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ORIGINAL ARTICLE

Understanding jumping to conclusions in patients with persecutory delusions: working memory and intolerance of uncertainty

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Background. Persecutory delusions are a key psychotic experience. A reasoning style known as 'jumping to conclusions' (JTC) – limited information gathering before reaching certainty in decision making – has been identified as a contributory factor in the occurrence of delusions. The cognitive processes that underpin JTC need to be determined in order to develop effective interventions for delusions. In the current study two alternative perspectives were tested: that JTC partially results from impairment in information-processing capabilities and that JTC is a motivated strategy to avoid uncertainty.

Method. A group of 123 patients with persistent persecutory delusions completed assessments of JTC (the 60:40 beads task), IQ, working memory, intolerance of uncertainty, and psychiatric symptoms. Patients showing JTC were compared with patients not showing JTC.

Results. A total of 30 (24%) patients with delusions showed JTC. There were no differences between patients who did and did not jump to conclusions in overall psychopathology. Patients who jumped to conclusions had poorer working memory performance, lower IQ, lower intolerance of uncertainty and lower levels of worry. Working memory and worry independently predicted the presence of JTC.

Conclusions. Hasty decision making in patients with delusions may partly arise from difficulties in keeping information in mind. Interventions for JTC are likely to benefit from addressing working memory performance, while *in vivo* techniques for patients with delusions will benefit from limiting the demands on working memory. The study provides little evidence for a contribution to JTC from top-down motivational beliefs about uncertainty.

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Introduction

Over the past decade there has been notable progress in understanding the cognitive mechanisms underlying a number of individual psychotic experiences. The greatest attention has been on delusional beliefs. A reasoning process repeatedly linked to delusions has been the presence of jumping to conclusions (JTC). This data-gathering bias has been found in 30 out of 38 clinical studies (see Garety & Freeman, 1999, 2013). It is hypothesized that a limited data search leads to a rapid acceptance of implausible ideas, without consideration of alternative explanations. Initial evidence indicates that JTC may be a predictor of delusion persistence (Menon *et al.* 2008; Dudley *et al.* 2013), and, importantly, that reducing the bias may reduce the delusion (Moritz *et al.* 2010; Waller *et al.* 2011). But what are the cognitive factors that contribute to the occurrence of JTC? In this study we test two hypotheses. First, JTC may result from information-processing limitations, as marked by working memory performance. Second, JTC may be a motivated strategy used to reduce difficulties coping with uncertainty.

JTC is assessed using 'the beads task', an experimental test originally based upon Bayesian probabilistic inference (Garety *et al.* 1991; Dudley *et al.* 1997; Warman *et al.* 2007; Lincoln *et al.* 2010). Participants are shown two jars varying in the proportion of differently

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coloured beads (e.g. one jar has 60 black beads and 40 yellow beads, the other jar has 40 black beads and 60 yellow beads). The jars are then hidden from view and the participant is told that the experimenter has selected one jar. The participant is asked to decide with certainty which jar has been chosen (e.g. the mainly black bead jar or the mainly yellow bead jar). The participant can request to see as many beads, drawn one by one from the selected jar, as he or she would like before making a decision. JTC is defined as deciding after being shown two or fewer beads. There is an easy version of the task, where the difference in the proportions of the two colours of bead is large (80:15), and a more difficult version of the task, where the two colours are present in proportions that are almost equal (60:40). About half of patients with delusions show JTC on the 80:15 beads task and about one-third on the 60:40 version (Garety & Freeman, 2013).

Two recent large studies have tested the association of JTC with neuropsychological functioning. Although neuropsychological problems have been linked to the negative rather than the positive symptoms of psychosis (e.g. Ventura *et al.* 2009), there is a plausible case for expecting a contribution of working memory to the beads task – task instructions, two alternative possibilities, and the previous beads drawn have to be kept in mind. Garety *et al.* (2013) tested 126 patients with delusions, comparing working memory and premorbid intellectual functioning in those patients who jumped to conclusions with those who did not. There were no differences between the two groups in premorbid intelligence quotient (IQ) estimated with the Wechsler Test of Adult Reading (Wechsler, 2001). But on the 60:40 beads task in particular, there were associations of JTC with poorer working memory performance. The effect sizes were small to moderate. Falcone (2013) tested 112 patients with first-episode psychosis. IQ was assessed with five subtests of the working memory tasks from the Wechsler Adult Intelligence Scale III (WAIS-III; Wechsler, 1997). There were strong associations of JTC with IQ and working memory. The results of these two large studies are consistent with a number of earlier initial reports (e.g. Woodward *et al.* 2008), including a study indicating that data gathering may improve when memory load in the beads task is reduced (Menon *et al.* 2006). However, a study with 29 patients with early psychosis did not find a significant association of JTC with verbal working memory (Ormrod *et al.* 2012). Given the results of the largest studies, there are increasing grounds to believe that working memory limitations contribute to the presence of JTC.

An alternative perspective is that JTC is a motivated top-down strategy to forestall the presence of distressing uncertainty. Rather than dealing with doubt, and therefore potential confusion, a decision is rapidly made. A meta-cognitive belief – that uncertainty is to be avoided – could guide the data-gathering process when a decision is made. A potentially useful concept here is 'intolerance of uncertainty', developed to understand generalized anxiety disorder (Dugas *et al.* 1998). Intolerance of uncertainty is hypothesized to lead to magnification of problems in situations of little realistic risk, and worry is a person's misguided attempt to regain control over these magnified threats. The Intolerance of Uncertainty Scale (IUS) was developed to assess the concept (Freeston *et al.* 1994). Consistent with the idea that JTC is a motivated strategy to reduce the occurrence of distressing uncertainty, Broome *et al.* (2007) found higher levels of intolerance of uncertainty to be associated with less data gathering in the beads task in a combined high risk of psychosis (n=35) and non-clinical control (n=23) group.

Nonetheless, the relationship of data gathering with intolerance of uncertainly may not be straightforward. In their original scale development report, Freeston *et al.* (1994) speculated a potentially reverse effect: that intolerance of uncertainty may lead to 'high degrees of evidence before a decision can be made'. Furthermore, Dudley *et al.* (2011) found no association between JTC and intolerance of uncertainty in 77 patients recruited from a first-episode service. Similarly, in individuals with eating disorders, Sternheim *et al.* (2011) found no association of intolerance of uncertainty with performance on the beads task. It is also notable that a concept related to intolerance of uncertainty is 'need for closure', defined as 'individuals' desire for a firm answer to a question and an aversion toward ambiguity' (Kruglanski & Webster, 1996). However, in a study with 187 patients with psychosis (Freeman *et al.* 2006), need for closure was unrelated to JTC. Although based upon similar concepts, the standard measures of intolerance of uncertainty and need for closure show only small to moderate associations (Berenbaum *et al.* 2008). Intolerance of uncertainty, and its relationship to JTC, remains to be tested in a large group of patients with current delusions.

The aim of the present study was to examine JTC in patients with delusions in relation to both neuropsychological functioning and intolerance of uncertainty. It was predicted that JTC would be associated with poorer working memory, lower IQ and greater intolerance of uncertainty. The association of JTC with working memory was expected to remain, even when controlling for levels of intellectual functioning. The association of JTC with intolerance of uncertainty was expected to remain, even when controlling for levels of worry. Hence information-processing constraints

and top-down motivations were both expected to contribute to the occurrence of JTC.

Method

Participants

A total of 123 patients with persecutory delusions completed the JTC task during the baseline assessment (prior to randomization) of a clinical trial (ISRCTN23197625) (Freeman *et al.* 2012*a*). Patients with persecutory delusions were recruited from two mental health National Health Service (NHS) Trusts: Oxford Health NHS Foundation Trust and Southern Health NHS Foundation Trust. The inclusion criteria were: a current persecutory delusion as defined by Freeman & Garety (2000); scoring at least 3 on the conviction scale of the Psychotic Symptom Rating Scales (PSYRATS)-delusions scale (i.e. at least 50% conviction in the delusion) (Haddock *et al.* 1999); that the delusion had persisted for at least 3 months; a diagnosis from the treating clinical team of 'non-affective psychosis', including schizophrenia, schizo-affective disorder and delusional disorder; a clinically significant level of worry, as indicated by scores above 44 on the Penn State Worry Questionnaire (PSWQ; Startup & Erickson, 2006); aged between 18 and 65 years; and no changes to medication in the past month. Only eight patients with persecutory delusions were excluded from entering the trial because of an insufficient level of worry as assessed by the PSWQ. Criteria for exclusion were: a primary diagnosis of alcohol or substance dependency or personality disorder; organic syndrome or learning disability; a command of spoken English inadequate for engaging in therapy; and currently having individual cognitive–behavioural therapy.

Assessments

JTC: the beads task (Dudley et al. *1997; Garety* et al. *2005)*

Data gathering was assessed with a probabilistic reasoning task that has been extensively used with individuals with delusions. Participants are asked to request as many pieces of evidence (coloured beads) as they would like before making a decision (from which of two hidden jars the beads are drawn). The two jars have beads of two different colours in opposite ratios. The ratio of beads used in the current study was 60:40. The key variable is the number of beads requested before making a decision. Requesting two or fewer beads is classified as JTC. A categorical method of assessing JTC is used to capture the extreme form of the bias and because the number of draws to decision is not a normally distributed continuous scale (the informational value of each additional bead varies).

WAIS-III (Wechsler, 1997)

Three working memory tasks were used: digit span forwards (repeating back series of numbers), digit span backwards (repeating back series of numbers in reverse), and letter–number sequencing (sorting and recalling a series of letters and numbers). The demands on working memory increase across each of these three tasks. These are the most commonly used working memory tasks in schizophrenia research (Nuechterlein *et al.* 2004).

Wechsler Abbreviated Scale of Intelligence (WASI)

The WASI (Wechsler, 1999) is a standardized short and reliable measure of intelligence. The vocabulary and matrix reasoning subtests were used to obtain an estimate of IQ.

IUS

The IUS (Freeston *et al.* 1994) has 27 items each rated on a 1 to 5 scale. Higher scores indicate greater levels of intolerance of uncertainty. There are four subscales derived from factor analysis (Berenbaum *et al.* 2008): desire for predictability (e.g. 'Unforeseen events upset me greatly'); a tendency to become paralysed in the face of uncertainty (e.g. 'When I am uncertain I can't function very well'); distress in the face of uncertainty (e.g. 'The ambiguities in life stress me'); and inflexible uncertainty beliefs (e.g. 'Being uncertain means that a person is disorganized'). These subscales in the present study had high levels of internal reliability: desire for predictability, Cronbach's α=0.85; uncertainty paralysis, Cronbach's α=0.85; uncertainty distress, Cronbach's α=0.80; inflexible certainty beliefs, Cronbach's α=0.76.

PSYRATS-delusions

The PSYRATS-delusions (Haddock *et al.* 1999) is a six-item multidimensional measure. It assesses the conviction, preoccupation, distress and disruption associated with delusions. Symptoms over the last week are rated. Higher scores indicate greater severity. The two assessors in the current study had high inter-rater reliability (n=20, intra-class correlation coefficient=0.99).

Positive and Negative Syndrome Scale (PANSS)

The PANSS (Kay, 1991) is a 30-item rating instrument developed for the assessment of patients with schizophrenia. Symptoms over the last week were rated (i.e. currently present). Higher scores indicate the

greater presence of psychiatric symptoms. The two assessors in the current study had high inter-rater reliability (n=20, PANSS total intra-class correlation coefficient=0.91).

Green et al. *Paranoid Thoughts Scale (GPTS)*

The GPTS (Green *et al.* 2008) is a 32-item measure of paranoid thinking. Part A assesses ideas of reference (e.g. 'It was hard to stop thinking about people talking about me behind my back') and part B assesses ideas of persecution (e.g. 'I was convinced there was a conspiracy against me'). Each item is rated on a five-point scale. Higher scores indicate greater levels of paranoid thinking. The scale was completed for the period of the previous fortnight. The internal reliability of the scale was high (Cronbach's α for part A was 0.90, and for part B it was 0.94).

PSWQ

The PSWQ (Meyer *et al.* 1990) is the most established measure of trait worry style and has been used in non-clinical and clinical populations (for a review, see Startup & Erickson, 2006). Each of the 16 items is rated on a five-point scale. Higher scores indicate a greater tendency to worry. In the current study Cronbach's α for the scale was 0.79.

Perseverative Thinking Questionnaire (PTQ)

The PTQ (Ehring *et al.* 2011) is a 15-item questionnaire asking about how a person typically thinks about negative problems (e.g. 'The same thoughts keep going through my mind again and again'), with each item assessed on a 0 to 4 scale. Higher scores indicate greater levels of repetitive negative thinking. Cronbach's α for the scale was 0.92.

Analysis

Analyses were carried out using SPSS (version 20.0, release 20.0.0; IBM, USA). The patient group was divided into two: those showing JTC and those who did not. To test the two primary hypotheses the groups were then compared using t tests on the measures of working memory and intolerance of uncertainty. Binary logistic regressions with JTC as the dependent variable (0=no JTC, 1=JTC) were then carried out to allow for analyses with covariates. All hypothesis testing was two-tailed.

Results

Demographics

The demographic details of the participants are summarized in Table 1. Levels of persecutory delusion were high as assessed using the PSYRATS and the GPTS, with scores similar to those in other samples selected for current persecutory delusions (e.g. Foster *et al.* 2010). Hallucinations were common, with 75 of the patients scoring four or above on the PANSS hallucination item. Only seven patients scored four or above on the PANSS grandiosity item.

Table 1. *Basic demographic and clinical information*

	Persecutory delusions group (n=123)
Mean age, years (S.D.)	40.6 (11.2)
Sex, *n*	
Male	73
Female	50
Ethnicity, *n*	
White	113
Black Caribbean	0
Black African	0
Black other	0
Indian	3
Pakistani	0
Chinese	0
Other	7
Diagnosis, *n*	
Schizophrenia	87
Schizo-affective disorder	10
Delusional disorder	10
Psychosis NOS	16
Neuroleptic medication (chlorpromazine equivalents), *n*	
None	7
Low (1–200 mg)	37
Medium (201–400 mg)	27
High (>400 mg)	51
Mean PSYRATS-delusions score (S.D.)	18.3 (3.1)
Mean PANSS total score (S.D.)	79.8 (13.5)
Mean GPTS – part A score (S.D.)	51.2 (13.7)
Mean GPTS – part B score (S.D.)	51.0 (13.9)
Mean total GPTS score (S.D.)	102.1 (25.2)
Mean IQ score (S.D.)	99.4 (18.4)

S.D., Standard deviation; NOS, not otherwise specified; PSYRATS, Psychotic Symptom Rating Scales; PANSS, Positive and Negative Syndrome Scale; GPTS, Green *et al.* Paranoid Thoughts Scale; IQ, intelligence quotient.

JTC

The mean number of beads drawn on the 60:40 task was 7.6 (S.D.=5.9). This is comparable with that found in the study of Garety *et al.* (2013) who reported a mean of 7.2 (S.D.=5.7) (n=126). In the current study 30 patients (24.4%) with persecutory delusions jumped

Table 2. *Neuropsychological functioning and JTC*

	JTC: mean (S.D.)	No JTC: mean (S.D.)	Mean difference (95% CI)	*p*
Forward digit span	8.9 (1.8)	9.8 (2.5)	0.9 (0.1–1.8)	0.033
Backward digit span	5.0 (2.1)	6.2 (2.1)	1.2 (0.3–2.0)	0.013
Letter–number sequencing	6.8 (3.5)	8.9 (3.1)	2.1 (0.7–3.5)	0.003
IQ	91.4 (16.8)	102.0 (18.3)	10.6 (3.2–18.1)	0.006

JTC, Jumping to conclusions; S.D., standard deviation; CI, confidence interval; IQ, intelligence quotient.

to conclusions. Again, this rate of JTC is comparable with that found in the study of Garety *et al.* (2013) (27% showing JTC), but it is lower than that reported by So *et al.* (2012) (40%) (n=184). There were no differences between those who jumped to conclusions and those who did not in levels of paranoia (GPTS total; t_{120}=0.642, p=0.522), severity of the persecutory delusions (PSYRATS total; t_{121}=0.018, p=0.986), the presence of hallucinations (PANSS hallucinations item; t_{121}=−0.263, p=0.793) or in overall psychopathology (PANSS total; t_{121}=−1.028, p=0.306). However, the patients who showed JTC did have higher levels of negative symptoms (PANSS negative; t_{121}=−2.227, p=0.028).

Neuropsychological functioning and JTC

Those patients who jumped to conclusions, compared with those who did not, showed poorer working memory performance and had lower IQ scores (see Table 2). IQ scores correlated with forward digit span (r=0.36, p<0.001), backward digit span (r=0.50, p<0.001) and letter–number sequencing (r=0.55, p<0.001). Letter–numbering sequencing showed the strongest association with JTC. In a binary logistic regression predicting JTC, when letter–number sequencing and IQ were entered together as independent variables they both became non-significant predictors (p>0.1). The presence of negative symptoms negatively correlated with forward digit span (r=−0.14, p=0.129), backward digit span (r=−0.24, p=0.008), letter–number sequencing (r=−0.24, p=0.009) and IQ scores (r=−0.37, p<0.001). In a binary logistic regression predicting JTC, letter–number sequencing remained a significant predictor (p=0.020), but negative symptoms did not (p=0.095).

Intolerance of uncertainty and JTC

The total delusion group's mean IUS score of 88.4 (S.D.=24.1) was high. For example, Buhr & Dugas (2002) reported a mean score in a non-clinical population (n=273) of 54.8 (S.D.=17.4), and Norton (2005) reported a mean score in a non-clinical population (n=540) of 54.9 (S.D.=18.7). Dudley *et al.* (2011) reported a mean score of 65.2 (S.D.=24.6) in patients seen in a first-episode psychosis service (n=77). The scores of the patients with persecutory delusions are closer to those of a generalized anxiety disorder group. For example, van der Heiden *et al.* (2012) reported a mean IUS score of 82.3 (S.D.=21.1) in a generalized anxiety disorder group (n=42). There was no difference in the current study in IUS scores between patients with and without hallucinations (t_{119}=−1.037, p=0.302).

Those patients who jumped to conclusions, compared with those who did not, showed lower levels of intolerance of uncertainty, although this was only statistically significant for the presence of inflexible certainty beliefs (see Table 3). Patients with JTC also reported significantly lower levels of worry, but no differences in anxiety or repetitive negative thinking. Worry positively correlated with total IUS scores (r=0.49, p<0.001). When total IUS score was entered with worry as independent variables in a binary logistic regression, there was a trend for worry scores to predict JTC (B=−0.055, odds ratio (OR) 0.95, p=0.067), but IUS scores did not predict JTC (B=−0.008, OR 0.99, p=0.450). A similar pattern was found for the IUS inflexible certainty beliefs score. In a binary logistic regression predicting JTC, there were indications that worry was a predictor (B=−0.051, OR 0.95, p=0.078), but the IUS certainty beliefs did not predict JTC (B=−0.073, OR 0.93, p=0.213).

Working memory, worry and JTC

There were no significant correlations between worry and the working memory tasks (all p>0.1). In a binary logistic regression with JTC as the dependent variable, and letter–number sequencing and worry as the independent variables, both poorer working memory (B=−0.229, OR 0.80, p=0.002) and lower levels of worry (B=−0.082, OR 0.922, p=0.005) predicted JTC. Similarly, in a binary logistic regression, JTC was predicted by both lower IQ (B=−0.037, OR 0.963,

Table 3. *Intolerance of uncertainty and JTC*

	JTC: mean (S.D.)	No JTC: mean (S.D.)	Mean difference (95% CI)	*p*
IUS total	81.6 (22.2)	90.6 (24.4)	9.1 (−0.9 to 19.0)	0.074
Desire for predictability	21.5 (23.9)	23.9 (6.9)	2.4 (−0.4 to 5.3)	0.088
Uncertainty paralysis	18.4 (5.6)	20.2 (6.0)	1.8 (−0.7 to 4.2)	0.159
Uncertainty distress	16.5 (4.5)	17.3 (5.0)	0.8 (−1.3 to 2.8)	0.453
Inflexible certainty beliefs	10.1 (3.4)	11.9 (4.3)	1.8 (0.1 to 3.5)	0.036
Anxiety	24.9 (11.1)	26.4 (14.9)	1.5 (−3.6 to 6.6)	0.565
Worry	60.7 (8.4)	64.8 (7.6)	4.2 (0.9 to 7.4)	0.012
Perseverative thoughts	44.0 (9.5)	44.6 (9.6)	0.6 (−3.4 to 4.7)	0.757

JTC, Jumping to conclusions; S.D., standard deviation; CI, confidence interval; IUS, Intolerance of Uncertainty Scale.

$p=0.004$) and lower levels of worry ($B=-0.076$, OR 0.927, $p=0.007$). When letter–number sequencing, IQ and worry were simultaneously entered as independent variables, JTC was predicted by worry ($B=-0.083$, OR 0.921, $p=0.005$), but not significantly by working memory ($B=-0.160$, OR 0.853, $p=0.070$) or IQ ($B=-0.022$, OR 0.978, $p=0.149$).

Discussion

Two potential contributors to the JTC reasoning style were examined within a large group of patients with current persecutory delusions. JTC was considered in relation to basic information-processing capacity problems and motivational beliefs concerning uncertainty. It is the former contributor for which the most confident conclusions can be drawn. Given the similar findings of the large studies of Garety *et al.* (2013) and Falcone (2013), we can now be confident of an association of JTC with working memory. Arguably, studies such as that of Ormrod *et al.* (2012) failed to find such an association because of a small sample size. The working memory impairment was associated with levels of current intellectual functioning (and these were not separable predictors of JTC). Keeping alternative explanations in mind, gathering data, and weighing the evidence all have plausible memory load; pursuing one explanation, gathering confirmatory evidence, and reaching a definitive conclusion are likely to reduce demands on memory. Working memory difficulties via the reasoning strategies that they provoke are likely to be a factor in the persistence of delusional beliefs.

Levels of intolerance of uncertainty in the patients with persecutory delusions were high, consistent with the presence of worry in this group at a level comparable with patients with anxiety disorders. A number of studies have now identified high levels of worry in patients with persecutory delusions (e.g. Freeman & Garety, 1999; Startup *et al.* 2007; Bassett *et al.* 2009; Freeman *et al.* 2010). Against prediction, however, IUS scores were slightly higher in the patients with delusions who did not jump to conclusions compared with the patients who did jump to conclusions. Greater intolerance of uncertainty was clearly not associated with JTC, consistent with the study of Dudley *et al.* (2011). As originally proposed by Freeston *et al.* (1994), intolerance of uncertainty may, at least within a clinical psychosis sample, lead to greater information search before certainty. However, the levels of worry in the group may well explain the association. Caution is needed about over-interpreting this result before replication. This is especially the case since: there was no association with the occurrence of general repetitive negative thinking; an experimental study with patients with persecutory delusions showed no change in JTC in the period after a bout of worry (Freeman *et al.* 2013); and there is little evidence that anxiety disorder groups seek more data during the beads task relative to non-clinical controls (e.g. Jacobsen *et al.* 2012). The study provides little evidence that one form of motivational belief – intolerance of uncertainty – is a factor in JTC.

The key weakness of the study design is that it only identifies factors associated with JTC. An unmeasured variable may better explain the occurrence of JTC. Testing of causal roles is needed, for example, by manipulating working memory performance during data gathering. The group had persistent persecutory delusions, and therefore testing of different delusion types and stages of illness could result in different results. Relationships with other symptom types remain to be established; for example, in the current study there was an association of JTC with negative symptoms, but this was not found in the study of Garety *et al.* (2013). There are also other factors that could moderate the extent of data gathering, for example, a reliance on experiential reasoning (Freeman *et al.* 2012*b*). As the work is taken forward there will

ideally be investigation of data gathering directly in relation to delusional ideas, and hence study of particular reasoning styles that can enhance recovery from persecutory delusions. A greater understanding of the reasoning processes that lead to erroneous beliefs becoming corrected is a clear priority for the development of a new generation of interventions for delusions.

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Declaration of Interest

None.

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