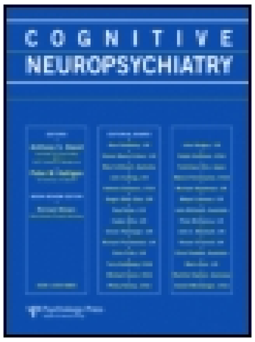

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Hopping, skipping or jumping to conclusions? Clarifying the role of the JTC bias in delusions

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Introduction. There is substantial evidence that patients with delusions exhibit a reasoning bias—known as the "jumping to conclusions" (JTC) bias—which leads them to accept hypotheses as correct on the basis of less evidence than controls. We address three questions concerning the JTC bias that require clarification. Firstly, what is the best measure of the JTC bias? Second, is the JTC bias correlated specifically with delusions, or only with the symptomatology of schizophrenia? And third, is the bias enhanced by emotionally salient material?
Methods. To address these questions, we conducted a series of meta-analyses of studies that used the Beads task to compare the probabilistic reasoning styles of individuals with and without delusions.

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Results. We found that only one of four measures of the JTC bias—"draws to decision"—reached significance. The JTC bias exhibited by delusional subjects—as measured by draws to decision—did not appear to be solely an epiphenomenal effect of schizophrenic symptomatology, and was not amplified by emotionally salient material.

Conclusions. A tendency to gather less evidence in the Beads task is reliably associated with the presence of delusional symptomatology. In contrast, certainty on the task, and responses to contradictory evidence, do not discriminate well between those with and without delusions. The implications for the underlying basis of the JTC bias, and its role in the formation and maintenance of delusions, are discussed.

INTRODUCTION: THE "JUMPING TO CONCLUSIONS" BIAS

Delusions are currently defined as "belief[s] based on incorrect inference" (American Psychiatric Association, 1994, p. 765). Accordingly, one significant approach to the explanation of delusion hypothesises that a reasoning bias contributes to delusion formation and/or retention. The seminal articulation of this hypothesis is that of Garety and colleagues (e.g., Garety & Freeman, 1999; Garety & Hemsley, 1994) who have proposed that at least some individuals with delusions possess a reasoning style characterised by "a tendency or bias to the early acceptance and, to a lesser extent, the early rejection of hypotheses" (Garety & Freeman, 1999, p. 127). Such a reasoning style has been encapsulated in the phrase "jumping to conclusions" (hereafter "JTC"). A JTC style is generally considered to be only one of a number of factors that potentially contribute in complex ways to the formation and retention of delusions (e.g., Garety, Hemsley, & Wessely, 1991; Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001). Other contributors may include personality, affective, motivational, and perceptual factors, the relative importance of which will vary from patient to patient. As Garety and Freeman (1999) note, the nature of such models makes it difficult to generate clear predictions about group differences. Nonetheless, a substantial body of research has found evidence of a JTC bias in patients with delusions. In a review of the JTC literature, Garety and Freeman (p. 147) concluded that there is "strong support for a reasoning bias in people with delusions which is best described as a data-gathering bias, a tendency for people with delusions to gather less evidence than controls so that they jump to conclusions".

Whether a JTC bias plays a causal role in delusion formation remains contentious. While suitably cautious, Garety and Freeman (1999, p. 127) speculate in favour of a causal relation. They suggest that a JTC reasoning style may "under certain conditions, contribute to erroneous inferences and, therefore, to delusion formation". Other researchers concur (e.g., Colbert & Peters, 2002; Dudley, John, Young, & Over, 1997a; Linney, Peters, & Ayton, 1998; McGuire, Junginger, Adams, Burright, & Donovick, 2001; Peters & Garety, 2006; van Dael, Vermissen, Janssen, Myin-Germeys, van Os, & Krabbendam, 2006). A JTC bias has also been suggested as a possible contributory factor in several well-known multifactorial accounts of the formation of specific categories of delusion, for example, persecutory delusions (e.g., Bentall, Corcoran, Howard, Blackwood, & Kinderman, 2001) and the Capgras delusion (e.g., Young, 2000). The claim that a reasoning bias contributes to the formation of delusions has also had an impact on the development of cognitive therapies for delusions, some of which now target the reasoning processes thought to be involved in delusional belief formation and the maintenance of those beliefs (see Rector & Beck, 2002).

WHAT IS THE JTC BIAS?

Dependent variables used to measure JTC

Investigation of a JTC bias in patients with delusions has been primarily conducted within a Bayesian reasoning framework in which participants assess the probabilities of events on the basis of empirical evidence. In the paradigmatic experimental task—the Beads task—participants are told that beads will be drawn from one of two jars. The jars contain beads of two different colours, in complementary ratios, for example, 85:15 red to green, versus 85:15 green to red. (In various manipulations of the task, different stimulus pairs are substituted for the two bead colours, or the ratios of the two types of stimuli are changed.) Participants are shown the beads supposedly being drawn from the jar, the selection of which is actually predetermined, and are required to guess from which jar they are being drawn. The central prediction of the task is that if delusional patients do in fact have a JTC tendency, they will make a guess about the jar more quickly, or with greater certainty, than controls.

To assess these predictions, two different methodologies have been used. In the "draws to decision" methodology, participants request as many beads as they deem necessary to decide from which jar the beads are being drawn. The prediction is that patients with delusions will require significantly fewer beads to "draw to decision" than control groups. A small number of studies have used the related dichotomous variable of "extreme responding", that is, requiring only one (or sometimes two) beads to make a decision. In the "draws to certainty" methodology, all participants see the same number of beads, and this number is predetermined by the experimenter. After each bead draw, participants are asked how certain they are that the beads are being drawn from a particular jar. The variables of interest are the number of draws required to reach a high level of certainty, and/or the mean level of certainty on the early trials of the task. A variant of this procedure is the "graded estimates" approach. Here, after each trial the participant is asked whether the bead is definitely, almost certainly, or probably from jar A or B, or whether there is currently no preference.

The "draws to certainty" methodology is also used to assess a second prediction of the JTC hypothesis, that patients with delusions will be more likely than controls to reject hypotheses in response to contradictory evidence (Garety & Hemsley, 1994). In what we refer to as "response to potentially disconfirmatory evidence", the dependent variable is the change in certainty in response to a single bead that potentially disconfirms the participant's likely hypothesis. For example, Garety et al. (1991) calculated participants' certainty after Bead 3 (the third of three pink beads) minus certainty after Bead 4 (the first green bead), as a measure of "response to potentially disconfirmatory evidence".

Some researchers have also examined participants' change in certainty when, in the latter half of the experiment, the evidence is genuinely disconfirmatory. Participants are presented with a sequence of beads such as the one below:

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

In this sequence, the first 10 beads suggest that beads are being drawn from the "mostly As" jar, while the second 10 beads suggest that the beads are being drawn from the "mostly Bs" jar. It is then assessed whether patients with delusion are the same as, or different from, control groups in the way they lose confidence in their initial hypothesis. We refer to this dependent variable as "response to reversal".

The range of dependent variables used to tap JTC reflects uncertainty in the literature regarding what, precisely, are useful and valid measures of "jumping to conclusions". There appears to be consensus that hastiness in decision making derives from a lower threshold for amount of information required (measured by the dependent variable "draws to decision"), rather than a bias in reasoning about probabilities per se (e.g., Dudley, John, Young, & Over, 1997b; Garety & Freeman, 1999; Moritz, Woodward, & Hausmann, 2006; Peters, Thornton, Siksou, Linney, & MacCabe, 2005). However, "draws to certainty" has been used as a measure of JTC bias in several recent studies (e.g., Moritz & Woodward, 2005; Peters & Garety, 2006; Peters et al., 2005). The issue of whether or not "draws to certainty" predicts the presence of delusions is an important one, since the answer could constrain in significant ways our understanding of the JTC phenomenon. Finally, it is not clear whether the JTC phenomenon should also be taken to include a tendency to "jump to new conclusions", indexed by the dependent variables "response to potentially disconfirmatory evidence" and "response to reversal". After all, one feature of delusional beliefs is their apparent incorrigibility in the face of contradictory evidence (e.g., American Psychiatric Association, 1994). One might then expect patients with delusions to be *less* responsive to contradictory evidence than controls (e.g., Moritz & Woodward, 2005). Thus whether or not the JTC bias observed in patients with delusions is restricted to the initial formation of a hypothesis, or also extends to the individual's response to later evidence, is also an important question.

Theoretical accounts of the JTC bias

Determining which putative measures of JTC are statistically reliable in distinguishing between those with and without delusions is of critical importance if we are to refine theoretical accounts of the underlying cause of the JTC bias. Accounts of the information processing style hypothesised to be responsible for patients' tendency to jump to conclusions fall into two main categories that we will refer to as "information integration" and "motivation" accounts. We discuss them in turn.

The "information integration" account of Menon and colleagues (Menon, Woodward, Pomarol-Clotet, McKenna, & McCarthy, 2005; Menon, Pomarol-Clotet, McKenna, & McCarthy, 2006), for example, extrapolates from the suggestion that in schizophrenia, currently experienced stimuli are imbued with an abnormal salience (Kapur, 2003). As a consequence of this abnormal stimulus valuation, patients inappropriately weight evidence in the Beads task. As a result, the decision-making threshold is crossed more quickly. In another account of this type, Bentall and Young (e.g., Young & Bentall, 1995) have proposed that delusional patients have difficulty making use of sequential information. According to this account, they make hasty decisions on the Beads task in order to avoid making a judgement on the basis of a sequence of information.

If the cause of a JTC style is placing too much value on a current piece of evidence (as proposed by Menon and colleagues), then one should see both reduced "draws to decision" as well as reduced "draws to certainty" on the grounds that if a current piece of evidence is overvalued then this should give rise both to hastiness in judgement as well as an inflated confidence in one's hypothesis. In addition, this account predicts that delusional patients will also "jump to new conclusions" because they overvalue current stimuli relative to beads that have gone before. Thus confidence in their initial hypothesis should diminish significantly more than controls following disconfirmatory evidence. By contrast, it seems to us that a difficulty in processing sequential information (as suggested by Bentall and colleagues) predicts hastiness in decision making, but does not imply that delusional patients will have greater confidence in their hypotheses, or that their confidence will be unusually influenced by disconfirmatory evidence.

In contrast to "information integration" accounts of the JTC bias, "motivation" accounts hypothesise that patients' hasty reasoning style arises from a motivation to confirm beliefs. Bentall et al. (2001), for example, have suggested that the JTC bias arises from a "need for closure". The need for closure (NFC; Kruglanski & Webster, 1996) is the "desire for definite knowledge on some issue and the eschewal of confusion and ambiguity" (p. 278). Individuals with an NFC are thought to consider less evidence before making a decision, entertain fewer hypotheses, experience greater certainty about their judgement and cling to it, "becoming impervious to subsequent data" (p. 265). If the JTC bias arises from an enhanced NFC, then it should manifest in reduced "draws to decision" and "draws to certainty", and in greater stability in the level of confidence following contradictory evidence.

Dudley and Over (2003) have recently suggested that a high NFC in delusional patients reflects a need for "threat confirmation", and is part of a "confirmatory reasoning style". The JTC bias, in their view, arises from this confirmatory style of reasoning: "people without delusions demonstrate a normal tendency to confirm danger-related conditional statements [but] people with delusions perceive danger and threat where others do not. Hence, this normal reasoning style is extended to non-threatening situations" (Dudley & Over, 2003, p. 263). This account predicts reduced data gathering in patients with delusions (since they are hypothesised to be less motivated to find evidence that disconfirms their hypothesis). However, it is not clear that Dudley and Over's position predicts any differences in certainty ratings in either confirmatory or disconfirmatory phases of the Beads task. Their position, therefore, predicts that delusional subjects will require fewer "draws to decision" but not fewer "draws to certainty" compared to controls.

Summary

Theoretical understanding of the JTC bias currently lacks precision. Different studies have used different dependent measures to tap a JTC bias and it is not yet clear which measure(s) best discriminate between subjects with and without delusions. Reflecting this uncertainty, current accounts of the cause underlying the tendency to jump to conclusions differ in the predictions they make regarding how the JTC bias should manifest in patients with delusions. An investigation into which of these measures best discriminates the reasoning style of delusional patients from controls is needed therefore to clarify the nature of the putative JTC bias in delusion, and to indicate viable accounts of an underlying mechanism.

STUDY 1: A META-ANALYTIC COMPARISON OF DEPENDENT MEASURES OF THE JTC BIAS

The aim of Study 1 was therefore to address the question of which operational definition(s) of the JTC bias best discriminate between individuals with and without delusions.

"Draws to decision" and "draws to certainty" are the most frequently utilised measures of JTC. In their review, Garety and Freeman (1999) concluded that "draws to decision" successfully discriminates between the presence and absence of delusions, but "draws to certainty" does not. To date, 10 studies have used the "draws to decision" procedure. Six of these studies demonstrated significant differences between patients with delusions and psychiatric controls (Dudley et al., 1997a,b; Fear & Healy, 1997; Moritz & Woodward, 2005[1]; Peters & Garety, 2006; Peters et al., 2005). The remaining four studies demonstrated significant differences with nonpsychiatric controls (Conway et al., 2002[2]; Garety et al., 1991; Huq, Garety, & Hemsley, 1988; Menon et al., 2006).[3]

Six studies have used the "draws to certainty" or similar procedures. Garety et al. (1991) found no significant differences between patients with delusions and either psychiatric or nonpsychiatric controls using this procedure. Peters et al. (2005) found no differences on this measure between psychiatric patients grouped according to the presence or absence of delusional symptomatology. Similarly, Moritz and Woodward (2005), using the "graded estimates" procedure, found no differences between patients with schizophrenia grouped according to the presence or absence of delusional symptomatology. Using the same measure, Young and Bentall (1997) found mixed support for a difference between patients with delusions and nonpsychiatric controls (using both standard and emotionally salient versions of the Beads task), but observed no differences in comparisons with depressed psychiatric controls. Fear and Healy (1997) found a significant difference between patients with delusions and psychiatric controls with obsessive-compulsive disorder (OCD). However, the patients with delusions did not differ from the nonpsychiatric controls, and the patients with OCD required a significantly greater "draws to certainty" than did nonpsychiatric controls. This suggests that the significant difference in "draws to certainty" observed between the patients with delusions and the patients with OCD should perhaps be attributed to increased "draws to certainty" in the latter

[1] However, no significant differences were found in comparison with a nondelusional group with schizophrenia.

[2] No psychiatric control group was used.

[3] For the harder 60:40 ratio. However, no significant differences were observed in comparison with a nondelusional group with schizophrenia, or when a memory aid was provided.

group (see Pélissier & O'Connor, 2002; Volans, 1976; also Dudley & Over, 2003), rather than a reduction in the delusional group, relative to normal nonpsychiatric performance. The only unambiguous support for reduced "draws to certainty" in patients with delusions comes from Peters and Garety (2006), who found that their delusional group showed a significantly greater mean certainty over the first three trials than did both psychiatric and nonpsychiatric controls.

Overall, it appears that "draws to certainty" does not discriminate well between the presence or absence of delusions once the confounding effects of psychiatric symptomatology are taken into account. From this it has been inferred that patients with delusions have a tendency to seek less information prior to reaching a decision (and thus have a reduced "draws to decision"), rather than a tendency to differ with respect to certainty (Dudley et al., 1997b; Garety & Freeman, 1999). In line with this conclusion, a number of studies have demonstrated that patients with delusions show normal sensitivity to variations in the ratio of beads in the Beads task. Thus when the ratio of different coloured beads in the jar is changed (for example, reduced to 60:40) patients with delusions, like controls, appropriately change the number of beads they require for a decision or for certainty (e.g., Dudley et al., 1997b; Young & Bentall, 1997).

Five studies have used "responses to potentially disconfirmatory evidence" as a dependent variable. The majority of these found that individuals with delusions become significantly less certain about their hypotheses following potentially disconfirmatory evidence in comparison with nonpsychiatric, but not psychiatric, control groups (Fear & Healy, 1997; Garety et al., 1991; Peters & Garety, 2006; Young & Bentall, 1997). One exception is Moritz and Woodward (2005), who found that this dependent variable distinguished between delusional patients with schizophrenia and nondelusional patients with schizophrenia, as well as psychiatric and healthy controls.

A fourth variable, "responses to reversal", has also been used as a measure of a JTC style. Overall, the evidence from studies using this variable also offers little support for the idea that patients with delusions "jump to new conclusions". Three studies using this measure found no significant differences between patients with delusions and control groups (Dudley et al., 1997b; Fear & Healy, 1997; Young & Bentall, 1997). Moritz and Woodward (2005) found some evidence of greater adjustment of certainty responses in delusional patients with schizophrenia compared with psychiatric and nonpsychiatric controls. However, significant effects were not observed for all disconfirmatory beads (only two of the eight beads in the latter half of the experiment that disconfirmed the original hypothesis), and no significant differences were seen when these patients were compared with nondelusional patients with schizophrenia. Brankovic and Paunovic (1999) found that delusional patients showed significantly *smaller* "responses to reversal", compared with both psychiatric and nonpsychiatric controls, but this may be due to their unconventional method of quantifying this putative measure of JTC.

Garety and Freeman (1999, p. 131) have concluded that "people with delusions may be more ready to abandon existing hypotheses and form new ones, again on the basis of little evidence". Relating this hypothesised manifestation of the JTC bias to the clinical setting, Moritz and Woodward (2005, p. 204) noted that "many deluded schizophrenic patients dramatically switch their attitude towards the persecutor or persons embedded in the paranoid belief". However, as noted by Peters and Garety (2006) and indicated by the data reviewed above, it is not clear that measures of response to contradictory evidence do in fact often successfully differentiate between delusional and other psychiatric control groups. The data justify some suspicion as to whether increased "response to potentially disconfirmatory evidence" is actually associated with delusions, or merely with psychiatric symptomatology, and there is little evidence that patients with delusions show an increased "response to reversal".

A qualitative summary of the research thus suggests that a reduced number of "draws to decision" may be most strongly associated with the presence of delusions. The status of the variables "draws to certainty" and "response to potentially disconfirmatory evidence" are less clear, given the role psychiatric symptomatology appears to play in contributing to these effects. "Response to reversal" appears to find little support from the literature.

In order to provide a more objective evaluation of the association of different JTC measures with delusions, we conducted a meta-analysis. We were interested in three main questions. First, we investigated which dependent variable best discriminates between individuals with and without delusions. Second, we explored the impact of comparison group (psychiatric control vs. nonpsychiatric control) on effect size to establish whether psychiatric symptomatology contributes to the JTC effect. Third, in the case of evidence for an overall contribution from psychiatric symptomatology across all measures of JTC, we explored the effect of psychiatric symptomatology on each of the putative measures of JTC.

Method

Studies to be included in the meta-analysis were identified by carrying out an electronic search using the Medline and PsycInfo databases. Search terms used included: delusion, jumping to conclusions, reasoning. In addition, the review of Garety and Freeman (1999), and the reference lists of other more recent articles in this area, were used to identify potentially relevant publications. Finally, a reviewer, E. Peters, provided a number of important prepublications that were included in our study.

Studies included were those examining the association between clinical delusion symptomatology and reasoning bias by either (1) comparing a group of patients with delusions with a control group without delusions or (2) examining correlations between delusional symptomatology and reasoning within a clinical sample. One study, Brankovic and Paunovic (1999), was excluded on the grounds that highly unconventional measures of JTC were employed. We also did not include two studies that presented only the dichotomous dependent variable, "extreme responding" (Garety et al., 2005; van Dael et al., 2006). After searching the literature and screening for inclusion criteria, 47 effect sizes were extracted from 12 studies. The published studies included are summarised in Table 1. Effect sizes were also extracted from two additional studies that employed a subclinical "prone to delusions" group. These effect sizes are reported in the Results and Discussion of Study 2.

Effect sizes were calculated primarily from published means and standard deviations. Where these were not available, effect sizes were derived from reported statistics such as F, t, or r (see Rosenthal, 1991, for formula). The effect size estimate, g (Hedges, 1981), refers to the standardised difference between delusional and nondelusional groups' performance on a single measure from the Beads task and is reported for each study in Table 1. In cases where studies reported repeated testing or effects relating to manipulations not of concern to the present investigation (e.g., bead ratio, presence of a memory aid), separate estimates of effect size were first computed before being combined using the arithmetic mean (Rosenthal, 1991). However, for some studies, more than one effect size was extracted. We included all available effects from a particular study relating to our moderators of interest, study design, and dependent variable. Although caution has been advised regarding the analysis of nonindependent effects (e.g., Rosenthal, 1991), it has been argued that violation of the assumption of independence has little effect on statistical precision (Tracz, Elmore, & Pohlmann, 1992).

The meta-analysis employed procedures described by Rosenthal (1991). Two types of analysis were used. In order to assess whether the pooled data from several similar published studies jointly achieved significance, reported effects were combined using the method of adding Z's (the Stouffer method; Mosteller & Bush, 1954). In order to assess whether a moderator variable had a reliable effect on the results of published studies, reported effects were compared using focused comparisons (Rosenthal & Rubin, 1982).

TABLE 1

Summary of published studies examining the association between clinical delusion symptomatology and reasoning bias included in the meta-analyses

	Design: Groups		*Effect size (g)*			
Reference	*Delusional*	*Control*	*Decision*	*Certainty*	*Pot. Disc.*	*Reversal*
Huq et al. (1988)	Schizophrenia	Psychiatric	0.94			
		Nonpsychiatric	1.00			
Garety et al. (1991)	Schizophrenia	Psychiatric	0.74	−0.22	0.31	
		Nonpsychiatric	1.15	0.42	0.19	
	Delusional disorder	Psychiatric	0.27	0.32	0.62	
		Nonpsychiatric	0.74	1.10	0.35	
Mortimer et al. (1996)	Schizophrenia[a]	Schizophrenia without delusions[a]	−0.37			
Dudley et al. (1997a)	Schizophrenia	Psychiatric	0.88			
		Nonpsychiatric	0.96			
Dudley et al. (1997b)	Schizophrenia	Psychiatric	1.32			0.32
		Nonpsychiatric	1.43			0.43
Fear & Healy (1997)	Delusional disorder	Psychiatric[b]	0.98	1.72	0.00	−0.04
		Nonpsychiatric	0.96	0.18	0.84	0.00
Young & Bentall (1997)	Schizophrenia[c]	Psychiatric		0.03[d]	0.13	−0.06
		Nonpsychiatric		0.46[d]	0.82	0.35
Conway et al. (2002)	Delusional disorder	Nonpsychiatric	0.96			
Menon et al. (2006)	Schizophrenia	Schizophrenia without delusions	0.12			
		Nonpsychiatric	0.34			
Moritz & Woodward (2005)	Schizophrenia	Schizophrenia without delusions	0.14	−0.22[d]		
		Psychiatric[e]	0.79	0.50[d]		
		Nonpsychiatric	0.82	0.35[d]		

	Design: Groups		*Effect size (g)*			
Reference	*Delusional*	*Control*	*Decision*	*Certainty*	*Pot. Disc.*	*Reversal*
Peters & Garety (2006)[f]	Mixed	Mixed without delusions	1.49	−0.60	0.23	
Peters et al. (2005)[f,g]	Mixed	Psychiatric	–		–	

Effect sizes (g) are reported by study design and dependent variable. The studies included are marked in the reference section with an asterisk.

Pot.Disc. = Response to potentially disconfirmatory evidence.

[a]Mortimer et al. (1996) employed a correlational design to examine the relationship between draws to decision and delusional items of the CASH.

[b]Psychiatric controls had OCD.

[c]The delusional group had predominately a diagnosis of schizophrenia (58%). The remainder had delusional disorder.

[d]The "graded estimates" procedure was used. Effect sizes are for "definitely the bag with..." judgements, unless insufficient data was available in which case "almost certainly the bag with . . ." was used (Young & Bentall, 1997, Exp. 2).

[e]39% of the psychiatric control group had OCD.

[f]A symptom-based approach was employed in these studies. The delusional group had mixed diagnoses, containing at least 50% patients with schizophrenia.

[g]Insufficient data were reported to compute an effect size. However, this study was included in tests in which p values were meta-analytically pooled.

Results and discussion

Figure 1 illustrates how published effect sizes varied by measure of JTC and by type of nondelusional control group. Focused comparisons confirmed that the effect size for "draws to decision" was significantly larger than the effect size for "draws to certainty" ($Z = 3.79$), "response to potentially disconfirmatory evidence" ($Z = 3.14$), and "response to reversal" ($Z = 4.22$, all p values $< .001$). No significant differences were observed between any other JTC measures (all p values $> .1$).[4]

A significant effect of comparison group was also found, with significantly smaller effect sizes for comparisons between delusional patients and psychiatric controls, than with nonpsychiatric controls ($Z = 2.16$, $p = .015$). To explore further the effect of comparison group, for each JTC measure the data from the more rigorous delusional patients vs. psychiatric control comparison were meta-analytically pooled. This revealed a significant effect for both "draws to decision" ($Z = 6.63$, $p < .001$) and "draws to certainty" ($Z = 3.17$, $p < .001$). This latter result contrasts with the qualitative review for this dependent variable which revealed little evidence in support of an effect (see also Garety & Freeman, 1999). It was noted, however, that the data from the delusional patients vs. psychiatric control comparison in the Fear and Healy (1997) study made a substantial contribution to this effect size ($g = 1.72$). As noted previously, in this study the psychiatric control group comprised patients with OCD who required significantly *more* "draws to certainty" than did nonpsychiatric controls. Excluding the Fear and Healy data from the analysis eliminates the significant effect for the "draws

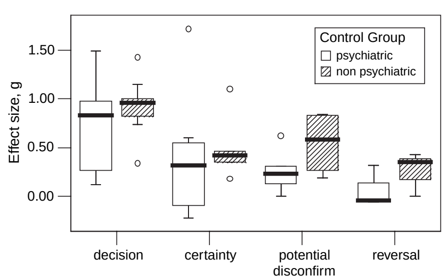

Figure 1. The distribution of effect sizes (g) by type of control group and dependent variable.

[4] This pattern of significance and nonsignificance also remained after Bonferroni correction for multiple comparisons ($n = 6$).

to certainty" measure ($Z = 1.35$, $p = .088$) by reducing the mean effect size, g, from 0.39 to 0.17.

There was a marginal effect for "response to potentially disconfirmatory evidence" ($Z = 1.59$, $p = .056$), which did reach significance for a comparison with nonpsychiatric controls ($Z = 3.31$, $p < .001$). There were no significant effects for "response to reversal", either in comparison with psychiatric controls ($Z = 0.31$, $p = .38$) or nonpsychiatric controls ($Z = 1.25$, $p = .105$).[5]

The aim of Study 1 was to determine which measure of JTC bias best discriminates between individuals with and without delusions. Consistent with the qualitative review above, and with the conclusions of the Garety and Freeman (1999) review, the effect size for the dependent variable "draws to decision" was significantly greater than those for the other three putative measures of JTC. Thus, a tendency to request fewer beads before making a decision appears to best characterise the behaviour of people with delusions as against those without. In line with previous conclusions (Dudley et al., 1997b; Garety & Freeman, 1999), our findings concerning "draws to certainty" suggest that delusional patients do not differ from controls in their certainty judgements, at least as measured by the Beads task.

It is not clear how best to interpret the trend to significance observed for the JTC measure "response to potentially disconfirmatory evidence". This result provides marginal support for the idea that patients with delusions show greater reductions in certainty than controls in response to evidence that potentially disconfirms their hypotheses. However, it clearly does not discriminate between the presence and absence of delusion as well as the "draws to decision" measure and disappears when corrected for multiple comparisons. A decision to interpret the findings as significant, however, would raise the question of why what appears to be a conceptually similar measure of JTC—"response to reversal"—does not predict the presence of delusions. If delusional patients are thought to show greater reductions in certainty in response to potentially disconfirmatory evidence, there is no clear theoretical reason why they should not also change their minds more quickly than comparison groups, in response to actually disconfirmatory evidence. Taken together, then, the findings from the measures of "response to potentially disconfirmatory evidence" and "response to reversal" suggest that delusional patients are no more likely than comparison groups to "jump to new conclusions".

The critical feature of patients with delusion thus appears to be specific to a tendency to make a decision on the basis of less evidence than comparison groups.

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[5] Bonferroni correction for repeated significance testing ($n = 8$) did not affect this pattern of results other than to confirm the nonsignificance of "response to potentially disconfirmatory evidence" for comparisons with psychiatric controls.

IS THE JTC BIAS AN EPIPHENOMENAL EFFECT?

The results of Study 1 suggest that the presence of psychiatric symptomatology contributes to the JTC reasoning style. It further shows that the measure "draws to decision" unambiguously taps an effect that supersedes this contribution. However, a potential confound remains. The majority of JTC studies involve patients with delusions who are diagnosed with schizophrenia and as Menon et al. (2006), for example, have noted, the cognitive skills commonly impaired in schizophrenia are likely to affect the performance of reasoning tasks (e.g., memory, attention, and executive functions; see Sharma & Harvey, 2000). Thus, a bias in reasoning observed in delusional patients with schizophrenia may be a behavioural outcome of one or more cognitive deficits in schizophrenia and not causal in the formation of their delusions. In line with this epiphenomenon view, some studies have found evidence suggestive of an interaction between schizophrenic symptomatology and task demands, which may contribute to the observed JTC effect in patients with schizophrenia (e.g., Menon et al., 2006; Moritz & Woodward, 2005; van Dael et al., 2006).

Three approaches have been utilised to address the problem of confounding factors in schizophrenia. First, and most directly, three recent studies have either used nondelusional patients with schizophrenia as a psychiatric control group for delusional patients (Menon et al., 2006; Moritz & Woodward, 2005), or have used the presence of delusions to distinguish between groups and then compared the performance of those with and without a diagnosis of schizophrenia (Peters et al., 2005). Second, a small number of studies have investigated reasoning in patients with delusions who have a diagnosis of delusional disorder (Conway et al., 2002; Fear & Healy, 1997; Garety et al., 1991). The advantage of using this population is the relative absence of possible confounding cognitive deficits. As Manschreck (2000, p. 1254) puts it: "In general, patients with delusional disorder show little disorganisation or impairment in their behaviour or in the clarity of their thinking." Third, some researchers have explored JTC style in nonclinical participants who experience high levels of delusional ideation or who are at above average risk of psychosis (Broome et al., 2003; Colbert & Peters, 2002; van Dael et al., 2006). We review the results of each of these approaches below.

JTC bias in schizophrenic patients with and without delusions

The first study to include delusional and nondelusional patients with schizophrenia was a correlational study (Mortimer et al., 1996). Mortimer et al. gave the Beads task to a group of patients with schizophrenia whose delusion scores ranged from 0 to 22 on delusional items of the Comprehensive Assessment of Symptoms and History (CASH; Andreasen, Flaum, & Arndt, 1992). This scale assesses range of delusional beliefs as well as degree of conviction, preoccupation, and extent to which the belief is acted upon. Despite the wide range of delusional symptomatology reported in their sample (from 0 to 22 on the CASH), Mortimer et al. found that 42% of patients required only one draw to decision, a proportion similar to that observed by Garety and colleagues. Moreover, number of draws to decision did not correlate with the CASH delusion score. As Mortimer et al. (1996; p. 301) noted, "[t]his suggests that abnormal probabilistic reasoning is a consequence of having schizophrenia rather than having the particular schizophrenic symptom of delusions". By contrast, however, van Dael et al. (2006) explored the association between JTC (indexed by "extreme responding") and the presence of delusions, and found evidence for a significant link between the two in their patient group.

Menon et al. (2006) compared the performance of delusional and nondelusional patients with schizophrenia on variants of the Beads task. In their first experiment they found no differences on "draws to decision" between delusional and nondelusional patients with schizophrenia nor indeed between any groups. There were slight procedural differences between the Menon et al. task and that used by Huq et al. (1988) and Garety et al. (1991). For example, in the original studies the beads, once drawn, were then hidden from view. However, in the Menon et al. study the beads remained in sight, thus providing a memory aid. In follow-up experiments, Menon et al. found significant differences between the groups with schizophrenia and nonpsychiatric controls when the original procedure was used. However, they found no significant differences between the delusional and nondelusional patients with schizophrenia. Furthermore, when the beads were left in sight (the memory aid condition), the differences between the groups disappeared. Menon et al. (2006; p. 533) thus suggested that "a key component of the 'jumping to conclusions' (JTC) effect relates to the memory demands imposed by the task". This study therefore supports the epiphenomenon view and, in particular, identifies memory demands as a possible contributory factor to the JTC effect observed in patients with schizophrenia (but see Dudley et al., 1997b, who found that the addition of a memory aid had no effect on the performance of patients with delusions).

A second recent study conducted by Moritz and Woodward (2005) also compared the performance of delusional and nondelusional patients with schizophrenia on the Beads task. The presence of delusional symptomatology did not distinguish between patients with schizophrenia on "draws to decision". Although Moritz and Woodward did find that delusional patients with schizophrenia were significantly more likely than nondelusional patients to make a decision on the basis of one bead (extreme responding), there was no significant difference between these two groups when decisions based on the second bead were compared.

The final study to examine the issue of whether or not a JTC bias is specific to the presence of delusions is that of Peters et al. (2005). Using a symptom-based approach, they found that the delusional group requested significantly fewer "draws to decision" in the first task (Condition 1). In contrast to the epiphenomenon view, there was no difference between delusional patients with and without a diagnosis of schizophrenia on "draws to decision".

JTC in delusional disorder patients

The first study including delusional disorder patients conducted by Garety et al. (1991) was somewhat inconclusive with regard to the relative performances of delusional patients with schizophrenia and those with delusional disorder. On the one hand, there were no significant differences in "draws to decision" or "responses to potentially disconfirmatory evidence" between these two groups (see Garety & Hemsley, 1994). This is consistent with a specific relationship between a JTC style and the presence of delusions, regardless of diagnosis. On the other hand, while a significant difference was seen between the patients with schizophrenia and nonpsychiatric controls on "draws to decision", no differences were seen between the delusional disorder patients and either control group. This is more consistent with the view that the JTC style is an epiphenomenon of schizophrenic symptomatology.

Fear and Healy (1997) found that patients with delusional disorder made significantly fewer "draws to decision" than an OCD group, a group with delusions and OCD, as well as nonpsychiatric controls. However, as noted earlier, patients with OCD may have a relatively overcautious reasoning style, which makes the psychiatric comparison difficult to interpret. In the third study of this sort, Conway et al. (2002) observed a reduced number of "draws to decision" in delusional disorder patients relative to nonpsychiatric controls. Unfortunately, the study did not include a psychiatric control group, leaving open the possibility that the performance of the patients with delusions was not due to the presence of delusion but to other factors present in psychiatric populations.

JTC bias in nonclinical populations

Research using nonclinical populations has found mixed evidence for the role of a JTC bias in delusion. Colbert and Peters (2002) found a JTC bias in psychiatrically healthy individuals scoring highly on the Peters et al. Delusions Inventory (PDI; Peters, Joseph, & Garety, 1999). Since this nonclinical population does not suffer from psychiatric symptomatology, Colbert and Peters have argued that this suggests that the reasoning bias observed in clinical populations is related to delusional ideation rather than schizophrenic symptomatology. It is important to note though that there is as yet no known relationship between scores on the PDI and the development of clinical delusions. Therefore, while suggestive, this work does not provide strong support for an association between a JTC bias and the presence of clinical delusions.

Interestingly, Broome et al. (2003, personal communication) recently found evidence of a JTC bias on hard versions of the Beads task (60:40 and 44:28:28 ratios) in individuals identified as having an "at risk mental state" of developing a psychotic illness (Yung et al., 1998). Since approximately 40% of young people so classified will go on to develop a psychotic illness (e.g., Phillips, Yung, & McGorry, 2000), this provides some support for an association between a JTC bias and vulnerability to mental illness likely to include delusional symptomatology. Similarly, van Dael et al. (2006) recently measured JTC (extreme responding) in four groups at increasing risk of psychosis liability: patients with schizophrenia or schizoaffective disorder; first degree nonpsychotic relatives of people with psychosis; and nonclinical participants with either an above average, or average, level of psychotic experiences. They found a dose-response relationship in the association between psychosis liability and JTC bias. However, unlike Broome et al. (2003) they found no evidence of a JTC bias in their "at-risk" nonclinical groups (nonpsychotic first-degree relatives of patients with psychosis, and psychiatrically healthy individuals reporting above average psychotic experiences), compared with not-at-risk controls.

STUDY 2: DETERMINING THE CONTRIBUTION OF SCHIZOPHRENIC SYMPTOMATOLOGY TO THE JTC BIAS

Given the equivocal data concerning the role of schizophrenic symptomatology in delusion, we attempted to quantify its contribution to the JTC bias using meta-analytic techniques. We tested predictions arising from both a *strong epiphenomenon view* (that the JTC effect is purely a consequence of schizophrenic symptomatology unrelated to the presence of delusions per se) and a *weak epiphenomenon view* (that schizophrenic symptomatology makes a significant contribution to the JTC effect). "Draws to decision" was used to test the predictions, as this was shown in the first study to be the most reliable measure of JTC bias.

Results and discussion

The strong epiphenomenon hypothesis. The strong epiphenomenon hypothesis was evaluated in two ways. First, we examined evidence for a JTC effect for schizophrenic patients with delusions in comparison with nondelusional schizophrenic controls. Evidence for a JTC effect would challenge the strong epiphenomenon hypothesis. When data for four studies that evaluated the association between delusions and "draws to decision" within a schizophrenic population were meta-analytically pooled (Menon et al., 2006; Moritz & Woodward, 2005; Mortimer et al., 1996; Peters et al., 2005[6]), evidence for a significant JTC effect was found ($Z = 1.73$, $p = .042$), contrary to the strong epiphenomenon position.

It was not possible to test the strong epiphenomenon prediction that there would be no significant JTC effect for delusional disorder patients in comparison with psychiatric controls. This was because only one study (Garety et al., 1991) used an appropriate psychiatric control group. The second test, therefore, was for a JTC effect in nonclinical populations prone to delusional ideation or at risk for development of delusions. "Draws to decision" effect sizes were retrieved from two studies employing nonclinical comparisons (Broome et al., 2003: $g = 0.90$; Colbert & Peters, 2002: $g = 0.80$). When these data were meta-analytically pooled, evidence for a significant JTC effect was found ($Z = 3.89$, $p = .003$), contrary to the strong epiphenomenon position. On the basis of these two results, we were able to reject the null hypothesis that the JTC effect is purely an epiphenomenal effect and went on to test predictions from the weak epiphenomenon position.

The weak epiphenomenon hypothesis. We tested four predictions arising from the weak epiphenomenon view. First, we tested the prediction that the effect size for the comparison between nondelusional and delusional patients with schizophrenia would be significantly smaller than the effect size arising from the comparison between delusional patients with schizophrenia and psychiatric controls. Figure 2 illustrates how effect size for published studies examining JTC in delusional patients with schizophrenia varies as a function of nondelusional control. The effect sizes for studies employing a psychiatric control group illustrated in Figure 1 have thus been partitioned into those involving nondelusional patients with schizophrenia and those involving

[6] This study employed a symptom-based approach involving clinical groups including a high proportion of patients with schizophrenia.

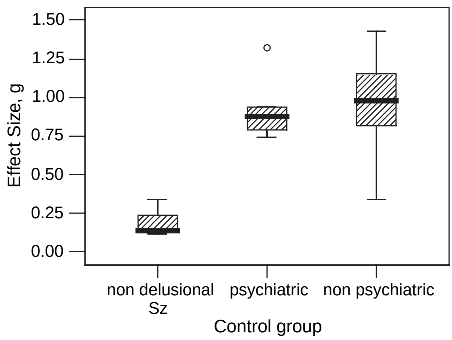

Figure 2. The distribution of "draws to decision" effect sizes (g) for studies comparing a group with schizophrenia and delusions with three types of control group. Data for the nondelusional schizophrenia control group also includes one study that employed a correlational design (Mortimer et al., 1996).

other psychiatric groups. The meta-analysis provided support for this prediction ($Z = 2.79$, $p = .003$).[7]

Second, we predicted that the effect size for delusional disorder patients compared with psychiatric controls would be significantly smaller than that for delusional patients with schizophrenia compared with psychiatric controls. Figure 3 illustrates how effect sizes for published studies examining JTC in delusional disorder compared with those examining JTC in schizophrenia. Marginal support was found for the prediction ($Z = 1.59$, $p = .056$).

Third, we tested the prediction that the effect size for delusional disorder patients compared with nonpsychiatric controls would be significantly smaller than that for delusional patients with schizophrenia compared with nonpsychiatric controls. As illustrated in Figure 3, the meta-analysis revealed no significant differences ($Z = 0.23$, $p = .41$) between these effect sizes.

Finally, we tested the prediction that the effect size for nonclinical populations would be significantly smaller than that for delusional patients with schizophrenia, in comparison with both psychiatric and nonpsychiatric controls. Meta-analytic comparisons failed to support this prediction. No significant differences were observed between effect sizes for nonclinical comparisons and comparisons between delusional patients with schizophrenia and psychiatric ($Z = 0.23$, $p = .41$) or nonpsychiatric controls ($Z = 0.28$, $p = .39$).

[7] Peters et al. (2005) was not included in this comparison because insufficient data was reported in this study to compute an effect size.

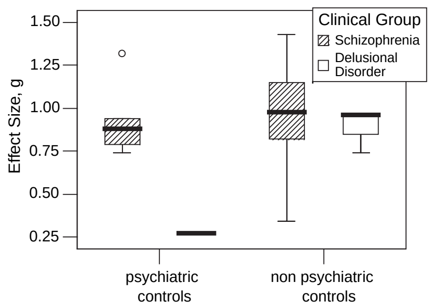

Figure 3. The distribution of "draws to decision" effect sizes (g) by type of clinical group with delusions and type of control group.

Our findings support the conclusion that a JTC bias, as represented by "draws to decision", is not entirely an artefact of schizophrenic symptomatology (contrary to the strong epiphenomenon hypothesis). However, it remains unclear whether or not schizophrenic symptomatology contributes to a JTC style (the weak epiphenomenon hypothesis). Two of our four tests of the weak epiphenomenon hypothesis provided support for that hypothesis. When the best possible psychiatric control group is used (schizophrenic patients without delusions), or delusional disorder patients are the target group, the effect size for the JTC bias is more modest than that seen when delusional patients with schizophrenia and nonschizophrenic psychiatric controls are compared. On the other hand, the other two comparisons fail to support the weak epiphenomenon hypothesis. The effect size for delusional disorder patients compared with nonpsychiatric controls was no different to that for delusional patients with schizophrenia compared with nonpsychiatric controls. Furthermore, the effect sizes for nonclinical populations did not differ to that for delusional patients with schizophrenia, in comparison with both psychiatric and nonpsychiatric controls.

Even if we set aside this latter finding, on the grounds that we do not as yet have a clear understanding about delusional ideation in nonclinical populations, evidence for the weak epiphenomenon hypothesis remains equivocal, and further research will be required to resolve the discrepancy in our findings.

We conclude this section by noting a possibility concerning the epiphenomenon hypothesis, which we are not in a position to evaluate. While our findings support the view that the JTC bias is not an epiphenomenon of schizophrenia, we have not ruled out the possibility that it is an epiphenomenon of a symptom, or a small family of symptoms, of schizophrenia. Because patients with schizophrenia can exhibit a variety of symptoms, and we do not have detailed symptom profiles of the patients included in the JTC studies, the JTC bias could be an epiphenomenon of one or more symptoms of schizophrenia overrepresented in the sample of delusional patients studied. In order to rule out this hypothesis, it would be necessary to consider the relation between a JTC bias and individual symptoms of schizophrenia rather than schizophrenia as a whole (e.g., Garety et al., 2005; van Dael et al., 2006). While this is an onerous task, future studies of the JTC should, where possible, make use of a more fine-grained taxonomy of experimental subjects.

DOES EMOTIONAL SALIENCE EXACERBATE THE JTC EFFECT?

The results of the first two studies show that "draws to decision" is a reliable measure of JTC style, and that it cannot be attributed solely to psychiatric symptomatology or to an epiphenomenal effect of the many symptoms associated with schizophrenia. People with delusions have a tendency to require less evidence before making a probabilistic decision.

Two concerns have been expressed regarding the JTC bias. First, it is unclear how substantial a contribution a relatively subtle reasoning bias could make to the production of the dramatic phenomena of delusion. Second, the JTC bias is a reasoning style that appears to be independent of subject matter, and this is at odds with the relatively small number of known delusional themes (e.g., Yager & Gitlin, 2000). Regarding the first concern, Young and Bentall (1995, p. 366) comment that, "[t]he extent to which deficits of the magnitude observed [in their own study], or indeed the comparable findings observed by Huq, Garety, and Hemsley (1988) or Garety et al. (1991), could directly contribute to the formation and maintenance of delusional beliefs, therefore remains a topic for further investigation". Underlining this point is the observation that, on the neutral Beads task, patients with delusions are actually reaching the *correct* hypothesis more quickly than are controls, and that by certain standards their reasoning could be regarded as more effective (see Maher & Spitzer, 1993). One suggestion that attempts to address these concerns is that the "jumping to conclusions" style in patients with delusions is exaggerated when reasoning about material with a particular content (e.g., Dudley et al., 1997a; Dudley & Over, 2003). For example, Dudley et al. (1997a, p. 582) suggest that:

> the effect of the pre-existing hastiness bias, in combination with additional hastiness for material that is emotional or self-related in content, leads to more errors being made in reasoning. Errors are therefore more likely to be made when reasoning with emotional material. Hence it seems likely that more false beliefs may be concerned with emotionally salient information.

If emotional or self-related content enhanced a JTC bias, that might, in one stroke, explain both how a small bias could lead to extreme beliefs, and why delusions seem to focus on a small number of themes. Whether or not the JTC bias is disproportionately increased in delusional patients when forming beliefs about emotionally salient material is therefore a pertinent question for accounts of how the JTC bias contributes to delusion formation. It was the aim of Study 3 to address this question.

STUDY 3: DETERMINING THE EFFECT OF EMOTIONAL SALIENCE ON THE JTC BIAS

Three studies have examined the effect of emotional salience on the JTC bias. Dudley et al. (1997a) compared "draws to decision" in two conditions, realistic-neutral and emotionally salient. All groups were hastier in the emotionally salient condition. Further, when a realistic version of the Beads task was used (involving students and schools or positive and negative comments in a survey), content (neutral vs. emotionally salient) had an equal effect on all groups. Using a similar design, Menon et al. (2006) found no evidence that emotionally salient material increased hastiness in any of their groups, compared with the neutral beads version of the task. In a third study that used a "graded estimates" procedure, Young and Bentall (1997) found marginal support for a Group $\times$ Salience interaction, but this reflected a trend for a greater effect of emotional salience in both the delusional and psychiatric control groups, compared with the nonpsychiatric group.

In order to clarify the putative effect of emotional salience on the JTC bias, we conducted a meta-analysis.

Results and discussion

Table 2 summarises the 14 effect sizes yielded from the three studies investigating the role of emotional saliency on variants of the Beads task. Contrary to the expectations of the "emotional saliency" position, effect sizes for the comparison between patients with delusions and nonpsychiatric controls were not significantly greater for emotionally salient stimuli when compared with realistic-neutral ($Z = 0.33$, $p = .37$), neutral beads ($Z = 0.22$, $p = .41$), or neutral stimuli combined (realistic neutral plus neutral beads; $Z = 1.07$, $p = .14$). Similarly, no significant differences in effect sizes for comparisons with psychiatric controls were found between emotionally salient stimuli and realistic-neutral ($Z = 0.63$, $p = .26$), neutral beads ($Z = 0.24$, $p = .41$) or neutral stimuli combined ($Z = 0.75$, $p = .23$).

These results thus reveal no statistical support for the idea that a "jumping to conclusions" reasoning style is disproportionately exacerbated

TABLE 2
Summary of effect sizes yielded from three published studies investigating the role of emotional saliency on variants of the Beads task

		Effect size (g)		
Reference	*Control group*	*Neutral*	*Realistic neutral*	*Emotionally salient*
Dudley et al. (1997a)[a]	Psychiatric		0.76	1.00
	Nonpsychiatric		0.86	1.05
Young & Bentall (1997, Exp. 2)[b]	Psychiatric	0.08		0.05
	Nonpsychiatric	0.38		0.78
Menon et al. (2006, Exp. 1)[a]	Psychiatric[c]	0.05	0.02	0.24
	Nonpsychiatric	0.03	−0.27	−0.22

The delusional group in each case were patients with schizophrenia.
[a]Dependent variable was "draws to decision".
[b]Composite effect sizes were computed as the arithmetic mean of "draws to certainty", "draws to reversal", and "response to potentially disconfirmatory evidence".
[c]The psychiatric control group were nondelusional patients with schizophrenia.

by emotional material in patients with delusions. In line with this conclusion is the recent finding that a similar percentage of patients with delusions were "extreme responders" (required only one or two beads) on the neutral Beads task as were "extreme responders" on an emotionally salient version of the task (Garety et al., 2005).

GENERAL DISCUSSION

Three conclusions are supported by the current findings. First, "draws to decision" is the most reliable measure of JTC bias. This offers some important constraints on our theoretical understanding of the JTC reasoning style. Second, the JTC bias, as represented by "draws to decision", appears to make a genuine contribution to delusional symptomatology, and is not solely an epiphenomenal effect. This provides evidence for the possibility of a causal role for a JTC reasoning style in the formation and/or retention of delusional belief. Third, emotional salience does not increase the hastiness of decision-making in patients with delusions. This finding suggests that the particular delusional beliefs adopted by a patient cannot be explained by the emotional nature of those types of belief. Rather, delusional patients may be hasty with respect to all types of material.

In the following sections we consider two questions about the JTC bias. First, what are the implications of our findings for the underlying basis of the JTC bias? And, second, what role does the JTC bias play in the development of delusion? With respect to the latter question, we consider a possible role both in the formation and the retention of delusion.

Implications for the underlying basis of the JTC bias

In line with the conclusions of previous authors (e.g., Dudley et al., 1997b; Garety & Freeman, 1999), the present results support the view that a critical idiosyncrasy in reasoning amongst patients with delusions is a willingness to make a decision on the basis of less evidence than nondelusional groups; however, delusional patients do not differ with respect to certainty of judgement. Our findings also suggest that in response to conflicting evidence, delusional patients are not especially inclined to "jump to new conclusions"; nor are they especially recalcitrant with respect to conclusions they have already reached.

Only two of the prominent accounts of the cognitive disturbance underlying the JTC bias are consistent with our current findings. Both predict that delusion will be associated only with reduced "draws to decision". The first is Bentall and colleagues' suggestion that the JTC bias arises from a difficulty in processing sequential information (e.g., Young & Bentall, 1995). The second is Dudley and Over's (2003) proposal that delusional patients have a confirmatory reasoning style.

In contrast, accounts based on the propensity of individuals with schizophrenia to be overinfluenced by current stimuli at the expense of prior learning (e.g., Kapur, 2003; Gray, Feldon, Rawlins, Hemsley, & Smith, 1991) have difficulty explaining why patients with delusions do not "jump to new conclusions". Menon et al.'s (2006) variant of this proposal, which suggests an inappropriate weighting of evidence, is inconsistent with the normal certainty ratings seen in delusional groups. Further, our findings do not fit with the idea that delusional patients have a high "need for closure", as conceptualised by Kruglanski and Webster (1996), since we found no strong evidence that they are more certain about their judgements, or that they cling tenaciously to those judgements in the face of disconfirmatory evidence.

A possible role for the JTC bias in the development of delusion

Delusion formation. As indicated above, our results appear to restrict the current theories of the JTC mechanism either to that of Young and Bentall's (1997) hypothesis that the JTC bias derives from a difficulty in the processing of sequential information, or to that of Dudley and Over (2003), according to which delusional patients have a confirmatory reasoning style. If either of these hypotheses is true, then the JTC bias would appear to come into play after a delusional hypothesis has already been formulated. Sequential information does not seem to play any role in the development of a hypothesis but only in the evaluation of evidence for or against it. Thus, on Bentall and colleagues' account, a delusional hypothesis must already be present before a JTC bias would be manifested in delusional cognition. Similarly, a confirmatory reasoning style can make an appearance only after a hypothesis has been formulated and is available to be confirmed or rejected. Thus, on Dudley and Over's account as well, a JTC bias could only play a role in delusion development once a delusional hypothesis occurs to the patient.

In particular, on Dudley and Over's (2003) account, while people without delusions apply a confirmatory reasoning style to danger-related conditional statements, delusional patients apply such a style even to neutral situations because they perceive danger and threat in them. It is a normal reasoning strategy applied to situations in which only the delusional individual erroneously perceives threat. Thus the patient must presumably first develop a delusional sense of threat or danger prior to extending their confirmatory reasoning style to neutral situations. This position is supported by our finding that the JTC effect is not disproportionately enhanced by emotionally salient material. Thus it cannot be that a JTC bias, applied to an emotionally salient domain, can "boot-strap" the development of a delusional belief. The situation being reasoned about must first gain a delusional significance before the JTC bias can get a purchase.

A delusional thought must therefore be present before a JTC bias can have an effect on the development of delusion. A JTC bias may, however, lead to a premature acceptance of such a thought. Evidence for this view comes from Garety et al. (2005) who have recently found evidence that a JTC style of reasoning is associated with delusional conviction. Their analysis supported a model in which "belief inflexibility"—a reluctance to consider the possibility that one might be wrong about one's delusional belief—largely mediates the contribution of a JTC reasoning style to delusional conviction. The role of JTC in this account appears to be one of facilitating the precipitous acceptance of the delusional hypothesis, and "precluding reflection on past learning to consider whether the information fits with previous knowledge, with the result that the possibility that one might be mistaken is not considered" (p. 381). In line with this position, Freeman et al. (2004) found that patients who did not report any alternative explanations for the experiences on which their delusions were based were more likely to jump to conclusions than were patients who could come up with alternative explanations.

There is another reason for limiting the role of the JTC bias in this way, and this is the strikingly small number of forms of delusion that exist. Yager and Gitlin (2000, p. 801) list only 14 "classic" forms, and over 85% of delusions observed in patients with schizophrenia fall into one of four delusional forms (Gutiérrez-Lobos, Schmid-Siegal, Bankier, & Walter, 2001; Jørgensen & Jensen, 1994). Identical delusional forms recur across the large number of psychotic and nonpsychotic disease states in which delusions occur (Jørgensen & Jensen, 1994). Moreover, the existence of only a small number of delusional forms is not only uniform across disease states, but also across cultures (e.g., Gutiérrez-Lobos et al., 2001; Kim et al., 2001; Stompe et al., 1999). A domain-general JTC bias, such as acts even on the neutral Beads task, cannot easily explain this feature of delusional beliefs. For example, there is presumably any number of bizarre beliefs an individual with a "jumping to conclusions" information processing style could jump to. Even if the claim that reasoning disorders are exacerbated by emotionally salient material were supported by the data, one would still expect to observe a very large number of delusion forms. Thus it is not obvious how the domain-general JTC bias could be involved in the genesis of the limited number of actual forms. A better explanation of this feature of delusion may come from the proposal that in order to make sense of unusual internal or external events we turn to one of a small number of explanatory frameworks (e.g., Zimbardo, 1999).

Delusion maintenance. We have found that patients with delusions do not seem to treat evidence that potentially disconfirms their hypothesis differently to nondelusional controls. This appears to be in conflict with Moritz and Woodward's (2005) suggestion that patients with schizophrenia have a specific impairment in the processing of disconfirmatory evidence—the "bias against disconfirmatory evidence" (BADE). Our findings thus leave us with no obvious explanation of the tenacity of delusional beliefs, except that all beliefs that are personally significant are held tenaciously.[8] There is no evidence at the moment, therefore, that the JTC bias plays any role in the maintenance of a delusional belief once it has been accepted.

Overview

Taken together, our findings suggest that a causal role for a JTC bias should be hypothesised to lie in that stage of delusion development in which a patient is considering whether or not to accept or reject a thought with a delusional content. The JTC bias does not seem to play any role in either the production of a delusional thought or in its maintenance once it has been accepted. We conclude that further research on the processes of delusion acceptance may illuminate the role of a JTC bias in delusion.

[8] We are grateful to one of our reviewers for this point.

We note that three issues could fruitfully be addressed in the investigation of delusional belief acceptance. The first concerns insight in delusion. There is evidence that a significant proportion of patients with delusion are able to recognise deficiencies in the reasoning associated with their own delusional beliefs. One study (Jørgensen, 1995) found that some two-thirds of individuals with delusions exhibit insight from the onset of their illness. On the face of it, to have insight into one's delusion is to recognise that the belief one takes to be plausible enough to be embraced should not be embraced. In the context of a JTC bias, this seems to mean that one can recognise that the evidence that one has taken to be sufficient to adopt a delusion is, in fact, insufficient. In order to have insight, then, it seems that one must have reasoning abilities that are unbiased, and this is at odds with the bias that is implicated in the acceptance of the delusion to begin with. One possible solution to this difficulty would be to establish that insight amounted to a recognition that one's delusion was odd or bizarre rather than a recognition that the evidence supporting the delusional belief was insufficient. The JTC approach to explaining delusion would be enhanced by investigating whether insight can coexist with a JTC bias, and by a deeper understanding of the exact nature of that insight.

A second topic for investigation concerns the way in which hypotheses come to be entertained. A hypothesis must first be deemed worthy of investigation before confirmatory or disconfirmatory evidence will be sought. It is a common experience among nondelusional individuals to have a thought that is immediately rejected as a nonstarter and for which evidence is never sought. Persecutory thoughts, for example, occur to nondelusional individuals but are regularly rejected as implausible. The question arises, therefore, why delusional patients take delusional hypotheses—particularly those that are, on the face of it, extremely implausible—as serious contenders for acceptance. Since the JTC bias concerns the relation of evidence to the delusional hypothesis, it is unlikely to be relevant to this issue. As Freeman and colleagues have hypothesised, an individual's emotional state and pre-existing beliefs about herself, others and the world are likely to contribute to the content of her explanations of anomalous experiences, and whether particular explanations continue to be entertained (Freeman, Garety, Kuipers, Fowler & Bebbington, 2002).

A third issue worthy of investigation is the nature of evidence in delusion. For a JTC bias to play a role in delusion acceptance, the patient must be able to identify putative evidence on the basis of which to jump to a delusional conclusion. The identification of evidence is likely to involve an abnormal cognitive process distinct from the JTC bias itself because there can be no good evidence for some delusions. For example, were a nondelusional individual to entertain the hypothesis that a thought had been inserted into his mind, it is unlikely that any putative evidence would be taken to be good evidence. In contrast, if a JTC bias plays a role in delusion formation, there must be evidence that the patient takes to be good evidence on the basis of which they can jump to the delusional conclusion. A complete account of delusional belief acceptance, therefore, must be able to explain how delusional individuals identify the evidence for a JTC bias to work on. Since the JTC bias concerns the quantity of evidence required for the acceptance of a delusion, it is unlikely to be relevant to an understanding of how evidence comes to be chosen by the delusional individual in the first place.

Conclusions

The results of our meta-analyses provide support for the view that patients with delusions exhibit a genuine difference in the amount of evidence they require to embrace a hypothesis, and that this difference is not entirely a consequence of the presence of schizophrenia. The JTC bias does not extend to the processing of contradictory information following the formation of a hypothesis, and it is not disproportionately increased when the content of material being reasoned about is emotionally salient.

Overall, consideration of our findings and the possible role the JTC bias could take in delusion, suggests that the JTC bias is not relevant to the formulation of delusional hypotheses. In particular, it does not appear to be relevant to the question of why delusional forms are so small in number. Nor is the JTC bias likely to play a role either in an explanation of why patients take these implausible hypotheses seriously or in the explanation of how delusional patients identify putative evidence for the hypotheses. Finally, the JTC bias seems to have no role to play in the maintenance of delusion in the face of disconfirmatory evidence. Further investigation into the processes of belief acceptance—both pathological and nonpathological—may prove fruitful in illuminating the way in which the JTC bias exerts its effect in delusional patients.

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