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Schizotypal personality traits and atypical lateralization in motor and language functions

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ABSTRACT

Atypical cerebral lateralization in motor and language functions in regard to schizotypal personality traits in healthy populations, as well as among schizophrenic patients, has attracted attention because these traits may represent a risk factor for schizophrenia. Although the relationship between handedness and schizotypal personality has been widely examined, few studies have adopted an experimental approach. This study consisted of three experiments focusing on motor and language functional lateralization in regard to schizotypal personality in the absence of mental illness: line-drawing, finger tapping, and a semantic go/no-go task. The results suggested that positive schizotypal personality might be related to functional non-lateralization in regard to at least some functions (e.g., spatial motor control and semantic processing in the present study). Subjects with high schizotypal personality traits performed equally with their right and left-hands in the line-drawing task and they reacted equally with their right and left-hands in a semantic go/no-go task involving semantic auditory stimuli presented in both ears. However, those low in schizotypal personality traits showed typical lateralization in response to these tasks. We discuss the implications of these findings for schizotypal atypical lateralization.

1. Introduction

Atypical cerebral lateralization may represent a risk factor for developing schizophrenia (Crow, 2004). The issue of handedness has interested researchers examining schizophrenia (Claridge & Broks, 1984; Gruzelier & Richardson, 1994) and patients with schizophrenia have shown differences in lateralization, as measured by handedness, when compared to controls (Reilly et al., 2001). Such investigations have generally used two populations: patients with schizophrenia and normal participants scoring high on measures of schizotypal personality traits, which are considered a reflection of a genetic predisposition toward schizophrenia (Cyhlarova & Claridge, 2005; Lenzenweger, 2006). While studies of handedness in patients with schizophrenia have yielded a range of results (see for review, Dragovic & Hammond, 2005), studies of schizotypal personality traits and handedness in normal participants have yielded more consistent results (Chapman & Chapman, 1987; Claridge, Clark, Davis, & Mason, 1998; Kim, Raine, Triphon, & Green, 1992; Poreh, 1994; Richardson, 1994; Shaw, Claridge, & Clark, 2001). The predominant finding emerging from this research is increased schizotypal personality scores among mixed-handed participants (Annett & Moran, 2006; Somers, Sommer, Boks, & Kahn, 2008) even in non-western cultures (Asai & Tanno, 2009). This result might implicate a relationship between schizotypal personality and non-lateralized cerebral functioning, at least in regard to motor ability.

Handedness is generally measured by self-report questionnaires (e.g., Annett & Moran, 2006; Asai & Tanno, 2009), which are convenient but which yield data that are less objective and more likely to vary according to the particular questionnaire. Indeed, it has been suggested that cultural differences may interfere with using self-report measures of handedness to elucidate relationships between this factor and other variables (Asai & Tanno, 2009). In this context, experimental methods might also be helpful in examining these issues. Although some experimental methods addressing handedness or motor asymmetry exist, ranging from those measuring finger-tapping speed to those measuring handgrip force, few studies have used them to examine the relationship between schizotypal personality and motor asymmetry even though some objective techniques have been used to assess motor activity in schizophrenic patients (e.g., Blyler, Maher, Manschreck, & Fenton, 1997; Lohr & Caligiuri, 1997; Tabarés-Seisdedos et al., 2003). Only one previous study has shown non-lateralized motor symmetry in subjects with schizotypal personality traits using experimental methods. That study found that subjects high in schizotypal personality traits were equally likely to draw a straight line with their right and left-hands (Lenzenweger & Maher, 2002). In our first experiment (Experiment 1), we tried to expand this by study using a PC-based methodology.

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The majority of language function is lateralized in the left hemisphere in typical human brains (Geschwind & Levitsky, 1968), although the relationship between handedness and language lateralization is complicated, especially in left-handers (Kimura, 1967). Although the data are not entirely consistent, the majority of relevant studies have reported that normal asymmetry in this regard is absent in people with schizophrenia (see the review by Petty, 1999). Both structural and functional evidence have suggested that schizophrenia is associated with reduced left-hemisphere lateralization of language, and some studies have even reported a reversal of lateralization favoring the right hemisphere (Aydin et al., 2001; Gruzelier, 1999; Gur & Chin, 1999; Kircher et al., 2002; Kwon et al., 1999; Petty, 1999; Sommer, Ramsay, Kahn, Aleman, & Bouma, 2001; Sumich et al., 2002). For example, individuals with schizophrenia showed greater activation in the right temporal cortex in response to speech stimuli (Ngan et al., 2003). One previous study on schizotypal personality found that low scores on right-hemisphere language tasks (e.g., proverbs, logical grammatical sentences, and humor) were significant predictors of high scores on the positive schizotypal personality scale (Nunn & Peters, 2001). Although this might imply an atypical language asymmetry associated with schizotypal personality, nothing is clear about the relationship between schizotypal personality and language lateralization. We examined this relationship in the second experiment (Experiment 2). A failure in the lateralization of language and motor functions is proposed as a critical feature in the predisposition to schizophrenia (Crow, 2000). Thus, we focused on the relationship between these two brain functions and schizotypal personality traits.

2. Experiment 1

2.1. Experiment 1A

Experiment 1A focused on the lateralization of motor function in people with schizotypal personality, especially in regard to spatial motor (or visuomotor) accuracy (line-drawing task), as suggested by a previous study (Lenzenweger & Maher, 2002). The left-hand performed better in response to this task in right-handed participants. This was contrary to expectations, as spatial processing is normally lateralized in the right hemisphere (e.g., Barthelemy & Boulinguez, 2001, 2002), although the relationship between brain laterality and behavior laterality may be more complicated in left-handed people (e.g., Kimura, 1967). Thus, we hypothesized that the left-hands of people low in schizotypal personality traits would perform better than their right-hands and that the right and left-hands of those high in schizotypal personality traits would perform equally well if their motor functions were non-lateralized.

2.1.1. Method

2.1.1.1. Participants. A total of 42 university students (aged 18–22 years, mean = 19.3; 20 men, 22 women) participated in the experiment and completed questionnaires. Respondents were recruited from an introductory psychology class participant pool. Participants responded voluntarily to an e-mail describing the experiment and the questionnaire. None of the subjects had a history of mental illness. We obtained written informed consent from all participants before conducting the experiment.

2.1.1.2. Apparatus. The experiment was conducted in a silent dark room. The visual stimuli were created and the experiments conducted using MATLAB (MathWorks, Natick, MA, USA) and Psychophysics Toolbox (Brainard, 1997; Pelli, 1997). The cursor on the screen (1024×1280 pixels) moved in response to movements of a wireless mouse device. The speed of the cursor was synchronized with the movement of the mouse (e.g., when the mouse device was moved 10 cm, the cursor also moved 10 cm on the screen), the cursor originated at the center of the screen in every trial (Fig. 1).

2.1.1.3. Procedure. Participants were asked to move the mouse device in a straight line to one of the four targets and then click the mouse (line-drawing task; Lenzenweger & Maher, 2002). The targets were small squares (2×2 pixels) at the corners of the screen. The x–y coordinates of the squares were 250×250 pixels.

Three mouse–cursor conditions controlled task difficulty: normal, cursor-disappearing, and cursor-leaving trajectories. Participants did not know which condition was in effect before starting to move the mouse device. Under the normal cursor condition, the cursor moved in synchrony with the mouse. Under the cursor-disappearing condition, the cursor disappeared as soon as the mouse was moved, requiring participants to reach the target without having visual feedback to monitor their arm movements. The cursor appeared again after participants clicked the mouse, revealing the actual errors. Under the leaving-trajectory condition, the cursor left the trajectory independent of the movements of the mouse, and participants could not gauge the actual trajectory of the cursor.

The x–y coordinates were recorded from initial mouse movement to click with a sampling rate of 100 Hz. Subjects participated in two blocks: the right-hand block, in which they moved the mouse device with their right-hand; and the left-hand block, in which they moved the mouse device with their left-hand. The order was counterbalanced among participants. In each block, 48 trials (three cursor conditions $\times$ four direction conditions $\times$ four repetitions) were conducted in random order. Before beginning the experiment, we briefly trained participants in order to familiarize them with the instruments and experimental requirements.

2.1.1.4. Data analysis. For the spatial motor accuracy value, MATLAB randomly selected the 50 sampled points at each trial and determined the Euclidean distance between the target line and

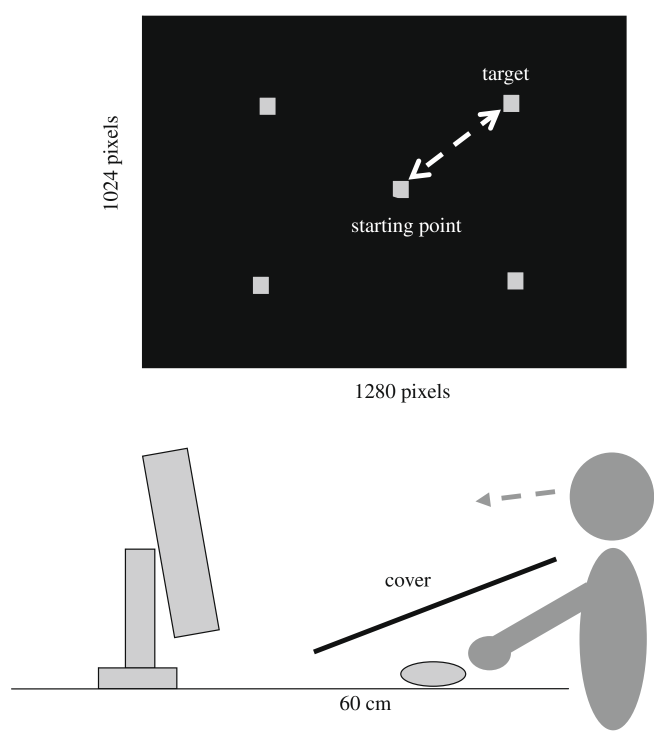

Fig. 1. Illustration of the experimental apparatus.