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Association of impaired reality processing with psychotic symptoms in schizophrenia

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ABSTRACT

Reality evaluation (i.e., the discrimination of things existing outside of oneself and figments of others' imagination) may be impaired in patients with schizophrenia, and impairment in reality evaluation may be related to psychotic symptoms such as hallucinations and delusions. In this study, we investigated the nature of impairment of reality processing and its relationship with hallucinations and delusions in schizophrenia. Twenty-six patients with schizophrenia and 25 healthy controls completed the reality evaluation task, in which subjects judged whether scenes in a series of drawings were real or unreal and whether they were familiar or novel. The patient group exhibited significantly lower accuracy in reality evaluation than the control group, and lower accuracy in the patient group was related to more severe hallucinations and delusions. These findings provide preliminary evidence that impaired reality evaluation is related to the formation or maintenance of hallucinations and delusions in schizophrenia.

1. Introduction

Hallucinations and delusions are distinct symptoms of schizophrenia, and may arise due to impaired reality monitoring. Patients with schizophrenia are thought to have difficulties in discriminating between an internally generated, imagined event and an externally presented, real event. However, previous studies have failed to reach a consensus on errors in reality monitoring in patients with hallucinations or delusions. Several studies (Brebion et al., 2000, 2002; Keefe et al., 2002; Brunelin et al., 2006) found that patients with hallucinations or delusions made more errors in reality monitoring than did psychiatric or normal control subjects, whereas other studies (Seal et al., 1997; Li et al., 2002) failed to observe such deficits. Additionally, deficits in reality monitoring have been reported in other nonclinical samples, such as children (Foley and Ratner, 1998) and the elderly (Deglinnocenti and Backman, 1996).

In order to investigate the cognitive processes involved in hallucinations and delusions of schizophrenia, we created the concept of reality evaluation. Reality monitoring refers the process of distinguishing past perceptions from past imaginations in memories (Keefe et al., 2002), while the process of discriminating between things existing outside of oneself and figments of other's imagination can be referred to as reality evaluation. Because reality evaluation is involved not only in evaluating the reality of external stimuli, but also in objectively estimating one's own thoughts, memories and imaginations, it would be reasonable to presume that hallucinations and delusions in schizophrenia may derive from impairment in reality evaluation. During the reality evaluation process, people typically perceive complex features of objects and backgrounds, examine their contexts, store the contexts in short-term memory, and compare the contexts with social norms of reality in memories. However, patients with schizophrenia may exhibit impaired reality evaluation due to deficits in processing complex stimuli (Carter and Neufeld, 1999), integrating visual context information (Talamini et al., 2010), and short-term (Elvevag et al., 2001) and semantic memory (Reichenberg, 2010).

Reality evaluation may be related to psychotic symptoms via abnormal memory processes of real/unreal stimuli. For example, a response bias, a tendency to report imaginary events as real, has been linked to underlying psychotic symptoms, and a liberal response bias in a recognition memory task has been reported to be associated with hallucinations (Brebion et al., 2005) and delusions (Ragland et al., 2003). A liberal response bias may stem from a general deficit in the processing of contextual information (Brebion et al., 1998). It is plausible to suggest that reality evaluation is related to memory processes in patients with schizophrenia as the processing of contextual information may be a prerequisite for reality evaluation. Additionally, confabulation,

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Table 1
Demographic and clinical characteristics of subjects.

	Patients with schizophrenia ($n=26$)	Healthy controls ($n=25$)	t/χ^2	P value
Age (years)	35.9 ± 5.5	34.0 ± 5.2	1.27	0.21
Education (years)	12.6 ± 1.8	14.9 ± 2.7	−3.61	0.001**
Gender (M/F)	18/8	17/8	0.01[a]	0.93
Information	20.1 ± 6.2	20.5 ± 5.5	−0.22	0.83
Picture completion	13.6 ± 4.0	16.7 ± 2.4	−3.26	0.002**
Digit span	17.8 ± 4.3	21.2 ± 3.2	−3.12	0.003**
RAVLT recognition	12.1 ± 2.5	14.1 ± 1.0	−3.71	0.001**
RCFT copy	31.9 ± 5.8	34.1 ± 1.8	−1.78	0.09
RCFT immediate recall	15.3 ± 9.1	26.7 ± 4.2	−5.77	< 0.001**
RCFT delayed recall	13.5 ± 9.0	25.3 ± 4.8	−5.78	< 0.001**
PANSS positive	13.6 ± 6.6	–		
PANSS negative	15.5 ± 7.2	–		
PANSS general	29.4 ± 9.7	–		
PSYRATS AHS (total)	10.3 ± 11.1	–		
PSYRATS DS (total)	7.5 ± 6.6	–		
Duration of illness (years)	11.4 ± 6.8	–		
Chlorpromazine equivalent dose (mg)	405.2 ± 236.1	–		

RAVLT: Rey Auditory Verbal Learning Test, RCFT: Rey Complex Figure Test, PANSS: Positive and Negative Syndrome Scale, PSYRATS: Psychotic Symptom Rating Scales, AHS: Auditory Hallucination Subscale, DS: Delusion Subscale.
*$P < 0.05$.
[a] Pearson's χ^2.
** $P < 0.01$.

a falsification of memory in the context of memory impairment, has been proposed to be linked to delusions (Langdon and Bayne, 2010).

The cognitive model (Morrison, 2001) provided possible explanations for the relationship between impaired reality evaluation and psychotic symptoms. According to this model, hallucinations and delusions are intrusions into awareness or culturally unacceptable interpretations of such intrusions and the interpretation of these intrusions causes distress and disability (Morrison, 2001). Impairment in reality evaluation can make it difficult for patients with schizophrenia to detect their misinterpretations and to correct them. Therefore, impaired reality evaluation may contribute to the formation or maintenance of hallucinations and delusions, but issues concerning the reality evaluation process in schizophrenia have not yet been investigated.

The primary aim of this study was to elucidate the nature of impairment in reality evaluation in schizophrenia. In order to address this issue, we created a reality evaluation task, in which subjects judged whether scenes in a series of drawings were real or unreal and whether they were familiar or novel. This is the first study to investigate reality evaluation in patients with schizophrenia. Considering previously known facts of reality processing in schizophrenia, we formed the following hypotheses: first, patients with schizophrenia would demonstrate impairment in reality evaluation and this impairment would be associated with the severity of hallucinations and delusions. Second, correlations with impairment in reality evaluation would demonstrate a similar pattern between hallucinations and delusions. Third, the degree of response bias would be associated with the severity of psychotic symptoms and impaired reality evaluation in patients with schizophrenia.

2. Methods

2.1. Subjects

Twenty-six patients with schizophrenia (18 males) and 25 healthy controls (17 males) participated in this study. All patients were recruited at psychiatric outpatient clinics and were in stable phases of illness. The exclusive diagnoses of schizophrenia in the patient group and the exclusions of psychiatric disorders in the control group were made using the Structural Clinical Interview for DSM-IV (SCID-IV; First et al., 1996) by a skilled psychiatrist. Exclusion criteria included the presence of neurological or significant medical illness and current or past substance abuse or dependence.

Demographic and clinical characteristics of subjects are summarized in Table 1. There were no significant group differences in terms of gender and age. Intellectual function was assessed using three subtests (Information, Picture Completion and Digit Span) of the Wechsler Adult Intelligence Scale-Revised (Wechsler, 1981). Raw score of the Information subtest was used as a measure of general knowledge, and those on the Digit Span (DSp) and Picture Completion (PC) subtests were also used to assess working memory and perceptual organization (i.e., the processes structuring visual information into coherent patterns) abilities, respectively (Dickinson et al., 2002). Memory function was assessed using the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964) and the Rey Complex Figure Test (RCFT; Meyers and Meyers, 1995). There were significant group differences in years of education, DSp and PC scores, RAVLT recognition score, and RCFT immediate and delayed recall scores.

Clinical symptoms were rated using the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987). The mean ratings of positive, negative, and general symptom subscale scores in the patient group were 13.6 ± 6.6, 15.5 ± 7.2, and 29.4 ± 9.7, respectively. Auditory hallucinations and delusions were assessed using the Psychotic Symptom Rating Scales (PSYRATS; Haddock et al., 1999), semi-structured interviews that consist of an 11 item Auditory Hallucination Subscale (AHS) and 6 item Delusions Subscale (DS). Each item of the PSYRATS is rated on a five-point ordinal scale (from 0 to 4) with higher scores representing more severe symptoms. The mean AHS and DS total scores in the patient group were 10.3 ± 11.1 and 7.5 ± 6.6, respectively, and the two scores were homoscedastic and normally distributed. All patients were taking one or two combinations of antipsychotic medications. The mean chlorpromazine-equivalent dose for the patient group was 405.2 ± 236.1 mg. This study was approved by the local institutional review board. Written informed consent was obtained from all participants before the study began.

2.2. Task design and procedure

2.2.1. Stimuli

In order to assess the ability of reality evaluation, we developed the reality evaluation task. As shown in Fig. 1, hand-drawn, black-and-white pictures were used in reality evaluation and picture recognition. Real pictures (e.g., A-1, B-1 in Fig. 1) were composed of objects (e.g., human, animal, house, furniture) with appropriate backgrounds, while unreal pictures were composed of distorted objects with appropriate backgrounds (e.g., A-2 in Fig. 1) or of intact objects with inappropriate backgrounds (e.g., B-2 in Fig. 1). Twelve healthy controls rated the degrees of reality of the pictures using a 9-point scale (−4=most unreal; 4=most real). Pictures with reality ratings over 2 were defined as real and pictures with ratings below −2 were defined as unreal. The pictures used are included as an electronic supplement.