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Plausibility Judgment in Schizophrenic Patients: Evidence For a Liberal Acceptance Bias

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Abstract

Previous work conducted with the probabilistic reasoning task has provided support for the claim that patients with delusional disorder and schizophrenia display a jumping to conclusions bias (early decisions on the basis of little evidence). Various explanations for this response pattern have been proposed. The goal of the present study was to provide further insight into the underlying mechanism(s) of this reasoning bias using a novel task for which competing accounts of the jumping to conclusions bias make opposing predictions. Twenty-nine schizophrenic patients and 28 healthy controls were administered pictures from the Thematic Apperception Task (TAT) and were asked to judge the plausibility of various interpretations for each picture. The results demonstrated that patients gave relatively high plausibility ratings for those interpretations that were judged as poor or unlikely by controls, but did not display abnormality on interpretations judged as good or excellent by controls. Contrary to a strict jumping to conclusions account, patients did not converge on one particular interpretation, but rather pursued multiple alternatives. Liberal acceptance is seen as a possible contributor to the emergence or maintenance of delusions: initial ambivalence may subsequently promote the acceptance of fallible interpretations.(German J Psychiatry 2004; 7: 66 -74).

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Introduction

Delusions are among the most prominent features of schizophrenia though they are not confined to this disorder. For the last two decades, three functional accounts have dominated cognitive research on delusions: the *attributional bias* account by Bentall and Kinderman (see Bentall, 1994; Kinderman & Bentall, 1997), the *perceptual abnormality* account by Maher (1974, 1999) and the *jumping to conclusions* (JTC) account put forward by Garety and coworkers (1991; for a review see Garety & Freeman, 1999),

The primary aim of the present study was to address issues relevant to the JTC account. Garety et al. (1991) theorized that deluded patients are biased towards making hasty decisions: they tend to draw firm conclusions on the basis of little evidence, whereas healthy participants and psychiatric controls are more cautious in their decision making. To illustrate, a defective telephone pole in front of one's house, combined with noise emerging from the telephone receiver due to the malfunctioning system, may, according to this view, be sufficient evidence for a delusion-prone individual to suspect that the telephone pole is in fact an espionage device, and that the telephone line is being tapped. Although healthy subjects may generate similar thoughts (i.e., "as if" feelings), such "working hypotheses" do not prevail, but are rejected after retrieval of prior knowledge and/or subsequent evidence collection. The JTC bias is hypothesized to be a general response bias displayed by paranoid patients and is not confined to the delusional system itself.

To date, the JTC account has predominantly been investigated with probabilistic reasoning tasks (e.g., Dudley et al., 1997; Fear and Healy, 1997; Garety et al., 1991; Huq et al., 1988; Mortimer et al., 1996). In these tasks, the participant is typically presented two containers holding different propor-

tions of colored beads (e.g., container A: 85:15 % green and red beads; container B: 85:15 % red and green beads). These containers are then removed from view. The participant is told that the experimenter will draw beads, one at a time, from only one container. Depending on the task employed, (a) the participant is required to provide estimates of the likelihood that the experimenter is drawing from container A or B at each stage of the drawing procedure ("probability estimates" procedure) or (b) the participant is free to determine how many beads have to be drawn before a decision is reached as to the source of the beads ("draws to decision" procedure). Results in favor of the model have been more consistent when the "draws to decision" procedure was used (see Fear and Healy, 1997; Dudley et al., 1997). Patients with delusional disorder or schizophrenia tend to reach a conclusion after fewer draws than healthy participants and psychiatric controls (Fear and Healy, 1997; Dudley et al., 1997; Moritz and Woodward, in press). This pattern of results is suggestive of a "data gathering bias" in paranoid (schizophrenic) disorder, that is, a final decision is reached abnormally early in the process of gathering information. Experiments conducted by Dudley et al. (1997) render it unlikely that the JTC bias is due to impulsivity, as decision-making in deluded patients was delayed for tasks with a less discriminable ratio of beads (60:40%) relative to tasks with a more discrepant ratio of beads (85:15%).

Despite consistent findings with only few exceptions (Young and Bentall, 1997), the exact mechanism that contributes to the JTC bias is not entirely clear. Several explanations may account for the data. First, a strict JTC account predicts that patients with delusional disorder or schizophrenia will lock onto the strongest among different options due to a "winner takes it all" mechanism, even if this option is not fully supported by the evidence. To illustrate, after a green bead (see example above) has been drawn from a hidden container, a participant adopting such a strategy would decide in favour of container A because this alternative is the most likely. A related but inverse account is that deluded participants rule out alternative hypotheses too quickly (Garety and Freeman, 1998, p. 127). According to such an *early rejection* account, container A would be chosen as a consequence of a decision against container B (predominantly red beads). Applied to the clinical example given above, the early rejection account claims that the patient first dismisses alternative hypotheses (e.g., the telephone is malfunctioning) and, as a consequence, accepts the remaining hypothesis (e.g., that one is being spied upon). Third, a *recency account* would also fit the data (e.g., see Young and Bentall, 1997, p. 456). This account suggests that recently encountered information is weighted more heavily when making decisions. Thus, being presented with just one green bead, the participant is fixated on the container with predominantly green beads. This explanation is especially powerful for explaining why patients over-adjust when faced with contradicting evidence (e.g., a red bead is presented after four green beads have already been displayed) as found in some studies (e.g., Garety et al., 1991, p. 200; Moritz and Woodward, in press; however, see Dudley et al., 1997). In the clinical example, this account would predict that a patient may discount or be unable to retrieve past experiences (e.g., telephones commonly make "strange" sounds) because he/she is fixated in the "here and now".

For the present study, a new task was constructed that generates contrasting predictions for each of the competing accounts of delusion formation and may thus elucidate the mechanism behind the response pattern in the "beads task". This new task used ambiguous scenes from the Thematic Apperception Test (TAT), for which various alternative interpretations were created (three or six per picture). Participants were instructed to rate the plausibility of each interpretation on a four-point scale ranging from *does not fit/poor interpretation* to *excellent interpretation*. The task thus captures reasoning when confronted with incomplete evidence. If schizophrenic patients make firm decisions on the basis of little evidence (strict JTC account), only one interpretation should be rated as highly plausible by patients. In contrast, controls may not converge onto one interpretation, as the pictures do not provide enough information to infer a correct interpretation. If patients, on the other hand, rule out alternatives too readily (early rejection account), one should expect more alternatives to be rated as "does not fit" by patients. Unlike the beads task, a rejection of alternatives does not necessarily predict that patients would jump to conclusions in our task, because multiple or even none of the interpretations might be evaluated as plausible. Finally, a recency account would predict that patients favor interpretations that were presented last.

The present task also allowed us to test a weaker version of the JTC account, hereafter referred to as the *liberal acceptance* account. This account holds that schizophrenic patients more readily accept even implausible response options. In tasks that provide only two (mutually exclusive) options, such as in the beads task, an early decision may be reached by patients because the more likely alternative provides sufficient information for support, whereas the less probable alternative is unsupported even according to liberal criteria. However, with multiple competing alternatives that are less contrasting in probability, liberal acceptance will create greater ambiguity since more interpretations are considered possible according to liberal reasoning. A definitive decision is delayed accordingly. To illustrate, a delusion-prone individual may not initially adhere to the delusional interpretation, but instead may entertain it as one possibility among others. In contrast, healthy subjects may dismiss the delusional interpretation immediately due to its implausibility and lack of supporting evidence. Once the delusional hypothesis is contemplated, additional "evidence" (in the telephone example, a stranger calls who has dialed the wrong number) may further strengthen the delusional hypothesis. In accordance with the latter account, longitudinal studies show that the exacerbation of a delusion formation is often not a rapid process, but that the delusional idea first evolves from an "as if" feeling (e.g., that the telephone is making sounds *as if* someone has manipulated it) which slowly transforms into a delusion as more "evidence" accumulates. Often, delusion formation is a long-term development, and weeks to months can pass before "as if" feelings expand into a full-blown delusion (Klosterkötter, 1992). In contrast, a strict JTC account would imply a short period of time for delusion formation.

A final point that needs clarification is whether any of these competing accounts is restricted to presently deluded patients. Studies conducted with the beads task suggest that the

JTC bias is also demonstrated by currently non-delusional schizophrenic patients. For example, Mortimer et al. (1996) did not find an association between severity of delusions in a schizophrenia sample and a hasty response style. In addition, our own research with the beads task suggests that deluded and non-deluded schizophrenic patients demonstrated tendencies to jump to conclusions (Moritz & Woodward, in press), and only under some conditions was the bias stronger for deluded patients. Longitudinal data also confirm that JTC is a trait rather than a state characteristic of delusions (Peters & Garety, in press). In line with this, healthy participants with elevated scores on delusional belief scales display a response pattern similar to manifest delusional patients (Colbern and Peters, 2002), suggesting that this bias may be a predisposing (trait) rather than a state characteristic of delusional beliefs.

For the present study, schizophrenic patients, with and without delusions, were recruited to investigate whether deluded and non-deluded schizophrenic patients perform differently on the task

Methods

Participants

Thirty-three inpatients fulfilling DSM-IV criteria of schizophrenia were recruited from Riverview Hospital in Coquitlam, British Columbia, Canada. A diagnosis of schizophrenia was determined by ward psychiatrists. Whenever a diagnosis was in doubt, or when patients had a history of alcohol/drug abuse and/or possible brain damage (head trauma leading to loss of consciousness for > 10 minutes), patients were excluded from the experiment. Four participants were later excluded due to severe concussion and an IQ lower than 85. Thirty healthy controls were recruited from hospital staff, students and through word of mouth. 2 healthy participants were excluded because of previous head trauma. The final sample of 29 schizophrenic and 28 healthy participants did not significantly differ with respect to age and gender (see Table 1). Premorbid IQ, as assessed with the NART, was comparable between groups. However, patients had a lower educational level than controls.

Psychopathological Assessment

Psychopathology was assessed by trained raters using the Signs and Symptoms of Psychotic Illness rating scale (SSPI; Liddle et al., 2002). Twenty-one of the schizophrenic patients displayed high levels of delusions (SSPI item delusions, score > 2). Three syndrome scores were computed from the SSPI. The positive syndrome score was the sum of item 7 (delusions) and 8 (hallucinations). The negative syndrome score was the sum of items 3 (anhedonia), 12 (underactivity), 13 (flattened affect) and 16 (poverty of speech). Disorganization included items 10 (disorientation), 14 (inappropriate affect), 17 (disordered form of speech) and 18 (peculiar behavior).

Material

Pictures from the Thematic Apperception Test (TAT, Murray, 1943) served as stimulus material. The TAT was chosen because many of its pictures evoke a variety of different interpretations. Through consensus decisions, we excluded cards displaying dominant aggression (e.g., card 15, man among gravestones), nudity (e.g., picture 17BM, naked man) or pictures with only few details (e.g., picture 16 which is a blank card). In addition, card selection was restricted to those with well-documented themes, and those that typically evoke multiple meanings. For this purpose, experts in the field were contacted (for example several authors of chapters in the book edited by Geiser and Morris, 1999) and the relevant literature was screened for common interpretations (Bellak and Abrams, 1997; Holt, 1978; Murstein, 1972; Rosenzweig and Fleming, 1949). Nine pictures were selected eventually (pictures 1, 2, 4, 6BM, 7GF, 9GF, 12BG, 17GF, 18GF). Picture 6BM served as practice trial. Either three or six interpretations were created for each of the remaining pictures. This manipulation was introduced to assess whether the degree of ambiguity moderates task performance.

For each picture, different interpretations were generated, which were all randomly administered to each participant (see the appendix for an example).
Interpretations within each trial were equated regarding word length (M = 18.10 words per interpretation; SD = 3.87; individual interpretations were +/- 3 words of the mean word length of all interpretations per picture) and grammatical complexity, the latter was determined according to the

Table 1. Sociodemographic and psychopathological characteristics of the samples

Variables	Schizophrenia sample (n = 29)	Healthy sample (n = 28)	Statistics
age	34.59 (9.19)	34.61 (11.85)	t=.01; p > 0.9
gender (male/female)	20/9	17/11	$\chi^2(1)$=.42; p > 0.5
years of education	11.67 (1.64)	14.42 (1.98)	t=5.43; p < 0.001
IQ (NART)	107.57 (7.82)	110.54 (6.01)	t=1.32 ; p > 0.2
length of illness	14.14 (9.15)	- - -	- - -
SSPI total	13.68 (4.82)	- - -	- - -

Flesch-Kincaid readability index. An index score of 9, for example, means that a grade 9 student is able to comprehend the corresponding text. The mean Flesch-Kincaid readability index was 6.16 (*SD* = 2.31). Readability scores for each interpretation fell below 12. Interpretations were written in Arial Narrow 28 point font. Interpretations and pictures were affixed to cue cards.

Procedure

Participant and experimenter sat face-to-face and were separated by a table. An envelope with the practice trial (picture 6BM) was opened and the picture presented for approximately 10 seconds. Then, the experimenter randomly selected one interpretation from the envelope, laid it on the table and read it to the participant. The participants indicated when they were ready for the next interpretation. Then the next interpretation was displayed and so on until all interpretations were laid out on the table (all interpretations and the picture remained visible throughout the trial). After the last interpretation was displayed, the participant was asked if he or she had an interpretation which would fit the picture better. In these cases, another card was placed on the table with the label "own story". Subsequently, the participant was encouraged to assign each interpretation according to four response categories located on another part of the table. These four response categories were labeled as following: *does not fit/poor interpretation, possible interpretation but not likely*, *good interpretation*, *excellent interpretation* (from left to right). Participants were told that it was possible to leave some category options empty, or to assign more than one interpretation to one category option. Participants were free to decide which interpretation card to start with.

Following the practice trial, participants were allowed to ask questions. The procedure for the subsequent test trials was similar to the practice trial. In alternating fashion, envelopes containing three or six interpretations were selected, the test session always started with a picture with three interpretations.

Scoring

The experimenter recorded the random order of individual pictures on a scoresheet. The random order of interpretations per picture was also recorded. The plausibility estimates per interpretation were recorded as follows: 1 = *does not fit/poor interpretation*, 2 = *possible interpretation but not likely*, 3 = *good interpretation*, 4 = *excellent interpretation*. Whenever participants provided their own interpretations, this was recorded as well.

Results

Order and Trial Type Effects

The following analysis tested the recency account of JTC. A mixed-model three-factor analysis of variance (ANOVA) was conducted with group (schizophrenia, healthy) as the between-subject factor, and order (first interpretation, middle interpretation(s), last interpretation) and trial type (three interpretations, six interpretations) as within-subject factors (for the pictures with six interpretations, the "middle order" variable was computed as the mean plausibility score of interpretations presented second, third, fourth and fifth). Mean plausibility scores served as the dependent variable. A p-value of 0.05 was used as the cut-off for significance for all statistical tests, two-tailed.

The mixed-model ANOVA resulted in significant main effects for group ($F(1,55) = 7.72$; $p = 0.007$), order ($F(2,55) = 3.48$; $p = 0.034$) and trial type ($F(1,55) = 7.89$; $p = 0.007$). None of the interactions achieved significance ($p > 0.1$).

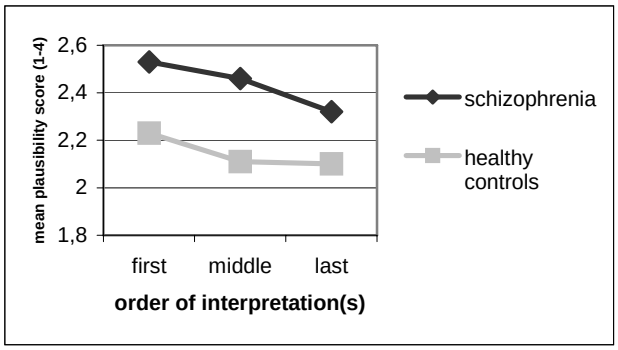

Figure 1. Mean plausibility scores separated by order of interpretation(s) (collapsed over trials with three and six interpretations). The group effect achieved significance: schizophrenic participants judged interpretations as significantly more plausible than controls. A significant order effect emerged that reflected a primacy effect: earlier interpretations received higher plausibility scores than later ones.

As can be seen in figure 1, the highly significant group effect can be explained by higher plausibility scores given by the patient sample relative to controls. The significant order effect mirrors a primacy effect: plausibility scores generally decline with increasing number of already presented interpretations. The significant effect of trial type represents higher plausibility scores in the set of pictures containing six interpretations. The absence of an interaction between group and order provides evidence against the recency account.

Group Differences in Distributions of Response Options

The following analyses were performed to address the strict JTC and early rejection accounts. A mixed-model ANOVA with response options (does not fit, unlikely, good, excellent) as a within-subjects factor and group as a between-subjects factor was performed. The total number of interpretations assigned to each response option served as the dependent variable (see figure 2). A significant effect was observed for response option ($F(3,55) = 11.25$; $p < 0.001$). Overall, participants chose the excellent interpretation category less often than any other category (all contrasts at least $p < 0.005$; no other response option contrast achieved significance). The interaction of response option and group was also highly significant ($F(3,55) = 4.89$; $p = 0.003$). Post-hoc t-test revealed that this interaction is due the preference of the

schizophrenic group for the excellent (p = 0.025) and good categories (p = 0.038) relative to healthy controls, whereas healthy participants chose the does not fit (p = 0.049) and unlikely categories significantly more often (p = 0.019) than patients. These results contradict the early rejection account by demonstrating that patients do not tend to use low plausibility ratings more often than controls.

In order to directly test the strict JTC account, we analyzed how often participants judged solely one interpretation as good or excellent (all other possibilities were correspondingly considered not possible or unlikely). For all pictures with three interpretations, healthy controls had a single preference in 54.5% of the trials compared to 39.7% in patients ($\chi^2(1) = 5.02$; $p = 0.025$). For pictures with six interpretations, such a response style was found for 20.9% of all trials in healthy participants and 10.4% of all trials in schizophrenic participants ($\chi^2(1) = 4.70$; $p = 0.03$). Thus, no evidence for the strict JTC account was observed; in fact, the results pointed in the opposite direction.

The following analysis tested the liberal acceptance account. We also assessed whether group differences were moderated by the plausibility of the interpretations. Current ratings of the healthy participants served as the baseline for plausibility. Based on these ratings, we separated interpretations into the following categories: judged as poor (mean plausibility score < 2 (i.e., rating below "possible/unlikely"); 15 interpretations), judged as possible (mean plausibility score 2 < x < 2.5 (i.e., ratings in the range of "possible/unlikely"); 12 interpretations) and judged as good (mean plausibility score > 2.5 (i.e., ratings judged as rather good or better); 9 interpretations) by healthy participants. The patient and control ratings did not differ for the interpretations in the good category (i.e., interpretations judged as good or better by controls were also judged as good or better by patients). For three out of 12 interpretations in the possible category, patients gave substantially higher plausibility ratings (at least $p < 0.1$). Substantial group differences in plausibility ratings emerged only for those interpretations in the poor category: For 13 out of 15 interpretations of the poor category, schizophrenic participants gave at least at trend level higher plausibility scores compared to controls ($p < 0.1$).

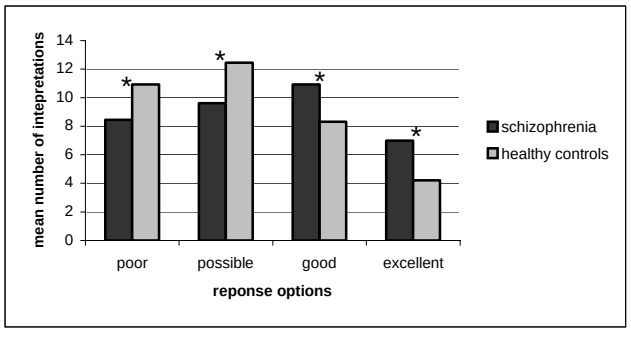

Figure 2: Distributions of mean plausibility scores across groups: Overall, the excellent interpretation option was chosen the least often. Patients more often chose the good and excellent interpretation options relative to controls (at least p = 0.05), while healthy controls more often judged interpretations as does not fit or unlikely relative to patients (at least p = 0.05). Both the response option and the response option X sample interaction achieved significance (both p = 0.001). * at least $p < 0.05$

Self-generated (own) stories

Self-generated (own) stories were supplied equally often by schizophrenic patients (M = 3.41) and healthy controls (M = 2.71; $t(55) = 1.05$; $p > 0.2$). These self-generated stories received comparable plausibility scores in both groups ($p > 0.7$). No differences occurred when the schizophrenic group was further subdivided into deluded and non-deluded patients. The correlation with the delusion item of the SSPI was likewise not significant ($p > 0.2$).

Contents

For 16 of the 36 interpretations, schizophrenic patients gave higher plausibility scores than controls (at least, $p < .1$). We analyzed if greater preference for these interpretations depended on special content characteristics, for example, whether patients favor more violent themes. This analysis was undertaken because there is evidence that patients with schizophrenia show an attentional bias for mood-congruent material (Bentall and Kaney, 1989). A mood-congruent bias is also well documented for TAT pictures (e.g., Bower, 1981, p. 139). All 36 interpretations were categorized along the following dichotomies (i.e., criterion met or not):

1. deals with interpersonal conflict (interpretations deals with a quarrel, argument or fight: yes (16 interpretations) vs. no (20 interpretations))
2. deals with violence (interpretations contain themes of death or (self-)aggression: yes (7) vs. no (21))
3. interpretation involves a person not displayed in the picture (yes (8) vs. no (28)).
4. interpretation does not mention at least one person displayed in the picture (yes (11) vs. no (25)).
5. pleasantness (rather unpleasant (27) vs. pleasant/not unpleasant (9)).

Pictures could meet multiple criteria. For example, most interpretations dealing with violence (#2) also contained interpersonal aggression (#1) and interpretations from both categories had an unpleasant valence (#5). None of the chi-square tests (interpretation rated significantly more plausible by patients (yes or no) x content criterion (met/not met)) achieved significance ($p > .1$).

Correspondence with Symptoms

Severity of delusions did not correlate with higher plausibility scores (whether or not they were separated by order of presentation, at least $p > .1$). Moreover, when the sample was split according to the SSPI delusions item (no and low delusional group: SSPI score lower-equal 2), the subsamples did not differ on the mean plausibility score (high delusional group: M = 2.46 versus M = 2.38; $p > 0.6$). NART-IQ and

SSPI syndrome scores did not correlate with the mean plausibility score either.

Severity of delusions was not associated with any preferences for response categories (i.e., excellent, good, unlikely, does not fit, at least $p > 0.1$).

Moreover, presence of delusions was not associated with a tendency to judge only one interpretation as good or excellent.

Negative symptomatology was inversely correlated with the number of excellent responses ($r = -0.39$; $p < 0.05$). Disorganization was not related to any of the effects.

Medication effects

The schizophrenic sample was split according to the median of chlorpromazine equivalent dosage, and its influence on judgment was assessed. Medicated and unmedicated subgroups did not differ on age, gender, SSPI syndrome scores, or SSPI total score. While no effect emerged for the mean plausibility judgment ($p > .2$), patients with higher neuroleptic doses (> 500 mg) judged significantly fewer interpretations as excellent (high dosage group: $M = 9.07$ (6.44), low dosage group: $M = 4.79$ (4.06), $t(26) = 2.11$; $p < 0.05$).

Discussion

The present study was designed to challenge several competing hypotheses of aberrant reasoning in participants with schizophrenia. Three hypotheses were not supported by the data. Schizophrenic patients did not converge onto one interpretation, or fewer interpretations than controls. Therefore, a strict formulation of the JTC account, which holds that patients are more willing to *make a definite decision* in the face of incomplete evidence, was not supported. Instead, schizophrenic patients judged more interpretations as excellent or good, and the preference for only one interpretation per picture occurred less frequently than for controls. Additionally, patients did not display a tendency to quickly reject multiple hypotheses (early rejection account). On the contrary, such a bias was stronger for healthy participants. Moreover, there was no support for a recency account, as no interaction between order and group was observed. As will be described in more detail below, all groups judged later interpretations as poorer compared to earlier ones.

The present set of results is consistent with a liberal acceptance account. This hypothesis provides a parsimonious explanation of results in the present study, and can be extended to investigations conducted with the "beads task". Like the JTC account, the liberal acceptance account assumes that (deluded and non-deluded) schizophrenic patients have an increased tendency to endorse, but it does not necessarily imply that patients jump to conclusions in the sense that the most dominant "working hypothesis" is taken while others are discarded. The account holds that response options/interpretations are accepted, and/or further considered, on the basis of less evidence. According to this hypothesis, a decision is reached if either no competing hypotheses exist, or if these are discarded even by liberal criteria. In tasks such as the beads task, where only two (mutually exclusive) options are presented, liberal acceptance would indeed lead to an early, seemingly definite decision, because the competing alternative is largely unsupported even when applying less conservative criteria. However, when multiple interpretations are entertained as plausible (i.e., surpass the acceptance threshold), indecision may be observed. More response options are thus able to create greater ambivalence.

Put differently, we propose that a core disturbance associated with schizophrenia is that initially more explanations are taken into consideration when interpreting complex events, whereas healthy participants are more selective, and rule out improbable hypotheses more quickly. Interestingly, group differences on plausibility were highest for interpretations that were judged as poor by healthy participants, whereas no group differences occurred for interpretations that healthy subjects found reasonable. This indicates that patients were not generally more liberal in their ratings, but that this bias was especially pronounced for absurd or less likely scenarios, that is, scenarios that are ruled out by "common sense", prior knowledge, or additional evidence by healthy subjects. This finding has recently been replicated by our group (Woodward et al., 2004, submitted) using a different cognitive paradigm.

We are currently attempting to pinpoint the mechanisms contributing to liberal acceptance. One possibility is that the patients possess a reduced threshold to endorse, leading to an increased number of hypotheses passing the acceptance threshold, which in turn contributes to the apparent ambivalence in the present paradigm. Another possibility that is not mutually exclusive with the threshold account is that patients with schizophrenia are less sensitive to fallible information, that is, that they are not processing cues that would persuade a healthy subject to reject or down-rate an alternative. To illustrate, on the picture in the appendix (woman on the bridge) the "comet hypothesis" (i.e., "The sun is exploding, meteorites are crashing down the earth. The men try to move them away or even catch them.") was judged as poor by most healthy subjects, whereas schizophrenic patients more often considered this a possibility. According to the first cognitive account, the stormy skies and men carrying loads may have provided sufficient evidence to allow the "sun is exploding" interpretation to surpass the lowered acceptance threshold, whereas healthy subjects might have needed *more* evidence in favor of this interpretation (e.g., rocks flying, people seeking shelter). According to the second account, the fallibility of the "sun is exploding" interpretation may not have been detected and/or processed by the patients. According to this account, the conservative behavior of healthy subjects is due to the detection and processing of incompatibilities between the picture and the interpretation (e.g., the house is undamaged, the woman does not seem to seek for shelter, why should someone try to catch a comet crashing down to earth).

The core difference between the two accounts is that the first one proposes a reduced threshold to accept, whereas the second one proposes a normal threshold to accept, but a reduced ability to process potentially incorrect (i.e., fallible) information. To decide among these possibilities, or judge

their relative weight for liberal acceptance, it might prove useful to directly ask participants how ratings were formed.

It is important to note that the present pattern of results was not moderated by the presence or severity of current delusions. This asserts that the liberal acceptance bias is not an epiphenomenon of delusional symptomatology, but may represent a trait characteristic of paranoid schizophrenia, and more specifically, may represent a risk factor for the emergence of delusions. With respect to this observation, it should be emphasized that the number of non-deluded patients was rather small, so that interpretative caution is warranted. Moreover, longitudinal investigations are required to directly address the state vs. trait question.

As already outlined, the liberal acceptance bias may contribute to the emergence of fixed, false beliefs: in many situations relevant to delusions, initial contemplation of a "working hypothesis" can subsequently promote the acceptance of fallible interpretations, especially when the correct interpretation is difficult to verify. Once a "nonsense" or unlikely hypothesis is taken into consideration together with alternative interpretations, it is sometimes easier to collect support for the unlikely one. To return to the clinical example, a misdialed phone call, and/or taking note of by-passers looking at one's house (which may be given extra attention due to hightenend alertness) may further strengthen the delusional hypothesis, which at this stage may have still carried an "as if" character. A telephone employee inspecting the cable, on the other hand, may not dismiss the delusional hypothesis, because the "worker" could be a spy/agent in camouflage. An analogy in healthy subjects is the feeling that one is being followed when leaving a bus at night. This thought, which may have been nurtured by general fearfulness, recent crime reports, or an unidentified noise somewhere, may receive further evidence due to an alert perception (e.g., people whispering in the distance).

Interestingly, the present results suggest that patients who received higher doses of antipsychotic agents accepted fewer interpretations than patients receiving low doses. Thus neuroleptic agents may guard patients against the consideration of absurd scenarios, for example, by raising the acceptance threshold, enhancing sensitivity to fallibility (critical awareness) or strengthening the connections between reasoning and prior knowledge/correcting experiences. However, caution is warranted in interpreting these findings as we have not manipulated medication independently.

Both healthy and schizophrenic participants displayed a primacy effect: interpretations presented first had a clear processing advantage and received higher plausibility scores than interpretations presented later. Since interpretations were randomized and remained visible throughout the trial, effects for content and memory were controlled for. We interpret this finding as suggestive of interference effects analogous to those seen in memory tasks (Lezak, 1995, p. 443). Each interpretation card suggests a different story by either ignoring some details of the picture, or presenting additional information not included in the picture. For each new interpretation presented, aspects of prior interpretations (e.g., that the woman on the bridge is a detective and that the people below the bridge are smugglers; see appendix) must be removed from working memory. Thus, residuals left over from prior interpretations may make it more difficult to give equal consideration to novel interpretations. Therefore, earlier interpretations will have a clear advantage relative to interpretations shown later. This result may be very important for our understanding of delusion formation, since there is evidence that delusional people have a heightened susceptibility to delusion-relevant information. When such hypotheses come to mind first, they have an apparent processing advantage so that the correcting influence of subsequent hypotheses is weakened.

Finally, it is necessary to acknowledge some shortcomings of the present study. (a) It remains to be established whether the judgment bias found in schizophrenic patients is specific to this diagnostic group, or can also be found in psychiatric controls. (b) The present task did not require patients to provide response options themselves. It is therefore necessary to explore whether similar results would be obtained when patients are asked to self-generate alternatives. For example, it could be argued that because of compromised intellectual skills patients may generate fewer interpretations than controls. If this were true, greater ambivalence would not occur. However, in a new study we have tested this directly and found no strong differences between groups on the number of self-generated responses. (c) The present study investigated only a small group of non-deluded participants (see above), so that the study did not contain high statistical power to reveal differences between deluded and non-deluded participants. However, the finding that schizophrenic patients, irrespective of present delusional status, over-estimate the plausibility of improbable/absurd scenarios has been recently replicated thus confirming the present conclusions (Woodward et al., submitted, 2004). In accordance with this, none of the direct comparisons between the two sub-samples approached trend level, and all correlations were not significant

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Appendix

Example of a test stimulus with six interpretations (interpretations are presented randomly)

- Smugglers are loading stolen goods from ships into a warehouse. The person on the bridge is a detective watching.
- The sun is exploding, meteorites are crashing down the earth. The men try to move them away or even catch them.
- The woman is sick, perhaps from the sun, or the smell of the goods the workers are carrying, and is about to vomit.
- From a bridge, a rich woman is supervising her servants who are moving boxes into her new house or factory.
- The woman is complaining about the noise the workers are making or perhaps the smell of the goods they are carrying.
- A woman on the bridge is thinking whether or not she should jump from the high bridge.

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