



The effect of viewpoint on visual stimuli: A study of episodic memory in schizophrenia

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ABSTRACT

In everyday life, objects are rarely perceived in the exact same position as they were the first time. This change of position alters the perceptual viewpoint influencing the likelihood of recognizing the object – the similarity effect. Moreover, this effect may be a contributing factor to the overall episodic memory deficits that are apparent in people with schizophrenia. The present study investigated the influence of viewpoint on memory recognition in 43 schizophrenia and 23 healthy comparison participants. Photos of target objects were presented during the encoding phase alone and then during the recognition phase (as an old object) along with never-before presented objects. The old objects, however, now appeared either from the same viewpoint (unaltered condition) or from a different viewpoint (altered condition). Participants performed an old/new discrimination task during the recognition phase. Results, for both groups, revealed better recognition performance when the viewpoint was unaltered; that is, memory recognition was sensitive to viewpoint manipulation. There was no significant interaction however, between this similarity effect and group. Thus, visual functions solicited by changing the viewpoint, as well as the influence on the encoding and the subsequent memory retrieval, are likely intact in people with schizophrenia.

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1. Introduction

Cognitive impairment is considered to be a core feature of schizophrenia and, as such, is not a consequence of either the presenting symptoms or the treatment process (Green, 2006; Reichenberg and Harvey, 2007). Among the various impairments, declarative (episodic) memory has been reported the most consistently (Saykin et al., 1991; Aleman et al., 1999; Cirillo and Seidman, 2003) and is considered the most impaired area of memory in schizophrenia; in contrast, non-declarative (procedural) memory appears to be unaffected in schizophrenia (Reichenberg and Harvey, 2007). Declarative memory deficits have been related to influential aspects of the illness such as poor neuroleptic response to treatment (Jooper et al., 2002), poor functional outcome (Green, 1996; Green et al., 2000), and poor quality of life (Ritsner, 2007). Moreover, recognition has been proposed as the single most impaired domain associated with the very poor outcome group found in schizophrenia (i.e. the Kraepelinian outcome) (Harvey et al., 2000).

To understand the memory recognition deficit in schizophrenia, we must first understand the variables modulating yes/no recognition performance in tasks classically used to examine these deficits. Memory recognition is investigated by presenting stimuli that act as cues for retrieving previously studied information. Generally, the cuing stimuli

are replicates of the originally studied stimuli and are referred to as copy cues (Tulving, 1983). Although such cues are used in many studies, they nevertheless lack an ecological value. That is, when we encounter a stimulus or situation in everyday life, the second time we encounter this stimulus the context is usually different – the stimulus is perceived under new or altered conditions (luminance, viewpoint, etc.). In such cases, recognition of the stimulus initially relies on the identification of the stimulus which must evidently match the first stimulus presented. To aid with recognition, independent visual features may be used. For instance, a stimulus presented a second time may be the same colour but in a different position. As such, the colour feature will contribute the most to the recognition (see Cave et al., 1996), while the shape will contribute less as the altered viewpoint has modified the shape per se.

The contribution of the colour feature is referred to as a similarity effect (Snodgrass and Hirshman, 1994). Similarity effects are not restricted to colour but also include many other visual features such as the orientation and reflection of the stimuli (Cooper et al., 1992; Zimmer, 1995; Seamon et al., 1997; Schacter et al., 1997), size (Jolicoeur, 1987; Cooper et al., 1992; Zimmer, 1995), viewpoint (Köhler et al., 2000; James et al., 2002; Vaidya et al., 2002), and contour completeness (Snodgrass and Hirshman, 1994). As such, tasks that incorporate a copy cue condition improve recognition by maximizing the similarity effect of all the visual features. So, memory recognition with visual copy cues relies on two aspects: the identity of the stimulus during first presentation and recognition, in the replication of the visual features. Disruption in the processing of one of these aspects or a dysfunction in their storage or retrieval should reduce recognition memory. Most of the studies investigating recognition memory in schizophrenia have used copy cue

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conditions which control for physical variations in the stimuli (Pelletier et al., 2005). Following that, the serious memory deficits seen in schizophrenia are believed to be, in part, due to the poor identification of the stimuli (Aleman et al., 1999; Pelletier et al., 2005). However, less is known about the contribution of altering other visual features on the recognition memory deficit in schizophrenia.

There is evidence suggesting that some visual processes are dysfunctional in schizophrenia and, as such, might lower the benefit provided by the use of copy cues in memory recognition tasks. The visual impairment most consistently found are related to the visual organization of the visual information (Schwartz-Place and Gilmore, 1980; Heinrichs and Bury, 1991; Sullivan et al., 1992; Silverstein et al., 1996, 2000; Parnas et al., 2001; Peters et al., 2002; Seidman et al., 2003; Must et al., 2004; Uhlhaas et al., 2005; Boyer et al., 2007, see Uhlhaas and Silverstein, 2005 for a review). Dysfunction of the magnocellular visual system has frequently been considered responsible for these organizational visual impairments (O'Donnell et al., 1996; Kéri et al., 2005; Butler and Javitt, 2005). The magnocellular system is the visual stream responsible for processing transient information, coarse information, and information presented under reduced luminosity (Livingstone and Hubel, 1988). This is generally demonstrated by the responses of their constituent neurons to appearance and disappearance of stimuli as well as by their greater sensitivity to low luminance contrast and stimuli of lower spatial frequencies (Kaplan and Shapley, 1986). The magnocellular system is distributed mostly within the dorsal visual pathway, where neurons are the most responsive to location and motion stimulations (Livingstone and Hubel, 1988). As such, the magnocellular system has frequently been associated to the processing of the spatial aspects of stimuli (Ungerleider and Mishkin, 1982).

The visual impairments that exist in people with schizophrenia might not allow them to extract the maximum information from the display making their perception of the same stimulus presented at different times to be altered. In turn, this should considerably reduce the likeliness of matching the visual features of the copy cues with those of the encoded stimuli reducing their ability to recognize an object compared to healthy comparison participants who are not affected by this. This idea is supported by studies indicating that a larger recognition deficit is apparent with visual stimuli than with verbal stimuli in schizophrenia (Kline et al., 1992; Whittaker et al., 2001; Tracy et al., 2001). This was further supported in a recent meta-analysis of 84 recognition memory studies showing a larger effect size for nonverbal visual material (patterns, abstract forms, simple geometrical figures, etc.) than for the verbal material for episodic memory deficits in schizophrenia (Pelletier et al., 2005). Nonverbal material limits the recognition accuracy to the capacity of processing, storing, and retrieving of only the physical aspects of the stimuli. Accordingly, a poorer processing of these physical aspects can be regarded as the reason for the greater deficit. The visual impairment might not be limited to the perception of specific features but also to the way they are analyzed and integrated. For instance, several studies have demonstrated that people with schizophrenia used more dysfunctional visual integration strategies to encode complex figures such as the Rey–Osterrieth Complex Figure (Sullivan et al., 1992; Seidman et al., 2003). Moreover, there is evidence for a deficit during the integration of the object and the spatial features, however, this has only been demonstrated in a working memory task (Leiderman and Strejilevich, 2004).

In light of this, it may be assumed that people with schizophrenia are not taking full advantage of the visual features processing and/or the features integration while performing memory recognition tasks. The focus of the present study is to investigate the contribution of one specific visual feature: viewpoint. This feature was chosen as the dependent variable primarily because of its ecological value but also because it clearly modulates memory recognition accuracy (Köhler et al., 2000; James et al., 2002; Vaidya et al., 2002). Any effect this will have on

recognition memory should be reflected by a difference of memory accuracy to stimuli having the same viewpoint (i.e. the copy cues) relative to stimuli having different viewpoints at first presentation and at recognition. It must be stressed that viewpoint can modulate memory at different levels of processing which are all dysfunctional in people with schizophrenia. For instance, stimuli presented at recognition with the same viewpoint benefit from the same retinal image and the same integration of features (contours, position, colour, etc.). We thus hypothesize that 1) there will be a group main effect with an overall lower ability to recognize objects for the schizophrenia group compared to the healthy comparison group; 2) there will be a similarity effect in both groups, meaning that memory recognition will be higher for copy cues (i.e. same viewpoint) than for the stimuli from a different viewpoint; 3) the group and similarity effect will interact in such a way that the similarity effect will be smaller for the schizophrenia group than for the comparison group.

2. Methods

2.1. Participants

Forty-four people with schizophrenia and 23 healthy comparison participants were considered for the present study. One participant with schizophrenia was subsequently removed as behavioural performance was three standard deviations above the mean. All participants were screened to exclude those who had experienced a past or current medical condition, a past or current neurological condition, a current drug or alcohol abuse problem, or a family history of any hereditary neurological disorder. The age, gender, education level, and parental socio-economic status (SES) were obtained for each participant (Table 1). Education level was recorded as the number of years of school completed while SES was determined using the Hollingshead four-factor score (Miller, 1991).

The schizophrenia participants were chronic, stable outpatients, recruited via ads placed in local mental health service centres or through contacts with psychiatrists affiliated with the Douglas Institute. They all met the diagnostic criteria for schizophrenia or schizoaffective disorder as determined by the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) (First et al., 1998) and by past medical records or clinician reports. Symptoms experienced by these participants were determined through a structured interview and scored on three scales: the Scale for the Assessment of Positive Symptoms (SAPS) (Andreasen, 1984a), the modified Scale for the Assessment of Negative Symptoms (SANS) (Andreasen, 1984b), and the Brief Psychiatric Rating Scale (BPRS) (Ventura et al., 1993). Ratings were determined for only the month prior to the interview date. The healthy comparison participants were recruited through ads published in local newspapers or by word-of-mouth. They were interviewed with a modified form of the Structured Clinical Interview for DSM-IV Axis I Disorders Non-Patient Edition (SCID-I/P) (First et al., 1998) in order to exclude those presenting any psychiatric symptoms. Healthy comparison participants also completed the Schizotypal Personality Questionnaire (SPQ) (Raines, 1991) on which none was determined to be afflicted; the average score was 9.3 (± 7.7). This experiment was part of a larger study for which all participants provided a written consent to take part after a full description was provided. The consent form and study were approved by the Douglas Institute Research Ethics Board.

2.2. Stimuli and procedure

Each participant was brought into the same testing room and seated in front of the same computer monitor used to display the stimuli. The stimuli employed in the experiment were photos of various objects extracted from a bank of 250 high-quality coloured digital photos of common objects (e.g. comb, pen, and flower) solely created

Table 1
Socio-demographic data and clinical ratings

	Participants with schizophrenia	Healthy comparison participants	Analysis
Age	38.0 \pm 7.8	38.6 \pm 7.7	$t(64) = 0.30, P = 0.763$
Education	12.4 \pm 2.6	14.4 \pm 2.9	$t(64) = 2.78, P = 0.01^*$
SES	3.6 (± 1.3)	3.4 (± 1.2)	$U(64) = 440, P = 0.655$
Gender (male/female)	26/17	13/10	$\chi^2(1) = 0.096, P = 0.140$
SAPS total score	14.5 \pm 14.7	–	–
SANS total score	17.5 \pm 9.9	–	–
BPRS total score	41.3 \pm 11.6	–	–
SPQ	–	9.3 \pm 7.7	–

Abbreviations: SES, socio-economic status; SAPS, Scale for the Assessment of Positive Symptoms; SANS, Scale for the Assessment of Negative Symptoms; SPQ, Schizotypal Personality Questionnaire.

* Significant value at $P = 0.05$.

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