Altered time-perception performance in individuals with high schizotypy levels

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ABSTRACT

The possibility of altered time-perception in high schizotypy scorers, as postulated through previous differences shown in performance between high and low scorers in schizotypy on schedules of reinforcement with temporal elements, was examined using a series of retrospective timing tasks. Three stimuli ratio manipulations were made across two experiments, and, using an adjusted version of the bisection-point method for data analysis, results showed that high scorers on the Unusual Experiences subscale of the O-LIFE(B) estimated the mid point of the stimulus range to be at a significantly longer interval than low scorers. This was true when the ratios between "short" and "long" standard stimuli were 4:1 (Experiment 1), 3:1 and 2:1 (Experiment 2). These findings are consistent with the notion of altered time-perception for high schizotypals.

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1. Introduction

An important brain region where neurotransmitter activity contributes to schizophrenic symptoms is the striatum (Buhusi and Meck, 2007; Arbuthnott and Wickens, 2007; Body et al., 2009), which is known to be involved in the control of timing (Gibbon, 1977; Killeen and Feterman, 1988). Changes in dopamine activity has been shown to influence performance in timing tasks (Body et al., 2009; Cheung et al., 2007), where increased dopamine activity in the striatum slows subjective time-perception, making subjects over-estimate the passage of time (Abi-Dargham and Moore, 2003; Carroll et al., 2009). Although multiple mechanisms may be responsible for dopamine-related disruption of time-perception in schizophrenia (e.g., impact on pacemakers and accumulators, working and reference memory, and comparator processes; see Gibbon (1999)), the episodic nature of schizophrenia (Weinberger, 1988; Zubin and Spring, 1977), and the changes in potentially-associated dopaminergic levels (Howes and Kapur, 2009; Laruelle et al., 1999), suggest that individuals in an acute phase of the disorder, or not on medication, might be particularly prone to altered time-perception and that such time-perception effects may be variable.

In fact, those with schizophrenia show time-perception effects consistent with the above view (Carroll et al., 2008; Densen, 1977; Elvevåg et al., 2003; Freeman and Garety, 2003; Tysk, 1983; Waters and Jablensky, 2009). In tasks that require behavior to be modulated by concurrent judgments of the passage of time, participants with schizophrenia over-estimate the passage of time (Densen, 1977; Freeman and Garety, 2003; Tysk, 1983; Waters and Jablensky, 2009). That is, if subjective estimates of the passage of time are longer, then responding occurs sooner than expected. Other timing tasks require a retrospective judgment of the passage of time. During temporal-bisection tasks, participants initially learn to label the presentation lengths of two stimuli as of either 'short' or 'long' duration in relation to each other in a training phase. They are then presented with a range of stimuli of different durations between these two extremes, and are required to judge the duration of these stimuli as 'short' or 'long'. If subjective perceptions of time are slowed in schizophrenic participants, then a retrospective judgment of the same duration stimulus compared to a control would tend to be shorter. Such studies have found that schizophrenic patients are, indeed, less accurate in their timing judgments than controls, and are also more variable in these judgments (Carroll et al., 2008; Elvevåg et al., 2003). However, other studies using this procedure that report results divergent to these above reports, some find no difference in the estimation of the passage of time in schizophrenic outpatients, but an increased variability in their time judgments (Carroll et al., 2009). One factor implicated in interpreting such discrepancies (Carroll et al., 2009, 2008; Elvevåg et al., 2003), and the increased variability of temporal perception (Carroll et al., 2009), is the role of anti-psychotic medication. This consideration introduces a possible confound in interpreting the results, as the impact of many medications used to treat schizophrenia (e.g., risperidone) is to

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reduce dopamine activity in the striatum (Agid et al., 2007), and effectively speed up an internal clock (Rammsayer, 1990).

In overcoming such potential issues, the use of individuals scoring high on schizotypy may be useful (Reine and Lencz, 1995). Schizotypy refers to psychometrically-measured behavioral traits and dispositions associated with schizophrenia, but present in the non-clinical population (Bentall, 1990; Meehl, 1962). The validity of schizotypy has been supported by factor analytical studies that have linked schizotypal traits to schizophrenic symptoms (Bentall et al., 1989; Claridge and Beech, 1995). Moreover, research into a number of topic areas have shown both schizophrenic patients and high schizotypy scorers to show the same performance effects on the same tasks depending on the type of task and dominant trait or symptom cluster (i.e. positive, negative or cognitive disorganization), supporting the use of schizotypy as a model for research into schizophrenia (see Lubow (2005); Dagnall and Parker (2009) for examples). The use of this population avoids many confounds associated with schizophrenic patients, such as the effects of medication, symptom severity and patient distress (Dagnall and Parker 2009; Reine and Lencz, 1995; Tsakanikos and Reed 2005), which may mask or lead to false results (see Kane (2006)) or where symptoms are so severe that patients are unresponsive. Moreover, the use of this group also allows differentiation between specific traits and symptoms associated with schizophrenia and their impacts on the ability in question (Reine and Lencz, 1995; Esterberg et al., 2007; Phillips and Seidman, 2008, Tsakanikos and Reed, 2005).

In terms of timing processes in high schizotypal individuals, rates of response are higher on random interval schedules in high- compared to low schizotypal subjects (Randell et al., 2009, 2012), particularly those with high scores on the Unusual Experiences (UE) sub-scale of the O-LIFE(B) scale (Mason et al., 2005). In addition, high UE subjects are unable to describe the temporal nature of the RI schedule (Randell et al., 2012). Moreover, high scorers in UE have different performance profiles to low UE scorers on both fixed interval, and differential reinforcement of low rate, schedules of reinforcement (Randell, et al., 2011). Both of these latter schedules involve concurrent timing to judge whether a certain amount of time has passed before a response will elicit reinforcement, and high UE scorers tended to respond later on the schedules than low scorers. These differences between high and low schizotypal subjects imply differences in the ability to accurately incorporate timing into schedule performance.

It would be useful to examine the performance of these groups on timing tasks outside the context of reinforcement schedules, especially as mechanisms, such as response disconfirmation, and reinforcement rates may influence response patterns over and above the various aspects of timing (Dickinson, 1989, Ferster and Skinner, 1957; Roper and Zentall, 1999). It is also worth noting that, in the schedule tasks used previously (Randell et al., 2009, 2012, 2011), the participants were not necessarily aware of any timing component incorporated in the task. Thus, timing was not an explicitly studied behavior on those tasks, and any potential deficits in this process are only inferred from patterns of responding, rather than being measured directly. Given these considerations, the use of temporal-bisection tasks (Church and Deluty, 1998), previously employed for schizophrenic patients (Carroll et al., 2009, 2008), could forward understanding in this area.

Given the previous results noted above for schizophrenic patients (Carroll et al., 2008; Elvevåg et al., 2003; Tysk, 1983; Rammsayer, 1990), and those reported on schedules of reinforcement for high-schizotypals (Randell et al., 2009, 2011), the expectation was that, if timing differences exist between low and high schizotypy scorers (who are free of the impact of medication), these would manifest in differences in the observed bisection point of these two groups. Specifically, it was predicted that high schizotypal subjects, when making retrospective judgments, should tend to label any given stimulus duration as shorter than low schizotypal scorers.

2. Experiment 1

Experiment 1 presented stimuli for a short (S) or long (L) standard durations during a training phase. In the subsequent experimental phase, stimuli were presented for lengths ranging between, and including, these S and L stimuli. The participants were required to press a button labeled 'SHORT' or 'LONG' for each of the stimuli in the experimental phase, and the bisection point was then calculated (the point at which the probability of making a SHORT or LONG response was equal). Differences in bisection-point location with a relatively large ratio size (4:1) of the stimulus range was used as clear differences have been found in previous research using this ratio (Allan and Gibbon, 1991), whilst a reduction in the ratio size to 3:1 and 2:1 in Experiment 2 was used to extend the generality of the findings in Experiment 1 and also because a reduction in the bisection ratio provides for some ambiguity in the bisection-point location in human performance in general (see Wearden and Ferrara (1996)). If high scorers perform in a similar manner to individuals with schizophrenia (Carroll et al., 2008; Elvevåg et al., 2003), then they should emit greater number of S responses for longer presentations than low scorers (i.e., high scorers would judge 50% of the stimuli as 'short' at a longer objective time period than low scorers).

2.1. Method

2.1.1. Participants

Fifty-two participants (13 males and 39 females) with an age range of 18–39 (Mean=21 ± 3) were recruited. No participants reported psychiatric problems. Ethical approval was granted by the Psychology Ethics Committee, Swansea University, and all participants gave informed consent.

2.1.2. Measures
2.1.2.1. Oxford Liverpool Inventory of Feelings and Experiences – Brief Version. (O-LIFE(B); Mason et al., 2005) is a 43-item scale comprising four subscales: Unusual Experiences (UE), Cognitive Disorganization (CD), Introvertive Anhedonia (IA), and Impulsive Nonconformity (IN), designed to measure schizotypy in the normal population. The scales have an internal reliability (Cronbach α) of 0.62 to 0.8, and a concurrent validity of between 0.9 and 0.94 (Mason et al., 2005).

2.1.2.2. Beck's Depression Inventory. (BDI; Beck et al., 1961) is a 21-item questionnaire assessing symptoms of depression over the past week. The internal reliability (Cronbach α) is between 0.73 and 0.92, and concurrent validity is between 0.55 and 0.73 (Beck et al., 1988).

2.1.2.3. Spielberger Trait Anxiety Inventory. (STAI-T; Spielberger, 1983) rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (i.e., trait anxiety). The internal reliability (Cronbach α) of the scale is 0.93, and a concurrent validity=0.52–0.8 (Spielberger et al., 1970).

Measures of depression and anxiety were included as a controlling measure for statistical analysis on hallucinatory reports and schizotypy scores, given that both are associated with hallucination formation (Freeman and Garety, 2003).

2.1.3. Procedure
All participants were tested individually in a quiet room, in front of a desk and computer (60 cm from the monitor). Participants were