



# Investigation of metamemory dysfunctions in first-episode schizophrenia

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Received 13 April 2005; received in revised form 5 September 2005; accepted 13 September 2005

Available online 26 October 2005

## Abstract

A number of recent studies have suggested that schizophrenia patients share metamemory deficits, particularly, a decreased ability to distinguish between errors and correct responses in terms of response confidence (i.e., decreased *confidence gap*): patients are over-confident in errors while at the same time being under-confident in responses that are in fact correct. This, along with increased error rates, leads to an inflation of inaccurate but confidently held memories, which has been termed *knowledge corruption*. Previous studies on metamemory in schizophrenia patients predominantly tested chronic patients, leaving open the possibility that metamemory deficits stem partly from increased chronicity and long-term treatment. The primary aim of the current study was to establish whether a decreased confidence gap is also detectable in first-episode schizophrenia. For this purpose, a source memory task was administered to 30 first-episode patients with a diagnosis of schizophrenia or schizophreniform disorder, and 15 healthy control subjects. During encoding, items were read aloud by the experimenter and the participant in alternating order. For the recognition phase, participants were required to state the source of the item, and their confidence in their response. In agreement with previous studies, the patients displayed a decreased confidence gap, and increased knowledge corruption relative to controls. A reduced distinction between correct and incorrect information in metacognition is proposed to be a vulnerability factor for the development of delusions in schizophrenia. © 2005 Elsevier B.V. All rights reserved.

## 1. Introduction

Traditionally, research on cognition in schizophrenia relies on “objective” measures to draw inferences about the integrity of higher cortical functions (Lezak, 1995). More recently, objective cognitive assessment has been complemented by the study of self-report cognitive dysfunction and the study of metacognition

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(Danion et al., 2003; Koren et al., 2005; Moritz et al., 2004a; Parnas et al., 2003; Stip et al., 2003). For example, a number of studies found that patients with schizophrenia recollect memory episodes less vividly than controls (Bacon et al., 2001; Danion et al., 2003, 1999; Huron et al., 1995). There is also increasing evidence that patients with schizophrenia overestimate their actual performance level (Huron et al., 1995; Moritz et al., 2004a).

A dissociation between objective and subjective cognition has recently been put forward as a possible pathogenetic mechanism for delusion formation (Moritz and Woodward, 2002, *in press*; Moritz et al., 2004b, 2003, 2005). In a number of studies our group has demonstrated that patients with schizophrenia are insensitive to the distinction between accurate and inaccurate memories. This pattern of results has been demonstrated using the false memory paradigm (Moritz et al., 2004b) and source memory tasks (Moritz and Woodward, 2002; Moritz et al., 2003, 2005). For the source memory studies, participants were required to read or generate responses in alternation with the experimenter or a computerized voice. For the subsequent recognition trial, which contained studied and new items, each stimulus had to be judged as either old or new followed by a source assignment in the case of an old rating (self or computer/experimenter). Subsequently, subjective memory confidence was rated. All studies demonstrated a decreased *confidence gap* in schizophrenia: increased confidence for memory errors in combination with decreased confidence for correct responses. This pattern of results, along with an increased error rate in patients (the latter not being confined to schizophrenic illness, Aleman et al., 1999; Moritz et al., 2001), leads to a state referred to as *knowledge corruption*, that is, a high proportion of what patients *strongly* believe to be true is in fact false (Moritz and Woodward, 2002; Moritz et al., 2004b, 2003, 2005). Healthy participants, on the other hand, in most cases appropriately attach “not trustworthy” tags to false responses, as reflected by comparatively low confidence ratings in the case that an error was committed. Knowledge, according to our definition, refers to true memories as well as false memories that an individual holds with strong conviction (Hemsley and Garety, 1986, p. 52). Correspondingly, a memory episode — irrespective of its validity — on which doubt is attached, is not considered knowledge.

The behavioural consequences of knowledge corruption may be dramatic, because invalid memory information is not adequately detected, and doubt is not imposed (see also Koren et al., *in press*; Koriat and Goldsmith, 1996; Koriat et al., 2001). Thus, day-to-day activities may be obstructed by over-confident acceptance of inaccurate memories/beliefs as knowledge. In healthy subjects, false memories also occur, but, as described, they are held with lower confidence, preventing them from interfering with assessments of reality (for a further discussion see Moritz et al., 2005).

The evidence thus far suggests that knowledge corruption is significantly more prevalent in schizophrenia patients relative to healthy and psychiatric controls, is typically present for both false-positive and false-negative errors, and is not related to current symptom status, and thus may represent a vulnerability mechanism to the schizophrenic disorder. It is important to note that knowledge corruption, and the decreased confidence gap, have been demonstrated with neutral material, precluding a tautological explanation.

The present study aimed at replicating and extending the obtained set of results. First, our prior studies predominantly involved chronic patients, so that it cannot be ruled out that knowledge corruption may be related to hospitalization and long-term treatment with antipsychotics. For example, there is some evidence that a self-serving attributional style is weaker in first-episode than chronic psychotic patients (Krstev et al., 1999). For the present study, first-episode schizophrenia patients were recruited to rule out this possibility. Second, prior results have been exclusively collected in the western hemisphere (Canada and Germany) so that the possibility must be entertained that the findings might not be globally representative, particularly in view that Asian samples have been found to differ from Western populations in terms of metamemory performance (Yates et al., 1998). This is the first study on schizophrenia patients to our knowledge that assesses memory confidence in an Asian sample.

## 2. Methods

### 2.1. Subjects

The final sample was selected from a larger population (49 patients and 21 controls) to equate on age,

gender and education level (initially, samples differed especially on gender distribution, age and educational level). To achieve this, the 19 male patients with the lowest education level and the six oldest healthy control females were dropped blind to results. All patients were experiencing their first psychotic illness (i.e., no previous history of remission from a psychotic episode and no previous treatment of more than two weeks with antipsychotic medications before the current treatment). Recruitment was conducted in the early psychosis clinics at the Queen Mary Hospital and the Pamela Youde Nethersole Eastern Hospital in Hong Kong, China. Patients in the study also took part in a more extensive study of cognitive function in first-episode psychosis after written informed consent was obtained. The study was approved by the IRB of the University of Hong Kong and Queen Mary Hospital. Patients were recruited when they were sufficiently stabilized to understand and cooperate in the study.

Diagnoses were determined by trained psychiatrists at ward using DSM-IV criteria. The patient group was diagnosed as follows: schizophrenia ( $n=24$ ), schizoaffective disorder ( $n=1$ ), schizophreniform ( $n=2$ ), and psychosis not otherwise specified ( $n=3$ ). The control subjects were recruited by advertisement and word of mouth. Healthy participants were excluded if they responded positively to a questionnaire asking about psychiatric illness. Substance abuse, learning disability, head injury, or any other neuronal abnormality that may affect cognition were general exclusion criteria. For all subjects their primary language was Cantonese. At the time of testing, all patients were receiving atypical antipsychotic medication.

## 2.2. Source memory task

### 2.2.1. Procedure

The experimental procedure was derived from a previously used source memory task (Moritz et al., 2005), translated into Cantonese, and adjusted to minimize completion time. The translation process was performed by a native Cantonese speaker who was fluent in English. For the encoding phase, the experimenter read 20 words drawn from the Kent–Rosanoff association test to the participant. Unlike in our previous source memory tasks, where subjects had

to generate their own associations for cue words, this time the participants were requested to read a semantic associate from a list, which was handed to the subject beforehand. This proceeded in alternating order until the end of the list. Immediately after the encoding phase was terminated, the recognition phase was initiated.

In the recognition phase, a list of 80 words was read to the participant in fixed random order. Four different stimuli types were used:

- (1) 20 experimenter-generated words
- (2) 20 self-generated words
- (3) 20 new words with no semantic relation to words from conditions 1 or 2
- (4) 20 new words which were semantically related but never identical to words from 1 or 2 (for details see Moritz et al., 2005).

After each presented word, the participant had to provide three responses:

1. *recognition*: decision whether an item was new or previously studied
2. *source attribution*: in case the word was recognized as being studied, a source judgment was requested (i.e., experimenter or participant)
3. *memory confidence*: participants were instructed to rate on a four point scale how confident they were that their previous response was correct (experimenter, participant or new; 1=don't know; 2=rather uncertain; 3=rather certain; 4=convinced). No feedback on whether responses were correct or incorrect was given.

### 2.3. Strategy for data analysis

Consistent with past studies, two indices were computed: the confidence in responses index (CIR), computed as the percentage of all ratings that were made with high confidence (computed for both errors and correct responses), and the knowledge corruption index (KCI), computed as the percentage of all high confident ratings that are errors. An additional measure was computed which in past studies has been shown to be most sensitive to patient–control differences: the confidence gap. The confidence gap was computed in two ways: (1) the difference between

mean confidence in correct and incorrect responses, and (2) the difference between CIR indices for correct and incorrect responses. There are alternative measures for assessing the association between accuracy and confidence, such as output-bound accuracy, monitoring resolution (Koriat and Goldsmith, 1996) and gamma-correlations (Gonzalez and Nelson, 1996). We have selected the confidence in response parameters for our experimental approach mainly as they are straight forward with respect to computation and interpretation, and provide independent scores for confidence in errors and correct responses.

### 3. Results

#### 3.1. Sociodemographic and psychopathological variables

The groups did not differ significantly with respect to age, education and gender (see Table 1). Overall, the level of symptoms was very low. For delusions, 21 patients warranted a rating of absent on item P1 (Delusions) on the PANSS, and only four patients had moderate or higher ratings on this item. Only four patients had moderate or higher ratings on hallucinations (item P3). The mean positive and negative PANSS scores are displayed in Table 1.

#### 3.2. Cognition

Controls ( $M=19.13$ ,  $SD=5.91$ ) made significantly fewer memory errors than schizophrenia participants ( $M=24.47$ ,  $SD=6.60$ ), replicating the commonly reported memory performance deficit for patients with schizophrenia,  $t(43)=2.64$ ,  $p=.01$ . Broken down into error type, schizophrenia participants ( $M=12.03$ ,  $SD=5.84$ ) made significantly more false-negative errors than controls ( $M=7.53$ ,  $SD=2.85$ ),  $t(43)=2.81$ ,  $p<.01$ , but patients and controls did

Table 1  
Sociodemographic characteristics of the sample

Variable	Group		
	Controls	Patients	Statistics
Age	24.80 (8.99)	24.73 (8.73)	$t(43)=0.02$ , $p>.9$
Sex (male/female)	5/10	14/16	$\chi^2(1)=0.73$ , $p>.3$
Education	13.47 (2.33)	12.30 (2.38)	$t(43)=1.26$ , $p>.1$
PANSS positive score	–	9.67 (4.20)	–
PANSS negative score	–	12.77 (6.17)	–

Table 2  
Confidence ratings for correct and incorrect judgments

Measure	Group	
	Controls	Patients
<i>Mean confidence rating</i>		
Correct	3.25 (0.34)	3.15 (0.71)
Errors	2.59 (0.46)	2.81 (0.82)
Confidence gap	0.66 (0.28)	0.34 (0.29)
<i>CIR index</i>		
Correct	52.05 (18.13)	51.40 (35.96)
Errors	19.76 (14.21)	39.73 (34.58)
Confidence gap	32.29 (11.83)	11.67 (12.74)

Cells contain means (standard deviations in brackets).

Note. CIR=confidence in responses index (i.e., the percentage of high confidence responses out of all responses for that particular item type).

not differ significantly on the number of false-positive errors, ( $M=5.50$ ,  $SD=5.29$ ;  $M=5.13$ ,  $SD=4.39$ , respectively),  $t(43)=0.23$ ,  $p>.8$ , or source discrimination errors, ( $M=6.93$ ,  $SD=3.38$ ;  $M=6.47$ ,  $SD=2.36$ , respectively),  $t(43)=0.48$ ,  $p>.6$ .

Patients displayed a significantly decreased confidence gap relative to controls, when computed as the difference in mean confidence ratings for correct and incorrect responses,  $t(43)=3.60$ ,  $p<.001$  (see Table 2), and when computed on the CIR index,  $t(43)=5.24$ ,  $p<.001$ . In both cases, the decreased confidence gap was due to higher confidence in errors combined with lower confidence in correct responses, although the over-confidence in errors was numerically more remarkable (see Table 2). The confidence gap did not significantly correlate with total errors, confirming the unique character of the two aspects of memory ( $r=-.17$ ,  $p>.2$ ). In addition, compared to controls, patients displayed increased knowledge corruption, determined by the KCI ( $M=9.42\%$ ,  $20.85\%$ , respectively),  $t(42)=4.48$ ,  $p<.001$ . The knowledge corruption index differed for all types of memory errors: false-positives,  $t(43)=2.17$ ,  $p<.05$ , false-negatives,  $t(43)=3.27$ ,  $p<.01$ , and source errors,  $t(42)=2.34$ ,  $p<.05$ .

Signal detection analyses (Macmillan and Creelman, 1990) revealed a somewhat lowered sensitivity in patients ( $d'$ ; patients:  $M=1.86$ ; controls:  $M=2.18$ ) and a somewhat increased tendency to respond new, as evidenced by a more conservative criterion (patients:  $M=.36$ ; controls:  $M=.17$ ). However, neither statistic differed significantly between groups ( $t(43)=1.65$ ,  $p=.11$ ,  $t(43)=1.44$ ,  $p=.16$ , respectively).

In agreement with our previous studies, correlations between the positive and negative PANSS subscores with the major dependent variables (confidence in errors and

correct responses, knowledge corruption) did not yield significant relationships ( $p > .1$  for all).

#### 4. Discussion

The present study supports the hypothesis that metamemory impairments in schizophrenia are not confined to chronic patients, but are also detectable in first-episode schizophrenia patients with low symptom profiles. Patients displayed over-confidence in memory errors, combined with under-confidence in correct responses (i.e., a decreased confidence gap). This, along with an increased error rate, led to a significant difference in knowledge corruption relative to controls (increased percentage of high-confident memory responses that were errors). It should be noted that although patients differed from controls on false-negative errors, but not on false-positive or source errors, group differences emerged on metamemory measures for all three error types, suggesting that the investigation of metamemory contributes unique information that is not explained by a generalized performance deficit in patients. Overall, the level of knowledge corruption was largely comparable to previous source memory studies (Moritz and Woodward, in press; healthy participants: 12.6%; patients: 21.9%; Moritz et al., 2005, healthy participants: 8.6%; patients: 20.9%).

As we have explained in detail elsewhere (Moritz and Woodward, 2002; Moritz et al., 2004b, 2003, 2005), a deficit in differentiating between false and correct memories in terms of confidence has implications for reality monitoring and social interaction, and may partially explain the emergence of fixed, false beliefs. As a working hypothesis, we propose that the significantly decreased confidence gap stems from a *liberal acceptance* bias, whereby incomplete information that would not persuade a healthy person to make strong inferences is taken as sufficient evidence for a high-confident judgment. This conclusion overlaps with a wealth of literature demonstrating that schizophrenia patients jump to conclusions (i.e., hastily draw decisions, Garety et al., 1991; Huq et al., 1988; Moritz and Woodward, 2005) and are more guided by immediate stimuli than taking the entire stream of available stimuli and context into account (Cohen et al., 1999; Hemsley, 2005; Salzin-

ger and Serper, 2004). A related line of research suggests that patients rely more on mere familiarity to confidently make memory decisions, whereas healthy subjects require rich episodic information to achieve high confidence (Moritz et al., 2004b; Weiss et al., 2002). The decision-making process may be terminated prematurely in patients, while healthy participants may scrutinize their option more closely, thereby enhancing the likelihood that valid cues are retrieved.

Liberal acceptance cannot only parsimoniously explain over-confidence in errors for patients (Moritz and Woodward, in press), but can also explain why patients show somewhat less confidence in correct responses: premature termination of information collection when considering confidence in correct responses may lead to a neglect of affirmative information which would have otherwise raised subjective confidence. At first glance the notion of liberal acceptance may seem difficult to reconcile with a more conservative criterion suggested by the signal detection results. Apparently, patients with schizophrenia are conservative with respect to old/new decisions, but liberal with respect to confidence in errors (both false memories and misses). This discrepancy can be understood as a dissociation across levels of memory, with conservativeness being observable on the level of episodic memory, and liberalness being observable on the level of metamemory. To confirm this dissociation, in a recent study we demonstrated that, in addition to liberal acceptance of responses that they endorse, patients with schizophrenia are also liberal with respect to response rejection (Moritz et al., submitted for publication): patients displayed significantly decreased positive decision thresholds for general knowledge items, but also rejected alternatives more easily. In contrast, signal detection response criterion concepts apply to accepting and rejecting in a reciprocal fashion (i.e., a change in response criterion implies reciprocally changing old and new response tendencies).

Following up on the thesis that liberal acceptance stems from premature termination of data collection, future research may directly test this account by quantifying the amount of information (e.g., amount of perceptual details) that is considered sufficient for schizophrenia and healthy subjects to draw decisions.

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