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Reduced perception of the motion-induced blindness illusion in schizophrenia

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Abstract

Motion-induced blindness (MIB) occurs when target stimuli are presented together with a moving distractor pattern. Most observers experience the targets disappearing and reappearing repeatedly for periods of up to several seconds. MIB can be viewed as a striking marker for the organization of cognitive functioning. In the present study, MIB rates and durations were assessed in 34 schizophrenia-spectrum disorder patients and matched controls. The results showed that positive symptoms and excitement enhanced MIB, whereas depression and negative symptoms attenuated the illusion. MIB was more frequently found in normal subjects. The results remained consistent after adjusting for reaction time and error rates. Hence, MIB may provide a valid and reliable measure of cognitive organization in schizophrenia.
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Keywords: Cognitive organization; Motion-induced blindness; Neurocognitive binding; Psychopathology; Schizophrenia spectrum disorder; Stage marker

1. Introduction

Research on cognitive organization in schizophrenia dates back to the gestalt school of psychiatry (Matussek, 1952). The general hypothesis according to which symptoms of schizophrenia arise from the dysfunctional processing of visual patterns has found support in a number of investigations into diverse tasks requiring perceptual organization (Uhlhaas and Silverstein, 2003, in press; Silverstein et al., 2000; Rabinowicz et al., 1996). Moreover, several reports indicate correlations between perceptual organization and psychopathology, instances of which include schizotypy, the disorganization syndrome, as well as positive and negative symptoms (Goodarzi et al., 2000; Doniger et al., 2001; Parnas et al., 2001).

Perception coordinates sensory input in a manner that commonly goes unnoticed in natural settings, but can be strikingly demonstrated in a laboratory setting. A well-known example is figure/ground reversal in ambiguous figures. In Fig. 1 (Rubin, 1921), the viewer either perceives two black silhouettes or a white vase, but never both at the same time. Several

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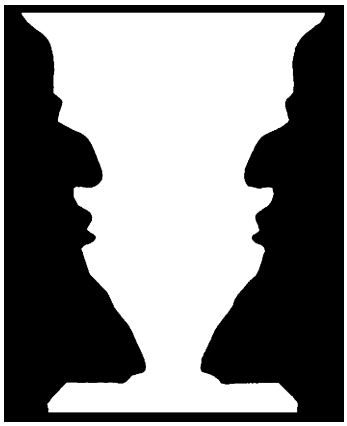

Fig. 1. The "vase/face" ambiguous figure.

illusions have been described in which specific areas or aspects of a stimulus field are completely disregarded. For instance, the phenomenon of *change blindness* or *inattentional blindness* is the inability of viewers to spot even highly conspicuous changes in areas of the scene not focused on (Milner and Goodale, 1995). A remarkable demonstration of inattentional blindness was reported by Simons and Chabris (1999), who instructed subjects watching a ball game to count the number of passes made by the team wearing white jerseys. It was found that clearly visible events (in this trial, a gorilla walking across the middle of the playing field) may go completely unnoticed. *Perceptual filling-in* (Ramachandran and Gregory, 1991) occurs when an homogeneous gray square lying peripheral to the center of vision is displayed against a background of twinkling two-dimensional noise made up of black and white dots. On steady eccentric fixation, the square vanishes and is filled in by the surrounding twinkling noise.

The present study focused on the similar phenomenon of *motion-induced blindness* (MIB) as recently described by Bonneh et al. (2001) in a small sample of normal observers. In this trial, yellow stationary dots were presented as target stimuli on a screen, while a distractor pattern–in this case, a cloud of low-contrast blue dots–rotated next to the targets. A large majority of the sample perceived the salient target dots vanishing and reappearing repeatedly for periods of several seconds at a time. The phenomenon could be reproduced reliably over a range of pattern variations. The effect depended, however, on the movement of the distractor pattern. Bonneh et al. suggested that this illusion probably reflects attentional mechanisms operating in a "winner-takes-all strategy." Presumably, MIB cannot be explained by low hierarchy processes, such as retinal suppression or contrast maximizing. This supposition has since been corroborated by a study on the intensity of negative afterimages of target stimuli. Hofstoetter et al. (2004) found that afterimages were not attenuated by MIB, thus indicating that MIB originates from sites higher than those responsible for visual afterimages. Montaser-Kouhsari et al. (2004) found that information about the orientation of Gabor patches was used even when these patches were invisible during MIB episodes. These authors conclude that MIB originates in an area higher than the primary visual cortex where orientation features are processed.

Therefore, the MIB illusion likely reflects holistic processes which group and organize features of visual input (so-called neurocognitive binding). This view was supported by Hsu et al. (2004), who found that MIB (as well as perceptual filling-in) was enhanced when perceptual grouping between targets and distractors was weak, i.e., when both targets and distractors, taken for themselves, provided clear cues for grouping. Graf et al. (2002) correspondingly showed that MIB can be induced by illusory surfaces originating from Kanizsa elements. This body of results points to a common mechanism underlying reversals in ambiguous figures (cf. Fig. 1) as well as motion-induced blindness.

In the present study, MIB was chosen as a marker of this neurocognitive binding system, because it can be elicited in most participants (including psychiatric patients) and can also be reliably detected. The primary hypothesis specified that MIB is associated with psychopathological symptoms. It was secondarily hypothesized that performance would differ in patients and controls.

2. Methods

2.1. Participants

The study sample consisted of 34 patients (27 [79%] men and 7 [21%] women with mean age 27.9 years (S.D. 7.1) and 34 controls (male/female ratio

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