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Under what circumstances do patients with schizophrenia jump to conclusions? A liberal acceptance account

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Background. A consistent body of studies suggests that schizophrenia patients are extremely hasty when making decisions, and generally opt for the strongest response alternative. This pattern of results is primarily based on studies conducted with the beads task, which requires participants to determine from which of two possible jars a series of beads has been drawn. We have recently proposed a liberal acceptance (LA) bias to account for decision-making biases in schizophrenia, which claims that under heightened ambiguity the jump to conclusions (JTC) bias is abolished in schizophrenia.

Methods. A total of 37 schizophrenia patients were compared with 37 healthy controls on different versions of the beads paradigm. For the first task, participants were required to rate the probability that a bead was being drawn from one of two jars, and had to evaluate after each bead whether the amount of presented information would justify a decision. The second task was a classical draws to decision experiment with two jars. The third task confronted participants with four possible jars. If JTC was ubiquitous in schizophrenia hasty convergence on one alternative would be predicted for all three tasks. In contrast, the LA account predicts an abolishment of the JTC effect in the final task.

Results. Tasks 1 and 2 provide further evidence for the well-replicated JTC pattern in schizophrenia patients. In accordance with the LA hypothesis, no group differences were detected for task 3.

Discussion. The present results confirm that JTC is not ubiquitous in schizophrenia: in line with the LA account a JTC bias in schizophrenia occurred under low but not high ambiguity. LA may partly explain the emergence of fixed, false beliefs.

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A wealth of studies has confirmed that patients with schizophrenia or delusional disorder show abnormal performance on the probabilistic reasoning or beads task (Dudley, John, Young, & Over, 1997; Fear & Healy, 1997; Freeman *et al.*, 2004; Garety, Hemsley, & Wessely, 1991; Huq, Garety, & Hemsley, 1988; Moritz & Woodward, 2005; Mortimer *et al.*, 1996). In this paradigm, participants are typically presented two jars holding two different coloured beads in inverse ratios (e.g. jar A: 85:15% green and red beads; jar B: 85:15% red and green beads), which are then removed from the participant's view. Subsequently, beads are drawn, one at a time, from *one* jar only. After each draw, the participant is asked to estimate from which jar the bead(s) is/are drawn. Depending on the version, the participant is asked after each draw whether a decision has been reached as to the source of the beads, which immediately terminates the task (*draws to decision* (DTD) procedure). Another variant of the task requires participants to provide *graded estimates* for a fixed amount of draws (e.g. ranging from *entire certainty* for jar A to *entire certainty* for jar B). Alternatively, the participant may be requested to provide *probability estimates* (0–100%) that beads are drawn from jar A or jar B after every draw. In the latter two versions, the task is usually terminated after a fixed number of beads (for a review and discussion of these procedures see Garety & Freeman, 1999). Although the results are more consistent if a DTD version of the paradigm is used, there is evidence that a graded estimates version also significantly differentiates schizophrenia patients from healthy and psychiatric control groups (Moritz & Woodward, 2005).

Schizophrenia patients typically decide extremely hastily relative to healthy controls from which of two jars a series of beads is drawn. This finding has been termed jumping to conclusions (JTC). Between 40 and 70% of patients decided after the first bead (Freeman *et al.*, 2004; Moritz & Woodward, 2005; Mortimer *et al.*, 1996). This pattern of results has been observed for currently paranoid schizophrenia patients, although there is increasing evidence that this bias is also found for non-paranoid schizophrenia patients, and thus may represent a trait rather than a state marker of the disorder (Menon, Pomarol-Clotet, McKenna, & McCarthy, 2006; Moritz & Woodward, 2005; Peters, Day, & Garety, 1999).

The pattern of results suggests that patients with schizophrenia are generally hasty to make decisions. Although some alternative hypotheses have either been ruled out (e.g. impulsiveness; Dudley *et al.*, 1997) or rendered unlikely (poor motivation, low intelligence; Moritz & Woodward, 2005), there are accounts that have not been put to the test with the original procedure; namely, liberal acceptance (explained below) and a forward vs. backward decision-making strategy for decision (i.e. premature decision for the most likely jar vs. decision secondary to the premature exclusion of the less likely candidate).

Recently, a liberal acceptance (LA) account has been suggested as a predisposing factor to delusions and proposed to explain the performance pattern exhibited by schizophrenia patients in the beads task (Moritz & Woodward, 2004). According to this account, patients with schizophrenia require less evidence to accept options, which, importantly, does not necessarily imply JTC. In two-choice tasks, such as the conventional beads task, where alternatives are mutually exclusive, the LA account predicts early decisions. Likewise, JTC is expected when only one alternative stands out among many (Moritz, Woodward, & Hausmann, 2006). In contrast, with more alternatives that are less distinct in probability, greater ambiguity is created, and a delay of decision making is expected since multiple options are deemed acceptable. For example, it was found that patients with schizophrenia, irrespective of symptom profile,

judged more interpretations of TAT pictures as good or excellent than controls, and that controls showed an even stronger JTC bias than patients in this task, as indexed by a higher number of single interpretations judged as excellent (Moritz & Woodward, 2004). The LA bias in patients was most pronounced for alternatives that healthy controls rated as poor, fostering the proposition that patients with schizophrenia require less affirming information before endorsing an alternative.

The present study involved three tasks, whereby the final task was designed to test an assumption of the LA account that is incompatible with the assertion that JTC is ubiquitous in schizophrenia. For the first task, participants were required to make plausibility judgments after each draw of a bead along with simulated decision ratings. In line with prior research, it was predicted that schizophrenia patients make a decision after fewer beads. It was also predicted that hasty decisions would be associated with lower probability ratings in patients (i.e. decreased decision threshold). To illustrate, while a healthy subject may consider a probability of, for example, 85% as insufficient for a strong judgment and accordingly requests more beads, a schizophrenia patient may regard that probability level already as sufficient.

The second task was a draws to decision experiment, primarily designed to replicate past JTC findings. Subsequent to a probability rating, participants were asked whether or not they have arrived at a decision which automatically terminated the procedure. After a decision was made, participants were directly asked what guided their decision to shed light on the question of whether poor motivation, active endorsement or rejection of the less likely alternative led to the decision.

In the third experiment, a new variant of the beads task was introduced, for which a specific prediction can be made according to the LA account. Here, the subject is confronted with four jars instead of the classic two jar situation. If the JTC bias was ubiquitous, schizophrenia patients would under these circumstances also decide very hastily, whereas the LA account predicts that multiple jars containing beads with closer ratios (i.e. a more ambiguous situation) would lead to greater ambivalence, and a delay of decision because more (improbable) alternatives surpass the lowered threshold of acceptance. This would lead to abolishment or reduction of the JTC effect.

Methods

Participants

Thirty-seven schizophrenia patients fulfilling DSM-IV criteria for schizophrenia participated in the study (gender: 20 male, 17 female; age: $M = 36.35$, $SD = 12.05$; years of formal education: $M = 11.57$, $SD = 1.76$). Mean premorbid intelligence, as assessed with a vocabulary task (Lehrl, 1995), was 107 IQ-points ($SD = 12.57$). Patients were drawn from an acute psychosis ward and an out-patient clinic, specializing in psychosis and personality disorder, from the University Hospital for Psychiatry and Psychotherapy in Hamburg.

Diagnoses were confirmed through the MINI neuropsychiatric interview (Sheehan *et al.*, 1998). Psychopathology was assessed with the Positive and Negative Symptoms Scale (PANSS; Kay, Opler, & Lindenmayer, 1989) by a trained psychologist. The PANSS was complemented by six additional items from the Positive and Negative and Disorganized Symptoms Scale (PANADSS, Andresen & Moritz, 2000). Twenty-two schizophrenia patients displayed paranoid delusions at the time of testing as evidenced by a score of 3 or higher on the paranoid ideation item (item six on the positive

subscale) of the PANSS. Exclusion criteria were severe substance abuse, any form of documented or suspected brain damage/disease, and an additional axis I diagnosis other than depression. All schizophrenia patients were medicated with atypical neuroleptic medication at the time of testing.

As the healthy control group, we recruited 37 participants who were drawn from hospital staff and the general population via advertisement and word-of-mouth. Control participants were matched for gender (20 male, 17 female), age ($M = 35.24$ years, $SD = 9.22$) and years of education ($M = 11.38$ years, $SD = 1.62$), and were screened for absence of brain damage and mental illness, also via the same semi-structured interview. None of the participants had completed a variant of the beads task previously.

Experiment

A computerized beads task was constructed using Superlab® for the Macintosh. The set-up of the present experiment closely resembled a previously published version (Moritz & Woodward, 2005). In total, three tasks were presented in fixed order. Tasks 1 and 2 integrated the probabilistic estimates and draws to decision procedures, but only in task 2 did a decision terminate the task. In Task 3 participants were presented with four possible jars (see below for a more detailed description). For each task, the ratio of beads varied (task 1: jar 1 80:20% yellow vs. blue, jar 2 80:20% blue vs. yellow; task 2: jar 1 90:10% red vs. green, jar 2 90:10% green vs. red; task 3: jar 1 90:10% red vs. green, jar 2 50:50% red vs. green, jar 3 90:10% green vs. red, jar 4 90:10% yellow vs. red). Conversation between participants and the experimenter during the tasks was kept to a minimum to prevent occurrence of a Rosenthal effect (i.e. deliberate or unconscious manipulation of the participant's task performance in the direction of the study hypothesis). Instructions were read by the experimenter from the monitor. Experiments were conducted by interns who were blind to the study's hypotheses.

Task 1 (draws to decision procedure with simulated decisions and probability estimates)
Task 1 was designed to replicate the previous JTC findings, and to expand on previous theoretical accounts by measuring probability ratings and decisions separately. Instructions were displayed next to a picture of two jars holding coloured beads. The proportions of beads in each jar were made explicit (i.e. participants were told the exact ratios). It was then explained that the computer would randomly draw beads *from one jar only* throughout the task. Beads would then be put back in the jar and reshuffled. After each bead, the participant was asked to make a probability judgment (0–100%) about the likelihood that beads are being drawn from one of the jars (participants could provide ratings for either jar A or jar B, but not for both). Coding was always made with reference to jar A (e.g. 80% probability for B was coded as 20%). After each probability judgment, the participant was asked whether this amount of information would normally be sufficient for a decision. However, it was made clear that the task would continue regardless of whether or not participants indicated that sufficient information was collected for a decision (i.e. simulated decisions). Participants were told that decisions could be removed/changed at later stages. The experimenter was permitted to answer only those questions that would familiarize participants with task instructions, and the experimenter was allowed only to repeat or paraphrase the written instructions.

When the first bead appeared, the computer prompted participants to provide a probability estimate. If this was deemed by the subject to be sufficient to make a decision,

this was marked by the experimenter with an 'E' (for *Entscheidung* = decision). There was also an explicit reminder about the proportion of beads in the two jars to minimize memory load (Menon *et al.*, 2006; Moritz & Woodward, 2005). To decrease memory load further, each new bead was shown along with the previous beads, such that all drawn beads appeared at the bottom of the computer screen, connected by a string. The current bead (always far right) was marked with a small arrow. Along with each new bead, a probability judgment was requested, and whether this amount of information would now suffice to make a decision. In total, 10 beads were drawn.

Task 2 (draws to decision procedure and probability estimates)

Task 2 was designed primarily to replicate previous JTC findings, as JTC in schizophrenia has most often been demonstrated with the draws to decision procedure; thus, task 2 aimed to validate the novel experimental set-up, and the generalizability of the findings. With the exception of the instructions, the set-up in task 2 was similar to that in task 1. Participants were again familiarized with the general principle that the computer selects one jar and then draws beads from only this jar. This time, however, participants were required to judge, for each new bead, whether they were certain (i.e. have made their decision) that a bead came from jar A or jar B, or whether they needed more beads to arrive at a decision. Subjective probabilities were again noted. After a decision was made, the task was terminated, which had been made clear to the participants beforehand. Responses were recorded by the experimenter.

Task 3 (multiple jars with simulated decisions)

Task 3 was designed to determine how participants would perform in response to multiple jars. Participants were confronted with four jars, and were required to report, after each bead, the probability associated with each of the jars on a scale ranging from 1 (excluded) to 5 (absolutely certain = decision). In other words, for each bead all four jars were assessed. The task was terminated after 10 beads. As in task 1, an 'absolutely certain = decision' rating did not terminate the task prematurely.

Subjective assessment

Subsequent to task 2, participants were asked why they decided on one of the two jars. Participants were asked to choose from four possible answers: *the chosen jar was the most likely* (inclusion strategy), *the rejected jar was too improbable* (rejection procedure), *participant aimed to end the task as quickly as possible*, *task was not understood*. After these alternatives were read to the participants, they had to endorse which option fit their response behaviour best. If participants provided other reasons this was documented separately.

Sequence of beads

The three tasks presented beads in the following order (B = blue; G = green; R = red; Y = yellow):

  Task 1: Y-Y-Y-B-Y-Y-Y-B-Y
  Task 2: R-R-R-R-G-R-R-R-R-R
  Task 3: R-R-R-G-R-R-R-R-R-R

Tasks 1 and 2 unequivocally favoured jar A. In task 3, jar D could be ruled out after the fourth bead because the colour of this bead was not contained in any of the four jars. Eventually, the sequence favoured the first jar.

Results

Owing to careful matching, groups did not differ on any socio-demographic background variable ($p > .6$). When the schizophrenia group was split according to current paranoid delusions, no differences were detected ($p > .3$ including chlorpromazine equivalent dosage and length of illness).

A substantial minority of schizophrenia participants displayed a JTC pattern (i.e. deciding immediately after the first bead was presented) for tasks 1 (46%) and 2 (27%, see Table 1). This result was corroborated by a significantly decreased mean for requested draws in both tasks. When the group was split according to paranoid delusions, the schizophrenia subgroups did not differ on their decision-making behaviour. Independence with current delusions was confirmed by inspection of correlations ($p > .1$). Premorbid intelligence in patients was neither correlated with draws to decision in task 1 ($r = .04$, $p > .8$), task 2 ($r = -.15$, $p > .3$), nor task 3 ($r = -.03$, $p > .8$).

Table 1. Experimental parameters. Means and percentage values

Variable	Healthy (N = 37)	Schizophrenia (N = 37)	Statistics
Subtask 1 (2 jars; simulated decisions)			
% decisions on first draw (JTC)	10.8% (N = 4)	45.9% (N = 17)	$\chi^2(1) = 11.24$; $p = .001$
Draws to decisions	5.86 (3.32)	2.89 (2.60)	$t(72) = 4.29$; $p < .001$
Decision threshold in %[a]	83.06 (10.87)	75.51 (19.24)	$t(72) = 2.08$; $p = .04$
Subtask 1 (2 jars; draws to decision)			
% decisions on first draw (JTC)	2.7% (N = 1)	27.0% (N = 10)	$\chi^2(1) = 8.65$; $p = .003$
Draws to decisions[a]	4.97 (2.55)	3.73 (2.45)	$t(72) = 2.14$; $p = .04$
Decision threshold in %[a]	92.43 (10.49)	85.24 (18.73)	$t(72) = 2.05$; $p = .04$
Subtask 3 (4 jars; graded estimates)			
% decisions on first draw (JTC)	10.8%	13.5%	$\chi^2(1) = 0.12$; $p > .7$
Draws to decisions[b]	6.92 (3.32)	6.16 (3.72)	$t(72) = 0.92$; $p > .3$

Note. Standard deviations are set in brackets
[a] If participants made no decision, the missing value was substituted by the corresponding group mean.
[b] If participants made no decision, the missing value for the number of draws was substituted by the value 11, following the procedure by Young and Bentall (1997)

In accordance with previous studies (e.g. Moritz *et al.*, 2006), the threshold for endorsing an alternative was significantly decreased in patients: in both tasks 1 and 2, patients made a decision on the basis of less certainty. The decision threshold was approximately seven points lower in patients than in controls (task 1: 83 vs. 75.5%; task 2: 92 vs. 85%). The decision threshold and the draws to (simulated) decision were correlated (task 1: $r = .31$, $p = .008$; task 2: $r = .28$, $p = .02$).

As predicted by the LA account, no group differences occurred for task 3: patients and controls did not differ on the extent of JTC, or the mean draws until a definite rating was made.

As can be seen in Figure 1, the groups did not differ on probability estimates in task 1 in the course of the 10 beads: both groups underestimated the correct probabilities (e.g. the objective probability for the first bead is 80%). The mixed ANOVA with group as between-subject analysis and trial number as within-subject analysis with probability estimates as dependent variable did not yield any group differences ($p > .8$) or a significant interaction of group × trial number ($p > .5$). However, the main effect of trial number was significant ($p < .001$) because of a rather monotonous increase of probability estimates in the course of the 10 beads, which was only interrupted twice by conflicting evidence. Again, paranoid patients did not differ from non-paranoid and healthy patients with respect to probability estimates.

Subjective evaluation

Subjective evaluation was administered following completion of task 2. Five controls (13.5%) and one schizophrenia patient (2.7%) did not respond to the question (for one of the healthy controls, this was because he did not decide at all on subtask 2).

No group differences emerged with regard to reasons why a decision was made: the interaction between the nominal variables group and response type (*the chosen jar was the most likely*, *the rejected jar was too improbable*, *participant aimed to end the task as fast as possible*, *task was not understood*, other reason) was not significant, $\chi^2(5) = 5.84, p > .3$. Most often, participants decided on a jar because this was actively favoured (patients: 70.3%; controls: 64.9%). Endorsement of a jar subsequent to a rejection of the alternative was rated by a minority of participants (patients: 13.5%; controls: 16.2%). An early decision in order to rush through the task was reported by two of the patients (5.4%). Only one healthy participant stated that he did not understand the task (2.7%). Miscellaneous reasons were provided by two patients and two control participants (5.4%).
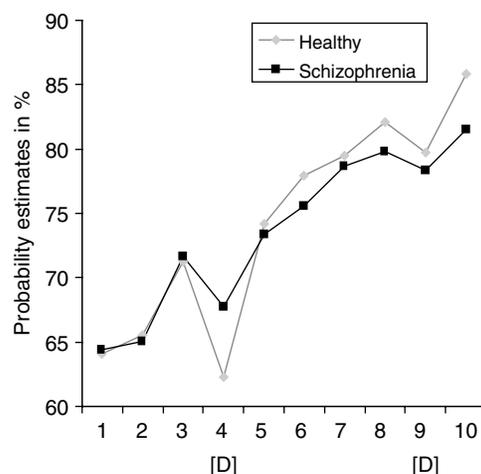

Figure 1. Patients with schizophrenia and healthy controls do not differ with respect to their probability estimates in the course of subtask 1. Probability estimates are decreased for beads 4 and 9 because here the beads were of the less frequent colour (D = disconfirmatory evidence). All probability estimates presented are for jar A.

Discussion

The present results support a LA account of decision making in schizophrenia. According to this account, JTC in schizophrenia is confined to less ambiguous situations. The well-replicated JTC bias in schizophrenia patients was observed using both a graded estimates (task 1) and a draws to decision version of the beads task (task 2), with both involving presentation of two jars. This confirms that the JTC performance pattern can be elicited by different task versions, and that the JTC bias does not reflect poor motivation. That premature task termination reflects a reasoning bias rather than poor motivation is further supported by the subjective evaluation data: only two patients (5.4%) said that they ended task 2 because they wanted to rush through the procedure.

To test whether JTC is ubiquitous or confined to low ambiguity situations, we designed a third task for which participants were presented with four jars. Here, the LA account predicts an absence of group differences, because multiple alternatives with closer ratios are expected to create greater ambiguity in schizophrenia patients owing to a low acceptance threshold. Put differently, with a lax criterion, more alternatives seem plausible/surpass a threshold of acceptance (Moritz & Woodward, 2004, p. 67).

The order of test administration was not randomized, because we first wanted to familiarize participants with the basic task before turning to the more complex procedure. Thus, the abolishment of the JTC bias could reflect practice or order effects. However, in an earlier study, where three experiments each using two jars were presented in fixed order (Moritz & Woodward, 2005), group differences remained stable over the course of the trials. In fact, for paranoid patients there was even evidence for stronger JTC in the long run. Similarly, for the present experiment, no attenuation of group differences occurred from task 1 to task 2. Therefore, it is unlikely that our finding can be attributed to a simple order effect, although randomization would have addressed this antithesis directly. For future research, this potential confound could be addressed by using tasks that are more easily comprehended (eg. Moritz *et al.*, 2006).

Further support for the LA account comes from the probability data: patients translated probability ratings more liberally into a decision than controls. Correlational analyses confirmed that decision threshold and draws to decisions were, indeed, related. Since both groups largely underestimated the base rates (see Figure 1), a JTC bias can clearly not be taken as evidence for better Bayesian reasoning in patients, as has been argued by some theorists (Maher, 1999). When taking into account the underestimation of probability estimates, the threshold applied by patients implies a reasoning style that is, in fact, more risky.

The findings from task 3 fit nicely with a recent study from which the predictions for the present study were initially derived (Moritz & Woodward, 2004). Using TAT pictures, schizophrenia patients endorsed more of the three or six interpretations per picture as excellent or good while at the same time ruling out fewer interpretations. A JTC bias, in the sense of more single excellent interpretations per picture, was more pronounced in healthy controls, which can be accommodated with the LA account. The LA account holds that patients make use of less information for making logical inferences than controls, which, importantly, does not imply hasty *decision* making but rather that patients more easily accept (response) options as a valid hypothesis *among others*. A decision is reached once the threshold is surpassed by only one alternative. With multiple, less discrepant choices, however, more interpretations are likely to surpass a level of acceptance, and thus create ambivalence (for predictions of the LA

account on different scenarios see Figure 2). Ambivalence is also a well-known symptom of schizophrenia spectrum disorders and has been part of the four A's proposed by Bleuler (Bleuler, 1911; Meehl, 1989).

Before turning to the theoretical implications of the findings, several shortcomings must be noted. First, the present findings should be replicated with psychiatric controls to demonstrate that LA is confined to schizophrenia and not psychiatric liability as such. Steps in this direction have already been made (Woodward, Moritz, Cuttler, & Whitman, 2006). Second, as noted, future studies may utilize a larger range of response options, after some basic comprehension of the task set-up has been achieved, and these tasks should be administered in a random order.

What do the present findings imply for our pathogenetic understanding of schizophrenia? First, a low threshold of acceptance leads to over-acceptance of false hypotheses, which healthy people are more likely to reject. Once these false interpretations are contemplated, they might be further strengthened through new 'evidence', which may be attracted by means of a confirmation bias (Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002), or a bias against disconfirmatory evidence (Woodward, Moritz, & Chen, 2006; Woodward, Moritz, Cuttler *et al.*, 2006) that seeks to consolidate the working hypotheses. Such an outcome becomes more likely as the difficulty for validating the correct hypothesis increases. Thus, the emphasis of the LA account is not on quick termination of the data gathering process *per se*, but on lax criteria for judging hypotheses, which in conjunction with other biases may lead to the acceptance of a false hypothesis. Quick termination of data collection occurs only under some conditions; namely, when only one option passes the acceptance threshold.
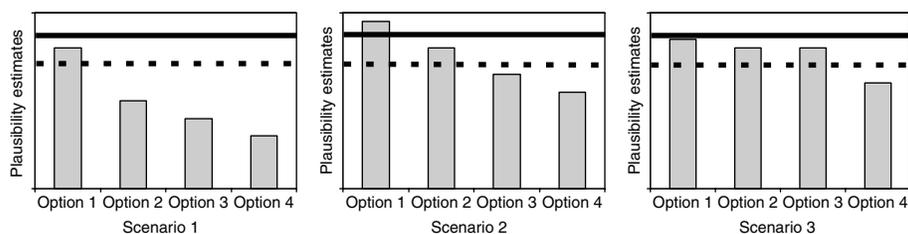

Figure 2. Hypothesized effects of liberal acceptance (LA) on decision-making. The height of the four columns represents subjective plausibility scores for three different scenarios (e.g. probabilities for four alternatives, such as in task 3 in the current study). For convenience we applied the same plausibility values for the two groups, which, at least for the beads task, seems a valid assumption (see Fig. 1). The horizontal lines represent the acceptance thresholds for the two groups, which are theorized to be significantly lower in patients. The solid line represents the acceptance threshold for the healthy controls, and the dotted line that for the schizophrenia patients. For Scenario 1, option 1 surpasses the acceptance threshold in patients only, leading to a (hasty) decision (JTC bias) in patients. In contrast, none of the four options reaches the acceptance threshold of the controls so that no decision is made on this trial. In Scenario 2, LA even leads to greater ambivalence in patients relative to controls (see Moritz & Woodward, 2004, for an example, although this pattern has not yet been observed in a version of the beads task). In Scenario 3, multiple options surpass the acceptance threshold of schizophrenia patients creating strong ambiguity, whereas none of the options provide strong enough evidence for healthy controls to accept. For this scenario, no differential response pattern for decision-making, and no JTC bias would be observed (task 3). With respect to the typical two-jar beads task, it is important to note that for both Scenarios 1 and 3, a JTC bias in schizophrenia patients would be observed if only options A and D were presented.

Liberal acceptance is seen as a vulnerability rather than a state factor paranoid schizophrenia that is present in patients with a liability to psychosis and delusion formation. This predicts that LA should be confined to patients who currently or in the past have displayed (paranoid) delusions. In cases where only two alternatives are presented (as in the case of false memories; e.g. I imagined this vs. I experienced this) a false decision may be reached quickly. It is also possible that the heightened ambiguity created by a lowered threshold (in the case of multiple competing alternatives) is later counteracted by means of a 'need for closure' style (Colbert & Peters, 2002), which may serve as a coping strategy to decrease the standstill generated by rivalling ideas: the subject may exclude some hypotheses because of intolerance to uncertainty, and the most negative scenario is chosen to prepare oneself for the worst.

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