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Impaired visual recognition of biological motion in schizophrenia

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Abstract

Background: Motion perception deficits have been suggested to be an important feature of schizophrenia but the behavioral consequences of such deficits are unknown. Biological motion refers to the movements generated by living beings. The human visual system rapidly and effortlessly detects and extracts socially relevant information from biological motion. A deficit in biological motion perception may have significant consequences for detecting and interpreting social information.

Methods: Schizophrenia patients and matched healthy controls were tested on two visual tasks: recognition of human activity portrayed in point–light animations (biological motion task) and a perceptual control task involving detection of a grouped figure against the background noise (global-form task). Both tasks required detection of a global form against background noise but only the biological motion task required the extraction of motion-related information.

Results: Schizophrenia patients performed as well as the controls in the global-form task, but were significantly impaired on the biological motion task. In addition, deficits in biological motion perception correlated with impaired social functioning as measured by the Zigler social competence scale [Zigler, E., Levine, J. (1981). Premorbid competence in schizophrenia: what is being measured? Journal of Consulting and Clinical Psychology, 49, 96–105.].

Conclusion: The deficit in biological motion processing, which may be related to the previously documented deficit in global motion processing, could contribute to abnormal social functioning in schizophrenia.

Keywords: Schizophrenia; Motion perception; Biological motion; Visual perception; Social function; Superior temporal cortex

1. Introduction

Accumulating evidence suggests that perceptual and cognitive abnormalities may be among the core deficits of schizophrenia. Among these abnormalities are a host of deficits pointing to abnormal visual information processing. A large proportion of schizophrenia patients report visual abnormalities (e.g. affecting the way colors, people, space and facial expression) during at least some stages of the illness (Bunney et al., 1999; Cutting and Dunne, 1986). In line with these subjective reports are the results from

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perceptual studies documenting deficits on visual tasks such as detection of spatial location (Cadenhead et al., 1998), spatial frequency discrimination (O'Donnell et al., 2002), velocity discrimination and motion perception (Chen et al., 1999a,b).

One particularly intriguing visual impairment in schizophrenia is the relative difficulty of detecting weak translational motion in animations portraying a circumscribed set of coherently moving dots embedded within a larger array of randomly moving "noise" dots (Chen et al., 1999b, 2003a; Li, 2002). However, in the natural environment we are seldom confronted with these kinds of visual motion conditions, so it is difficult to relate these deficits to the core features of schizophrenia. What we do routinely encounter, however, is dynamic optical information specifying the activities of people and animals, known as 'biological motion'. Biological motion contains information about the identity of the moving stimulus, his or her actions, intentions, and even emotions. The human visual system is fine-tuned to detect biological motion rapidly and effortlessly and biological motion provides socially relevant information. Our ability to efficiently process social signals is crucial for effective social interactions. Therefore, a deficit in biological motion perception may have wide ranging consequences for social perception and interpersonal functioning.

It has been hypothesized that the brain has specialized networks for processing the unique patterns of optic flow specifying biological motion. These networks are thought to include the superior temporal sulcus (STS) and surrounding regions (Bonda et al., 1996; Grossman et al., 2000; Hoffman and Haxby, 2000; Jellema et al., 2000; Puce et al., 1998; Vaina et al., 2001). The superior temporal cortex is a central component of the neural circuitry that mediates our ability to utilize the "Theory of Mind" (ToM) (Baron-Cohen et al., 2000), which refers to ability to represent the mental states of others. Schizophrenia patients show deficits in tasks that demand the use of the ToM (Frith and Corcoran, 1996). Structural imaging data from schizophrenic patients reveal reduced volume of the left superior temporal gyrus that is correlated with increased psychotic symptoms, especially formal thought-disorder (Shenton et al., 1992). Given that patients with schizophrenia have structural abnormalities of the superior temporal gyrus and show difficulties on tasks that are associated with the functional integrity of the superior temporal cortex, we hypothesized that they would show deficits in biological motion perception, which is supported by the neural circuitry that includes the superior temporal cortex.

We investigated whether patients with schizophrenia could distinguish biological from non-biological motion that is portrayed by point–light animation sequences (Johansson, 1973). Since deficits on a biological motion task could also reflect general deficits visual processing, we included a difficult perceptual grouping task (global-form task) that requires subjects to detect global form against background noise. Its difficulty would allow us to assess the motivational and attentional state of our subjects, and furthermore, this task would provide additional confirming evidence of relatively spared visual information processing when processing motion signals is not required (e.g. O'Donnell et al., 1996).

2. Experimental materials and methods

2.1. Subjects

Fourteen outpatients (5 females) who met criteria for a DSM-IV diagnosis of schizophrenia were recruited from a private psychiatric hospital; diagnosis was determined on the basis of Structured Clinical Interview for DSM-IV (Spitzer and Williams, 1985). The mean age of the patients was 38.3 years (SD = 7.8 years), mean education level was 12.6 years (SD = 2.0 years), and they had been ill for an average of 14.5 years (SD = 8.7 years). All patients were taking atypical antipsychotic medication at the time of testing (risperidone, clozapine or olanzapine). The CPZ equivalent dose was calculated (Bezchlibnyk-Butler and Jeffries, 1999). Clinical symptoms were assessed with the Brief Psychiatric Rating Scale (BPRS, Overall and Gorham, 1962). Positive and negative symptoms were assessed using the Scale for Assessment of Positive Symptom (SAPS, Andreasen and Olsen, 1982), and the Scale for Assessment of Negative Symptom (SANS, Andreasen and Olsen, 1982) respectively. Mean BPRS, SAPS, and SANS scores were 28.3 (SD = 11.7), 30.8 (SD = 20.2) and 30.9 (SD = 20.7), respectively (Table 1).