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Event-related potential correlates of paranormal ideation and unusual experiences

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ABSTRACT

Separate dimensions of schizotypy have been differentially associated with electrophysiological measures of brain function, and further shown to be modified by sex/gender. We investigated event-related potential (ERP) correlates of two subdimensions of positive schizotypy, paranormal ideation (PI) and unusual experiences (UEs). Seventy-two individuals with no psychiatric diagnosis (men = 36) completed self-report measures of UE and PI and performed an auditory oddball task. Average scores for N100, N200 and P300 amplitudes were calculated for left and right anterior, central and posterior electrode sites. Multiple linear regression was used to examine the relationships between the measures of schizotypy and ERPs across the entire sample, as well as separately according to sex. PI was inversely associated with P300 amplitude at left-central sites across the entire sample, and at right-anterior electrodes in women only. Right-anterior P300 and right-posterior N100 amplitudes were negatively associated with UE in women only. Across the entire sample, UE was negatively associated with left-central N100 amplitude, and positively associated with left-anterior N200 amplitude. These results provide support from electrophysiological measures for the fractionation of the positive dimension of schizotypy into subdimensions of PI and UE, and lend indirect support to dimensional or quasidimensional conceptions of psychosis. More specifically, they suggest that PI may be associated with alteration in contextual updating processes, and that UE may reflect altered sensory/early-attention (N100) mechanisms. The sex differences observed are consistent with those previously observed in individuals with schizophrenia.

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1. Introduction

Dimensional models of psychosis may be traced from Bleuler, through Eysenck's concept of psychoticism and Claridge's schizotypy construct, to current dimensional and quasidimensional conceptions of psychosis and psychosis-proneness (Van Os, 2003; Claridge, 1997; Chapman et al., 1994). These ideas have evolved over the years and currently schizotypy has no universally agreed latent structure (Lawrence and Peters, 2004), nevertheless, it is usually considered to comprise factors that correspond to the symptom dimensions of schizophrenia (e.g., positive, negative and cognitive symptoms,

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disorganisation, social impairment; Claridge, 1997). Studying individuals who lie at varying positions on a spectrum of risk for schizophrenia – but who are not actively unwell – circumvents the problems presented by confounding variables, such as medication effects (Mohr et al., 2005a; Mucci et al., 2005; Houran and Lange, 2004). In addition, it may also facilitate aetiological investigation of distinct symptoms/syndromes, their interactions, and compensatory mechanisms (Spitznagel and Suhr, 2004; Folley and Park, 2005; Gruzelier, 2003). The current study investigates the relationship between brain function and two purported subdimensions of positive schizotypy, namely paranormal ideation (PI) and unusual experiences (UEs).

According to the misattribution hypothesis, belief in psychic abilities results from the misattribution of paranormal causation to normal experiences and/or perceptual aberrations, and may be akin to delusional belief (for reviews see Wiseman and Watt, 2006; Bell et al., 2006; Houran and Lange, 2004). Factors implicated include perceptual distortion, poor general cognitive abilities, probability misjudgements, fantasy proneness, impaired content-specific reasoning, delusional ideation and disinhibition in semantic networks (Schulter and Papousek, 2008, this issue; Wiseman and Watt, 2006; Bell et al., 2006; Lawrence and Peters, 2004; Houran and Lange, 2004; Gianotti et al., 2001; Pizzagalli et al., 2001; Mohr et al., 2001). Reliance on right hemisphere function – perhaps reflecting lateralised hyperdopaminergia – is consistent with findings of ''loose'' semantic networks in believers of magic and the paranormal, given reputed right hemisphere specialisation in processing remote associations (Mohr et al., 2003, 2004, 2005a, 2005b; Pizzagalli et al., 2000; Kiefer et al., 1998; Brugger et al., 1993). Others report a loss of hemispheric dominance in believers (Barnett and Corballis, 2002). However, right hemisphere underactivation or left-hemisphere overactivation is also seen in positive schizotypy (Goodarzi et al., 2000; Overby, 1992; also for review see Mucci et al., 2005), consistent with findings in paranoid schizophrenia (Sumich et al., 2006a; Bruder et al., 2001).

Methodological differences may contribute to apparent inconsistencies in findings, including the use of psychometric scales that load differentially for perception, experience, ideation, interpretation and affective factors (see Bell et al., 2006; Mucci et al., 2005) and differences in asymmetry assessment (see Mucci et al., 2005). In schizophrenia, cerebral asymmetries depend on syndrome and processing stage (Gruzelier et al., 1999a). Furthermore, sex modulates the aetiology and manifestation of schizotypy (Gruzelier and Kaiser, 1996; Gruzelier, 1994). Compared to men, women have fewer negative, positive and cognitive symptoms, but more unreality symptoms (which could be related to underlying depression; Maric et al., 2003; Voglmaier et al., 2005; Gruzelier and Doig, 1996; Greyson, 1977). They also have less pronounced, or even opposite, syndrome-dependent cerebral asymmetry than men, at least for some behavioural measures (Gruzelier et al., 1999b; Gruzelier, 1994; Friedman et al., 2001a).

The event-related potential (ERP) offers a direct, temporally precise measure of post-synaptic electrophysiological function that is time-locked to exogenous (e.g., stimulus presentation) and/or endogenous (e.g., decision processes and effortful orientation of attention) events. It is formed of a series of negative (N) and positive (P) deflections called components (Coull, 1998). The P300 component occurs at about 300 msec post-stimulus and reflects mechanisms involved in orientation and maintenance of attention, cognitive set-shifting, subjective probability and the global integration of an event with its cognitive and emotional contexts (i.e., contextual updating Polich and Criado, 2006; Mucci et al., 2005; Friedman et al., 2001b). Impairments in subjective probability and contextual updating may underlie poor probability judgments and semantic disinhibition, respectively, leading to a compensatory recruitment of right hemisphere mechanisms. Thus impaired P300 mechanisms might be expected in individuals high in PI.

Whilst reduced parietal-P300 amplitude is reliably reported in schizophrenia (Jeon and Polich, 2003) and is seen in college students with very high psychosis-proneness scores (Nuchpongsai et al., 1999), others specifically associate it with negative symptoms and thought disorder (Frodl et al., 1998; Turetsky et al., 1998a; Squires-Wheeler et al., 1997). In comparison, left-centrotemporal P300 reduction or abnormal cerebral lateralisation (right > left) is associated with the presence of positive symptoms in schizophrenia, major depression and schizotypal personality disorder (Kaustio et al., 2002; Turetsky et al., 1998a; Mannan et al., 2001; Niznikiewicz et al., 2000; Klein et al., 1999; Salisbury et al., 1996). Gruzelier et al. (1999a) observed left-hemisphere P300 deficits in patients with an active syndrome which is suggested to represent a distinct construct from reality distortion and is characterised by raised levels of activity, pressure of speech, accelerated cognition, positive or labile affect, and affective delusions (Gruzelier, 2003).

In comparison, Mucci et al. (2005) did not find a left temporal deficit in relation to subclinical psychotic symptoms in healthy individuals. Rather, they report a leftward shift in the P3a field associated with paranoia in a small group of women who were not actively unwell. Compared to women with low psychotic scores, those with high psychotic scores had higher current density in the left frontal and temporal regions (Brodmann areas 11 and 38). This contrasts patient studies in which frontal P300 deficits are associated with psychosis or depression and are more prominent in women, and those in which men show greater right-parietal deficits (Papageorgiou et al., 2004a, 2004b; Turetsky et al., 1998a, 1998b). Also in men – but not women – conceptual loosening is negatively associated with midline parietal-P300 amplitude, but not subclinical positive symptoms (McConaghy et al., 1993; Ward et al., 1992).

Poor primary-sensory/''bottom-up'' processing and/or relatively stronger ''top-down'' control over perception is thought to underlie dreaming during rapid eye-movement (REM) sleep, hallucinations and the Ganzfeld effect (Antrobus, 1991; Aleman et al., 2003; Sumich et al., 2005; Wackermann et al., 2008, this issue). Thus, impaired sensory processing may play a role in susceptibility to unusual perceptions. In ERP terms, sensory processing is measured by the N100 component. This component is measured about 100 msec after a stimulus and responds to its physical attributes. However, N100 subcomponents are also dependent on a number of other cognitive processes such as attention, expectancy, short-term memory associations, and conscious effort (Mulert et al., 2005; Coull,

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