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Is disorganization a feature of schizophrenia or a modifying influence: Evidence of covariation of perceptual and cognitive organization in a non-patient sample



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ABSTRACT

A subgroup of people with schizophrenia is characterized by reduced organization in perception, thought, language, and motor functioning, and these impairments covary significantly. While this may reflect multiple expressions of an illness-related core processing impairment, it may also represent the extreme end of an organization–disorganization dimension that is found throughout the general population. In this view, disorganization is a modifying influence on illness expression. To obtain preliminary information on this hypothesis, we examined covariation of perceptual and cognitive organization in a non-patient sample. Subjects completed a battery of perceptual tasks with demonstrated sensitivity to schizophrenia and disorganization, and a battery of questionnaires examining cognitive organization. Our results indicated that level of perceptual organization ability, across multiple tasks, was associated with self-reported levels of cognitive organization on multiple measures. This is thus preliminary evidence for a common process affecting perceptual and cognitive organization in the general population, suggesting that disorganization may reflect a modifying influence mechanism, instead of an illness-related process, in schizophrenia.

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1. Introduction

Better characterization of the varied conditions within the syndrome of schizophrenia, and their relevant dimensions, has become a research priority (Insel et al., 2010). One strategy has been to focus on core biobehavioral processes thought to be dysfunctional (i.e., functioning at an extremely high or low level) in the disorder. Included among these are perceptual impairments, for which much evidence now exists regarding their nature, biological bases, and functional significance in schizophrenia (Silverstein and Keane, 2011; Chen, 2011; Green et al., 2011).

One perceptual process that has shown promise for characterizing heterogeneity in schizophrenia is perceptual organization (PO). PO refers to the ability to organize stimulus elements into meaningful edges, patterns, groupings, or object representations. PO dysfunction has been repeatedly demonstrated in schizophrenia patients (e.g. Snyder, 1961; Cox and Leventhal, 1978; Wells and Leventhal, 1984; Silverstein et al., 1996, 2000; for review, see Silverstein and Keane, 2011) and, among biobehavioral markers,

has shown a high level of specificity for schizophrenia, having not been observed in psychiatric control groups (e.g., substance abuse, bipolar disorder, mixed affective psychoses) (Silverstein et al., 2000; Phillips and Silverstein, 2003; Silverstein and Keane, 2011). PO dysfunction has also been associated with multiple schizophrenia-related symptoms and features, including poor premorbid social functioning, long-term hospitalization, elevated nailfold plexus visibility, earlier illness onset, and reduced gamma- and beta-band synchrony (Phillips and Singer, 1997; Silverstein et al., 1998b, 2009; Knight and Silverstein, 1998; Rapoport et al., 2005; Uhlhaas et al., 2005, 2008; Schenkel et al., 2005; Butler et al., 2013). In particular, impaired PO is associated with more severe disorganization, a symptom dimension including inappropriate affect, odd movements, and formal thought disorder (Lindenmayer et al., 1994; Peralta and Cuesta, 2007). Disorganization is highly heritable and linked to many of the same features as is PO impairment, including impaired attention, poor premorbid social adjustment, and poor long-term functional outcome. Many of these features typically correlate and represent a ‘poor outcome’ or ‘process’ subtype of schizophrenia (Farmer et al., 1983; Sham et al., 1996; Wickham et al., 2001).

One interpretation of the above evidence is that impaired PO is an aspect of schizophrenia or subtype thereof. However, an alternative explanation is as follows: (1) PO is a manifestation of

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cognitive coordination: a canonical cortical function involving dynamic, context-based stimulus organization based on current spatial, temporal, or semantic relationships, which is thought to subservise PO, selective attention, and lexical disambiguation (Phillips and Singer, 1997; Phillips and Silverstein, 2003, 2013; Kay and Phillips, 2011); (2) the integrity of this function varies considerably in the general population and is independent of schizophrenia; and (3) when individuals with schizophrenia (which is characterized by stimulus flooding, attentional impairment, and working memory failures) are low on PO and related aspects of cognitive coordination, they will demonstrate pronounced disorganized symptoms. Stated differently, poor cognitive coordination may be a *modifying influence* (Pogue-Geile and Harrow, 1985), but not a feature of schizophrenia per se.

The concept of an organization personality construct modifying the expression of schizophrenia-spectrum symptoms and task performance has received empirical support. For example: (1) cognitive disorganization is related to perceptual impairments in people without schizophrenia who have high levels of schizotypy (Cappe et al., 2012); (2) while both highly heritable, disorganization and psychosis have been shown to sort independently, suggesting different genetic origins (Rijsdijk et al., 2011); (3) disorganization traits are persistent across illness duration regardless of state (Paulus et al., 2001); and (4) trait-related allusive thinking, a mild form of thought disorder, occurs in the general population and is associated with reduced auditory mismatch negativity amplitude, suggesting that disorganized thinking is related to poorer pre-attentive processing, of which reduced PO is also a manifestation (Ward et al., 1992; McConaghy et al., 1993).

It is important, however, to distinguish between a personality dimension and a taxonic element. There is currently much debate about the latent structure of schizophrenia-spectrum symptoms. One approach conceptualizes schizotypic experiences as individual differences continuously distributed (i.e., dimensional) within the population (Eysenck, 1958; Claridge, 1972, 1987; Roberts and Claridge, 1991). Another group, following Meehl (1962, 1989, 1990), conceptualizes true schizotypy and its related symptoms as taxonic latent entities. Most investigations examining the latent structure of positive schizotypic symptoms support a taxonic view, while the evidence regarding the latent structure of negative symptoms is far more mixed (Fossati and Lenzenweger, 2009). To our knowledge, there have been no explicit investigations of the latent structure of disorganized symptoms. Our conceptualization of disorganization aligns more closely with the dimensional view, as we posit disorganized thinking and behavior arise from individual differences in neural functioning that impact the context-sensitivity of information processing (i.e., lead to reduced cognitive coordination). We do not believe deficits in cognitive coordination are an aspect of the latent liability for schizophrenia, rather that individual differences in cognitive coordination modify the expression of schizophrenia should it develop. As our conceptualization extends beyond classically observed disorganized symptoms characteristic of schizophrenia, so too do the behaviors and cognitive issues with which it may associate. We believe disorganization, broadly defined, can manifest in various aspects of cognition (e.g. reduced contextual constraint in language, decreased selective attention, greater interference with working memory, less stable mental representations, and poorer perceptual organization) and predictable compensatory strategies (e.g. increased subjective perception of a need for external structure).

To date, explorations of the nature of individual differences in PO in the general population have been limited. However, clinical studies have shown that PO ability can be as diverse in non-patient samples as among schizophrenia patients: some control subjects perform at chance levels on PO tasks and there can be significant overlap between patient and non-patient groups (Uhlhaas et al., 2006; Kurylo et al., 2007; Nikolaev et al., 2010; Baggett et al.,

2010), suggesting a range of individual differences exists. Wholly unexamined in patient and non-patient samples is whether PO integrity is associated with cognitive organization. Here, we tested the hypothesis that decreased PO is associated with less organized cognition and behavior in a non-schizotypic community sample. To do this, we used a battery of self report questionnaires that, *prima facie*, assess some aspect of cognitive organization, including: interference with selective attention and maintenance of representations in working memory, behavioral evidence of poor organization (e.g., frequent tardiness, forgetfulness), disruption in the perceived organization and maintenance of internal thoughts, alterations in somatic perception, intensification of (internal) visual imagery, and, at the most global levels, a perceived increased need for external structure in order to function effectively. We predicted that lower levels of cognitive organization reported on these measures would correlate with lower levels of PO. If confirmed, this would suggest that variation in integrity of a common cognitive-perceptual coordination process may contribute to observable behavioral differences in the general population and to the nature of symptomatology in schizophrenia patients.

2. Methods

2.1. Subjects

The study was conducted at Rutgers University. Eighty-one subjects (43 female) participated. All participants were recruited from the community, between the ages of 18 and 56, and, based on a set of standard questions, denied having a history of psychotic or neurologic illness, serious head injury, or drug use in the prior 6 months. Demographic details can be found in Table 1.

2.2. Apparatus

Stimuli were presented on a Samsung 2243BWX LCD monitor with viewable dimensions of 47.5 cm by 29.8 cm. The viewing distance was approximately 24 in. (60.9 cm). The screen resolution was 1680 × 1050, and therefore, the viewable screen subtended approximately 43° × 27° of visual angle. Spyder 3 Elite software was used to calibrate the monitors at the start of the study and then weekly afterwards. Monitors were set to a γ value of 2.2 and a white point of 6500 K.

2.3. Stimuli and procedures

2.3.1. Jittered Orientation Visual Integration task (JOVI)

In this task, a continuous path of individual Gabor elements, embedded in background noise, forms an egg shaped contour (see Fig. 1A–D) and on each trial subjects are required to determine whether the shape is pointing right or left. Stimuli parameters were identical to those used in Silverstein et al. (2012), study 2. Difficulty was manipulated by applying varying degrees of orientational jitter to contour elements (see below). With two prior versions of this task, extent of performance impairment was related to level of disorganized symptoms in a population of schizophrenia patients (Silverstein et al., 2000; Uhlhaas et al., 2006).

Each trial consisted of a 2 s stimulus presentation with a 1 s interstimulus interval during which no responses were recorded. Blocks consisted of trials of stimuli at one level of orientation jitter (relative to their original positions) of the contour elements: $\pm 0^\circ$, 7° , 9° , 11° , 13° , and 15° (see Fig. 1A–D). Each block of 12

Table 1
Demographic information of study participants.

Total participants	81
Age (years)	34.16 ± 11.23
Sex (# female)	43
Race (#)	
White	32
Black	30
Hispanic	7
Asian	9
Other	3
Education (years)	14.3 ± 3.1
Shipley-2 score	99.76 ± 14.6

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