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Contour integration impairment in schizophrenia and first episode psychosis: State or trait?

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ABSTRACT

Contour integration is a fundamental visual process that recovers object structure by representing spatially separated edge elements as a continuous contour or shape boundary. Clinically stable persons with schizophrenia have repeatedly been shown to be impaired at contour integration but it is unclear whether this process varies with clinical state or whether it arises as early as the first episode of psychosis. To consider these issues, we administered a contour integration test to persons with chronic schizophrenia and to those with a first episode of psychosis. The test was administered twice—once at admission to short term psychiatric hospitalization and once again at discharge. A well-matched healthy control group was also tested across the same time points. We found that contour integration performance improved to the same degree in all groups over time, indicating that there were no recovery effects over and above normal practice effects. Moreover, the schizophrenia group demonstrated poorer contour integration than the control group and the first episode group exhibited intermediate performance that could not be distinguished from the other groups. These results suggest that contour integration ability does not vary as a function of short-term changes in clinical state, and that it may become further impaired with an increased number of psychotic episodes.

1. Introduction

Evidence is increasing for the presence of visual perceptual impairments in schizophrenia, along with their etiologic (Schiffman et al., 2004; Schubert et al., 2005) and functional (Rassovsky et al., 2011; Green et al., 2012) significance. One well-documented impairment is in perceptual organization, which refers to processes by which individual elements of sensory information are collectively structured into larger units of perceived objects and their interrelations (Palmer, 1999). Over 50 studies have now demonstrated reduced perceptual organization in schizophrenia across various paradigms, labs, and countries (for review, see Silverstein and Keane, 2011). One of the most widely used measures of perceptual organization in the schizophrenia and basic vision literatures is contour integration (CI) (Field et al., 1993; Kovacs, 2000; Chandna et al., 2001; Levi et al., 2007). CI is typically measured as the ability to detect or make a judgment about a closed contour made up of non-contiguous elements, embedded within a display of randomly oriented elements. Previous studies have shown that people with schizophrenia are less able to detect and make shape judgments about integrated contours when compared to various healthy and psychiatric control groups (Uhlhaas and Silverstein, 2005; Silverstein and Keane, 2011). Poor performance on CI tasks, as with other forms of perceptual organization impairment in schizophrenia (Silverstein and Keane, 2011), has also been associated with poorer premorbid social functioning (Schenkel et al., 2005; Joseph et al., 2013), elevated disorganized symptoms (Silverstein et al., 2000; Uhlhaas et al., 2005, 2006a,b), and a more chronic course of illness (Silverstein et al., 2006a) — a triad of characteristics which have been demonstrated to significantly covary and which may represent a particularly severe form of the condition (Farmer et al., 1983; Sham et al., 1996; Wickham et al., 2001).

An unanswered question in the perceptual organization and CI literatures in schizophrenia is the extent to which these impairments are state- or trait-related. Only a single study has demonstrated state sensitivity of CI in schizophrenia. In Uhlhaas et al. (2005), schizophrenia patients scoring higher than 3 on the PANSS P2 conceptual disorganization item, but not other groups of schizophrenia, psychotic, or non-psychotic patients, demonstrated improvement in CI during the course of short-term inpatient treatment, and CI improvement covaried significantly with reductions in conceptual disorganization, but not positive, negative, cognitive, excitement, or depression symptom dimensions. An issue with the Uhlhaas et al. (2005) study, however, is that the

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card-based CI task had a small number of stimulus trials (15), which undoubtedly limited sensitivity to impairments or to change over time. On the other hand, that task only included one practice trial and so the poor initial performance of disorganized patients may have reflected a reduced or delayed comprehension of the nature of the task. The purpose of the present study was, therefore, to examine state-sensitivity of CI in schizophrenia using a recently improved, computer-based CI task with previously demonstrated validity and good test–retest reliability, and with a large number of trials and an adequate practice session (Silverstein et al., 2012).

A second unanswered question concerns the degree of contour integration impairment at the first episode of psychosis. Therefore, we examined the extent to which CI impairments are observed at first episode, and the extent to which they are ameliorated over the course of initial hospitalization. Only 2 prior studies investigated visual perceptual organization at first episode. One did not include a measure of CI, and found no impairment on other perceptual organization indices (Silverstein et al., 2006b). The other found that on a measure of CI, first episode patients performed at a level intermediate between controls and chronic schizophrenia patients; however, they did not use a longitudinal approach, and their CI measure differed in significant ways from the standard paradigm that we report on here (Parnas et al., 2001). Therefore, in this study, we included a group of first episode psychosis patients, a group of people with schizophrenia with more than one psychotic episode, and healthy controls well-matched to the schizophrenia group.

2. Methods

2.1. Subjects

Demographic information for subjects is provided in Table 1. Three groups of subjects were recruited: 1) subjects hospitalized for a first episode of psychosis (FEP) (n = 18, 9 males), whose final diagnosis, in most cases, is still currently unknown (see Supplemental Methods), based on the length of time required for a diagnosis of schizophrenia spectrum disorder; 2) patients at a second or later episode of schizophrenia (SCZ) (n = 24, 17 males) and recruited from the same short-term inpatient unit as the FEP group; and 3) healthy controls (CON) (n = 36, 18 males) who were screened for presence of a psychotic or mood disorder.

Inclusion criteria for all subjects included age between 18 and 60, and, for patients, a diagnosis of either schizophrenia or a first episode of a psychiatric disorder with psychotic symptoms, as confirmed by the Structured Clinical Interview for DSM-IV Diagnosis, patient version (First et al., 2002b). Exclusion criteria for patients included any history of traumatic brain injury or head injury with loss of consciousness exceeding 10 min, current mood disorder if a diagnosis of schizophrenia was established, substance abuse disorder within the previous 6 months or positive urine toxicology screen on the day of any testing session, or electroconvulsive therapy in the prior 8 weeks. Subjects were also excluded if they had a history of a neurological disorder, developmental disorder, or evidence of intellectual disability. This latter condition was confirmed by the electronic medical record if subjects demonstrated any evidence of intellectual impairment via their behavior, staff report, or score on the Shipley-2 (Shipley et al., 2009). Exclusion criteria for control subjects are those items just listed for patients, in addition to: current mood disorder or psychotropic medication use in the prior 6 months, and presence of any lifetime Axis-I disorder as indicated by the SCID [non-patient version (First et al., 2002a)], excepting past substance use disorders. Subjects were also excluded if they self reported having a first degree relative with a diagnosis of bipolar disorder, schizoaffective disorder, or schizophrenia. A Snellen chart was used to assess subjects for visual acuity; all subjects had normal or corrected-to-normal visual acuity.

All patients were on antipsychotic medication, but the precise medications for two patients could not be confirmed. Subjects were excluded from data analysis if the CI catch trial (see below) accuracy fell below 62.5% accuracy at either of the two times on the CI task. All other exclusion and inclusion criteria are listen in the Supplemental Methods.

Initial subject recruitment was 27 for FEP, 35 for SCZ, and 43 for CON; the number of subjects who either declined to participate for the second session or were released from the inpatient unit before the study team could assess them was 7 (26%) of the FEP, 9 (26%) of the SCZ, and 7 (16%) of the CON groups. The drop-out rates did not differ significantly between groups [χ^2 (2) = 1.348, p = .51]. Two FEP and SCZ subjects were excluded from analyses for performing below the catch trial accuracy cutoff. Subject testing sessions were conducted as close to admission and discharge dates as possible.

Table 1
Demographic variables.

Variable	SCZ		FEP		CON		
Demographics	Mean	SD	Mean	SD	Mean	SD	p value
Age (years)	39.92	11.24	26.5	8.84	42.78	12.08	<.001
Gender (% male)	70.8		50		50		.22
Ethnicity (% Caucasian)	50		38.9		36.1		.17
Personal education (years)	13.04	1.73	13.61	2.87	14.11	2.3	.59
Mother education	13.14	4.02	13.28	4.6	12.53	4.51	.80
Father education	13.84	3.45	14.24	3.98	12.36	4.35	.23
Estimated IQ (Shipley-2)	88.68	18.05	94.82	21.84	93.76	13.37	.45

2.2. Contour integration task

The CI task was implemented in the same way as in previous studies (Feigenson et al., 2014; Kozma-Weibe et al., 2006; Silverstein et al., 2009, 2012). Stimuli comprised a non-continuous path of individual Gabor elements forming an egg shaped closed contour which itself was embedded within an array of noise Gabor elements (see Fig. 1). Difficulty was manipulated by varying the degree of orientational jitter added to the individual elements composing the contour. On each trial, subjects were asked to indicate whether the shape pointed to the left or right. Each stimulus included a gray background containing 207 distracter Gabor elements and 15 target elements. Task specifications are listed in Supplemental Methods.

On each trial, the stimulus was presented for 2 s, during which time subjects could enter a response. This was immediately followed by a 1 s interstimulus interval during which no responses were recorded. Blocks consisted of 12 trials at only one of the orientation jitter levels: ±0°, 7°, 9°, 11°, 13°, and 15° (see Fig. 1) plus an additional two randomly interspersed catch trials to determine how well subjects were attending to the task (i.e., these stimuli should always be responded to correctly if a person is attending to them). There were two types of catch trials: 1) unjittered contours with luminance-defined lines drawn through the Gabor elements to eliminate the need for integrating adjacent contour elements; and 2) contours presented without background Gabor elements, to eliminate the need to extract the contour from noise. Blocks were presented in increasing order of difficulty (starting with ±0° and ending at 15°), and each 6 block sequence was repeated 4 times for a total of 288 experimental and 48 catch trials.

2.3. Clinical assessment measures

The Structured Clinical Interview for DSM-IV Diagnosis (SCID), patient version (First et al., 2002b) was used to interview all patients, whereas non-patients were assessed for psychopathology using the non-patient version of the SCID (First et al., 2002a). Information for patients was also obtained from medical records and through confirmation with clinical staff. At each session, symptoms during the past two weeks were determined via the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) and scored using a 5-factor model (Lindenmayer et al., 1994a,b) including positive, negative, cognitive,