



# Necessary, but not sufficient: Links between neurocognition, social cognition, and metacognition in schizophrenia are moderated by disorganized symptoms



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## ABSTRACT

Intact neurocognition has been posited as a necessary, but not sufficient prerequisite for efficient social cognition and metacognition in schizophrenia. Disorganized symptoms likely play a prominent role in these cognitive processes, given the detrimental effects of disorganization on one's ability to synthesize discrete information into an organized whole. However, the relationship between disorganized symptoms and cognitive processes remains unclear. In this study, we examined whether disorganized symptoms: 1) exhibited stronger inverse relationships with cognitive processes than other symptoms, and 2) moderated links between neurocognition and a) social cognition, and b) metacognition. Trained raters assessed psychotic symptoms, neurocognition, social cognition, and metacognition in patients with schizophrenia from a Midwestern VA Medical Center ( $n = 68$ ) using validated, clinician-rated instruments. We observed significantly greater inverse associations with cognitive processes for disorganized compared to reality distortion symptoms; inverse associations with neurocognition and social cognition were significantly greater for disorganized than negative symptoms. Our hypotheses that disorganized symptoms would moderate relationships between neurocognition and a) social cognition, and b) metacognition were also supported. These findings highlight the importance of disorganized symptoms in elucidating links between neurocognition and social cognitive and metacognitive abilities. Future work should assess whether similar findings occur across the schizophrenia-spectrum, and investigate if targeting disorganization can ameliorate social cognitive and metacognitive impairments in schizophrenia.

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## 1. Introduction

Schizophrenia is a debilitating disorder that typically leads to impairments in a wide range of cognitive processes, including neurocognition, social cognition, and metacognition (Frith, 1992; Green, 1996; Penn et al., 1997; Lysaker et al., 2005; Green and Leitman, 2008). The significant heterogeneity found in schizophrenia poses a considerable challenge when assessing impairment in these processes, as no single deficit or symptom affects all, or even most, cases (Cohen and Docherty, 2005; Menezes et al., 2006). One method of accounting for heterogeneity is to group symptoms based on similar putative causes. Although there has been substantial debate on the number of factors in schizophrenia, evidence suggests that the best fitting model includes three symptom clusters: 1) reality distortion (e.g., delusions, hallucinations), 2) negative

(e.g., anhedonia, alogia), and 3) disorganized (e.g., tangential speech, inappropriate affect; see Liddle, 1987; Cuesta et al., 2007; Malla et al., 1993). Of these, disorganized symptoms have received the least attention, as many early models combined disorganized and reality distortion symptoms to form the positive cluster (Crow, 1980). However, disorganized symptoms have proven to hold important implications in schizophrenia, as their presence is linked with poor occupational functioning (Smith et al., 2002; Evans et al., 2004) and long-term disease course (Shenton et al., 1992; Metsanen et al., 2006).

In studies utilizing the three-factor approach, disorganized symptoms appear to be more closely associated with impairments in cognitive processes than reality distortion symptoms. In a meta-analysis conducted by Ventura et al. (2010), disorganized symptoms demonstrated moderate inverse associations with overall neurocognition and neurocognitive functioning across six core domains, whereas reality distortion symptoms were only weakly related. A separate meta-analysis including over 7000 individuals with schizophrenia showed that disorganized symptoms exhibited stronger inverse associations with social cognitive abilities than reality distortion symptoms (Ventura et al., 2013). Metacognition is a third cognitive process where disorganized

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symptoms appear to have a more prominent role. Metacognition can be defined as a spectrum of mental activities that involve thinking about thinking (Flavel, 1979; Frith, 1992), ranging from more discrete acts in which people recognize specific thoughts and feelings to more synthetic acts in which an array of intentions, thoughts, feelings, and connections between events are integrated into larger complex representations of others (Semerari et al., 2003; Lysaker et al., 2013; Lysaker and Dimaggio, 2014). It differs from social cognition in that metacognition focuses on synthesizing psychological experiences into mental representations that vary by complexity, adaptiveness and flexibility, whereas social cognition is more concerned with the accuracy of perceptions and representations. Recently, Hamm et al. (2012) observed that disorganized symptoms were inversely linked to metacognition at baseline and six month follow-up and that these associations were considerably greater compared to reality distortion symptoms.

Although previous studies have examined the link between disorganized symptoms and cognitive processes, the nature of the relationship between neurocognition, social cognition, and metacognition remains unclear. One area of contention is whether these three cognitive processes are discrete constructs, as each represents trait phenomena that require both lower- and higher-order abilities (Lysaker et al., 2011; Biedermann et al., 2012; Hamm et al., 2012; Ventura et al., 2013). Resolving this issue is critical for delineating whether these constructs should be treated as independent or converging abilities when assessing their impact in schizophrenia. In terms of what is known regarding these relationships, previous studies have observed that neurocognition, social cognition, and metacognition demonstrate moderate correlations with one another, with  $r$ -values typically ranging from 0.2 to 0.4 (Hamm et al., 2012; Ventura et al., 2013). However, this indicates that each ability only accounts for approximately 5% to 15% of the variance in the other constructs. Moreover, a number of studies have examined whether these processes can be disentangled from one another, with a growing consensus suggesting that neurocognition, social cognition, and metacognition are related, but independent constructs (Pinkham et al., 2003; Allen et al., 2007; Fanning et al., 2012; Lysaker et al., 2013).

Evidence of construct independence informs our understanding of these processes, yet does not clarify their relationship with one another. To date, we know little about how these processes overlap. A theory that has been posited is that intact neurocognition is a necessary, but not a sufficient prerequisite for exhibiting efficient social cognition (Penn et al., 1997; Fanning et al., 2012) and metacognition (Lysaker et al., 2010). One possibility is that the links between these abilities are moderated by additional variables. Understanding how moderators influence links between neurocognition, social cognition, and metacognition is important, as it provides the possibility to discern when relationships between these cognitive processes are strongest. From a clinical standpoint, identifying moderators also offers the potential of clarifying how cognitive processes lead to the social and occupational impairments prevalent in schizophrenia.

Disorganized symptoms are prime moderator candidates, given the detrimental effects these symptoms have on one's ability to synthesize discrete information into an organized whole, a critical component of both social cognition and metacognition. This connection between disorganization and cognitive processes was introduced by Bleuler (1911), who believed that brain dysfunction was characterized by a disruption in cognitive processes stemming from a "loosening of associations." As a result of neurocognitive compromise, the capacity to form the complex thoughts needed to engage in goal-directed behaviors may significantly be disrupted. The "loosening of associations" described by Bleuler is similar to updated models of disorganized symptoms that are currently being examined (see Hardy-Bayle et al., 2003). In this study, we examined whether disorganized symptoms moderated relationships between neurocognition and social cognition and metacognition. To our knowledge, this possibility has not been explored previously.

## 1.1. Objectives and hypotheses

This study had two primary aims. First, we investigated whether disorganized symptoms exhibited stronger inverse correlations with neurocognition, social cognition, and metacognition compared to other symptom clusters. Our expectation was that associations with each cognitive process would be significantly greater for disorganized than reality distortion symptoms. Second, we aimed to clarify the role of disorganized symptoms in the link between neurocognition and a) social cognition, and b) metacognition. Our hypothesis was that disorganized symptoms would moderate the relationship between neurocognition and both constructs.

## 2. Method

### 2.1. Participants

Participants were outpatients in a Midwestern VA Medical Center with confirmed DSM-IV-TR (American Psychological Association, 2000) diagnoses of schizophrenia ( $n = 46$ ) or schizoaffective disorder ( $n = 22$ ). All participants were in a post-acute phase of illness, with no change in medication, housing, or outpatient status (e.g., hospitalizations) within the past 30 days. Exclusion criteria included active substance dependence or a documented intellectual disability at any time point. This data was part of a larger randomized controlled trial examining the role of cognitive remediation on work outcomes in schizophrenia. For the purposes of this project, we focused solely on participant's baseline scores (i.e., prior to any intervention). To be included in the final sample, participants had to have completed baseline scores for all symptom, neurocognition, social cognition, and metacognition measures ( $n$  excluded = 3), resulting in a total of 68 participants. The majority were male ( $n = 64$ , 94%), African-American ( $n = 41$ , 60%), had received a GED or high school diploma (education  $M = 12.68$ ,  $SD = 2.20$ ), were middle-aged ( $M = 50.50$ ,  $SD = 10.38$ ), and were hospitalized for the first time in their late twenties ( $M = 29.15$ ,  $SD = 12.24$ ).

### 2.2. Measures

Psychotic symptoms were assessed using the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987), a 30-item scale that was completed by trained research staff following chart review and a semi-structured clinical interview. The PANSS has been used in hundreds of studies to assess symptoms and has demonstrated good internal consistency (Kay et al., 1987), interrater reliability (Bell et al., 1992; Lysaker et al., 2013), and predictive validity (Bell et al., 1992). Scores on PANSS items range from 1 to 7, with higher scores indicating greater symptom severity. In this study, we focused on three PANSS factors (see Bell et al., 1994): reality distortion ( $M = 17.92$ ,  $SD = 5.12$ ), negative ( $M = 19.94$ ,  $SD = 5.09$ ), and disorganized symptoms ( $M = 16.93$ ,  $SD = 3.82$ ). The reality distortion category consisted of 6 items (delusions, hallucinations, unusual thought content, somatic concerns, suspiciousness, grandiosity), the negative symptoms included 8 items (passive social withdrawal, emotional withdrawal, blunted affect, lack of spontaneity, poor rapport, disturbances of volition, preoccupation, motor retardation), and the disorganized factor contained 7 items (difficulty in abstract thinking, stereotyped thinking, conceptual disorganization, lack of insight, poor attention, tension, and mannerisms/posturing).

The Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS; Nuechterlein et al., 2008) battery was used to assess neurocognition. The MATRICS was designed to measure neurocognitive ability in schizophrenia; it includes ten subtests across seven neurocognitive domains (processing speed, attention, working memory, verbal learning, visual learning, reasoning and problem solving, and social cognition). In this study, the neurocognition composite

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