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Metamemory in schizophrenia: Retrospective confidence ratings interact with neurocognitive deficits

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ABSTRACT

Prior studies with schizophrenia patients described a reduced ability to discriminate between correct and false memories in terms of confidence compared to control groups. This metamemory bias has been associated with the emergence and maintenance of delusions. The relation to neuropsychological performance and other clinical dimensions is incompletely understood. In a cross-sectional study, metamemory functioning was explored in 32 schizophrenia patients and 25 healthy controls. Metamemory was assessed using a verbal recognition task combined with retrospective confidence level ratings. Associations of metamemory performance with six neuropsychological domains (executive functioning/problem solving, speed of processing, working memory, verbal and visual learning, and attention/vigilance) and psychopathological measures were analyzed. Results revealed a significantly smaller discrepancy between confidence ratings for correct and incorrect recognitions in the patient group. Furthermore, patients showed significantly lower recognition accuracy in the metamemory task and marked deficits in all neuropsychological domains. Across all participants, metamemory performance significantly correlated with executive functioning and working memory. No associations with delusions were found. This data confirms prior findings of metamemory biases in schizophrenia. Selective neuropsychological abilities seem to be modulating factors of metamemory functioning. Longitudinal studies in at risk mental state and first-episode patients are needed to reveal causal interrelations.

1. Introduction

In general, memory abilities are among the most severely impaired cognitive functions in schizophrenia (Aleman et al., 1999; Heinrichs and Zakzanis, 1998; Fioravanti et al., 2005). Several aspects of memory are affected (Gras-Vincendon et al., 1994; Lee and Park, 2005; Assaf et al., 2007; Leavitt and Goldberg, 2009). But in addition to the analysis of memory accuracy, more qualitative examinations of memory processes have recently concentrated on reflection- and monitoring processes of one's own memory, so-called metamemory processes (Flavell, 1971). A good strategy to gain insight into various aspects of these monitoring abilities is to explore peoples' subjective judgments of their memory performance (Shimamura, 2000). One way to explore knowledge about memory abilities is to use self-rating scales. For example, Bacon et al. (2011) found that schizophrenia patients reported lower memory capacity, marginally lower mastery over their memory functions as well as less access to memory strategies compared to healthy controls. Another way is to ask for patients' introspective judgments of their actual performance in memory tasks. This can be done at different temporal stages of the memory process (Nelson and Narens, 1994). For example, judgments-of-learning can be given at the time of encoding, regarding upcoming memory retrieval. Second, feeling-of-knowing statements can be given about the likelihood that a correct answer will be recognized in future, after some

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information has not been successfully retrieved. Third, confidence level ratings about a given answer can be indicated retrospectively at the time of retrieval. Using these methods, impaired metamemory abilities of schizophrenia patients were found compared to healthy and psychiatric control participants (Bacon et al., 2001, 2007; Kircher et al., 2007; Moritz et al., 2006d, 2006e, 2008).

Retrospective confidence level ratings, measuring cognitive confidence, have been shown to be valid indicators of the subjective accuracy of memory retrieval (Moritz et al., 2011). Prior studies found support for a biased evaluation of memory performance in schizophrenia patients using these confidence level ratings (Danion et al., 2001; Moritz and Woodward, 2006b; Moritz et al., 2003, 2005; Peters et al., 2013). More recently, similar results have also been detected in studies regarding source monitoring (Gaweda et al., 2012, 2013) and social judgments (Köther et al., 2012; Moritz et al., 2012). A main bias seems to be an increased confidence in incorrect memories in addition to a decreased confidence in correct responses compared to healthy people and psychiatric controls (Moritz and Woodward, 2006b; Moritz et al., 2008; Peters et al., 2013). This phenomenon has been described as a decreased "confidence gap", i.e. a discrepancy between the certainty for correct and incorrect responses. Another bias of metamemory ability has been termed "knowledge corruption" (Moritz et al., 2006d). The research group found schizophrenia patients to have an increased proportion of errors which they judged with very high confidence to be correct. The knowledge corruption index thus describes high-confident subjective, but false knowledge (Moritz et al., 2008).

Overconfidence in memory errors may represent a risk factor for delusions and hallucinations (Moritz and Woodward, 2006a; Gaweda et al., 2013). It might be a consequence of a liability to accept false hypotheses as true and evaluate them on the basis of too little information–a liberal acceptance–which in turn results in wrong and delusional interpretations of situations (Moritz et al., 2005, 2008), comparable to the "jumping to conclusion" bias (Fine et al., 2007). Some investigations suggested this bias to be schizophrenia-specific (Moritz and Woodward, 2004, 2006a, 2006b). Correlations between overconfidence in memory and delusions were not only found in schizophrenia patients (Moritz and Woodward, 2002) but also in healthy controls with schizotypic properties (Corlett et al., 2009). However, findings of overconfidence and knowledge corruption in patients with alcohol dependence and a history of hallucinations rather point to more general associations with positive symptoms in different illnesses (Gaweda et al., 2014). There are also studies with schizophrenia patients which did not reveal any association (Kircher et al., 2007; Peters et al., 2013).

So far, the literature lacks comprehensive examinations of associations between metamemory function and neuropsychological performance. The existing studies reported inconsistent results and only a small number of studies included behavioral designs to test metamemory abilities. In healthy controls, correlations between items of metacognitive rating scales and executive functions (updating, shifting and inhibition) were described (Mäntylä et al., 2010). Furthermore, divided attention at encoding in a verbal memory task resulted in overconfidence in memory prediction in healthy controls (Sacher et al., 2009). In schizophrenia patients, some studies reported correlations between metacognitive rating scales and cognitive performance, as executive functions (Bacon et al., 2011; Lysaker et al., 2008; Souchay et al., 2004), whereas others discussed independence between metamemory deficits and executive function as well as verbal memory (Moritz et al., 2003), attention and immediate memory (Kircher et al., 2007) and intelligence measures (Kircher et al., 2007; Moritz et al., 2003, 2005). To shed light on associations between metamemory and neurocognitive abilities and to understand possible modulating effects, more detailed investigations seem necessary.

This study aimed at replicating findings regarding metamemory abilities in a well characterized sample of schizophrenia inpatients compared to healthy control participants. First, in order to assess retrospective confidence level ratings of memory, we used a variant of the Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959), a verbal false memory task. Second, we aimed at evaluating correlations between psychosis symptoms and cognitive confidence in memory. Third, we intended to address the basic cognitive mechanisms of retrospective cognitive confidence in memory using the comprehensive neuropsychological battery Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive Battery (MCCB; Kern et al., 2011; Nuechterlein et al., 2008) to extend the literature regarding mutual interrelations between neurocognition and metacognitive biases in schizophrenia. Referring to the previous literature, we hypothesized that patients with schizophrenia show a decreased confidence gap and an increased knowledge corruption index compared to healthy participants, indicating metamemory biases. In secondary analyses, we addressed the following research questions: Is confidence in errors associated with positive symptoms in schizophrenia? Are there associations between the performance in neurocognitive domains and overconfidence in errors?

2. Methods

2.1. Study design and participants

The present study was designed as a cross-sectional parallel-group comparison and was part of a comprehensive investigation of metacognition in schizophrenia. It was approved by the ethical board of the Ruprecht-Karls-University Heidelberg (accession number: 2009-296 N-MA). Analyses of endpoints beyond metamemory included partially overlapping participants (Eifler et al., 2014; Rausch et al., 2014). All participants were informed about aims and procedures of the study and provided their written consent after a sufficient period of consideration and resolving open questions. A number of 32 patients with schizophrenia were recruited during their inpatient treatment at the Central Institute of Mental Health (CIMH) in Mannheim, Germany. Seven patients fulfilled symptomatic remission according to Andreasen et al. (2005) with PANSS scores ≤ 3 on remission criteria items. All of them fulfilled a set of predefined inclusion criteria: diagnosis of schizophrenia according to the Diagnostic and Statistical Manual (DSM-IV-R; Saß et al., 2000), age between 18 and 60 years, ability to provide informed consent, sufficient German language skills and residence within a 50 km radius around Mannheim. We did not include patients with substance dependence (excluding nicotine), other disorders of the central nervous system requiring treatment and patients receiving combined antipsychotic treatment or augmentation with antidepressants or mood stabilizers. Current antipsychotic treatment with second generation antipsychotic agents was quantified using chlorpromazine (CPZ) equivalents (Andreasen et al., 2010). Twelve patients were treated with benzodiazepines (lorazepam: $n=12$, mean dosage: 2.0 (S.D.: 1.57) mg/day) because of anxiety, agitation, or sleep disorder. No patient was treated with anticholinergic agents. 25 control subjects were matched on group level according to gender, age and levels of education. They were carefully characterized regarding family and previous medical history before study entry. Subjects with suicide, schizophrenia and bipolar disorder in first-degree relatives, as well as subjects with disorders of the central nervous system, inpatient treatment in psychiatric hospitals, current treatment with psychotropic agents, substance dependence (excluding nicotine) and abuse of illegal substances within the 4 weeks before investigation were excluded. In addition, a screening regarding currently present psychopathological syndromes according to DSM-IV-R was performed using the M.I.N.I. (Mini-International Neuropsychiatric Interview; Sheehan et al., 1998).

2.2. Psychopathology

Current psychopathology was assessed by trained raters (either by S.E. or F.R). Training was established by standardized video-based sessions. No psychopathological scales were rated by both raters for the same patient and no inter-rater reliability data was collected. The Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987) was used to assess positive and negative symptoms as well as the general psychopathology. Besides these scale-sumscores, we were interested in single PANSS items representing delusions (P1) and hallucinations (P3). Furthermore, the delusion part of the Psychotic Symptom Rating Scales (PSYRATS; Haddock et al., 1999) was used to measure qualitative aspects of delusions in six domains (preoccupation with delusions, duration of preoccupation, delusional conviction, amount of distress, intensity of distress and disruption of life). The PSYRATS is a semi-structured interview. Every item can be rated on a five-point scale ranging from 0 to 4. A