irony, as if they do not really believe it themselves. Also, the attitude of the person with the delusion reveals the belief as inconsequential. There is very little acting on the belief. In addition, there is according to Sass, no accompanying emotional state in keeping with the delusional belief. This is odd given the usual profound content of the delusion.

This contention that delusions are not beliefs at all is perhaps typified by Berrios (1991, p. 12) who states:

> *"Delusions are likely to be empty speech acts, whose informational content refers neither to the world nor self. They are not the symbolic expression of anything. Its 'content' is but a random fragment of information trapped in the very moment the delusion becomes crystallised. The commonality of certain themes can be explained by the fact that informational fragments with high frequency have a higher probability of being trapped."*

This clearly suggests that delusions are not beliefs. However, the assumption that delusions are empty speech acts contributes very little to the debate on aetiology. There is no attempt to explain a symptom that is considered the hallmark of schizophrenia and that causes a great deal of distress to the experiencer and the family of the sufferer. The recurrence of specific themes implies that delusions cannot be mere random events as a theme implies a structure. The characteristic resistance to counter

argument of a delusion seems incompatible with Berrios's view. Why would one defend an "empty speech act"? A meaningless speech act seems more consistent with confabulation than a delusion.

In addition, as will be shown in chapter three, there is considerable evidence that delusions act in the same way as normal beliefs and provide order for the believer. This is true to such a degree that the delusion can give the believer a sense of purpose in life that is similar to the purpose that religion serves for Anglican ordinands (Roberts, 1991). The assumption that delusions are mere notions does not concur with the high incidence of acting on the delusional belief that has been reported. Buchanan, Reed, Wesseley, Garety, Taylor, Grubin and Dunn (1993) noted that over 50% of patients with delusions had acted in accordance with their beliefs in some way in the last month. Persecutory beliefs were far more likely to be acted on, but fortunately violence was very rare.

Therefore, to assume that delusions are meaningless speech acts seems inappropriate unless one considers the possibility that there are varieties of delusions. The description given by Berrios may be true of some particular people. Such people may make statements that are inconsistent and vary in content from moment to moment and day to day. However, all of the people with delusions who participated in the studies that follow expressed ideas of persecution or grandeur, that were consistent in theme and over time. In addition, in all cases there was an appropriate emotional state usually of anger, fear or sadness at being persecuted (or of happiness in the grandiose delusions). For many of the subjects there was recent evidence of acting in accordance with the beliefs or of wanting to. Where no action was occurring it was usually because action in the past had led to a period of hospitalisation. Such subjects had learned to not act whilst continuing to believe. Therefore, whilst accepting that there may be people who fit the criteria outlined by Berrios and Sass, this description is not appropriate for the people who were the subject of this thesis. Perhaps, there is a need for a more specific phrasing to distinguish between people with delusions and those who are describing experiences.

1.8 Conclusions

This chapter has tried to give a flavour of what is meant when one talks about a delusional belief. The intention has been to demonstrate what a delusion is, how it can be defined and how it can be distinguished from other experiences. It has been argued that delusions are interesting symptoms in their own right and are worthy of separate study outside the mantle of schizophrenia (Bentall, Jackson and Pilgrim, 1988, Brockington, 1992). Whatever the outcome of the long-standing debate on the value of the schizophrenia diagnosis it is clear that research on the symptoms of the syndrome can only contribute to a greater understanding of the psychological processes in operation (Persons, 1986, Costello, 1992).

In defining delusions there has been a gradual change away from the Jasperian concepts of primary and secondary delusions to more descriptive and atheoretical systems. However, even with such classification systems (e.g. DSM-IIIR or DSM-IV) there still remain problems of definition. For instance, the DSM-IIIR description implies that delusions are categorically different from other beliefs. As will be shown in chapter 3, the assumption that delusions are the only beliefs that are irrational, incorrigible and formed using "faulty inference", is not accurate as a great many "normal" beliefs fulfil these criteria. In addition, it has been noted that there is a great difficulty in distinguishing delusions not only from normal beliefs but also from other psychiatric symptoms such as obsessions, hallucinations and overvalued ideas.

There are alternatives to categorical definitions of delusions. Maher (1988) has argued that consideration of delusional content is not useful whereas classification according to differences in grammatical structure may be. This is an approach that has not been pursued. An alternative method for classifying delusions is to use a dimensional approach such as that suggested by Oltmanns (1988). Whilst not solving the problems of classification it acknowledges the difficulties and goes some way towards dealing with them.

Delusions have a complex definition (or at least description). Ideally, any theory of delusions should be able to explain the formation and maintenance of delusions. In addition, there is a need to identify factors influencing a person's conviction, preoccupation and the way a belief can fluctuate over time. What is also needed is to identify the way these people collect and interpret information from the environment and the manner in which this evidence is used to support or disconfirm their beliefs. Chapter two will describe some of the main accounts of delusion formation and attempt to assess how successful they have been.

2 Theories of Delusion formation

2.1 Introduction

Recently, cognitive psychologists have turned their attention to the study of delusions, which had previously been neglected. This has led to new experimental research into the formation and maintenance of these abnormal beliefs. Prior to this new found enthusiasm, there had been comparatively little attention paid to them. In the two major reviews to date (Arthur, 1964, Winters and Neale, 1983) theories tended to be of a speculative, often psychodynamic nature and largely lacking in empirical support.

In comparison to investigations of the processes involved in auditory hallucinations, delusions have received comparatively little attention (see Bentall, 1990a for a review of the research into hallucinations). This paucity of research seems baffling when one considers the enormous amount of research conducted on the formation of normal beliefs and attitudes (this will be covered in the next chapter).

Bentall (1994) attributes this lack of research into delusions to three possible reasons. Firstly, as a result of a failure in communication between psychopathologists and psychologists. Secondly, as a reflection of the psychopathologists' preference for studying broad syndromes rather than "specific manifestations of madness" such as delusions or hallucinations. Thirdly, the belief of the psychopathologists that delusions and normal beliefs have little in common. A failure in communication seems readily corrected. The preference for studying broad syndrome categories has been questioned by a number of researchers (Persons, 1986, Costello, 1992, 1993) and there is now a greater emphasis on studying the symptoms of the syndromes. The third possibility is that delusions and normal beliefs have little in common. This suggestion is considered in the next chapter where it is argued that delusions lie on a continuum with normal beliefs and are fundamentally similar. In addition, the relative difficulties of defining and diagnosing delusions has already been outlined indicating the possibility that delusions do share some similarities with normal beliefs.

Only a selective review of recent research will be considered in the next section. Theories arising prior to 1983 are very comprehensibly dealt with by Winters and Neale. Four main types of theory have been proposed to account for delusions and these will be mentioned here. The theories are classed as Psychodynamic, Organic, Perceptual abnormalities and Reasoning abnormalities. However, they are no means the only classification and are not necessarily mutually exclusive.

2.2 Psychodynamic theories of delusions

In contrast to the organic approach (below) the psychodynamic theorists place no importance on locating the cause of a delusion to a brain area. Rather these accounts are wholly dependent on explanations in terms of psychological processes and life events (see Winters and Neale, 1983 for a full review of theories) and place a great deal of importance on the content of the delusion.

Typical of the psychodynamic formulations of delusions is the Schreber (1903, 1988) case commented on by Freud. Freud (1915), who never actually met Schreber, proposed that delusions of paranoia (and grandiosity) resulted from repressed homosexual desires. The desire of the subject is expressed as "I, a man, love him", owing to the unacceptable nature of this thought, anxiety reverses this to "I, a man, hate him" and is projected to "He hates me, so I can hate him". This eventually becomes "I hate him because he persecutes me". This implies that the persecutor is always the same sex and is secretly loved by the sufferer. Paranoia is seen as the denial of homosexual love. As with most psychoanalytic theories there is little, if any, evidence for such a claim. Lester (1975) reported an apparently high co-incidence of paranoia and overt homosexuality. However, this is actually contradictory to Freud's theory as the homosexual urges should be inexpressible. The reported high incidence of paranoia and homosexuality is most likely owing to the genuine persecution this group have experienced. In addition, the occurrence of persecutors of a different sex to the apparent victim throw Freud's account into doubt.

In the psychoanalytic literature, the concept of projection is most commonly used to explain delusions. Therefore, delusions act as externalisations of personal wishes, conflicts or fears. Hence, a delusion may be viewed as an expression of inner unconscious wishes that are externally attributed. Recent attempts at an integration and updating of psychodynamic ideas still ultimately leave open ended hypotheses in which any outcome can be "explained" post hoc (Hingley, 1992). Whilst valuable in placing an emphasis on listening to the person with the delusion and valuing the beliefs, ultimately many theories do not stand up to experimental scrutiny.

2.3 Organic causes of delusions

Delusions occur in a wide variety of organic disorders of the central nervous system. As noted earlier, it is not surprising that a disorder that affects the brain may alter cognition, reasoning, judgement and potentially beliefs. However, the concern here is with delusions arising in the background of a psychotic syndrome, which by definition has no currently known organic cause. Despite this apparent contradiction in terms there are numerous theories proposed to account for delusions. Naturally, the research in

organic causes of delusions is intimately entangled in the search for the elusive organic basis of schizophrenia. For a review of such work see Chua and McKenna (1995). However, there have been specific attempts to link delusions to specific brain pathologies.

2.3.1 Frontal Lobe accounts of delusions

Benson and Stuss (1990) account for delusional misidentification syndromes and other delusions as problems arising in the frontal lobes (see also Butler and Braff, 1991). Disturbances in frontal lobe functioning leads to an inability to be self critical and this leads to a disturbance in reality testing.

Evidence for the frontal lobe hypothesis is often derived from studies on people with schizophrenia using the Wisconsin Card Sorting Task (WCST). This task requires subjects to arrange cards according to one of three criteria: colour, number or shape. The person is required to ascertain the nature of the rule. After a time the experimenter changes the rule, and the number of trials required to learn the new rule is an index of perseverative responses. Patients with frontal lobe resections were found to be impaired on completing a set within a category and they tended to continue sorting according to one dimension after it had been changed, called perseverative errors (Lezak, 1976). Since some schizophrenic symptoms such as lack of motivation, social withdrawal, distractibility, and shallow affect are apparently similar to people with damage to the frontal lobes an analogy with frontal lobe patients was considered appropriate. Thus, people with schizophrenia were tested on tasks sensitive to frontal lobe damage.

People with schizophrenia have been found to perform poorly on WCST (Fey, 1951, Malmo, 1974). However, other psychiatric patients (Franke, Maier, Hardt, Friebos, Lichtermana and Hain, 1993) and those with diffuse brain damage or focal lesions outside the Frontal lobes (Pendleton and Heaton, 1982) have been found to perform poorly too. Additionally, there are examples of gross frontal pathology and normal response. Recently, it has been possible to link performance on WCST with cerebral blood flow imaging (Weinberger, 1988). It appears that subjects with schizophrenia fail to activate their dorsolateral prefrontal cortices as is normally seen. Hence, there is a circular argument that poor performance is because of a failure to activate the relevant frontal regions or the failure to activate is because of poor performance.

In people with chronic schizophrenia perseverative errors are negatively correlated with activation of the frontal cortex. They do improve if offered money indicating the core deficit is a failure to accept praise as sufficient reward (Summerfelt, Alphis, Wagman, Funderburk, Hierholzer, and Strauss, 1991). Metz, Johnson, Pilskin, and Luchins (1994) demonstrated that subjects with schizophrenia were able to benefit

from instructions on the task which subjects with Frontal lobe lesions are unable to do (Nelson, 1976). These instructional benefits were maintained at six weeks indicating that the poor performance seen in people with schizophrenia is not caused by the same pathology as in people with lesions to the frontal lobes. More importantly, when using a number of tests sensitive to frontal lobe functioning, rather than one alone, there is no single frontal lobe test sensitive to the cognitive impairment in schizophrenia (Goldberg, Kelsoe, Weinberger, Pliskin, and Berman, 1988). Delusions are considered to be caused by frontal lobe abnormalities by association only as there are no reports of the performance of people with delusions (rather than schizophrenia) using the WCST.

David (1992) notes that the frontal lobe is assigned a role in almost all psychiatric conditions including personality disorders, obsessions, depression and delusions. As the frontal lobes constitute about one third of the brain, localising a disturbance to this region is grossly inadequate. Even when reduced to three main sub areas of the orbital, mesial and dorsolateral there are still many psychological processes in each area.

Generally, it is regarded that the frontal lobes carry out 'executive' functions. The lobes control and deploy other functions such as language. Hence, the systems are not likely to be modular but distributed and this increases the difficulty of localisation. In a sense the frontal lobes have a role in everything in general and nothing in particular. In conclusion, David (1992) states that the attempt to construct a neuropsychology of psychiatric disorders needs to go beyond crude localisation and instead define psychiatric phenomena in terms of breakdown or malfunction of psychological processes.

2.3.2 Temporal lobe account of delusions

The work of Liddle and colleagues indicates that the underlying pathology in delusions is more likely to be in the Temporal lobes rather than Frontal lobes. Liddle and Morris (1991) used a battery of neuropsychological tasks on subjects with schizophrenia and correlated the performance with the schizophrenic subsyndromes identified by Liddle (1987). The subsyndromes of Disorganisation (characterised by Formal Thought Disorder, and inappropriate affect) and Psychomotor Poverty (poverty of speech, and lack of spontaneous movement) were associated with poor performance on tasks sensitive to frontal lobe functioning. The subsyndrome of Reality Distortion (Delusions and Hallucinations) was associated with temporal lobe abnormalities. This result was further strengthened by the finding that increased regional Cerebral Blood Flow (rCBF) was correlated with the severity of the subsyndromes. The people with the most reality distortion symptoms had the most abnormal activity in the temporal lobe. The other two syndromes were associated with frontal lobe rCBF increases (Liddle,

Friston, Hirsch and Frackowiak, 1990, Friston, Liddle, Frith, Hirsch, and Frackowiak, 1992). This theory is strengthened by the fact that people with lesions of the left temporal lobe often exhibit delusional symptoms (Davison and Bagley, 1969) and that temporal lobe epilepsy can be associated with a syndrome characterised by delusions and hallucinations in the absence of formal thought disorder or flattening of affect (Slater, Beard and Glitero, 1963). Therefore, it appears that delusions are more likely to arise from an abnormality in the Temporal lobe.

Cummings (1985) reported that many delusions associated with organic conditions could be accounted for by toxic metabolic processes and disorders affecting the limbic system and basal ganglia. This was proposed on the basis of studying a group of elderly subjects (mean age 63.7) with Alzheimer's disease, Parkinson's disease and Huntingdon's chorea. Therefore, these delusions (often simple in nature) where seen against a background of dementia. Cummings (1992) further developed this idea of limbic system involvement in delusions. It is reported that lesions of the temporal lobes or caudate nuclei and bilateral brain involvement are common in disorders manifesting psychosis.

Despite different delusions apparently occurring in different locations with different effects, a common property associated with delusions is the areas of the temporal lobes and caudate nuclei, which are both parts of the limbic system. The cortical structures of the limbic system include the subcallosal gyri, cingulate gyri, parahipppocampal gyri, and hippocampi. Nuclear structures of the limbic system include the amygdaloid complexes, septal nuclei, hypothalamus, epithalamus, and anterior thalamic nucleus.

The function of the limbic system is mediation of the emotional life and environmental surveillance. Thus, dysfunction of this area would interfere with the assessment of environmental threat, produce incorrect assignment of danger and cause inappropriately fearful and threatened behaviour perhaps manifesting itself as paranoia. The possible involvement of the Temporal lobe will be returned to when discussing accounts of delusions proposed by McKenna (1991), and Gray, Feldon, Rawlins, Hemsley, and Smith (1991).

A further neuropsychological approach was taken by Cutting (1985, 1991, 1992) who proposed that some delusions in schizophrenia are caused by either left temporal or right parietal dysfunction. Left sided damage in the form of left temporal lesions is associated with paranoid beliefs and delusions of reference (Toone, Garralda and Ron, 1982). This may mean that affective associations are being made to previously neutral stimuli. Right sided parietal damage may cause delusions by its effect on perception. The Capgras delusion is the belief that a familiar person is no longer the same and has been replaced by an impostor. This delusional belief, like the other DMS and anosognosia are frequently associated with right sided damage (Fleminger and Burns,

1993). The Capgras delusion will be referred to later as it illustrates the need for a number of different ideas to be taken into account (Young, 1994).

2.3.3 Limitations of organic accounts

Whilst there are many studies citing a relationship between schizophrenia or delusions and dysfunction in a certain area of the brain, the limitations of the organic accounts mean that psychological explanations are required also. Even if it is possible to identify the location of the proposed defect there is still a need to explain the processes by which it is expressed (McKenna, 1991).

Charlton (1990) states that there has been an over reliance on biological psychiatry, whilst at the same time an ignoring of the philosophical objections to biological research in the absence of psychological theory. Bentall (1994) expresses three of these objections. The first is that a reliance on the biological cause as an explanation of abnormal behaviour is Dualistic. The psychological phenomena become epiphenomena to a biological cause (Rose, 1984). Naturally, the mind-brain relationship is very complex and greatly debated. However, it appears reasonable to expect that interaction between the brain and the environment is not one way. Brain events can determine subjective experiences and so too environmental stimuli can help to determine brain functioning.

The second objection is in the viewing of the brain as an information processor. Associating an area with an ill understood process is little more than "sophisticated phrenology" (Bentall, 1994, p. 340). In Bentall's opinion, Marr (1982) outlined the proper relationship between psychology and physiology. To understand how the brain works it is necessary to i) define its functions (what solutions it provides to the ecological problems), ii) define the algorithms or rules that the brain runs by (Cognitive psychology) and iii) only once the algorithms are defined is it possible to ask how the brain as a biological and physical machine operates these algorithms. Biological research needs to be conducted in the light of psychological knowledge.

A third problem is that of "intentionality" (Tallis, 1991). This is the 'aboutness' that links mental events to the world they represent. This carries the implication that the information processing of the brain is content specific and therefore to some extent how the brain processes information depends on what the information is.

As Dennett (1971, cited in Bentall, 1994) notes when we are unable to explain behaviour in terms of benefits or goals (no intentional behaviour) we seek biological explanations. One can decide the behaviour is non intentional (i.e. Jaspers "ununderstandable" delusions) and dismiss it as epistemologically worthless (Berrios, 1991) or attempt to search a little deeper for non apparent meanings. Typically, delusions have recurring themes especially concerning the person's social position.

Thus, delusions can be seen not as being non intentional, but as a disorder of intentionality. Therefore, to understand the mind of a person with delusions one must take account of the person's brain, and individual history and perceived position socially and not ascribe the cause of the delusion to an organic impairment alone.

2.4 Perceptual abnormality theory of delusions

Delusions have been explained as rational interpretations of unusual experiences, and are essentially secondary to some other deficit. Frith (1979) argued that schizophrenia and the symptoms of delusions, hallucinations and thought disorder could be accounted for by a disturbance in consciousness. He proposed that a defective preconscious filter would allow into consciousness percepts and material that would normally be ignored. Therefore, the subject would have strange experiences that would be explained using fundamentally normal reasoning processes. Partial support for this theory was provided by Bullen and Hemsley (1987) who predicted that schizophrenics should fail to inhibit alternative meanings of words because the defective filter would allow multiple meanings into consciousness. Peters, Pickering and Hemsley (1994) used the negative priming paradigm which, in normal subjects, is used to demonstrate that unattended information is actively inhibited rather than being allowed to decay. High schizotypes and people with a diagnosis of schizophrenia were less able to actively inhibit this unattended material (Beech, McManus, Baylis, Tipper and Agar, 1991).

Frith (1992) revised his theory and proposed that rather than having a defective preconscious filter, subjects with schizophrenia have a defect in the system that monitors actions and the preceding intention to act. It is suggested that the subject fails to recognise self generated thoughts and actions. As the thoughts are not recognised as internally generated then they must have come from somewhere else. Therefore, the thought may seem alien and the person may experience the symptom of thought insertion. If an action occurs such as moving an arm that is not preceded by an awareness of an intention to move that arm, the person may feel that his body is controlled from without (delusions of control or passivity experiences). If the subject is unable to monitor the intention to switch attention then the person may find that his attention has moved without his awareness. He may infer that his attention moved for a reason such as his name was mentioned. Therefore, the subject may feel that people are talking about him (persecutory delusions) or if his attention is captured by the television or radio that they are talking about him there (Ideas of reference).

The hypothesis that there is an inability to monitor willed intentions has been supported by a number of studies that have shown central monitoring is faulty. For instance, Frith and Done (1989) had subjects follow a target on a computer screen using a joystick. Normal subjects can correct errors even before receiving visual feedback

indicating that they are monitoring their intended responses and do not require external feedback. Acute schizophrenics corrected their errors like normals when visual feedback was available but not in the absence of visual feedback. A similar finding was reported by Mlakar, Jensterle, and Frith (1994) who found that schizophrenics were poor at drawing in the absence of feedback. Once again indicating a defect in the central monitoring of actions.

Frith's (1992) theory is seemingly able to account for many positive symptoms including hallucinations, delusions and thought disorder. However, the delusions it explains are more like abnormal experiences than beliefs. Frith's account is best suited to passivity experiences where the person feels that his actions or thoughts are controlled by someone else. It is less able to encompass the many other types of delusion where a person's actions are not involved, such as Grandiose delusions. In fact, in the study by Frith and Done (1989) the inability to correct performance on the non visual feedback condition was most marked in people with delusions of control, thought insertion and thought blocking.

Authors such as Jaspers (1963) view some delusions as understandable in the context of other psychopathologies such as hallucinations. Maher (1974) proposed that abnormal beliefs virtually always arise from rational interpretations of anomalous experiences (i.e. hallucinations). According to Maher (1974) the person has an unusual experience that results in a sense of puzzlement. This leads to the search for an explanation, which as the initial experience is odd is likely to be abnormal too. The explanation will bring relief and this is reinforcing. Cognitive abnormalities are not implicated, and it is assumed that the subject has essentially normal reasoning processes. In support of this there are some reports of "delusional moods" preceding delusions. These moods usually encompass feelings that the world has been subtly altered in some way so that it is sinister (Sims, 1988). This is found to be distressing and requires an explanation, even if it is bizarre. Similar reports have been found for bodily sensations (Maher and Ross, 1984).

Besides these anomalous experiences it is possible that perceptual deficits can leave the individual vulnerable to developing abnormal beliefs. For instance, Cooper and Curry (1976) reported that persecutory beliefs are sometimes associated with deafness. As the person is unable to fully discern what is being said, the person will believe that others are talking about him/her. Other supportive evidence is provided by the apparent induction of delusion like beliefs in subjects undergoing anomalous experiences (Zimbardo, Anderson and Kabat, 1981, Chapman and Chapman, 1988). Therefore, normal subjects with strange perceptual experiences were shown to form delusion like beliefs.

There is even evidence of normal reasoning processes operating in subjects with delusions. Williams (1964) reported that DSM II diagnosed schizophrenics

demonstrated normal syllogistic reasoning. In addition, the difficulty faced by clinicians in persuading the patient about the falsity of the belief led the clinicians to believe that more than reasoning processes were implicated. Slater and Roth (1969) considered reasoning with people with delusions is nothing but a "waste of time". This implied that intact reasoning processes were being driven by an abnormal experience.

2.4.1 Criticisms of Maher's theory

Useful as Maher's theory seems, there are some limitations that need to be addressed. Delusions are a common psychotic symptom but not all subjects in the same conditions experience them, indicating an element of judgement is involved. A great many people gradually lose their hearing but most recognise that they are going deaf and that others are not talking about them. In most cases of unusual experiences explanations tend to the mundane rather than the fantastic. Also, delusions often develop in the absence of either abnormal experiences or perceptual impairments. Chapman and Chapman (1988) examined the relationship between beliefs and experience in a large group of students and found that subjects responded to similar experiences with beliefs that ranged from the normal to fully delusional. This study is cited by both Maher and his critics as evidence that people under unusual circumstances can develop bizarre explanations. The critics mention that most people do not reach bizarre magical explanations and hence, there must exist differences in reasoning style.

Delusions are postulated to arise from hallucinations but hallucinations themselves may in some cases be secondary to abnormal beliefs. Hallucinations require an element of judgement. The experiencer has a reality discrimination task and must decide between internal or external origin of the information (Bentall, 1990a). Bentall, Baker and Havers (1991) demonstrated the importance of judgement in experiencing voices. They reported that subjects who heard voices externally misattributed their own internally generated ideas on a Reality Monitoring task (Johnson and Raye, 1981). The hallucinators were not as good at recognising their own thoughts. Thus, it would seem that abnormal inferences are important and not just abnormal perceptions.

Moreover, beliefs can influence perceptions. This was demonstrated by Barber and Calverley (1964) who played white noise to subjects who were told that they may be able to hear the song "White Christmas". Despite no song being played 5% of the subjects reported hearing it. Mintz and Alpert (1972) used the same task on people with hallucinations and found that they were more likely to believe that they heard the song than non hallucinators. Hallucinations often occur against backgrounds of unpatterned stimulation such as traffic noise (Tarrier, 1987). Therefore, what appears to be happening is that subjects are projecting expectations (or beliefs) onto the background.

Unfortunately, the evidence of normal reasoning, supporting Maher's theory is poor. Williams (1964) used a diagnosis of schizophrenia that allows the subjects not to exhibit delusional symptoms. Also, the syllogistic reasoning task has been rejected as a model of normal human reasoning (discussed in chapter 3).

The final problem for Maher's theory is that any demonstration of abnormal reasoning will negate the proposal. The next explanation cites many examples of such differences in reasoning.

2.5 Differences in Reasoning Styles

The distinction between reality and imagination is a question of judgement (Johnson and Raye, 1981). In support of this notion there is evidence accumulating of the importance of a reasoning bias in delusion formation and maintenance. The recent research has followed two lines of enquiry. The first, studies the reasoning of subjects on tasks completely unrelated to the theme of the delusion. This is in order to show that the reasoning differences extend beyond the material of the delusion itself. A reasoning bias demonstrated with material that is unrelated to the content of the delusion implies that there is a more generalised judgemental abnormality. The other line of enquiry has specifically used material that is related to the theme of the delusional belief in order to try and demonstrate the biased processing of this type of information.

2.5.1 Hypothesis evaluation

Huq, Garety and Hemsley (1988) report a study in which subjects were shown two jars containing different proportions of coloured beads in containers, and were required to determine from which of the containers the experimenter was selecting a series of beads. Huq et al. (1988) report a "jump to conclusion" style exhibited by subjects with delusions on this neutral probabilistic reasoning task. The people with delusions (diagnosed as schizophrenic) requested fewer items and were more confident in their judgements than psychiatric controls. This work was replicated and extended by Garety, Hemsley and Wessely (1991) who included separate groups of patients who meet the DSM-IIIR criteria for delusional disorder (and paranoid schizophrenia) and schizophrenics with delusions. Patients with delusions, irrespective of diagnosis, requested less information than the control groups before reaching a decision and showed a greater inclination to reduce confidence in their estimates in the face of potentially contradictory evidence.

Hemsley and Garety (1986) have suggested that delusions may result from deficits in the ability to weigh evidence when compared against a model of reasoning (Bayes's theorem). People with delusions accept conclusions at levels of probability too

low for normals. The Bayesian model proposes that individuals assign probabilities to propositions about reality. Effective reasoning is assumed to be based upon correct assessment of the probabilities inherent in the empirical evidence. Weighing of evidence requires recognition of base rates for the occurrence of classes of events. Garety (1991) proposes that people with delusions are excessively influenced by immediately available information and that they make much less use of previously acquired information. This will lead to a neglect of factors such as base rate, and hence lead to differences in reasoning.

2.5.1.1 Failure to utilise previously acquired information

Hemsley (1987) proposed that people with schizophrenia have a weakening of the influence of stored memories of regularities of previous input on current perceptions. This means that people with schizophrenia are less able to use past experience to reduce current cognitive demands. Instead of using top down processing the subjects with schizophrenia are essentially data driven and have to build up the environment around them (John and Hemsley, 1992). Gray, Feldon, Rawlins, Hemsley, and Smith, (1991) related this hypothesis to delusions in schizophrenia. It is assumed that normal people have a tendency to search for a causal explanation when events do not meet expectations (i.e. when the unusual occurs). The unusual is detected by noting the temporal order and relative proximity of two events and comparing this against stored regularities of the world, to note if this pairing is unusual. Therefore, if there is a broadening of attention and a noticing of normally neglected material (Frith, 1979) and, a reduced ability to test if these events are normally associated, there is a tendency to make abnormal causal relationships on the basis of a single co-occurrence.

Salzinger (1984) proposed a not dissimilar idea; the "immediacy hypothesis". The behaviour of people with schizophrenia is controlled by stimuli immediately available in the environment. Therefore, the people with schizophrenia are stimulus bound and respond to stimuli in isolation and, are not able to use context to give a meaning to the experience.

Evidence for these similar ideas is derived from a number of studies. Brennan and Hemsley (1984) reported that subjects with paranoid beliefs tended to see "illusory correlations" between random events, indicating abnormal causal relationships are made. Baruch, Hemsley and Gray (1988) used the fact that subjects with schizophrenia are less able to use redundancy and patterning of sensory input to produce a task on which the schizophrenics actually did better than the controls. The normal subjects were hampered by the tendency to use previous information. Baruch et al. (1988) used the latent inhibition (LI) paradigm which consists of two conditions. The first exposes a group of subjects to a stimulus that is not associated with reward and is soon ignored. A second

group are not exposed to the stimulus. Later this stimulus becomes salient and rewarding. Subjects that have been pre-exposed, take longer to learn that the stimulus is important than non pre-exposed subjects. The pre-exposed subjects pay less attention to the previously ignored stimulus and have to unlearn that it is irrelevant. A failure to utilise previously acquired information would lead to people with schizophrenia in the pre-exposed conditions to relearn faster than normal people who did have access to previously acquired information. Subjects with acute schizophrenia were shown to do this. It appears that the people with schizophrenia treated all the stimuli as novel and were therefore quicker to respond to the previously redundant stimulus.

Gray et al. (1991) used the latent inhibition paradigm as well as similar tasks such as the Kamin blocking paradigm to argue for a model that emphasises the failure to utilise previously acquired information, and a role for limbic system dysfunction. The function of the limbic system is mediation of the emotional life and environmental surveillance (see section on temporal lobe accounts of delusions, page 17). It is thought that in some general way the septohippocampal system promotes efficiency, flexibility and sophistication in learned behaviour. After damage to this area, rats typically show a complex set of behaviour changes in the direction of perseveration and disinhibition. Specifically, damage to the hippocampal formation causes the loss of Latent Inhibition (Kaye and Pearce, 1987). In rats latent inhibition can also be functionally reduced by administration of amphetamine and restored with antipsychotic drugs. Latent inhibition can also be abolished in man under administration of amphetamine (Gray, Pickering, Hemsley, Dawling and Gray, 1992).

Gray et al. (1991) proposed that the septohippocampal system acts to compare actual with expected in an animal's environment. If there was a functional excess of dopamine (drawing attention to events) the septohippocampal system may become abnormally biased towards its passive, match function. It would be expected that neutral stimuli would become important and thus, events in the environment will acquire abnormal significance. Since these events are now significant they may be associated with other co-occurring events and there will be illusory correlations or relationships between non related events. Then knowledge concerning the relationship of events will be subverted and this will alter the stored regularities for future predictions.

2.5.1.2 Criticisms of the failure to utilise previously acquired information account

The results of the latent inhibition paradigm have recently been challenged. O'Carroll, Murray, Austin, Ebmeier, Goodwin and Dunan (1993) used the proactive interference (PI) paradigm and failed to support the findings of Gray et al. (1991). PI occurs when new learning is diminished as a consequence of previously learned

material. This paradigm used on people with acute schizophrenia, depression and normal controls produced no evidence of a difference in learning.

The failure to utilise previously acquired information is proposed to account for the formation of delusions. However, disruption of LI (failing to use previous experience) is only seen in the first few weeks of an illness. After this the restorative effects of medication (Baruch et al. 1988) or the natural course of the illness (Gray, Pilowsky, Gray, and Kerwin, in press) means that disrupted LI is no longer demonstrated. However, the subjects used by Huq et al. (1988) and Garety et al. (1991) all had long histories of illness and were receiving medication. Hence, the jump to conclusions strategy is unlikely to arise from the same process that underlies the disruption to LI. There is disruption to LI for only a short time period, yet delusions, and voices persist over a long time and are often not responsive to medication. This begs the question of what are the psychological processes that operate in the "chronic" patients.

However, other investigations of hypothesis testing have revealed results consistent with those of Garety et al. (1991). John and Dodgson (1994) found that subjects with delusions requested less information on an inductive reasoning task. Once again demonstrating an apparent hastiness bias.

The classic inductive reasoning task is the Wisconsin Card Sorting Task (WCST). This has been given to groups of schizophrenics with the general result that they perform poorly (although by no means always, see the earlier section on Frontal lobe accounts). The value of these results in relation to delusions seems unclear. However, Young and Bentall (1995) had subjects complete a series of visual discrimination problems which in many ways resembled the WCST. People with delusions, depression and normal controls had to choose between pairs of stimuli presented on cards. Following positive or negative feedback from the examiner, subjects' ability to progressively narrow down the set of possible correct solutions was assessed. The groups did not differ in the range or total number of hypotheses generated. The people with delusions were less inclined than the controls to stick to their hypotheses when given positive feedback 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.

The possible 'jump to conclusions' strategy has been demonstrated on analogous ambiguous perceptual stimuli tasks. McReynolds, Collins and Acker (1964) showed subjects incomplete pictures of common objects. People with delusions were seen to 'jump to perceptions'. This was interpreted as an attempt to make sense of the environment, reducing ambiguity at the expense of reality distortion. Abroms, Taintor and Lhamon (1966) extended McReynolds et al. (1964) work of showing ambiguous images. In this case subjects were selected according to the severity of the paranoid

ideation. Paranoid subjects were more likely to make incorrect judgements rather than wait till they could be sure. Increasing hastiness was associated with severity of the paranoia. Similarly, McCormick and Broekema (1978) studied people with paranoid delusions, non deluded paranoid subjects and alcoholic controls on a perceptual recognition task. The paranoid subjects were seen to jump to conclusions, responding rapidly with complete certainty on the basis of little information. Hence, there is evidence of hastiness in decision making from a number of studies.

2.5.2 Social Reasoning

Bentall and his colleagues take an opposing view to Maher and argue that delusions do not arise from the operation of completely normal reasoning processes. In a series of studies it was proposed that people with persecutory delusions have information processing or cognitive biases to material that is related to the theme of the delusional belief. It is assumed that the theme of the persecutory delusion is intrinsically related to how the person with the abnormal belief perceives himself and the behaviour of others in the social universe. Since the delusions are assumed to be specific to certain themes or ideas, Bentall and colleagues specifically use material relevant to the delusional theme.

People with persecutory delusions have been shown to differentially attend to threat related items in an emotional Stroop paradigm (Bentall and Kaney, 1989). In addition, these subjects with delusions preferentially recall material that is related to the theme of the delusion (Bentall, Kaney and Bowen-Jones, 1994). In these tasks people with depression have been shown to exhibit similar biases to depression related material. This implies that people with delusions have schemata concerning material relating to personal threat in the same way that people with depression have been shown to have negative toned schema (Williams, Watts, Macleod and Mathews, 1988).

Reasoning biases in patients with delusions have also been studied using theoretical models derived from attribution theory. Social Attribution Theory (Hewstone, 1989) is a way of examining the explanations given for social behaviour. It deals with how social perceivers make use of information to arrive at causal explanations for events. As stated earlier, many delusions concern the relative social position in the environment. Depressed patients given the Attributional Style Questionnaire (ASQ, Peterson, Semmel, Von Bayer, Abramson, Metlasky and Seligman, 1982) provide responses for negative social events that are internal, global and stable. This means that people with depression tend to blame themselves for a negative outcome. For instance, if asked to explain why a romantic date went badly, depressed subjects would say it was their fault because they were boring to be with (internal), that others found them boring in other situations (global) and, that they would always would

be boring (stable). Kaney and Bentall (1989a) used the ASQ on subjects with persecutory delusions and found they made global and stable attributions for negative events too, but that they attributed them to external causes. People with delusions attribute the bad date to the fact that the other person was boring. This finding was independently replicated by Candido and Romney (1990). To some extent this pattern of attributions is normal as non patients typically attribute positive outcomes to themselves and negative outcomes to external causes. This is called the Self Serving Bias, and is seen as a form of self esteem maintenance. Other examples of the presence of a self esteem maintaining bias have been demonstrated on a number of different paradigms (Kaney and Bentall 1989b, Bentall, Kaney and Dewey, 1991)

2.5.2.1 A Paranoid Defence?

These biases in reasoning are found in non deluded normal subjects and appear to protect the individual from feelings of low self esteem. Thus, depressed people appear not to display these biases. Ackermann and DeRubeis (1991) report a phenomenon called "Depressive Realism" in which depressed people perform better at certain tasks in comparison to normal people. This is probably owing to the normal group being biased by an optimistic approach that the depressed patients no longer use. The studies reported above seem to indicate that paranoid subjects (and possibly patients with other delusions) have biases operating that are opposite in effect to the depressed group. The biases in persecutory delusions are extreme versions of what is found normally, perhaps indicating their function is to defend the individual from extreme feelings of low self esteem. This is consistent with the reports of Mirowsky and Ross (1983) who state that beliefs in external control (paranoia) are associated with low social status (and low self esteem).

In Melges and Freeman's (1975) Cybernetic model of paranoia they stressed the effects of the perceived loss of control over the self and others as a primary factor in the formation of delusions. This loss of control bears a striking resemblance to theories of depression advocated by Brown and Harris (1978) or Seligman (1975) in which the loss of control or mastery is seen as fundamental in the cause. The link between paranoia and depression is made explicit by Zigler and Glick (1988). They proposed that paranoid schizophrenia is really camouflaged depression. Similarly, Colby's (1975) shame humiliation theory argues that paranoia develops because individuals are prone to make inferences implying the self is inadequate and if this is acknowledged it will lead to humiliation. As this emotion is negatively valued the blame is transferred to others. This blame transfer prevents feeling shame but leads to a general suspiciousness of others.

Drawing on a model of the self outlined by Higgins (1987), Bentall, Kinderman and Kaney (1994) proposed that there may be discrepancies between how the person with delusions perceives aspects of the self. Depression has been hypothesised to arise from discrepancies between actual and ideal selves. Scott and O'Hara (1993) found that in students, depression was associated with actual-ideal discrepancies and anxiety was associated with actual-ought discrepancies. Bentall and his colleagues proposed that persecutory delusions may arise from an attempt to try and reduce the self-ideal discrepancy. This hypothesis implies that subjects with persecutory delusions should be biased towards processing of self related material in the same way that they were shown to be biased to threat related material. Kinderman (1994) asked subjects with depression, delusions and normals to endorse or reject a set of negative and positive adjective traits. Then in an emotional Stroop task they were required to colour name similar words. People with delusions endorsed a high number of positive trait words (more than depressed and similar to normals) and a high number of negative words (about the same as depressed and more than normals). The subjects with delusions showed interference on both sets of words whereas the depressed subjects were only slower on the negative words. This is interpreted as being consistent with the desire of the subjects with persecutory beliefs to maintain a positive self image.

This defensive style would appear to rely on explicit processes that are activated by a conscious self/ideal discrepancy. If the person was unaware that the self concept was being assessed then the defensive processes may not be activated. In this case it would be predicted that the people with delusions would be similar to the depressed people in attributional style. Lyon, Kaney and Bentall (1994) tested this hypothesis that the cognitive biases in delusions explicitly operate to defend self esteem. For this they used the ASQ as an obvious or 'transparent' test of attributional style, and thus self esteem defence. Additionally, the Pragmatic Inference Task (PIT) was used. This was developed by Winters and Neale (1985) as a way of eliciting defended feelings of low self esteem. As it is not apparent that it is assessing self esteem, it is called an 'opaque task'. It is presented in the form of a memory task but actually requires inferences to be made that reveal the attributional style. Lyon et. al., found that on the ASQ the subjects with delusions, as before, demonstrated an opposite style of attribution to the depressed subjects. The group with delusions made external attributions for negative events and internal for positive. On the opaque task (PIT), however, the group with delusions exhibited the same reasoning style as the depressed subjects and attributed negative events to internal causes. Thus, the explicit process of self-ideal discrepancy reduction is only seen on transparent tasks and not when the subject is unaware of the discrepancy.

The nature of the externalising bias for negative events is shown to work in an explicit manner in a report by Kindermann, Kaney, Morley and Bentall (1992) using the ASQ. Independent judges rated the attributions given as either internal or external. The

people with delusions externally rated causes that the judges considered internal causes. The judges were in close agreement with the other groups' ratings. It seems that the people with delusions generate an internal attribution consistent with the self-ideal discrepancy expected with depression and then explicit processes operate to reduce this discrepancy and externalise the blame.

2.5.2.2 Criticism of Social Reasoning Theory

Kaney and Bentall (1989a) have proposed that delusions of persecution may be understood as the reflections of a cognitive style in social attribution. The fundamental premise of this hypothesis is that delusions of persecution act to maintain the self esteem of the person with delusions. This approach draws heavily on a role for affect in persecutory delusion formation which few other theories do.

Maher (1992b) criticises the work on social reasoning on two grounds. The first is that in the task of attributing cause to person or stimulus the subjects with persecutory beliefs are seen as making more person judgements. This is a hypothetical judgement as there is no independent check of the falsity or truth of the inference that is made.

The second criticism is aimed at the evidence derived from the Emotional Stroop task. Bentall and Kaney (1989) regard the fact that people with delusions are more disrupted by threatening words as evidence of an emotional disorder. Maher regards this evidence as relatively unimportant as it would be expected since it is consistent with the general proposition that specific intense motivational and emotional states render individuals susceptible to stimuli relevant to their particular emotion. It reveals nothing about the cause. However, that either of these comments by Maher can really be considered criticisms seems doubtful. Differences in attribution, whether checked against an external criterion or not are still differences. As with an attentional bias to threat related stimuli, the fact that there are differences between groups is important. Even if not causal in nature they are almost certainly contributing to the maintenance of any delusional beliefs. Evidence that the attentional bias extends to self related material would not have been predicted if people with delusions attended only to threat related material.

2.6 Integration of theories

The proposed theories all have shortcomings and leave questions unanswered. It may be possible to arrive at an integrated and coherent view incorporating a role for abnormal perception, abnormal hypothesis testing and abnormal social attribution. This is accomplished to some extent in the accounts of Delusional Misidentification Syndromes (DMS). These syndromes are also useful as they reveal the blurring of the

strictly functional or organic distinctions. Until recently these syndromes were considered psychodynamic in origin, but modern techniques reveal the presence of brain injury in many cases (Fleminger and Burns, 1993). Like the concept of schizophrenia, the syndrome approach in these cases has been questioned as each of the types of delusional misidentification is really only defined by a single symptom.

Capgras Syndrome, or more appropriately the Capgras delusion, is where the person claims that relatives have been replaced by doubles or impostors. Usually the delusion is associated with a diagnosis of paranoid schizophrenia and used to be accounted for by explanations proposing conflicting or ambivalent feelings of love and hate. The delusion resolves the conflict by allowing hatred of the double without guilt. However, the organic contribution is hard to overlook and it is a combination of organic and psychological factors that provides the most compelling explanation.

Ellis and Young (1990) proposed that the Capgras delusion can be regarded as a mirror image of prosopagnosia. Prosopagnosia is a neurological impairment in which the patient is unable to recognise familiar faces. The subject loses the awareness of recognition but will maintain many covert signs of awareness. For instance, Galvanic Skin Responses show a greater change when a name is read that belongs to a face being shown to a prosopagnosic than when the name does not match the face, indicating covert recognition of the face. In Capgras, it is thought, the person retains the overt recognition abilities but loses the covert or affective component of the recognition. Bauer (1984, 1986) offers a neuroanatomical explanation of how this may occur. He proposed that overt recognition depends on the ventral visual limbic system pathway involving the ventromedial occipitomeporal cortex whereas, a more dorsal visual limbic pathway through the superior temporal sulcus and inferior parietal lobule subserves processes of emotional arousal. Ellis and Young (1990) proposed that in Capgras it is the dorsal route that is more severely affected than the ventral. Thus, overt recognition may be relatively unimpaired but covert recognition will be disrupted. This failure to elicit the normal emotional response will be most discrepant when regarding close family members. The loss of an affective reaction on recognition will lead to a search for an explanation. Here the importance of a reasoning deficit may be evident. As was mentioned earlier, Huq et al. (1988) report a jump to conclusions approach in people with delusions. It is possible that people with DMS may equally exhibit a hasty decision style (although this has not yet been investigated). Thus, any data gathering is likely to be restricted if the Capgras patient exhibits such a bias. The role of social attribution is also implicated in the formation of this delusion. Any change in the recognition (or lack of it) of others needs to be explained. The Capgras patient is usually suspicious and this implies they would have an external attributional bias for negative events (Kaney and Bentall, 1989a, Candido and Romney, 1990). Thus, the cause of the apparent perceptual change is likely to be attributed to a change in other people; they have changed.

A role for a combination of perceptual abnormality and reasoning biases is also proposed for the Cotard delusion. This delusion is the belief that everything is so unreal that the person believes he or she has died. This delusion is also manifested as a belief that the body is dead and decaying or rotting. This has little apparent similarity with the Capgras delusion. However, both can be seen as sharing a perceived change in the world. Young (1994) proposed the underlying basis of both delusions may lie in a delusional interpretation of altered perception (especially loss of affective familiarity). In Capgras this change is attributed to the outside world owing to the external bias associated with suspiciousness. Cotard delusions commonly arise in the setting of a depressive illness, implying an internal attributional bias. Hence, in Cotard the perceived change is attributed to an internal cause. The Capgras patient perceives a change and externally attributes it to "they have changed, they are impostors". The Cotard patient perceives a change and internally attributes it to "I have changed, I have died".

Therefore, it can be seen there is a role for a perceptual abnormality as a cause of the delusion (the failure to evoke the emotional reaction). This may be combined with a failure to sufficiently evaluate the evidence (jump to conclusion). Then the final expression of the delusion is dependent on the mood state (internal or external attribution).

The actual importance of each type of factor is relative. Fleminger and Burns (1993) report an inverse relationship between the presence of paranoid delusions preceding the delusional misidentification, and the intensity of the organic cerebral disorder. Essentially, a very suspicious person may need little perceptual impairment to arrive at a delusional explanation and a person with a substantial perceptual abnormality (brain damage) may require very little suspiciousness as the quality of the input is evidence enough.

This account starts at an organic level but links the observed brain disease to the disturbed psychological functions that aid in creating the delusion. It argues that Capgras and Cotard delusions are in part caused by an impairment of the visual system. However, reasoning processes are necessary to the formation of the belief.

This demonstration of a role for a perceptual abnormality and reasoning biases is important as an analogous situation may exist in other delusions. Maher (1974) states clearly that the reasoning processes of individuals with delusions in no significant way differ from those of non deluded controls. However, the bizarreness of the explanations, the maintenance of the delusions across time and in the face of counter evidence, and the fact that not all people with the same perceptual abnormality arrive at the same explanation, implies a reasoning deficit or bias in the formation and maintenance of delusions. Maher (1974) is unable offer a reason as to why the delusion is bizarre except that it will offer relief from the perceptual abnormality and will thus be accepted.

According to Maher, delusions should always arise in the context of hallucinations or abnormal perceptual experience. However, in many instances of delusions there is no apparent perceptual abnormality. Conversely, it would follow that all people with hallucinations would have delusions yet this is not the case either. In addition, there are clear instances of people with perceptual abnormalities such as hearing loss, tinnitus, and phantom limb experiences where there are not delusional interpretations. With these factors in mind the attention now turns to possible models of delusion formation that have been suggested.

2.7 Models of delusion formation and maintenance

Maher (1974, 1988) proposed that delusions arise from the operation of normal reasoning processes attempting to explain an abnormal perceptual experience. Maher's theory advocates that reasoning is entirely normal in people with delusions. This is clearly not the case. Maher's account is inadequate unless a role for reasoning biases is acknowledged. It is the rigid distinction between perception and judgement that is problematic for Maher's proposal. Judgement is involved in perception. In the case of a perceptual abnormality such as a hallucination the experiencer has a judgement as to the source of the experience (i.e. internal or external origin of the voice). A role for both perception and reasoning is considered necessary for the formation of delusions. Therefore, additional accounts of delusion formation need to be considered.

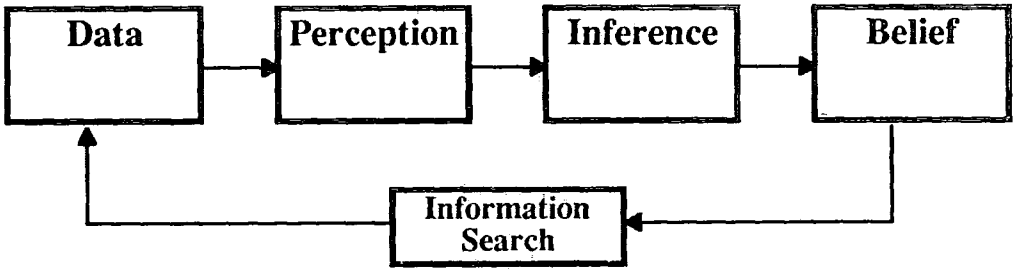
Capgras and Cotard delusions were proposed to be formed by the interaction of a perceptual abnormality (loss of affective familiarity) and reasoning as to the cause of the change. The reasoning style was determined by the predominant mood state. The presence of a reasoning difference is essential to the formation of the delusion. The presence of a perceptual abnormality is not sufficient in itself. In the absence of the additional reasoning bias the subject would be considered to have a different type of psychiatric symptom. For instance, the feeling that the world has changed is called Derealisation. The feeling that the subject has changed is categorised as Depersonalisation. Therefore, in some delusions it seems that a combination of factors is necessary for the formation of an abnormal belief. This multifactorial nature of delusional beliefs can be represented with the help of a model.

2.7.1 Bentall's model of belief formation

The model outlined below is taken from Bentall (1990b). It represents four stages of belief formation. A subject receives data, this is perceived, an inference is made and this is passed on to be stored as a belief. This belief will then direct any future information gathering (i.e. confirmatory information search). A belief can be formed at

any point in the system. Maher (1974) would argue that the perceptual process is faulty and this abnormal experience is interpreted using normal inferential processes. Bentall (1990b) would argue that the perceptual experiences are irrelevant but that it is the reasoning processes that are biased. However, the view forwarded here is there likely to be a combination of abnormal perceptual and inferential processes necessary for the formation of delusions.

Figure 2.1: Bentall's (1990b) model of belief formation



Bentall acknowledges that this is a crude model of belief formation and it is only meant to be an illustration of where differences may occur. However, it seems that there are two large omissions from the model; namely the effect of mood state and the importance of beliefs about the self.

Mood state determines the attributional style. Negative mood leads to an internal attributional style for negative events and a suspicious mood leads to an external style. Without the appropriate mood state there is less chance of a delusion being formed. The attributional style is determined by the mood state and this drives the inferential system. As was shown in the Capgras delusion in the absence of the appropriate suspicious mood state the abnormal perceptual experience is not delusionally interpreted but is expressed as a strange perceptual experience. The person is considered to have the symptom of derealisation as people and places seem artificial or not real.

The mood state is to some extent determined by the individual's beliefs about him or herself. Depression has been hypothesised to arise from discrepancies between the actual and ideal selves (Scott and O'Hara, 1993). Bentall, Kindermann and Kaney (1994) proposed that persecutory delusions may arise from the attempt to try and reduce self-ideal discrepancies. Therefore, discrepancies between how the person perceives aspects of the self may contribute to the determining of mood state and to the attributional style. Hence, to the expression of the delusional belief. Therefore, the belief box should consist of a number of submodules that take account of the importance of beliefs about the self.

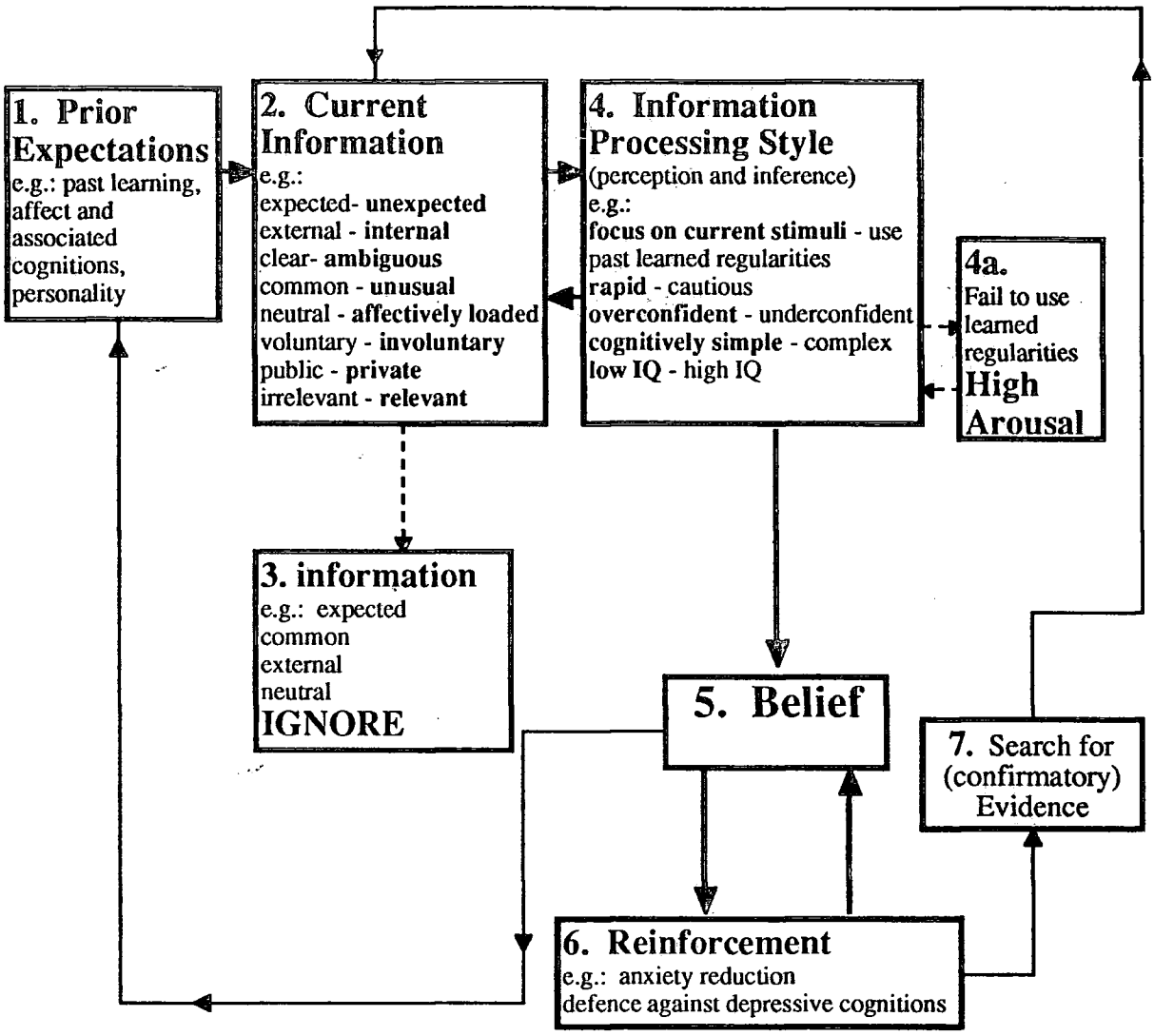
Once the belief box has been revised there is a need to appreciate what a strong role beliefs can play on the other stages of belief formation. A pre-existing belief can shape what data is selected as one tends to look for evidence to support an existing belief

(confirmation bias, chapter 3). In addition, the beliefs can influence what is perceived as was shown in the White Christmas task (Barber and Calverley, 1964, and Mintz and Alpert, 1972). Beliefs also influence the inferential processes (i.e. Belief bias, chapter 3). Therefore, the arrows on the model ought to be bi-directional to recognise that beliefs can drive perception and inference.

2.7.2 Garety's model of belief formation

A more complete account of delusion formation and maintenance was proposed by Garety (1991) and is shown below in Figure 2.2. The model outlines the process of belief formation in general and indicates features of information processing that may be implicated in delusion formation. An individual starts with pre-existing expectations which are dependent on mood states and personality (box 1). This influences the selection of information in the environment which is detected (box 2). Material that is expected, common and affectively neutral is disregarded (box 3) but selected salient information is processed further (box 4). The belief (box 5) arises from the interaction of the type of information and the style of information processing. According to Garety (1991) there will be occasions in which the type of information will be the primary abnormality thus, a perceptual abnormality will lead to a delusion. Such instances may be drug/alcohol induced psychoses or in neurological disorders (presumably including Capgras and Cotard delusions). However, in cases where the perceptual system is less disrupted the information processing and judgemental processes play a larger role. The items in bold represent factors that are especially implicated in delusion formation. The broken lines represent processes that are thought to be impaired in people with delusions. Boxes 6 and 7 are essentially concerned with belief maintenance and would operate for delusions as they would for any other belief.

Figure 2..2: Garety's (1991) model of belief formation



Delusions are thought to occur in the non affective psychoses primarily from a failure to utilise previously acquired information. This inability to use past experience leads to errors of processing in the information selection (box 2). Material that should be ignored is considered as unusual, and unexpected and is passed on for further processing (box 4). Here the processing style of focusing on current stimuli and being hasty and overconfident in processing will lead to previously neutral and ignored stimuli having an abnormal sense of significance. This then leads to a state of high arousal (box 4a) which itself leads to poor processing of material (see Garety, 1991 or Garety and Hemsley, 1994 for a full account of the model).

The strength of this model is that it is multifactorial. Many psychological models of schizophrenia try to specify one single cognitive dysfunction. However, this model argues that a number of factors contribute to the formation of one symptom within the

mantle of the term schizophrenia. This model explicitly recognises that delusions are complex phenomena that are not all likely to be caused by the same factors. Delusions occur in a wide variety of conditions. In some cases there may be a large distortion of perceptual input that drives the belief. Garety emphasises neurological and drug induced delusions. However, as has been detailed previously an inferential bias seems necessary for the expression of the delusion (Capgras and Cotard beliefs).

Another strength of the model is the significant role given to the importance of the belief. To an extent beliefs drive the entire system. Prior expectations (box 1) based on personality and past learning influence the selection of data from the natural environment. In addition, previous experiences determine which information is unusual or unexpected and requires further processing. This then overcomes one of the limitations of Bentall's model where the person was very undirected in the selection of information from the external.

A third strength is that the model clearly recognises the intimate entanglement of perception and judgement. Box 4 explicitly combines the functions of perception and inference. This then draws attention to the similarities between delusions and hallucinations and helps overcome the limitations of Maher's theory.

A final strength is that it can be usefully applied to individual cases both to facilitate understanding and as an aid to any clinical intervention (Garety, 1992). A clear description allows the testing of the model in single cases in an application of the principles of neuropsychology to psychiatric symptoms (David, 1993).

An apparent weakness with the model is the reliance on the failure to utilise previously acquired information to explain delusions. As was mentioned in earlier, the inability to use previously acquired information is usually assessed on the Latent Inhibition (LI) paradigm. Disruption to LI is only seen in the early stages of the psychotic illness and is no longer present after treatment with antipsychotic medication (Gray et al. 1992) or after a few months into the natural course of the illness (Baruch et al. 1988). The inability to utilise previously acquired information is proposed to account for the jump to conclusions strategy seen on the beads task (Huq et al. 1988). Since virtually all of the subjects used in the beads tasks had delusions for some considerable time presumably despite having had aggressive medical treatments it is doubtful that they would exhibit disruption to LI. This would indicate that these subjects who have delusions are able to utilise previously acquired information. Therefore, an additional factor is required to explain the continued maintenance of the delusional belief. Failure to utilise may account for the formation of the initial belief but beliefs emerging later and the continued existence of delusion requires a separate explanation.

2.8 Conclusions

Many explanations have been put forward to account for delusions. All have relative merits and faults. The lack of clear hypotheses and empirical research precludes the Psychoanalytic theories from further consideration. However, the valuable contribution that is made is the recognition that the delusions serve a function to the person. At the very least the delusion acts as a belief and helps organise incoming information. The fact that delusions may have other self esteem serving functions does not require acceptance of the psychodynamic viewpoint either. Erotomania or De Clerembault's syndrome, where the person believes that they are loved by a person of importance, is clearly self esteem enhancing. In a similar way, persecutory beliefs require the person to be important enough to be watched and spied on in the first place. Roberts (1991) has found that delusions can give the believer a sense of purpose in life in a similar way that religion can for Anglican Ordinands.

Organic accounts of delusions should not be dismissed too hastily. Any theory of delusions must ultimately account for their presence with reference to the organic substrate. However, this must be conducted in the manner outlined by Marr (1982) and should only occur after the psychological theory has been fully formulated.

Other accounts often refer to an organic location as a source of dysfunction but only as an association with a psychological process. Of these theories Frith's (1992) theory of willed intentions is perhaps the most elegant even if it is not able to account for the full range of delusions.

Of the explanations offered for the formation of delusions, two seem the most acceptable, despite being apparently incompatible. Maher (1974) advocates that delusions arise from perceptual abnormalities. The reasoning processes of the patient with delusions are essentially normal. An alternative explanation for the formation of psychotic delusions (especially paranoid) is advocated by Bentall (1994) and Garety (1991) in which abnormal reasoning processes are thought to be the cause. The abnormality is not considered a deficit as such, but an extreme form of normally operating biases. The difference is not qualitative as there is no truly logical thought, only degrees of bias. It is postulated by Bentall (1994) that the biases are motivated by a need to defend self esteem. In actual fact, these theories may not be as different as they appear. Essentially, both are proposing that delusions are at least maintained, if not formed, with normal cognitive processes. Maher (1992a) states that the reasoning processes differ in no significant way from normal. In Bentall's case the processes are normal but are operating at an abnormally biased level. Hemsley's (1994) proposal that delusions arise from a failure to utilise previously acquired information is somewhat both a perceptual and reasoning theory. A failure to draw on past experience will leave perception unguided and normally neglected material will enter consciousness (a

perceptual abnormality). In addition, the same cognitive inability to draw on prior experience will mean that the material now in consciousness will gain abnormal significance and likely be erroneously linked with other unrelated events (reasoning abnormality). This failure to utilise previously acquired information is given a key role in Garety's model of delusion formation.

Perceptual abnormalities almost certainly play a role in the formation of some neurological delusions (i.e. Capgras Delusion), but it is probable that additional factors are needed to account for the development of the delusional belief. This is because not all subjects under the same unusual experiences develop delusion like ideas to explain the events. Factors that may contribute to delusion formation include attributional biases and a "jump to conclusion" reasoning style. However, there is an apparent conflict present in the literature, between the reasoning and perceptual approaches. The aim of this thesis is to examine the nature and extent of any reasoning differences exhibited by people with delusions. However, before this goal is made explicit (chapter 4) attention is paid to what constitutes normal reasoning. Prior to embarking on an attempt to reveal incidences of abnormal reasoning it is worth considering what is the basis of normal reasoning, which is the purpose of the next chapter.

3 Reasoning, decision making and rationality

3.1 Introduction

The implication of the DSM-IV (1995) definition of a delusion is that the abnormal belief is formed and maintained using fundamentally different processes to those used in normal belief formation (see chapter 1). The definition states that delusions are based on incorrect inference, that there is a neglect of easily available discrepant evidence, and that the belief is resistant to counter argument. In this chapter it is argued that a great many beliefs held by "normal" subjects are surprisingly similar to this criteria. Hence, the distinction between normal and abnormal beliefs is not as categorical as suggested in the definition. The importance of this proposal is that in the previous chapter it was shown that the two most acceptable theories of delusions stated that either delusions were formed using reasoning processes that did not differ from normal (Maher, 1974) or that only differed in degree (Bentall, 1994, Garety, 1991). The purpose of this section is to discuss what constitutes normal reasoning. When studying supposedly abnormal beliefs it seems prudent to consider how normal beliefs are formed.

Here it is proposed that the vast majority of normal thinking may appear faulty if it is compared to an ideal prescriptive norm. This is because reasoning is proposed to serve the individuals' goals and not to adhere to a prescriptive model. Reasoning may be based to some extent on non logical biases that serve the individual very well in real reasoning and decision making. The purpose of these biases is considered as two fold. Firstly, these biases operate to reduce cognitive demands. Using a normative statistical model (such as Bayes Theorem, discussed later) as the basis of decision making would be time consuming and require a great deal of cognitive processing. All the relevant information would be have to be drawn to mind and reasoned with. Secondly, beliefs serve a purpose to the holder and reasoning in accordance with the laws of logic, may yield a conclusion that the subject does not desire. Reasoning is rarely a neutral process as it may affect beliefs. Beliefs are supports for cognitive activity and aid in reducing uncertainty. They serve to organise the world and support optimal functioning and self esteem. They appear to serve a purpose to the holder and are not scientific hypotheses that are devoid of personal significance. Shared beliefs on topics of religion or politics allow identification with a group or subculture. Since beliefs serve a purpose to the holder it is possible that beliefs may be developed to suit the individual rather than meet the logical norm.

This is only one view of the nature of reasoning and belief formation. To allow a full discussion of these ideas a brief summary of theories of reasoning will be outlined. To support the proposal that reasoning in normal beliefs is not qualitatively different from that seen in delusions, examples of biases in belief formation and maintenance will be detailed. The similarities to processes in delusional beliefs will be noted as well. The existence of non logical biases in reasoning is seen as evidence that delusions share many of the features of non delusional beliefs. Thus, delusions should be viewed as existing on a continuum with other beliefs and not as categorically different. The existence of unusual beliefs widely spread throughout the normal population will be demonstrated as support for the continuum idea. Thus, this chapter has four main aims. The first is to give a brief review of some of theories of reasoning and decision making. Secondly, there are examples of numerous errors and biases in thinking prevalent amongst the normal population. This indicates that the processes proposed to be at fault in delusions are found in people without delusions. Thirdly, these biases are shown to underlie the formation of many apparently faulty beliefs widespread amongst normal people. Thus, it is proposed that there are many unusual beliefs in the normal population. These beliefs are thought to be formed using processes similar to those in people with delusions. Hence, the fourth aim is to outline a possible continuum of beliefs that would demonstrate such a relationship.

3.2 Theories of Reasoning and Decision Making

This chapter covers two main areas of research, namely reasoning and decision making. Reasoning is concerned with the ability to use rules, pursue arguments, and determine the consequences of assumptions and hypotheses. Typically, research has focused on the solving of deductive tasks such as syllogisms, propositional reasoning and the Wason's selection task (all described later). Decision making is concerned with the use of statistical and probabilistic models of thinking. Decisions are often complicated and involve balancing a number of factors. For instance, the decision to continue at University or take a job requires determining the probability of achieving outcomes in each field and the reward that each outcome would bring. The distinction between the two types of thinking reflects the interests of the different groups of researchers more than any assumption that each area relies on fundamentally different mechanisms and processes. Consideration will first be given to theories of reasoning.

The theories forwarded to account for reasoning essentially differ on whether they propose that people are able to use an internalised form of natural logic or that people rely on implicit heuristics such as calling to mind similar cases. (For a fuller account of all of the theories see Evans, Newstead and Byrne, 1993)

3.2.1 Mental Logics

According to this proposal people use content free syntactic inference rules to reason about situations (e.g. Braine and O'Brien, 1991). People possess an abstract logical competence that is implemented in an equivalent way to syntactic rules of a standard logical system. This normative theory of formal logic dates back to Aristotle who proposed a system based on the syllogism. It is assumed that there is an inherent mental logic comprised of a set of abstract inference rules or schemas that are applied in a general manner for reasoning in all contexts (also the view held by Piaget, 1952).

The general assumption is that humans are natural logicians who only perform poorly on reasoning tasks when affected by extraneous influences. Such factors may be difficulties in comprehension or limitations of cognitive abilities such as working memory. The problem is that this theory is mainly derived from studies of propositional logic (reasoning involving the use of words such as *and*, *or*, *not* , *if .. then*). This is only one of many types of reasoning that people can perform. Thus, it is difficult to see if the mental logic approach can account for results in other areas. For instance, performance on the Wason selection task (chapters 7 and 8) improves the closer the content of the task becomes to real life scenarios. Abstract content free rules should be applicable in all situations and not be susceptible to content effects.

3.2.2 Mental Models

The Mental Models theory (Johnson-Laird, 1983) proposes that logically competent reasoning can be achieved without any use of syntactic rules. People are meant to manipulate representations of the semantic contents of an argument in order to test whether a conclusion must be true given that the premises are true. The premises of a problem are constructed into Mental Models that represent the possible states of the world, consistent with the information in the premises. The conclusion can be tested trying to construct a counter example; alternative models in which the premises are true but the conclusion is false. If no counter example is found, the conclusion is accepted as valid. Although the Mental Models theory does not presume that people have formal rules of inference, it does imply an implicit understanding of some logical principles. This theory is less heavily committed to the application of logical rules and thus, differs from the above approach.

The Mental Models approach is more able to account for the biases and errors in reasoning and is more complete as a psychological theory of reasoning (for a recent review see Johnson-Laird and Byrne, 1991). However, it is to some extent still mainly applied to the solving of syllogisms (*All A are B, All C are A, Therefore, all C are B*).

3.2.3 Schema theories

In this account domain sensitive rules or schemas are elicited by the context of the reasoning problem. This allows the application of specific rules, that have been previously learnt, to the solution of the problem. It is thought that we learn to reason in certain contexts (perhaps by example, or trial and error) and that schemas are formulated that abstract the knowledge. This type of approach is typified by the Pragmatic Reasoning Schema theory of Cheng and Holyoak (1985). It is most commonly applied to explain the effects of changing the content of the problem on the Wason selection task (see chapter 7). For instance, people may have a Permission schema that encapsulates knowledge of rules and obligations. If a reasoning problem elicits this pre-existing schema it may provide an example from previous experience of what should occur. The abstract permission schema may be expressed as:

If an action is to be taken then a precondition must be met.

If a subject is given the following problem of deciding if a rule is being broken, elicitation of this schema is thought to provide the correct solution.

If a person is drinking alcohol then they must be 18 or over.

Paul is 16.

If the schema is elicited the concept of permission will provide the inference that "Paul may not drink alcohol" without requiring formal reasoning. Thus, if Paul is drinking, the subject will be aware that this means that the rule is being broken.

The strength of this theory is that it can explain the good performance of subjects on reasoning tasks that are realistic in content. The formal mental logic and Mental Models theories are less able to do this. More realistic content is not sufficient in itself. The content must overlap with real life experience, perhaps allowing the solution to be obtained from memory (Griggs and Cox, 1982). Alternatively, the content must be sufficiently close to elicit a suitable schema. One difficulty the schema theories face is the ability to solve abstract tasks that should not allow the application of a schema.

3.2.4 Theories of decision making

Decision making research is concerned primarily with the making of statistical judgements. Like the study of reasoning, models based on deviations from an optimal normative theory have led the research. The models have been developed by economists, philosophers and mathematicians. The normative theories describe how one should go about determining the best possible course of action, given one's knowledge about the world and what one wants to achieve (i.e. the probability of, and utility of achieving the outcome).

One model applied to the study of statistical judgements is that of Bayesian probability theory. Bayes's theorem provides a rule for changing a belief in the light of evidence. The rule is formerly presented as:

$$P(H/E) = \frac{P(E/H) \times P(H)}{P(E/H) \times P(H) + P(E/Ha) \times P(Ha)}$$

The left side of the equation represents the probability (P) that the hypothesis (H) is true given the evidence [P(H/E)]. The upper part of the right half of the equation shows the probability of evidence occurring given the hypothesis [P(E/H)], multiplied by the prior probability of the hypothesis being correct [P(H)]. This is all divided by the probability that the evidence will occur i.e. P(E). The chance that this evidence will occur is calculated from the probability of evidence given the hypothesis P(E/H) multiplied by P(H) plus the probability of the alternative hypothesis (Ha), being correct given the evidence ([P(E/Ha)]. This is multiplied by the probability of an alternative hypothesis [P(Ha)].

An example may help! Huq et al. (1988) showed subjects two containers full of beads in equal but opposite ratios. One jar contained 85 red beads and 15 blue, whilst the other jar contained 85 blue and 15 red. The jars were hidden from view and subjects were shown one bead at a time from a randomly selected jar. Assume that one red bead was shown. Bayes's theorem allows a calculation of how likely this bead came from the mainly red bead jar.

The prior probability (P) that the bead is from the red jar is 50% since there were two jars. Therefore, P(H) = 0.5 as does the alternative hypothesis [P(Ha)= 0.5)]. If one assumes that the red jar has been chosen then the probability that a red bead was chosen is 0.85. The probability of the a blue bead being chosen was 0.15. Therefore, the lower line of the theorem can be calculated:

$$\begin{aligned} P(E) &= P(E/H) \times P(H) + P(E/Ha) \times P(Ha) \\ &= 0.85 \times 0.5 + 0.15 \times 0.5 \\ &= 0.5 \end{aligned}$$

This provides the posterior probability of the jar being red.

$$P(H/E) = \frac{P(E/H) \times P(H)}{P(E)} = \frac{0.85 \times 0.5}{0.5} = 85$$

Therefore, according to Bayes theorem on the basis of one piece of evidence the probability is 85% that it is the red jar. Two red beads, according to the theorem, provides a probability of 97%. Normal people are usually more conservative than this.

Bayesian analysis was used in three of the following studies. Fischoff and Beyth-Marom (1983) argued that Bayesian inference provides a general framework for peoples' performance to be compared against. Thus, it is possible to assess one's departure or consistency from the ideal standard. Hemsley and Garety (1986) have stated that this model can be applied to the study of delusional reasoning and have used it a number of studies (Huq et al. 1988, Garety et al. 1991, Garety and Hemsley, 1994).

Decision making research is of great practical value as there are many everyday situations in which probabilities and utilities of future events are necessary to consider. However, there are some limitations with this approach. The use of a normative model presupposes that we know all the actions that are within our power, all the possible outcomes of the actions and the relative utilities associated with each. This is computationally enormous, and implies that we are omniscient. It is difficult to believe people can make decisions in real time by applying a normative theory. In addition, it has great difficulty in accounting for many of the systematic errors and biases revealed in decision making tasks that are detailed below.

3.2.5 Dual Process Theory

A different perspective on thinking is provided by Evans and Over (submitted). Rather than viewing thinking as an attempt to attain an internal statistical or logic based ideal, it is necessary to consider what functions the thinking serves. It is likely that reasoning and decision making did not evolve for their own sakes. They would have developed to serve a purpose that was presumably very much goal oriented. It is doubtful that there would be an evolutionary advantage from the development of syllogistic reasoning. A recent theory has taken this into account. Evans, Manktelow and Over (1994) argued that there may be two types of thinking. There is a distinction between rationality^1, that is reasoning to achieve one's goals within cognitive constraints, and rationality^2 which is reasoning by a process of logic. It seems that rationality^2 does not provide a good basis for rationality^1 and therefore, comparison of subjects' performance on tasks against prescriptive norms (such as propositional logic, or Bayes's Theorem) does not imply that subjects are necessarily irrational even though they may apparently be illogical.

Rationality^1 is best determined by assessing the extent of the person's ability to achieve his or her goal. Rationality^1 is thought to be determined by essentially preconscious implicit processes that are computationally powerful and operate in parallel, and present the end products to consciousness. Rationality^2 is thought to be dependent on explicit and sequential processes that people are able to report to an extent. Someone may still be seen to be rational^1 even if their reasoning does not fulfil the

requirements for rationality[2]. For instance, a politician may dismiss the results of a report that conflicts with his views. This is apparently irrational[2], but if his goal is self esteem maintenance, and belief preservation then his behaviour is still rational[1].

This dual process theory of Evans and Over (submitted) is essentially a development of Evans's Heuristic-Analytic (H-A) theory (1989). Both of these view reasoning as consisting of two possible stages. The unconscious heuristic stage selects the information that is 'relevant' for the reasoning task. This selection is produced by choosing some of the current information available and retrieving additional information from memory. This may be sufficient in itself to produce an answer. If necessary, the selected 'relevant' information is passed on to the second stage of analytical reasoning where the chosen information is explicitly reasoned with. It is thought that the analytic stage is probably a form of Mental Models. Therefore, there are separate implicit and explicit reasoning modules. The implicit heuristic stage is considered to be very powerful and allows rapid, real time processing of information whereas, the explicit analytic stage is essentially slow and sequential.

The value of this approach is that reasoning is goal oriented. Rationality[1] is most likely to be dependent upon the implicit selection heuristics that reduce cognitive effort. The heuristic process although not clearly described, is apparently a form of Mental Models or is memory based. This framework of rationality being goal oriented will be used in the subsequent discussion of the numerous biases in reasoning and decision making demonstrated by normal subjects on either type of task.

3.3 Errors and Biases in Reasoning and Decision Making

Evidence for this discrepancy between reasoning by logic and reasoning to achieve one's goals is derived from a number of sources. The following examples are all considered biases or faults in that they are departures from some optimal system. Previously, these errors would be accounted for by claiming the inherent natural logic was constrained by limitations of working memory or another cognitive factor. However, these biases can be seen to serving the goals of the individual and hence, are rational[1]. The first three biases can be considered examples of faulty inference, then there are examples of a biased data gathering style, and disregard of discrepant evidence resulting in the maintenance of a belief in the face of contradictory evidence. Hopefully, the similarity to the processes implicated in delusions (chapter 1) will be obvious .

3.3.1 Heuristics

In real life a subject may not have all of the evidence available to base a decision on or may not have the cognitive capacity available to reason it through. Hence, there is a need for people to use cognitive shortcuts called heuristics that act as rules of thumb. These heuristics are biases and are not logical but they offer a satisfactory solution given the limited resources.

Kahneman, Slovic and Tversky (1982) demonstrated a number of such shortcuts. The Availability heuristic is one such rule of thumb used in inductive reasoning. It is a way of estimating the frequency of certain events, by considering how many such events can be called to mind (are currently available to memory). If someone is asked how many traffic accidents there are each day, the answer will be heavily dependant on whether any were seen in the last few days. Therefore, the judgement of probability is not formed in accord with a theory of statistics but by the ease of which an example is brought to mind.

Therefore, reasoning is often based on a lack of all the appropriate information. However, given the constraints of spending time gathering evidence and reasoning with it, heuristics appear to provide an adequate representation of the world (rational[1]). It would seem apparent that a subject with persecutory beliefs may have a specifically biased or distorted availability heuristic. When asked to call to mind the likelihood of people wanting to harm him, the availability heuristic will provide evidence that is relevant to that person. In this case it will be that people have recently been persecuting that person and that it is likely to continue. Bentall and Kaney (1989) reported that subjects with persecutory delusions had an attentional bias towards threat related material. Kaney, Wolfenden, Dewey and Bentall (1992) also found that similar subjects had a bias to remembering threat related material. Clearly these subjects differentially attend to and remember salient information that will invariably bias the information available to reason with. Presumably this will help maintain any paranoid beliefs.

The heuristics outlined above appear to serve the goal of reducing cognitive effort in decision making. However, reasoning is potentially subject to even greater biasing in order to achieve a desired goal, especially if the goal is self esteem related. Subjects have been proposed to have 'motivated reasoning' which is driven by a wish to achieve a conclusion (Kunda, 1990). The motivation to be accurate enhances the use of those beliefs and strategies that are considered most appropriate; whereas the motivation to arrive at particular conclusion, enhances the use of those beliefs that are more likely to arrive at the desired conclusion. For instance, people who smoke tobacco will reject or disregard evidence that is harmful or will not regard themselves as subject to the laws of statistics. People are more likely to arrive at conclusions that they want to reach.

Taylor (1983) implied that motivated reasoning may be beneficial as the resulting 'illusions' promote mental health: unrealistically positive views of the self and the world are often adaptive (see section on overconfidence below).

3.3.2 Overconfidence

One method of studying confidence in judgement is to present subjects with general knowledge questions with two alternative answers provided, one of them being correct. Subjects are asked to choose one of the answers and rate how confident they are in the correctness of their decision (from 0.5 to 1). If on average a subject gave a rating of 0.7 and actually was correct on 70% of those items he would be considered well calibrated. Lichtenstein, Fischoff, and Phillips (1982) reviewed this field of research and reported that subjective probabilities were consistently higher than the objective probabilities. Subjects were generally over estimating what they knew. People are apparently irrational[2]. However, there do appear to be potential advantages to being overconfident and not being well calibrated.

For instance, if one is overconfident (relative to the statistics) that one is going to recover from a life threatening illness it may actually aid the chance of recovery. If one was well calibrated and aware of the low chance of survival it may lead to a depression that may adversely affect the health of the subject, further reducing the chance of survival. Taylor (1983) studied the cognition's of patients with serious cancers and found many sustained illusions that may have helped them recover. Illusions serve a useful purpose. Thus, distortion of the facts may be a normal process when faced with a threatening or disturbing event. If one was well calibrated then one may well be aware of what low chances one had of survival. However, this is not the only goal that people have when reasoning. If one's aim was good health then the rational[1] behaviour would be to ignore or forget the objective probability of recovery.

Studies of people with depression have revealed that this state is associated with greater realism, and that mental well being is actually a state of unrealistic optimism (Alloy and Abramson, 1979, Ackerman and DeRubeis, 1991). It has been suggested that optimism (overconfidence) may act as a spur to initiate action. If it is thought that an action will be completed successfully it is more likely that the action will be performed.

Mild depression may occur in order to reduce overconfidence (Nesse and Lloyd, 1990). Someone may fail to achieve a goal that had been pursued unrealistically because of an overconfident expectation of success. Depression that occurs after the failure, may help recalibrate the expectations of the subject so that s/he strives for more attainable goals. Hence, mild depression is seen as leading to a state of being that is "sadder but wiser"(Alloy and Abramson, 1979). Huq et al. (1988) reported that people with

delusions were more confident than control subjects on a probabilistic reasoning task. Therefore, they were relatively overconfident in decision making. Optimism is usually seen as a self esteem enhancing process. This overconfidence appears consistent with Bentall's (1994) view of delusions serving to protect the self from feelings of low self esteem, as depressed subjects are typically under confident. (Confidence in judgement will be specifically dealt with in chapters 5 and 6).

3.3.3 Belief Bias

A third example of apparently faulty inference is belief bias. This occurs for instance, in the solving of syllogisms. People are less able to solve syllogisms that although logically correct, contradict normal beliefs. For instance, if the syllogism requires a person to endorse as correct a conclusion that cigarettes are not addictive, fewer people will choose this as the right answer. The person has added his real world knowledge to the premises. This inability to dissociate real world knowledge from the demands of the task is considered as another irrational[2] fault. However, it would seem quite rational[1] to bring in additional knowledge and add it to the premises. To an extent it seems wise to rely on what one knows and not necessarily what one is told to believe. In addition, the successful communication of thoughts is very dependant on the making of inferences, and on bringing additional information to what is said to create a meaningful context.

Once a belief is established it will influence what is subsequently encountered. It is easier to rely on what you hold to be true rather than what you are told at that moment (see below for further illustrations).

3.3.4 Hypothesis Preservation

In addition to examples of faulty inference, there are cases where normal people fail to gather data efficiently or do so in a biased way. Hypothesis preservation occurs when someone is presented with evidence that is contrary to the existing belief. If the person does not reject or alter the belief they are considered to be incorrigible (as in the definition of delusions). Once again this is seen as evidence of irrationality[2]. However, it is apparent that disregarding evidence that is discrepant with your existing beliefs may be rational[1]. For instance, the politician may be faced with evidence that a policy s/he advocated failed. Rationally[2] the politician should alter the belief. However, there may be additional goals of maintaining self image and self esteem. Once a position has been publicly stated, to yield it would involve loss of face. Military decision making has revealed episodes where a decision was maintained despite it obviously being wrong.

The usual reason that this occurred appears to be as self esteem maintenance (Dixon, 1976). The events leading to the bombing of Pearl Harbour, are with hindsight, now seen as clear predictors of the attack. These easily available pieces of evidence were readily ignored at the time.

In many ways it is not rational[1] to reject a belief that has served you well before hand on the basis of discrepant evidence. The Popperian model of falsification requires the rejection of a theory when counter evidence is provided. However, there is always a chance that the evidence may be incorrect. In addition, changing beliefs requires cognitive upheaval and effort. Before a belief is rejected it needs to be replaced with another acceptable belief. Therefore, rather than look for disconfirming evidence it may be beneficial (rational[1]) to seek evidence that endorses your view, as in shown next.

3.3.5 Confirmation Bias

Wason (1960) demonstrated an 'error' in inductive reasoning called the Confirmation Bias. The bias is the way a person seeks to confirm rather than disconfirm his views. Wason (1960) used the 2-4-6 task. Subjects had to generate 3 numbers that conform to a rule the experimenter was using. When generating numbers to test a hypothesis, subjects only generated numbers in accordance with the possible rule. They would not try to disconfirm their own hypothesis. This behaviour is not rational[2]. Disconfirmation is very valuable as one negative instance should refute all of the positives (Popper, 1959). However, it seems that people do not want to acknowledge the possibility of being wrong.

Disconfirmation is not used as much as confirmation. Gilhooly (1983) notes people are more likely to try to confirm rather than disconfirm their ideas. It is usual that someone returns to a restaurant where they had a good meal as they wish to confirm that it was good, and repeat the experience. It is not very likely that they would return to a restaurant where they had a bad meal to see if it will not happen again (disconfirming behaviour).

Lord, Lepper and Ross (1979) note that confirmatory evidence is accepted uncritically and that discrepant evidence is scrutinised. A possible reason is that any denial of a schema (or belief) will cause cognitive upheaval and require a reorganisation of one's ideas after they have been shown to be wrong. Thus, any discrepant evidence will cause cognitive dissonance (is unwelcome) and concordant evidence will reduce dissonance (welcome). Hence, it would appear to be rational[1] to maintain a set of beliefs and search for confirmatory evidence.

These biases reflect processes that are usually adaptive in the real world. The conflict with the explicit measurement of them is usually revealed on laboratory

paradigms or when large errors are revealed in real life (e.g. a plane crash). The aim has been to show that many normal beliefs are based on apparently faulty inference (heuristics, overconfidence, belief bias), that typically only confirmatory evidence is sort (confirmation bias) and any discrepant evidence is often ignored (hypothesis preservation). Therefore, faulty inference and incorrigibility are not unique to delusional thinking. Sutherland (1992) reports a collection of around 100 systematic errors in reasoning. This is taken as evidence of the essential irrationality of humans but it seems that it is actually irrational^2 rather than irrational^1. Consideration should also be given to the fact that these biases occur in normal people on tasks that are usually neutral in content. If a person is very stressed or emotionally upset then it is likely to reduce any information search, distort any facts and reduce consideration of any alternatives even further.

There are a number of reasons not to expect a formal logic to underlay real life reasoning. Firstly, evolutionary pressure is likely to favour short term, goal oriented reasoning more than formal logic abilities. A decision or belief that is achieved quickly and works effectively will be a satisfactory solution even if it is not optimal. If a predator is nearby it is desirable to climb up a tree that is high enough to achieve one's goal and not to worry specifically about which tree to select. Simon (1956) called this satisficing. This means that an option is chosen that meets the minimal standards. A tree is chosen that is high enough. It does not matter too much which one it is.

Secondly, the use of logic as the inherent reasoning system for humans seems wrong. Logic views the world as truth and falsehood. Therefore, there are only two states, but the real world is based on uncertainty. It seems that a Popperian view of reasoning is incorrect. Given that reasoning is goal oriented then there are utilities placed on the achievement of different goals. Different utilities have different probabilities of attainment. I may place a high value on marrying a model but the probability of doing so are low. Therefore, reasoning and decision making is not neutral and is not all or nothing but based on utilities and probabilities of outcome.

Given the large demands on the system it is likely that rational^1 thought would be achieved using computationally powerful implicit processes. Recognising a familiar face is presumably easier than explicit logical thought even though the computations in the former are enormous. Thirdly, reasoning is bounded by a general mental efficiency. Thus, it is preferable to rely on mental shortcuts that generally lead to adequate solutions. A final and very important reason for the apparent irrationality^2 of people is the self serving bias. Beliefs support self esteem and issues of identity. Resistance to material that challenges such beliefs is almost to be expected.

3.4 Evidence of Abnormal Thinking

The belief that human thought is truly logical and that errors only occur as slips, appears to be a false assumption. There is no legitimate reason to expect logical thought to be the basis of reasoning. Rather, it would be expected that illogical thought (but not irrational[1]) would be considered the natural state and that the presence of logical reasoning (rationality[2]) needs to be proven. Scientists, themselves, do not appear to behave in a strictly rational manner. Popper (1959) proposed that science progresses because of the development of competing theories held by different scientists. Not by one scientist evaluating all the available evidence and altering his hypotheses as necessary. The scientist is acting rationally in wanting to devise and test a theory, or disprove other people's ideas. However, it is unlikely that this will progress in an entirely unbiased way. If scientists are not truly rational then it makes the widespread acceptance of the existence of apparently abnormal beliefs, such as in paranormal phenomena, easier to understand.

A recent poll (Gallup and Newport, 1991) revealed over half of the Americans interviewed believed in paranormal phenomena (UFO's, ESP, etc.). Research has identified possible reasons why people believe in the paranormal. The first is that the pertinent evidence suggests it is justified. For example, the Theory of Evolution is based on scientific methods, but it is not especially attractive to many people. The other reason to believe in an idea is that it is attractive, e.g. religion. Research into the paranormal reveals that the holding of a belief is not owing to reference to the facts but because of the attractiveness of the belief. In addition, the belief is supported by the existence of numerous biases in thinking. Belief in the paranormal can be seen to fulfil many of the criteria for delusional beliefs except that even if the person is preoccupied by the belief he is unlikely to be the only one sharing it.

Like a patient with delusions, the paranormal believer regards the burden of proof as being with the scientists or doctors. The beliefs need to be shown to be incorrect. Yet, with the case of the paranormal it is impossible to prove that something does not exist, only that it has never been recorded. When a believer in the paranormal is confronted with contradictory evidence there is a reluctance to accept it (Hypothesis preservation). In fact there is usually an active search for confirmatory evidence (Confirmation bias).

A commonly stated cause of belief in the paranormal is personal experience (Blackmore, 1990). This usually means an unusual event has occurred that "could not have happened by chance". Blackmore (1990) suggests that people constantly search for connections between events and thus, for explanations. Chance is not regarded as a possible explanation. Hence, the demonstration of poor probability judgements can be

seen to be relevant. Normal, non deluded people when presented with an anomalous experience (chance occurrence) seek an explanation without realising it may be owing to chance alone. The death of a loved one after a dream is often quoted. Scott (discussed in Blackmore, 1990) actually calculated that if everyone in Britain had one dream of the death of a named relative once in their life then such an event would come true once a fortnight. In apparent support of this, Blackmore and Troscianko (1985) noted that believers (sheep) were poorer judges of probability than sceptics (goats). Brennan and Hemsley (1984) report a similar finding in subjects with persecutory beliefs. These subjects were found to see more "illusory correlations" between non related items than people without delusions.

Another phenomenon experienced is psychokinetics. In an event that is purely random the subject may feel he has had some control. If someone needs a six in a dice game and throws it he will regard himself as the cause. Sheep suffer more from the illusion of control than goats (Blackmore and Troscianko, 1985). Once again similar biases have been demonstrated in people with delusions (Kaney and Bentall, 1989b). This similarity between belief in the paranormal and the symptoms of schizophrenia has been noted. For instance, Thalbourne (1994) reported that people who believe in and claim experience of the paranormal tend to score higher on various measures relevant to schizophrenia.

Existence of paranormal events would require an enormous re-evaluation of the laws of physics. In such case the evidence would have to be very good indeed. To date there is not a replicable finding in support of paranormal phenomena that cannot be exposed as fraud or as methodologically weak (see Marks, 1986 or Randi, 1982, for a full discussion of this field). Therefore, belief in the paranormal is completely unfounded, yet despite this it is very widespread.

The evidence indicates that normal people do not engage in much purely logical reasoning. Such people demonstrate a willingness to believe in ideas that are only distinguishable from delusions by the fact they are quite widely held (ESP, odd or extreme religious and political beliefs). If rationality is defined by consensus agreement then it would appear that scientists are in the minority.

Evidence presented in this chapter indicates that reasoning in the general population is by no means logical. A number of biases operate to reduce cognitive effort as well as to help maintain self esteem. Thus, the suggestion that psychotic delusions are not qualitatively different from normal beliefs, but exist on a continuum of thought does not seem that radical.

3.5 Continuum of beliefs

Strauss (1969) examined data from studies on schizophrenia and proposed that symptoms like delusions, are best thought of as existing on a continuum of beliefs rather than being categorically different. Venables (1990) felt that there existed a continuum of belief from the cold rationality of science through the more interesting "milder madness of belief in horoscopes and magical intervention" (p.204) through to the delusions of mental illness

The implication of this continuum approach is not that delusions are "normal". However, this proposal allows the use of concepts from normal belief formation to be applied to research on the formation of delusions. The placing of a delusion on a continuum with other beliefs allows recognition that the delusion may fulfil a function in the same way as a normal belief. The delusion may act as a cognitive support to organise incoming information and be self esteem enhancing. Therefore, delusions may be considered as rational[1] in that they still serve goals and thus, have an "intentionality" that is denied them by theorists such as Berrios (1991).

3.6 Conclusions

From a review of the literature on normal reasoning and decision making it seems more likely that thinking occurs by the use of non logical biases, than by the use of internalised logic. This does not mean that normal subjects are necessarily illogical. Their behaviour is best thought of as being goal oriented (rational[1]) and not logic oriented (rational[2]). This has led to a shift away from explaining departures from optimal norms to explaining compliance with it. Rather than assuming that errors represent faults or limitations in an inherently logical system, errors can be viewed as representing the heuristic implicit processes underlying the reasoning.

The notion of people using heuristics and biases during reasoning has not gone unchallenged. Gigerenzer (1991) has argued that people reason very much in accord with statistical models if given tasks that deal with the long run or frequency rather than single cases. However, errors still frequently occur in single cases, and in many ways these are more representative of normal reasoning. For instance, when deciding whether to have an operation, or marry, it is the single case that is of interest and not the chance of success for other people (Kahneman and Tversky, forthcoming). Therefore, human reasoning is considered biased at least when dealing with material that is relevant to the self.

Errors in reasoning can be accounted for as rational[1] reasoning. Faulty inference based on heuristics has been interpreted as rational in that it reduces cognitive demands

or provides evidence that allows a desired conclusion to be attained. A confirmatory information search is also rational because if someone has an idea or belief then that person wants it to be proven and not disproven. Disregarding of discrepant evidence allows the retention of a belief that may have been useful in a number of other situations. Although the belief may not be applicable in every case it will probably provide a solution on most occasions.

This review has been purposefully brief. The focus has been on reasoning and decision making processes and biases in the system. There exists an additional vast literature that details problem solving, as well as belief and attitude formation on social issues. Given the nature of the experimental studies reported later this field has not been considered however, for a review of these areas see and Nisbett and Ross (1980).

The existence of non logical reasoning in normal people requires a reconsideration of the definition of delusion. The current definition requires that normal reasoning is based on correct inference and that beliefs are not held in face of discrepant information. The reliance on non logical but rational[1] reasoning biases makes it far easier to understand the great many apparently abnormal beliefs in the normal population. Thus, rather than view delusions as categorically different it seems far more realistic to consider them as lying on a continuum of thought.

The next chapter explicitly states the aims and methods of studying the possible reasoning biases in people with delusions.

4 Research aims and methodology

4.1 Aim of thesis

Chapter 1 considered the description and definition of delusional beliefs. It clearly indicated that the definition of a delusion was not as useful as it appeared. There was an apparent overlap with other psychiatric symptoms of obsessions, overvalued ideas, and hallucinations. Alternative classification systems that were based on a continuum approach were apparently more successful in describing delusions. Chapter 3 also emphasised the importance of a dimensional approach to understanding delusions. This was owing to the demonstration of the abundance of reasoning in normal subjects that appears to fulfil many, if not all the criteria for delusions (incorrect inference, incorrigibility). The reason for this apparent overlap between non delusional beliefs and delusions arose because reasoning was seen to be goal oriented (rationality[1]) rather than logic based (rationality[2]). Reasoning and beliefs (and delusional beliefs) were seen to serve a purpose to the holder.

Chapter 2 examined the theories of delusions, of which two appeared the most worthy of further consideration. Maher (1974, 1988, 1992) proposes that delusions are the result of normal reasoning processes operating to explain an anomalous experience, such as a hallucination. The alternative hypothesis is that there is actually a reasoning abnormality for material related to the theme of the delusion (Bentall, 1994). In addition, there appears to be a more general hastiness and overconfidence in decision making. This is even demonstrated when the material is unrelated to the delusional belief (Huq et al. 1988, Garety et al. 1991). Bentall and his colleagues have demonstrated that people with persecutory delusions preferentially attend to and recall threat related material. In addition, these subjects have a social reasoning style that is an exaggeration of that seen in normal people, where negative events are attributed to external causes. Essentially, the work of Bentall and his colleagues is demonstrating an apparent bias of processes. Whereas, the results of Garety and her co-workers implies that the reasoning difference is more generalised and more deficit like, as it applies to tasks unrelated to the content of the delusion. This is an important distinction. A deficit is usually a way of showing that a person cannot do something. Typically, neutral material is used to show that this limitation is generalised. A bias concentrates on the way that information is processed. Therefore, the content of the material is very important and a bias is best assessed with emotionally salient material. Deficits are thought to reflect damage or loss to the system whereas biases in the absence of cognitive deficits possibly reflect past learning and unusual life experiences. It has been

the case that deficits are usually studied, but biases can help reveal a great deal about the preferential processing of information. Essentially, a deficit will reduce the amount of information that is available whereas a bias will affect what is selected and how it is processed.

The purpose of this present research was to examine the nature of the possible reasoning biases or deficits in people with delusions. Performance of these subjects was compared with control subjects on a number of reasoning tasks that differed in form and content. The different forms of the tasks allowed a number of different types of reasoning to be examined (i.e. probability judgements, confidence in reasoning, hypothesis testing). The tasks were also varied in content so that both the abstract neutral (deficit) and the socially relevant material (bias) could be explored. Garety (1991) proposed that people with delusions had a biased information processing style. Namely, they should be hasty, overconfident, and pay undue attention to current stimuli by failing to draw on past experience in comparison to non deluded subjects (Box 4 in the model). The different forms of the reasoning tasks allow a test of these features.

The question of the existence of a reasoning bias or defect in people with delusions is an important one to be answered. It should not be confused with a search for a general intellectual deficit. Gruhle (1915) proposed that delusions are secondary to poor intellect. However, delusions occur in people demonstrating all levels of intelligence. According to Maher and Spitzer (1993) the more intelligent the person, the more integrated and cohesive the delusional belief will be, with regards to that persons other beliefs (systematised or encapsulated). High intelligence does not prevent delusions from forming, but it may affect the content and the expression of the beliefs. It would seem unlikely however, that there is a linear relationship between intelligence and systematisation of belief.

The practical implications for the value of this work appear twofold. Firstly, there is a definite need for the greater understanding of reasoning differences in Cognitive Behavioural Treatments (CBT) of delusions (and psychotic illness more generally). These treatments have had some limited success with people with delusions (Chadwick & Lowe, 1990; Kingdon & Turkington, 1991a, 1994). Refinements of these techniques will be possible once a fuller understanding of how these subjects arrive at their decisions is attained. Also, the increasing responsibility placed on the patient in the management of his or her own treatment (informed choice of medication, care in the community) means the person must be in a position to make an informed decision. Therefore, any defect in reasoning is potentially serious.

4.2 Method for studying reasoning

The demonstration of faulty or different reasoning processes in subjects with delusions requires more than asking the people why they think the way that they do. As Maher (1992a) notes the delusion cannot be the only example of faulty reasoning (see below). In addition, one cannot rely on introspection to demonstrate faulty reasoning. Nisbett and Wilson (1977) asked normal subjects to account for the way they reached a decision. The subjects were able to construct plausible accounts of the mental processes, rather than reporting on the actual processes themselves. Therefore, delusional reasoning processes need to be investigated experimentally.

However, one cannot decide if a group of subjects is competent at inference on the basis of responses to a single type of problem. To investigate reasoning it is necessary to use a number of measures that are manipulated in form and content. This should allow identification of the nature of the processes and the extent of the biases operating.

4.3 Issues to be addressed

Maher (1988) states that "nobody seems to have yet established that the processes of logical inference are basically impaired in delusional subjects". To demonstrate such an impairment Maher suggests "we need well controlled comparisons of the cognition's of deluded patients with those of non deluded psychiatric controls and normal controls, before we can confidently claim that delusions are due to a pathology of cognition"(p. 336). Therefore in this research one must aim to produce "a demonstration of cognitive malfunctioning independent of the delusion itself but of a kind that could still account for the delusion." In order to demonstrate such a difference Maher (1992a) states very clear methodological criteria that the research has to consider. Maher's criteria are detailed below.

A) Prescriptive or Comparative approach:

Defective reasoning may be assessed by comparing actual performance with a fixed ideal standard of performance. Alternatively, it is possible to compare the actual performance of a group of people with delusions against the performance of matched non deluded people. Neither group may perform perfectly but they may differ in the extent of their respective departures from the ideal. People with delusions will, according to Maher's criteria, show a greater departure from the optimal. However, the value of comparing subjects' performance against a normative model has

already been found to be lacking because reasoning is not based on logic but on goal achievement (chapter 3). Measuring departure from an optimal model implies that the subjects have an internal mental logic that is the same or similar to this model. Thus, poor performance by people with delusions may be owing to pragmatic limitations such as the availability of working memory (see chapter 3). This is not an undisputed assumption (Evans et al. 1993, Evans and Over, submitted). In the literature on depressive realism a similar call has been made for the use of a prescriptive norm (Ackerman and DeRubeis, 1991). On tasks like confidence measurement there are no right or wrong estimates of certainty. The experimenter is unable to control the beliefs and expectations that the subjects bring with them. How an external prescriptive logic is supposed to remedy this is unclear. However, where possible in the following studies an external prescriptive optimal norm is included in order to satisfy Maher's requirements.

B) Deductive or inductive reasoning:

Consideration needs to be given to the type of reasoning processes that are expected to be different or faulty. If one expects that the reasoning defect lies in the ability to deduce logical consequences from initial premises, then the comparison task will be based on the solution of syllogisms. In this case, one would expect to see one or more of the common fallacies associated with this type of reasoning. Alternatively, if the critical process is inductive reasoning then the investigator should, according to Maher, find errors that scientists will try to guard against (effect of sample size, failure to understand the unreliability of small differences, failure to abandon an initially plausible inference when subsequent observations produce strong counter data etc.). Therefore, in this thesis a number of types of reasoning tasks were used to explore a number of areas of reasoning.

C) Subjects with delusions must reason in ways that lead to false conclusions:

The third of Maher's criteria is that the group with delusions must make more errors than the non deluded group. Paranoid subjects tend to have higher IQ scores than non paranoids. Maher states that this is incompatible with the hypothesis that paranoid ideas arise from a cognitive deficit. However, it seems that the method of reasoning, rather than the outcome, is what is of interest. In Huq et al.'s study people with delusions

were better Bayesians according to the prescriptive norm. However, they did not reason like the control subjects. Despite this difference in style, the people with delusions did not make substantially more errors, indicating that a different style does not necessarily produce more errors. False conclusions may arise when the material is specific to theme and more errors are not necessary on all tasks with a neutral content. A deficit may not be evident in all tasks, even when a difference in style is revealed.

D) The delusion cannot generate and test the hypothesis at the same time:

For a reasoning difference to have a causative status, any difference must be evident on tasks that are unrelated to the theme of the delusion. Demonstrating that the person cannot reason about the delusion is not evidence that the person has faulty inference. It is not possible to say that someone has faulty reasoning because he or she is deluded. Take the case of a man who believes that a he is responsible for a war that happened before his birth. Clearly, the false inference is that he could have caused a war before he was born. If this is taken as evidence of the person having faulty inference processes it is akin to saying that someone has amnesia because there is a problem with that person's memory. The faulty process must be demonstrated under other additional circumstances if it is to qualify for aetiological status in the alleged pathology.

E) The defect must be non specific:

In a development from the previous proposition, Maher states that the tendency to arrive at false beliefs must be evident in beliefs that go beyond the topic of the delusion. This must be demonstrable in the natural habitat. The subjects with delusions must demonstrate a global deficit. If a person is shown to exhibit a generalised reasoning bias then evidence of this will be shown in other non delusional beliefs. If an individual holds only one specific delusional belief and has no evidence of faulty inference in the other beliefs, then this seems incompatible with a generalised reasoning difference. According to Maher, clinical evidence indicates that delusions tend to be limited in range implying that there is not a generalised reasoning deficit. However, demonstration of biased data gathering, preferential attendance to salient material and so on are all biased processes that alter the information available to reason with and should be studied.

F) Correlational studies:

Correlations do not demonstrate causes. Most studies of persons with delusions begin when the subjects are already diagnosed as deluded. Therefore, the subject is already a psychiatric patient. Delusions of persecution can be self fulfilling if that person is admitted to hospital. The only satisfactory solution of the causal direction dilemma is to produce evidence of the premorbid attributional style and inferential styles of the person with delusions. It is not possible to establish that hypothesis testing abnormalities are implicated in the origins of delusional thinking by a group comparison. It is only possible to demonstrate an association between a particular type of reasoning deficit and a particular type of psychopathology.

Whilst not in complete agreement with many of Maher's considerations it may be prudent to take on board as many of his requirements as possible, if only to help convince any sceptical readers. The studies that follow incorporated prescriptive norms and were varied in content from abstract and neutral (generalised deficit) to socially relevant and theme related material. It should be borne in mind that Maher's criteria are derived from the fact that the definition of a delusion requires the presence of faulty inference, whereas his theory argues that there is normal reasoning occurring in subjects with delusions. However, the previous chapter demonstrated that reasoning in normal subjects is not based on some system of logic. Rather, reasoning is about subjective goal achievement. Therefore, comparisons with optimal norms or demonstration of more errors may not be strictly necessarily if differences in reasoning style can be indicated.

4.4 Other considerations

As mentioned earlier, this thesis is an attempt to study one specific symptom, delusions, usually seen within a context of a diagnosis of schizophrenia. This approach recognises the value of studying psychological processes involved in symptoms. Whilst at the same time this avoids the problem of the relative heterogeneity of the schizophrenia diagnosis, that often leaves uncertainty in what is being studied. Not all schizophrenics have delusions and not all people with delusions have schizophrenia. For many years there have been countless experimental studies of the psychology of schizophrenia with very little agreement between them. Possibly, some of the lack of consensus is owing to the heterogeneity of people with a diagnosis of schizophrenia (Bentall, Jackson and Pilgrim, 1988). In addition, some of the so called problems in schizophrenia may simply be the consequence of being psychologically unwell and having a chronic illness.

4.4.1 Control groups

It is essential to consider the possibility that poor performance on tasks is merely a consequence of having a psychiatric illness. To control for this factor there are a number of possible comparison groups.

Since this thesis advocates the use of a symptom rather than a syndrome approach, it may be thought best to use patients with hallucinations (and no apparent delusions) with a diagnosis of schizophrenia. However, there are problems of using these people as a psychiatric control group. It is not clear whether hallucinations result from a failure of reality testing which is a judgmental skill (Slade and Bentall, 1988). In which case they may exhibit reasoning biases similar to people with delusions. In addition, people with voices often have secondary delusions, i.e. explanations of voices as telepathy or messages from God (see chapter two). If subjects with voices are not suitable that only really leaves patients with essentially negative symptoms. These negative signs are associated with intellectual impairment (Frith, Leary, Cahill and Johnstone, 1991) and possibly with ventricular enlargement (Crow, 1980). Given the very different pattern of presentation by subjects with predominantly negative signs it was considered best to use a group of patients without this degree of intellectual impairment.

People with anxiety tend to be treated very differently to subjects with delusions. Anxiety patients are usually treated as outpatients, in group sessions and are maintained on different types of, and generally less medication. However, Garety et al. (1991) did successfully compare subjects with delusions against a control group of anxiety patients, so their use is perhaps not always inappropriate.

Obsessional patients are known to have an over cautiousness bias on Bayesian tasks (Volans, 1976) and differ from normal subjects. Thus, it is considered best to exclude people with this symptom. Bipolar disorder patients (manic-depressives) often have grandiose ideas or delusions in manic stages and delusions of depression or guilt in depressive stages, and are best excluded on this basis.

On balance, people with depression were considered most appropriate to act as a psychiatric comparison group. There are a great number of similarities both in the shared symptoms and shared types of treatment. People with delusions often have depressive symptoms. The prevalence of depression in schizophrenia is apparently much overlooked. Lindenmayer, Grochowski and Kay (1991) found high levels of mild or moderate depression that was associated with the presence of positive symptoms (delusions and hallucinations) and not with negative symptoms as one might expect. Also, people with delusions may perform poorly on tasks because of a lack of motivation or poor attention spans, which are symptoms also associated with depression. Reich and Cutting (1982) noted that depressed subjects made good controls for

schizophrenics on a number of cognitive measures. Thus, there may be similarities in psychiatric symptoms and cognitive difficulties. Finally, unlike anxiety patients depressed subjects are more likely to be treated as psychiatric in-patients and will share the same ward environments as the people with delusions .

There are a number of possible drawbacks of comparing people with depression. For instance, the majority of depressed people are treated as outpatients by GP. or by outpatient units (Goldberg and Huxley, 1980). Depressed people who become in-patients have specific characteristics which distinguish them from the majority of depressed patients (Blackburn, 1989). Typically, depressed people that become inpatients in the NHS have one of the following characteristics: Psychotic features (delusions and hallucinations), a high risk of suicide or actual para-suicidal behaviour, severe impairment with gross retardation or agitation, anorexia, and sleep disturbance. They will probably be receiving Electroconvulsive Therapy (ECT). Therefore, care was taken in selection of subjects with depression so that they did not exhibit any of the above features.

4.4.2 Chronicity/Length of admittance

Until relatively recently most patients tested in psychological experiments were from a heterogeneous diagnostic group and were most likely to come from large institutions in which they had been living for many years. Institutionalisation invariably has effects on behaviour and performance on psychological tasks (Frith, 1992). Recent developments in policy have led to the closure of many of the institutions. Hence, this problem of institutionalisation impairing performance may be less of a factor. To control for any possible effect, only out-patients or patients on acute admissions wards were selected for participation. The out-patients all had active delusional beliefs but were able to function without in-patient care. Importantly, Goldstein, Zubin and Pogue-Heile (1991) found that the association between length of hospitalisation and cognitive decline is no more than is seen in normal ageing. Therefore, if a subject had had a long period as an inpatient this factor alone will not exclude him or her.

4.4.3 Medication

The vast majority of people with delusions are treated with drugs. The possibility that drug treatment leads to cognitive impairment needs to be acknowledged. One needs to consider a way to control for drug type and dosage. Theoretically it is possible to convert all the neuroleptics (antipsychotic drugs) to chlorpromazine equivalencies and equal body weights. However, this approach assumes that there is an equivalence between drugs, but the relationships between drugs and doses are non linear.

Thus, any estimates of equivalencies are unlikely to have much meaning. Different drugs are prescribed because they have different effects on patients. Thus, it is not really possible to control for these effects (Spohn and Strauss, 1989).

Fortunately, neuroleptics are associated with normalisation on many cognitive and psychological measures (Spohn and Strauss, 1989). Therefore, neuroleptics are likely to increase the homogeneity of cognitive functioning across patients. The anticholinergics that are sometimes prescribed to counter the side effects of the anti dopaminergic drugs can cause some disruption to some aspects of memory (Frith, 1984). Most likely it will effect recall but not recognition (Spohn and Strauss, 1989). Levin, Ben-Artzi, Levy, and Neumann (1992) reported that antipsychotics can have an effect on short term verbal memory but not on immediate, long term or short term visual memory. This degree of impairment was directly related to the anticholinergic effects of the neuroleptics. Therefore, subjects receiving courses of anticholinergic drugs were not asked to participate in the studies reported here.

Delusions are often resistant to pharmacological treatment and this implies that the processes may be fairly drug resistant anyway. Johnstone, Owens, Frith and Leavy (1991) in a follow up of over 500 people with a diagnosis of schizophrenia found that over 50% had moderate to severe delusions. In most cases the therapeutic effect of any medication is generally the moderation rather than abolition of any symptom.

4.4.4 Cognitive measures

For the research reported here, matching of groups of subjects for age was supplemented with an attempt at control for intelligence. Naturally, if one is to study reasoning differences between different groups it is desirable to demonstrate intellectual comparability. Otherwise poor performance on a reasoning task by a subject or group will be most parsimoniously explained by lower intellectual ability. Therefore, the groups of subjects used in the research were matched as far as possible for age, sex, and estimates of IQ. For an estimate of IQ. the National Adult Reading Test (NART, Nelson 1991) was used. The NART is a relatively robust measure of premorbid IQ. It is an oral reading test consisting of 50 words of irregular pronunciation. Subjects with a better education or who are more intelligent will be more likely to have been exposed to these irregular words. The words become progressively harder to read and the more a person correctly reads the higher their IQ. estimate. The NART is a quick, reliable and relatively robust indicator of intelligence (Crawford, Besson, Bremner, Ebmeier, Cochrane and Kirkwood, 1992). The NART correlates well with other measures of intelligence (Crawford, Parker, Allan, Jack and Morrison, 1991). An added benefit is that the person does not know if they are incorrect and this tends to reduce any anxiety associated with testing.

In addition, the Mini Mental State Examination (MMSE) was given to the participants. In this task the subject is asked a number of questions about his or her surroundings to assess current awareness. Also, the person is asked to perform a number of simple tasks such as comprehension of instructions or counting backwards from 100. The MMSE is used to confirm that the person is able to understand the instructions of the investigator and is a rough gauge of current cognitive functioning. Devised by Folstein, Folstein, and McHugh (1975) the Mini Mental State Examination is a widely used screening test for dementia. Like the NART, the MMSE is brief and easy to use. Several studies (e.g. Anthony, LeReche, Niaz, Von Korf, and Folstein 1982) have indicated that a score of 23/24 (out of 30) provides a sensitive and specific cut off for the presence of intellectual impairment. Thus, any participants scoring below this threshold were excluded from the main studies.

The importance of using cognitive measures arises from the demonstration of apparent impairments on intelligence measures by people with schizophrenia (Payne, 1973). However, this impairment is more marked in patients with chronic illnesses that are not characterised by the presence of delusions. In acute patients, intellectual decline is variable but usually very minor (McKenna, 1994). Most decline is seen in patients who are disoriented for time, place and their own age. Such subjects were screened out by the MMSE. Hence, intellectual impairments in the experimental group are expected to be minor if present at all.

4.5 Conclusions

Maher states quite clearly that "a reasoning defect in deluded patients remains to be demonstrated" (Maher, 1992a, p. 266). Whilst disagreeing with this statement (see Chapter 2 for demonstrations of abnormal reasoning) it does serve as a starting point for the thesis. The aim of the following investigations was to examine the performance of people with delusions on a number of reasoning tasks that differed in form and content. Manipulations of form allowed a coverage of deductive and inductive reasoning tasks (see Maher's criterion B). Manipulations of content allowed a series of tasks to be used that ranged from abstract, neutral material to socially and delusional related material. This allows the demonstration of any possible non specific defects in reasoning (criterion E) and reduces the chance of tautological explanations of delusions (criterion D). In all but one case (Chapter 6, the Cognitive Estimates Task) a prescriptive or optimal norm was used as well as a comparative approach (criterion A).

In this chapter consideration has been given to the suitability of different control groups. On balance, it was decided that people with a diagnosis of depression were most suitable. Attempts to control for medication, chronicity of the illness and cognitive measures were all outlined as well. The format for the following studies was the

comparison of the performance of groups of subjects with delusions, depression and normal people on a variety of reasoning tasks that differed in form and content. The participants were matched as closely as possible for demographic details. Screening procedures (NART, MMSE) meant the groups were relatively similar intellectually. People with a primarily negative or chronic type of illness were not asked to participate.

The study of reasoning in people with delusions seems of crucial importance. Beliefs (and delusions) are born out of the capacity to make inferences. The capacity to form and hold beliefs about the world and other people is vital to successful adaptation to the environment. A difference in reasoning that left a person susceptible to forming beliefs different to the rest of the population, may well lead to difficulties for that person.

5 Experiment 1: The Biased Coin Task

5.1 Introduction

As has been shown, relatively little is known about the formation and maintenance of delusional beliefs. Two main approaches have dominated the scant literature, these seek to account for delusions as primarily disturbances of perception (Maher, 1974, 1988) or as differences in reasoning (Von Domarus, 1944, Huq et al. 1988).

Reasoning biases cannot be overarching, since it is known that people with delusions do not fail all logical tasks; for example, they solve syllogisms as well (or as badly!) as non-deluded people (Williams, 1964, Evans, Newstead and Byrne, 1993). However, biases have been found in two particular areas; social information processing (Bentall and Kaney, 1989, Bentall, 1994) and hypothesis testing (Huq et al. 1988).

The concern here is with biases in hypothesis testing. Previous studies have demonstrated biased hypothesis testing in people with delusions, even for tasks with neutral content. For example, John & Dodgson (1994) used a twenty questions game to reveal evidence of a difference in reasoning styles in which people with delusions, in comparison to matched depressed and normal subjects, requested less information before reaching a decision. In this sort of study, the fact that the materials have no social or personal relevance supports the idea that the reasoning bias is generalised, rather than confined to material with affective or personal significance.

Maher (1992a) outlined the requirements for an adequate investigation of reasoning biases in people with delusions. He proposed that a prescriptive or optimal norm is needed to compare the subjects with delusions against. Reasoning about probabilities forms one such candidate, since Bayes's theorem can be used as a model (Fischoff and Beyth-Marom, 1983). Hemsley and Garety (1986) suggested that this model could usefully be applied to the study of delusional reasoning. Huq et al. (1988), employed this model and showed subjects two jars containing opposite proportions (85:15, 15:85) of coloured beads. Subjects were required to decide from which of the containers the experimenter was drawing a series of beads. People with delusions (schizophrenics) requested less information and were relatively over-confident in their judgements in comparison to normal controls and a psychiatric control group of mixed diagnoses. Garety et al. (1991) used the same paradigm with groups of patients with relatively pure delusional disorders (delusional disorder or paranoid schizophrenia on DSM-IIIR; APA, 1987) or more mixed problems (deluded schizophrenics). Irrespective

of their particular diagnosis, the people with delusions requested less information in comparison to anxious or normal subjects.

These findings are potentially important, since it is possible that such differences in hypothesis testing may contribute to the maintenance of an abnormal belief once formed. However, it is not known whether they apply in all tasks which involve weighing the probabilities of events, or only in those which take a certain form. Specifically, in the studies reported to date, subjects were always free to determine when they had enough evidence for their decisions. In this study it was therefore decided to explore biases in the reasoning of people with delusions in tasks which involve probabilities, but in which all the information necessary for a decision is given in advance. In subsequent studies (Chapters 9 and 10), the interest is in the possibility that the biases of people with delusions might relate to failures to gather sufficient evidence, rather than an inability to reason about probability *per se*.

Experiment 1 used the 'Biased Coin' task (Griffin and Tversky, 1992). In this task, subjects are presented with a set of results which they are told come from spinning a biased coin; it is their job to estimate the chance that the coin is biased to heads. Performance can be assessed by how closely subjects' estimates approximate the probability given by Bayes's theorem. Therefore, this method allows a comparison against an optimal model (Bayes's theorem) as well as a comparative study of reasoning between different groups.

Even more interestingly, however, is that it is known that normal subjects show specific biases. In particular, estimations of probability in such a task might be influenced by one of two factors, which Griffin and Tversky (1992) call the strength and the weight of the evidence. Consider the case where you are told that a coin is biased so that on average it comes up one particular way on 3 out of 5 times. Your job is to estimate the likelihood of whether the bias is to heads (rather than tails), and you are told that when this coin was spun 7 times it came up heads on 6 of those occasions. The strength of the evidence is represented by the proportion of heads in the sample; in this case 6/7. The weight is the number of spins (7 in this example), and represents the predictive validity of the sample. Griffin and Tversky (1992) found that normal subjects are unduly influenced by the strength of the evidence (i.e., the proportion of heads in the given sample) and do not take account of the weight (sample size). In other words, for normal people, the influence of sample size is overruled by the proportion of heads. For instance, when normal subjects are presented with evidence from 3 spins of a coin that produced 3 heads and no tails (a high strength and low weight trial) they often give a high probability that the coin is biased to heads (around 90%). When presented with evidence from 17 spins, 10 of which produced heads and 7 were tails (a high weight and low strength trial), subjects usually assess the probability that the coin is biased as much lower (around 60%). However, the actual Bayesian probability for both trials is 77%.

Therefore, subjects can be seen to be overconfident when the strength of evidence is high (high ratio of heads to tails) and the weight of evidence (number of trials) is low. Conversely, normal people tend to be under confident relative to the Bayesian optimum when weight is high and strength is low. (see Griffin and Tversky, 1992 for more definition of Strength, Weight, discriminability and the relation to Bayes's theory)

If subjects with delusions are shown to reason abnormally on this task it is predicted that they will be relatively overconfident, and give higher estimations that the coin is biased (Huq et al. 1988). Garety (1991) proposed the subjects with delusions are failing to draw upon previously acquired information and are relying on the immediately available evidence. Thus, they are presumably less able to take account of factors such as base rate and are reliant on the strength of the evidence. If they are excessively swayed by the strength (stimulus driven as in Salzinger's Immediacy hypothesis, 1984) subjects are likely to give estimates that are higher than those prescribed by Bayes's theorem. This will be considered as overconfidence. Therefore, overconfidence may be more evident on those trials where strength is high and weight is low. Also, in the literature on normal subjects, overconfidence is viewed as a self esteem enhancing bias (Sutherland, 1992) that is apparently lacking in subjects with depression (Ackerman and DeRubeis, 1991). Given that delusions operate as an active defence against feelings of low self esteem, in essence the opposite of depression (Bentall, 1994), overconfidence may well be expected.

An advantage of the biased coin task is therefore that it gives us a variety of ways of determining whether reasoning is normal. We can ask not only whether the probability estimates made by people with delusions are of normal size, but also whether they take account of (or fail to be influenced by) the same factors.

5.2 Method

Subjects: Three groups of subjects participated; patients with delusions, patients with depressive symptoms, and normal controls. All were given the National Adult Reading Test (NART: Nelson, 1991) to establish intellectual comparability across groups, and the Mini Mental State Examination (MMSE: Folstein et al. 1975) to determine mental status. Studies (e.g. Anthony et al. 1982) have indicated that an MMSE score of 23 or 24 (out of 30) provides a workable cut-off for the presence of intellectual impairment. Thus, anyone scoring below this threshold was excluded from the main study.

The experimental subjects were 12 patients with delusions. The criteria for inclusion were:

1) present delusional symptoms expressed by the patient in interview or to staff. Specifically, delusions of persecution or grandeur. Patients met a number of DSM-IIIR diagnostic criteria (9 schizophrenic, 1 bipolar disorder with psychotic features, 1 delusional disorder, and 1 schizoaffective disorder).
2) absence of formal thought disorder or negative symptoms to such a degree that the delusions were secondary features of the illness.
3) no evidence of any organic cause of illness, and no history of drug or alcohol abuse sufficient to warrant clinical attention.
4) have not received a course of ECT for at least the last month.
5) aged 18-60.

The first comparison group involved 12 psychiatric control subjects; the criteria were:

1) diagnosed as suffering from unipolar depression with no psychotic features.
2) no evidence of any organic cause of illness, and no history of drug or alcohol abuse sufficient to warrant clinical attention.
3) have not received a course of ECT for at least the last month.
4) aged 18-60.

A second comparison group involved 12 normal subjects drawn from the non-academic staff of Durham University and informal contacts. None were undergraduates or postgraduates. They were selected according to the following criteria:

1) no history of psychiatric care.
2) no training in psychology or statistics.
3) aged 18-60.

The diagnostic classification of patients, and presence of current symptoms was confirmed on the basis of inspection of case notes, recommendation by the responsible consultant, or by discussion with the responsible medical officer and staff.

Subject characteristics for these three groups are shown in Table 5.1. There were no significant differences across groups in age, NART estimated IQ, and MMSE performance.

Table 5.1: Subject characteristics in Experiment 1. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender* *M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	12	6	6	8	4	37.0 (9.9)	102.0 (10.8)	28.5 (1.5)
Depressed	12	5	7	2	10	38.3 (7.5)	99.0 (13.8)	28.2 (1.7)
Control	12			6	6	43.0 (12.4)	109.9 (7.4)	29.3 (1.5)
Significance						NS	NS	NS

Procedure: Subjects were presented with the following information:

> "Imagine you are spinning a coin, and recording how often it lands on heads and how often it lands on tails. Unlike tossing of a coin, which (on average) produces an equal number of heads and tails, spinning a coin leads to a bias favouring one side or the other because of slight imperfections in the rim of the coin and an uneven distribution of mass. Now imagine that you know the bias is 3/5. It tends to land on one side 3 out of 5 times. But you do not know if this bias is in favour of heads or in favour of tails."

Any further explanation required to clarify these concepts was given. The subject was then given a number of trials, in each of which she or he was asked to estimate the probability that the coin's bias favoured heads rather than tails. The subject was asked to state what the chance was (as a percentage) that the coin was biased to heads.

Twelve trials were given in total. Given that there is an equal chance of the coin landing on heads or tails there are three levels of probability calculable according to Bayes's theorem (0.60, 0.77, 0.88). At each level of objective probability, there were 4 trials that differed in the strength and weight of the evidence. These were chosen so that strength and weight were inversely related; at high weights (large numbers of spins) there would always be low strength (proportion of heads in the sample), and vice versa. In all, then, there were 12 trials; these are listed in full in Appendix 1. They were presented in a fixed pseudo-random order.

5.3 Results

The measure of interest is the probability estimates of subjects in each group. However, data for the 0.6 level of probability according to Bayes's theorem were excluded from analysis owing to the pronounced skew of the data; most subjects simply put the probability at 50% on these trials.

Data for the 0.77 and 0.88 levels of objective probability are shown in Table 5.2. A Group by Probability by Trial mixed analysis of variance was conducted. This analysis looked at objective Probability (0.77 vs. 0.88; repeated measure), trial Type (4 levels, ranging from high strength to low strength of evidence; repeated measure) and subject Group (deluded, depressed, normal).

Table 5.2: Estimates of likelihood that a coin is biased to heads at the 0.77 and 0.88 Bayesian levels of probability, from deluded, depressed and control groups. At each level of objective probability, the 4 trials are arranged in order of increasing weight and decreasing strength of evidence.

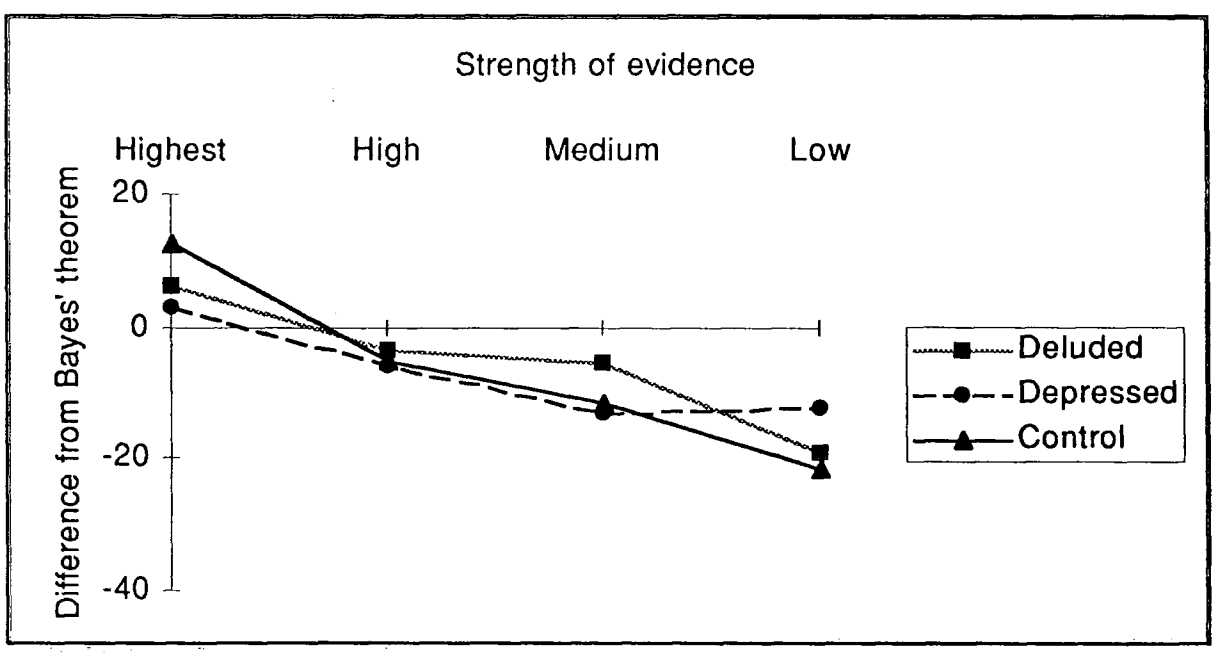
Bayesian probability	0.77				0.88			
Weight of evidence (number of spins)	Low	Medium	High	Highest	Low	Medium	High	Highest
	3	5	9	17	5	9	17	33
Strength of evidence (ratio of heads/tails)	Highest	High	Medium	Low	Highest	High	Medium	Low
	3:0	4:1	6:3	10:7	5:0	7:2	11:6	19:14
Deluded								
Mean:	93.3	75.4	76.3	63.7	84.2	82.9	77.8	62.9
SD:	14.4	15.6	17.2	13.2	21.5	12.9	11.2	12.3
Depressed								
Mean:	82.9	77.9	64.6	70.4	87.9	75.8	74.6	70.2
SD:	20.7	13.9	11.2	14.7	18.6	11	12.3	12.3
Control								
Mean:	91.7	80.4	73.1	60.9	98.6	74.5	69.2	60.9
SD:	13.4	11.4	9.15	9.3	2.6	12.2	12.8	6.3

The results of this analysis indicated no overall significant difference between the groups' estimates of the probability of the coin being biased (Group: $F(2, 33) < 1$). Also, there was no significant difference in subjects' estimated probabilities between the objective probability levels of 0.77 and 0.88 (Probability: $F(1, 33) < 1$). The average estimated probability levels were 76% chance at objective p=0.77 and 77% at objective p=0.88 respectively. There was, however, a significant difference between the different types of trial (Type: $F(3, 99) = 31.15$, $p < 0.001$). Across the pooled data for 0.77 and

0.88 levels of objective probability, the highest strength trials produced an average 90% estimate that the coin was biased to heads, the estimates for the successively lower strengths were 78%, 73%, and 65% respectively. Therefore, high strength trials produced higher probability estimates than the high weight trials. In fact, since weight was inversely related to strength in the trials used, it is clear that subjects were much more influenced by strength of evidence in arriving at their estimates, as Griffin and Tversky (1992) had also observed.

Turning to the interactions, there was no significant difference between estimated probability levels across groups (Group x Probability: $F(2, 33) < 1$). The people with delusions produced averages of 77% for the 0.77 and for the 0.88 levels of objective probability. The depressed subjects average estimates were 74% and 77% for these two levels, and the normal group produced average estimates of 77% and 76%. There was also no subject Group x trial Type interaction ($F(6, 99) = 1.98$, $p = 0.08$), although this began to approach a significant level, and no Probability x Trial type interaction ($F(3, 99) < 1$). Hence, it was apparent that all of the groups altered their estimates in the same way, in line with changes in strength of the evidence given.

Figure 5.1: Graph showing the mean difference from Bayes' theorem on each trial type for the combined 0.77 and 0.88 objective levels of probability.



However, there was a 3-way interaction between subject Group, Probability and trial Type ($F(6,99) = 2.79$, $p < 0.05$). This is shown in Figure 5.1. Post hoc Tukey tests ($\alpha = 0.05$) showed that there were differences between the normal subjects and the people with depression at the objective level of probability 0.88 on trial one. Overall, it can be seen in Figure 5.1 that the depressed subjects are less extreme and are less

influenced by the effect of Strength and Weight of evidence. Normal subjects are the most extreme, and the subjects with delusions fall in between.

5.4 Discussion

The main finding of Experiment 1 is that in estimating the probability that a coin is biased, people with delusions reason in much the same way as non-deluded comparison groups. The sizes of their probability estimates are in line with those of normal people, and show an equal influence of strength of evidence (i.e., the ratio of heads to tails in the sample given) and an equivalent disregard of the weight of the evidence (number of trials). This demonstrates the reliability of the task as strength and weight have acted in the directions expected from Griffin and Tversky's (1992) study, producing high estimates at high strength and lower estimates as strength decreases. This is important evidence as it demonstrates that the psychiatric subjects were not responding randomly or without consideration of the problems. If this had been the case, the clear relationship between strength and weight would not have been demonstrated. What is seen is that the people with delusions are more like normal subjects in their performance on this task than subjects with depression. The depressed subjects are more balanced in the assessment of the strength and weight of the evidence and produce less extreme responses. This would appear to be consistent with work on depressive realism (Ackermann and DeRubeis, 1991).

At first sight, these findings are markedly discrepant with the evidence of abnormal biases for people with delusions in probability reasoning tasks reported by Huq et al. (1988) and Garety et al. (1991). It has been shown that there is a bias in reasoning for the group with delusions in Experiment 1, but their bias (toward strength of evidence) is completely normal!

However, the discrepancy with Huq et al.'s (1988) results may be readily resolved by noting a subtle but potentially important difference between the tasks. This is that the biased coin experiment sets out all information which must be considered, whereas in the task favoured by Garety, Hemsley and their co-workers the subject is free to determine at which point sufficient evidence for a decision is available (this issue will be returned to in Chapter 9).

5.5 Conclusions

The results of the Biased Coin task provide no evidence that subjects with delusions are unable to reason with probabilities. Subjects were not stimulus bound when provided with all of the information. Thus, there was no evidence of people with delusions being overconfident relative to the Bayesian benchmark. These subjects were neither more confident generally on all the trials nor on specific trials that presented a large ratio of heads to tails, the high strength trials. This appears to be strong evidence that the probabilistic reasoning of the group of subjects with delusions was entirely normal. People with delusions did not make abnormal probability estimates either generally or specifically on high strength trials in comparison to the control subjects. The difference between this result and previous work is possibly accounted for by the difference in presentation of the material. However, before moving on to examine this difference more fully, it was considered worthwhile to investigate whether overconfidence in decision making may be demonstrable on a different type of task. Thus, in the next chapter a different approach to confidence in decisions is taken. This is to try and distinguish between neutral, abstract probability judgements and general confidence in more realistic decision making.

6 Experiment 2: The Cognitive Estimates Task

6.1 Introduction

Huq et al. (1988) reported that people with delusions were more confident on a probabilistic reasoning task than control subjects without delusions. Further research has found no evidence of abnormal probability estimates in the form of overconfidence on the Biased Coin task or on a replication of the Huq et al. study (Garety et al. 1991). This inconclusive state of affairs prompted Experiment 2 which examined whether subjects with delusions were more confident on a realistic but neutral in content reasoning task. The paradigm chosen was the Cognitive Estimates Task (CET, Shallice and Evans, 1979).

The CET's origins lay in the noticing of the often inappropriately bizarre estimations given by patients with frontal lobe lesions. Given questions such as the ones below, subjects with frontal lobe damage show an inability to judge accurately in these novel situations.

"What is the height of the post office tower?"
"How fast do race horses gallop?"
"What is the age of the oldest person in Britain today?
"What is the length of an average man's spine?"

These questions are ones that can be answered using general knowledge available to almost all subjects but for which no immediately obvious strategy is available. Performance in such a task demonstrates that answering such questions stresses the abilities to select an appropriate cognitive plan and of checking any putative answer obtained, as much as the ability to carry out the selected plan. To obtain a reasonable estimate of the length of an average spine, the subject must utilise the items of common knowledge in a novel fashion. It is possible to derive such knowledge from a guess based on length of a jacket, or of the torso without head or legs. Then the subject must check the answers against ideas of common sense. For instance, the answer cannot be 5 feet as some people are not much taller than 5 feet. Answers are rated on a scale of bizarreness. Essentially, this task would seem to rely on executive or metacognitive skills in order to check the quality of the answer produced.

In addition to providing an estimate, the subjects were asked to rate their confidence in their responses'. Therefore, the task provided two measures; the degree of bizarreness of the answer and the degree of confidence in the answer. The main aim of the

study was to examine confidence in judgements given by people with delusions. This is because overconfidence in decisions appears to be a feature of the information processing style in people with delusions. Huq et al. (1988) reported that such subjects were hasty and overconfident on the beads task. On analogous perceptual recognition tasks people with delusions were also shown to be hasty and overconfident (McCormick and Broekema (1978).

The use of the CET with people with delusions is considered useful for a number of reasons. The brief review of the literature (chapter 2) concerning frontal lobe dysfunction in schizophrenia, and especially in people with delusions, has already stated the proposed role for the frontal lobes. The frontal lobes are specialised for the planning, execution and control of movements. Typically, they are regarded as playing an executive role in the deployment of other functions such as language, attention and movement, as such the frontal lobes are assigned a role in most functions. A proposed role for dysfunctional frontal lobes in schizophrenia is derived from three main sources. Firstly, there are the observed similarities between schizophrenic patients and subjects with lesions of the frontal lobes. Both sets of patients reportedly demonstrate lack of motivation, social withdrawal, and shallow affect. Secondly, there are similarities between the performance of the two groups on neuropsychological tasks that are meant to tap the processes operated by the frontal lobes (Benson and Stuss, 1990). Thirdly, there is evidence accumulating from studies of functional imaging of the brain that show hypo function in the frontal lobes in patients with schizophrenia (Weinberger, 1988). Thus, there may be an impairment in the psychological processes associated with the frontal lobes contributing to delusional beliefs.

The CET would appear to rely on metacognitive abilities that, if faulty, may be involved in delusion formation. Hemsley (1994) proposed that schizophrenics are less able to utilise previously acquired information. Therefore, performance by the people with delusions may be poorer on the CET. They may make more bizarre estimates. This may be owing to the inability to draw to mind adequate information on which to base the decision, or on the ability to check the answer. McKenna, Mortimer and Hodges (1994) have argued that there is a semantic memory dysfunction in people with delusions that would probably lead to poor performance on this task as the subjects are not able to access the information with which to make an estimate. Similarly, Cutting and Murphy (1988) have proposed that people with delusions have deficient real world knowledge. Such a deficiency would act as a disadvantage on a task like this. Benson and Stuss (1990) would suggest that any poor performance by people with delusions is related to an inability to be self critical, leading to bizarre estimates. This is more like the metacognitive skills apparently tested in the CET. Therefore, persons with delusions may be expected to perform poorly for one of two reasons; impairment of access to semantic knowledge

(temporal lobe) or an inability to critically utilise this information once provided (frontal lobe).

Whilst speculation about possible frontal lobe involvement in delusions is interesting it is not central to this study. The Cognitive Estimates task was used on people with delusions primarily to investigate the relationship between accuracy of estimation and confidence in the decision. The main purpose was not to demonstrate a link between delusions and frontal lobe damage. As has been noted overconfidence in reasoning appears to be a feature of the information processing style of people with delusions.

Overconfidence in the decision was expected for two possible reasons. Firstly, it may be predicted that the subjects with delusions may not draw on past experience as well as others and hence, may get the answers wrong. This would be revealed as higher scores on the bizarreness index. Then they may not realise they are wrong and be overconfident in their estimation of correctness. If there is a clear relationship between bizarreness and high confidence then it implies that the people with delusions do not know when they are wrong, and that they are not able to be self critical.

Secondly, generally high confidence ratings may be predicted as the people with delusions are more likely to want to think that they are doing well as a form of self esteem maintenance (Bentall, 1994). It may be predicted that the people with delusions will be more confident in their answers to the neutral content questions as it may be important for them to be correct, as it reflects on self image and self esteem. Therefore, it is predicted that they will be overconfident in comparison to the controls.

6.2 Method

Subjects: As before, three groups of subjects agreed to participate in this study. All subjects were administered the National Adult Reading Test (NART) as a rough gauge of intelligence. Subjects were also given the Mini Mental State Examination (MMSE). As before, any subjects scoring less than 24/30 were excluded.

The criteria for selection were the same as in the Biased Coin task, except only subjects with delusions with a clear diagnosis of schizophrenia or paranoid schizophrenia participated. The 15 psychiatric controls and the 15 normal subjects were selected by the same criteria used in the Biased Coin task. Subject's characteristics are shown in table 6.1. There are no differences in age, sex, MMSE or NART estimated IQ scores.

Table 6.1: Subject characteristics in Experiment 2. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender* *M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	15	5	10	8	7	39.2 (10.5)	106.5 (10.2)	28.4 (1.4)
Depressed	15	8	7	8	7	40.0 (11.6)	103.9 (10.6)	28.7 (0.8)
Control	15			8	7	39.6 (13.3)	104.7 (9.8)	29.1 (0.9)
Significance						NS	NS	NS

Procedure: Subjects were told that they were participating in an investigation of the way that people think, reason and make decisions. They were presented with the revised 10 item CET as described by Shoqeriat, Mayes, MacDonald, Meudell, and Pickering (1990). This consists of ten questions on a sheet of paper. Beneath each question was a 10cm long line with 0% and 100% on either end (see appendix 2 for test sheet). The subject was asked to write in the answer to the question and then to estimate how confident they were about the answer by marking the line or writing a percentage. This was repeated for all 10 questions.

Subjects' responses were scored for bizarreness on a scale of 0 to 3. Zero indicates that the response was good and the more bizarre the estimate the higher the score. The rating of bizarreness was based on the norms provided by Shallice and Evans (1978). The performance of their control patients was used to derive a four point scale of the extremeness of the response (normal, quite extreme, extreme and very extreme). In this study subjects' responses were scored for bizarreness and confidence in that score.

6.3 Results

The table below indicates the mean bizarreness rating for each of the three groups on all of the 10 questions. Also shown is the mean confidence rating given by the groups on all of the questions.

Table 6.2: Mean bizarreness rating and confidence rating for the 3 groups. Standard deviations are shown in brackets.

Group	*Mean bizarreness score*	*Mean confidence score*
Deluded	6.0 (2.7)	54.7 (15.5)
Depressed	6.0 (3.1)	57.9 (16.1)
Normal	5.3 (3.5)	53.6 (17.5)

A one way Anova conducted on the mean confidence scores revealed no difference between the groups ($F(2,42) = 0.28$, $p= 0.76$). None of the groups differed in overall confidence. The depressed group produced an overall estimate of confidence (57.9) and the group with delusions and normal group were a little lower (54.7, and 53.6 respectively).

A Kruskall-Wallis test on the bizarreness ratings indicated no significant differences between the 3 groups ($H= 0.45$, $p= 0.78$). The group with delusions did not differ in bizarreness from the other groups. As a point of comparison O'Carroll, Egan and MacKenzie (1994) collected a large amount of normative data from a wide variety of people of different ages and social classes and the average score for normal subjects was 5.3 as well. Therefore, there was no evidence of more bizarre answers being given by the people with delusions or of more confidence in their estimates. Also, there was no correlation between the bizarreness and confidence in an answer for all of the groups combined ($r= 0.05$, $p >0.05$) or for the group with delusions in particular ($r= 0.3$, $p> 0.05$). On any individual question the subjects with delusions did not differ from the other subjects in their estimations or in the confidence expressed in the answer.

The lack of a difference between the groups in the bizarreness score may have occurred because the bands in the rating scale are so large. For the length of the average man's spine question, a score of 0 (normal) is given for estimations from 18 inches to four feet. Similarly, the speed of a race horse is scored 0 if the estimate is between 15 and 40 mph. The population of Britain question allows a response of between 10 and 500 million. Therefore, it may be have been the case that the people with delusions were giving abnormal estimates but that the scoring system was too insensitive to detect a difference between the groups. Eight of the ten questions require a number as an answer. On these questions the raw values were compared between groups to see if the people with delusions were giving more bizarre estimates than the others. There were no significant differences between the responses of the groups on any question. Therefore, people with delusions were not substantially different from the other subjects in the bizarreness of the estimates.

6.4 Discussion

This present study, like the Biased Coin (experiment 1) has indicated that the subjects with delusion are no more confident than the control subjects when reasoning on a realistic but neutral in content task. When tested on the CET they were neither more confident generally ($p= 0.8$) nor on any specific question. Therefore, there is no evidence to support the finding that subjects with delusions are more confident than controls on these tasks. In addition, the group with delusions were no different in the bizarreness of the estimations given.

Two reasons were suggested as to why subjects with delusion would be more confident than other subjects. Firstly, in line with Hemsley's proposals (1994) it was expected that subjects with delusions would fail to utilise previously acquired information and would therefore give an incorrect answer. They would be overconfident in comparison to others as they would be unaware that the answer was incorrect. Hence, a higher mean bizarreness score was expected in combination with a higher overall estimate of confidence.

Another theory explaining overconfidence in reasoning was derived from the work of Bentall and colleagues (Bentall, 1994). It was proposed that people with delusions utilise normally existing biases to defend against feelings of low self esteem (Bentall, Kinderman and Kaney, 1994). In normal subjects, self deception and bias contribute to the maintenance of a person's sense of well being and allows a continued pursuit of goals. Being slightly optimistic is a normally existing bias that allows actions to be undertaken as there is a biased view of the chance of success (Nesse and Lloyd, 1992). Therefore, as a way of defending against feelings of low self esteem it was proposed that people with delusions would be more confident than normal subjects. People with depression were not more confident than the control subjects nor were they more bizarre in their estimations. Therefore, there is no apparent support for either hypothesis.

People with depression are held to be lacking these biases that operate to defend self esteem. Depressed subjects are supposed to view the world in an unbiased way and are more accurate on estimation tasks as they are not biased in the way that normal subjects are. People with depression are supposed to exhibit what is termed "depressive realism". This attenuation of normally existing biases leads to an inability to defend the self against feelings of low self esteem and thus, to depression. If depressed subjects lack a bias leading to optimism and overconfidence then they would be less likely to initiate action as they would see there being less chance of success. Therefore, promoting apathetic lethargy.

In the current study and the Biased Coin task there was no evidence of the depressed subjects being less confident (i.e. better calibrated) than the other groups which contradicts previous findings (Alloy and Abramson, 1979). However, Ackerman and DeRubeis (1991) reviewed the depressive realism literature and found that though many studies have produced evidence consistent with the hypothesis just as many have proved inconsistent. These authors have argued that only studies using tasks containing an objective standard against which to compare subjects response can inform us about the validity of this depressive realism. The Biased coin used a Bayesian model and revealed no difference between the groups. Although, overall the depressed group could be seen to be less extreme in the judgement that they made. The CET had no external criterion to judge accuracy by and that revealed no difference either. The lack of external criteria means that there is no way to decide if someone should have a low or high degree of

confidence in the answer. It may be entirely right that someone with depression has a low degree of confidence in their decision. However, there were no differences between any of the groups. On both of these abstract and realistic tasks no differences were found.

The other main finding of the CET study was that the subjects with delusions did not differ from the controls in the bizarreness of their responses. According to the Shallice and Evans (1979) report, normal control subjects score on average 3.6. The scores of the present groups places all of the groups in the left posterior and right posterior damaged groups. None of the groups score highly enough to be in the range scored by patients with left or right anterior lesions. However, the CET has been criticised for not having large enough normative data sets. O'Carroll et al. (1994) gathered data from 150 normal subjects of a wide range of ages, social and economic levels and found a mean score of 5.3, the same as in this normal group. The patient groups did not significantly differ from the normal group in the estimations given. Despite these scores being higher than Shallice and Evans reported, the groups did not differ from each other. This indicates that it is unlikely that there is any impairment of frontal lobe processes.

It may be the case that more bizarre estimates and overconfidence in the decision would not be revealed on a neutral in content task such as this. Producing more bizarre estimates would be indicative of an inability to be self critical (Benson and Stuss, 1990) but it is possible that the loss of self criticism will only occur on salient material. If the subjects were asked to give estimates on material that is salient in content then there may be more bizarre estimates. For instance, a subject may grossly over estimate the number of policeman in the country if he or she is being persecuted by this group. In addition, when the subject is required to estimate the certainty of an event that is related to the theme of the delusion, then overconfidence may be demonstrated. Garety (1992) reports that a man with delusions over estimated the occurrence of delusion related events. When this belief was tested it was found that the events were happening a great deal less often than he expected. For instance, a subject may vastly overestimate the number of policeman in the country and then be very confident in the correctness of the answer.

As noted earlier there have been numerous attempts to link delusions and schizophrenia to frontal lobe damage. Benson and Stuss (1990) specifically explain delusions as reflecting deficits in frontal lobe functioning especially self monitoring/criticism and reality testing.

The CET was not used specifically to demonstrate dysfunction of frontal lobe functioning in people with delusions. Whilst impairment was not anticipated, it is not possible to exclude frontal lobe involvement in delusions. Naturally, a battery of frontal and non frontal lobe dysfunction sensitive tests would be required to make decisions about possible involvement in delusional beliefs. To accept frontal lobe involvement is not possible with the CET alone. Firstly, there is the lack of normative data as mentioned above. In addition, Kopelman (1991) reports that CET scores did not correlate with any

other putative frontal lobe tests. CET scores were correlated with premorbid and current IQ. however. Kopelman (1991) suggested that the CET was either measuring an area of frontal lobe not tapped by any other test or it was actually tapping semantic memory. If semantic memory is being accessed then there is no evidence that this is deficient in the people with delusions as has been suggested before (McKenna et al. 1994, Cutting and Murphy, 1988).

The lack of evidence of a frontal lobe involvement from the CET study indicates that perhaps other sites of impairment need to be considered. As noted earlier, Liddle and colleagues (Friston, Liddle, Frith, Hirsch, and Frackowiak, 1992, Liddle, Friston, Frith, Hirsch, Jones, and Frackowiak, 1992) found that delusions were associated with temporal lobe abnormalities and frontal lobe impairments were associated with negative symptoms of schizophrenia.

6.5 Conclusions

The aim of the present study (CET) was to examine the proposed higher confidence in judgements of people with delusions. For this purpose a task realistic but neutral in content was used. Subjects were required to provide answers to novel questions and rate how confident they were in the accuracy of their decisions. People with delusions did not provide answers that were more bizarre than the control subjects. Nor were the people with delusions more confident in the answer being correct. This result and that from the Biased coin task provided no evidence that people with delusions were excessively confident when making decisions.

A possible reason for there not being a difference between the groups in the confidence estimations is attributed to the neutral nature of the material. Had the tasks' content been salient or theme related then biased overconfident reasoning may have been demonstrated.

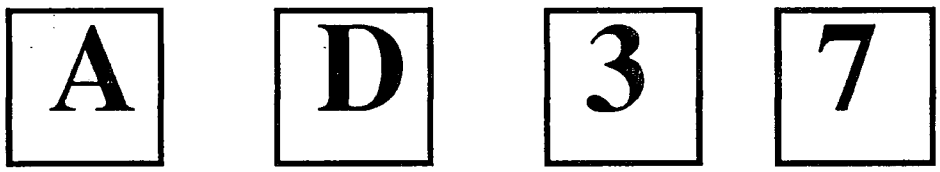
The possibility of frontal lobe impairment was considered as a secondary issue. It has been proposed that delusional thinking is associated with deficits in the psychological processes attributed to the frontal lobe. However, for the reasons discussed above this question could not be addressed by the present research. In this study subjects with delusions were found to be no more bizarre in their estimates than the control subjects.

The Biased Coin and Cognitive Estimates Tasks have provided no apparent evidence of abnormal reasoning in judgements of probability, nor in confidence in correctness. The question must be raised that people with delusions do not have abnormal reasoning processes, as Maher (1974) advocates. However, the stated aim of this thesis is to examine reasoning processes on a variety of tasks that differ in form and content. Therefore, in the next chapter consideration is given to perhaps the single most widely investigated reasoning task, namely the Wason Selection task (Wason, 1968).

7 Experiment 3: Wason's Selection Tasks

7.1 Introduction

The two previous studies have not revealed any apparent difference in reasoning between people with delusions and control subjects. It may be concluded that there is no difference, or it may be the case that the differences in reasoning are only revealed on certain other types of tasks. To explore this possibility further another reasoning task was selected. Perhaps the most widely investigated paradigm used is the Wason Selection task (Wason, 1968). In the standard form it is presented in an abstract way. The subject is shown four cards drawn from a pack which all have a capital letter on one side and a number on the other. The subject is given a conditional statement usually presented as " If there is an A on one side of the card there is a 3 on the other." The four cards presented consist of one letter and one number that are mentioned in the statement and one letter and one number that differ (see below). These correspond to the *p* and *q* cards and the *not p* and *not q* cards respectively. They are referred to as such, as the statement is expressed in a general form as *if p then q*.



p *not p* *q* *not q*

Subjects are asked to decide which cards to turn over to determine if the statement about the cards is false. The normative model against which performance has been assessed is based on falsificationist views in the Philosophy of science. Popper (1959) argued that a scientific law cannot be shown to be true because by uncovering a single counter example it is always possible that the next instance of the law is false. Hence, one should look for false instances or the rule breaker. Logically, in the selection task the correct answer is the *p* and *not q* cards. The A (*p*) card may have a 3 (*q*), or not, on the back and needs to be checked in order to see if it contradicts the rule. The D card need not be turned over as the rule has no implication for this letter or any other than A. The 3 card may have an A on the back, but even if it does not this does not contradict the rule. The rule does not state that there must be an A on the back of the 3. If the 7 card

(*not q*) has an A on the back this would indicate that there is a case of an A without a 3 and would mean the rule had been broken.

This apparently simple task has generated a great deal of research since it was devised, primarily because the great majority of intelligent adults fail to solve it (see chapter 4 in Evans et al. 1993 for a full review of the research into this task).

The original studies (Wason, 1968) indicate that people typically choose the *p* card alone or the *p* and *q* cards. Thus, they are failing to select the *not q* case and often select the unnecessary *q* case. Successful selection of the *p*, and *not q* cards was reported in less than 10% of the subjects. Typically, incorrect choices where made when the conditional had an arbitrary content (as above). The *p*, or *p* and *q* cards selection pattern was called the confirmation bias, as it was believed that subjects chose to confirm the rule rather than disconfirm it (Wason, 1968). Recently, it has been renamed the matching bias as it is thought that people choose the two cards mentioned in the rule (Evans, 1989, Evans and Lynch, 1973).

In apparently equivalent rules in which the content of the task is more realistic, performance improves considerably. For instance, Griggs and Cox (1982) told subjects that the rule was "One must be over 18 to drink alcohol". The subjects were given cards with BEER, COKE, 22 years old and 16 years old on. Here correct performance requires finding anyone who may be breaking the rule. In this instance the subject must turn over the BEER and 16 years old card. Subjects showed a high number of correct responses, in excess of 75%.

The fact that patterns of reasoning differ enormously as a function of the thematic content of the premises, even for problems that are formally equivalent, is an area of much debate. Accounts of performance on the task have drawn on theories of mental logics (see chapter 3 for details). However, an inherent mental logic system has difficulty explaining the poor performance on the abstract rules (most like an internalised logic) and the best performance on logically equivalent but more realistic tasks. The theory of Mental Models is similarly limited by attempts to explain the thematic "facilitation" effects. Basically, it is proposed that realistic content "fleshes out" the Mental Models and possibly reduces the number of models necessary to manipulate. However, neither account is particularly satisfactory (see chapter 3).

Arbitrary rules typically produce a high percentage of erroneous *p* and *q* card responses whereas formally equivalent rules that may be interpreted as expressing deontic relations of permission or obligation produce *p* and *not q* responses far more frequently. Deontic thinking takes place when we consider what we may (or are allowed to) do, or what we ought to do, rather than what is or will actually be the case. Thus, basic forms of deontic thought are concerned with permissions and obligations. Once an obligation or permission is introduced, the conditional is no longer indicative as in the

example of a card having a 3 on the back of an A. Rather than being tested as true or false, as in the indicative conditional, the rule can be broken or upheld (deontic task).

It has only been recently recognised that there are these two distinct forms of the selection task. The indicative form of the conditional is more like the original abstract task. Indicative forms express scientific hypotheses that can be tested and be shown to be true or false. The other form of the selection task is the deontic form. This format is used to express laws, rules, regulations and moral or social agreements. This crucial difference affects the way in which it is thought that the selection tasks are reasoned with. For instance, an indicative statement such as "If it is a television then it has plug" states a factual relationship that may be true or false. A deontic conditional would be "If the television is used it must have a licence". This is a rule that may or may not be obeyed. If one applies the notion of goal oriented reasoning (rationality [1], chapter 3) to these types of conditional it can be seen that the goal in the indicative version is to decide if the statement is true or not. In most thematic tasks the form of the conditional is deontic and here the goal is to decide if the rule has been obeyed or broken. The rules in the abstract tasks are falsifiable but in deontic tasks the rules are more like obligations.

Since they are obligations there are different perspectives that can be taken, i.e., people can have different goals. Someone may choose to cheat the system and not meet the obligation. For instance, consider the rule "If someone spends £30 or more in the shop they receive a free gift". In this instance, there are outcomes that have different utility to the relative participants in the conditional. The customer (or actor) may try and cheat the shop and get a gift without paying thirty pounds. The shop (enforcer) will want to make sure that it is not giving out gifts without customers paying, but it may try not to give out gifts when £30 is spent as this is to its advantage. Therefore, there are different utilities associated with performance (Manktelow and Over, 1991, 1992). Once utilities are associated with an outcome, the nature of the selection task changes from being a deductive logic task to a decision theory type judgement. Subjects no longer reason deductively with a rule but assess the relative likelihood and utility associated with an outcome (this will be returned to in chapter 8).

Cosmides (1989) has argued that subjects use a Darwinian Algorithm, a type of innate thought, that determines performance on the selection task. The subject is supposed to have an innate understanding of social exchange and thus, an appreciation of the cost-benefit relationship in social exchange. Essentially, people are meant to be aware that others may cheat and take a benefit without paying the cost. Therefore, content facilitation effects on tasks occur because the contents fit the proposed cheater detection system. Manktelow and Over (1991) and Cosmides (1989) both advocate approaches in which the rational performance on the selection task is not determined by employing a falsification strategy but by assessment of the relative utility to the subject.

Cosmides's (1989) algorithm is said to be innate whereas the schemas utilised in the account of Cheng and Holyoak, 1989, (see below) are assumed to be learned. Here there are obvious parallels with rationality[1]. If there are different utilities associated with an outcome then there are different goals that can be achieved. Hence performance on the selection task can be judged not against an optimal norm but against how well the subjects' goals are met. Note also the implicit assumption in Cosmides's theory that there is an evolutionary advantage to mild suspiciousness. This supports the dimensional approach to the study of delusional beliefs.

An additional way of explaining the performance on the selection tasks is the theory of Pragmatic Reasoning Schemas (PRS, chapter 3). It is proposed that subjects use "clusters of rules that are highly generalised and abstracted but nonetheless are defined with respect to classes of goals and types of relationships". (Cheng, Holyoak, Nisbett & Oliver, 1986).

Pragmatic reasoning schemas fall into broad categories such as causal inference (Cheng and Holyoak, 1985), as well as regulations such as permissions and obligations. The PRS theory predicts that performance on a selection task will be facilitated when the stated rule has a content that evokes an appropriate schema. Correspondence between the stated rule and the schematic rules may be such that the latter map onto the standard rules of logic and thus, provide *p* and *not q* card responses. Consider the example taken from chapter 3. If a reasoning problem elicits a pre-existing schema it may provide an example from previous experience of what should occur. The abstract permission schema may be expressed as:

If an action is to be taken then a precondition must be met.

If a subject is given the following problem of deciding if a rule is being broken, elicitation of this schema is thought to provide the correct solution.

If a person is drinking alcohol then they must be 18 or over.

Paul is 16.

If the schema is elicited the concept of permission will provide the inference that "Paul may not drink alcohol" without requiring formal reasoning. Thus, if Paul is drinking, the subject will be aware that this means that the rule is being broken.

Evidence for pragmatic reasoning schemas is derived from a number of tasks. Cheng and Holyoak (1985) found facilitation on a selection task with an abstract permission conditional rule but no facilitation for a concrete conditional. This indicates that the schema is abstract and domain independent. Additionally, attempts to train subjects in the use of logic were only successful in conditions when permission schema were trained rather than being taught the laws of standard logic. This indicates an intuitive grasp of the schema and a natural ability to map the permission schema onto an abstract conditional if the permission schema is evoked (Cheng et al. 1986).

Jackson and Griggs (1990), criticised the work of Cheng and Holyoak arguing that the demonstration of facilitation for the abstract permission rule was not owing to evocation of a permission schema but rather it resulted from a combination of two presentation factors. The first is providing explicit negatives in the statement of cases. Rather than providing cases such as A, not A, X, not X, the cases should be A, B, X, and Y. The second factor suggested by Jackson and Griggs was providing a violation checking condition. This means telling the subjects to check for violations or breaking of a rule rather than seeking to test or confirm a hypothesis.

Kroger, Cheng and Holyoak (1994) compared the effects of these two factors on an abstract permission rule and a rule with arbitrary content. No facilitation was observed for the arbitrary conditional but strong facilitation was noted for the abstract permission rule under the same conditions. This can be viewed as strong support for the Pragmatic Reasoning hypothesis.

Similarly, it has been proposed that subjects use representations of specific experiences and reason by calling to mind specific counter examples that they have encountered before (Griggs and Cox, 1982). Essentially, this is a theory of reasoning by memory.

The reason for the differences in reasoning across thematic conditions, is naturally a disputed issue. However, the exact cause of the effect of content is not vital to the current study. The fact that realistic content appears to reliably improve performance in normal subjects allows a comparison to be made with the performance of people with delusions. The purpose of this study was not to explain the Wason selection task. The intention was to use it as an investigatory tool in the same way a phenomena like the Stroop task is used to investigate cognitive processing.

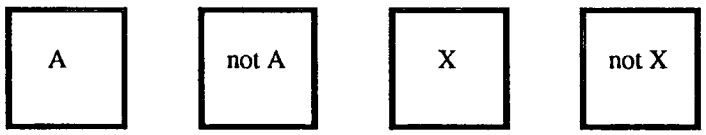
Thus, the aim of this study was to employ a number of Wason selection tasks to compare the performance of people with delusions against that of psychiatric and normal control subjects. The tasks were matched as closely as possible for structure but differed on thematic content, and thus, the chance of correct solution.

There are numerous reasons for using the Wason selection task with subjects with delusions. Firstly, the task is traditionally viewed as a test of deductive logic. Von Domarus (1944) reported that subjects with schizophrenia were poor at tests of deductive syllogistic reasoning. However, Williams (1964) found that schizophrenics were no worse than appropriately matched control subjects. To study any possible deductive reasoning differences it would seem prudent to utilise the most widely researched of tasks that is used on normal subjects, which the selection task appears to be.

Additionally, performance on the selection task has reliably been shown to be affected by changes in content. The more realistic the content, the greater the chance of correct solution. This feature can then act as a bridge between the neutral abstract tasks

used by Garety and colleagues and the social reasoning tasks employed by Bentall and co-workers. The content-specific biases shown by subjects with persecutory beliefs appear to have little in common with the more deficit like problems revealed on the abstract tasks. Thus, the effect of different types of content may help reveal more about these apparent differences. One final reason for the use of the selection task is that it does not merely produce an error score. The subjects can also produce different patterns of performance that may reveal additional information. Merely showing that the people with delusions performed more poorly at the task is not as interesting as demonstrating that they differed in a consistent way.

The first two tasks were taken from Kroger et al. (1994). The first conditional was an arbitrary rule incorporating explicit negatives (A, not A etc.) and a violation checking condition. Performance on this task even with the additional factors included is typically very poor (5-10% correctly chose the *p* and *not q* cards). For this task the format was slightly different from Wason's original task. The arbitrary rule referred to "A" and "X" rather than vowels and numbers as in the original studies. This was used as it is logically and linguistically close to the other tasks. Being arbitrary in content, this first conditional should not elicit any Pragmatic Reasoning schemas and will thus, lead to poor performance by all the groups. The instructions were given as "Below are four cards. One side of each card has written on it either "A" or "not A". The other side has written either "X" or "not X". Your task is to make sure the cards conform to the rule: "If a card says 'A' on one side then the other side must say 'X'." Participants should chose the *p* and *not q* cards (A and not X).

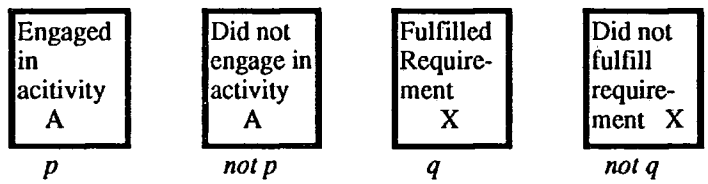


p *not p* *q* *not q*

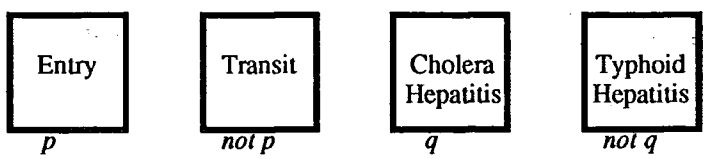
For the second task, rather than being given an arbitrary conditional, subjects were given an equally abstract rule but one that was likely to elicit a permission schema. This should increase the chance of the correct selection of *p* and *not q* cards as the permission schema provides responses that are in accord with those of standard logic. It is possible to increase the chance of successful use of the negative instance (rule breaker, *not q* card) by making the task more likely to elicit the permission schema. In previous studies far higher numbers of correct *p* and *not q* responses were recorded (47%).

For instance, Cheng and Holyoak (1985) used such an abstract deontic conditional rule. The rule was stated as "if one is to take action A then one must first satisfy precondition P". In other words in order to be permitted to do A one must have first fulfilled prerequisite P (i.e. completed P first). Subjects often respond correctly

even when much specific content is removed. In this general content, there is an introduction of the concept of an outside authority that is determining the rule. Cheng and Holyoak (1985) found that an abstract permission rule elicited better performance than a rule worded in terms of concrete but arbitrary terms (as in the first conditional above). This task was included to investigate whether subjects with delusions were able to utilise the domain specific abstract permission schema that normal subjects use. The format is the same as that used by Kroger et al. (1994) and closely matches the wording of the arbitrary conditional so that the only difference is that this conditional should increase the chance of the permission schema being used. The rule was presented as " If one is to engage in activity A, then one must fulfil requirement X."



The third task is taken from Cheng and Holyoak (1985). The format has been changed so that the conditional and the instructions now match the two earlier ones. Subjects were told they are immigration officers that have to check all entrants have cholera vaccinations (if entry, then cholera). Passengers in transit are not important. Four cards are presented with entry details on one side and vaccinations on the other. It is unlikely that a person would have had any direct experience of being an immigration officer. However, the subject should be able to map the permission schema rules onto this conditional, as he or she is likely to be familiar with the concept of permission. Cheng and Holyoak (1985) report 60% of the responses were the *p* and *not q* cards. Many subjects correctly solved the task, despite never having been immigration officers. Here it would seem that even though the subjects lacked personal relevant experience, they were able to apply the general representative framework or schemata indicating that memory is not the only component. Thus, higher numbers of *p* and *not q* cards were expected to be chosen in this conditional. The rule was "If one is to enter the country, then one must have a cholera inoculation".

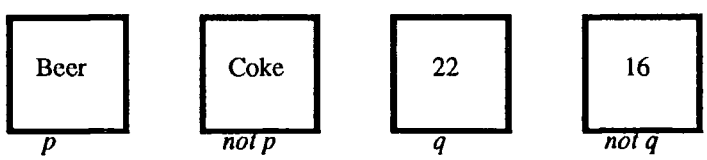


What is seen in normal subjects is a progression from poor performance on the arbitrary task to better performance on the more realistic conditionals. This inability to reason with the abstract materials leads to a frequent number of matching bias responses

(selection of the *p* and *q* cards). People unable to utilise a permission schema or apply laws of logic appear to rely on a non logical or arbitrary system such as matching cases in the conditional and in the responses. Better performance is found on the abstract deontic task (the second conditional). Then greatly facilitated performance is seen when people are given a full and realistic context. The three tasks mentioned are all expected to be solved by the ability to map permission schema onto the content of the problem. The more realistic the content, the more likely that the permission schema will be elicited and the more likely that the subject will choose the *p* and *not q* cards. However, it has also been proposed that these selection tasks are solved by pulling to mind from memory specific counter examples. Therefore, a final task was included to distinguish between a possible memory effect or the application of a schema.

The fourth task was taken from Griggs and Cox (1982) but has once again been altered in format in order to match the earlier conditionals. Subjects were asked to imagine they were a pub Landlord checking for underage drinkers. The person probably would not have been a Landlord but will almost certainly be familiar with the concepts of being 18 years of age or older before being allowed to drink in pubs. Here high facilitation was expected owing to the high likelihood of being able to draw an example from memory of who would be breaking the rule.

In this condition subjects were given cards with ages and types of drink on. For instance, 16 22 Beer Coke. The rule was "to drink alcohol you must be over 18 years of age." In such instances normal subjects perform much better and turn over the 16 and Beer cards. Griggs and Cox (1982) report that if a person has had previous experience of a rule, then performance is facilitated. It is presumed that nearly all subjects will have had experience with this rule. This task was included as it may help reveal if people with delusions can reason deductively, and also the types of errors they may be prone to, even though they have had experience of the rule before. The rule was "to drink alcohol you must be over 18 years of age."



Thus, across the increasingly realistic tasks there should be an increased chance of correct solution, possibly by evocation of the permission schemas although this is only one possible mechanism. People with delusions have not been used in this task before and thus, it is difficult to predict if their reasoning deficits extend to this type of paradigm. They may be less able to evoke the schemas generally owing to an inability to draw on previous experience. This could lead to a "jump to conclusions" reasoning style meaning that not all of the cards would be considered. However, it may be the case

that they are more likely to elicit the schemas if they are sensitive to the concepts of permission from authority figures. The formats of the conditionals are as alike as possible to try and reveal any effect of permission and content.

7.2 Method

Subjects: Three groups of people participated. There were 15 people with delusions, 15 with depression and 15 normal subjects. The participants were selected according to the same criteria as before. Subject's details are in the table below.

Table 7.1: Subject characteristics in Experiment 3. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender* *M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	15	8	7	9	6	36.7 (8.8)	101.9 (11.2)	28.5 (1.4)
Depressed	15	8	7	5	10	40.3 (8.1)	101.5 (13.4)	28.2 (1.6)
Control	15			7	8	40.2 (12.5)	107.8 (7.9)	29.1 (0.7)
Significance						NS	NS	NS

Apparatus: Each conditional was written on a separate piece of paper and consisted of the rule and the four representations of cards.

Procedure: Representations of cards were presented to the subject, on the test sheet (see appendix 3). The presentation order of the conditionals and the position of the cards on the test sheet were randomised. Subjects were handed one sheet at a time and were not allowed to alter the answers once completed. All of the conditionals were of the same basic format. They differed only in the thematic elements and all followed the basic structure of the example below, which is actually the immigration officer conditional.

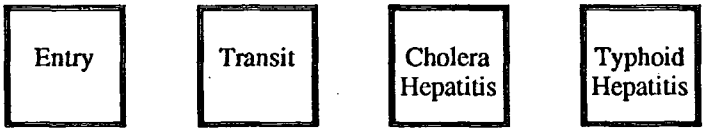
Suppose people wish to enter the country. You know that before one can enter, one must have a cholera inoculation. Your task, as an immigration officer is to make sure that people follow the regulation: "If one is to enter the country, then you must have a cholera inoculation."

There are four cards represented below, one each for four people. Each card gives information on a single person. One side of each card shows whether this person wishes to enter the country. The other side shows whether he or she has a cholera inoculation.

You want to see if any person violated the regulation. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not turn over a card unless what is on the other side can potentially tell you that the person violated the regulation.

Tick below a card to indicate the one(s) you have chosen.

Rule: If one is to enter the country, then one must have a cholera inoculation.



p *not p* *q* *not q)*

All the other conditionals followed the same basic format as the task above (on the test sheets, the *p* and *q* cards were not indicated. The full task sheets are in appendix 3).

Task 1: *Arbitrary* content conditional. The rule "if the card says "A" on one side then the other side must say "X"".

Task two: *Abstract Permission* conditional: The rule was "If one is to engage in activity A, then one must fulfil requirement X."

Task Three: the *Immigration officer* as above.

Task four: The *Alcohol* conditional. The rule was stated as "to drink alcohol you must be over 18 years of age or over."

7.3 Results

The table on the next page (table 7.2) summarises the number and types of responses for each conditional. The responses in the table were collapsed to produce three types of answer. Responses were classified as being logically correct (*p, not q*) or classed as the matching bias response of the *p* card or the *p* and *q* cards together or as any other incorrect response.

It is readily apparent that all three groups performed poorly on the first three conditionals. In line with Wason's original results, the groups as a whole were poor at the arbitrary task with only 13% (6/45) correctly responding *p* and *not q*. In the second task Kroger et al. (1994) report correct solution rate of about 47%, whereas in this

sample as a whole there were only 16% (7/45) correct. The immigration officer produced a higher chance of successful response but still only about 42% (18/45) which is much lower than the 60% reported by Cheng and Holyoak (1985). Finally, the alcohol conditional produced a far higher solution rate of 67% (30/45). Thus, there does appear to be a facilitative effect across the conditionals. However, examination of the performance of the individual groups indicates that facilitation does not occur evenly in all three groups. For the alcohol conditional the normal group were 87% correct, the depressed were 80% correct and the group with delusions only 33% correct.

In the difficult abstract tasks there is a strong indication that the groups all tended to respond in accord with the matching bias response. In the harder conditions there are a disproportionate number of *p* and *q* card responses from all the groups.

Table 7.2: Type of response made by the groups to the Wason Conditionals.

Group	*Conditional*	*Correct p and not q*	*Matching p or pq*	*Other*
Deluded	Arbitrary	2	7	6
Deluded	Abstract Permission	1	9	5
Deluded	Immigration	4	4	7
Deluded	Alcohol	5	6	4
Depressed	Arbitrary	2	5	8
Depressed	Abstract Permission	3	4	8
Depressed	Immigration	7	5	3
Depressed	Alcohol	12	1	2
Normal	Arbitrary	2	7	6
Normal	Abstract Permission	3	8	4
Normal	Immigration	7	6	2
Normal	Alcohol	13	2	0

The main analyses presented here are in terms of matching indices and logic indices. The logic index is calculated by scoring a *p* card choice as +1 and the same for a *not q* card choice. If the subject responds with the *not p* or *q* card a negative value is given (-1) for each card. The matching index is calculated by scoring +1 for a *p* or *q* card response. Negative scores are given for *not p* or *not q* card selections. Therefore, each subjects' response yields a score from -2 to +2. The mean value of these indices

are shown in table 7.3 below (Pollard and Evans, 1987 for further explanation of analysis).

A one way Anova performed on the logic indices revealed a significant difference between the groups on the alcohol conditional [F (2, 42) = 7.1, p = 0.002). Post hoc comparisons (Tukey HSD test) showed the differences to be between the group of subjects with delusions and the other two groups, but not between the two control groups. Therefore, people with delusions perform significantly worse than the control subjects on the easiest Wason conditional. No differences between the groups were revealed on any of the other conditionals. Performance by all groups was very poor on these other conditionals. Differences in matching response were shown on the matching index for the alcohol conditional. This is to be expected as the scores are not independent of each other. If the subject scores 2 on matching (i.e. *pq* cards) then that person will score 0 on the logic index.

Table 7.3: Mean matching and logical indices for the four conditionals. Each index varies between +2 and -2.

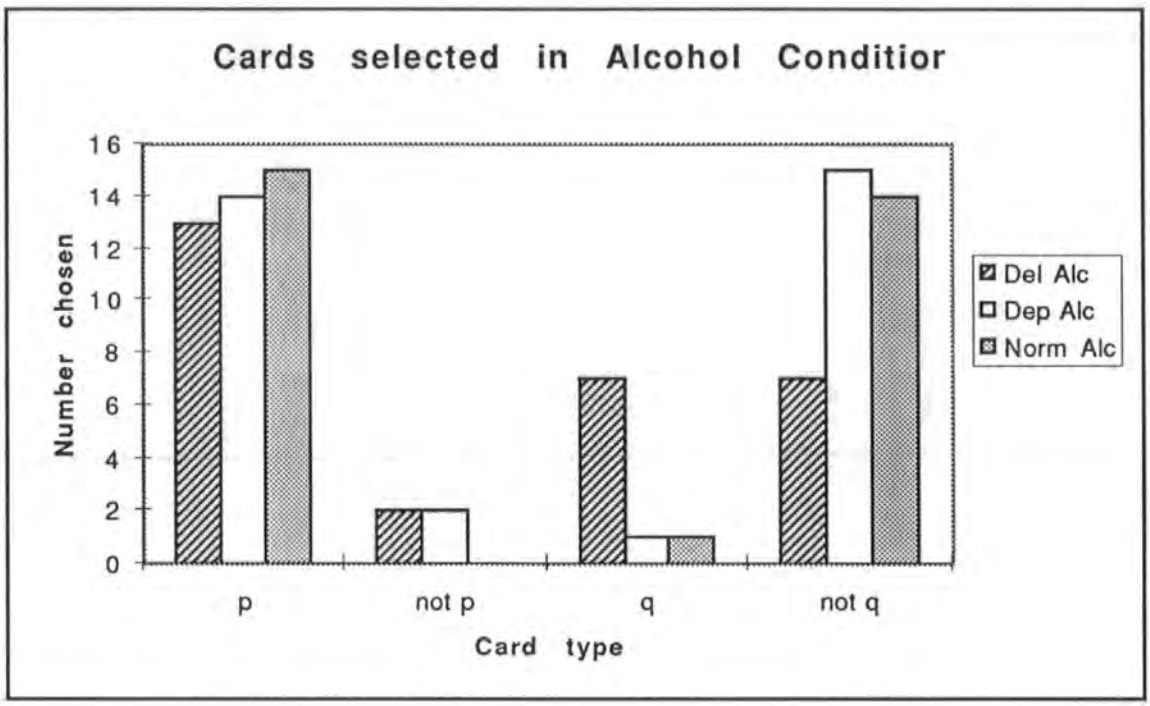
Group	*Indices*	*Arbitrary*	*Abstract Permission*	*Immigration Officer*	*Alcohol*
Deluded	Logic	0.4	0.07	0.47	0.8
Deluded	Matching	0.67	1.13	0.73	0.8
Depressed	Logic	0.27	0.07	1.0	1.7
Depressed	Matching	0.0	0.07	0.6	-0.07
Normal	Logic	0.2	0.4	1.07	1.8
Normal	Matching	0.6	1.07	0.67	0.2

In addition to producing an error score the Wason selection task allows an examination of which cards were chosen. It may be the case that people with delusions differed systematically in the selection of the cards. This possibility was investigated by recording which cards specifically were chosen. The graph on the next page (figure 7.1) represents how often each of the cards were chosen by each group for the alcohol conditional. Performance on the other conditionals was equally poor amongst all of the groups and comparisons of these graphs indicates that all the groups were similar in the cards that were chosen. The bars on the graph below represent the number of each type

of card that was selected. The *p* card represents the Beer, the *not p* the coke, the *q* card is the 22 year old and the *not q* card corresponds to the 16 year old.

As can be seen the main differences are on the *q* and *not q* card selection. People with delusions chose the *q* card seven times whereas the other two groups chose this card far less frequently. This selection of the *q* card is a result of the matching bias response of the *p* and *q* cards which was chosen six times by the people with delusions. In addition, the group with delusions chose far fewer of the *not q* card than the two control groups. Therefore, when the people with delusions were wrong in their selection of cards it seems that they were not that far off the mark. The pattern of responses does not indicate a random selection of cards. For instance, the *not p* card was selected no more frequently than by the depressed group. When the people with delusions are incorrect it appears that they tend to choose the *p* and *q* card combination which is the most frequent error seen in non deluded normal subjects when the conditional is difficult.

Figure 7.1: Type of cards selected by each group in the alcohol conditional.



7.4 Discussion

The performance of people with delusions was compared with that of matched normal and psychiatric controls on a number of Wason selection tasks. The tasks differed in the amount of realistic content provided, a manipulation shown to alter the solution rate. As the tasks become more realistic, performance in normal subjects typically improves.

The people with delusions did not differ from the matched controls on their performance in the three harder conditionals. Essentially, all that was demonstrated is that everyone performs poorly on abstract, or arbitrary conditionals. Successful *p*, and *not q* card responses were so low in the first three conditionals that no difference could be demonstrated. Solution rates of 13, 16 and 42% are below those reported by other researchers for the tasks (except the arbitrary task). However, these results are often derived from College undergraduates or academic staff and are not necessarily representative of the responses made by members of the non academic populations that were tested here. In these difficult conditionals there are a high number of *p* and *q* cards selected. This is the typical matching response if one is unable to obtain the answer using logic or Pragmatic Reasoning schemas. On these hard conditionals the people who experience delusions make a high number of matching bias responses. This is the same as the performance of the control subjects. This indicates that subjects with delusions are not answering totally at random or without attempting to reason at all. If this were the case the answers to the task would be more erratic.

The performance of people with depression and normal subjects on the alcohol conditional was very good. The majority (80%) of the depressed subjects and normal subjects (86%) correctly chose the BEER and 16 cards. However, only 33% of the subjects with delusions chose these cards, and this is a significant difference ($p = 0.002$). Therefore, on the easiest task the group with delusions performed significantly poorer than either of the other two groups. This then supports the hypothesis that people with delusions are poorer at deductive reasoning in comparison to matched normal and psychiatric controls. All the groups performance on the other tasks is so poor that differentiation is not possible or worthwhile.

It should be apparent that as a group the people with delusions are not completely unable to reason. They, like the other groups, benefit from the increased realism of the immigration officer and especially the alcohol conditional. However, the people with delusions do not attain the same level of performance as the other groups. It should also be noted that on the more difficult abstract tasks the errors that the people with delusions made were in keeping with those of the other subjects. The typical answer was the *p* and *q* card response; the matching bias. Therefore, we can see that people with delusions are affected by the same factors as the other subjects. Namely a tendency to answer

incorrectly on abstract conditionals (often giving as an answer the cards named in the rule) and an improvement in performance when the material is more realistic. Notably, when the people with delusions are wrong on the alcohol conditional the tendency is to select the *q* card rather than the *not q* card. This indicates an inefficiency in reasoning rather than an absolute inability to reason.

It may be the case that poor performance by subjects with delusions is owing to a failure to utilise previously acquired information (Garety, 1991). If the subjects with delusions had a hasty data gathering style then perhaps less consideration would be given to the cards. Only one or two cards may be considered and they may be chosen. An account in terms of "jump to conclusions" is inadequate though as the people with delusions did not choose less cards than the other groups and the ones they chose tended to be the *p*, *q* and *not q* cards rather than the *not p* card. Therefore, even if the selection was hasty it was generally focused on the most appropriate cards.

The failure to attain the level of performance of the other two groups on the alcohol conditional implies a possible memory problem. Griggs and Cox's (1982) account of the selection tasks is essentially that people rely on memory of similar experiences. There may be a problem with the memory of the subjects with delusions. It is possible that they are unable to pull to mind specific counterexamples, meaning that they may not perform as well other subjects. Cutting and Murphy (1988) proposed that people with delusions have deficits in real world knowledge. In a similar way McKenna (1991) suggested that people with delusions have deficits in semantic knowledge that could possibly hamper performance on such a task. However, the performance on the Cognitive Estimates Task (chapter 6) indicated that there appeared not to be a problem in accessing or utilising semantic knowledge.

An alternative possibility is that subjects with delusions are not particularly sensitive to concepts of permission and thus, do not evoke the relevant schema. It may be that they do not look for cheaters (Cosmides, 1989). However, intuitively this seems at odds with the nature of persecutory beliefs. If anything, people with persecutory beliefs will be very sensitive to instances of being cheated.

It may well be the case that performance on the task is not limited by an inability to reason but is limited by some other performance factors (Chomsky, 1959). The selection tasks rely on mental manipulation of the cards and mentally testing the rule whilst contemplating what is on the back of the cards. This may place too great a demand on the working memory capacity of the subjects with delusions (Fleming, Goldberg and Gold, 1994).

The effects of intelligence, education and training on the Selection Task should not in this case have determined the performance of the groups. Every effort was made to match the groups as closely as possible for performance on the NART. The groups

did not differ in the estimated IQ. scores. Thus, it is doubtful that differences in intelligence accounts for the differences in performance.

7.5 Conclusions

People with delusions do not perform as well as control groups on even the most realistic Wason selection tasks. This would appear to lend weight to the argument that subjects with delusions have impairments in reasoning. If the Selection Task is viewed as a hypothesis testing paradigm rather than a test of formal deductive logic (Oaksford and Chater, 1994) then this result appears consistent with the results of Huq et al. (1988) and Garety (1991).

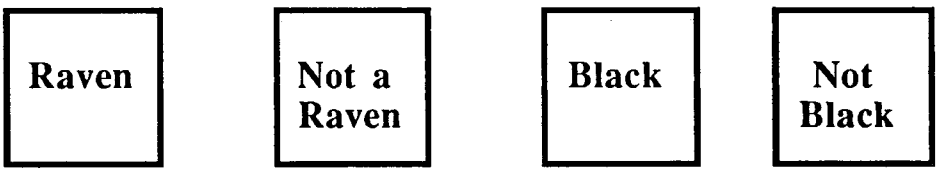
The Wason's tasks were systematically varied in the degree to which the content was realistic. Control subjects showed improved performance when the content of the task was most like real life. The subjects with delusions also improved in their performance on the more realistic tasks. However, they failed to achieve the same level of correct performance as the control groups. Therefore, people with delusions appeared to be susceptible to the same content effects as other subjects. In addition, the pattern of card selection on the alcohol conditional implies that the people with delusions were generally less efficient in the choice of cards. However, the overall performance of the group of people with delusions was not as good even on the most realistic of tasks. The importance of the content of the material will be further explored in the next chapter.

8 Experiment 4: Wason's Selection Task revisited

8.1 Introduction

In the previous experiment people with delusions were seen to have an impairment in the ability to reason deductively. Whilst they performed as poorly as the other groups on the hardest Wason selection tasks, the people with delusions did not solve the most realistic, and easiest, tasks, as well as the control groups. In the hardest conditionals the group with delusions made the same typical error as the other groups. The typical pattern was to select the cards mentioned in the rule; the matching bias error. Performance of all of the groups, did improve for the more realistic alcohol conditional. However, the subjects with delusions did not achieve the same level of performance as the other two groups. Therefore, it can be seen that people with delusions are susceptible to the same types of errors (matching bias) and are affected by the content of the task. Yet, they do not perform as well as the other two groups on the easiest of the tasks. To further explore this interesting finding three more conditionals were used.

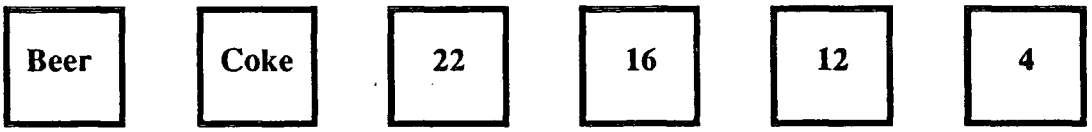
Selection task performance has been shown to affected by two factors; the probability that cards will yield important outcomes and the utility of possible outcomes (Kirby, 1993). Therefore, there are likely costs and benefits associated with performance on the selection task. If on the task the class of objects in the *p* set is small, this may influence the probability of finding the *not q* case. For instance, take the hypothesis "If it is a Raven then it is black" as in the cards below. It is the subject's task to find any instances of there being a Raven that is not black (*p* and *not q* cards)



In this case, real world knowledge will indicate that you only need to see one male and one female raven as they tend to be similar. Therefore, you may not feel that you need to see many *p* cards. To check the hypothesis thoroughly would require an exhaustive search of all non black objects to determine if the statement is correct. There are a large number of non black objects in the world. The probability of finding a not black raven out of all of the not black objects in the world is really very low. Therefore, a rational[1] decision may be merely to check that the ravens are black and to leave the class of non

black objects alone. The probability of finding a non black raven is probably not worth the effort (utility) of searching.

To show the influence of probabilities on card selection consider the example taken from Kirby (1993). Here the drinking age problem is presented as in the last chapter, except that there are six cards instead of four. There are two cards for drinks and four cards representing ages.



The ages of 16, 12, and 4 all represent the *not q* cards and should all be logically selected. When given to subjects there is a decrease in the selection of cards from 86% for the 16 year old to 71% for the four year old. Naturally enough the chance of a four year old drinking alcohol seems lower. Hence, the probability of the cards producing a valuable outcome is important. An additional manipulation made by Kirby was to vary the utility of selecting the cards. In a condition where subjects would lose their job if they checked someone underage who was not drinking alcohol, the probability of selecting the 12 and 4 year old cards fell to 47% and 39% respectively. Where the utility was varied the other way so that the selector was encouraged to check, the selection rates of the 12 and 4 cards was 86% and 80%. As was demonstrated in the Biased Coin (and later the Beads tasks) subjects with delusions do not apparently have difficulties using probabilities. Therefore, the loss of utility in selection may be a factor in their poorer performance.

The possibility is that performance on the selection task is dependant on the utility of turning over the cards. It may be the case that people with delusions do not place the same value on the solution of the task as the other groups. Perhaps, the subjects with delusions are able to reason correctly about the cards in the alcohol conditional but they may attach less importance to the potential outcomes. For instance, the people with delusions may merely regard as less important the fact that a 16 year old is drinking beer. Thus, they may be less concerned with the need to check that person.

Utility may be decreased in people with delusions on tasks where the content is not related to the concerns of the person. However, when the material is of a nature that is related to the theme of the delusional belief, this may raise the utility to the person. The subjects with delusions may in a sense be less motivated to find the correct response when the material is not directly related to the theme of their delusion. Motivation would be expected to be low in the depressed subjects but the motivation here is more like a cost benefit analysis of examining the cards. A low level of utility may lead to less of an information search, i.e. a jump to conclusions reasoning style. Or it may be the case that

owing to the quite memory-intensive nature of the reasoning tasks, people with delusions are less able to reason with the rule. Rather than jumping to conclusions then, these people may impose an answer in order to "cut their losses".

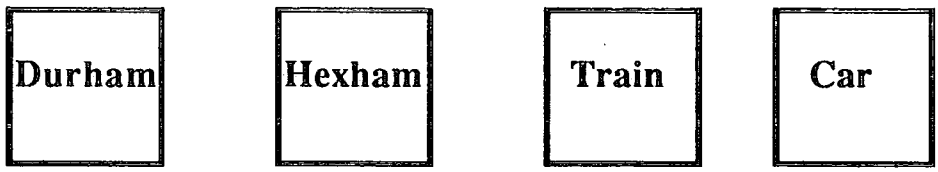
To explore the possibility of differences in utility between the groups, three more Wason selection tasks were used on three more groups of subjects. The first selection task was a direct attempt to investigate the possible relationship between utility of outcome and performance on the selection task. Subjects were given the Alcohol conditional as before. However, in addition, the participants were asked to rate on a utility rating scale what the relative value of each outcome was. The people in the study were asked to rate the importance of a 22 year old drinking beer or coke, and of a 16 year old drinking the same. It is possible that the people with delusions may well have lower utility ratings on these dimensions. This may account for the poorer performance if the subjects with delusions are shown to be poorer at this task again. The people with delusions are proposed to have a lower utility, and therefore may place less value on the outcomes of the rule. The reduction of utility would lead to a less efficient information search and less consideration of the cards. This may lead to the subject merely selecting the cards mentioned in the conditional rule, i.e., making the matching bias error. Therefore, lower utility ratings generally are expected to be associated with the *pq* cards response and a lower utility specifically associated with the *not q* card.

The second conditional was designed specifically to be of high familiarity and utility to the subjects with delusions. The rule was concerned with an aspect of hospital policy on discharge. This should be relevant and available to the people with delusions and depression from past experience (considered an aid to correct solution, Griggs and Cox, 1982). The form of the rule was "If one is to be discharged, one must have completed the medication" Four cards were presented with Discharge (*p*), Not discharged (*not p*), Taken medication (*q*) and Not taken medication (*not q*). The task was to identify anyone who had broken the rule and been discharged without completing the medication. It was predicted that the people with delusions performance would be improved as the task is familiar in content and available from experience. It should also be salient to many of the people with depression. However, they have been shown to perform well on the alcohol conditional already so little improvement was expected.

Once again the visual analogue utility scale was used. It was expected that a higher number of correct *p* and *not q* card responses provided by the people with delusions would be correlated with a higher utility on the relevant outcomes than in the alcohol conditional. The raised salience and utility on this conditional would, it was expected, lead to a more efficient information search by the people with delusions.

The third task took the form of an indicative conditional in which the statement needs to be checked as being true or false. Unlike the alcohol and hospital conditionals (above) there are no deontic terms in an indicative conditional. The deontic conditionals

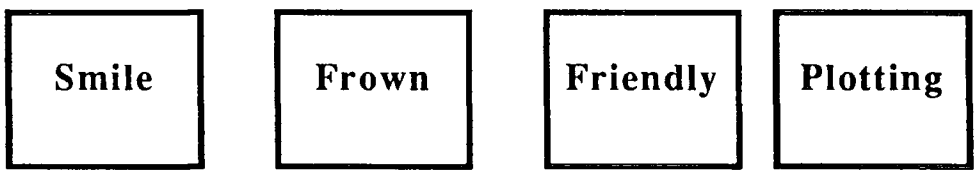
require consideration of what ought to happen, whereas indicative conditionals consider whether an event did or did not occur. Usually indicative conditionals are solved less well than the deontic conditionals. An example of an indicative conditional is "Every time I go to Durham I travel by train." The task is to find if the statement is true or false. Typically this produces the *p* and *q* card response, when the cards are:



p *not p* *q* *not q*

In the version used in this study, participants were given a task in which the theme of the conditional was very close in nature to the theme of the delusional belief. Bentall and his colleagues have shown that people with persecutory beliefs differentially process material that is related to the theme of the delusional belief. As the form was an indicative conditional it was expected that the normal and depressed subjects would turn over the typical *p* and *q* cards. However, a different pattern of responding was expected for the subjects with delusions. It was expected that they would turn over a higher frequency of the *not q* card. This was expected in combination with the *p* card and perhaps with *pq* cards. The content should be more available and relevant to the people with delusional ideas. Thus, improved performance was expected.

The participants in this study were told that they have identified two types of people in the world. The first group are genuinely friendly and the second group are telling lies about the person and plotting against him or her. There is a simple way to distinguish the two types: "If someone smiles then they are friendly." The person's task was to determine if this statement was true or false.



p *not p* *q* *not q*

Therefore, it was predicted that on the alcohol conditional the people with delusions would perform as poorly as on the previous study. This was proposed to occur because these subjects would ascribe lower utilities to the statements than the other groups. This should account for the lower number of correct responses on the last study. The second conditional deliberately tried to raise the utility of a correct solution to subjects with delusions. The conditional was based on a discharge policy of a hospital and was designed to be familiar and salient to the patients groups. This manipulation was expected

to produce improved performance in the group with delusions and bring them in line with other two groups who were already performing well. The third prediction was that on an indicative conditional with a realistic content that was salient and relevant to the subjects with delusions, these subjects would produce a differential pattern of performance to the other groups. Specifically, more *p*, *not q* card responses.

8.2 Method

Subjects: Three groups of subjects agreed to participate in this study. The experimental subjects were 15 patients with delusions of persecution or grandeur who were selected by the usual criteria. Control subjects were also selected by the previous criteria.

Table 8.1: Subject characteristics in Experiment 4. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	15	7	8	10	5	39.8 (11.9)	102.9 (8.3)	28.4 (1.2)
Depressed	15	9	6	8	7	42.5 (9.6)	104.1 (11.1)	28.3 (1.3)
Control	15			7	8	38.2 (10.4)	105.6 (8.5)	28.7 (0.8)
Significance						NS	NS	NS

Apparatus: Each of the three conditionals was written on a separate piece of paper and consisted of the rule, four representations of cards as well as the utility scale where appropriate (shown in appendix 4).

Procedure: Subjects were shown the conditionals one at a time according to a randomised order. The order of the cards on each conditional was also randomised. The conditionals were identical in form to those reported earlier but differed in content as outlined above. After completing the alcohol and hospital conditional participants completed the utility assessment scale (appendix 5). Subjects were given four situations that corresponded with or broke the rule and had to assess on a scale of 1 to 7 whether it mattered to the person whether such a situation occurred. The utility scale for the alcohol conditional is represented here, only the first scale is shown as the others were identical. The first three situations represent situations that are in accord with the rule and the fourth represents the rule breaker. Low values were expected for the situations that are in accord with the rule. People would be expected to say that the situation should be allowed to

happen. However, a high score was expected for the rule breaker as this should not be allowed to occur.

Please indicate how important it is to you that the following situations should or should not be allowed to happen.

A) A 22 year old drinks beer

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely should not be allowed
.....	.....	.....	.....	.....	.....	.....

B) A 22 year old drinks coke

C) A 16 year old drinks coke

D) A 16 year old drinks beer

8.3 Results

The table below shows the types of, and the number of responses given by each group of participants on the three conditionals. As in the previous study, the responses are divided in to correct (*p* and *not q*), matching bias (*p* card alone or *p* and *q* cards) and then a category of other incorrect responses (combinations of cards).

Table 8.2: Type of response made by the groups to the Wason Conditionals.

Group	*Conditional*	*Correct (pq~)*	*Matching (p or pq)*	*Other*
Deluded	Alcohol	5	4	6
Deluded	Hospital	1	4	10
Deluded	Paranoid	0	7	8
Depressed	Alcohol	9	2	4
Depressed	Hospital	2	3	10
Depressed	Paranoid	0	5	10
Normal	Alcohol	13	1	1
Normal	Hospital	6	5	4
Normal	Paranoid	2	7	6

The people with delusions were poorer at selecting the *p* and *not q* cards on the alcohol conditional. Out of the 15 people in the group only 5 correctly chose this combination. Nine of the people with depression and 13 of the normal controls were correct. The performance is very similar to that in the previous chapter. However, people with depression did not perform as well on the alcohol conditional as they did before (12 *p* and *not q* responses last time). Analysis of the results was conducted in the same way as reported in the previous chapter. Responses were scored in terms of matching and logic indices. These are shown in table 8.3. A one way Anova revealed a significant difference between the groups [F (2, 42) = 7.5, p = 0.002). Post Hoc analysis (Tukey HSD test) indicated that there was a significant difference between the people with delusions and the other two groups on the alcohol conditional. The control groups did not differ from each other. A significant difference is found because the people with depression responded with a *p* or *not q* card alone on five occasions. Therefore, despite giving the *p* and *not q* choice on 9 occasions, the index score was raised by the correct selection of the *p* and *not q* cards singly but not in combination. As before, when incorrect, the people with delusions frequently made the common matching bias error.

Table 8.3: Mean matching and logical indices for the three conditionals. Each indices varies between +2 and -2.

Group	*Indices*	*Alcohol*	*Hospital*	*Paranoid*
Deluded	Logic	0.67	-0.07	0.2
Deluded	Matching	0.13	0.33	0.87
Depressed	Logic	1.53	0.33	-0.13
Depressed	Matching	-0.07	-0.6	0.13
Normal	Logic	1.8	0.9	0.13
Normal	Matching	0.07	0.33	0.27

The hospital conditional produced poor performance in all of the groups. The normal subjects were able to give the correct response on 6 occasions. Whereas the other control group were only correct twice and the people with delusions once. A one way Anova on the logic index scores revealed a significant difference between the groups [F(2, 42) = 4.1, p = 0.02]. Post hoc tests revealed that the difference was between the normal subjects and the group with delusions. No differences existed between the two patient groups nor between the two control groups.

All of the subjects performed poorly on the paranoid theme conditional. None of the people from the two patient groups solved it correctly and only two normal subjects were correct. Note that when all of the groups were unable to provide the correct *p* and *not q* cards, there were a high number of matching bias (*p* and *q*) responses. All of the groups rely on selecting the cards mentioned in the rule. There were no differences between the groups on the logic index scores for the paranoid conditional [F (2,42) = 0.76, p = 0.5].

It was hypothesised that the poor performance by people with delusions may be attributable to lower judgements of utility to an outcome. The average utility ratings are given in the table below. Subjects rated the importance of situations occurring given the rule. For instance in the table, the utility rating for the A) scenario on the alcohol conditional corresponds to a situation of a 22 year old drinking beer. On the alcohol conditional it was hypothesised that there may be lower utility of outcome ratings, especially for the D) condition or the rule breaker card. However, it is clear that there is no difference on the utility of outcome on this situation as all groups rate this as 6. This means that all groups said that a 16 year old drinking alcohol "Definitely should not be allowed to happen". In fact there are no significant differences between the groups on any of the ratings of utility. However, the difference approaches significance [H(2,3) = 5.6, p = 0.06) on the ratings for C) which corresponds to a 16 year old drinking coke.

Table 8.4: Mean utility rating of each outcome made by the groups to the Wason Conditionals. A low value indicates that the situation should be allowed to occur, and a high score that it should not. Standard deviations are shown in brackets.

Groups	*Conditional*	*A) rule keeper*	*B) rule keeper*	*C) rule keeper*	*D) rule breaker*
Deluded	Alcohol	2.3 (1.5)	2 (1)	2.7 (1)	6 (1)
Deluded	Hospital	2.9 (0.9)	4 (1)	3.4 (1.2)	5 (2)
Depressed	Alcohol	2.1 (1)	2 (1)	1.9 (1)	6 (1)
Depressed	Hospital	1.9 (0.9)	4 (2)	2.1 (1.4)	6 (2)
Normal	Alcohol	1.5 (0.8)	1 (1)	1.7 (1)	6 (1)
Normal	Hospital	1.6 (0.8)	4 (2)	2.6 (1.5)	6 (1)

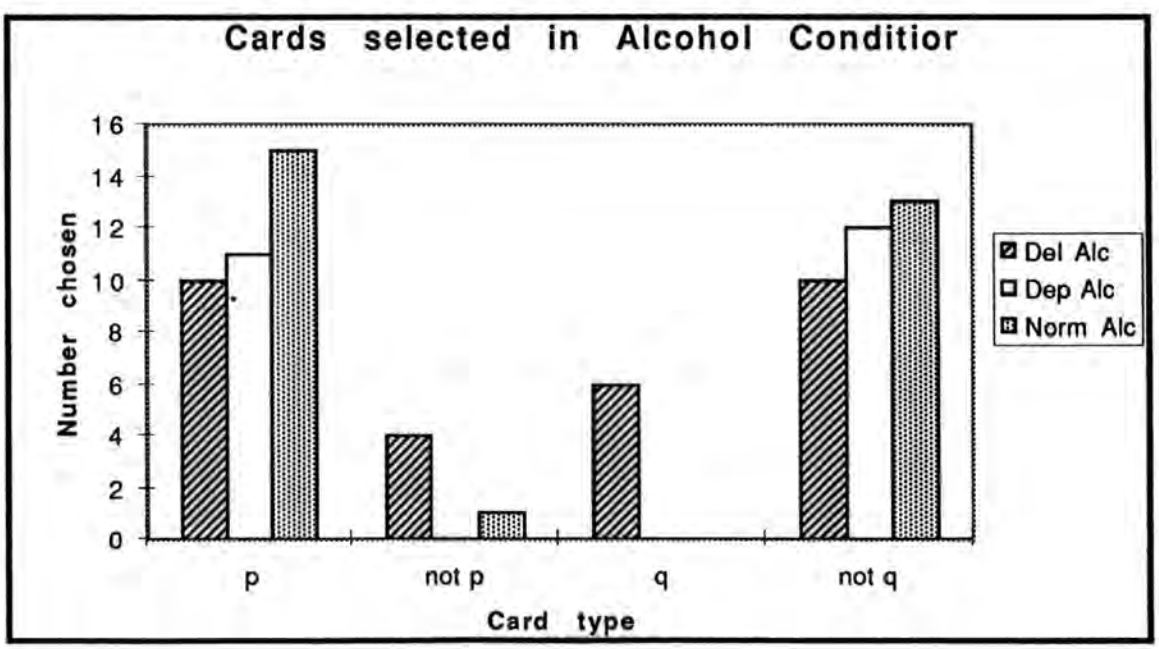
On the Hospital utility rating scale there are some significant differences between the groups on the ratings of utility of outcome. The situation of someone being discharged after having finished their medication (condition A) produces mean utility ratings of 2.9 for the people with delusions, 1.9 for the group with depression and 1.6 for the normals. There is a significant difference between the groups

[H(2,3) = 12.2, p = 0.002]. Post hoc tests reveal that the difference lies between the group with delusions and both the depressed group (U = 48.5, p = 0.008), and the normal group (U = 28.5, p = 0.003) but not between the two control groups (U = 94.5, p = 0.45).

Also, there is a significant difference between the groups on the C) scenario which is the situation in which someone is kept in when they have lapsed on medication. Once again, the people with delusions rate this as less important than the other groups [H(2,3) =7.5, p = 0.02]. The difference lies between the people with delusions and both the depressed subjects (U = 51.5, p = 0.01), and the normals (U = 63, p = 0.04). Once again there is no difference between the two control groups (U =101, p = 0.6). Finally the groups do not differ on the utility rating given to the rule breaker condition of someone being discharged without having completed the prescribed medication [H(2,3) = 5, p = 0.08]. People with delusions rate this as of lower importance and on average rate it as 5 whereas the other groups rate it as a score of 6 meaning that they think that it definitely should not be allowed. Overall, people with delusions seem to give less extreme utility ratings to the different outcomes. However, this cannot account for performance as the people with depression ascribe similar ratings to the normal controls but perform as poorly as the people with delusions.

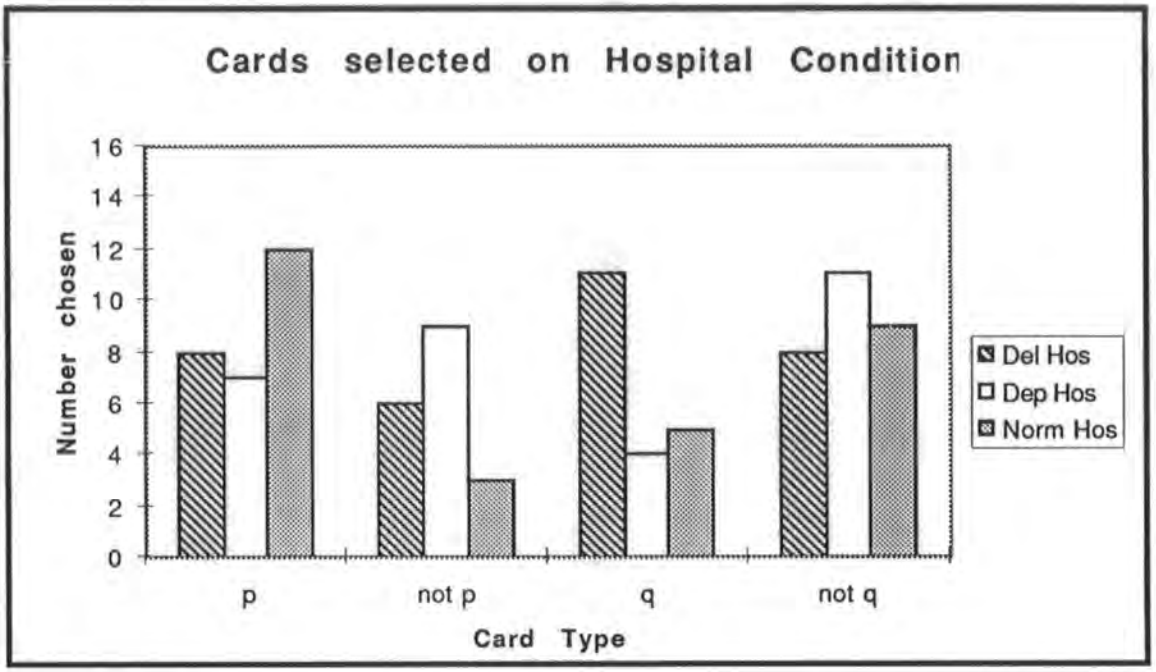
As in the last chapter it is possible to examine the card selection and not just the error rates. On the graph below (figure 8.1) the different card selections made by each group on the alcohol conditional are shown. As can be seen people with delusions choose less of the *not q* card (16), and more of the *not p* (coke) and the *q* card (22). This pattern of selection is very similar to that seen on the previous alcohol conditional (chapter 7).

Figure 8.1: Cards selected on the alcohol conditional by each of the three groups.



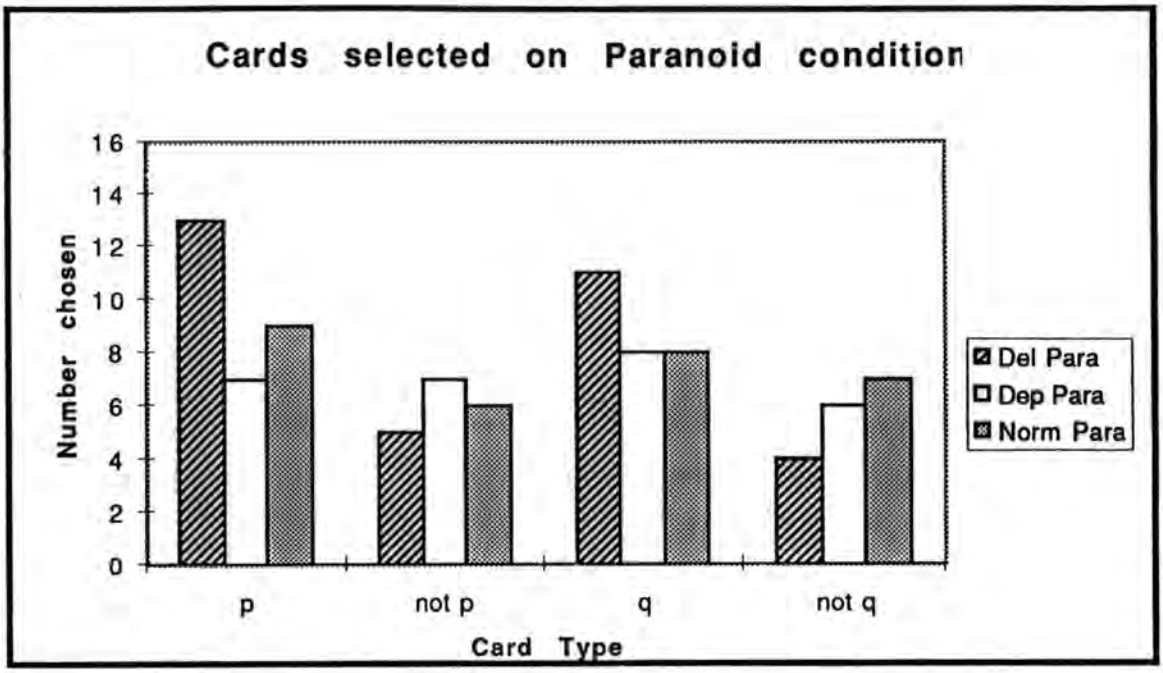
The poorer performance of all of the groups on the hospital conditional is reflected in the cards chosen. This is represented on Figure 8.2. There is an increase in the selection of the irrelevant *not p* card (kept in) and a reduction in the selection of the *not q* (lapsed on medication) card. People with delusions appear to be mainly choosing the *p* (Discharged) and *q* (completed medication) cards.

Figure 8.2: Cards selected on the hospital conditional by each of the three groups.



The performance by all of the groups was very poor on the paranoid conditional. The selection of cards is shown below (figure 8.3). It can be seen that once again there is an increased selection of the irrelevant *not p* card (frowning) and very little selection of the *not q* card (plotting). Surprisingly, this card was selected the least by the people with delusions who are held to have an attentional bias to threat related material (Bentall and Kaney, 1989). The people with delusions once again show a preference for selecting the *p* (smiling) and *q* (friendly) cards, reflecting the high number of matching bias responses provided by this group.

Figure 8.3: Cards selected on the paranoid conditional by each of the three groups.



8.4 Discussion

People with delusions were shown to be poorer at reasoning deductively in the last chapter. The utility of the outcomes is thought to be one particular factor that influences the chance of correct performance. This study investigated whether people with delusions were poorer at reasoning deductively and whether lower judgements of value or utility played a role in this impaired performance.

To study this, the utility of outcome was manipulated in three Wason selection tasks. It was expected that the more salient and relevant the material was to the person, the higher the utility judgements would be, and the more correct *p* and *not q* card selections would be produced.

People with delusions were once again shown to be poorer than control subjects on the alcohol conditional. However, the utility of outcome was not predictive of the *not q* card being selected. The groups did not differ in their rating of whether a 16 year old should be allowed to drink beer. All the groups rated it as 6, or "definitely should not be allowed to happen". Nevertheless, they differed in the successful selection of the *p* and *not q* cards.

The hospital conditional was designed to be both available and salient to the patient groups and to improve the performance of the people with delusions in comparison to that of the other groups. In fact, all groups did poorly on this conditional especially the patient groups. There was a significant difference in performance on the logic index between the normal group and the group with delusions. There were no other differences. On this

conditional, the groups did differ to some extent on the judgement of utility. The people with delusions generally rated the outcomes as having less importance, these people were generally less concerned with whether a rule was upheld or broken. However, this did not affect the chance of correct solution, as the people with delusions did not differ from the people with depression in their performance on this task. Possibly, the reason the patient groups performed differently was owing to the different perspective that they had to the normal controls. The rule stated that the hospital had a policy that in order to be discharged, one must have completed the medication. The *p* and *not q* card response required checking the discharged card, and the not completed medication card. However, the patient groups both checked the *not p* card frequently. This card had "Kept in" written on it. Therefore, the patient groups perhaps were looking more for instances where someone had completed the medication and not been discharged. Similarly, the people with delusions chose the completed medication perhaps to check if discharged was on the back more than any other group. Perhaps, the patient groups had a different perspective to the normal subjects who adopted the hospital's view more readily and looked for people who had been discharged without completing their medication (i.e. had cheated the system). The patient groups may have been more concerned with ensuring that the system had not cheated the patient. Checking whether the hospital had not discharged someone after that person had completed the medication. However, the groups did not differ on the value that they placed on someone having been kept in even though that person had completed the medication. All groups rated it as 4 indicating that they were neutral on the matter.

The final conditional was designed to be very salient to the people with delusions. As it was an indicative conditional which usually produces a high number of *pq* responses in people, it was assumed that this is what would happen in the two control groups. The people with delusions were expected to have processing biases for material that is related to the theme of the delusion (Bentall, 1994). Hence, it was expected that these people would have a preference for viewing the *not q* card which had the word "plotting" on it. In actual fact, the people with delusions chose this card less often than the other two groups and chose it less than any other card. The group with delusions mainly chose the *pq* cards as is seen when people make the matching error. The attentional biases for threat related material have been demonstrated on tasks that require automatic processing of material. For instance, Bentall and Kaney (1989) used the emotional Stroop paradigm to show that people with delusions took longer to colour name threat related words. Therefore, the biases in processing may only be present on tasks that require automatic processing of material and not when effortful, non-automatic processing is used as in reasoning tasks. Perhaps then this failure to select the *not q* card with the word "plotting" on it reflected some sort of deliberate avoidance of threat related material. However, Bentall, Kaney and Bowen-Jones (1995) have reported that there is preferential recall of

threat related material in memory tasks that seems unlikely to rely on automatic processes. Therefore, the infrequent selection of the plotting card remains perplexing.

People with delusions appear to solve the easiest conditionals less efficiently than control subjects. This is most notable on the alcohol conditional which the group with delusions were less able to solve on this, and the previous occasion (chapter 7). The difference between the people with delusions and the other groups appears to represent an inefficiency in reasoning rather than an inability. In the last chapter, the people with delusions' performance did improve with increases in the realisticness of the content. However, they did not attain the same level of performance. When the people with delusions are wrong they make the "normal" error of selecting the cards mentioned in the rule. This indicates that the group with delusions are not responding at random but are at least attempting to reason.

The poor performance on the alcohol conditional by the group with delusions was hypothesised to be owing to lower judgements of value being placed on outcomes by this group. However, no difference in utility was observed on the alcohol ratings. Further attempts to manipulate utility did not appear to aid correct selection of the *p* and *not q* cards. On the hospital conditional, which was designed to be salient and available to the patient groups, the people with delusions were significantly worse than normal subjects. On a conditional designed specifically to access the processing biases for theme related material, there was no difference in overall performance between all of the groups. Surprisingly, the people with delusions chose the *not q* card that had the word plotting on it, less than the other groups. This is despite the fact that people with delusions are held to have attentional biases to material related in theme to the delusion (Bentall and Kaney, 1989).

As utility of outcome does not appear to be able to explain the inefficiency in reasoning by the people with delusions, alternatives need to be considered. It is possible that the people with delusions are performing less well owing to impaired working memory ability (Fleming et al. 1994). Conditional reasoning is working memory intensive. It requires considering the rule, mentally manipulating the cards, checking what is on the back with what implications the rule holds. If a limitation in working memory capacity meant that the person was less efficient at selecting the cards, it may lead to a "cut your losses" reasoning style. A person would reason as far as possible but once working memory capacity was exceeded the person would decide. This would lead to performance that was influenced by the same factors as affects normal subjects. Also, when incorrect it would be expected that someone with reduced working memory capacity may demonstrate errors that are commonly made by normal people on harder tasks, namely the matching bias. This possibility that reduced working memory capacity may affect the performance of subjects with delusions on Wason Selection tasks clearly needs to be investigated. Performance on conditionals needs to be correlated with working memory tasks.

8.5 Conclusions

People with delusions were, once again, shown to be poorer in their performance than either of the two control groups on the alcohol conditional. This poor performance was not attributable to the group with delusions ascribing lower judgements of utility to the outcomes of the rule. Performance on two other conditionals, designed to raise the utility and availability for the people with delusions, was poor by all of the groups. On a conditional that was concerned with people plotting, which was expected to be salient to people with delusions, there was no difference in performance. Overall, it appears that people with delusions show an inefficiency in reasoning rather than an inability to reason. This inefficiency was not obviously owing to differences in utility. A possible role for impairments in working memory is suggested.

Therefore, at this stage there appears to be mixed set of results. On the one hand, people with delusions have been shown to reason with probabilities no differently from other groups (Biased Coin task). Also, the people with delusions were shown to be no more confident in the correctness of their decision making than other groups (Cognitive Estimates Task). However, the results of the Wason selection tasks indicate that people with delusions appear to perform poorly on tasks on which other groups perform well. The aim of this thesis is to explore reasoning over a variety of different tasks and with a variety of different types of material. For instance, tasks that are abstract and neutral in content or tasks that are realistic and relate to social interaction. Next, the attention turns to apparent discrepancy between the results of Huq et al. (1988) indicating biased probabilistic reasoning and the results of the Biased Coin task.

9 Experiment 5: Probabilistic reasoning (Beads task)

9.1 Introduction

Subjects with delusions appeared to reason accurately and were not biased in their reasoning in comparison to controls in the Biased Coin task used for Experiment 1. However, similar people have been shown to be hasty and overconfident when reasoning about probabilities (Huq et al. 1988). One way to account for this difference is that it may be the case that biased reasoning, such as hastiness is only apparent when subjects are allowed to determine the level of evidence. Were this so, then when given a predetermined level of evidence (such as in the coin task), people with delusions would be expected to reason very much as normal subjects. Essentially, this hypothesis proposes that people with delusions have a biased data gathering style and not an absolute deficit in reasoning ability. Experiment 5 therefore explored this possibility, utilising the beads task adopted by Huq et al. (1988) and Garety et al. (1991).

In the beads task a subject is presented with two jars full of beads. The person is told that the jars contain equal and opposite ratios of beads (e.g., 85 green beads and 15 pink in one jar, and 85 pink and 15 green in the other). The jars are hidden from view and then the experimenter draws beads from one of the jars and shows them to the subject. The bead is replaced in the jar after viewing. If requested by the subject another bead will be shown. The subject can view as many beads as she or he likes, and informs the experimenter when she or he is certain which jar has been selected. The number of beads seen can act as an index of how much evidence is required prior to a decision being made. People with delusions have been reported to request fewer beads (less evidence) before deciding. Thus, the people with delusions are considered to be hasty and jump to conclusions in this type of task (Garety et al. 1991).

This basic task lends itself to a number of investigations. Experiment 5 had four principal aims. The first aim was to determine whether people with delusions would only give biased responses in this task when allowed to determine the number of beads themselves, in line with the hypothesis derived from Experiment 1. Namely, that there is a difference in performance when all of the information is provided to when the subject is allowed to determine the amount of evidence to be reasoned with. Therefore, Experiment 5 included conditions where subjects determined how much information was available before they made their decisions, or where the experimenter told the subject to decide at a fixed point. It was hypothesised that in line with Garety and Hemsley's findings, in the subject-determined condition people with delusions may respond earlier than the comparison groups. In the experimenter-determined condition, participants were not

allowed to respond until they had viewed a predetermined number of beads (10). From the discussion of Experiment 1, it was hypothesised that this should lead to equivalent performance across people with delusions and non deluded comparison groups. Essentially, the aim was to demonstrate not an absolute deficit in reasoning but a difference in data gathering style.

A second aim of Experiment 5 was to determine whether any bias is a reflection of a genuine reasoning bias, or mere impulsiveness. A less discriminable ratio (60:40) should increase the number of beads requested before a decision is made. If the people with delusions were unable to alter their judgements to take account of this different level of discriminability, then it would imply they are not really reasoning at all but merely being thoughtless or indiscriminate in their answering style. Thus, two levels of discriminability were used in Experiment 5; 85:15 in order to replicate the original finding and 60:40 to investigate if the subjects with delusions were able to take into account this obvious change in the base rate. It would still be expected that the people with delusions would be hasty relative to the comparison groups in the 60:40 condition, but they should require more evidence than in the 85:15 condition.

A third aim was concerned with the maintenance of hypotheses in the face of contradictory evidence. Garety et al. (1991) reported that subjects with delusions more readily altered beliefs in the face of contradictory evidence. This is paradoxical, as the generally accepted definition of a delusion implies persistence of a belief despite incontrovertible and obvious evidence to the contrary. This unusual result is thought to occur because people with delusions fail to utilise previously acquired information (Baruch et al. 1988) and are therefore stimulus bound. To investigate this further, we studied the effect of presenting disconfirmatory evidence to the subjects after they had made a decision, to see if the people with delusions would change their minds sooner. After having seen ten beads in the experimenter-determined condition, the subjects were asked to decide from which jar the beads had been drawn. Then, disconfirmatory evidence was presented by making further draws of beads of predominantly the other colour. Two measures were taken; the number of times that the subjects changed their decision as a measure of willingness to alter the hypothesis, and the number of extra beads seen before altering the decision as an index of speed of change.

Finally, the possible role of memory in this type of experiment was considered important. Recent research has emphasised the previously neglected memory deficits found in schizophrenia (McKenna, Tamlyn, Lund, Mortimer, Hammond, and Baddeley, 1990; Saykin, Gur, Gur, Mozley, Resnick, Kester, and Stafiniak, 1991; Tamlyn, McKenna, Mortimer, Lund, Hammond, and Baddeley, 1992; Clare, McKenna, Mortimer and Baddeley, 1993) and delusions (McKenna, 1991). In Experiment 5, subjects were required to retain information regarding the number and colours of the previously seen beads. If people with delusions were less able to retain this information it would probably

lead them to make a decision early, as they would not be able to incorporate any new information without forgetting what had already been seen. Therefore, in half the conditions the memory demands of the task were reduced by presenting a record or tally of the previously viewed beads, in order to allow the person to concentrate on making the decision and not on maintaining the information in mind. If the group with delusions were relatively hasty on the conditions where there were no memory aids but were no different to comparison groups in the conditions in which there were memory aids, it would indicate that the subjects with delusions only have an inferential bias or jump to conclusion strategy when they are not able to reason with the same evidence as other subjects.

9.2 Method

Subjects: Three groups of subjects agreed to take part in this study The experimental subjects were 15 people with a diagnosis of schizophrenia and currently suffering from delusions. The selection criteria for the control subjects were as before. Subject characteristics for these three groups are shown in Table 9.1. There were no significant differences across groups in age, NART estimated IQ, and MMSE performance.

Table 9.1: Subject characteristics in Experiment 5. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender* *M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	15	6	9	8	7	40.3 (10.1)	106.1 (8.6)	28.4 (1.5)
Depressed	15	8	7	8	7	40.0 (13.8)	103.9 (10.6)	28.7 (1.7)
Control	15			8	7	39.6 (13.2)	104.7 (9.8)	29.1 (1.5)
Significance						NS	NS	NS

Apparatus: Macintosh portable computer running the experimental presentation package Superlab (version 1.5.5).

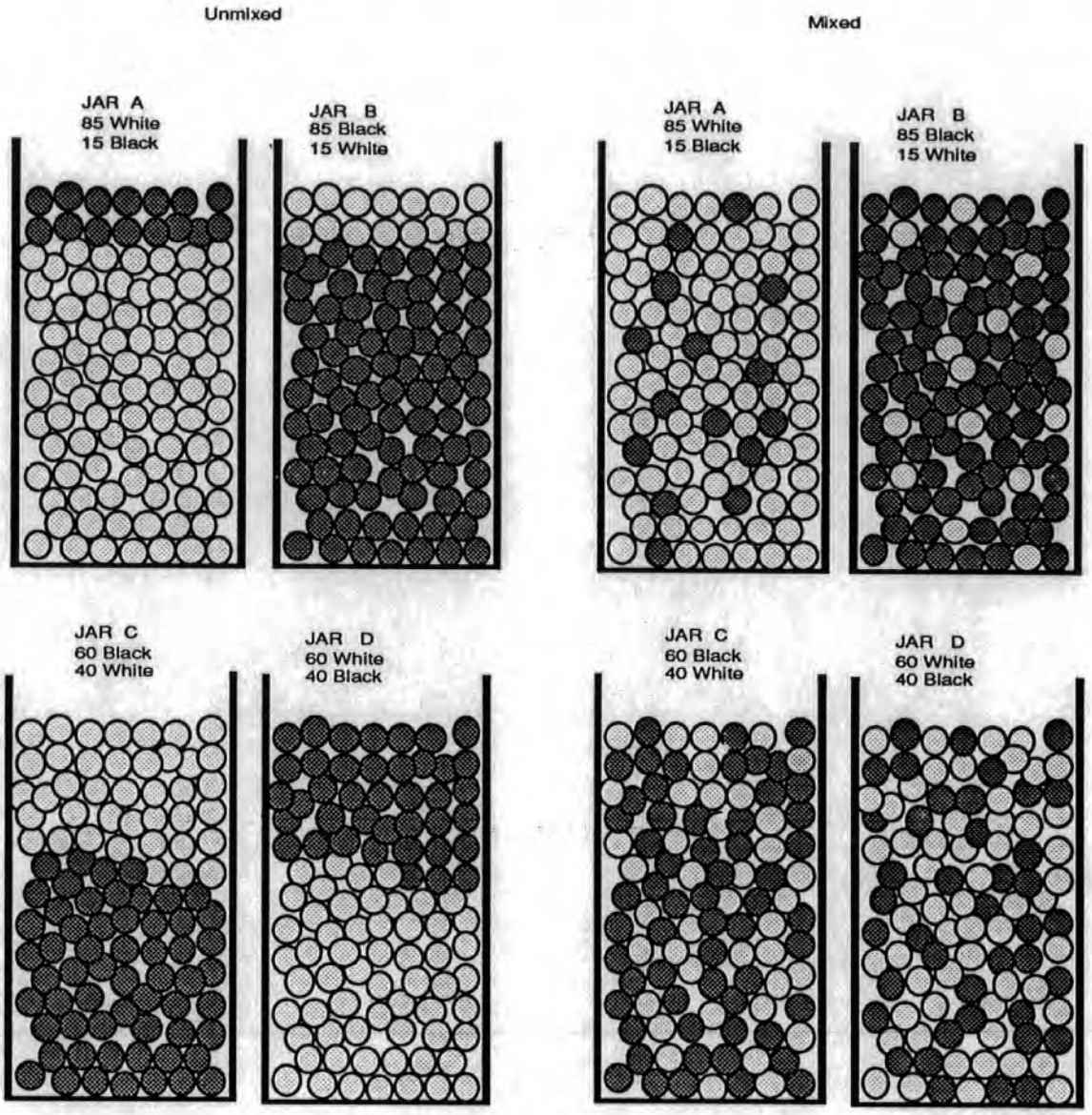
Procedure: Materials were presented on a portable computer. Subjects were seated in front of the screen and were told that they were participating in a study looking at the different ways people think. Then they were presented with written instructions detailing the principle of the beads task and of choosing from which jar the beads come from. Any questions were answered at this stage. Then there was a brief practice session, in order to ensure subjects were familiar with what they needed to do.

Two jars were presented on the screen showing equal and opposite ratios of beads. The proportions of black:white beads in each jar were 85:15 or 60:40. Here the beads

were separated into the relative proportions and the discrimination was obvious (see Figure 9.1). The subject was then instructed that the computer had mixed up the beads, and was shown the jars again (see Figure 9.1). Next, the subject was told that the computer had chosen one of the jars at random and that it was their job to determine which jar had been chosen on the basis of the computer drawing beads from the jar and presenting them on screen. The beads were presented one at a time and were returned to the jar after presentation and rerandomised.

Each subject was presented with four types of trial (details given below). In half of the trials the subject was allowed to decide where the beads were from as soon as he/she felt certain that he/she knew (subject-determined evidence). In the other half of the trials the subject was not allowed to decide until ten beads had been seen (experimenter-determined evidence). In the subject-determined evidence condition, the subjects were encouraged to decide only when certain, and the number of beads seen prior to a decision was recorded. The subject was asked if he/she was completely sure. If not, they were offered the chance to see more beads. To help reduce any confusion the pictures of the mixed up beads were placed next to the subject to remind them of the proportions in each jar.

Figure 9.1: Examples of the Jars shown to the subjects in Experiment 5. Jars A and B show the jars in the 85:15 ratio condition. Jars C and D represent the 60:40 condition. The jars are shown to the subject firstly unmixed (on the left) to demonstrate the differences in the proportions, and then in a mixed state (on the right).



At each of the two levels of discriminability (85:15 or 60:40) there were 4 trials, given in a fixed order with or without a memory aid. For each trial, different representations of jars and different shaded beads were used. This is an illustration of the sequences of trials using the 85:15 ratio. The sequences for the 60:40 ratio were the same.

85:15 ratio without memory aid:

Trials 1 and 2: Draws till decision (subject-determined evidence): Beads were drawn from the jar and displayed one at a time on the computer screen, and the subject decided when they had seen enough to make a decision as to the source of the beads. For example, this was the order of beads in trial 1:

A A A B A A A A A B B A A A A A A A B

Trials 3 and 4: Experimenter-determined evidence and reversal: The subject was presented with 10 draws of beads before being allowed to offer a decision. Then, once a decision had been made, counter-evidence was presented (i.e. beads of predominantly the other colour, up to a maximum of 10) and the number of beads required before the decision was changed was recorded.

85:15 ratio with memory aid:

Trials 1 and 2: Draws till decision (subject-determined evidence) with memory aid: As the beads were presented in the draws till decision task, a small marker or tally was incremented at the bottom of the computer screen, indicating the colours of the previous beads. Therefore, any bias resulting from failure to remember previous draws was reduced.

Trials 3 and 4: Experimenter-determined evidence and reversal with memory aid: The subject was presented with 10 draws of beads before being allowed to offer a decision. Then, once a decision had been made, counter-evidence was presented (i.e. beads of predominantly the other colour, up to a maximum of 10) and the number of beads required before the decision was changed was recorded. The previously drawn beads were shown along the bottom of the screen.

No effects of ordering in similar tasks have been reported (Huq et al. 1988). Trials with the 60:40 and 85:15 sets were blocked together and given in counterbalanced order, as were the memory-aided and unaided conditions within each level of discriminability. Full details of the orderings are given in appendix 6.

9.3 Results

The results are dealt with in two sections. First, to be considered is the number of beads requested before a decision was made in the 85:15 and 60:40 conditions (i.e., data from Trials 1 and 2 in each block). The second section considers the conditions in which ten beads were presented before a decision was requested (experimenter-determined evidence) and then counter-evidence was provided (i.e., data from Trials 3 and 4 in each block).

Draws till decision (subject-determined evidence):

The first analysis involved the mean number of beads viewed prior to a decision on the draws till decision task. Table 9.2 shows the mean number of beads requested in the 60:40 and 85:15 conditions, and indicates whether or not a memory aid was present.

Table 9.2: Results of Draws till Decision in Experiment 5. The mean numbers of beads requested by each group and standard deviations are shown at each of the two levels of discriminability (60:40 and 85:15). The presence of a memory aid is indicated as well.

Level of discriminability		*60:40*		*85:15*	
Presence of memory aid		*No*	*Yes*	*No*	*Yes*
Deluded	Mean:	5.2	5.1	2.4	2.5
	SD:	2.4	2.4	0.7	0.7
Depressed	Mean:	8.4	7.9	4.1	4.5
	SD:	2.9	2.7	1.6	1.6
Control	Mean:	9.4	7.7	4.1	4.9
	SD:	3.7	2.0	1.4	1.9

A three-factor Analysis of Variance was used to investigate the effects of subject Group (deluded, depressed, and control), level of Discriminability (60:40 or 85:15; repeated measure), and Memory load (presence or absence of memory aid; repeated measure).

A significant main effect of subject Group was found ($F(2, 44) = 11.8$, $p < 0.001$). Post hoc Tukey tests ($\alpha = 0.05$) showed that the difference lay between the subjects with delusions and the other two groups; people with delusions requested fewer beads prior to a decision. Planned comparisons showed that this was true of both the

85:15 level ($F(2, 42) = 11.1$, $p<0.001$) and the 60:40 level ($F(2, 42) = 8.3$, $p< 0.001$) of discriminability.

A significant main effect was also found for the Discriminability factor ($F(1,42) = 125.2$, $p < 0.001$) indicating an overall difference between the 60:40 and 85:15 conditions; fewer beads were required to make a decision at the 85:15 level of discriminability, as would be expected. There was no Group by Discriminability interaction ($F(2,42) = 1.9$, $p > 0.1$) indicating that all of the groups took account of the change in base rates and altered the number of beads requested accordingly. The group of subjects with delusions changed from 2.5 beads to 5.2, and the controls from around 4.5 to about 8.5.

There was no main effect of Memory load ($F(1,42) = 1.2$, $p > 0.1$), indicating no overall difference between conditions in which the previously seen beads were presented or not. There was however, a Discriminability by Memory interaction ($F(1,42) = 6.6$, $p <0.02$). When the task was more difficult (60:40) the groups benefited from seeing the previous beads on the screen, and this allowed a slightly earlier decision. Without the burden of having to remember the previously seen beads in the 60:40 condition the control group subjects were thus able to respond a little earlier. There was no Group by Memory interaction ($F(2, 42) = 0.6 < 1$). Finally, there was no significant 3-way interaction between Group, Discriminability, and Memory load ($F(2, 42) = 2.3$, $p > 0.1$).

Errors (incorrect choice of jar) were rare, and not subjected to formal analysis. However, it did seem that although error rates were low, there were more errors for the group with delusions. At the 85:15 level of discriminability the subjects with delusions incorrectly chose the wrong jar on 4 of the total 60 trials. None of the comparison subjects made an error. At the 60:40 level of discriminability, there were a total of 12 errors made by the group with delusions, 4 by the subjects with depression, and 3 by the normal control group.

Ten beads (experimenter-determined evidence) and reversal:

Next to be considered was the number of errors made by the subjects when deciding from which jar the beads were drawn after having had to wait until they had seen 10 beads. With the 85:15 ratio, subjects were typically presented with 8 beads of one colour and 2 of the other. Subjects with delusions made 5 decision errors (i.e., incorrect choice of jar) on the 85:15 condition. This is out of a total of 60 trials, and represents an overall error rate of about 8%. The depressed subjects made 1 error, and the normal subjects made no mistakes. At the 60:40 level of probability, people with delusions made 6 errors, the subjects with depression made 5 errors, and the normal subjects 2 errors. On the whole, accuracy can be considered very good.

Once the subjects had made a decision after the tenth bead had been shown, extra beads were then presented that would be discrepant with the answer given. The mean number of times that the groups changed their minds is shown in Table 9.3. Also shown

are the mean number of beads required for subjects to change their minds when they did change. A Kruskall-Wallis test on the number of times that the subjects switched jars revealed no difference between groups ($H = 1.7$, $p = 0.3$) in the number of times the hypothesis was changed. The subjects with delusions were no more willing to alter their decisions than any of the other groups. In fact, all of the subjects were quite reluctant to change their minds at all. Additional Kruskall-Wallis tests on the number of beads required to change the decision revealed no difference at the 85:15 ($H = 1.23$, $p = 0.5$) or the 60:40 ($H = 2.9$, $p= 0.2$) levels of discriminability. Therefore, there were no group differences in the number of times that subjects changed, or in how long it took them to change their decisions.

Table 9.3: Results of Reversals in Experiment 5. The mean numbers of times that subjects in each group were willing to reverse a decision (out of a possible maximum of 2) at the two levels of discriminability are indicated. The mean numbers of extra draws required to alter are also shown.

Level of discriminability		*60:40*		*85:15*	
Presence of memory aid		*No*	*Yes*	*No*	*Yes*
Mean number of reversals (max = 2):					
Deluded	Mean:	0.73	1.00	1.13	0.40
	SD:	0.04	0.04	0.04	0.09
Depressed	Mean:	0.53	1.00	1.4	0.6
	SD:	0.09	0.14	0.14	0.24
Control	Mean:	0.47	0.87	0.67	0.47
	SD:	0.14	0.05	0.28	0.05
Mean extra draws before changing:					
Deluded	Mean:	3.09	7.27	5.06	6.67
	SD:	2.55	2.82	2.93	2.66
Depressed	Mean:	5.00	7.00	5.48	7.78
	SD:	2.45	2.24	2.77	2.11
Control	Mean:	4.57	8.15	7.00	6.00
	SD:	1.51	2.12	0.94	2.83

9.4 Discussion

The possibility was examined that people with delusions only show differences in reasoning in conditions in which the amount of evidence collected is determined by the subject. Results were consistent with this hypothesis. In conditions where the evidence was predetermined by the experimenter, and all of the subjects were required to decide at the same point, there was no difference between the groups in the ability to reason. However, when subjects were free to determine the amount of evidence they required before making a decision, people with delusions requested fewer beads. At the 85:15 level of discriminability, on average the group with delusions requested only 2.5 beads whereas the depressed and normal control groups requested 4.3 and 4.7 beads respectively ($p < 0.001$). The performance of the patients with delusions appears very similar to the study by Garety et al. (1991), who found that schizophrenic patients requested 2.4 beads (SD = 1.9) and patients with delusional disorder requested 3 beads (SD = 3.3). Garety et al.'s (1991) anxious control group requested 3.7 beads (SD = 1.7) and the normal controls requested 5.4 (SD = 3.2).

To examine if this was a reflection of a genuine reasoning bias, or mere impulsiveness, a less discriminable 60:40 condition was included. In this condition, the subjects with delusions *did* take account of the change in base rate and delayed their decision accordingly. The mean number of beads rose from 2.5 in the 85:15 condition to 5.2 in this 60:40 condition. The people with delusions still requested fewer beads than the two comparison groups however. The depressed subjects requested 8.1 beads on average. The normal controls requested 8.6. These differences are highly significant for both levels of discriminability ($p < 0.001$). The use of this 60:40 ratio, which makes the decision harder, indicates that the subjects in the delusions group were not ignoring base rate, and were able to delay their decision. Hence, their early responses do seem to reflect a reasoning bias, not impulsiveness.

The addition of a memory aid indicating the previously drawn beads made no difference to the reasoning style of the people with delusions. Thus, it would appear that the subjects with delusions are not hasty because they fail to remember the previously shown beads. Again, their early responses seem to reflect a genuine bias.

In the experimenter-determined evidence conditions, few mistakes were made. This indicates that, as in Experiment 1 (Biased Coin task), the people with delusions were mostly able to reason like the comparison groups when all of the information was available. However, the subjects with delusions did make 5 errors at the 85:15 level of discriminability, whereas the subjects with depression only made 1 error and the normal subjects made none. Note that these errors arise out of a total of 60 trials for each group, and hence in no way represent any absolute deficit or inability to reason. None the less, it is surprising that any mistakes would be made on the 85:15 condition, especially in the

memory aid condition where the previous beads are on display; yet this happened twice in people with delusions and once in the group with depression.

The possible reason for the slightly increased error rates in the delusion group is that, owing to the nature of persecutory delusions, the subjects with these problems were by nature suspicious. Therefore, they did not always trust what they saw and were willing to believe that they were sometimes being tricked. One subject appeared to learn that after giving a response after 10 beads had been shown, further beads of predominantly the other colour would be drawn, and was trying to pre-empt this! In addition, another patient with delusions spontaneously explained why she had chosen the white bead jar having seen 8 black beads and 2 white beads; she stated that the black beads were more magnetic and would therefore be attracted to the top and be picked out more often. The number of errors at the 60:40 ratio was 6 for the subjects with delusions, 5 for the depressed sample and 2 for the normal group. In this case, the ratios are so close it is perhaps surprising more errors were not made by all of the groups.

The results of Experiment 5 therefore confirm the findings of Huq et al. (1988) and Garety et al. (1991) in demonstrating that people suffering with delusions request less information before reaching a decision on a probabilistic reasoning task; they are hasty and jump to conclusions in comparison to depressed and normal controls. This hastiness generalised to a more difficult condition in which the ratios were less discriminable. The hastiness was not apparently caused by the inability to retain the information long enough to allow a decision, as the presence of a memory aid did not affect the decision style of people with delusions. Nor was the reasoning bias merely owing to impulsiveness, since the change in discriminability from an 85:15 ratio to a 60:40 ratio affected people with delusions as much as it affected comparison groups. However, in this experiment there was no apparent evidence of subjects with delusions being more willing to change their minds or of being especially quick to do so, as was found in previous work (Garety et al. 1991). This may be owing to a difference in testing methods. In previous studies the reversal measure was a change in confidence, rather than a complete reversal as used here.

The results of Experiments 1 and 5 provide clear evidence that people with delusions do not have an inability to reason *per se;* they are able to reason in a similar way to non-deluded comparison groups when provided with all of the necessary evidence. In Experiment 1, subjects were given the results of spinning a supposedly biased coin and asked to estimate the chance that the coin was biased to heads. The people with delusions gave estimates that did not differ from those of the comparison groups. In fact the people with delusions were subject to the same biases in reasoning as the normal subjects. When the strength of the evidence was high (a high ratio of heads to tails) and weight was low (very few spins) subjects were relatively overconfident. However, when strength was low (heads and tails were similar) and weight was high (a large number of spins) all subjects were relatively underconfident in comparison to Bayes's theorem. Similarly, the

subjects with delusions did not differ from comparison groups in Experiment 5 (beads task) for conditions where the amount of evidence viewed was predetermined by the experimenter.

However, people with delusions appear to limit the amount of data gathered before a decision is made, if allowed to do so. In the conditions of Experiment 5 involving subject-determined evidence, people with delusions were found to require fewer beads than comparison groups. Therefore, it is apparent that these people are willing to reach a decision on the basis of less evidence. This data-limiting bias does not apparently arise from a disregard for task demands, impulsiveness, or from boredom or lack of motivation. Subjects with delusions did request more beads in the less discriminable 60:40 condition than in the easier 85:15 condition, indicating that they took what they were doing seriously. Neither was the hastiness the result of an obvious limiting cognitive factor such as memory, as the addition of a memory-aided conditions had no effect on decision style.

Garety (1991) proposed that the willingness of people with delusions to decide earlier and then alter their hypotheses is consistent with the studies of information processing that emphasise the greater influence accorded by schizophrenics to immediate environmental stimuli compared with the effects of prior learning. Similarly, Chapman and Chapman (1988) suggested that schizophrenics have a selection bias in which prominent stimuli are focused on and weaker stimuli are neglected to a greater degree than is seen in controls. Young and Bentall (1995) proposed that subjects with delusions may have an inability to attend to and make use of sequential information about outcomes. Difficulty in integrating information over time would presumably lead to an early response when presented with information bit by bit. Young and Bentall also state that this difficulty may lead to increased errors when the subjects are made to decide at a fixed point by the experimenter. This is not in keeping with what is found here.

An alternative way of viewing such a biased reasoning style is as a functional way of reducing cognitive demands. An early jump to conclusions style may reduce the investment that a subject has to make in the decision. It may be possible that the subjects experiencing delusions do not especially care whether they are right or wrong, and the additional motivational cost of requesting additional information is not worth it to them. However, the same would then be expected of subjects with depression. Alternatively, the hasty style could be considered as an extreme version of the confirmation bias (Wason, 1960), in which people with delusions may be less able to consider alternatives or are unwilling to entertain other hypotheses or tolerate ambiguity, and thus impose an answer on the task. Brett-Jones, Garety and Hemsley (1987) reported that patients with delusions did not search for disconfirmatory evidence as much as patients without delusions.

A possible anecdotal illustration of this confirmation bias is the case of one patient suffering from delusions. She would explicitly state that she would see a set number of

beads before making a decision. Then, regardless of the actual sequence of draws, she would decide at the predetermined number.

It should be borne in mind that a hasty decision style does not inevitably lead to incorrect decisions. There were only 4 errors made at the 85:15 ratio by the people with delusions, despite gathering less evidence. However, no comparison subjects made such errors. At the 60:40 ratio, a hasty decision style should apparently leave the subject open to making errors. However, even if a hasty decision style did lead to incorrect hypotheses if the material is neutral, as in the case of this beads task, a faulty idea or belief could be revised in the face of disconfirmatory evidence, as was shown by the willingness to alter beliefs in the reversals condition. Overall, then, with these neutral materials the subjects with delusions appear to be as rational as comparison groups and are no more or less willing to alter their hypothesis or quicker or slower to do so than the controls. The difference is simply that people with delusions choose to make up their minds when less evidence is available. When the subjects with delusions have made an incorrect decision they do not stick doggedly to the conclusion. However, this is not to deny that if the belief is of a personally salient nature then the resistance to counter-argument may be increased and presentation of disconfirmatory evidence may be ignored. In such circumstances, the subjective importance of the content may serve to exaggerate the biased thinking (Bentall, 1994).

A jump to conclusions reasoning style could of course be contributing to the maintenance and intensity of delusional beliefs. Moreover, such reasoning biases may be a focus for cognitive behavioural treatments. Kingdon and Turkington (1991a) described the course of cognitive therapy with patients with delusions and noted that people often made arbitrary inferences (or jumped to conclusions). The finding that when given all of the evidence, the people suffering from delusions were able to reach the same conclusion as the normal subjects indicates that when the material is of a non-salient nature the reasoning process is functioning normally.

9.5 Conclusions

Subjects who experience delusions have been shown to exhibit a hastiness bias on tasks unrelated to the content of the delusion. However, these subjects do not have an inability to reason as was shown on the Biased Coin, and Cognitive Estimates Tasks. It appears to be the case that subjects with delusions appear to prefer to view less evidence prior to a decision. Bentall and colleagues have reported that subjects with delusions preferentially attend to and subsequently bias the processing of material related to the theme of the delusional belief. This raises the intriguing possibility of manipulating the material used on the beads task so that it now becomes salient to the subject with delusions. This is the focus of the next study.

10 Experiment 6: Reasoning with self referent material

10.1 Introduction

People suffering delusions have been shown to be hasty relative to control subjects when making up their minds on abstract, neutral probabilistic reasoning tasks (previous chapter). This jump to conclusions strategy is thought to occur because people with delusions fail to draw on previously acquired information (Garety, 1991). However, the cause of the hastiness is by no means clear.

In addition, subjects who have delusions (though more specifically with a persecutory theme) have also been shown to have content specific information processing styles. For instance, they have attentional and memorial biases for threat related material (Bentall and Kaney, 1989) as well as for self esteem related concepts (Kindermann, 1994). It is suggested that normally existing biases found in non deluded subjects are operating to an excessive degree in order to defend the subject with persecutory beliefs against feelings of low self esteem. The paranoid subject is held to have a discrepancy between the self as it actually is and the ideal self. In depressed subjects this discrepancy leads to feelings of sadness and inadequacy and naturally leads to depression. Subjects with delusions in an attempt to stave off this depression utilise self esteem enhancing biases in order to bolster apparent self esteem and actively try to reduce the discrepancy between actual and ideal self. This leads to a biasing of any threat related or self related material (Bentall, Kinderman and Kaney, 1994).

This current study was an attempt to investigate the two types of biased reasoning. People with delusions have been shown to have a hasty decision style on material unrelated to the theme of the delusion (Garety, 1991). In addition, such subjects have been shown to have attentional, processing and reasoning biases with material that is related to the theme of the delusion (Bentall, 1994) or is related to the self concept (Bentall et al. 1994). Thus, following a functional model of delusions acting to protect self esteem, it would be expected that these subjects are likely to amplify or exaggerate the hastiness demonstrated on the beads task if it the material is made salient and is changed from abstract neutral to realistic and social in content. People with delusions will become even more hasty in data gathering. Possibly the subjects with delusions may want to impose an answer quickly to reduce the ambiguity. Given the importance of the self esteem defending function of delusions (Bentall, Kinderman and Kaney, 1994) any study that did not find saliency of self esteem related material would seriously weaken the hypothesis involving the self concept.

People with delusions are supposed to be less able to utilise previously acquired information on neutral tasks. Thus, it would be expected that salient material will reduce this ability even further, as it places a greater demand on the already biased (or inefficient) information processing systems.

To explore this possibility two versions of a beads type task were used. The first task was realistic in that it used concrete examples but remained neutral in content. Subjects were presented with two schools, one that is mainly for boys (60%) and one that is mainly for girls (60%). On the basis of random sampling from the school the subject had to identify whether it is mainly boys or girls that attend the school. The first names of the students were presented and the participant requested as many names as necessary to make a decision. It was expected that the people with delusions would perform in the same way as they did on the previous study and respond on the basis of less evidence in comparison to control groups. Since the content is only different in the degree of realism and not in personal salience it was not expected that there would be a difference from the beads task in the amount of evidence viewed by each group.

In an emotional self referent (salient) version of the above task, participants were presented with a short scenario that two surveys had been conducted that gathered comments about someone who was very similar to the subject. One survey was generally positive and indicated the person was generally liked by other people (60%) and in the other survey the person was generally disliked (60%). On the basis of showing the participant a series of comments it was his/her job to decide if the survey indicated that the person was generally liked or disliked. The subject requested as many comments as necessary in order to decide if the comments originated from a mainly positive or a mainly negative survey. People with delusions were expected to request even less information than on the neutral tasks as the material is self related and this group show a biased processing of this type of material.

Since an increase in hastiness was expected the 85:15 ratio was not used as in this instance subjects with delusions were deciding on the basis of very little evidence (2 or 3 beads). Hence, there was very little scope for even hastier deciding. Therefore, the harder to discriminate 60:40 ratio was used throughout.

The words used in the self referent (salient) task were rated for likeableness of personality traits (Anderson, 1968). Participants in the study decided whether there were generally positive traits mentioned (sincere, honest, loyal, warm etc.) or generally negative comments (liar, mean, cruel, dishonest etc.). It was expected that dealing with this salient material would cause an exaggeration of the hastiness bias and would lead to even less evidence being collected by the people with delusions.

Self esteem related words were preferred to threat related material (i.e. Emotional Stroop task, Bentall and Kaney, 1989) because persecutory delusions are not all necessarily the same. They often differ in the actual detailed content of the delusion. The

theme is consistent in that one feels to be the victim of a plot or conspiracy. However, the detail may concern poisoning, stealing, watching, or any of a multitude of other methods. Thus, it is unlikely that different people's delusions will share common words such as spy, follow, watch, etc.. Therefore, using a limited number of words may not be salient to some of the experimental group. Self esteem related words are meant to reflect the concern with self image that is considered the basis of the paranoid defence (Bentall, 1994) and should apply to all persecutory type delusions (patients with grandiose delusions also participated as they were expected to be preoccupied with self concepts as well, Neale, 1988).

Maher criticised the work of Bentall and colleagues stating that the bias associated with processing threat related material may occur as the subject is very familiar with the materials. Thus, the person with persecutory beliefs would have an attentional bias to threat related material in the same way that a golfer may have an attentional bias to golf related material. However, in Maher's theory people with delusions would not be expected to be attentive to self concept material. If they are shown to be attentive to this type of material it indicates that the subject is preoccupied with their self concept even if they do not openly discuss it. This would lend support to Bentall et al.'s (1994) proposal that delusions arise from a discrepancy in the self concept.

No predictions were made a priori about whether there would be a bias between positive and negative outcomes. It is sufficient at this stage to demonstrate an increased bias with salient material. Kinderman (1994) demonstrated an increased latency on the Emotional Stroop task for both positive and negative words implying that both types are difficult for the person with delusions to cope with. There is a possibility that choice of survey may be congruent with the subjects' moods. Thus, people with depression may be more likely to choose the negative survey. People with delusions may be more likely to choose the positive survey as a deliberate attempt to stave off feelings of low self esteem. This is only a speculation however. Generally, accuracy of the decision at this level of probability is less important because at the 60:40 ratio it is very difficult to be truly positive that one choice is better than the other.

10.2 Method

Subjects: Once again three groups of subjects agreed to participate in this study. The experimental subjects were 15 people with delusions of grandeur or persecution and who were diagnosed as schizophrenic. The criteria for experimental and control groups selection were the same as in the previous study. Subject details are in table 10.1 below.

Table 10.1: Subject characteristics in Experiment 6. Mean age, NART estimate of IQ. and MMSE performance are given, and standard deviations are in brackets.

Group	*N*	*Inpatients*	*Outpatients*	*Gender* *M*	*F*	*Age*	*NART estimated IQ*	*MMSE*
Deluded	15	5	10	11	4	44.4 (9.7)	102.8 (13.2)	28.4 (1.2)
Depressed	16	12	4	8	8	44.6 (9.4)	106.3 (12.7)	28.3 (1.2)
Control	15			7	8	38.5 (10.4)	105.6 (8.5)	28.7 (0.8)
Significance						NS	NS	NS

Procedure: Materials were presented on a portable computer using the same experimental computer package (Superlab) as in the last study. Subjects were told that they were participating in a study looking at the different ways people think. They were told about the general procedure. Then they were presented with written instructions detailing the general principle of choosing from which school or survey the names or comments come from. Any questions were answered at this stage. Brief details of the trials are reported here. The presentation of the tasks followed a very similar format to the previous study.

Realistic version: Two schools were presented on the screen in equal and opposite ratios of boys and girls in proportions of 60:40. They were represented by different coloured beads, or counters, in school buildings. Here the children (beads) were separated into the relative proportions and the discrimination was obvious. The subject was instructed that in real life the children are found around the school and so the computer had mixed up the beads, which were then shown. Next the subject was told that the computer had chosen one of the schools at random and that it was the subject's job to decide which school had been chosen on the basis of the computer drawing names of the children from the school and presenting them on screen (i.e. James, David, Jenny, Clare, Mark etc.). The names were presented one at a time and returned to the school after presentation. A reminder of the previously seen names was presented on the bottom of the screen. The subject was encouraged to decide only when certain that he/she knew whether it was mainly a boys' or girls' school. The number of names seen prior to a decision was

recorded. The subject was asked if he/she was completely sure. If not, they were offered the chance to see more names. To help reduce any possible confusion, the pictures of the mixed up beads representing children in the schools was placed next to the subject to remind which was the mainly boys' and girls' school.

Salient version: The procedure was identical except instead of schools the subject was told to imagine that two surveys of 100 people each were asked what they thought of a person who was very similar to the subject. In one survey most people made positive, or nice comments about the subject. In fact 60% said they did like subject and had given positive comments and 40% said that they did not like the person and had given negative comments. In the other survey the opposite ratio of good to bad comments was found. Comments were then presented on the screen one at a time and the subjects decided when they felt certain they knew whether the survey was generally positive or negative The previous comments were in a list on the bottom of the screen.

For each of the two content types (realistic, or salient) there were 6 trials. For each trial different representations of schools or surveys were used. An illustration of the sequence of trials will be given.

Realistic Trials

Trial 1: Names of children were displayed one at a time on the screen. The subject determined when sufficient had been seen. For example the order of names in trial 1 was:

Catherine, Gregory, Heather, Pauline, Russell, Leonard, Edward, Margaret, Rosemary, Josephine, Elizabeth, Maureen, Dorothy, Patrick, Michelle, Charles, Veronica, Maxwell, Theresa, Winston.

Two further realistic trials followed. Then a block of three salient trials was presented.

Salient Trials

Trial 4: Comments from the surveys were displayed as above. An example is given here of the comments seen.

Offensive, Reliable, Cheerful, Pessimistic, Selfish, Kind, Amusing, Wise, Gentle, Envious, Positive, Unreliable, Helpful, Bright, Unfriendly, Generous, Honest, Truthful, Annoying, Witty.

3 more neutral trials and then 3 salient trials followed. The trials were in 4 blocks that were presented in a fixed pseudo random order. Full details of the orderings and the stimuli are in appendix 7. There were no differences in word lengths of the boys, girls names or of the positive and negative comments.

10.3 Results

The analysis involved the mean number of names of children (neutral) or the number of comments (salient) viewed prior to a decision being made. Table 10.2 shows the mean number of names and comments requested.

Table 10.2: Results of Draws till Decision in Experiment 6. The mean numbers of words requested by each group and standard deviations are shown at each of the two levels of content (neutral and salient). A memory aid was present in all trials.

Type of material		*Neutral*	*Salient*
Deluded	Mean:	5.2	4.2
	SD:	2.6	1.9
Depressed	Mean:	7.5	7.1
	SD:	3.4	3.6
Control	Mean:	8.0	7.3
	SD:	3.8	3.7

A 2 factor analysis of variance was used to investigate the effects of subject Group, (3 levels, deluded, depressed, normal) and the effect of the Content on reasoning (2 levels, neutral or salient, repeated measure). The mean scores for each subject were derived from the 6 trials on the realistic task and the same number of self related trials (i.e. 3 positive and 3 negative outcomes).

A significant main effect of Group was found ($F(2, 43) = 7.3$, $P < 0.002$). Post Hoc Tukey tests ($\alpha = 0.05$) indicated that the difference lay between the subjects with delusions and the other two groups but there was no difference between the 2 control groups.

A main effect was also found for the Content factor ($F(1, 43) = 11.25$, $p<0.002$). Fewer items of information were requested in the salient condition than in the realistic condition. Simple main effects tests ($\alpha = 0.05$) showed that the group with delusions requested fewer items at both the neutral and salient versions of the task. In both content conditions the control subjects did not differ from each other.

There was no Group by Content interaction ($F(2, 43) = 0.5$, $p = 0.6$). In the neutral condition the people with delusions viewed on average 5.2 names and only 4.2 comments on the salient condition. Both control groups also requested fewer comments than names. Depressed subjects requested on average 7.5 names and 7 comments and the normals requested 8 names and 7.3 comments. Thus, content apparently has an effect on

all groups decision processes. The greatest effect apparently being for the subjects with delusions and least on the people with depression.

Overall, the number of errors made was fairly small. People with delusions made 7 errors on the schools task and 15 on the survey task. People with depression made one error on the schools task and 4 on the survey task. The normal control subjects made 2 errors on each. Given the low discrimination of the two hypotheses and the early response strategy of the people with delusions it is surprising more errors were not made. The people with delusions did make more errors in deciding the source of the material generally, and even more when the material is of a salient nature. However, this can in no way represent an absolute deficit as these 22 errors occurred in 180 trials. No one subject made more than 3 errors out of 12 trials.

The cause of the errors is the people with delusions responding too early. For instance in trial 3, the comments block starts with a negative comment, then two positive and then two negative. In the long run more positive than negative words would be shown. However, the people with delusions typically respond after 4 or 5 comments and thus, say it is a negative survey. Given the evidence, this is the right decision but the early decision has led to an error. As people with delusions view less data on the salient trials they make more errors.

The people with delusions wrongly said that the comments were from a negative survey when the comments actually came from a positive survey 9 times. The opposite error was made 6 times. The people with depression made more of the first type of error (4 to 1). This is likely to occur as a result of a particular presentation order of one the comment trials rather than from any systematic bias. All the errors of saying the source is negative when it was actually positive occurred on the same trial. Therefore, it is doubtful that there is a systematic bias in either of the groups to pick favour one sort of survey above the other.

Performance on the previous beads task at the 60:40 ratio, which is equivalent to this task, is virtually identical. In the previous study, people with delusions requested on average 5.1 beads and the depressed subjects viewed 7.9 and the normal subjects 7.7 beads. Therefore, performance on the neutral names tasks and the neutral beads task is very similar.

10.4 Discussion

The present study examined whether the apparent hastiness in reasoning exhibited by people with delusions would be evident on more realistic tasks and whether the hastiness would be affected by changes in the saliency of the material. Namely, would the decision style be affected when the material was self referent and required a self focused value judgement. The results of the experiment indicate that people with delusions once again, make decisions on the basis of less evidence than control subjects ($p = 0.002$). Therefore, the hastiness in reasoning or the "jump to conclusions" style is evident on tasks that use more realistic materials.

Moreover, when the material is of a self related nature, concentrating on how others view the person, it seems that people with delusions actually become even more hasty in their decision making. This reduced data gathering is true of all the groups but the largest proportional difference is for the people with delusions.

Therefore, this study supports the previous findings that people with delusions reliably gather less data before making decisions. In the previous study, it was demonstrated that this hastiness bias was not a mere artefact of being generally impulsive and answering without consideration of the task. This was shown by the increase in the amount of evidence collected in the 60:40 condition relative to the 85:15 ratio. Also, the hastiness bias was shown not to arise from the people with delusions being unable to retain the information in mind in order to reason with it. The addition of a memory aid in the form of showing the previously presented beads did not radically alter the decision style. This present study has indicated that the early decision style is evident when the material is more complex and realistic. The people with delusions made up their minds based on a similar amount of evidence as in the beads task. Finally, this hastiness appears to be increased when all subjects are dealing with material that is self referent and concerns value judgements about the self. There is a hint that this increase is especially marked in the people with delusions.

The results of this and the previous study support the finding that people with delusions are hasty in their decision making (Garety, 1991) and that they are especially hasty whilst reasoning with material that is related to the self concept (Bentall, 1994). The reason for this increased hastiness in people with delusions when dealing with self related material is proposed to occur because an already biased and inefficient data gathering system is stretched further by the salient material. This biased processing of self related material places an increased demand on the reasoning system. In order to reduce this strain, or cognitive effort, it is proposed that the subject decides early to reduce the ambiguity of not having an answer. Since the material is presumably difficult for all subjects, as all of the groups show a decrease in the amount of evidence viewed, it may be

the case that the material is merely accelerating an already hasty system in the people with delusions.

More errors were made by the people with delusions than the control subjects (22 errors, versus 5 and 4 for the depressed and normals respectively). This is still not representative of a pervasive inability to reason by people with delusions. The number of errors is still small relative to the number of trials in total (180). The group with delusions made 7 errors on the school tasks and 15 on the comments task. Although it is tempting to believe that this represents an inability to reason with salient information this is probably not the case. The early decision style simply leads to more errors being made. There is no evidence that there is a deliberate conversion of answers. The people with delusions do not systematically claim the comments come from a negative or a positive survey, regardless of the data. Rather, it appears that when the subjects with delusions are hasty it merely leads to more errors. The people with delusions are not viewing enough evidence to be correct. When reasoning with salient material they become even more error prone owing to the increase in hastiness.

Despite being more likely to make errors than the control subjects such a "jump to conclusions" bias does not mean that errors are necessarily maintained. In the previous study subjects with delusions were as willing as control subjects to change their decisions when presented with discrepant evidence. One obvious question to ask is whether people with delusions would as readily alter a belief when the content of the belief is self related and not neutral in content.

10.5 Conclusions

People with delusions have been shown to request less evidence than other subjects when making a decision. This hastiness in data gathering is present in a realistic reasoning task. In addition, the tendency to jump to conclusions is apparently increased when the material reasoned with is of personally salient nature. Specifically, if the material is self related, people with delusions become even hastier in their decision making. However, this increase is not disproportionate to that demonstrated by other control groups.

11 Summary and conclusions

11.1 Overview of thesis

The aim of this present research has been to explore the possibility that people who suffer delusions have biases or errors in their thinking. These differences are thought to contribute to them forming and holding their abnormal beliefs. This chapter serves to recap and to review the results of the experimental studies and to discuss these findings in relation to models of delusion formation.

An important consideration in this research on reasoning is what type of task should be used to compare the groups' performance on. The strategy taken here was to manipulate the reasoning tasks in both form (statistical, deductive) and in content (abstract or realistic and neutral or self referent). Using different forms of tasks allowed an examination of the information processing biases proposed to be characteristic of people with delusions (Garety, 1991). The use of different contents in the tasks acted to bridge the apparent divide between the previous research concerning social reasoning (Bentall, Kinderman and Kaney, 1994) and hypothesis evaluation (Garety and Hemsley, 1994).

11.2 Overview of results

The results of the experimental studies showed both similarities and differences between reasoning in people with delusions and control subjects. These will be examined in turn.

11.2.1 Similarities in reasoning

On the Cognitive Estimates task (chapter 6) the participants were required to utilise existing information in a novel way to provide an answer to an unusual question. For instance, subjects were asked "how fast do race horses gallop?". The people with delusions provided estimates that did not differ from those provided by the other groups. In addition, the subjects with delusions were no more confident in the certainty of their answers. Garety's (1991) model suggested that overconfidence is a feature of the reasoning style of people with delusions. Previous research had found examples of such overconfidence in decision making (Huq et al. 1988).

In the Biased Coin task (chapter 5) subjects were presented with the results of spinning a supposedly biased coin. The person estimated the chance or probability that

the coin was biased to heads. It was expected that subjects with delusions would neglect base rate information and be particularly affected by the saliency or strength of the information (ratio of heads to tails). This would have led to estimates different to those of the control groups. However, the people with delusions were shown to reason in accord with the other normal and depressed subjects. In fact, all groups were susceptible to the same biases in estimates caused by differing the strength (ratio of heads to tails) and weight (number of trials) of the evidence.

Similarly, in the Experimenter determined condition of the Beads task (chapter 9) subjects were presented with 10 pieces of evidence and were required to decide from which jar the beads were most likely coming. Here the subjects with delusions reasoned very much like the control subjects. Once a decision had been made after viewing ten beads, subjects were presented with evidence that would conflict with their judgement of the source of the beads. The people with delusions did not change their minds more quickly nor more frequently than the control subjects. If these people with delusions were excessively influenced by stimuli currently in the environment (Garety, 1991) then they would have been expected to have reversed their decisions more often or faster than the control subjects.

Therefore, on tasks that were unrelated to the theme of the delusional belief, people with delusions reasoned in the same way as control subjects. In probabilistic reasoning (Biased Coin, 10 beads) when the people with delusions were provided with all of the necessary information, the decisions made were the same as those of people without delusional beliefs. The evidence demonstrated that people suffering from delusions were able to reason normally. However, differences were revealed when reasoning on different forms of reasoning tasks and when dealing with material of an emotional nature.

11.2.2 Differences in reasoning

The second set of results provided clear evidence of differences in reasoning between the groups. For instance, the people with delusions were significantly poorer at solving the easiest Wason Selection task, the alcohol conditional (chapter 7). On the less realistic conditionals the pattern of performance was similarly poor for all of the groups. When unable to produce the logically correct *p* and *not q* card selection, all the groups tended to choose the *p* and *q* cards. They made the matching bias response and chose the cards mentioned in the rule. It is interesting to note that the people with delusions did improve in their performance across the conditionals. Like the comparison groups, the subjects with delusions produced more correct responses when the content was more realistic. Therefore, people with delusions were subject to the same biases as the other

groups. Namely, a tendency to make the matching error response when the task was abstract and difficult, and an improvement in performance with facilitatory content. This indicates that the group with delusions were attempting to reason and were not disregarding the task demands or merely responding at random. However, they did not achieve the same level of performance as the other groups on the easiest alcohol conditional.

In a second set of conditionals the utility of outcome was assessed as it may have affected the performance of the groups (chapter 8). It was thought that the values placed on the different consequences of a rule may have been different for subjects with delusions. These people may have been less concerned about the rule being broken than the other groups. This would have led to less efficient performance on the task by this group as utility of outcome has been shown to affect performance (Manktelow and Over, 1992). Once again people with delusions were significantly worse at providing the correct answer on the alcohol conditional. However, there was no relationship between the poor performance and the utility judgements made by the groups. Therefore, utility did not appear to be a factor influencing the poor performance of the subjects with delusions.

One of the conditionals used a threat related content. This manipulation should have made the conditional both salient and available to the people with delusions. Increasing familiarity and salience are factors that usually improve performance in normal subjects (Griggs and Cox, 1982). Surprisingly, when the conditional was closely related to the theme of the delusion there was no difference in performance between the groups. This task did not reveal the processing biases for theme related material that subjects with delusions have demonstrated previously (Bentall, 1994).

The performance of people with delusions on the Wason's selection tasks was worse than that of the control subjects on the easiest of the conditionals; the alcohol conditional. However, the difference in performance was attributed to the functioning of an inefficient reasoning system rather than one that was fundamentally different. This was owing to the demonstration of the facilitatory effect of realistic content on all groups' performances and the tendency by all groups to make the matching bias error on the more difficult, abstract conditionals. The cause of the inefficiency and the failure of the subjects with delusions to attain the same level of performance as the other groups is not known. The people with delusions are clearly finding these tasks more difficult than the other subjects. It was speculated that the people with delusions may be hampered by some limitation in a cognitive process such as working memory ability (Fleming et al. 1994).

The Beads task (chapter 9) demonstrated that people with delusions gathered less evidence before making a decision. They did not necessarily make an incorrect decision. In fact, the subjects with delusions reasoned very well and made few errors

overall. However, when allowed to view as much or as little evidence as they wished, this group requested less evidence than the control subjects. This hastiness was also evident on a less discriminable and thus, more difficult condition (60:40). The group with delusions requested more beads than in the easier condition. However, they still requested significantly fewer beads than the other groups. Therefore, the people with delusions took account of the task demands and altered the decision style accordingly. The hastiness was not the result of a disinterest in the task. Similarly, the hastiness was not obviously caused by an inability to retain the information in mind. The addition of a memory aid did not alter the decision style. In this instance a memory limitation was not the apparent cause of the reasoning bias. However, poorer performance on the Wason's selection tasks may still be explained by working memory impairments. The Wason's conditionals seem to be more difficult tasks that strain cognitive resources more than the bead tasks. Hence, any working memory limitation would have a greater impact on a harder task.

The hastiness exhibited by people with delusions was also evident when the material used was realistic but neutral in content (names) and when the material was salient and self referent (comments in the Salient beads task, chapter 10). All of the groups were affected by the self referent information and decided slightly sooner in the salient condition. The people with delusions it seemed were disproportionately affected by the emotional material. In comparison to the control subjects, the people with delusions showed a greater percentage decrease in the amount of evidence viewed on the self referent comments task. Whilst, this difference was not significant it does suggest that there was a greater effect of the emotional material on the reasoning of people with delusions.

The effect of emotional content on reasoning was also shown to be an important factor by Kemp, Chua, McKenna and David (1996). People with delusions and non deluded controls were given syllogisms that were neutral or emotionally laden in content. Both groups were equally affected and made more errors when reasoning with emotional material. David proposed that emotional content causes the person to rely on pre-existing beliefs rather than trying to reason with the current data. This is the opposite of Garety and Hemsley's (1994) proposal in which people with delusions are held to be stimulus bound or data driven. David is proposing that all subjects impose an answer from pre-existing beliefs when reasoning with this emotional material.

People with delusions do not necessarily have fundamentally different reasoning processes to other subjects. Some of the studies have shown reasoning that is very much like that seen in non deluded subjects (Biased Coin, CET, 10 beads). However, there are clear instances where people with delusions do not reason as well as comparison groups (Wason Selection task, alcohol conditional) or reason in a different way to the other groups (Beads and Salient Beads tasks).

Maher (1992a) suggested criteria that need to be fulfilled in order to demonstrate a causal status for a reasoning abnormality as the basis of delusions. Criterion D (chapter 4) specified that reasoning biases should be present on tasks unrelated to the theme of the delusion. The evidence presented here provides quite ample demonstration of such biases (i.e. beads tasks or conditionals). In addition, criterion E required that the tendency to arrive at false beliefs should go beyond the topic of the delusion itself. Maher argued that as delusions are generally fairly limited in scope it indicated that the reasoning bias could not be generalised. However, this implies that a generalised reasoning bias naturally leads to errors in thinking and, thus faulty beliefs, on a wide variety of topics.

A generalised difference in reasoning style such as hastiness, does not necessarily require that people with delusions are compelled to make false inferences. A hasty style does not automatically lead to more errors (as was shown in the beads task, chapter 9). Even if a false conclusion was reached, if the material was neutral in content it was readily revised in the face of disconfirmatory evidence (10 beads and reversal). Therefore, a false belief will be revised if it is neutral in content. Thus, a generalised reasoning bias does not necessarily cause faulty reasoning. People with delusions do not have to have abnormal beliefs about a wide range of areas. If they make a false conclusion owing to a hasty data gathering style then it will be readily revised owing to the neutral nature of the material. However, if the material is salient in nature it appears to increase the hastiness in decision making seen in people with delusions. This may lead to an increased chance of errors (as was seen in the salient beads task). Whether a false belief would be as readily revised in the face of discrepant evidence remains to be seen.

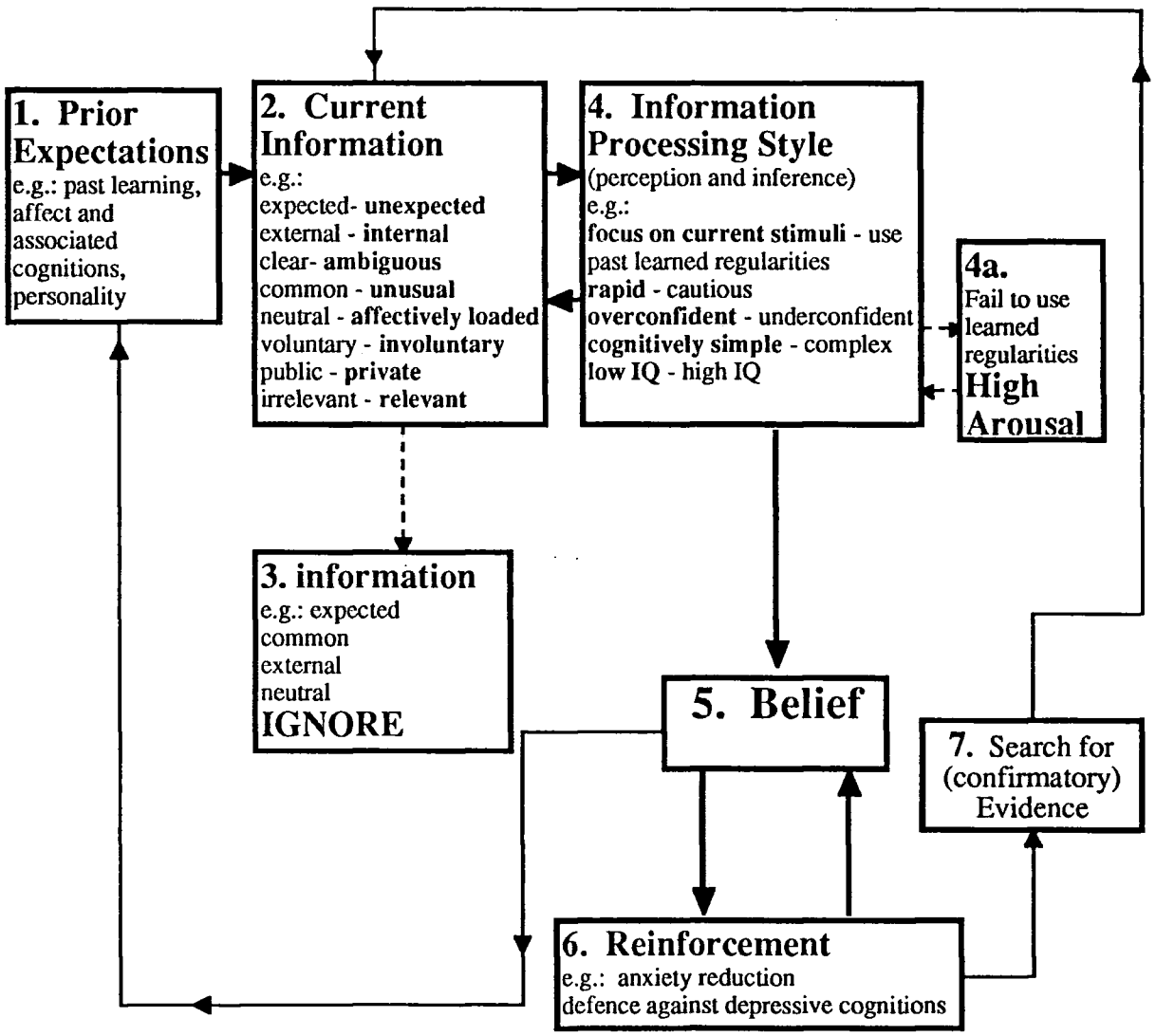
11.3 Implications for theories of delusion formation and maintenance

People with delusions have been shown to have a reasoning style that is different under some circumstances to the reasoning of non deluded subjects. According to Maher's (1974, 1988) theory, delusions are normal explanations of abnormal perceptions. Therefore, people with delusions should have reasoning processes that are not different to those of other non deluded subjects. This view is incompatible with the reasoning differences reported here.

Garety's (1991, Garety and Hemsley, 1994) model of delusions seems to be the most complete to date. The model is shown below and is discussed more fully in chapter 2. Unlike Maher, Garety clearly recognises the intimate relationship of perception and inference (box 4). To briefly recap, delusions are thought to occur primarily from a failure to utilise previously acquired information. This can cause stimuli in the environment to be given abnormal significance (box 2). The failure to utilise previously

acquired information also affects how this abnormally significant material is processed. The model predicts that there are a number of biases in the processing of information that are characteristic of people with delusions. Specifically, such people are thought to be rapid and overconfident in their decision style. Also, they are supposed to display low IQ and focus on current stimuli (box 4). These features were tested in the reasoning tasks reported above.

Figure 11.1: Garety's (1991) model of belief formation



The results of this research indicated that many of the features of information processing attributed to the people with delusions were not present. Whilst there appears to be ample evidence of a hasty decision style (beads tasks) the remaining features are a little less certain. For instance, there was no apparent evidence of subjects being overconfident in their decisions on the Cognitive Estimates Task. Even in a replication

of the beads task there was similarly no indication that people with delusions were more confident in their decisions than other subjects (Garety et al. 1991)

A low IQ is considered to be a feature of delusion formation. However, all of the subjects in the research were matched for premorbid intelligence scores. Whilst the NART is not a true indicator of current IQ it does correlate well with current measures (Crawford et al. 1991). Therefore, there should be little if any difference between the groups for intelligence. Despite the apparent intellectual comparability, reasoning differences did exist under certain conditions. Hence, the status of a low IQ in delusion formation seems unclear.

An additional factor that is proposed to be a feature of information processing of people with delusions is the tendency to focus on current stimuli. This means that current situational information is accorded undue weight. However, the Biased Coin task showed that people with delusions did not focus on the strength of the evidence (ratio of heads to tails) more than any other group. Therefore, the group with delusions did not appear to be ignoring past experience (understanding of the weight) more than any other group. In addition, a tendency to focus on current stimuli was proposed to account for the tendency of people with delusions to change their minds faster than other subjects. Garety et al. (1991) showed subjects 10 beads and asked for a decision as to the source of the beads. Then beads of predominantly the other colour were shown. People with delusions changed their minds more rapidly than the other subjects. This was taken as evidence that the people with delusions were focusing on current stimuli. However, in the beads task reported here subjects with delusions were no quicker to change their decisions as to the source of the beads when presented with discrepant evidence.

There is clear evidence that people with delusions are hasty and jump to conclusions. However, whether this is caused by a failure to utilise previously acquired information is less certain. The relationship between disruptions to Latent Inhibition (LI) and course of the illness make it unlikely that the hastiness evident on the beads task can be accounted for by a failure to utilise previously acquired information. The people with delusions who performed hastily on the beads task all had their illness for some considerable time and had or were receiving antipsychotic medication. Both of these factors have been shown to restore the LI effect (Baruch et al, 1988, Gray et al. 1992). This implies that the subjects in these studies would have been able to utilise previously acquired information.

Therefore, an alternative explanation needs to be considered. It may well be the case that early in the acute stage of a psychotic illness people do fail to utilise previously acquired information. This may lead to the noticing of illusory correlations, feelings of abnormal significance and hastiness in decision making, and thus to the formation of a delusion. However, hastiness may be maintained even though the person is no longer

having difficulties using past experience. Hastiness may act as a learned heuristic. Decisions made hastily are not necessarily incorrect. Early decisions also lead to quicker less effortful reasoning. Therefore, this style may be adopted in the long term. Being hasty may serve the purpose of the reasoner by rapidly imposing an answer rather than having to endure the ambiguity of not knowing what is the correct answer. Rather than "jumping to conclusions" the people with delusions may be "cutting their losses".

Hastiness in decision making was increased when reasoning with self referent material (chapter 10). Therefore, when dealing with emotional material perhaps it encourages everyone to cut their losses and decide earlier. Alternatively, David (1996) proposed that emotional material causes someone to rely on pre-existing beliefs to solve a syllogism rather than trying to reason with the material provided. Hence, hastiness may be increased because the person is also relying on what they expect rather than what is actually presented. The increased jumping to conclusions on tasks with material that is self referent or emotionally laden causes more errors to be made. Thus, false beliefs are more likely to be formed on topics that are of an emotional nature.

Clearly the content of the material has an impact on reasoning both in the hypothesis testing paradigms (i.e. salient beads task, chapter 10) and in social information processing (Bentall, 1994). Whilst Garety's model is proposed to account for delusions within the non affective psychoses, it seems that there should be a greater role for the importance of the material that is reasoned with. When the content of the material is related to self esteem or affective state, reasoning is biased even further. Therefore, there is an apparent interaction of emotional material with a generalised reasoning bias.

Throughout this thesis it has been argued that delusions are like normal beliefs and serve a purpose to the holder. Therefore it is important to consider the function that the delusional belief may serve. It is possible that the belief is abnormal because the function it serves is abnormal too. The paranoid defence proposal (Bentall et al. 1994) states that the delusion serves to reduce feelings of low self esteem by reducing the ideal-self discrepancy. Therefore, the beliefs about the self lead to a sense of depression and low self esteem. This is unacceptable and the belief that the person is being persecuted arises from the compensatory efforts to deny the depressive feelings.

Work concerned with treating people with delusions using cognitive behavioural therapies provides support for the proposal that the delusions serves a function for the holder. These therapies try to tackle the errors and biases in thinking that people with delusions exhibit (Garety, Kuipers, Fowler, Chamberlain and Dunn, 1994, Kingdon, Turkington and John, 1994). Whilst in many cases reality testing techniques help the patient, practitioners are beginning to realise that merely correcting the errors in thinking does not necessarily make the person better. It is vital to recognise that some people with delusions have an investment in their beliefs (John, 1996, John and Turkington, in

press). Delusions act like other emotionally laden beliefs and serve a purpose to the holder (Roberts, 1991). Hence, successful therapy needs to address the function of the belief. Neale (1988) proposed that people with bipolar disorder use their grandiose delusions to keep distressing thoughts or ideas out of consciousness. Therefore, the delusion has a defensive function. This hypothesis goes beyond the notion that the delusion is reinforcing, rather it seems that the delusion may actually be preferred to the alternative reality. People recovering from an episode of paranoia have a high incidence of depression (Kingdon and Turkington, 1994). Once the reality denying delusion has been removed, self esteem no longer has a defence and the person is susceptible to feeling depressed. This defensive role for delusional beliefs was also proposed by Zigler and Glick (1988) who viewed paranoia as camouflaged depression.

Any model forwarded to account for delusions must be able to account for both perceptual and reasoning abnormalities. In some cases a perceptual abnormality may be driving the inferential system. However, even in instances where there is an apparent perceptual abnormality (i.e. Capgras delusion) a reasoning bias still seems to be necessary for the full expression of a delusional belief (Fleminger, 1994, Young, 1994). Where there is no evidence of a perceptual abnormality, the possible function that the delusion serves may need to be addressed. Studies of reasoning in normal subjects (chapter 3) have demonstrated that inferential processes can be distorted to provide a belief that serves the purpose of the holder at the expense of a distortion of the data (Kunda, 1990). A similar process may be operating in people with delusions.

11.4 Implications for future research

The results of this and other work (e.g. Bentall, 1994, Garety and Hemsley, 1994) provide clear evidence that there are certain specific biases and errors in the reasoning of people with delusions. However, there is still considerable scope for further research.

Within the model proposed by Garety (1991) there is a need to consider the relationship between the proposed failure to utilise previously acquired information and the existence of delusions. As has been noted elsewhere, people with long histories of illness and receiving medication are not likely to exhibit this inability to utilise previously acquired information. Therefore, there is a need to measure the performance of people with delusions on tasks such as the LI paradigm and on the beads task. It may be the case that disruption to LI (increased failure to utilise previously acquired information) is associated with reduced data gathering on the beads task. This has not been demonstrated. Additionally, hastiness in performance on the beads task and disruption to LI may be measured in a longitudinal study. It may be that hastiness or disruption to LI is increased in the early stages of relapse. If this were so, it would

provide an objective psychological predictor of a relapse and the recurrence of severe symptoms.

A related issue is the need to consider the premorbid status of the reasoning abilities of people with delusions. A jump to conclusions reasoning style may be evident prior to the demonstration of psychotic symptoms. If this is the case there is a need to determine what the precipitants are that cause the pre-existing hastiness to cause a delusion. Similarly, it would be valuable to test the performance of people who are not presently deluded but have been so previously on the beads task. If the hastiness bias is a learned heuristic or is present premorbidly then it would be expected that it would persist despite the absence of the delusion.

A crucial question in this research is whether the hastiness demonstrated by people with delusions is specific to this group of subjects or is common to all people with a psychotic illness such as schizophrenia. Clare, Eastwood and McKenna (1996) tested people with schizophrenia and normal subjects on the beads task using the 85:15 ratio. The group with schizophrenia responded after seeing an average of 4.3 beads whilst the normal group saw an average of 4.8 beads. However, a large number of subjects with schizophrenia responded on the basis of seeing only one piece of evidence and thus exhibited the hasty decision style. When the responses of the people with schizophrenia were correlated with their symptoms (CASH scale), it was found that hastiness was not correlated with delusions but with the presence of negative symptoms. Naturally, this results casts doubt on the specificity of hastiness to delusions.

However, there are a number of methodological difficulties with this study that need to addressed. Firstly, the correlation of hastiness with current symptoms is an inadequate approach. People with predominantly negative symptoms may have previously had delusions and the hastiness learnt may have remained. It is not known whether previously deluded subjects exhibit this bias. The preferred approach would be to test people who are diagnosed schizophrenic but have never had delusions and to compare them against people who have delusions. However, to a large extent delusions are synonymous with schizophrenia (Benson and Stuss, 1990). Given the relationship between auditory hallucinations and delusions, people with voices could not be considered suitable as the control group (see chapters 2 and 4 for a fuller discussion). Secondly, the participants in the Clare et al. (1996) study were only tested on one trial and may well have not realised the nature of the task. There is no evidence that the subjects were reasoning and not merely being indiscriminate or were uninterested in the task. This is not an unrealistic possibility given that negative symptoms are characterised by apathy and low motivation. The best way to end the task would be to respond quickly. Additionally, the subjects that participated in the research reported here were selected on the basis that negative symptoms were not a prominent feature of

their illness. Quite clearly further research remains to be conducted on the exact relationship between hastiness and delusions.

Garety's (1991) model is well constructed but it has not been exhaustively tested. Whilst loathe to add an additional feature to the model, it seems necessary to consider the importance of affective state in more detail. It is possible that virtually all delusions will have a significant affective component and that this should be recognised on the model. To test the influence of affective state it is necessary to continue the type of work described in chapter 10 and use material related to the content of the delusion or that reflects concerns with the self image. People with delusions with different affective states could be compared to investigate the performance effects of affective state. For instance, Garety and Hemsley (1994) suggest that the performance of people with delusions of persecution could be compared against people with depression related delusions and people with depression who have no delusions. Naturally, the content of the material employed would need to be varied to include neutral and affectively loaded material relevant to the affective states of each patient group.

To further investigate the existing model the status of overconfidence in reasoning could be re-examined. The standard task used to assess confidence in reasoning is to give a series of questions based on general knowledge (Lichtenstein et al. 1984). Subjects are provided two answers and asked to rate on a scale of 50-100% how certain the subject is in the correctness of the answer. For instance, the subject may be asked which is further away New York or Moscow? Then the subject rates how certain he or she is in the answer. If the number of correct answers is less than the average confidence rating it indicates that the subject is overconfident. Normal subjects tend to be more confident than they actually should be. The model would predict that people with delusions should be even more confident in the correctness of the answers provided. Naturally, the content of the material could be manipulated to study the effect of self referent material on confidence estimations.

The importance of the content of the material could be investigated by presenting people with delusions and control subjects with a salient version of the 10 beads and reversal task. Once a decision had been made regarding the source of the comments conflicting evidence could be presented to see if this encouraged a quicker reversal.

A further investigation should consider the role of working memory on the Wason's Selection task. It may be that memory impairments are a cause of the inefficient reasoning seen most notably the alcohol conditional. Poor performance on the selection task should be correlated with impaired working memory ability.

An additional area that is clearly in need of further study is the social inference making of people with delusions (Bentall, 1994). An aspect of social inference making that could be assessed is the understanding of social situations that may require the use of deception. Deception can serve both a positive and negative value. Surprise birthday

parties or proposals of marriage require considerable planning and deception yet serve a positive purpose. Would someone with persecutory beliefs shown a video of people planning a surprise party make the attribution that it was a negative deception rather than positive deception?

The function of the delusion clearly needs to be more fully explored. It is postulated that in some cases delusions may serve to protect the person from feelings of low self esteem (Lyon et al. 1995). In addition, the delusion may offer a preferable reality at the expense of denial of the truth. John and colleagues are currently employing a cognitive paradigm to investigate the defensive function of a delusional belief.

11.5 Conclusions

Delusions occur in a wide variety of medical conditions. They vary in theme and content. Therefore, it is probable that they are caused by a combination of factors. However, differences in reasoning clearly have a strong role to play. Whilst a perceptual abnormality may be present, biased inferential processes are necessary for the expression of the belief (Capgras belief, Fleminger, 1994, Young, 1994). Subsequently, once a delusion is formed reasoning biases will contribute to its maintenance. The research reported here has shown that people with delusions do differ from other subjects in the way that they reason. Specifically, people with delusions were shown to be less able to reason deductively on Wason Selection tasks. Moreover, people with delusions were hasty and jumped to conclusions on probabilistic reasoning tasks when allowed to determine the amount of evidence viewed prior to a decision being made. This hastiness was also increased when the material was of a self referent nature indicating the difficulty that people have with reasoning with material that is emotionally laden. These findings were discussed in relation to current models of delusion formation and maintenance.

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Appendix 1: Biased Coin test sheet as used in Experiment 1.

"Imagine you are spinning a coin, and recording how often it lands on heads and how often it lands on tails. Unlike tossing, which (on average) produces an equal number of heads and tails, spinning a coin leads to a bias favouring one side or the other because of slight imperfections in the rim of the coin and an uneven distribution of mass. Now imagine that you know the bias is 3/5. It tends to land on one side 3 out of 5 times. But you do not know if this bias is in favour of heads or in favour of tails."

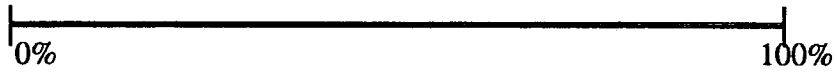
No. of Heads	No. of Tails	Sample Size	Chance that the coin. is biased to heads	Bayesian Probability
2	1	3	.....	.60
3	0	3	.....	.77
3	2	5	.....	.60
4	1	5	.....	.77
5	0	5	.....	.88
5	4	9	.....	.60
6	3	9	.....	.77
7	2	9	.....	.88
9	8	17	.....	.60
10	7	17	.....	.77
11	6	17	.....	.88
19	14	33	.....	.88

The ordering on the test sheet was different to the order above. This selection is ordered by sample size. The sheet presented to subjects used a fixed psuedo random order. The Bayesian probabilities were not included on the test sheet given to the subjects.

Appendix 2: The Cognitive Estimate Task given to participants in Experiment 2. Subjects were asked to answer the question and rate how confident they were in the decision.

1) What is the height of the Post Office Tower?

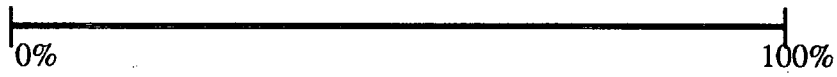
2) How fast do race horses gallop?



3) What is the best paid job or occupation in Britain today?

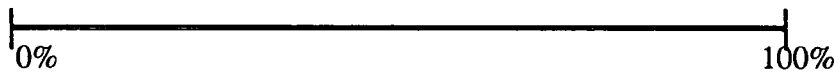
4) What is the age of the oldest person in Britain today?

5) What is the length of an average man's spine?

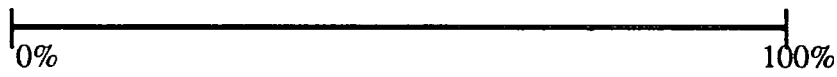


6) How tall is the average English woman?

7) What is the population of Britain?



8) How heavy is a full pint bottle of milk?



9) What is the largest object normally found in a house?

10) How many camels are there in Holland?

Appendix 3a: Wason Selection task given to subjects in experiment 3.
Arbitrary condition with explicit negatives and violation checking context.

Subject Number: Date:

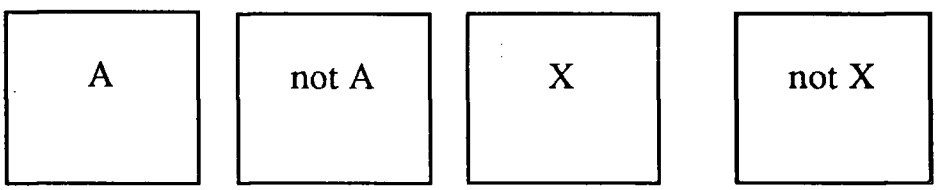
Below are four cards. One side of each card has written on it either "A" or "not A". The other side has written either "X" or "not X". Your task is to make sure the cards conform to the rule: "If a card says 'A' on one side then the other side must say 'X'."

You want to see if any of the cards violates the rule. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate, but do not turn over a card unless what is on the other side can potentially tell you that the card violates the rule.

Tick below each box to indicate the one(s) you have chosen.

Rule: If a card says 'A' on one side then the other must say 'X'.

Cards:



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Appendix 3b: Wason Selection task given to subjects in experiment 3.
Abstract permission rule with explicit negatives and a violation checking context

Subject Number: Date:

Suppose people wish to engage in activity A. You know that before one can engage in this activity, one must fulfill requirement X. Your task is to make sure that people follow the regulation: "If one is to engage in activity A, then one must fulfill requirement X."

There are four cards represented below, one each for four people. Each card gives information on a single person. One side of each card shows whether this person has engaged in activity A. The other side shows whether he or she fulfilled requirement X.

You want to see if any person violated the regulation. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not turn over a card unless what is on the other side can potentially tell you that the person violated the regulation.

Tick below each card to indicate the one(s) you have chosen.

Rule: If one is to engage in activity A, then one must fulfill requirement X.

Cards

Engaged in activity A	Did not Engage in activity A	Fulfilled requirement X	Did not fulfill requirement X
.....	.....	.....	.....

Appendix 3c: Wason Selection task given to subjects in experiment 3.
Immigration officer conditional

Subject Number: Date:

Suppose people wish to enter the country. You know that before one can enter, one must have a cholera innoculation. Your task, as an immigration officer is to make sure that people follow the regulation: "If one is to enter the country, then you must have a cholera innoculation."

There are four cards represented below, one each for four people. Each card gives information on a single person. One side of each card shows whether this person wishes to enter the country. The other side shows whether he or she has a cholera inoculation.

You want to see if any person violated the regulation. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not turn over a card unless what is on the other side can potentially tell you that the person violated the regulation.

Tick below each card to indicate the one(s) you have chosen.

Rule: If one is to enter the country, then one must have a cholera inoculation.

Cards:

Entry	Transit	Cholera Hepatitus	Typhoid Hepatitus
.....	.....	.....	.....

Appendix 3d: Wason Selection task given to subjects in experiment 3.
Alcohol conditional

Subject Number: Date:

Suppose people wish to drink alcohol. You know that before one can drink alcohol, one must be 18 years of age or over. Your task, as a Landlord of a pub, is to make sure that people follow the regulation: "If one is to drink alcohol then one must be 18 or over."

There are four cards represented below, one each for four people. Each card gives infromation on a single person. One side of each card shows the person's drink. The other side shows the person's age.

You want to see if any person has violated the regulation. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not urn over a card unless what is on the other side can potentially tell you that the person violated the regulation (law).

Tick below each card the one(s) you have chosen.

Rule: If one is to drink alcohol, then one must be 18 or over.

Cards:

Beer	Coke	22	16
.....	.....	.....	.....

Appendix 4: Alcohol utility rating sheet used in Experiment 4.
Please indicate how important it is to you as a Landlord of a pub that the following situations should or should not be allowed to happen.(Condition D represents the rule breaker or *not q* card).

A) A 22 year old drinks beer

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

B) A 22 year old drinks coke

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

C) A 16 year old drinks coke

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

D) A 16 year old drinks beer

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

Appendix 5 : Hospital Conditional used in Experiment 4.

Name: Date:

Suppose people wish to leave hospital. You know that before one can leave hospital, one must take all of the medication. Your task, as a Nurse on a ward, is to make sure that people follow the regulation: "If one is to leave hospital then one must complete the course of medication."

There are four cards represented below, one each for four people. Each card gives information on a single person. One side of each card shows the person's medication. The other side shows whether the person is leaving or not.

You want to see if any person has violated the regulation. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not turn over a card unless what is on the other side can potentially tell you that the person violated the regulation.

Tick below each card the one(s) you have chosen.

Rule: If one is to leave hospital, then one must have taken the medication.

Cards:

Completed Medication	Kept in	Discharged	Lapsed on Medication
.....	.....	.....	.....

Appendix 6: Hospital utility rating scale

Please indicate how important it is to you as a Nurse that the following situations should or should not be allowed to happen. (Condition D represents the rule breaker or *not q* card, Condition B also represents a condition where the rule is also broken).

A) Someone is discharged who has completed the medication

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

B) Someone is discharged who has lapsed on the medication

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

C) Someone is kept in who has lapsed on the medication

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

D) Someone is kept in who has completed the medication

1	2	3	4	5	6	7
Very definitely should be allowed	Definitely should be allowed	Should be allowed	Neutral	Should not be allowed	Definitely should not be allowed	Very definitely shouldnot be allowed
.....	.....	.....	.....	.....	.....	.....

Appendix 7: Paranoid conditional used in Experiment 4

Subject Name: Date:

Suppose you have noticed that there are two types of people. You know that there are people who are friendly, and those that are lying and plotting about you. Your task is to make sure that the statement is true or not "If someone smiles then they are friendly."

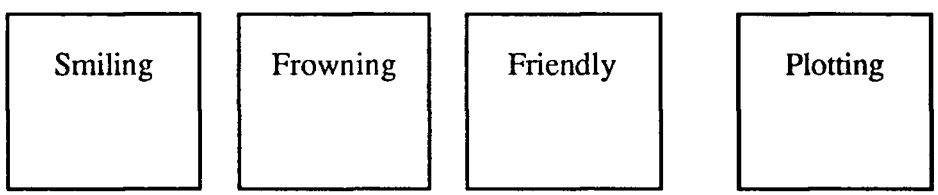
There are four cards represented below, one each for four people. Each card gives information on a single person. One side of each card shows whether the person is smiling. The other side shows whether the person is being friendly or plotting against you.

You want to see if the statement has been true or false. Which of the cards below would you have to turn over to check? Turn over as many cards as you think appropriate but do not turn over a card unless what is on the other side can potentially tell you that the statement is false.

Tick below each card the one(s) you have chosen.

Rule: If someone is smiling then they are friendly.

Cards:



....

Appendix 8: Order of beads presented in the 85:15 and 60:40 conditions of the beads task used in Experiment 5. The correct jars are in bold

85:15:

1) Draws till decisions (DTD). Jar A 85 white beads and 15 black, Jar B 85 black and 15 white. Order of beads taken from Garety et al., (1991), beads A= black beads, B= white beads.

A A A B A A A A A B B A A A A A A A A B

JAR A JAR **B**

2) DTD 2: Jar C 85 light striped, 15 dark striped, jar D 85 dark striped and 15 ligth striped. A= light striped and B= darks. Order derived from Huq et al., (1988).

A A A A B A A A A A A A A A A B A A B A

JAR **C** JAR D

3) 10 draws and counterevidence. Jar E 85 Light beads and 15 dark beads, Jar F 85 dark beads and 15 light. Order taken from Garety et al., (1991). A= light beads

A A A B A A A A B A*B B B A B B B B A B

JAR **E** JAR F

4) 10 draws and reversal 2. Jar G 85 plain or white beads, Jar H is 85 checkered beads. Order of beads is taken from Huq et al., (1988). Jar H = A.

A A B A A B A A A A * B B B B B B B B B A

JAR G JAR **H**

5) Draws till decision and memory (tally): Jar K 85 black beads, Jar L 85 white beads. Order generated from random numbers on a BBC microcomputer. Jar K = A.

A A A A A A A A A A A A B A A A A A A A

JAR **K** JAR L

6) Draws till decision and tally 2: Jar 1 85 light striped beads, Jar 2 85 dark striped beads Order generated as above. Jar 2= A

A A A B A A A B A A A B A A B A A A A A

JAR 1 JAR **2**

7) 10 draws and tally: Jar M 85 light beads, Jar N 85 dark beads, order generated. Jar M = A

A A A B A A A A A A * B B A B B B B B B

JAR M JAR N

8) 10 draws and memory 2: Jar 3, 85 White and Jar 4 85 Checkered. Order derived from computer. Jar 4 = A

A A A A A B A B A A * B B B B B A A B B B

JAR 3 JAR 4

60:40

1) Draws till decisions. Jar A 60 black beads and 15 white, Jar B 85 white and 15 black. Order of beads taken from computer, beads A= black beads, B= white beads.

B A B A A B A B A B A A A B A B A A B A

JAR A JAR B

2) DTD 2: Jar C 60 light striped, 40 dark striped, jar D 60 dark striped and 40 light striped. A= light striped and B= darks. Order derived from computer.

A A A B A B A A B A A B B B B A A A B A

JAR C JAR D

3) 10 draws and counterevidence. Jar E 60 light beads and 40 dark beads, Jar F 60 dark beads and 40 light. Order taken from computer. A= dark beads

A B A A B B B A A A * B B B A B A B A B A

JAR E JAR F

4) 10 draws and reversal 2. Jar G 60 checkered beads, Jar H is 60 white beads. Order of beads is taken from computer. Jar G = A.

A A B A A A B B A A * B B A B A A B A B B

JAR G JAR H

5) Draws till decision and memory (tally): Jar O 60 black beads, Jar P 60 white beads. Order generated from random numbers on a BBC microcomputer. Jar O = A.

A A A B A B A B A A A A B A A B B A B B

JAR O JAR P

6) Draws till decision and tally 2: Jar 5 60 light striped beads, Jar 6 60 dark striped beads Order generated as above. Jar 6 = A

A B A B B A A A B A A A A B A B B A A A

JAR 5 JAR **6**

7) 10 draws and tally: Jar Q 60 light beads, Jar R 60 dark beads, order generated. Jar R = A

B A B B A A A A A A * B B A B B B B B A B

JAR Q JAR **R**

8) 10 draws and memory 2: Jar 7, 60 White and Jar 8 60 Checkered beads. Order derived from computer. Jar 7 = A

B A A B B A A A A B * B A B B A B B B A B

JAR **7** JAR 8

Appendix 9: Ordering of childrens names and comments in Experiment 6. Two examples of the words used are given. Correct choice is in bold.

Realistic Neutral:

1) School A 60 boys and 40 girls, School B is 60 girls and 40 boys. Order of beads taken from computer, beads A= boys', B= girls' names.

A A A B A B A A B A A B B B B A A A B A

Martin, Thomas, Andrew, Jennifer, William, Lorraine, Douglas, Malcolm, Shirley, Lawrence, Michael, Melanie, Annette, Victoria, Caroline, Terrence, Kenneth, Arthur, Kimberely, Anthony.

School **A** School B

2) School C 60 Girls, 40 boys, School D 60 boys and 40 girls. A= girls and B= boys. Order derived from computer.

A B A A B B B A A A A A A B A B A B A B

School C School **D**

3) School E 60 boys and 40 girls, School F 60 girls and 40 boys. Order taken from computer. A= girls

B A B A A B A A A B A A A B A B B A B A

SCHOOL **E** SCHOOL F

4) School G 60 boys, School H is 60 girls. Order of beads is taken from computer. School G = A.

A A B A A A B B A A A A B A B B A B A A

SCHOOL **G** SCHOOL H

5) School I 60 boys, School J 60 girls. Order generated from random numbers on a BBC microcomputer. School J = A.

A A A B A B A B A A A A B A A B B A B B

SCHOOL I SCHOOL **J**

6) School K 60 girls, School L 60 boys Order generated as above. School L = A

A B A B B A A A B A A A A B A B B A A A

SCHOOL K SCHOOL **L**

Appendix 9: Ordering of childrens names and comments in Experiment 6. Two examples of the words used are given. Correct choice is in bold.

Realistic Neutral:

1) School A 60 boys and 40 girls, School B is 60 girls and 40 boys. Order of beads taken from computer, beads A= boys', B= girls' names.

A A A B A B A A B A A B B B B A A A B A

Martin, Thomas, Andrew, Jennifer, William, Lorraine, Douglas, Malcolm, Shirley, Lawrence, Michael, Melanie, Annette, Victoria, Caroline, Terrence, Kenneth, Arthur, Kimberely, Anthony.

School **A** School B

2) School C 60 Girls, 40 boys, School D 60 boys and 40 girls. A= girls and B= boys. Order derived from computer.

A B A A B B B A A A A A A B A B A B A B

School C School **D**

3) School E 60 boys and 40 girls, School F 60 girls and 40 boys. Order taken from computer. A= girls

B A B A A B A A A B A A A B A B B A B A

SCHOOL **E** SCHOOL F

4) School G 60 boys, School H is 60 girls. Order of beads is taken from computer. School G = A.

A A B A A A B B A A A A B A B B A B A A

SCHOOL **G** SCHOOL H

5) School I 60 boys, School J 60 girls. Order generated from random numbers on a BBC microcomputer. School J = A.

A A A B A B A B A A A A B A A B B A B B

SCHOOL I SCHOOL **J**

6) School K 60 girls, School L 60 boys Order generated as above. School L = A

A B A B B A A A B A A A A B A B B A A A

SCHOOL K SCHOOL **L**

Salient Beads:

Positive self esteem outcomes:

7) Survey 1 60 negative words, Survey 2 60 positive words, order generated. Survey 1 = A

A A A B A B A A B A A B B B B A A A B A

Calm, Modest, Relaxed, Deceptive, Amiable, Insincere, Happy, Forgiving, Loyal, Tolerant, Petty, Fickle, Mean, Unsociable, Pleasant, Intelligent, Courteous, Humourless, Trustful.

SURVEY **1** SURVEY 2

8) Survey 5, 60 positive and Survey 6 60 negative . Order derived from computer. Survey 6 = A

B A A B B A A A A B A B A A B A A A B A

SURVEY 5 SURVEY **6**

9) Survey 11, 60 positive, survey 12 60 negative. Survey 11 = A

A A B A A A A A B B A A B B A A B A A A

SURVEY **11** SURVEY 12

Negative self esteem outcomes:

10) Survey 3 = 60 positive, Survey 4 = negative

A A A A A B A A B B B B A A A A B A A B

SURVEY 3 SURVEY **4**

11) Survey 7= negative, Survey 8= positive

A B B A A B A A A B A A A A B B A B B A

SURVEY **7** SURVEY 8

12) Survey 9= positive, Survey 10= negative.

A A A B B B B A A A A A B A B B A B A A

SURVEY 9 SURVEY **10**

Appendix 10: Details of the subjects that participated in each experiment.

The experimental tasks reported in this thesis were not conducted in the order that they were presented. In actual fact three separate sets of studies were run. In each set of studies, two tasks were run in parallel. No subject participated in more than the two tasks that comprised a set. However, the subjects that were tested for each set of studies did not necessarily complete both tasks within the set. Hence, there were differences between members of the the groups reported on each task. This appendix serves to illustrate the order in which the tasks were run. In addition, the number of subjects that participated on both of the tasks within a set are detailed.

Set 1

Biased Coin (chapter 5) and the 4 Wason's Selections Tasks (chapter 7)

In the Biased Coin task there were 12 subjects per group. In the Wason's tasks there were 15 subjects per group. All the subjects who completed the Biased coin task also completed the Wason's tasks. Thus, 12 subjects completed both tasks. However, an additional three subjects per group were tested in the Selection tasks. A table is presented to illustrate.

Table 1: Numbers of subjects completing both or only one task in Set 1.

Group	Both Tasks	Biased Coin only	Wason's task only
Deluded	12	0	3
Depressed	12	0	3
Normal	12	0	3

Set 2

Beads task (chapter 9) and the Cognitive Estimates Task (chapter 6)

In both the Beads task and the Cognitive Estimates task there were 15 subjects per group. The same 15 psychiatric and normal control subjects participated in both of the tasks. However, only 13 people with delusions completed both tasks. There were two people with delusions who only participated in the beads task and a different two who participated in the Wason's tasks.

Table 2: Numbers of subjects completing both or only one task in Set 2.

Group	Both Tasks	Beads task only	Cog Est task only
Deluded	13	2	2
Depressed	15	0	0
Normal	15	0	0

Set 3

Salient beads task (chapter 10) and the second set of Wason's Selection tasks (chapter 8)

There were 15 people per group in the Wason's selection tasks. In the Salient beads tasks there were 15 per group for the deluded and normal group and 16 for the depressed group. 11 people with delusions completed both tasks. Similarly, 13 people with depression completed both tasks. 14 of the normal subjects completed both tasks.

Table 3: Numbers of subjects completing both or only one task in Set 3.

Group	Both Tasks	Salient beads only	Wason's task only
Deluded	11	4	4
Depressed	13	3	3
Normal	14	1	1