Psychological Medicine, 2007, **37**, 569–576.
doi:10.1017/S0033291706009780 First published online 25 January 2007 Printed in the United Kingdom

Verbal self-monitoring in psychosis: a non-replication

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ABSTRACT

Background. Current cognitive models of positive symptoms of psychosis suggest a mechanism of defective self-monitoring that may be relevant for (i) expression of psychosis at the clinical and subclinical level and (ii) transmission of risk for psychosis.

Method. The study included 41 patients with psychosis, 39 non-psychotic first-degree relatives, 39 subjects from the general population with a high level of positive psychotic experiences, and 52 healthy controls with an average level of positive psychotic experiences. All subjects performed a speech attribution task in which single adjectives with a complimentary or derogatory meaning were presented to them on a computer screen; subjects had to read aloud and determine the source (self/other/uncertain) of the words they heard. In some of the trials, participants' speech was distorted, in others they heard someone else's voice (alien feedback condition) that could also be distorted.

Results. No large or significant differences in errors in the speech attribution task were found between the four groups in any of the conditions.

Conclusions. Contrary to previous work using this paradigm, this study found no evidence that either expression of psychosis or risk for psychosis was associated with impairment in self-monitoring.

INTRODUCTION

Current cognitive models of positive symptoms of psychosis suggest that auditory hallucinations are the result of defective self-monitoring (Hoffman, 1986; Frith, 1987; Bentall *et al*. 1991*b*; Frith & Dolan, 1996). Defective monitoring of verbal thoughts may lead to a failure in the recognition of one's own thoughts as self-generated and, as a consequence, these thoughts are misidentified as externally generated voices (Frith, 1987; Frith & Done, 1989; Bentall *et al*. 1991*b*; Frith & Dolan, 1996). Empirical work has shown that patients with acute psychotic symptoms have difficulties discriminating between self-generated items and external-generated items (Bentall, 1990; Keefe *et al*. 1999; Brebion *et al*. 2002). To further examine this hypothesis, Johns *et al*. (2001) developed a paradigm in which immediate auditory verbal feedback was manipulated, leading to discrepancies in what subjects heard and what they expected to hear. Overall, patients with schizophrenia, in particular those with auditory hallucinations, made more errors than controls, with a bias towards misattributing their own distorted voice to another person (Johns *et al*. 2001, 2006).

Rates of psychotic symptoms approaching 5–15% in the general population (van Os *et al*. 2000, 2001; Hanssen *et al*. 2003; Johns, 2005) suggest that rather than a discrete entity, the

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psychosis phenotype may be better represented by a continuum with healthy functioning at one extreme and florid psychosis with clinical need at the other (Johns & van Os, 2001; Hanssen *et al*. 2003). There is evidence that psychological mechanisms also operate at lower levels of the continuum in individuals who have no current clinical needs but nevertheless are at risk of developing them (Bentall, 1990; Janssen *et al*. 2003; Hanssen *et al*. 2006). First-degree relatives of patients with psychosis, and individuals with subclinical psychotic experiences in the general population, are examples of such risk groups (Claridge, 1994; Cunningham Owens & Johnstone, 2006). Evidence for a deficit in self-monitoring in individuals at risk would imply that such a deficit is associated not only with phenotypic expression of psychosis but also with endophenotypic risk for psychosis. Indeed, one initial study showed partial misattribution in individuals with attenuated positive psychotic symptoms (Johns *et al*. 2005).

The current study set out to extend these findings by including four groups with different levels of vulnerability to psychosis: patients with a lifetime history of non-affective psychosis, non-psychotic first-degree relatives, subjects from the general population with a high level of positive psychotic experiences, and healthy controls from the general population with an average level of positive psychotic experiences. The following hypotheses were investigated: (i) patients with non-affective psychosis are more likely than healthy volunteers to misidentify their own voice as someone else's when its acoustic characteristics are altered; (ii) this bias is also present in individuals at risk of developing psychosis, albeit to a lesser degree; (iii) relatives of patients will show less impairment compared to their psychotic relatives, but more than unrelated individuals with subclinical psychotic experiences, and (iv) the presence of positive psychotic experiences will be associated with misidentifications in both patients and high-risk groups.

METHOD

Subjects

The Cognitive functioning in Psychosis (CoP) study included (i) patients with a lifetime history of a period of non-affective psychosis in clear consciousness; (ii) first-degree relatives of patients with non-affective psychosis; (iii) subjects scoring high (>75th percentile) on the positive dimension of psychosis-proneness measured by the Community Assessment of Psychic Experiences (CAPE; Stefanis *et al*. 2002), and (iv) subjects scoring in the average range on the CAPE. All participants were between the ages of 18 and 55 years, fluent in Dutch and without a history of central neurological disorders. Written informed consent was obtained from all participants conforming to the local ethical committee guidelines.

Patients were recruited from the catchment area Community Mental Health Centre (source population: 350 000) and the catchment area Psychiatric Hospital. Initial inclusion criteria for patients were the lifetime prevalence of a period of psychosis in clear consciousness (i.e. being aware of themselves and their environment, in order to exclude psychosis in delirium), according to the Research Diagnosis Criteria (RDC; Spitzer *et al*. 1978). Relatives were sampled through participating patients or through associations for relatives of patients with psychotic symptoms. Subjects with average and high levels of psychotic experiences were recruited from an earlier longitudinal family study (Continuum of Mental Disorders Study, COMED) in the general population conducted in the city of Sittard (Hanssen *et al*. 2005). All participants filled in the CAPE (Stefanis *et al*. 2002; www.cape42.homestead.com), a self-report trait questionnaire to assess dimensions of the subclinical psychosis phenotype. The CAPE includes dimensions of positive (20) and negative (14) psychotic experiences as well as depressive experiences (8). Subjects with a mean (i.e. between the 40th and 60th percentile) and a high (i.e. above the 75th percentile) score on the CAPE positive psychosis dimension were invited to participate in the CoP study.

The study included 45 patients with psychosis (44% in-patients), 47 non-psychotic first-degree relatives, 41 subjects from the general population with a high level of positive psychotic experiences, and 54 healthy controls from the general population with an average level of positive psychotic experiences.

For all participating patients, the Operational Criteria Checklist for Psychotic Disorder (OCCPI) was completed based on case-note material and the Positive and Negative Syndrome Scale (PANSS; Kay *et al.* 1987) interview. Where necessary, additional information was derived from ward staff or case managers. Using the information in the OCCPI, the computerized program OPCRIT yielded RDC diagnoses. There were 31 patients (69%) with an OPCRIT diagnosis of schizophrenia, three patients (7%) with an OPCRIT diagnosis of schizo-affective disorder, who were diagnosed with schizophrenia by their psychiatrist and consequently included in the study, and five patients (11%) with an OPCRIT diagnosis of unspecified functional psychosis.

Instruments

Speech attribution task

A shortened version, compiled of two-thirds of the original 108 words in the study by Johns *et al.* (2001), of the speech attribution paradigm developed by Johns and colleagues was used (Johns & McGuire, 1999; Johns *et al.* 2001). Single adjectives, half with a complimentary (e.g. 'cheerful') and half with a derogatory meaning (e.g. 'awful') were displayed to the participants on a computer screen. The adjectives were a subset of those used by Johns *et al.* (2001), translated into Dutch.

Procedure. Participants wore a set of stereo headphones with a microphone attached. This microphone was connected to an acoustic effects unit and an amplifier. The presented adjectives were read aloud by the participant and the speech was fed back through the headphones in real time as they spoke. In some of the trials, participants' speech was distorted. The pitch was either unchanged (no distortion), lowered by three semitones (moderate distortion), or six semitones (severe distortion). In another condition participants heard someone else's voice (alien feedback condition) instead of their own as they spoke. Similar to the person's own voice, the alien voice was presented at three levels of distortion. Summarizing, there were three self-conditions, one with distortion and one without distortion, and two alien-conditions, again with and without distortion. All this information was presented by the interviewing psychologist in the introduction that preceded the test. In each condition, four complimentary and four derogatory adjectives were presented. Participants had to indicate their opinion about the source of the speech by pressing the button that matched one of the three possible answers: 'self', 'someone else' or 'uncertain'.

The Present State Examination (PSE)

The purpose of the PSE (Wing, 1974) is to assess the presence and severity of symptoms associated with a broad range of major psychiatric disorders over a designated period (i.e. the last week), by means of a structured clinical cross-examination of the patient. In this study, only the sections that cover signs and symptoms of psychotic disorders were used (43 items: PSE 55–92, plus their subscale scores).

General intelligence

General intelligence was measured by a combined score on one performance subtest and one verbal subtest from the Groninger Intelligence Test (GIT), a widely used Dutch intelligence test (Luteijn & Van der Ploeg, 1983). This test yields results that are comparable to those of the Wechsler Adult Intelligence Scale – Revised (Wechsler, 1981).

Statistical analyses

Statistical analyses were carried out using STATA version 8.0 (Stata Corporation, 2005). A four-level ordinal group variable was constructed reflecting the risk for psychosis, with value 3 for patients, 2 for relatives, 1 for subclinical psychotic experiences, and 0 for controls. This creates the possibility to examine whether the four subject groups differ in a linear fashion.

Four words of the Speech Attribution Task were excluded from the analyses because their length caused difficulties in reading those specific words properly in the time span provided.

An error on the speech attribution task was defined as either an 'uncertain' response or a response that misidentified the source of the feedback given through the headphones. Analyses were repeated after exclusion of the 'unsure' answers. Errors were subdivided into two categories: (i) subjects misidentifying their own voice as someone else's, and (ii) subjects misidentifying an alien voice as their own. To examine whether the groups differed in the type

https://doi.org/10.1017/S0033291706009780 Published online by Cambridge University Press

of errors they produced, a variable was constructed that reflected the proportion of errors in which subjects did not recognize their own voice (self errors), relative to the total number of errors. The association between errors and symptomatology was assessed using continuous outcome variables for the PSE total score, as well as for the delusions and hallucinations subscales separately.

A multi-level approach to logistic regression, using the XTGEE module in STATA, was applied to assess the association between making an error on the speech attribution task and (i) the four-level group variable for psychosis risk and (ii) symptomatology as assessed with the PSE. Effect sizes were expressed as odds ratios (ORs) with their 95% confidence intervals (CIs), with the control group as the reference category. Multi-level random effects modelling techniques are a variant of the more often used uni-level regression analyses (Golstein, 1987) and are ideally suited for the analysis of data in which repeated observations (eight adjectives per level of distortion) are nested within subjects (Golstein, 1987). The main analysis was also performed in the subsets of subjects with current auditory hallucinations and Schneiderian symptoms respectively.

All analyses were *a priori* adjusted for age, general intelligence and sex because these are possible confounders of the association between psychosis risk and cognition.

Power analysis

Power of the analyses was calculated by simulation adapted from an example on the Stata website (www.stata.com/support/faqs/stat/power.html). The linear function of the ln(odds) was used to randomly generate a dichotomous variable, using the genbinomial procedure (STATA). This dependent variable was analysed 1000 times using logistic regression analyses. The power is the percentage in which the OR was statistically significant. Because the data had a multi-level structure, the multi-level *n* (7903) was first translated into the uni-level equivalent, using a multiplication factor (Snijders & Bosker, 1999). The uni-level equivalent of the *n* in the present analyses was 2023. These power simulations showed that the study has a power of approximately 80% to show an OR of 1·6.

RESULTS

Sample characteristics

The speech attribution task was carried out by 41 patients with psychosis, 39 non-psychotic first-degree relatives, 39 subjects from the general population with a high level of positive psychotic experiences and 52 healthy controls with an average level of positive psychotic experiences. Missing data were due to technical ($n=10$) or hearing problems ($n=4$). Two subjects from the patient group could not finish the task because of concurrent auditory hallucinations.

Demographic details are listed in Table 1. The mean total PSE score in the patient group was 16·2 (S.D. = 15·4) (see Table 1). Of the patient group, 15·2% had current auditory hallucinations, while 56·1% had current Schneiderian symptoms. We found that 19·5% of the subject group from the general population with a high level of positive psychotic experiences had had experiences of hearing voices during their lives. This is concordant with studies that suggest that psychotic experiences occur outside the realm of clinical disorder (Johns & van Os, 2001; Hanssen *et al.* 2003). In addition, 78% of the latter group had experienced at least one of the Schneiderian-like symptoms.

Verbal self-monitoring and psychosis

All four groups made errors. As no large or significant differences in error rates were found between the complimentary adjectives condition (OR 0·97, 95% CI 0·89–1·06, $p=0·53$) and the derogatory adjectives condition (OR 0·98, 95% CI 0·89–1·08, $p=0·74$), these conditions were combined into a single variable in the analysis.

There were no large or significant differences in the error rates between the four groups in any of the conditions (see Table 2). In the self-condition with distortion, which was the condition of interest for the present study, the ORs, relative to the controls, for the association between making an error and the psychosis-liability group variable were 0·94 (95% CI 0·60–1·47) in the group with a high level of psychotic experiences, 0·87 (95% CI 0·56–1·35) in the relatives group and 1·04 (95% CI 0·61–1·48) in the patient group.

The proportions of self-errors relative to the total number of errors were comparable across

https://doi.org/10.1017/S0033291706009780 Published online by Cambridge University Press

Table 1. *Summary statistics and symptom PSE scores of the sample*

	Controls (n=52)		Subclinical psychosis (n=39)		Relatives (n=39)		Patients (n=41)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Age	47·0	7·6	44·0	9·8	40·4	11·1	32·3	10·4
Education[a]	5·6	0·8	4·9	1·4	5·5	1·2	4·6	1·2
General intelligence	124·5	17·0	119·0	14·8	124·8	15·8	111·3	20·6
Gender (% male)	36·5		46·2		36·5		75·9	
Error (%)[b]	18·7		29·1		27·5		27·7	
Delusions[c]	0·0	0·0	0·4	1·4	0·1	0·9	8·0	8·8
Hallucinations[c]	0·0	0·0	0·4	1·7	0·3	1·0	3·3	4·7
Total[c]	0·02	0·1	1·6	4·3	0·8	2·8	16·2	15·4

S.D., Standard deviation.
[a] Education was measured on an eight-point scale from primary school to university degree (De Bie, 1987).
[b] Errors are defined as either an 'uncertain' response or a response that misidentified the source of the feedback.
[c] Present State Examination (PSE) scores.

Table 2. *Means and odds ratios for the percentage of errors made in each condition*

	Controls	Subclinical psychosis		Relatives		Patients	
	Mean (S.E.)	Mean (S.E.)	OR (95% CI)	Mean (S.E.)	OR (95% CI)	Mean (S.E.)	OR (95% CI)
With 'unsure' answers							
Self							
No distortion	8·3 (1·1)	16·7 (2·1)	2·06 (0·83–5·13)	12·8 (1·9)	2·01 (0·78–5·20)	12·5 (1·8)	2·30 (0·74–7·20)
Distortion	35·8 (1·7)	34·5 (2·0)	0·88 (0·56–1·39)	32·8 (1·9)	0·84 (0·53–1·31)	33·6 (1·9)	0·74 (0·42–1·30)
Alien							
No distortion	34·5 (2·4)	37·9 (2·9)	1·11 (0·65–1·92)	32·0 (2·7)	0·89 (0·51–1·56)	35·8 (2·8)	1·03 (0·53–2·02)
Distortion	29·6 (1·6)	26·1 (1·8)	0·86 (0·57–1·30)	27·9 (1·8)	1·03 (0·68–1·55)	26·1 (1·7)	0·91 (0·55–1·52)
Without 'unsure' answers							
Self							
No distortion	2·3 (0·7)	4·4 (1·2)	2·20 (0·54–8·99)	4·9 (1·3)	2·06 (0·49–8·64)	4·7 (1·2)	2·08 (0·36–11·8)
Distortion	34·2 (1·7)	31·9 (2·0)	0·84 (0·52–1·34)	29·9 (1·9)	0·78 (0·48–1·25)	30·1 (1·9)	0·63 (0·35–1·13)
Alien							
No distortion	31·6 (2·4)	35·2 (2·9)	1·10 (0·61–1·96)	28·8 (2·7)	0·86 (0·47–1·57)	31·7 (2·8)	0·95 (0·46–1·97)
Distortion	23·8 (1·5)	22·7 (1·7)	1·00 (0·63–1·58)	21·5 (1·7)	0·99 (0·63–1·58)	20·8 (1·7)	0·93 (0·52–1·64)

S.E., Standard error; OR, odds ratio; CI, confidence interval.
All analyses adjusted for age, general intelligence and sex.
Control group used as the reference category.

groups. Of all errors made by the patient group, 47·9% were misidentifications of their own voice (self-error). Proportions of self-errors were 45·7% in the group of first-degree relatives, 48·0% in the subclinical psychosis group and 45·3% in the control group.

There was no association between error rates and positive psychotic symptoms (PSE total) for the total subject group in the self-condition without distortion (OR 0·98, 95% CI 0·95–1·02), nor in the self-condition with distortion (OR 1·00, 95% CI 0·98–1·02), the other-condition without distortion (OR 0·99, 95% CI 0·97–1·01), and the other-condition with distortion (OR 0·99, 95% CI 0·97–1·01). Similarly, there were no significant group differences in error rates on the speech attribution task in subsets of patients with current Schneiderian symptoms (OR 1·18, 95% CI 0·82–1·72) or current auditory hallucinations (OR 0·95, 95% CI 0·54–1·69).

The same analyses using only true source misidentifications (errors), rather than source misidentifications and 'uncertain' responses,

https://doi.org/10.1017/S0033291706009780 Published online by Cambridge University Press

similarly did not yield any large or significant effect sizes.

DISCUSSION

No evidence was found for abnormalities in task performance in patients with psychosis or in individuals at risk of developing psychosis. These results deviate from previous findings with a similar paradigm (Johns *et al.* 2001, 2003, 2005, 2006) and with a different source-monitoring paradigm (Bentall *et al.* 1991*a*; Morrison & Haddock, 1997), but agree with other recent studies failing to detect differences with regard to the response bias in the detection of auditory signals in patients with psychotic disorder compared to controls (Li *et al.* 2002) and likewise in groups with varying levels of schizotypy (Li *et al.* 2003). On the basis of absence of abnormalities in response bias in the studies by Li *et al.* (2002, 2003), it could be speculated that impaired self-monitoring and the associated positive symptoms in psychosis are related to a top-down processing bias (e.g. expectations about sensorial information) rather than a bottom-up deficit (e.g. sensorial information to which one is exposed) (Aleman *et al.* 2003). This hypothesis is compatible with a study (Allen *et al.* 2004) by the same group that developed the current speech attribution paradigm (Johns *et al.* 2001). A crucial element of the original speech attribution paradigm was the on-line monitoring of one's own speech, in line with the concept that a difficulty in the monitoring of intended speech increases the risk for positive psychotic symptoms. However, in a modified version of the task, Allen *et al.* (2004) had subjects listen passively to their own recorded voice or to the voice of someone else, rather than speaking at the same time they received the feedback. Ascribing internally generated items to an external source occurred in patients in both experimental conditions. These findings cast some doubt on the original hypothesis that defective performance on the task reflects a deficit of self-monitoring. However, a top-down deficit would also have shown on the modified version of the task in the current study.

It is not likely that the lack of replication can be ascribed to a low level of symptoms. Although only a few of the patients had florid psychosis at the time of the assessment, the scores on the PSE show that, to a degree, persistent positive symptoms were present in the sample. In addition, a previous study demonstrated abnormal performance in people without frank psychotic symptoms but who were at risk of developing psychotic symptoms in the future (Johns *et al.* 2005). However, more recent findings of the same group (Johns *et al.* 2006) demonstrate that difficulty with source monitoring is associated more strongly with acute verbal auditory hallucinations than with a history of this symptom. When the current analysis was restricted to subjects with current hallucinations, however, again no significant associations with error rate on the speech attribution task were found.

The original version of the speech attribution paradigm developed by Johns and colleagues (Johns & McGuire, 1999; Johns *et al.* 2001) was shortened by two-thirds. This abbreviated version was used to avoid a drop in performance due to sustained attention dysfunction in patients with psychosis (Orzack & Kornetsky, 1966; Wohlberg & Kornetsky, 1973) and in at-risk groups (Mirsky *et al.* 1995; Chen *et al.* 1998). Additionally, four more words were excluded from the analyses because their length caused difficulties in reading those specific words properly in the time span provided. The possibility that the inconclusive findings were caused by a lack of power, considering the reduced number of stimuli in comparison with the original paradigm, is not likely given the size of the study groups, which is much larger than in previous source-monitoring studies (Cahill, 1996; Morrison & Haddock, 1997; Johns *et al.* 2001). Power simulations showed that the study has a power of approximately 80% to show an OR of 1·6. Furthermore, the fact that not even a trend towards more errors in the patient group was found renders the explanation that the negative finding was due to the reduced number of stimuli unlikely. Inspection of the performance of the control groups in this study and the study by Johns *et al.* (2001) shows comparable error rates. This suggests that both tests had the same level of difficulty and makes it unlikely that technical issues, for example timing of the feedback, influenced performance on our version of the task.

The choice to subdivide the 32 items into two categories (positive words/negative words), in contrast to the three categories (positive/negative/neutral) used by Johns *et al.* (2001), was made to allow for a sufficient number of items in each condition in the abbreviated test, with the strongest contrast expected between these two categories.

Contrary to previous source-monitoring research, the patient group in this study was not subdivided into patients with and without auditory hallucinations. Studies that did subdivide the patients into these two categories showed that patients with auditory hallucinations are impaired compared to controls whereas the deficit in patients without auditory hallucinations is much smaller (Bentall *et al.* 1991 *a*; Morrison & Haddock, 1997). However, as noted above, in the current data, the association between current auditory hallucinations and self-monitoring performance was neither large nor significant.

CONCLUSIONS

In summary, the study investigated whether defective self-monitoring occurs in patients with a psychotic disorder as well as in individuals at risk without current clinical needs. No evidence for abnormalities in self-monitoring was found in either group. These results deviate from previous findings using this paradigm.

DECLARATION OF INTEREST

None.

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