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Jumping to Conclusions, Liberal Acceptance and the Bias Against Disconfirmatory Evidence: An Evaluation of Reasoning Deviations in Delusions

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1 General Introduction

1.1 Delusions: Definitions and Introduction

Delusions are a hallmark clinical manifestation of psychosis and play an important role in the diagnosis of schizophrenia. Apart from schizophrenia, delusions occur in a wide variety of medical and psychiatric conditions, including Alzheimer's disease, Huntington's disease, epilepsy, vascular dementia, traumatic brain injuries and intoxication from a wide range of substances (Maher & Ross, 1984).

Despite its diagnostic significance for schizophrenia and other conditions associated with psychosis, delusions still lack a consistent common definition. A considerable number of authors have written about delusions without attempting to define it (e.g. Jaspers, 1913; Schneider, 1955; Arthur, 1964).

Historically, non-specific definitions have associated delusions with madness, absurdity, groundlessness, error and chaos. Modern psychiatric definitions are based on the work of the German phenomenologists Emil Kraepelin (1899), Eugen Bleuler (1911) and Karl Theodor Jaspers (1913).

In his essay "Delusion and awareness of reality", Jaspers (1968) linked the definition of delusions to four main characteristics: (1) subjective certainty, (2) incorrigibility, (3) impossibility or falsity of content, (4) underlying delusional judgments are a transformed experience of reality (implausible, bizarre or patently untrue).

Jasper's criteria persisted in the current Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR, APA, 2000). However, some of the criteria are not as strongly stated in the current definition of delusions:

> *"A false belief based on incorrect inference about external reality that is firmly sustained despite what almost everybody else believes and despite what constitutes incontrovertible and obvious proof or evidence of the contrary. The belief is not one ordinarily accepted by other members of the person's culture or subculture (e.g. it is not an article of religious faith)."*

Despite its wide acceptance among clinicians and researchers, the current definition of delusions remains problematic and is a source of some controversy. For example, it is debatable whether delusions are indeed false beliefs. Proving that delusional content is faulty might be impossible (e. g. if the necessary evidence is not available). Also, extreme validity judgments of real events and facts may lead to opinions that are deemed delusional by others (e.g. grandiose delusions). The observation of deluded patients has indicated that a patient's conviction in the veracity of their delusion can vary even over the course of a day and they are not always firmly sustained (Myin-Germeys et al., 2001). Furthermore, many patients with delusions accept that other people don't believe in their ideas (Garety et al., 2005). Conversely, even scientists persist in their fixed beliefs in the face of overwhelming contradictory evidence and are not diagnosed for a mental illness (Kuhn et al., 1962).

1.2 Phenomenology

1.2.1 Classification

Historically, delusions were classified by their hypothesized etiologies (Jaspers, 1913; Dupre & Logre, 1911). However, the current consideration of delusions focuses on their phenomenology. Consequently, delusions are most commonly classified by their content (Bleuler, 1911; Maher, 1988). In general, a delusional belief can have any theme, though some delusional themes are more common than others. Table 1 displays a selection of the most common themes.

Persecutory delusions	"My food is being poisoned by the police."
Grandiose delusions	"I have the power to heal all the illnesses."
Delusional jealousy	"My partner is cheating on me."
Erotomania	"A famous pop star secretly signals her love to me over the radio."
Somatic	"I am infected by tiny parasites."
Bizarre	"My mother's thoughts are being carried on raindrops that fall on the air conditioner."
Guilt	"I am responsible for the AIDS epidemic."

Table 1: Presentation of the most common delusional themes and examples (Bell et al., 2006)

1.2.2 Stability over Time

Karl Theodor Jaspers emphasized that delusions 'are held with absolute conviction, with incomparable, subjective certainty' and that 'there is an imperviousness to other experiences and to compelling counter-argument' (Jaspers, 1969). Similarly, the current DSM-IV-TR definition presents delusions as a stable phenomenon ('fixed, false belief', APA, 2000). In earlier studies, there is some evidence that delusions are fixed and stable over time. Self-reinforcing mechanisms of delusional ideation have also been found (e.g., Brockington, 1991). However, there is growing evidence that there is considerable plasticity in most delusions (Appelbaum et al., 2004). Not only do delusions frequently change in content, delusion scores also proved to be fluid. One third of the subjects who displayed delusional symptoms at any given interview no longer showed delusional symptoms in follow-up assessments.

1.3 Delusion Theories

1.3.1 Traditional Theories of Delusions

There have been numerous attempts to explain the phenomenon of delusions. At the beginning of the 20th century, Jaspers introduced the phenomenological method to psychiatry. In Germany, phenomenological research dominated until the end of the 1970s, when more biologically oriented concepts of psychosis and delusions became popular.

Early in the 20th century, Alfred Adler (1914/1925) hypothesized that (paranoid) delusions represent an attempt to escape reality and to blame others for one's own failures in order to protect the ego. Jaspers named delusions "one of the biggest mysteries" (Jaspers, 1913) and stated that delusions "are a basic phenomenon of madness". Distinguishing between *primary* and *secondary* delusions, he argued that secondary delusions arise from a person's personal background, current situation or mental state. In contrast, he considered primary delusions as ultimately 'un-understandable', believing that there was no coherent reasoning process behind their formation (Jaspers, 1913). Kurt Schneider (1955), another influential German psychiatrist, put forward the theory that delusions emerge from a two-step process of perception and interpretation which is not logically understandable and only explicable by altered brain function, whereby the somatic underpinnings would not be identifiable. Gerd Huber (1982) hypothesized that delusions emerge from basically altered cognitive functions on the basis of biological pathology.

In addition to these deficit-oriented theories, Sigmund Freud's (1856 – 1939) psychodynamic perspective (Freud, 1911) suggested that delusions stemmed from a defective defense mechanism against unresolved homosexual impulses.

Maher (1984) related delusions back to disturbances in *perception*. In his model, a basic biological perceptional abnormality results in vivid and intense sensory input. However, subsequent research provided evidence for impaired information processing and not perceptual disturbances in delusions. Despite its limited significance today, Maher's attempt to find a cognitive explanation for delusional thinking was an impulse for further cognitive research on delusions.

1.3.2 Multifactorial Cognitive-Neuropsychiatric Models of Delusions

Over the last decade, notwithstanding issues of definition, delusions research has moved more and more towards *cognitive neuroscience*. "Cognitive Neuropsychiatry" (David, 1993) is a research branch that attempts to explain psychiatric phenomena with the methods of cognitive neuropsychology. In the field of delusions, the challenge is to develop psychopathological theories that describe alterations in the normal psychology of belief formation and maintenance.

Today, the multifactorial model of Garety and co-workers (2001) is widely accepted. It is built on the work of other researchers (Maher, 1988; Hemsley, 1993; Bentall et al., 1994; Chadwick et al., 1994) and a large body of literature that investigated delusions within the framework of Bayesian models (Hemsley & Garety, 1986). The multifactorial model represents the integration of several cognitive deviations that were observed in experimental studies. Regarding *attributional style*, deluded patients were found to blame others rather than circumstances and take credit for themselves when personal outcome is favorable (Bentall et al., 1991). This ‘self serving bias’ applies particularly to paranoid delusions. Additionally, the putative role of delusions to *enhance self-esteem* and to provide protection to the ego has been postulated (Bentall et al., 2001). Recently, it was demonstrated that acutely deluded patients displayed higher explicit, but lower implicit self-esteem than remitted patients (Moritz et al., 2006a). Moreover, inabilities to empathize, labeled *theory of mind deficits*, have been linked to psychosis (Frith & Corcoran, 1996). Defective interpretation of other people’s intentions and facial expressions may produce problems in social inference and may lead to misinterpretations in social contexts.

If a person in a situation of distress with threatening or negative events tends to blame others instead of circumstances, incorrect hypotheses about these events may evolve. For example, eating strange-tasting food, a person might come to the interpretation that somebody has poisoned it. Consequently, such misattributions may lead to the formation of (paranoid) delusional ideas. The probability of such misattributions may be supported by the tendency to jump to conclusions or the liberal acceptance of recently formed hypotheses and the reduced ability to understand other people’s perspectives and intentions due to theory of mind deficits. In addition to premature termination of data gathering before reaching a conclusion, the external attributions of negative events may protect the ego and lead to the maintenance of faulty hypotheses (Figure 1).

In the following experiments, *deviations in probabilistic reasoning* are considered. Reasoning abnormalities have been studied in the frame of Bayesian models, which have previously been applied to normal reasoning models (Fischoff & Beyth-Marom, 1983). From a neuropsychiatric perspective, deviations from the theoretical model were studied in order to determine psychopathological mechanisms in delusions. The following paragraph will describe Bayesian Models and their implications to reasoning processes in more detail. This will be followed by a summary of reasoning abnormalities in delusions that have been studied using Bayesian methodologies, starting with the first experiment by Huq, Garety & Hemsley (1988).

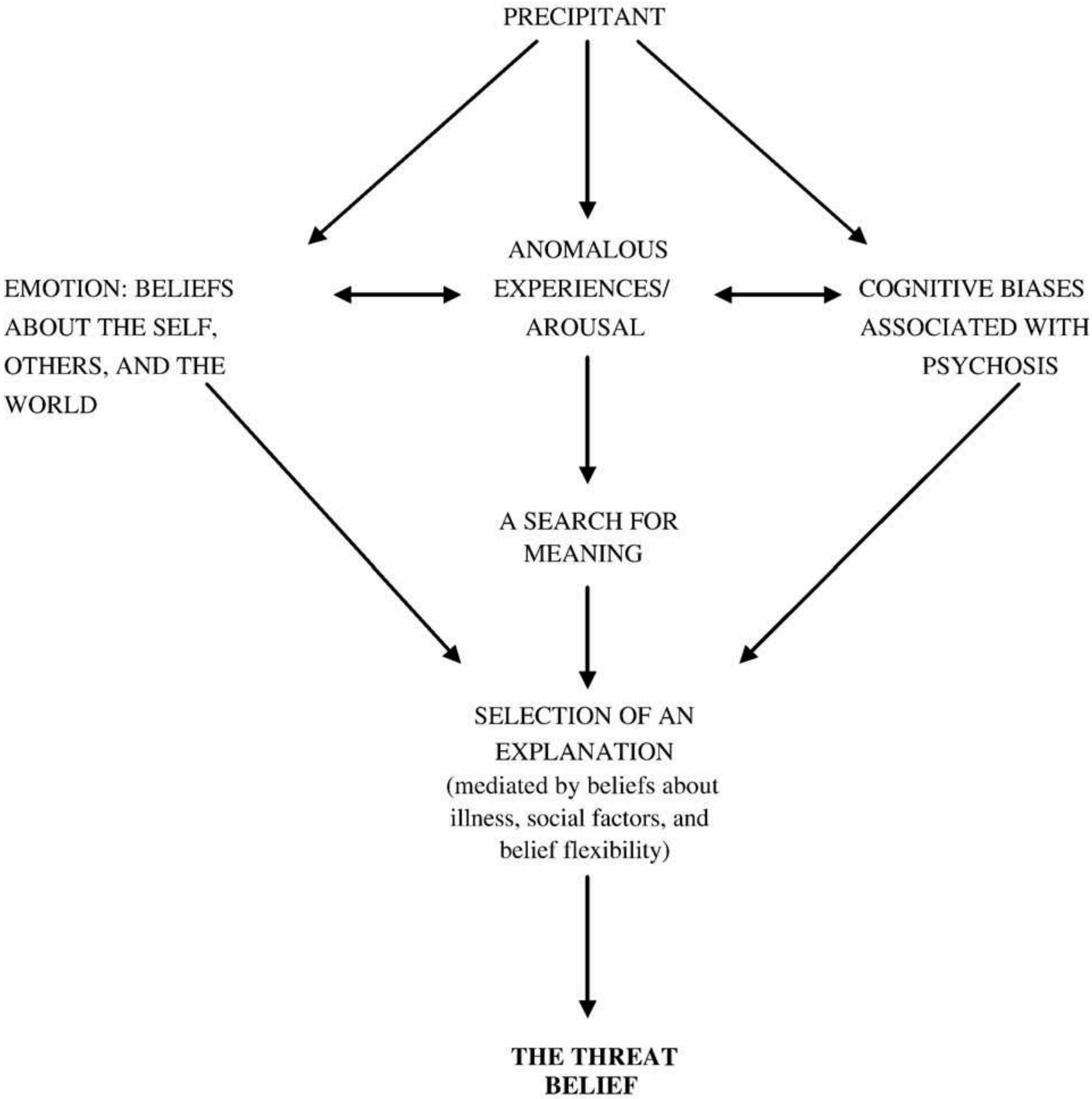

Figure 1: Summary of the multifactorial model of (persecutory) delusions (Freeman, 2007)

1.4 Bayesian Models

'Bayesian statistics' refer to methods in probability and statistics named after the Reverend Thomas Bayes (ca. 1702–1761). With respect to belief formation and maintenance, Bayesian models might provide us with a framework for evaluating hypotheses or beliefs by the comparison between the cognitive model and the actual behavior of a test person (Fischhoff & Bayth-Marom, 1983). This approach takes into account both prior beliefs or hypotheses and current new information for inferential processes. Hypothesis evaluation might deviate from the optimal model in several ways, resulting from different types of irregularities in several categorical judgmental processes. Investigation into whether a particular judgmental process is

consistently being altered in a certain population (e. g. delusional individuals with schizophrenia) might be a promising approach to the nature of delusions (Garety et al., 1991).

1.5 Probabilistic Reasoning in Delusions: An Overview Over the Findings

Although reasoning irregularities and possible flaws in probabilistic reasoning frequently occur in normal populations (Tversky & Kahneman, 1979; Kahneman, 2003), very few people develop delusions. Delusional thinking has been investigated by comparing deluded patients to healthy controls, employing a Bayesian model of probabilistic reasoning. Expectations were to be able to demonstrate distinct reasoning abnormalities in delusional and delusion-prone individuals. In the Bayesian model, these investigations address processes where the integration of new information is comprised. Although using paradigms in the 'framework of Bayesian models' (Garety & Freeman, 1999), observed reasoning deviations were not usually linked to a specific process of the theoretical model of Fischhoff & Bayth-Marom (1983). Designing paradigms that relate to specific aspects of this mathematical model may describe reasoning deviations more precisely.

1.5.1 The Basic Paradigm

In order to investigate probability judgments in delusions, the ‘beads task’ (Huq et al., 1988) has been employed, using several variations on the original paradigm. The study of Huq et al. (1988) can be regarded as the seminal study of reasoning abnormalities in delusions. In this experiment, two jars of beads were presented, one containing significantly more pink beads than green beads (ratio 85:15) and the other with the reverse relationship. From a single hidden jar, beads were taken, one by one, and participants were asked to guess whether the experimenter was taking the beads from the one or the other jar. Patients required less draws before they were ready to make their decision and displayed a higher initial certainty level (conviction), making decisions frequently after the very first bead was drawn. This finding, encapsulated in the phrase ‘jumping to conclusions’, has been replicated in numerous variations of the basic paradigm, suggesting a JTC bias for delusional and delusion-prone individuals (Garety & Freeman, 1999; Fine et. al., 2007).

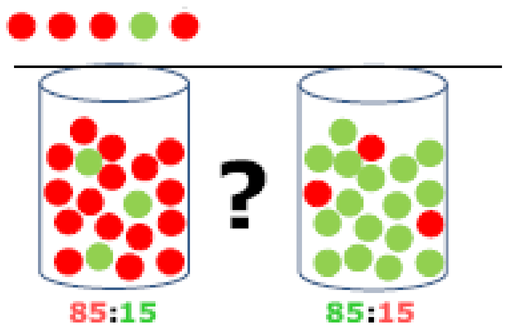

Figure 2: Two jars with different ratios of beads (Huq et al., 1988)

1.5.2 The 20 Questions-Task

In a similar study, probabilistic judgments and pre-decision data gathering were studied with the Twenty Questions game paradigm. The game usually involves one player raising a question, for example "What am I thinking of?", and the second player, the *questioner,* can then ask the first player questions, with the aim of finding the answer. Participants were the *questioners*, asking questions to narrow down the possibilities of what they were supposed to guess. Patients with schizophrenia were found to ask significantly fewer questions, and made their guesses more readily and with a higher certainty (John & Dodgson, 1994).

These findings have been replicated frequently, most recently by Moritz et al., (2006b), who describe reasoning as incautious, leading to premature decision-making. Probability estimates did not differ between the schizophrenia patients and control subjects, but the patient group appeared to more readily translate lower probabilities into decisions. Consequently, patients with schizophrenia performed worse in terms of correct responses.

These findings reconfirmed the JTC reasoning style and also demonstrated that this reasoning pattern is not a result of deficits in semantic knowledge generally, but relates to hasty or premature decision making.

1.5.3 Jumping to Conclusions (JTC)

The observation of arbitrary inferences (Kingdon & Turkington, 1991), a lack of active reality testing (Garety & Hemsley 1987), and both speedy and incautious thinking (John & Dodgson 1994, Moritz & Woodward, 2005) in deluded patients may lead to a JTC data gathering bias. This bias might enhance the probability for the formation and maintenance of delusions, particularly in patients with schizophrenia. Here, the tendency to decide rapidly on the basis of low evidence might be a protective mechanism taking into account the reduced cognitive capacity due to experiencing the world as an overwhelming flood of unfiltered, disorganized perceptual information (Hemsley, 1987). Similarly, a 'need for closure' (NFC) bias was suggested (Colbert & Peters, 2002) which holds that an overconfident and hasty reasoning style 'makes simple what is unmanageable and ambiguous'.

1.6 Current Debates, Aims of the Present Thesis

1.6.1 JTC and Its Relationship to Other Reasoning Biases

In delusions, reasoning biases other than the JTC bias have been found, such as reduced belief flexibility (Garety et al., 2005), a Liberal Acceptance Bias (LA; Moritz & Woodward, 2004) and a Bias Against Disconfirmatory Evidence (BADE; Woodward et al, 2006b). However, it remains unclear whether these reasoning biases are independent or share common underpinnings. One aim of the current thesis is to reproduce documented reasoning abnormalities and, in addition, to find potential interactions with other reasoning deviations. Second, reasoning abnormalities other than JTC are under-explored and potentially play an important role in either the formation or the maintenance of delusions and are therefore considered with the aim to improve the characterization of reasoning patterns in delusions.

Experiment 1 was designed both to replicate the JTC reasoning style in delusions, but also to test for the LA bias with a new paradigm that has not been employed before. In Experiment 2, the LA bias hypothesis was tested for two independent response options and, furthermore, the BADE was tested using neutral task material.

1.6.2 State or Trait?

Reasoning abnormalities, especially JTC, have been shown to be associated with delusions and are hypothesized to contribute to delusion formation and maintenance (Garety & Freeman, 1999; Fine et al., 2007). However, due to heterogeneous findings, based on varying methodologies and sample selections, there is currently a debate on the general character of reasoning biases in delusions (Garety & Peters, 2005; van Dael et al., 2006).

As delusions display considerable plasticity (Appelbaum et al., 2004), it is of interest whether risky reasoning is also unstable and accompanies delusion severity, thus representing a strong mechanistic factor and state-marker. If the JTC reasoning style is a general abnormality in conditions associated with delusions, independent of symptom severity, these reasoning abnormalities might only represent a general predisposition in patients with schizophrenia and other psychotic disorders. One approach to support a state-marker hypothesis is to cross-sectionally test for JTC, LA and BADE with a sensitive paradigm and to employ various control conditions and control groups in order to rule out that these biases depend on characteristics other than delusions. In Experiment 1 and Experiment 2, reasoning patterns in delusions are considered with a new variation the of previously used beads task, potentially allowing more sensitive measures. In addition to currently delusional patients with schizophrenia, different kinds of control groups were included in order to be able to relate JTC, LA and BADE specifically to delusions.

Longitudinal studies usually require more resources and are, therefore, conducted less frequently. However, longitudinal studies may provide even better clarification in the state-vs.–trait debate. This is reflected in Experiment 3, where a small sample was tested in a pre-post design in order to evaluate how the JTC bias correlates with delusion scores.

2 Experiment 1

2.1 Introduction

A number of probabilistic reasoning biases might contribute to the understanding of delusions, which are defined as 'fixed, false beliefs not amenable to contrary evidence' (DSM-IV-TR, APA, 2000). In the present experiment, the 'jumping to conclusions' bias (JTC, Huq, Garety & Hemsley 1988), the 'liberal acceptance' bias (LA, Moritz, Woodward et al., 2004) and their potential interactions are considered.

A JTC bias was found in a significant number of recent studies in deluded and delusion-prone individuals (Garety & Freeman, 1999; Fine et al., 2007), using various variations of the basic ‘beads task’ (Huq et. al, 1988). However, the question as to whether JTC is a response pattern that is specifically associated with delusions or with schizophrenia in general is currently subject to controversial debates. A number of studies on probabilistic reasoning in psychosis did not include non-delusional schizophrenia control groups (Dudley et al., 1997(a), Garety et al., 1991, Huq et al., 1988, Young & Bentall, 1997) and could thus not address that debate. Other studies, including delusional patients with schizophrenia and non-delusional schizophrenia control subjects (e. g. Peters al., 1999), were not able to detect differences between delusional and non-delusional schizophrenia patients and argue for delusions to be a trait-like rather than a state-like feature of schizophrenia. In contrast, in recent studies (Moritz & Woodward, 2005; Menon et al., 2006), a JTC pattern was more pronounced for patients with higher delusion scores under certain experimental conditions.

Several procedures have been employed to tap JTC. The ’draws to decision procedure’ hitherto displayed the most consistent findings (Fear & Healy, 1997; Garety et al., 1991, Garety and Freeman, 1999). In this procedure, the participants are asked after each bead if they reached a decision with respect to the source of the bead and the task is terminated once the participant has made his or her decision. Conversely, in a ’graded estimate procedure‘, first introduced by Young & Bentall (1997), participants are asked to rate certainty levels for one or the other jar to their best estimate after each bead, while the number of beads is fixed (e.g. 10 or 12). In this paradigm, the highest range of certainty rating closely imitates the response in a ’draws to decision’ procedure. Findings with this paradigm are more ambiguous (Fear & Healy 1997;

Dudley et al. 1997(b); Garety & Freeman 1999). Figure 3 illustrates the variations of the beads task.

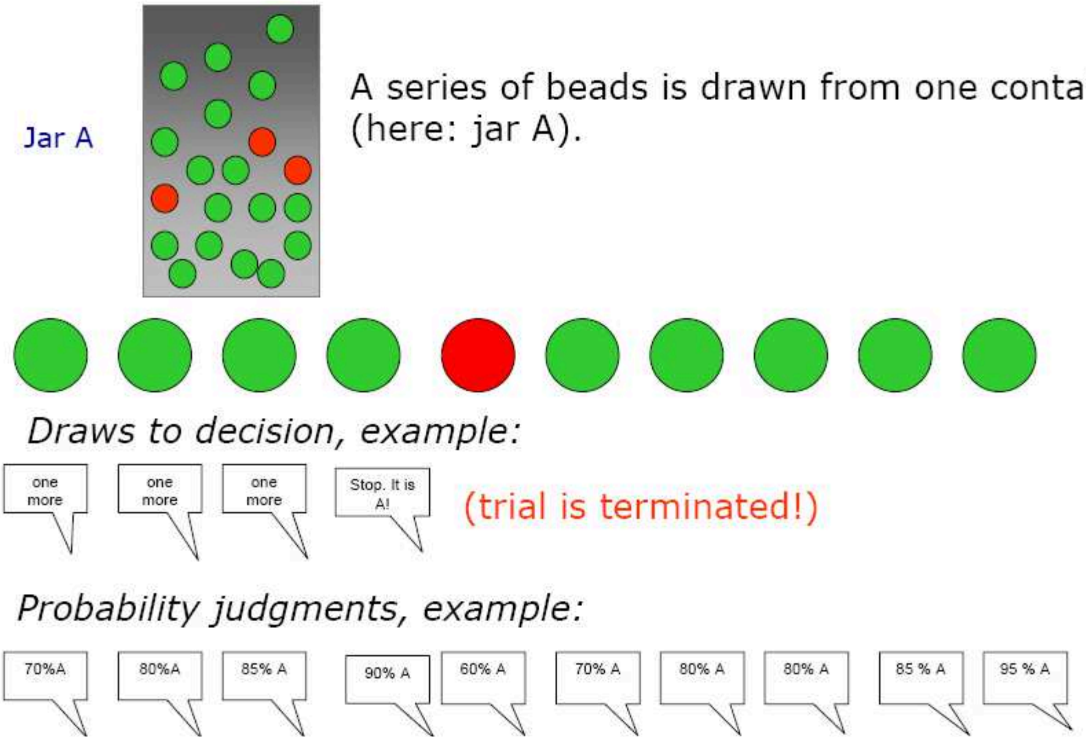

Figure 3: Illustration of the 'draws to decision procedure' and the 'graded estimates procedure' variation of the beads task.

Complementary to the JTC account, the role of a LA bias was put forward (Moritz & Woodward, 2004). This account predicts that patients with schizophrenia more liberally evaluate implausible response options. Using pictures from the Thematic Apperception Task (Aranow et al., 2001), the schizophrenia group generally responded with higher probability ratings, most pronounced for explanations considered highly implausible by healthy control subjects.

While a JTC approach would imply a contribution to immediate and rapid formation of a delusional belief, a LA bias might represent a facilitating mechanism for the usually slow development of a delusional belief by repeatedly accepting interpretations that support an initially weak delusional hypothesis. For clarification, based on an external attributional style or theory of mind deficits, the formation of a person's initial delusional belief that his or her food has been poisoned might be supported by a tendency to jump to conclusions. With a tendency to more liberally accept implausible interpretations, unspecific cues like seeing a police car can further contribute to the delusional idea that the police poisoned the food.

The LA account is supported by another study that used a variation of the beads task (Moritz et al., 2007b). While in an experimental condition with only two jars, a JTC-response pattern was present, the JTC effect disappeared when multiple competing alternatives were offered. Liberal acceptance of the less likely alternatives might lead to indecisiveness with respected to highly probable response alternatives and consequently inhibiting a pre-potent response in favor of the most likely alternative. In this context, it has been speculated that a LA account might be a more universal underpinning of delusions and might also be a more accurate model of delusion development and maintenance.

In studies investigating response patterns in patients with delusions on probabilistic reasoning, emphasis was put on *one* response alternative (e.g. jar or container), typically the one with a higher likelihood. Young & Bentall (1997) required participants to decide in favor of one or the other bag and give an estimate for the chosen option on a probability scale from 1 (“definitely the bag with mostly green beads”) to 7 (“definitely the bag with mostly red beads”). Likewise, Moritz & Woodward (2005) recorded probability estimates for container A or container B using a probability scale ranging from 1 (“definitely Container A”) to 7 (“definitely Container B”). Recently, using a “Who wants to be a millionaire” paradigm as a variation of the “Twenty Questions Game” (John & Dodgson, 1994), probability rates for correct and incorrect judgments did not differ between patients with schizophrenia and healthy control subjects (Moritz et al., 2006b). Notably, this study did not distinguish between delusional and non-delusional schizophrenia patients and did not include psychiatric controls. To the best of our knowledge, no previous study has investigated response patterns for both likely and unlikely response options in a variation of the beads task at the same time.

The present experiment is a variation of the bead task, employing fish and lakes instead of beads and containers. Using a graded estimates design, the probability ratings for both response alternatives were recorded.

With the experiment, several aims were pursued. First, testing four separate experimental groups (schizophrenia patients with delusions, schizophrenia patients without delusions, people with a psychiatric diagnosis other than schizophrenia, and healthy control subjects), we addressed the question of whether a JTC reasoning style is specifically associated with delusions. Starting from heterogeneous previous findings with JTC exclusively in delusional patients with schizophrenia or in both delusional and non-delusional patients with schizophrenia, we aimed to provide further clarification.

Second, by also recording probability estimates for response options with low probability rates, we aimed to investigate the response behavior of delusion-prone individuals for non-preferred response options of different probability levels. As putative underpinnings of delusions, higher ratings on less likely response options have been demonstrated for pictures from the TAT with potentially delusional content (Moritz & Woodward, 2004). The disappearance of the JTC effect towards the high probability jar in a paradigm using three low probability jars instead of one provided further indirect evidence for a LA bias (Moritz & Woodward, 2007a). In the same line, we hoped to tap a LA bias in neutral material directly by means of higher ratings for low probability response alternatives.

Finally, we aimed for a clarification of the relationship between the tendency to jump to conclusions and the tendency to more readily accept hypotheses by means of a correlation analyses.

2.2 Methods

2.2.1 Participants

Three groups of people took part in the study: people with schizophrenia or schizoaffective disorder, people with affective disorders and healthy people with no psychiatric diagnosis or history.

Thirty-nine patients, diagnosed with schizophrenia or schizoaffective disorder according to DSM-IV-TR criteria, were recruited from Riverview Hospital in Coquitlam, British Columbia, Canada. Fifteen patients with schizophrenia were considered actively delusional (SSPI 7 ≥ 3, see below), and 24 did not display delusions at the time of testing. The following diagnoses were recorded for the delusional group: schizoaffective (n = 10), paranoid (n = 4) and disorganized (n = 1). The following delusions were experienced: grandiose (n = 6), paranoid (n = 10), and Schneiderian (n = 4).

The psychiatric control group consisted of 44 people diagnosed for affective spectrum disorders, with the following diagnoses, all obtained by experienced psychiatrists according to DSM-IV-TR: Bipolar I (n = 35), Bipolar II (n = 5) and Major or Minor Depression (n = 4).

Twenty-nine people, drawn from hospital staff and the general population via advertisement and word-of-mouth, served as the healthy control group.

All participants underwent an assessment battery consisting of the National Adult Reading Test (NART, Blair & Spreen, 1989) and the Ammons Quick Test (QT, Ammons & Ammons, 1962) in order to estimate premorbid and current IQ, as well as the Hollingshead Two factor Index of Social Position (Hollingshead, 1957) in order to assess maternal, paternal and the subjects' social position.

The National Adult Reading Test is a widely accepted method in clinical settings to estimate intelligence levels of English-speaking subjects and is commonly used in neuropsychological research. The Ammons Quick Test is a passive response-picture-vocabulary test and is a favorable method for individuals with working memory and attention-span deficits. The Hollingshead Two factor Index of Social Position is a largely accepted estimation of socioeconomic status. The index comprises an occupational scale and an educational scale. While both are 7-point scales, occupation is given a weight of seven and education is given a weight of four.

Additionally, psychiatric patients were assessed by the Signs and Symptoms of Psychotic Illness scale (SSPI, Liddle et al., 2002). The SSPI is a rating scale that consists of 20 items, each with five points, in which 0 represents no pathology, 1 represents questionable pathology, and 2–4 represent increasing severity of clear pathology. If schizophrenia patients rated 3 or above for SSPI 7 (the item representing delusion severity), they were considered delusional.

Table 2 displays a comparison of group socio-demographic characteristics. Participants were not admitted if their IQ was less than 70, if they had primary or acquired brain damage or head injury (loss of consciousness for more than 10 minutes), or if they were HIV-positive. Ten participants (six in the psychiatric control group and four in the healthy control group) spoke English as their second language (ESL). Eye-sight under 20/40 (assessed corrected and bilaterally) or red-green blindness were also exclusion criteria.

All patients diagnosed for schizophrenia were currently receiving atypical neuroleptics (most frequently clozapine: n = 18; olanzapine: n = 9; risperidone: n = 3; chlorpromazine equivalent dosage in mg: M = 225.25, SD = 129.03) (Bezchlibnyk-Butler & Jeffries, 2004).

Socio-demographic Parameters of the Sample

	Delusional schizophrenia patients (n=15)	Nondelusional schizophrenia patients (n=24)	Psychiatric controls (n=44)	Healthy Controls (n=29)	ANOVA; Chi-square	Group comparison
Age	38.27±10.77	35.63±12.27	41.14±10.08	30.93±10.07	p<0.01	H<Ps, D; ND< Ps
Gender (M/F)	(10/5)	(19/5)	(18/26)	(9/19)	p<0.05	
Formal years of education	12.07±2.58	11.63±2.04	15.36±3.69	14.33±2.28	p<0.001	H, Ps > D, ND
IQ – NART						
V IQ	103.84±10.18	102.73±7.52	107.97±8.78	107.01±9.76	NS	
P IQ	107.67±3.55	107.14±4.81	109.62±4.14	109.16±4.61	NS	
FSIQ	106.01±6.59	105.04±8.92	109.63±7.7	108.79±8.55	NS	
IQ –QT	101.73±8.34	103.5±11.38	106.84±11.59	103.33±12.75	NS	
Social status	49.2±13.06	56.04±12.87	40.16±12.92	38.91±12.28	p < 0.001	H, Ps < D, ND
Maternal Social status	49.67±12.39	38.32±16.79	37.81±18.84	39.87±14.53	NS	
Paternal Social Status	38.5±14.01	35.47±17.09	32.70±15.58	36.18±14.69	NS	
Illness duration (years)	18±9.64	12.91±10.44	15.04±11.33	n/a	NS	
SSPI total	15.67±5.05	12.46±5.59	10.23±6.58	n/a	p<0.05	D > Ps
Delusions (SSPI 7)	3.47±0.52	0.87±0.87	0.45±0.73	n/a	p<0.001	D > Ps, ND; ND > Ps

Table 2: Psychopathological and socio-demographic characteristics of the samples. Mean values are accompanied by standard deviations (in brackets)

2.2.2 Experiment

Using Microsoft Internet Explorer 6.0, we constructed a computerized variation of the probabilistic beads task, following the 'graded estimates' approach of Young & Bentall (1997). Instead of beads and containers, participants were presented with fish and lakes. Fishing might be more familiar to participants than the artificially created situation of drawing beads from a jar and thus lead to more intuitive responses while the material might still be neutral with respect to delusional content (e.g. paranoid).

In between two lakes, each of which containing black and white fish in a certain proportion, a fisherman was displayed. Analogous to the draws of beads, the fisherman caught either a black or a white fish, one at a time. The lake on the left was named "Lake A" and the lake on the right was named "Lake B". A total of six Tasks were employed, with 10 fish catches for each task.

In all experimental tasks, the lakes were completely visible and the setup of the lakes remained the same. Prior to the administration of the tasks, the experimenter read all the instructions. After the start of Task 1, no further information was given by the experimenter. The proportions of fish in the lakes were not stated by the experimenter or displayed on the screen but were to be estimated by the participants.

After the initial scene, which showed the two lakes and the fisherman, the first fish was presented in his hands. Subsequently, the fish would be put back into the lake (so that the actual ratios would not change) and another fish would be caught, again visible in the fisherman's hands.

After each fish, participants were required to decide the probability that the fish was caught from Lake A and the probability that the fish was caught from Lake B, according to his or her best estimate. A probability scale from 0 to 10 was employed for both lakes on a horizontal bar and the participant indicated his or her rating by a mouse-click along the scale (0 = *very unlikely*, 2.5 = *unlikely*, 5= *possible*, 7.5 = *likely*, 10 = *very likely*). The ratings for the both lakes were independent of each other. High ratings for Lake A did not necessarily exclude the possibility of high ratings for Lake B. The instructions are given in the Appendix (Part I).

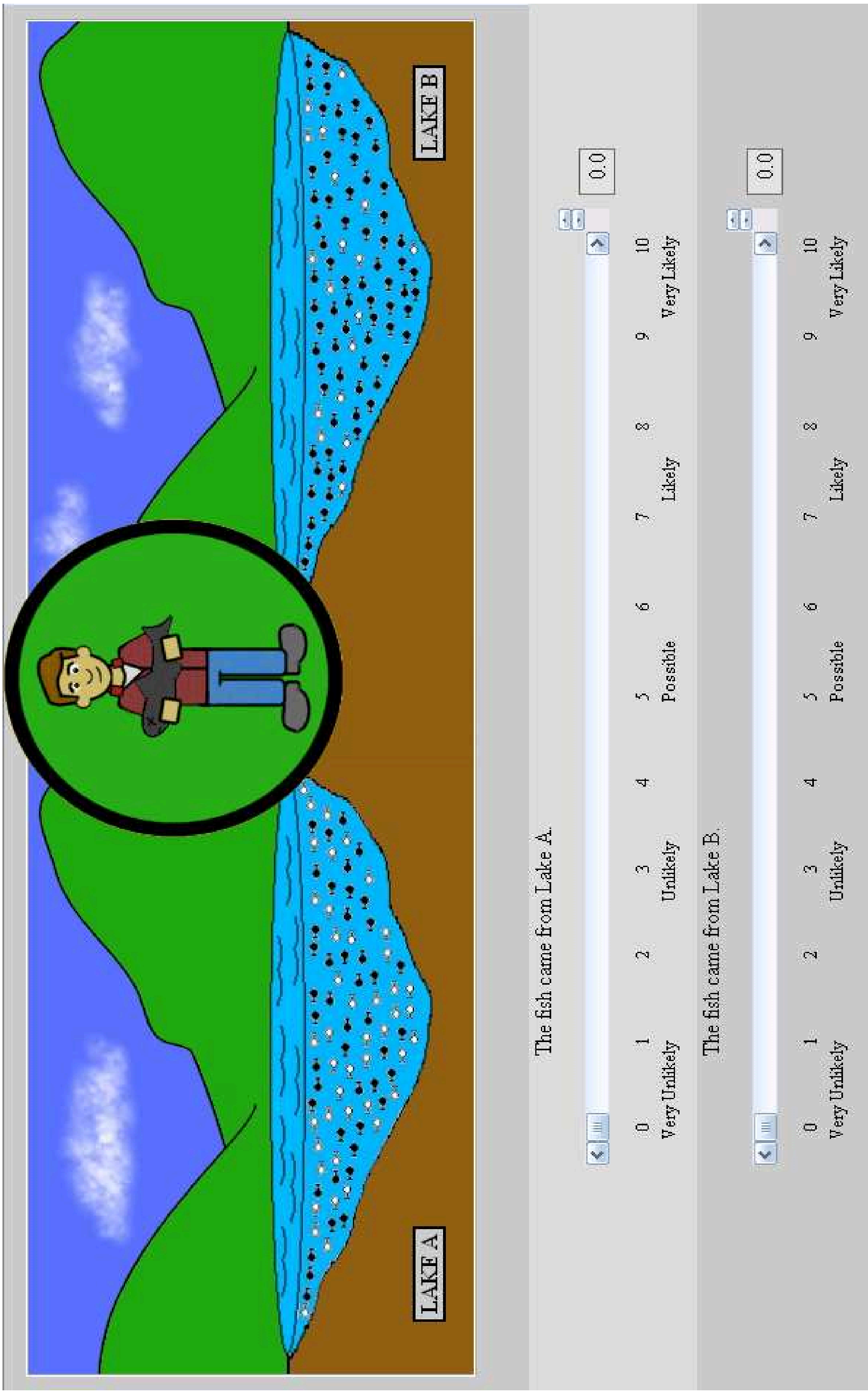

Figure 4: Illustration of the task procedure, here Task 4 with Lake A (50%/50%) and Lake B (20%/80%). Independent ratings were made for both lakes on two independent scrollbars.

The same procedure was repeated until the likelihood for the tenth fish was rated. Hereafter, the next task was employed. Probability rates for Lake A and Lake B were recorded to one decimal place.

The actual color of the fish caught and the positions of the lakes were randomly varied and counterbalanced in all tasks to avoid effects of preferred colors or lake positions. Except for Task 1 and Task 5, the distracter Tasks, all ten fish in a task were of the same color. Subsequently, the numerator in a ratio refers to the color of the caught fish, and the denominator to the opposite color.

In our experimental tasks, we employed the same color of fish for all the 10 catches. We were particularly interested in how participants rate probabilities with low evidence (1 or 2 fish) and how additional information affects their ratings. In a controlled manner, we aimed to assess the effect of a new piece of information on the previous hypothesis.

The proportions of black and white fish in the lakes were different in each task. An overview of the ratios in Tasks 2, 3, 4 and 6 is given in Table 3. For the data analysis, the ratings for the lake with the higher proportion of fish of the same color as the caught fish (“Lake 1”) were compared between groups, as well as the corresponding lake with the lower proportions (“Lake 2”), (regardless of color of the fish or the position of the lakes).

Task	Lake 1	Lake 2
Task 2	80%:20%	20%:80%
Task 3	80%:20%	50%:50%
Task 4	50%:50%	20%:80%
Task 6	50%:50%	50%:50%

Table 3: Ratios of fish in lakes in Task 2, 3, 4 and 6

Sequence of Fish and Ratios of Lakes in Distracter Tasks (Task 1 and Task 5)

Task 1 and Task 5 were designed as distracter conditions. The ratios of the lakes are displayed in Table 4.

Task	Lake 1	Lake 2
Task 1	50%:50%	20%:80%
Task 5	80%:20%	50%:50%

Table 4: Ratios of fish in lakes in distracter Tasks 1 and 5

The color of the caught fish was varied in the following order (B = black; W = white):

Task 1: W-B-W-B-B-W-B-W-W-B

Task 5: B-W-B-B-B-B-W-B-B-B

These two tasks were designed in order to avoid predictable patterns in the experimental tasks, where the color of the caught fish did not change.

Experimental Tasks (Task 2, 3, 4 and 6)

These Tasks were designed for testing the hypotheses of JTC across various conditions. For the LA hypothesis, Task 2 and Task 4 were of particular interest. With a portion of only 20% of fish in the critical color, the least probable non-preferred response options were given in these Tasks.

2.3 Results

2.3.1 Sociodemographic Parameters

One-way analyses of variance (ANOVAs) and follow-up t-tests revealed that the experimental groups differed in age, gender and years of education. However, all groups were matched for estimated premorbid and current IQ. According to the Hollingshead Two-Factor Index of Social Position (Hollingshead, 1957), both deluded and non-deluded schizophrenia patients had lower social positions than the psychiatric and healthy control subjects, but did not display differences for parental social positions, indicating similar socioeconomic backgrounds.

The influence of age on task performance is controversial (John & Dogson, 1994; Kemp et al., 1997). Introducing age and gender as covariates, we determined that, for each parameter, there was no impact of these factors on task performance. Generally, gender is not considered to have an effect on probabilistic reasoning tasks (Garety & Freeman, 1999) and didn't impact performance in our task.

Notably, the deluded and non-deluded schizophrenia group did not differ for any of the demographic variables. Also, patient participants were matched for the duration of illness. Delusional patients scored higher than psychiatric controls and non-deluded patients on the SSPI. All psychiatric control subjects were non-delusional except for one bipolar patient (SSPI 7 = 3). Likewise, deluded psychotic patients had higher total SSPI scores than psychiatric controls. Notably, the healthy control group was not assessed with the SSPI.

2.3.2 Behavioral Data

Distracter Tasks

Task 1 and Task 5 were designed as distracter conditions. For these tasks, the participants performed in the expected manner and no group differences were detected.

JTC

If participants gave an extreme rating after the first catch (over 9 or under 1), this was considered a JTC bias. All ratings after the first fish in all tasks were included in the analysis. A univariate ANOVA revealed a trend to a main effect of Group ($F = 2.47$, $df = 2$, $p = 0.06$) for ratings over 9 after the first fish. Although this ANOVA did not reach statistical significance, group differences were analyzed with 'difference contrasts', with the group orders as follows: healthy controls, psychiatric controls, non-delusional schizophrenia patients, delusional schizophrenia patients. With this group ordering, difference contrasts provide a one-degree-of-freedom test for a difference between the two control groups (contrast: -1 1 0 0), the difference between all controls and the non-delusional patients with schizophrenia (contrast: -.5 -.5 1 0) and the difference between all non-delusional groups and delusional schizophrenia patients (contrast: -.333 -.333 -.333 1). The analysis revealed that delusional patients scored higher than all the other groups ($p = 0.01$, contrast: -.333 -.333 -.333 1) while no other group differences were observed ($p = 0.6$, contrast: -.5 -.5 1 0; $p = 0.9$; contrast: -1 1 0 0). Group differences in probability ratings greater than 9 were not observed at the end of the tasks (fish 10).

An overview over the numbers of JTC-responses is displayed in Figure 1.

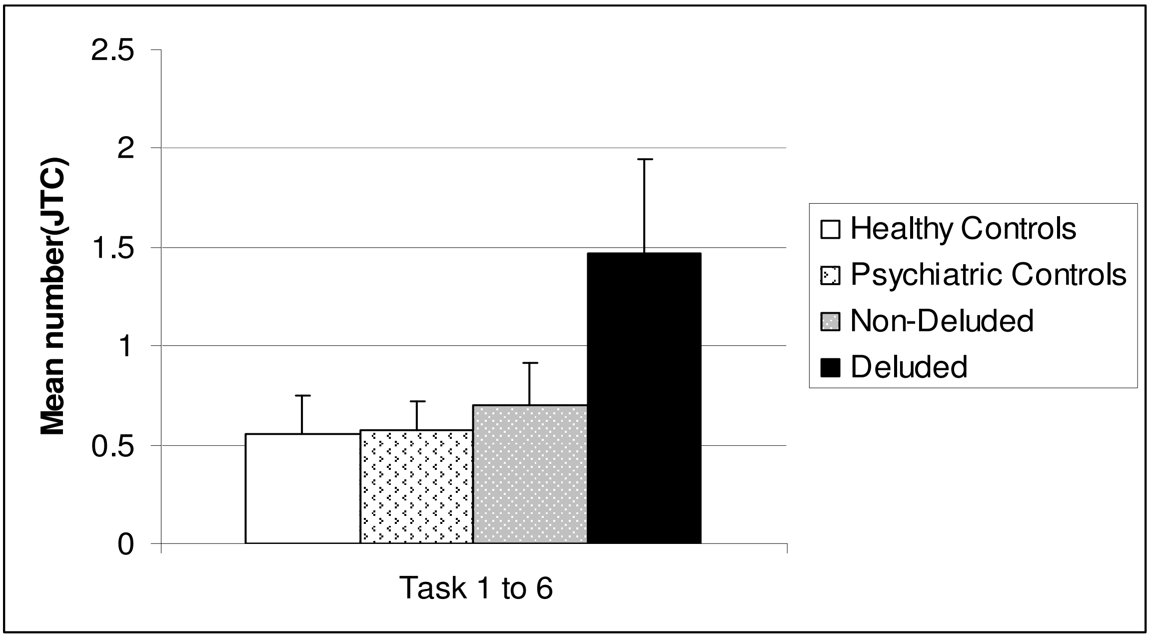

Figure 4: Number of extreme responses for preferred lakes

No group differences were detected for extreme decisions after the first catch in the low range (< 1).

2.3.3 Experimental Tasks

For the analysis of the four experimental tasks (Task 2, Task 3, Task 4 and Task 6), three periods were considered: the beginning (catches 1 and 2), the middle (catches 5 and 6) and the end (catches 9 and 10). We conducted an ANOVA with repeated measures to test for the main effects of Group (deluded, non – deluded, psychiatric controls, healthy controls), the main effect of Condition (beginning, middle, end), and for Group by Condition interactions.

As before, group differences were analyzed with 'difference contrasts', with the identical group order. Likewise, the difference between the two control groups (contrast: -1 1 0 0), the difference between all controls and the non-delusional patients with schizophrenia (contrast: -.5 -.5 1 0) and the difference between all non-delusional groups and delusional patients (contrast: -.333 -.333 -.333 1) were calculated.

2.3.4 Non-Preferred Lakes with Low Probabilities (20%:80%)

The overall performance of the four groups on Task 2 and Task 4 are illustrated in Figure 2. In Task 2, the lake with the 80%/20% ratio for the critical fish color was compared against the lake with the 20%/80% ratio. In Task 5, the lake with the 50%/50% ratio was compared against the lake with the 20%/80% ratio in the critical color. All four groups rated similarly for the preferred lakes, in other words, the lakes with the higher proportion of fish with the same color as the fish caught (80% and 50%, respectively). There were no group differences for this task.

However, for the non-preferred lakes, both with a portion of 20% of fish in the critical color, patients with schizophrenia who also displayed delusions, rated consistently higher than all other experimental groups. A repeated-measures ANOVA revealed a main effect of Group for the non-preferred lakes in both tasks ($F = 3.659$; $df = 3$; $p < 0.05$; respectively $F = 2.817$; $df = 3$; $p < 0.05$). Neither the between group contrast between the control groups ($p = 0.2$ in Task 2, $p = 0.3$ in Task 4) nor the contrast between all controls and non-delusional patients with schizophrenia ($p = 0.5$ in Task 2, $p = 0.4$ in Task 4) showed any significant differences. Delusional schizophrenia patients differed from all the other groups in Task 2 ($p < 0.05$) and Task 4 ($p < 0.05$).

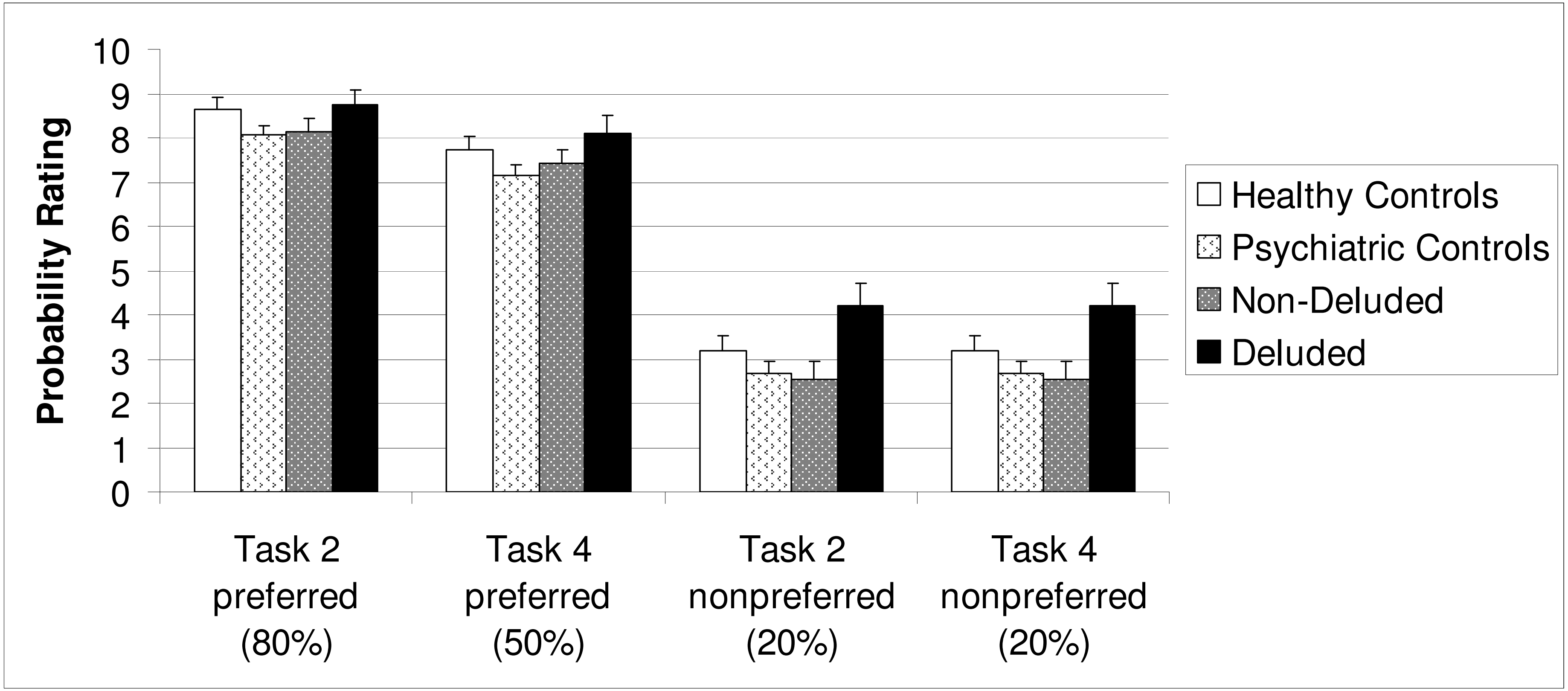

Figure 5: Average ratings in Task 2 and Task 4 for preferred and non-preferred lakes (means and standard errors of the mean).

2.3.5 Development of Ratings During the Duration of a Task

In many cases, non-deluded participants changed their more conservative ratings at the beginning to more extreme ratings by the end of the task.

There was no preferred lake in Task 6 since the ratio was 50%/50% for both lakes. In all other experimental tasks (Task 2, Task 3 and Task 4), a main effect of Condition ($F = 8.95$, $df = 2$, $p < 0.001$; $F = 7.90$, $df = 2$, $p < 0.05$; $F = 8.68$, $df = 2$, $p < 0.001$) was observed for the probability ratings of the preferred lakes. The mean increase in ratings from the beginning to the end was 1.06 rating points in Task 2, 0.87 rating points in Task 3 and 1.14 rating points in Task 4. However, there were no Group by Condition interactions.

Regarding the ratings of non-preferred lakes, a main effect of Condition was only detected in Task 4 ($F = 5.58$, $df = 2$, $p < 0.01$). On average, ratings were 0.46 rating points lower at the end compared to the beginning.

2.3.6 Correlation of Jumping to Conclusions and Liberal Acceptance

In our experiment, both a JTC pattern and a LA pattern were present in delusional patients. However, the question remains as to whether the JTC effect and the LA effect share common underpinnings.

In order to test for the correlation between JTC with a LA response pattern, all responses for the non-preferred lakes in Task 2 and Task 4 were combined into one variable. There was a correlation between JTC and an LA response pattern (Pearsons correlation $r(df) = 3$; $p < 0.05$). However, introducing a LA response variable pattern as a covariate, contrasts between delusional patients and the other control groups remained significant ($p < 0.05$; contrast: -.333 -.333 -.333 1), indicating that the difference in the JTC response pattern is independent of the tendency to LA responses.

Also, while a univariate ANOVA with ‘difference contrasts’ showed a clear LA response pattern ($F = 3.81$, $df = 3$, $p < 0.05$; $p < 0.001$, contrast: -.333 -.333 -.333 1), introducing the number of JTC responses as a covariate, between group contrasts (-.333 -.333 -.333 1) remained significant

($p < 0.05$). Thus, the tendency to a LA bias for unlikely response options does not share a common effect with the tendency to jump to conclusions.

2.4 Discussion

The present results both confirm and extend the current understanding of the role of probabilistic reasoning in the formation and maintenance of delusions. With the present fish paradigm, using two response options, the deluded group made significantly more extremely high ratings for the preferred response after the first catch, while all control groups displayed more cautious ratings with the small amount of evidence provided by only one fish.

In accordance with previous studies, patients with schizophrenia displayed more hasty and firm decisions on the basis of low evidence, which has been described as a 'jumping to conclusions' (JTC) bias. With the procedure and the sample used in the present study, a JTC tendency was clearly associated with delusions. None of the control groups displayed a JTC pattern; only the delusional patients with schizophrenia did. Studies that also compared delusional and non-delusional individuals with schizophrenia that did not find between-group differences (e.g. Peters et al., 1999) may not have had high enough statistical power to reveal an effect under the majority of the conditions.

On the other hand, the paradigm of the present study, using *two* independent response options, might represent a more powerful procedure to characterize the JTC pattern of delusional versus non-delusional populations. To our best knowledge, this 'graded estimates' variation of the beads task, with two response options, was not used in a similar experiment before. This procedure gives participants the option to rate high for a preferred option as well as high for the non-preferred option, since the probabilities for both options do not necessarily have to be integrated in one rating as in a pure graded estimates procedure (Young & Bentall, 1997). As JTC was not observed for low-probability options, an *early rejection hypothesis* (Garety & Hemsley, 1994) was not supported. In contrast, our data suggest that JTC is present in response options with high probabilities.

Also in the line with previous findings, there was a tendency for delusional patients with schizophrenia to more readily accept response options with low likelihoods (in our experiment lakes with a portion of only 20% of fish in the critical color). Delusional individuals made significantly higher ratings in both Task 2 and Task 4 (see Figure 5).

These findings were first observed in a variation of the Thematic Apperception Task and labeled a *Liberal Acceptance Bias* (Moritz & Woodward, 2004). Patients with schizophrenia displayed higher ratings than control groups, especially for response options that were deemed to be very unlikely by healthy control subjects. While that study employed pictures and offered potential explanations as response options, the present experiment confirms the hypothesis of a LA bias in delusions with more neutral material and consequently less confounded by potentially delusional content. In contrast to the study of Moritz & Woodward (2004), where people diagnosed for schizophrenia were compared to healthy control subjects, the present investigation demonstrated a LA pattern specifically in delusional patients versus all other control groups.

The data do not support a strict formulation of a JTC account, which assumes that (deluded) schizophrenia patients make early firm decisions for *one response alternative only*. Delusional individuals proved to more readily consider *two* response options. In a related experiment, using a classical beads task design, a JTC pattern, which has been observed for a one-response option design with two containers, was not observed in a more ambiguous design when four containers were displayed (Moritz et al., 2006b). This indicates that a fast decision was attenuated by the presence of a larger number of hypotheses held in simultaneous contemplation. In the present study, this over-contemplation was explicitly recorded. Delusional patients showed a reduced readiness to enclose a certain hypothesis in ambiguous situations, which fits well with the finding that deluded patients experience themselves as indecisive (Freeman et al., 2005). Consequently, not only a strict formulation of the JTC account, but also the need for closure (NFC) account (Colbert & Peters, 2002), that predicts that psychotic patients make hasty decisions in order to reduce ambiguity, must be challenged.

Notably, a LA pattern was not present for *all* unlikely response options. In Task 3, where there was one lake with 80% and another lake with 50% of fish in the critical color, deluded patients did not significantly differ from the control groups in ratings for the 50% lake. Group differences only became evident for response options with very low probabilities (20%) and were convincingly consistent.

In summary, besides a JTC tendency for high probability rates, there is growing evidence for an over-acceptance of hypotheses with extremely low probabilities, a feature that deluded participants did not share with any of the control groups. Consequently, the formation and maintenance of delusional beliefs appears to not only be based on quick, firm decisions in situations with low ambiguity, but also the increased likelihood of considering less likely hypotheses.

The acceptance of alternative interpretations that are deemed very unlikely by healthy control persons also covers another aspect of delusions. The definition of delusions also includes the following phrase: ‘The belief is not one ordinarily accepted by other members of the person's culture or subculture (e.g. it is not an article of religious faith)’ (DSM-IV-TR, APA, 2000). Often, healthy people cannot understand or even imagine what a delusional person thinks and believes and find delusional people very strange, leading to avoidance of deluded people. Frequently, individuals suffering from delusions sooner or later become outsiders, isolated and socially marginalized. LA might be an important factor in explaining the difference between delusional and unimpaired thinking and its interpersonal and social consequences.

In contrast to a single (isolated) JTC account, the combination of JTC and LA might represent a more accurate contribution to the understanding of delusions. Delusional, fixed beliefs usually evolve stepwise, as LA would explain and may be triggered by quick and incautious decision-making processes in favor of one response alternative. A pure JTC account would imply a quick development of delusional systems and the rejection of unlikely hypotheses. However, probabilistic reasoning abnormalities are not sufficient to explain formation of delusional ideas. Here, different aspects of the multifactorial model (Freeman, 2007), such as misattributions and theory of mind deficits, are of importance. The role of JTC and LA is to facilitate the formation and maintenance of delusional ideas.

Despite the consistent finding of an over-acceptance of improbable hypotheses resulting from, for example, misattributions or theory of mind deficits, the experiment did not address the question of which mechanisms might contribute to LA. Several putative possibilities can be considered. First, delusional patients might have a reduced threshold for accepting a hypothesis with low evidence and as such not dismiss it as early as healthy people would do. Second, delusional patients might display a tendency not to take into account all the information that would lead a healthy person to deem an alternative as impossible. As such, LA might be a matter of data gathering, which is also supported by several studies that characterized delusional patients with schizophrenia as displaying working memory deficits (Manoach, 2003) and a faulty attentional filter (e.g. Mathalon et al., 2004). Secondly, research investigating error detection found patients with schizophrenia to display impaired error detection (review: vVeen & Carter, 2006). To address this issue, investigations including physiological parameters, especially frontal lobe function measures, might be necessary. Thirdly, impaired semantic memory (McKenna, 1991; Tamlyn et al., 1992) was found in deluded individuals. Faulty, delusional hypotheses might not contradict with an individual’s stored semantic knowledge and as such be more readily accepted.

The association of JTC and LA with current high delusion scores, and non-deluded participants (partly in regression) not showing that pattern speaks for JTC and LA as involved in both the formation and the maintenance of delusions. Furthermore, we suggest that delusion is a state-like rather than a trait-like feature of schizophrenia. If so, the association of delusions with JTC (and LA) would predict that the presence of JTC fluctuates as a function of delusion severity. This prediction will be considered in Experiment 3.

However, other data suggest that JTC is also present in non-delusional people who are not diagnosed with schizophrenia, but display high delusional ideation (Colbert & Peters, 2002), and a previously delusional population has been found to display a JTC response pattern while in remission (Peters & Garety, 2006). Notably, Colbert & Peters (2002), examined non-delusional populations and found that the scores for a ‘beads to certainty scale’ were much higher ($M = 5.12$) than the scores delusional patients usually display. They observed no group differences in ‘initial certainty’, which was used as a JTC-measure. Peters & Garety (2006) lacked of non-deluded schizophrenia controls and, in addition, the criteria for a participant to be regarded as delusional were relatively high.

As JTC and LA both occur in delusions, we were interested in whether or not JTC and LA share common underpinnings. Earlier studies suggested LA to be a more general feature that also explains a JTC reasoning style, due to lowered probability thresholds for the acceptance of a hypothesis (Moritz & Woodward, 2004). However, correlation analyses revealed that JTC and LA are both correlated with delusions, but that there is no significant overlap of JTC and LA. Consequently, JTC and LA appear to be independent probabilistic reasoning biases that both contribute to delusions as complementary factors.

In future, investigations of JTC and LA might focus on several issues. In the present experiment, both delusional and non-delusional schizophrenia participants were included. However, with 15 individuals in the delusional group, statistical power was limited. The differences of age and gender between the experimental groups further limits the power our findings. Testing larger samples might allow the measurement of effects that are not detectable with a smaller sample and, additionally, allow investigation of relationships between the various reasoning aberrations in delusions. Also, the relationship of other consistent characteristics of delusional ideation (e. g. ‘theory of mind’ deficits; Frith, 1992) might be investigated in order to improve the current model of delusion formation and maintenance. In order to address the state vs. trait debate, a longitudinal study with delusional participants is required. This will be reflected in Experiment 3.

3 Experiment 2

3.1 Introduction

Deviations of probabilistic reasoning in delusional individuals are well established and the JTC bias (see Experiment 1) has been frequently replicated (Garety & Freeman 1999, Fine et al., 2007). However, the JTC pattern was not seen in all studies and it appears that only certain methodologies are sensitive to JTC (Menon et al., 2006; Experiment 1). Recently, it was found that delusional patients who usually jump to conclusions do not display such a reasoning bias in more ambiguous experimental conditions, e.g. in a beads task with four jars instead of two (Moritz et al., 2006b). It appears that delusional patients, more than controls, consider implausible hypotheses. The lack of a JTC pattern in more ambiguous situations represents the second prediction of the LA account: With lower subjective certainty, for example, seeing more jars with various portions of beads, the JTC effect disappears. A manipulation of the visible part of the lakes in our fish paradigm might be another way to create a situation of reduced subjective certainty. A more cautious response style in delusional individuals on the 'fish task' would enhance the role of LA in the formation and maintenance of delusions. Revealing the lakes in ten steps after each catch, beginning with a very small section (4 or 5 fish), we were interested in the response style on this probabilistic reasoning paradigm as a first goal of the present experiment.

In a Bayesian model of belief, it is of particular interest, how individuals integrate new pieces of information relative to their prior beliefs (Fischoff & Beyth-Marom, 1983). Strong beliefs might evolve through two mechanisms of dealing with new information:

A. The integration of confirmatory evidence

B. The discarding of disconfirmatory evidence

An increased tendency to integrate confirmatory evidence and/or a heightened tendency to discard disconfirmatory evidence ultimately leads to an over-fixation of beliefs. The investigation of the maintenance of delusions must address these two processes. If delusional individuals more readily integrate information consistent with their beliefs and, at the same time, more readily reject incongruent information, this may be an elegant approach to the nature of 'fixed, false beliefs' (DSM-IV-TR, APA, 2000).

3 Experiment 2

Based on the mathematical Bayesian model, Huq, Garety & Hemsley (1988) first employed the 'beads' task and found biases in the process of integrating *confirmatory* evidence in patients with schizophrenia. Subsequent research efforts led to models such as the 'Jumping to Conclusions' bias (Garety & Hemsley, 1991), the 'Need for Closure' bias (Colbert & Peters 2002), which have focused on abnormalities in the integration of confirmatory information and provided evidence that delusional people more readily consider delusion-congruent information. Moreover, these studies also focused more on the formation than the maintenance of delusions.

Recently, it has been observed that individuals with delusions also display a cognitive *Bias Against Disconfirmatory Evidence* (BADE, Woodward et al., 2006). This account predicts that delusional patients are more resistant to information that contradicts the already formed hypothesis. With an elegant experimental design, the effect of BADE became obvious: Participants were presented with pictures in the style of a cartoon strip of three pictures. First, they only saw the last picture and were requested to rate the probabilities of four given alternative interpretations. In a second and a third step, the previous pictures were shown and the interpretation options were given again. With the additional pictures, the content of the last picture changed in favor of an interpretation that seemed very unlikely in the beginning (Figure 6).

1 2 3

1) The man has just built a fence for his dog.

2) The man is shopping for guard dogs.

3) The man has just escaped from the barking dog.

4) The man is playing with his neighbor's barking dog.

Figure 6: Cartoon series of three pictures employed by Woodward et al., 2006[*]

While the non-deluded schizophrenia and healthy control group often changed their initial interpretations, deluded patients more often adhered to their initial interpretation. In a Bayesian framework, inferential processing of delusional individuals seems to be biased with respect to new pieces of information. If new pieces of information are congruent, they appear to be more influential than incongruent new pieces of information, which would increase the likelihood of an alternative interpretation. As such, delusional patients proved to be more resistant to new information that supports a hypothesis different from their previous beliefs. While JTC and LA appear important to enhance the probability of the formation of delusional ideas resulting from *external* hypotheses, BADE might represent a mechanism to maintain their *internalized* delusional systems.

The following experiment was designed to test two hypotheses: first, we aimed to investigate response behavior in a more ambiguous situation, reflected by smaller sections of the lakes in the beginning, hoping to find further support for a LA bias. Second, the hypothesis of a Bias Against Disconfirmatory Evidence (BADE) was tested with neutral task material, manipulating factors of

[*] Having seen the third picture only, response options 1), 2) and 4) might appear reasonable. Most non-delusional individuals change their response towards 3) after seeing the second and first picture, while (deluded) schizophrenia patients were found to be less flexible.

the Bayesian model of belief. Delusional patients were expected to hold firmly with initial ratings while the ratios of fish move to the opposite.

3.2 Methods

3.2.1 Participants

The sample was the same as in Experiment 1. All sample characteristics can be reviewed in Experiment 1. Experiment 2 was administered in the same session, after the administration of Experiment 1.

3.2.2 Material

Participants were presented with the fisherman variation of the 'graded estimates' procedure used in Experiment 1. Again, the experiment consisted of 6 Tasks, each with 10 catches of fish, and participants were requested to make probability ratings for both lakes after each fish. In all tasks, the color of the caught fish remained the same during the task.

Instead of the complete view of the lakes, only a partial view was given to start with. Prior to the catch of the first fish, only a small section of the lake (e.g. 4 or 5 fish) was visible, with the rest covered by a black layer (e.g. mud). Subsequently, the lake was revealed in ten steps, and for the very last fish, the entire lake was visible. The participants were introduced to this version of the task by the experimenter and they were allowed to ask questions before they were presented with Task 1. After that, no further information was given by the experimenter. Again, 'Lake 1' refers to the lake with the larger portion of fish in the critical color and 'Lake 2' to the remaining lake. The instructions are given in the Appendix (Part II).

3.2.3 Conditions

Constant Lakes

In Task 1, 3, 4 and 6, the portions of fish in the two lakes remained the same during the task. An overview over the ratios is given in Table 5.

Task	Lake 1	Lake 2
Task 1	80%:20%	20%:80%
Task 3	80%:20%	50%:50%
Task 4	50%:50%	20%:80%
Task 6	50%:50%	50%:50%

Table 5: Ratios of fish in lakes in Tasks 1, 3, 4 & 6

Variable Lakes

In Task 2 and Task 5, the ratios of one lake were different from catch to catch. With the lakes being revealed in ten steps, the portions could be manipulated with every additionally visible fish. For Task 2 and Task 5, one of the two Lakes ("Lake 1") had variable proportions of black and white fish. The numerator in the ratio refers to the color of the caught fish, the denominator refers to the remaining color.

An overview over the ratios of fish in lakes in Task 2 is given in Table 6. An overview for Task 5 is given in Table 7.

Trial (Fish)	Lake 1(variable)	Lake 2(constant)
Fish **1**	**50%:50%**	**80%:20%**
Fish 2	40%:60%	80%:20%
Fish 3	30%:70%	80%:20%
Fish **4**	**20%:80%**	**80%:20%**
Fish 5	30%:70%	80%:20%
Fish6	40%:60%	80%:20%
Fish 7	50%:50%	80%:20%
Fish 8	60%:40%	80%:20%
Fish 9	70%:30%	80%:20%
Fish **10**	**80%:20%**	**80%:20%**

Table 6: Ratios of fish in lakes in Task 2 with the extreme ratios in bold

Trial (catch)	Lake 1(variable)	Lake 2(constant)
Fish **1**	**50%:50%**	**20%:80%**
Fish 2	60%:40%	20%:80%
Fish 3	70%:30%	20%:80%
Fish **4**	**80%:20%**	**20%:80%**
Fish 5	70%:30%	20%:80%
Fish 6	60%:40%	20%:80%
Fish 7	50%:50%	20%:80%
Fish 8	40%:60%	20%:80%
Fish 9	30%:70%	20%:80%
Fish **10**	**20%:80%**	**20%:80%**

Table 7: Ratios of fish in lakes in Task 5 with the extreme ratios in bold

Overall, for the first draw, the ratio of fish in both lakes in one of the tasks of Experiment 1 corresponded to one of the tasks in Experiment 2, which allows a direct comparison of extreme responding after the first catch.

For the data analysis, three ratings in Task 2 and Task 5 were analyzed: the rating after the first catch (starting point), the rating after the fourth fish (lower extreme in Task 2 and upper extreme in Task 5), and, finally, the rating after the very last catch (upper extreme in Task 5 and lower extreme in Task 2), where the ratios in both lakes were equal.

3.3 Results

3.3.1 JTC (Lake 1 to 6)

Consistent with Experiment 1, ratings greater than nine were considered a JTC response. In this experiment, there were no significant between group differences and the JTC effect was not observed.

Development of Ratings During the Task

A repeated measures ANOVA was performed to test for the main effects of Group (deluded, non – deluded, psychiatric controls, healthy controls), the main effect of Condition (fish 1, fish 4, fish 10), and the Group by Condition interactions.

3.3.2 Constant Lakes (Task 1, 3, 4 & 6)

Preferred Lakes

For Lake 1, a main effect of Condition was observed in Task 1($F = 20.32$, $df = 2$, $p < 0.001$), Task 3 ($F = 29.35$, $df = 2$, $p < 0.001$), Task 4 ($F = 18.87$, $df = 2$, $p < 0.001$) and Task 6 ($F = 6.71$, $df = 2$, $p < 0.05$), indicating a tendency to be more cautious with a small section of the lake in the beginning and rating more extreme at the end when the entire lake was visible.

Non-Preferred Lakes

For Lake 2, the ANOVA did not reveal an effect of Condition in any of the Tasks. In Task 3, a main effect of Group was close to significance ($F = 2.645$, $df = 3$, $p = 0.06$) as well as the contrast between delusional patients and the control groups ($p = 0.06$). Apart from this task, no group differences were observed for the non-preferred lakes.

3.3.3 Variable Lakes (Task 2 and Task 5)

Both in Task 2 and Task 5, a main effect of Condition was observed for the variable lakes ($F = 19.916$, $df = 2$, $p < 0.001$, respectively $F = 11.040$, $df = 2$, $p < 0.001$). In Task 2, there was also a main effect of Group ($F = 4.765$, $df = 3$, $p < 0.05$). Post-hoc t-tests revealed that this was due to delusional patients rating significantly lower than healthy control subjects ($p < 0.001$) and non-delusional schizophrenia controls ($p < 0.01$).

The pattern of the initial data analysis looked promising and it appeared that delusional as well as non-delusional patients displayed a bias against disconfirmatory evidence, since they displayed smaller mean changes during the tasks than the other control groups. However, the differences between groups in mean rating changes from one extreme point to the other (e.g. fish 4 and fish 10) did not reach statistical significance.

For the complementary constant lakes, there was a main effect of Condition ($F = 11.065$, $df = 2$, $p < 0.001$, respectively $F=11.040$, $df =2$, $p < 0.001$) while no effect of Group was observed.

3.3.4 Bayesian Model

For the hypothesis of a BADE, Tasks 2 and 5 were of particular interest. In order to compare the performance of participants with the Bayesian model, likelihoods for the hypothesis that the fish actually comes from one of the lakes were calculated for both lakes. ‘Prior odds’ were acquired from the ratio of fish for the first fish and from prior inferential processes for all the remaining fish. The new ratio of fish in the lake and the color of fish in the fisherman’s hand after a catch formed the term ‘likelihood ratio’. Then, the ‘posterior odds’ were calculated. For the following fish, the ‘posterior odds’ formed the ‘prior odds’ for the inferential process of the next ‘catch’ (Fischoff & Beyth-Marom, 1983).

Trial (catch)	Task 2	Task 5
Fish **1**	50%:50%	50%:50%
Fish 2	40%:60%	60%:40%
Fish 3	22%:78%	78%:22%
Fish **4**	7%:93%	93%:7%
Fish 5	3%:97%	97%:3%
Fish 6	2%:98%	98%:2%
Fish 7	2%:98%	98%:2%
Fish 8	3%:97%	98%:2%
Fish 9	7%:93%	93%:6%
Fish **10**	22%:78%	78%:22%

Table 8: Task 2 and Task 5, likelihood ratios for Lake 1 to be (nominator)/not to be (denominator) the origin lake of the fish calculated after a Bayesian model

Figure 7 and Figure 8 illustrate response patterns for the variable lakes during the entire duration of Task 2 and Task 5 for all 4 experimental groups. Additionally, the Figures show the response patterns predicted by the Bayesian model.

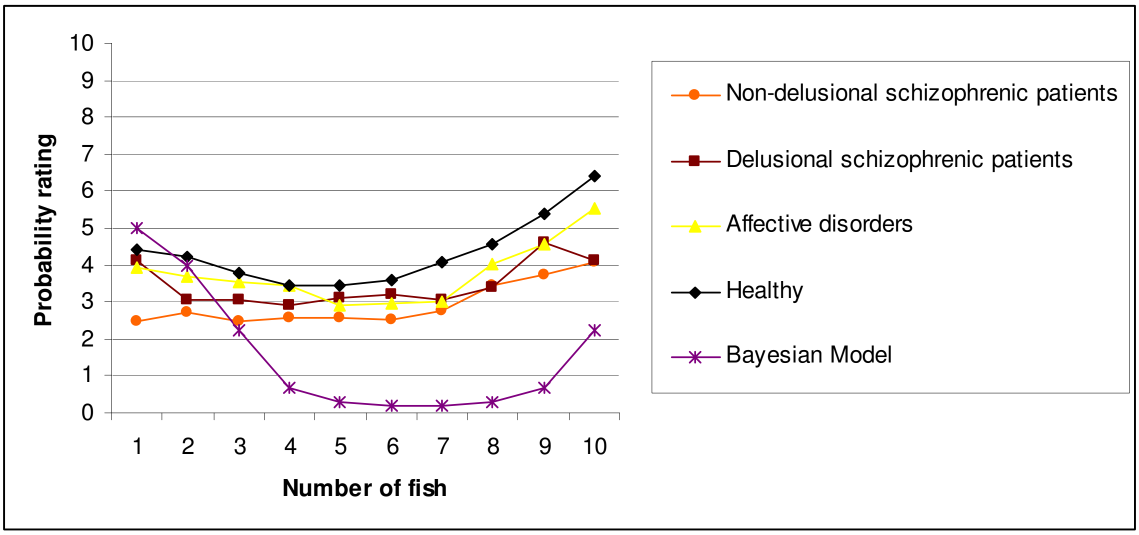

Figure 7: Response patterns and predictions of the Bayesian Model in Task 2

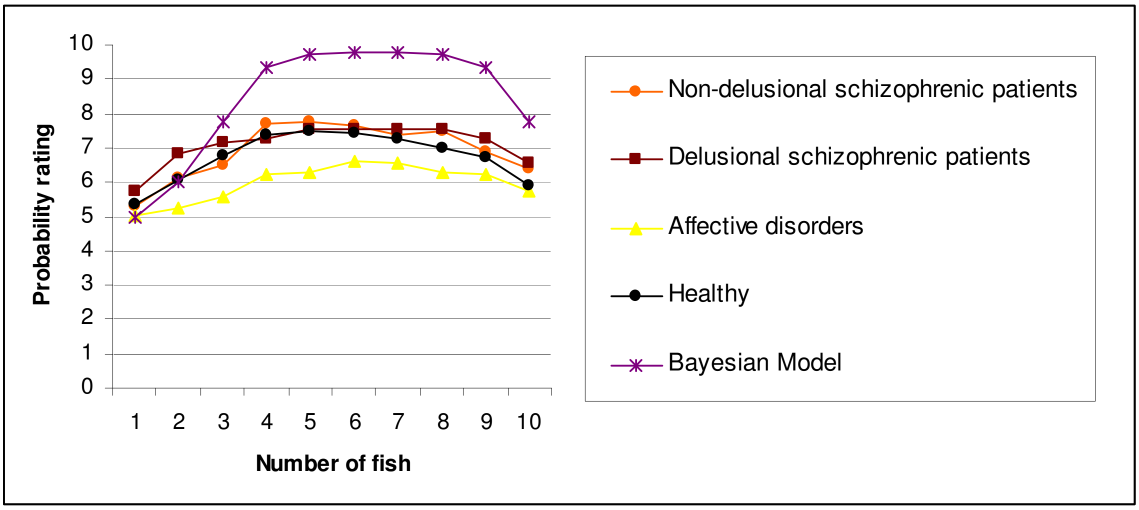

Figure 8: Response patterns and predictions of the Bayesian Model in Task 5

3.4 Discussion

In contrast to Experiment 1, a JTC effect was not detected. With a smaller section of the lakes visible, all groups consistently displayed more caution in the beginning, making more extreme ratings towards the end of the tasks, when larger portions of the lakes were visible. As such, the JTC effect appears to be dependent on low-ambiguity situations. Seeing only a small section of the lake, none of the groups felt ready to make firm, early decisions. The delusional group might consider several possible scenarios in this low-certainty situation, compared to Experiment 1. This finding supports a liberal acceptance (LA) hypothesis which predicts a diminished JTC effect in situations of higher ambiguity (Moritz et al., 2008). In all other studies that described a JTC response pattern (Huq et. al, 1988; Garety & Hemsley, 1991; Dudley & Over, 2003; Moritz et al., 2006b), participants were provided relatively complete information (e. g. fully visible jars of beads).

However, two manifestations of the LA account might be distinguished: in Experiment 1, delusional participants displayed higher acceptance of less probable response options, which is a positive manifestation of the LA bias as it has been observed using the TAT (Woodward et al., 2006). In the present experiment, we observed a negative manifestation of the LA bias in delusional individuals, where the JTC of Experiment 1 effect was inhibited by the higher ambiguity at the beginning of the task, comparable to the experiment of Moritz et al. (2008).

Put differently, it is not only the pure information that seems to be of significant for decision making, but also how *valid the information appears* to an individual and *how the information is weighted*. Seeing a small part of the lake with 4 or 5 fish obviously provides less certainty than seeing the entire lake with more than 60 fish. JTC appears to be a feature of delusional ideation which is dependent on the subject's perception how complete a piece of information is. It has often been argued that deluded schizophrenia patients make hasty decisions based on 'little evidence' (Garety & Hemsley, 1991; Garety and Freeman, 1999). In experiments where JTC was observed, delusional participants made premature decisions without requesting more potentially available information. So, with having all the information on the fish in the lakes, deluded patients use that available information and show a JTC pattern. Conversely, the do not respond hastily when the given information that only provides them with a lower grade of subjective certainty.

This provides further evidence for a *data gathering bias* rather than a basically biased probabilistic reasoning and supports previous findings (Garety and Freeman, 1999, p 131). In a clinical scenario, this would mean that a delusion-prone individual uses all information for inferential processes that he or she has available, but does not put effort in collecting more information and, importantly, testing the delusional hypothesis.

In our behavioral experiment, the amount of information was very easy to manipulate, reducing and enlarging the size of the visible section of the lakes. In clinical practice, *perception* might play a critical role in manipulating the amount of certain information, e.g., being more or less sensitive to certain stimuli. In a clinical scenario, a *preoccupied* patient might screen for information confirming his delusional ideas and gather information allowing a higher certainty level than for information that supports an alternative hypothesis.

In the experiment, the prediction of the *Bias Against Disconfirmatory Evidence* (BADE) could not be measured for abstract material; neither delusional nor non-delusional participants diagnosed with schizophrenia displayed lower flexibility to change their hypotheses in the face of disconfirmatory evidence.

Task 2 and Task 5 were designed to test whether or not delusional and non-delusional schizophrenia patients would less readily change their opinion in the face of changing evidence. The ratios of fish in the lakes changed and as such the likelihoods were expected to be estimated differently. In contrast to the hypothesis, statistical testing did not reveal significant group differences in the change of probability ratings. The finding of a Bias against Disconfirmatory Evidence (Woodward et al., 2006; Woodward et al., 2007) could not be replicated with more neutral material and the present sample.

One potential explanation might be that BADE only applies to material with scenic content and does not represent a flaw in pure probabilistic reasoning, and that the findings with the Thematic Apperception Task are due to a different mechanism. However, several shortcomings in the methodology might have lead to the negative finding. First, the sample size has to be considered rather small. Only 15 delusional and 23 non-delusional patients with schizophrenia were recruited, which might be a too small a sample size to pick up the effect that was observed in the study of Woodward et al. (2006) where 52 patients with schizophrenia were recruited and where the healthy group changed their initial ratings more than twice as much as deluded patients did. Future studies that aim to investigate a BADE effect in schizophrenia might recruit larger and statistically more powerful samples.

Second, several aspects of Bayesian reasoning were not reflected in the design which may have prohibited a BADE effect. To begin with, in both Task 2 and Task 5, the starting point for the variable lake was a ratio of 50%:50%, which actually did result in participants not being committed to the hypothesis that fish did or did not come from the lake, and presumably left participants in an indecisive state. The ratios were then manipulated, stepwise, in one direction, from the first to the fourth fish (e.g. down to a 20%:80 ratio in Task 2), giving growing evidence for one hypothesis. In the remaining six steps (from fish 5 to fish 10), evidence was gradually changed to the opposite hypothesis. Neither in the first part (from fish 1 to fish 4) nor in the second part (fish 4 to fish 10) did participants make ratings as extreme as in the other tasks with the same ratios. Furthermore, having only small visible sections of the lake might have provoked a cautious behavior which is reflected in the relatively small change in mean probability ratings in Task 2. This may also be the effect of a smaller amount of available information, as described above.

Moreover, with the present methodology, the four fish in the beginning of the task tended to confirm the initial hypothesis (H1). Hereafter, the ratios were stepwise manipulated in the direction of the opposite hypothesis (H2). However, following the Bayesian model, fish 5 and 6 also provided confirming evidence since the ratio still suggested the hypothesis that the participants would be committed to, reflected in the more extreme ratings in the Bayesian prediction (see Figure 5 and Figure 6), but also in the relative rigidity in the control groups. Only the last three fish can be interpreted as disconfirmatory information and might not be enough evidence to observe a significant between-group effect.

Regarding differences between the Bayesian model and actual ratings, the pure Bayesian model and its application in this experiment might be imprecise in representing a good model for inferential reasoning processes. Other aspects of reasoning might be taken into account in future. For example, the extent of information (in our example the size of the visible section of the lake) must be adequately represented in the model as a factor of new information. Also, this factor should be considered in light of the ‘prior odds’. In other words, it is not only pure information that should be regarded, but also the importance of new information in relation to ‘prior odds’.

To test the hypothesis of BADE in this neutral scenario, future studies might use a design where participants are presented with a relatively strong hypothesis in the beginning and then confronted with disconfirming information, eventually in bigger steps (with one picture in the task employed by Woodward et al. (2006) the interpretation changed generally and not gradually). As mentioned above, larger samples should be collected.

4 Experiment 3

4.1 Introduction

Delusions are associated with the well documented 'jumping to conclusions' (JTC) reasoning bias (Huq et al., 1988; Garety & Wesseley, 1991; Garety & Freeman, 1999; Fine et al., 2007). Delusions are an important, but not mandatory symptom for the diagnosis schizophrenia and, thus, samples tested for JTC type reasoning biases often consist of both delusional and non-delusional patients diagnosed with schizophrenia (Garety & Freeman, 1999). Besides more prominent symptoms such as delusions, schizophrenia is also characterized by deficits of executive function, memory and attention (e. g. Weickert et al., 2000) that might lead to jumping-to-conclusions response patterns on probabilistic reasoning tasks (Menon et al., 2006) and possibly confound the association of delusions with JTC. If reasoning biases are explicable by cognitive impairments in schizophrenia, JTC might be conceptualized as a *trait-like* feature of schizophrenia and not represent a *state-marker* of delusions.

In a recent longitudinal study, a JTC pattern in patients with schizophrenia (but also schizoaffective and bipolar disorder) was stable over time despite improving delusional symptomatology (Peters & Garety, 2005). In previous studies that tested schizophrenia patients with varying delusion scores, task performance was not correlated with delusion scores (e.g. Mortimer et al., 1996; Dudley et al., 1997; Moritz & Woodward, 2005) or dependent on methodological manipulations that interfere with schizophrenia associated deficits, such as working memory deficits (Menon et al., 2006). However, a meta-analysis of several independent studies employing variations of the beads task revealed that JTC is associated with delusions, but the impact of impaired cognitive functions in schizophrenia remained unclear (Fine et al., 2007).

Another approach that might provide clarification on the trait-vs.-state question is the testing of delusional individuals with no diagnoses of schizophrenia, since cognitive impairments contingent on schizophrenia can be ruled out. Non-schizophrenic individuals with delusional disorder have proven to perform no differently than delusional individuals with schizophrenia (Garety et al. 1991), but, on the other hand, there were also no differences between the delusional disorder group and psychiatric and non-psychiatric control groups.

Recently, van Dael et al. (2006) observed a 'dose-response relationship' between psychosis-liability level and task performance in an at-risk population and an even stronger relationship in currently deluded individuals, arguing for both a trait-like and a state-like character of probabilistic reasoning biases in schizophrenia.

Also, another longitudinal approach revealed probabilistic reasoning deviations in the deluded group which were not observed in remission (Brankovic & Braunovic, 1999), suggesting that certain reasoning deviations are *state-markers*. Notably, this study did not include explicit JTC measures.

In Experiment 1, delusional subjects were more hasty in their decisions than all other control groups (non-delusional individuals diagnosed for schizophrenia, psychiatric and healthy controls), suggesting that JTC is an effect of delusions and not significantly affected by the cognitive deficits of schizophrenia or general psychiatric liability and gives strong evidence that JTC may be a state-like feature of delusions. However, a longitudinal observation of delusional individuals might more accurately address the state-vs.-trait debate. As such, we included a sub-sample of psychiatric patients who changed in delusion scores from a longitudinal treatment study (Lecomte et al., 2008). In line with studies with the most consistent findings previously, we employed a variation of the beads task with a 'draws-to-decision procedure' (Garety & Freeman, 1999), using fish and lakes (see Experiment 1) instead of beads and containers.

A correlation of changes in delusion scores with changes in task performance would provide strong additional evidence for JTC as a state-like feature of schizophrenia, representing an integral factor in the formation of delusions.

4.2 Methods

4.2.1 Participants

We used a sub-sample from a longitudinal treatment study (Lecomte et al., 2008), comprising 19 patients with changes in delusion scores. All patients were aged between 18 and 35 years, fluent (verbally as well as reading and writing skills) in one of the official languages of Canada (English and French), currently presenting with persistent or fluctuating psychotic symptoms (defined as delusions or hallucinations appearing occasionally, such as in periods of stress), having consulted a mental health professional for psychotic symptoms (for the first time) during the last 2 years, and being treated by a psychiatrist and receiving antipsychotic medication. Individuals were only recruited once they had been discharged from the hospital and were considered 'stabilized' by their psychiatrist. Patients with an organic disorder or a previous intervention were not included.

Fourteen patients had an established DSM-IV-TR (APA, 2000) diagnosis of schizophrenia (paranoid: n=13, undifferentiated: n=1). One participant was diagnosed with schizoaffective disorder, and another was diagnosed with dysthymic disorder. The remaining three psychiatric patients were diagnosed for substance abuse (cannabis: n = 1, stimulants: n = 2). All diagnoses were obtained from experienced psychiatrists according to DSM-IV-TR criteria.

Eleven psychiatric patients were treated with *Cognitive Behavioral Therapy* (CBT, schizophrenia: n = 7, schizoaffective: n = 1, stimulant abuse: n = 1, dysthymic disorder: n = 1), and four patients completed *Symptom Management Training* (SM, schizophrenia: n = 2, cannabis dependence: n = 1, stimulant abuse: n = 1). Four schizophrenia patients were not treated with either of the above interventions. Four patients in the CBT group and one patient in the SM group failed to complete the respective therapy.

An overview of demographic information is given in Table 7.

Age(M±SD) at baseline	24.53 (6.04)
Gender (female/male)	(3/16)
Illness duration/years	2.69 (4.59)
Years of school education	12.95 (1.65)
BPRS baseline	45.16 (12.71)
BPRS after treatment	36.78 (8.67)

Table 9: sociodemographic and psychopathological characteristics of the sample. Mean values are accompanied by standard deviations (in brackets).

In order to estimate symptom severity, all participants underwent a short interview and were assessed by the Brief Psychiatric Rating Scale (BPRS, Ventura et al., 1993) at both baseline (Time 1) and the second testing session (Time 2). The BPRS is an easily applicable psychiatric rating scale that consists of 24 symptom constructs, each ranging from 1 (‘not present’) to 7 (‘extremely severe’).

Delusion scores were assessed by means of a computation of BPRS 8 (‘grandiosity’), BPRS 9 (‘suspiciousness’) and BPRS 11 (‘unusual thought content’). Fifteen participants improved from time 1 to time 2 (M = -1.689, SD = 1.012), four patients displayed higher delusion scores at time 2 (M = 0.917, SD = 0.31). Furthermore, six individuals displayed decreases in hallucinations (BPRS item 10; Time 1 M = 4.67, Time 2 M = 1.67) and 4 displayed increases (Time 1 M = 2.00, Time 2 M = 4.75), 7 displayed decreases in depression (BPRS item 3; Time 1 M = 3.57, Time 2 M = 1.57) and 3 displayed increases (Time 1 M = 2.00, Time 2 M = 3.67), and 2 displayed decreases in thought disorder (BPRS item 15; Time 1 M = 3.00, Time 2 M = 1.00).

4.2.2 Experiment

A longitudinal study was conducted, employing the same task before (Time 1) and after (Time 2) the treatment intervention. The task was administered as part of a longitudinal psychiatric treatment study (Lecomte et al., 2008). The mean duration of treatment was M = 141 days (SD = 46d). The minimum duration was 12 weeks.

Materials

In order to elicit a JTC pattern, a variation of the ‘beads task’ (Huq et al., 1988) was employed, using a ‘draws-to-decision’ procedure (Dudley et al., 1997a/b; Fear & Healy, 1997; Moritz & Woodward, 2005; Peters & Garety, 2006). As for Experiment 1, fish and lakes were employed.

A total of four tasks were administered. In all tasks, the proportions were 60%/40% black and white fish respectively and the opposite ratio in the other lake. The lake on the left was labeled 'Lake A', and the lake on the right was labeled 'Lake B'. One by one, a series of fish was ‘caught’ by a fisherman. The participants were instructed that the fisherman would always fish from the same lake, and that after each catch, the fish would be put back into the lake so that the proportions of fish did not change across the task. Task comprehension was checked by control questions. After each catch, participants were asked by the experimenter whether they had come to a decision or would like to see another fish (“Do you want to see more fish or have you decided?”). As soon as the participant made a decision, the task was terminated.

Task 1 and 2 were designed to test for JTC in situations with varying working memory load. In Task 1, the ratios of fish in the lakes were explicitly mentioned by the experimenter in order to rule out a high memory load. In Task 2, the ratio was not mentioned explicitly, representing a high WM condition. In Task 3 and 4, there was a monetary reward for correct responses in order to introduce a motivational component. In Task 3, participants were rewarded $0.25 for a correct response, independent of the number of fish they required. In Task 4, the amount of money was increased to $5.

In Task 1 and Task 3, Lake A contained more black fish. In Task 2 and Task 4, Lake A contained more white fish.

Sequence of Fish

The four tasks presented fish in the following order (B = black, W = white):

Task 1: B-B-W-B-W-W-B-W-B-B

Task 2: W-W-B-W-B-B-W-W-B-W

Task 3: B-B-W-B-W-B-W-B-W-B

Task 4: W-W-B-W-B-W-W-W-B-B

These sequences are more ambiguous than in previous studies using a 'draws to decision' procedure (Moritz & Woodward, 2004; Huq et al., 1988) and than the sequences in Experiment 1 and Experiment 2. As such, participants were expected to request more beads overall and that this would allow a more sensitive measure of changes in the requested number of beads.

4.3 Results

4.3.1 Change in Delusion Scores

Delusion scores were assessed by means of BPRS 8 ('grandiosity'), BPRS 9 ('suspiciousness') and BPRS 11 ('unusual thought content'). For our sample, the mean delusion score (average over BPRS 8, 9 and 11) was M = 3.35 (SD=1.39) at baseline and M = 2.21 (SD = 1.27) after the treatment courses, reflecting a significant improvement in delusional scores ($p < 0.01$). However, there were four patients that displayed higher delusion scores at time 2.

4.3.2 Change in Requested Beads (JTC)

The mean number of requested fish is presented in Table 10.

A 2 x 4 ANOVA was conducted with session (Time 1 and Time 2) and task (Task 1, 2, 3, 4) as within-subject factors. There was a Session effect ($F(1,18) = 5.79$; $p < 0.05$), but no effect of Task ($F(5,51) = 0.83$; $p = 0.48$) or Session by Task interaction ($F(3,54) = 0.57$; $p = 0.64$).

Task	Time 1 Mean(SD)	Time 2 Mean(SD)	Sig.
Task 1: lower cognitive load	7.32	5.89	$p < 0.05$
Task 2: higher cognitive load	7.11	5.74	$p < 0.10$
Task 3: $0.25 reward for correct answer	6.84	5.58	$p < 0.05$
Task 4: $5.00 reward for correct answer	6.74	5.74	$p < 0.10$

Table 10: Change in number of requested fish from Time 1 to Time 2

4.3.3 Correlation of Delusion Scores With Task Performance

In order to address the state-vs.-trait question of JTC in delusions, Spearman rank correlation coefficients were employed to asses the correspondence between changes in delusions scores and changes in the number of requested fish. Table 8 displays an overview over correlation analyses. There were significant negative correlations of the change in delusion severity with task performance for Task 1 and Task 4. To illustrate, improvement on the delusions scale was associated with more requested draws until a decision was reached and vice versa. In Task 2 and 3, changes in delusions scores were also negatively correlated with requested beads, but did not reach a statistically significant level. Closer consideration revealed that patients with higher delusion scores at Time 2 requested fewer draws (e.g. in Task 1, the mean change in draws to decision was $M = -0.375$, $SD = \pm 4.5$) than patients who improved on delusions (for Task 1, the mean was also negative, $M = -.08$, $SD = \pm 1.9$ indicating less draws to decision overall).

	Spearman's correlation
Task 1: lower cognitive load	-.484*
Sig. (2-tailed)	p < 0.05
Task 2: higher cognitive load	-.354
Sig. (2-tailed)	p = 0.1; p = 0.06 (1-tailed)
Task 3: $0.25 reward for correct answer	-.357
Sig. (2-tailed)	p = 0.1; p = 0.06 (1-tailed)
Task 4: $5.00 reward for correct answer	-.550*
Sig. (2-tailed	P < 0.05; p < 0.01 (1-tailed)

*Table 11: Spearman Correlation of change in delusion scores (BPRS 8, 9 & 11) and Task performance. * = significant at the 0.05 level (2-tailed).*

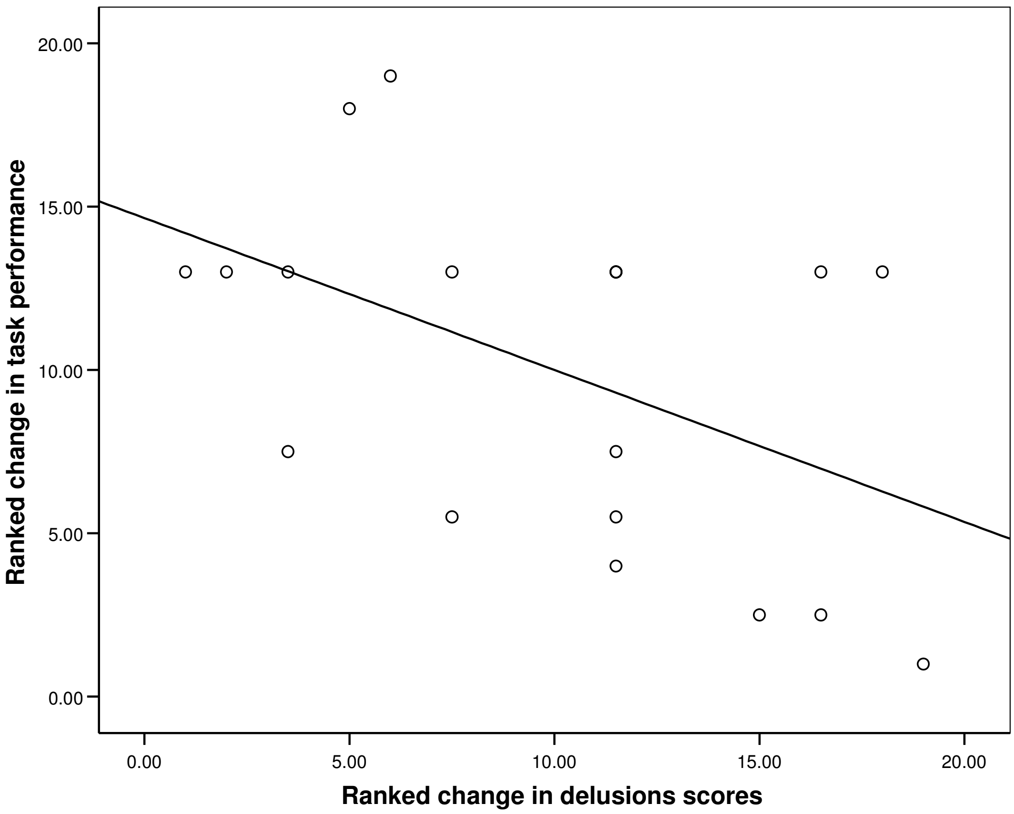

Figure 9: Ranked scatter Plot, Task 1

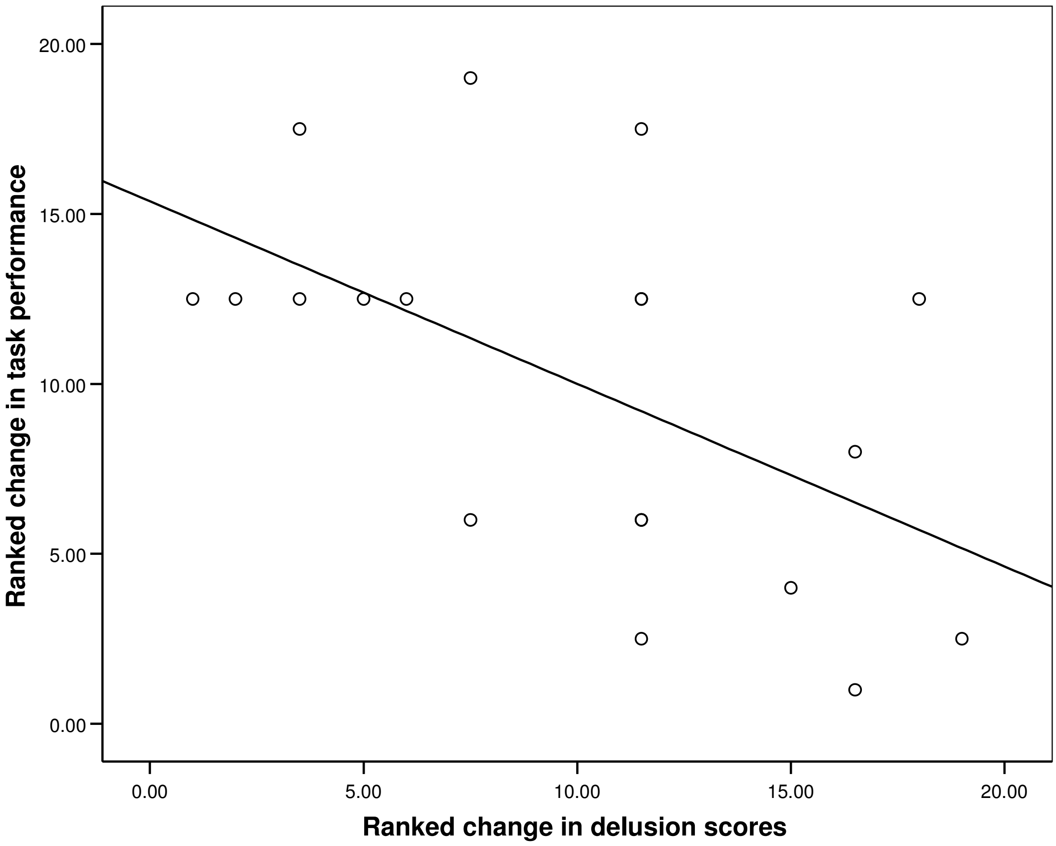

Figure 10: Ranked scatter Plot, Task 4

4.4 Discussion

The results indicate a negative correlation of task performance (requested beads) and development of delusion scores over time. So, the hypothesis of a state-like reasoning bias of JTC was confirmed. To illustrate, if patients improved in delusion scores over time, this was associated with a tendency to request more draws to a decision and vice versa. The correlation was significant for the memory assisted version (Task 1) and for the $5-bet condition (Task 4). In the remaining two conditions, the correlation did not reach statistical significance but displayed the same directionality. While the JTC bias has previously been shown to be counteracted by higher working memory demands and influenced by motivational manipulations (Menon et al., 2006), our manipulations might have been too weak to have a measurable impact on task performance.

In Experiment 1, low delusion scores were not associated with JTC while individuals with high delusion scores displayed a JTC bias. In this experiment the relationship of delusion scores with task performance was revealed in the same individuals at two different points in time with different symptom severity. This provides further evidence for a state-like character of the JTC reasoning style.

The present study supports other studies that observed a JTC bias independent of the impact of the cognitive impairments associated with schizophrenia and other psychiatric diseases (Van Dael et al., 2006, Moritz & Woodward, 2005), and extents those findings by indicating its longitudinal design. In contrast to our findings, a similar longitudinal study, Peters and Garety (2005) found no change in response style using a 'draws to decision' measure with previously deluded patients with schizophrenia in remission. In this study, only patients who improved in delusion scores were included, while in our sample, patients with increasing delusional severity displayed a larger decrease in requested fish than improving patients, who showed an increase in requested fish. This might be due to a ‘practice effect’, which was also reported in the study of Peters & Garety (2005). The finding that delusional patients differed from all control groups at baseline and were equal with all control groups in remission might also be interpreted as a diminished JTC effect at the second testing time: relative to the control groups, delusional patients requested more fish in remission compared to in the acutely delusional stage.

Some limitations of the present study must be acknowledged. First, the study must be regarded as a pilot study due to the small sample size. Second, the sample was not randomized for treatment strategies, so specific treatment effects of CBT or SM could not be ruled out. Third, a potential practice further limits the power of the actual finding. Finally, the design of the present paradigm did not allow a clear demonstration of the JTC bias.

Further studies might aim for larger sample sizes for both non-schizophrenia and schizophrenia groups, match for treatment (e.g., CBT) and demographic parameters, measure multiple reasoning abnormalities in the delusional and a non-delusional stage, record hypothesized cognitive deficits associated with schizophrenia (working memory deficits, attention deficits) and evaluate the effect of reasoning abnormalities in delusions in a multivariate approach.

5 General Discussion and Conclusion

Starting with the influential work of Jaspers (1913), there was a strong phenomenological line of research in the field of psychosis and delusions in Germany. In contrast to neurotic symptoms, delusions as a core psychotic symptom were conceptualized to be un-understandable phenomena, based upon an unidentifiable somatic ‘process’. The concepts of succeeding psychiatrists at the prominent Heidelberg University Psychiatric Clinic, e.g. Kurt Schneider and Walter von Baeyer, claimed that delusions arise from basically disturbed psychological processes, leading to the separation of psychotherapy from the treatment of psychosis. On the other hand, psychodynamic approaches, following the tradition of Sigmund Freud, have underlined the role of psychotherapeutic interventions in psychotic disorders.

With its beginning in Great Britain in the 1980s, a cognitive-neuropsychiatric research branch evolved, developing concrete and testable models of the formation and maintenance of delusions, and offered potential explanations of delusions complementary to the influential ideas of German phenomenologists and the psychodynamic conceptualizations of the 20th century.

Several cognitive biases are reported in psychotic disorders with delusions. Besides deviances in attributional style (Bentall et al., 1994), theory of mind deficits (Frith & Corcoran, 1996) and low self-esteem (Bentall et al., 2001), there is consistent evidence for deviations in probabilistic reasoning (Moritz & Woodward, 2005), resulting in a data gathering bias (Freeman, 2007). These biases are thought to underpin the emergence and the maintenance of the disorders, particularly delusions (Bell et al., 2006).

The present thesis investigates a range of probabilistic reasoning biases and their potential relationship to one another. A new paradigm was introduced, using a graded estimates procedure instead of the draws-to-decision procedure that has been predominantly employed in previous studies (Garety & Freeman, 1999). In Experiment 1, using a ‘graded-estimates’ procedure, a tendency of deluded patients to jump to conclusions (JTC) was found for highly probable response options. Distinguishing between high and low probability options is not possible with a draws-to-decision design, so the graded estimates procedure might represent a new resource for the investigation of cognitive systems underlying delusions. In line with previous findings, a liberal acceptance (LA) account was supported as patients with high delusion scores more readily accepted low probability response options. However, data analysis revealed that both phenomena are associated with delusions, but do not share common underpinnings, at least not in this sample that has limited statistical power. The manipulation of ambiguity in Experiment 2, with smaller sections of the lakes visible, revealed another interesting aspect of the JTC bias in this ‘graded-estimates’ procedure paradigm: JTC-type probability ratings require low ambiguity. As such, the tendency towards hasty decisions appears to depend on a subjective feeling of certainty.

Experiment 2 was designed to test the hypothesis of a Bias Against Disconfirmatory Evidence (BADE) with neutral task material. Unlike the previously employed scenic paradigm, where the second piece of information completely changed the basic interpretation of the comic strip series (Woodward et al., 2006), the material in this experiment was abstract. Also, contrary evidence was given gradually and stepwise, and the first catches after the most extreme ratio distribution (fish 4) also confirmed the initial hypothesis. Only for the very last catches was there any ‘disconfirming’ evidence. This paradigm failed to demonstrate a BADE with this neutral task material. One potential explanation is that BADE applies to scenic content, exclusively. Alternatively, a different ratio-distribution among the lakes with clear disconfirming evidence earlier in the task might represent a better method to investigate BADE in neutral task material.

Experiment 3 provides strong support that the JTC decision-making style is a state-like feature of delusions, independent of other cognitive impairments. Despite the small sample size and certain methodological shortcomings (see discussion, Experiment 3), this is the first study with a longitudinal design that displays an association of delusional ideation with JTC. So, the JTC reasoning style is not confounded by varying cognitive impairments in different subjects, as the longitudinal design provides intra-individual comparisons.

In summary, patients with delusions, whether they are diagnosed with schizophrenia or other psychotic disorders with delusions, display abnormalities in probabilistic reasoning that might contribute both to the formation and maintenance of delusions. The close correlation of these abnormalities with delusional scores demonstrates that it is not general cognitive impairments, but specific cognitive alterations in reasoning and decision-making processes that may contribute to the emergence and maintenance of delusions. Regarding probabilistic reasoning biases in general, effects sizes are rather small, and studies with larger samples are needed to allow a more accurate examination of the extent to which single reasoning biases interfere with each other. Additionally, larger samples will provide more statistical power for multivariate analysis.

As stated previously, probabilistic reasoning abnormalities are among other factors that form an integrative model of delusions (Freeman, 2007). While JTC and LA may play a facilitatory role in the formation of new delusional systems, BADE might contribute to the maintenance of already present delusional ideas. The more accurate characterization of neuropsychiatric phenomena and the investigation of their neural underpinnings might ultimately provide implications for biological and psychotherapeutic treatment.

In the past, psychotic episodes and positive symptoms of schizophrenia were categorized as endogenous and thus not treatable with psychotherapy (Walker, 1991). Instead, there was a predominance of psychopharmacological treatment. However, in the last decade, there have been attempts to treat psychosis with Cognitive Behavioral Therapy (CBT, Terrier & Wykes, 2004; Gaudiano, 2006). Still, use of CBT for psychosis is an exception rather than clinical routine and the efficacy of psychological interventions in psychotic symptoms is unclear.

Recently, a Metacognitive Training concept (MCT) has been proposed (Moritz & Woodward, 2007a) which is based on the presence of reasoning deviations and other cognitive characteristics in psychosis. MCT is a program designed for psychosis patients that attempts to transfer knowledge about basic cognitive alterations into clinical practice. It comprises several reasoning biases, namely (1) self-serving bias and depressive attributional style, (2) JTC, (3) BADE, (4) theory of mind deficits, (5) Need for Closure (NFC), (6) Liberal Acceptance (LA) and (7) mood and self-esteem.

MCT is employed in the frame of a psychotherapeutic group intervention comprised of eight sessions or modules. In single sessions, patients are supposed to first learn about current research findings by means of psychoeducation. Once patients are familiar with the target domain (e. g. JTC or theory-of-mind errors) and the significance for the clinical manifestations of psychosis in the patients' lives is explained, several exercises that aim to correct those biases are administered. Although patients are encouraged to vivify the sessions with examples from their own symptoms, the individual and personal psychotherapeutic treatment is not part of MCT, but should be restricted to therapeutic one-to-one sessions.

The preliminary results of MCT programs in patients with schizophrenia are promising. Thus, MCT possibly represents a useful part in multimodal treatment programs of schizophrenia and other psychotic disorders. However, the long-term effects of MCT have not yet been investigated (Moritz & Woodward, 2007a).

To conclude, the current thesis contributes to the characterization of reasoning abnormalities associated with delusions, and these abnormalities may be counteracted by psychotherapeutic interventions, e.g. using the aforementioned treatment program MCT. Additionally, the investigation of the underlying neural mechanisms of the described reasoning abnormalities might improve psychopharmacological interventions. However, these findings and putative treatment options only address parts of the complex nature of psychotic illnesses such as schizophrenia. Psychotic illnesses are disabling disease entities with a chronic illness course, starting with subtle impairment, eventually resulting in chronic clinical deterioration (Lieberman, 1999) and ultimately leading to diminished social and functional capacity. Current research on reasoning abnormalities in psychosis, including the present three experiments, represents only a small step towards improving treatment for patients who suffer from schizophrenia and related illnesses.

6 Zusammenfassung

Wahnhafte Überzeugungen gehören zu den häufigsten und prominentesten Symptomen einer Person mit einer schizophrenen Psychose, insbesondere bei Vorliegen des paranoiden Subtypus. Daneben wird Wahnsymptomatik z.B. bei schizoaffektiven Erkrankungen und affektiven Psychosen, aber auch bei Substanz-bezogenen Störungen oder im Rahmen neurologischer Erkrankungen beobachtet.

Die Ätiologie wahnhafter Symptomatik rief in der Geschichte großes Interesse bei Klinikern und Wissenschaftlern hervor. Dabei beeinflusste Jaspers Theorie des Wahns in der *Allgemeinen Psychopathologie* (Jaspers, 1913) die internationale Wahnforschung nachhaltig. Jaspers ging davon aus, dass Wahn auf „physisch-psychotische Hirnprozesse" zurückginge, die ein ungerichtetes „sinnloses Durcheinander" psychischer Funktionen verursachten. Auch andere einflussreiche deutschsprachige Psychiater, darunter Kurt Schneider und Walter von Baeyer, vermuteten eine biologisch verwurzelte generelle Störung psychischer Funktionen als Ursache von Wahnphänomenen, die einer logischen Systematik entbehrten und somit psychotherapeutisch nicht zugänglich seien. In Ergänzung dazu existierten psychodynamische Konzepte, Sigmund Freud z.B. sah in wahnhafter Symptomatik einen Abwehrmechanismus gegen homosexuelle Triebe.

Ausgehend von Großbritannien ist seit den 80-iger Jahren des vergangenen Jahrhunderts Wahn mit Methoden der kognitiven Neuropsychologie untersucht worden. Dabei sind eine Reihe von konkreten und testbaren Einzelmodellen (s.u.) entwickelt worden, die bei der Entstehung und Aufrechterhaltung von Wahnsymptomatik eine Rolle spielen könnten.

Dazu zählen Besonderheiten im schlussfolgernden Denken von wahnhaften Patienten, insbesondere bei Vorliegen der Diagnose Schizophrenie. Das Standard-Paradigma, um solche Abweichungen zu untersuchen, ist eine probabilistische Entscheidungsaufgabe, das so genannte Kugel-Paradigma ('beads task', Huq et al., 1988). Am häufigsten und besten ist die Neigung zu voreiligen Entscheidungen ('Jumping-to-conculsions'; JTC) bei wahnhaften Patienten gezeigt, und wird übereinstimmend als zu geringe Informationssammlung bei Entscheidungsfindungen interpretiert. Neben dieser viel verwendeten Aufgabenvariante, bei der das individuelle Ausmaß an Informationssammlung gemessen wird ('draws-to-decision' procedure), wurde das Paradigma unter anderem so variiert, dass für jeden Schritt Entscheidungswahrscheinlichkeiten registriert werden können ('graded-estimates’ procedure). So ist es möglich zu untersuchen, ob sich voreilige Entscheidungen auf Unterschiede in der Einschätzung von Wahrscheinlichkeiten zurückführen lassen. Dies führte zu der Formulierung einer zweiten Abweichung im schlussfolgernden Denken bei wahnhaften Patienten: der Liberal Acceptance Bias (LA, Moritz & Woodward, 2004). Dieses Modell besagt, dass wahnhafte Patienten tendenziell weniger wahrscheinliche Antwortalternativen eher als möglich ansehen als gesunde Probanden.

Eine weitere Aufgabenvariante, in der Bilder verwendet wurden, deren inhaltliche Bedeutung sich schrittweise mit der Zugabe weiterer Bilder änderte, diente der Erfassung der geringeren Änderungsbereitschaft nach einer bereits getroffenen Entscheidung bei Patienten mit Wahn, und führte zur Formulierung der 'Bias Against Disconfirmatory Evidence’ (BADE, Woodward et al., 2006).

All diese Einzelmodelle erfassen Besonderheiten des Denkens von wahnhaften Patienten im Sinne des Bayes-Theorems von bedingten Wahrscheinlichkeiten, auch 'Umkehrinduktion' genannt, ein gängiges mathematisches Modell im Bereich von Entscheidungen bei Unsicherheit ('Reasoning under uncertainty', Kahneman 2003).

Es wird postuliert, dass die oben beschriebenen Auffälligkeiten im schlussfolgernden Denken wahnhafter Patienten zusammen mit weiteren kognitiven Auffälligkeiten (s.u.) eine Rolle bei der Ätiologie von Wahnsymptomen spielen, da sie die Wahrscheinlichkeit falscher Schlüsse erhöhen und folglich die Entstehung und Beibehaltung wahnhafter Überzeugungen begünstigen.

In der vorliegenden Arbeit werden die bereits beschriebenen Auffälligkeiten bei wahnhaften Patienten und deren Verhältnis zueinander näher untersucht.

In den ersten beiden Experimenten wurde ein neues Paradigma eingeführt. Ein Fischer, der zwischen zwei Seen steht, fängt schwarze oder weiße Fische. Der Proband soll anhand der Reihenfolge von gefangenen Fischen sowie dem Verhältnis von Fischen in den Seen entscheiden, aus welchem Seen der Fischer seine Fische fängt, wobei die Probanden so instruiert sind, dass alle Fische aus dem gleichen See stammen. Nach einem Fang würde er die Fische wieder in den See werfen, so dass sich an der absoluten Anzahl von Fischen nichts ändert. Nach jedem Fang wurden die Probanden aufgefordert, anhand einer Skala von 0 bis 10 für jeden See die Wahrscheinlichkeit anzugeben, dass der gefangene Fisch aus diesem stammt. Die Ratings waren unabhängig, mussten also z.B. nicht in der Summe 10 ergeben. Dies entspricht einer 'graded-estimates procedure' mit unabhängigen Ratings.

Die simultane Erfassung der Ratings für hoch- und niedrigwahrscheinliche Antwortalternativen in Experiment 1 ermöglichte die gleichzeitige Untersuchung der Phänomene JTC und LA, mit dem Ziel, die Beziehung der beiden Phänomene untereinander zu verstehen. Es nahmen vier verschiedene Populationen an der Untersuchung Teil: Wahnhafte Patienten mit einer Schizophreniediagnose (DSM-IV-TR), Schizophrenie-Patienten ohne Wahnsymptome, psychiatrische Patienten ohne Schizophrenie (zum Großteil Bipolarstörung) sowie eine Kontrollpopulation ohne psychische Störungen. Dadurch sollte sichergestellt werden, dass die beobachteten Phänomene nicht mit anderen Voraussetzungen als Wahn zusammenhängen.

In Experiment 1 wurde erwartet, dass Psychosepatienten mit aktueller Wahnsymptomatik bei hochwahrscheinlichen Antwortalternativen zu schnelleren Schlussfolgerungen (JTC, gemessen an Ratings > 9 nach dem ersten Fisch) kommen, während sie bei weniger wahrscheinlichen Antwortalternativen höhere Ratings als die übrigen Probanden aufweisen (LA).

Zum einen wurde die JTC - Hypothese bestätigt, und zwar spezifisch für Patienten mit Wahnsymptomen. Dies erweitert das Verständnis von JTC, da bezüglich der Entscheidungsgeschwindigkeit in früheren Studien zum Teil kein konsistenter Gruppeneffekt zwischen wahnhaften und nichtwahnhaften Psychosepatienten beobachtet wurde. Das hier erstmals angewendete Paradigma erwies sich als eine sensitive Möglichkeit, die JTC - Bias zu demonstrieren.

Zum anderen konnte die LA - Bias ebenfalls beobachtet werden, wiederum ausschließlich bei wahnhaften Psychosepatienten, die Antwortmöglichkeiten mit geringen Wahrscheinlichkeiten konsistent eher für möglich hielten als die Vergleichsgruppen.

Sowohl für JTC als auch für LA ergaben sich signifikante Gruppeneffekte beim Vergleich von aktuell wahnhaften Psychosepatienten und nicht-wahnhaften Patienten und Probanden. Diese Ergebnisse sprechen dafür, dass die Auffälligkeiten im Denken von Psychosepatienten als wahnspezifische State-Marker und keine generellen Trait-Marker von Psychoseerkrankungen zu verstehen sind. In der statistischen Auswertung ergab sich jedoch keine klare Korrelation der beiden Phänomene JTC und LA, so dass die beiden Phänomene voneinander unabhängige Besonderheiten in Denkprozessen psychotischer Patienten darstellen.

Im Experiment 2 wurde die Hypothese der 'Bias Against Disconformatory Evidence' (BADE) in abstraktem Aufgabenmaterial getestet. Durch die schrittweise Vergrößerung des sichtbaren Segmentes eines Sees veränderte sich das Verhältnis von schwarzen und weißen Fischen. So wurde die Entscheidungsgrundlage manipuliert und getestet, ob Probanden eher auf ihren anfangs gebildeten Hypothesen verharren oder ihre Überzeugungen auf Grundlage der Mehrinformationen verändern.

Hier wurde erwartet, dass Psychosepatienten mit Wahn ihre Ratings nach den ersten Fischen gegenüber den Kontrollgruppen weniger stark verändern trotz des sich stetig verändernden Verhältnisses von schwarzen und weißen Fischen (BADE) durch vergrößerte Seesegmente. Außerdem wurde erwartet, dass sich wiederum nach dem ersten Fisch mit einer Farbverteilung analog zum Experiment 1 wahnhafte Patienten einen JTC-Effekt aufweisen (Ratings > 9).

Bezüglich der Flexibilität, auf neue Informationen zu reagieren, wurden keine Gruppeneffekte beobachtet. Ein Grund könnte sein, dass BADE nur für szenisches Testmaterial gilt, nicht aber für ein abstraktes mathematische Paradigma. Daneben ist festzuhalten, dass in dem Paradigma in der Nachbetrachtung methodische Mängel auffielen. So wurde als Anfangsbedingung in einem See ein Verhältnis von Fischen von 50%/50% vorgegeben, was keine Antwortmöglichkeit begünstigte. In den folgenden Schritten wurde die Wahrscheinlichkeit zunächst in eine Richtung manipuliert und kehrte sich erst nach dem sechsten Schritt um. 'Disconfirmatory Evidence' im eigentlichen Sinne wurde lediglich in den letzten vier Schritten des Experiments administriert. Daneben ist die geringe Stichprobengröße zu erwähnen. Ebenfalls entgegen der ursprünglichen Hypothese fiel auf, dass JTC bei gleichen Farbverteilungen von Fischen wie im Experiment 1, jedoch kleineren See-Segmenten mit weniger Fischen, nicht vorhanden war. Somit scheint der JTC - Effekt darauf zu beruhen, dass bei wahnhaften Psychosepatienten die Antwortmöglichkeit sicher erscheinen sollte, um zu einer schnellen Entscheidung zu führen. Dies unterstützt die Hypothese der LA-Bias, die auch postuliert, dass der JTC-Effekt durch eine erhöhte Ambiguität abgeschwächt wird (Moritz et al., 2007).

Bei der häufigen Replikation von JTC bei unterschiedlichen Stichproben, am deutlichsten aber bei Psychosepatienten mit aktueller Wahnsymptomatik, stellt sich die Frage, ob Auffälligkeiten im schlussfolgernden Denken aus der Gruppe von JTC bei Patienten mit wahnhaften Störungen einen generellen Risikofaktor darstellen, also so genannte Trait-Marker, zu denen auch generelle kognitive Beeinträchtigungen bei Psychosepatienten zählen, oder spezifische mit Wahnsymptomatik assoziierte Phänomene, so genannte State-Marker darstellen.

Dafür wurde eine prospektive longitudinale Studie (Experiment 3) durchgeführt, bei der Psychosepatienten zu zwei unterschiedlichen Zeitpunkten mit jeweils unterschiedlich ausgeprägter Wahnsymptomatik mit einem 'Beads-Task'-Paradigma untersucht wurden, allerdings mit einer 'draws-to-decision'-Variante.

Es wurde erwartet, dass Patienten bei stärkerer Ausprägung von Wahnsymptomatik, gemessen an charakteristischen Items des BPRS (Brief Psychiatric Rating Scale), eine größere Neigung zu voreiligen Schlussfolgerungen (JTC) aufweisen.

Tatsächlich korrelierte die Ausprägung der Wahnsymptomatik mit der Bereitschaft zu schnellen Entscheidungen, was eine Konzeptualisierung der Auffälligkeiten im Denken von Psychosepatienten als wahn-spezifischen State-Marker unterstützt. Die geringe Stichprobengröße limitiert die Aussagekraft dieser Studie. Dennoch ist diese Studie die bislang einzige, bei der JTC in longitudinalem Design als ein mit Wahn assoziiertes Phämonen dargestellt werden konnte.

Insgesamt trägt die vorliegende Arbeit zum besseren Verständnis dieser als wahn-spezifisch zu verstehenden Auffälligkeiten im abstrakt-logischen schlussfolgernden Denken von Psychosepatienten bei.

Neben Abweichungen in probabilistischen Entscheidungsparadigmen sind weitere kognitiv–neuropsychologische Auffälligkeiten bei wahnhaften Patienten beschrieben, die sich als Einzelphänomene zu einem integrierten Modell zur Ausbildung und Aufrechterhaltung von Wahnsymptomatik zusammenführen lassen. So neigen wahnhafte Patienten dazu, Ursachen für positive Ereignisse internal und Ursachen für negative Ereignisse external zu attribuieren (Fear et al., 1997). Daneben verfügen wahnhafte Patienten über eine verminderte Fähigkeit, mentale Zustände anderer Personen zu repräsentieren (‚Theory of Mind', Frith & Corcoran, 1996). Bezüglich der Abweichungen im schlussfolgernden Denken wurde eine Ambiguitätsintoleranz als Entstehungsmechanismus für voreilige Entscheidungen vermutet (Colbert & Peters, 2002). Undurchsichtige und widersprüchliche Situationen scheinen für wahnhafte Patienten mehr als für eine Normalpopulation unangenehm zu sein, so dass nach einer schnellen Interpretation gestrebt wird. Im Übrigen wurde postuliert, dass Wahnvorstellungen eine den Selbstwert schützende Funktion haben könnten (Bentall et al., 1994), wobei empirische Untersuchungen zu dieser Hypothese widersprüchlich sind, und somit die Schutzfunktion von Wahn in Bezug auf Selbstwertgefühl umstritten bleibt (Garety & Freeman, 1999).

Unter Berücksichtigung dieser beschriebenen Einzelphänomene wäre die Entstehung von Wahnphänomenen wie folgt modellhaft vorstellbar: Bei ungewöhnlichen, bedrohlichen oder negativen Ereignissen (Stress) mag es durch den typischen Attributionsstil dazu kommen, dass eine psychosekranke Person external anderen Personen die Ursache für diese Ereignisse zuschreibt, was die Entstehung (paranioder) wahnhafter Überzeugungen begünstigen würde. Eine Neigung zu voreiligen Schlussfolgerungen und Defizite in Theory-of-Mind Fähigkeiten erhöht die Wahrscheinlichkeit solcher Fehlattributionen um ein weiteres. Ebenfalls könnten die externalen Attributionen negativer Ereignisse protektive Wirkung für das Selbstwertgefühl bedeuten. Die Tendenz, weniger Information für eine Entscheidungsfindung zu sammeln und selektiv an sich primär aufdrängenden Hypothesen festzuhalten, mag die Wahnphänomene im Weiteren aufrechterhalten (Freeman, 2007). Dabei könnte die erniedrigte Akzeptanzschwelle (LA) dazu führen, dass eine oder mehrere nicht stimmige Hypothesen zur Erklärung des Stressors weiter in Betracht gezogen werden und sich ergänzen.

Auf der Grundlage dieser ätiologisch bedeutsamen Einzelmodelle könnte in Zukunft versucht werden, Wahnsymptomen auf psychotherapeutischem Wege entgegen zu wirken. Hierzu gibt es bereits ein Therapieprogramm (Metakognitives Training, Moritz & Woodward, 2007a). Die Pilotstudien verliefen viel versprechend. Unter einem psychoedukativen und präventivem Ansatz lernen Patienten an plastischen Beispielen, wie beispielsweise voreilige Entscheidungen oder eine erniedrigte Akzeptanzschwelle das Entstehen einer Wahnidee begünstigen. Damit verbunden ist die Hoffnung, dass Patienten bei einem eventuellen weiteren Schub und sich entwickelnden Wahnideen kritischer sind und gebildete Hypothesen über die Umwelt mehr hinterfragen. Während diese Intervention von Psychose-Patienten im Intervall gut angenommen wurde, ist für Patienten im akuten Schub diese Therapieform sicherlich keine Option.

Die Beeinflussbarkeit der neurokognitiven Auffälligkeiten durch Neuroleptika wurde bisher nicht systematisch untersucht. Erste Ergebnisse legen nahe, dass z.B. JTC durch Neuroleptika nicht beeinflussbar ist, jedoch die Wirkung von Neuroleptika auf psychotische Symptomatik voraussagen kann (So et al., 2010).

Eine Verbindung der Verhaltensexperimente mit bildgebenden oder neurophysiologischen Methoden könnte zum besseren neuronalen Verständnis von Wahnsymptomatik führen und somit die biologische bzw. pharmakologische Behandlung von Psychosekrankheiten, die immer noch mit enormem Krankheitswert verbunden sind, optimieren.

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Appendix

Instructions for Experiment 1 (Part I) and Experiment 2 (Part II)

Experimenter: You will see a little fisherman fishing in two lakes (Lake A or Lake B). The first fish that he catches decides which lake he will fish from for the remainder of the day (in other words, he is going to be fishing from one lake the whole time). He is fishing for black or white fish. This fisherman fishes as a hobby rather than fishing for food. That means every time he catches a fish he puts it back into the very same lake that he originally caught if from, so that the total number of fish in each lake never changes, no matter how many fish he catches.

Part I

In the first part of the study, you will see a full and complete view of both lakes. Then you will see each fish as it is caught one at a time. After each fish is caught, you will be asked to rate on a scale from 0 to 10, the probability that the man is fishing from Lake A and Lake B the whole time. In other words, both lake A and B will have their own scale or scroll bar similar to the following:

0 10
highly unlikely unlikely possible likely highly likely

You may rate the probability as high or as low as you believe it to be, and you may even have the same probabilities for both lakes.

After each fish is pulled you will be asked to change your ratings accordingly, however you may keep the ratings for both lakes or even one of the lakes the same if you believe that the probability has not changed.

Any questions?

Note: At this point begin Part I before giving instructions for Part II.

Part II

Experimenter: Part II is similar to Part I, but this time instead of a complete view of the lakes you will be given a partial view, where you will only see a piece of the lake with only a few of the fish in the lake.

However the task is the same as Part I. A fish will be caught from the lake, and you will be asked to rate the probability that is from Lake A and the probability that it is from Lake B. However, as each fish is drawn, you will be shown a larger piece of the lake, so that you can change your ratings accordingly, or you may even keep them the same. The lake will be revealed to you in 10 pieces, until you see the view of the whole lake at the very end.

Important: Please don't try to guess what is in the whole lake, but instead, make your ratings based on what you see.

Any questions?

Lebenslauf

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Eidesstattliche Versicherung

“Ich, Manuel Munz, erkläre, dass ich die vorgelegte Dissertation selbst verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt, ohne die (unzulässige) Hilfe Dritter verfasst und auch in Teilen keine Kopien anderer Arbeiten dargestellt habe.“

Datum Unterschrift

Thesen

Jumping to Conclusions, Liberal Acceptance and the Bias Against Disconfirmatory Evidence: An Evaluation of Reasoning Biases in Delusions

Hintergrund: Der Wahn ist ein häufiges und prominentes Symptom bei einer Reihe von psychiatrischen Erkrankungen, insbesondere bei schizophrenen Psychosen. Seit den 80iger-Jahren des letzten Jahrhunderts wird wahnhafte Symptomatik mit den Methoden kognitiver Neuropsychologie untersucht, wobei bei akut wahnhaften Psychosepatienten neben z.B. Theory-of-Mind Defiziten, einem charakteristischen Attributionsstil und Störungen der attentionalen Verarbeitung auch eine Neigung zu voreiligen Schlussfolgerungen beobachtet wurde, die hier näher untersucht wurde.

Experiment 1: In einem neu eingeführten Entscheidungs-Paradigma, bei welchem Probanden anhand des Verhältnisses von schwarzen und weißen Fischen in zwei Seen raten sollten, aus welchem der Seen ein gerade gefangener schwarzer oder weißer Fisch stammt, neigten ausschließlich wahnhafte Patienten zu voreiligem Entscheidungen („Jumping-to-Conclusions", JTC) und schlossen wenig wahrscheinliche Antwortmöglichkeiten gegenüber allen Kontrollgruppen bevorzugt ein („Liberal Acceptance, LA"), wobei die beiden Phänomene keine Korrelation aufwiesen.

Experiment 2: Die für szenisches Bildmaterial beschriebene Unkorrigierbarkeit getroffener Entscheidungen („Bias Against Disconfirmatory Evidence", BADE) wurde mit abstraktem Testmaterial untersucht, wobei kein Unterschied im Antwortverhalten der Untersuchungsgruppen auftrat. Bei initial weniger Fischen pro See, jedoch bei gleichen Grundwahrscheinlichkeiten wie in Experiment 1 war eine Neigung zu voreiligen Entscheidungen (JTC) nicht zu beobachten.

Experiment 3: In einer prospektiven longitudinalen Studie wurden Patienten mit unterschiedlich ausgeprägter Wahnsymptomatik zu zwei Zeitpunkten mit dem oben beschriebenen JTC-Paradigma untersucht. Die Veränderung der Ausprägung der Wahnsymptomatik korrelierte mit der Veränderung der Neigung zu voreiligen Entscheidungen.

Diskussion: Beschriebene Auffälligkeiten im schlussfolgernden Denken und deren Beziehung zueinander wurden in der vorliegenden Arbeit näher untersucht. Im Zusammenspiel mit den oben beschriebenen Einzelmodellen wie Theory-of-Mind Defiziten und einem externalen Attributionsstil könnten die hier beleuchteten Phänomene die Wahrscheinlichkeit falscher Schlüsse (JTC) und die Akzeptanz nicht stimmiger Hypothesen über die Umwelt (LA) zum Teil erklären und zur Entstehung und Aufrechterhaltung von Wahn beitragen.