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Slow habituation of arousal associated with psychosis proneness

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ABSTRACT

Background. Previous studies report skin conductance (SC) abnormalities in both patients with schizophrenia and psychosis-prone individuals. However, no studies have assessed SC abnormalities in relation to specific psychotic and emotional symptoms. The aim of the present study was to examine the relationship between SC orienting response and hallucination proneness, delusional ideation, anxiety and self-focused attention in non-clinical individuals.

Method. Forty-three participants were recruited and divided into two groups depending upon the SC habituation profile. Normal habituators ($n=28$) and slow habituators ($n=15$) were compared on measures of psychosis proneness, anxiety and self-focused attention.

Results. Slow habituators had significantly higher levels of delusional ideation and hallucination proneness than the normal habituators. SC habituation scores were particularly associated with the conviction of delusional ideas. Levels of anxiety or self-focused attention did not differ significantly between the groups.

Conclusions. The study provides evidence of 'aetiological continuity'. Common mechanisms may contribute to psychotic experiences in non-clinical and clinical samples, consistent with the notion of a psychosis continuum.

INTRODUCTION

Delusions and hallucinations, key symptoms of psychosis, can be conceptualized as being on a continuum with qualitatively similar but less severe experiences in the general population (e.g. Johns & van Os, 2001; Verdoux & van Os, 2002). Epidemiological and experimental psychological studies have provided evidence to support this view (e.g. Tien, 1991; Bijl *et al.* 1998; Myin-Germeys *et al.* 2003). Other studies indicate that having mild delusional or hallucinatory experience in childhood or adolescence is a vulnerability factor for later development of psychosis (e.g. Poulton *et al.* 2000), indicating that mild symptoms are a sign of psychosis proneness.

Little is known about the physiology associated with psychosis proneness. However, abnormalities in the skin conductance orienting response (SCOR) are reported in non-clinical individuals who score highly on schizotypy questionnaires (Simons *et al.* 1983; Raine & Venables, 1984), as well as in individuals in the early and later stages of psychosis (Ohman, 1981; Gruzelier & Raine, 1994; Hazlett *et al.* 1997). Electrodermal activity is a peripheral measure of the electrical conductivity of the skin, which is modulated by the autonomic nervous system (Edelberg, 1972). This is typically assessed by presenting participants with a series of auditory tones at pseudo-random intervals and measuring the electrodermal response.

One of the defining characteristics of the orienting response is its gradual reduction and

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disappearance with stimulus repetition. This is thought to reflect autonomic arousal adaptation in response to a novel/unexpected stimulus. Patients with schizophrenia have been found to show either SC hypoarousal or hyperarousal (Dawson *et al*. 1983). That is, patients often demonstrate no response to a series of innocuous stimuli or fail to habituate across a series of trials. In particular, several studies have indicated that the latter response is associated with a subtype of schizophrenia characterized by hallucinations and delusions (Mednick, 1978; Frith, 1979; Cooklin *et al*. 1983; Dawson *et al*. 1994).

The aim of the present study was to examine the relationship between the SCOR and hallucination proneness and delusional ideation in non-clinical individuals. We predicted that delusional ideation and hallucination proneness would be associated with abnormal habituation of the SCOR. As delusional ideation and hallucination proneness have previously been associated with heightened levels of anxiety and self-focused attention in non-clinical participants (Allen *et al*. 2005; Freeman *et al*. 2005), it was also predicted that these affective variables would be higher in the slow habituators.

METHOD

Participants

Forty-three non-clinical participants (17 males and 26 females) were recruited by an email circulated to staff and students at King's College London. The age range of the participants was 18 to 46 years (mean = 27·00, S.D. = 6·50). Premorbid IQ as assessed by the New Adult Reading Test (NART; Nelson & O'Connell, 1978) ranged from 95 to 127 (mean = 114·55, S.D. = 6·12). Years of education ranged from 11 to 18 (mean = 15·87, S.D. = 3·45). Potential participants were excluded if they reported a history of any DSM-V Axis I disorder (e.g. schizophrenia, bipolar disorder, depression).

Assessments

The Launay–Slade Hallucination Scale (*LSHS*; *Launay & Slade*, *1981*)

The LSHS is a self-report questionnaire for measuring vulnerability to hallucinatory experiences in both clinical and non-clinical populations. The scale was designed to reflect the notion that hallucinatory experiences are on a continuum with normal everyday experiences. Its test–retest reliability is good ($r = 0{\cdot}81$; Aleman *et al*. 1999). Participants were explicitly asked not to report experiences that occurred when under the influence of alcohol or a narcotic substance. Responses were measured on a five-point scale, where 0 = 'certainly does not apply to me' and 4 = 'certainly does apply to me'. This measure does not take into account the frequency of hallucinatory experiences. Scores could range from 0 to 48, with higher scores indicating an increased predisposition towards hallucinations.

The Peters Delusions Inventory (*PDI-21*; *Peters et al. 1999*)

The PDI is designed to measure delusional ideation in the normal population, using content items from the Present State Examination (Wing *et al*. 1974). The PDI is a self-report measure that assesses three dimensions of delusional ideation: distress, preoccupation and conviction. Respondents are instructed to complete these subscales only for delusional thoughts that they have endorsed. These subscales are not completed for items that respondents do not endorse. Each dimension is represented by a five-point Likert scale (from 'Not at all distressing' to 'Very distressing' for distress; from 'Hardly ever think about it' to 'Think about it all the time' for preoccupation; and from 'Don't believe it's true' to 'Believe it is absolutely true' for conviction). The psychometric properties are reported in Peters *et al*. (1999).

The Beck Anxiety Inventory (*BAI*; *Beck et al. 1988*)

The BAI scale consists of 21 items. Respondents are asked to rate how much they have been bothered by anxiety symptoms over the past week on a four-point scale ranging from 0 to 3. The items are summed to obtain a total score that can range from 0 to 63. The psychometric properties are reported in Beck *et al*. (1988).

The Private Self-Consciousness Scale (*PSCS*; *Fenigstein et al. 1975*)

The 14-item PSCS is a subscale of the Self-Consciousness Scale and is designed to assess

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awareness of the inner or personal aspects of self (i.e. self-focus). Each item is rated on a five-point scale (1 = strongly disagree, 5 = strongly agree). Higher scores indicate a greater degree of self-focus. The psychometric properties of this measure are reported elsewhere (Fenigstein *et al.* 1975; Seib & Vodanovich, 1998).

All participants reported recreational drug use by indicating if they had used cannabis, ecstasy, LSD, cocaine, amphetamines or other recreational drugs in the past week, month, year, longer than 1 year or not at all. A score of 3 was assigned to drug use in the past week, 2 in the past month, 1 in the past year and 0 for greater than 1 year or not at all.

Arousal (electrodermal activity)

The method used to measure electrodermal activity was based upon that described by Venables & Christie (1980). SC electrodes were placed on the medial flange of the index and middle fingers of the participant's dominant hand. Standard silver/silver chloride electrodes were used with an electrolytic gel. The recordings were made through a Contact Precision UK, Stand Alone Monitor unit (hardware) and specialized software installed on a Sony Vaio notebook computer.

After a baseline recording period of 5 minutes, the stimulus presentation began. This consisted of 10 innocuous 1-second tones of 80 dB and 800 Hz presented through headphones. The dB level was set using an electronic sound meter. The tones were presented binaurally at pseudo-random intervals (40–80 s, mean = 60 s). Specially designed software was used to present the tone and synchronize all events to the SCR recording software. The overall skin conductance level of the baseline (SCL) and the amplitude of the SCOR were recorded. A SCOR was defined as occurring within a latency window of 0–5 s post-stimulus (Gruziliar & Venables, 1972) and having an amplitude of at least 0·05 μS (Venables & Christie, 1980).

The participants were then categorized according to their SCOR habituation profile. Raine *et al.* (1997) advocates a trial-by-trial analysis of the SCOR data and proposes that habituation to innocuous tones is greatest over the first three trials. In accordance with this procedure, a dimensional index of the direction and extent to which participants habituate was established. Participants were thus classified as showing either the normal reduction in SCOR over Trials 1 to 3 or a failure to reduce amplitude over the three trials. The SCOR amplitude of Trial 3 was subtracted from the SCOR amplitude of Trial 1. On this index, high positive values indicate normal habituation whereas low (zero or negative) values indicate slow orienting. Participants with positive values were included in the normal habituation group and those with a negative or zero value were included in the slow habituation group (note: this index was rounded to 2 decimal places, thus a habituation index of 0·03 would have been rounded to zero and included in the low habituation group).

Analysis

All electrodermal traces were analysed using Psylab version 7 (Contact Precision Instruments, UK) and SCR analysis software developed locally at the Institute of Psychiatry. This software enabled all SCL and SCOR values for each participant to be quantified. These numerical data were then entered in SPSS version 11 (SPSS Inc., Chicago, IL, USA). Independent sample *t* tests were used for the comparison of questionnaire measures between groups. All significance tests were two-tailed. Pearson correlations were used to test for significant associations between the habituation index and assessment measures.

RESULTS

The electrodermal profiles of the normal and slow habituation groups are shown in Fig. 1. The mean difference between the SCOR for Tones 1 and 3 (SCOR tone1 – SCOR tone 3) was +0·49 μS for the normal habituation group and −0·02 μS for the slow habituation group. An independent *t* test indicated that this difference was significant ($t = 3{\cdot}2$, $p < 0{\cdot}01$). The normal habituators had a higher SCOR initially, which progressively declined, whereas the response in the slow habituators remained similar across the first three trials (Fig. 1). Basic demographic and clinical data for the two groups are presented in Table 1.

A series of independent sample *t* tests were used to compare the normal and slow habituators on measures of hallucination proneness, delusional ideation, anxiety and self-focused

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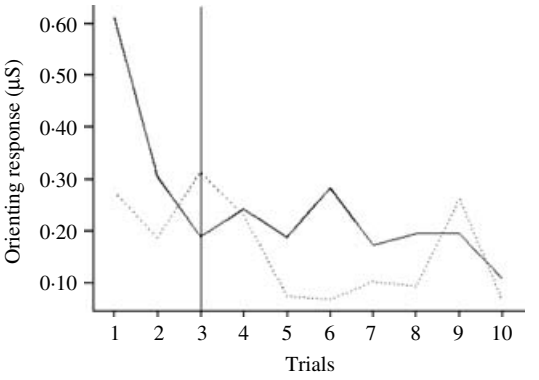

FIG. 1. Mean skin conductance orienting response (μS) by trial normal (—) and slow (·····) habituation groups.

attention. The mean scores for hallucination proneness and delusional ideation were significantly greater in the slow habituation group (Table 2). The group differences in anxiety and private self-consciousness scores were non-significant (Table 2).

Pearson correlations between the habituation index (the difference in SC between Tones 1 and 3) and the above measures were then calculated. There was a significant correlation between the habituation index and the PDI conviction of the belief subscale ($r = -0{\cdot}33$, $p = 0{\cdot}05$) and a trend for an association with the PDI preoccupation subscale ($r = -0{\cdot}30$, $p = 0{\cdot}07$) (Fig. 2). Slower habituation was associated with higher delusion conviction and preoccupation. There were no other significant correlations ($p > 0{\cdot}1$).

DISCUSSION

This study was concerned with physiological correlates of mild non-clinical psychotic experiences. Consistent with the main prediction, levels of hallucination proneness and delusional ideation in non-clinical individuals were higher in those individuals whose electrodermal response to auditory stimuli habituated slowly over successive trials. Slow habituation was particularly associated with high scores on the belief conviction subscale of the PDI. These findings are broadly consistent with data from studies in patients with schizophrenia (Dawson *et al.* 1994), and in people with a schizotypal personality disorder (Raine *et al.* 1997). Dawson *et al.* (1994) described phasic SCOR hyper-responsiveness to innocuous stimuli in both

Table 1. *Demographic characteristics, education, drug usage and NART IQ for normal and slow habituation groups*

	Normal habituation group ($n = 28$)	Slow habituation group ($n = 15$)	Analysis
Age, years	26·63 (4·74)	28·00 (8·84)	$t = -0{\cdot}72$, $p = 0{\cdot}47$
Gender ratio	12M : 16F	5M : 0F	
Years of education	17·77 (3·08)	18·00 (4·11)	$t = 0{\cdot}18$, $p = 0{\cdot}85$
NART	115 (4·43)	113 (8·35)	$t = 0{\cdot}81$, $p = 0{\cdot}42$
Drug use	1·20	0·90	N.S.

NART, New Adult Reading Test; M, male; F, female; N.S., not significant.

remitted and actively psychotic patients with schizophrenia. Moreover, although hyper-responsiveness was less marked in the remitted state, SCORs to innocuous stimuli were still greater in remitted patients than in healthy controls. Raine *et al.* (1997) found that in a non-clinical sample, scores on the Schizotypal Personality Questionnaire (SPQ) correlated with a dimensional measure of the orienting deficit. Taken together, these findings suggest that abnormal orienting is related to an increased vulnerability to experiencing psychotic phenomena.

Anxiety and self-focused attention scores did not differ between the normal and slow habitation groups. Previous studies have reported a relationship between anxiety, self-focused attention and psychosis-like experiences in both non-clinical individuals (Allen *et al.* 2005; Freeman *et al.* 2005) and patients with schizophrenia (Ensum & Morrison, 2003). The lack of differences in anxiety may seem surprising given the differences in SCOR. However, the relationship between elevated levels of anxiety and SCOR abnormalities may be a complex one. A key difference between SCOR measurement and a questionnaire measure of anxiety is obviously that the former is not dependent on the subjective experience of the participant and, furthermore, is temporally linked to each stimulus, rather than being a global resting state measure. Taylor (2004) also reports no difference on measures of anxiety between poor and good SCR modulators. Although anxiety is often associated with psychosis-like experiences, and is likely to be important in contributing to the development of such experiences, the biological

Table 2. *Mean questionnaire scores in normal and slow habituation groups*

	Normal habituation group ($n=28$)	Slow habituation group ($n=15$)	Analysis (t test)
LSHS	14·81 (9·53)	21.92 (10·28)	$t=-2·11$, $p=0·04$
PDI total	51·68 (34·76)	84·21 (37·33)	$t=-2·6$, $p=0·01$
PDI preoccupation	15·00 (10·72)	24·71 (11·35)	$t=-2·60$, $p=0·01$
PDI distress	16·81 (12·33)	25·50 (13·51)	$t=-1·9$, $p=0·05$
PDI conviction	19·86 (12·38)	34·00 (15·65)	$t=-3·01$, $p<0·01$
BAI	8·40 (9·11)	10·71 (7·68)	$t=-0·81$, $p=0·40$
PSCS	45·33 (9·15)	46·34 (12·67)	$t=-0·36$, $p=0·72$

LSHS, Launay–Slade Hallucination Scale; PDI, Peters Delusions Inventory; BAI, Beck Anxiety Inventory; PSCS, Private Self-Consciousness Scale.

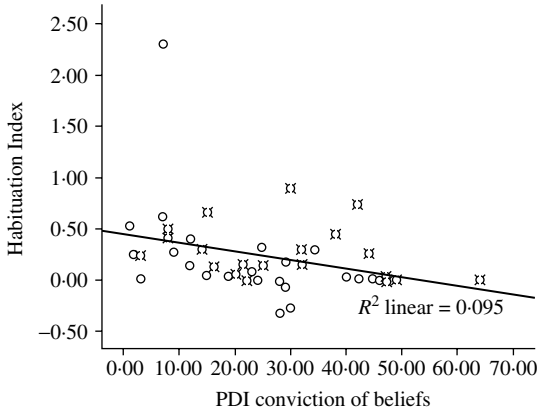

FIG. 2. Scatter plot of the Habituation Index (μS) and scores on the Peters Delusions Inventory (PDI) conviction of belief subscale.

mechanisms that underlie them may not be the same.

The significance of abnormal orienting in the experience and/or proneness to psychotic experiences is not clear. One possibility is that it merely reflects the emotional dysphoria associated with symptoms or subclinical experiences (although no association with anxiety or self-focus was observed in the present study). Alternatively, sympathetic arousal may play a mediating role in the development of symptoms and may be associated with a lack of inhibitory processes (Raine *et al*. 1995). We found that a failure to physiologically habituate to an external stimulus was related to how strongly unusual thoughts were held. This suggests that the arousal that is normally associated with encountering a novel stimulus persisted in these participants, and perhaps indicates that this persistence of a physiological response contributes to a tendency to become focused and preoccupied on salient-feeling stimuli.

The present study provides evidence that mild psychotic-like experiences are also present in non-diagnosed individuals with SCOR abnormalities. However, a causal relationship cannot be established by the study design and the widespread SCOR abnormalities in the general population suggests other factors are clearly important in psychosis development. Moreover, heightened vulnerability in the slow habituation group need not be conceptualized as part of a continuum. One further point relates to the observed rates of SCOR habituation. Slow habituators are defined as individuals who fail to habituate between Trials 1 and 3. However, this group do show marked habituation between Trials 3 and 10, demonstrating that the expected attenuation in SCOR does eventually occur. It is not clear why this relatively short increase in habituation latencies should be associated with psychotic experience.

In summary, in this small study non-clinical individuals with SC orienting abnormalities seem to experience higher levels of hallucination proneness and delusional ideation than individuals whose electrodermal response habituates with successive stimuli. The similarity between these findings and those in patients with schizophrenia is indicative of 'aetiological continuity', consistent with the notion of a psychosis continuum.

DECLARATION OF INTEREST

None.

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