Psychiatry Research 187 (2011) 18–23

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

# Sustained attention in the context of emotional processing in patients with schizophrenia

Sung-Hyouk Park [a,*], Jae-Jin Kim [b,c], Chan-Hyung Kim [b], Jin Hun Kim [a], Kwang-Hyuk Lee [d]

[a] Department of Psychiatry, Gongju National Hospital, Gongju, Chungnam, South Korea
[b] Department of Psychiatry, Yonsei University College of Medicine, Seoul, South Korea
[c] Institute of Behavioral Science in Medicine, Yonsei University College of Medicine, Seoul, South Korea
[d] Academic Clinical Psychiatry, Department of Neuroscience, School of Medicine and Biomedical Sciences, University of Sheffield, Sheffield, United Kingdom

ARTICLE INFO

*Article history:*
Received 16 March 2010
Received in revised form 2 November 2010
Accepted 3 November 2010

*Keywords:*
Schizophrenia
Sustained attention
Facial emotion
Continuous performance test

ABSTRACT

Patients with schizophrenia show dysfunction in sustained attention and facial emotion processing. We investigated the interplay between sustained attention and emotion by presenting emotional faces as background during AX-CPT in patients with schizophrenia. Nineteen schizophrenia patients and 21 healthy control subjects participated. We presented AX-CPT number stimuli superimposed on the nose of background facial expressions (happy, neutral or sad) over three experimental blocks for each emotion. Signal detection sensitivity ($A'$) and reaction time were measured. Patients showed a steeper sensitivity decline when happy faces (compared with sad faces) were presented as background stimuli. By contrast, controls' sensitivity was not affected by the background facial emotion stimuli. Across the emotion conditions, the decline of sensitivity over time was evident in patients, but not in controls. To our knowledge, the present study is the first to explore a change in sustained attention accompanied by simultaneous processing of emotional faces in schizophrenia patients. Our findings suggest that mechanisms underlying continuous performance test (CPT) performance decline over time and facial emotion deficit may interact with each other in patients with schizophrenia.



## 1. Introduction

The ability to accurately identify and respond to others' emotional expressions is crucial for successful social interactions. Patients with schizophrenia exhibit facial emotion recognition deficits, which are linked to poor functional outcome including interpersonal relationships, occupational functioning, independent living, and community functioning (Mueser et al., 1996; Poole et al., 2000; Hooker and Park, 2002; Kee et al., 2003; Addington et al., 2006; Pan et al., 2009). A better understanding of the features of facial emotion recognition deficits may lead to a better understanding of social functional outcomes of schizophrenia, which has important implications for social rehabilitation. However, to date, the exact nature of facial emotion recognition deficit has not been firmly established. A number of studies have shown that patients with schizophrenia are worse at recognizing negative, as opposed to positive, facial emotions (Gaebel and Wolwer, 1992; Archer et al., 1994; Bellack et al., 1996; Edwards et al., 2001; Kohler et al., 2003; Bediou et al., 2005; van 't Wout et al., 2007). By contrast, there is some evidence suggesting that patients may in fact have a greater deficit in recognizing happy faces compared with sad or fearful faces (Kohler et al., 2000; Tsoi et al., 2008).

The ability to sustain attention over time is essential in performing the continuous performance test (CPT). Rosvold and colleagues (1956) were the first to design a CPT to assess sustained attention in patients with brain damage. The subjects were required to press a lever whenever the letter X appeared; letters appeared one at a time in an inter-stimulus interval of 920 ms (known as the CPT-X or simple CPT). This task has been widely used to measure sustained attention deficit in schizophrenia (Nuechterlein, 1983; Cornblatt and Erlenmeyer-Kimling, 1985; Nuechterlein et al., 1986; Cornblatt et al., 1989; Nestor et al., 1990; Nuechterlein, 1991; Mass et al., 2000; Lee and Park, 2006; Liu et al., 2006; Birkett et al., 2007). The decline in performance over time has been hypothesized as the key feature of sustained attention deficit in schizophrenia (Nuechterlein, 1991). However, whether or not schizophrenia patients exhibit performance decline over time has been a matter of debate. Empirical studies have been inconsistent across various CPT studies: deficient performance at the early phase (Nuechterlein and Dawson, 1984; Cornblatt and Erlenmeyer-Kimling, 1985; Cornblatt et al., 1989; Buchanan et al., 1997) or performance deficit manifested in the later stage of CPT has been reported (Nestor et al., 1990; Mass et al., 2000).

Previous studies have found that the more patients are impaired in facial emotion recognition, the worse they perform in a CPT (Bryson et

* Corresponding author. Department of Psychiatry, Gongju National Hospital, 637, Ogok-dong, Gongju, Chungnam 314-200, South Korea. Tel.: +82 41 850 5844; fax: +82 41 855 6969.
*E-mail address:* inuone@hanmail.net (S.-H. Park).

0165-1781/$ – see front matter © 2010 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.psychres.2010.11.007

al., 1997; Addington and Addington, 1998; Kohler et al., 2000; Combs and Gouvier, 2004; Nienow et al., 2006; Tremeau, 2006). These studies support the role of sustained attention in facial emotion recognition in patients with schizophrenia. During a conventional CPT, the subjects are required to sustain their attention to stimuli presented on a blank screen. In the present study, we are interested in investigating sustained attention changes to CPT stimuli superimposed on a socially relevant stimulus (emotional faces). To date, there have been no CPT studies examining sustained attention in the context of emotion processing in patients with schizophrenia.

To explore sustained attention in the context of emotional processing in patients with schizophrenia and healthy control subjects, we designed a novel task by presenting CPT number stimuli on the nose of background facial expressions. To our knowledge, no previous studies have examined the impact of simultaneously presented emotional faces in the context of CPT. Here, we were interested in investigating whether patients with schizophrenia displayed a disproportionately large performance decline when emotional faces were presented as background stimuli, alongside digits in a conventional AX-CPT (a more difficult version of CPT where subjects were asked to press the button if the letter A preceded the letter X). We presented number stimuli superimposed on the nose of the background face, because the nose is the center of visual attention (i.e., the center of an inverted triangle formed by the eyes and mouth) during facial recognition (Loughland et al., 2002a, b). In this study, we focused only on happy and sad facial expressions as examples of positive and negative emotions, along with neutral expressions as a control condition. We also examined the subjective ratings of emotional reactivity (valence and arousal) to the background facial emotion stimuli, after the main experiment. We hypothesized a significant interaction of emotion over time in patients with schizophrenia, such that the presence of background emotional facial expressions would have a significant impact on AX-CPT performance. By contrast, we hypothesized that healthy controls would not show this interaction effect.

## 2. Methods

### 2.1. Participants

Nineteen patients with schizophrenia (9 males and 10 females) were recruited from Severance Mental Health Hospital, Gwangju, Kyeonggi, South Korea. Ten patients were recruited from in-patient wards and the remainder of patients was residing in the community. A diagnosis of schizophrenia was confirmed using the Structured Clinical Interview for DSM-IV Axis I Disorders, Patient Edition (First et al., 1996a). Exclusion criteria were diagnosis of an Axis I disorder other than schizophrenia, neurological disorders, or mental retardation. All patients were taking antipsychotic medications (atypical only: $n = 12$, typical only: $n = 1$, atypical and typical: $n = 6$). Schizophrenia symptoms were rated using the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987).

Twenty-one healthy control participants (10 males and 11 females) were recruited through local newspaper advertisements. They were screened for a history of psychiatric illness in themselves or first-degree relatives and treatment with psychiatric medication using the SCID non-patient version (First et al., 1996b). Neither mean age nor years of education were significantly different between the groups (see Table 1 for details). After complete description of the study to the participants, written informed consent was obtained. The study was approved by the Severance Mental Health Hospital Institutional Research Ethics Review Board.

### 2.2. AX-CPT with emotional face as background

There were three separate experimental conditions: AX-CPT with a happy face background condition, AX-CPT with a sad face background condition, and AX-CPT with a neutral face background condition. The order of the conditions was counterbalanced across participants in each group. The background face stimuli were chosen from Ekman and Friesen's Pictures of Facial Affect (Ekman and Friesen, 1976). Faces of seven individuals were used (3 males: EM, JJ, and PE; 4 females: JM, MF, PF, and SW). Nine numbers (1–9) were used as target and non-target stimuli which appeared on the nose of the background facial stimulus (see Fig. 1). In each emotion condition, there were 623 trials lasting 10 min and 23 s. Of these, 63 number stimuli were target stimuli. Participants performed each condition over three consecutive blocks continuously without a break. They had a break between the emotion conditions.

Participants were asked to press the left mouse button whenever '5' was preceded by '9' (i.e., button press only for target number '5'). Stimuli were presented at a constant rate of one per second as with other CPT studies in schizophrenia (Cornblatt et al., 1989; Kurtz et al., 2001). Each pair of stimuli (a number and a face) appeared for the first 50 ms followed by just the face for the remaining 950 ms to allow a response to be made to target. The background face therefore remained on the screen for the entire trial duration of 1 s. Prior to the main experiment, participants read standardized instructions and completed a block of 70 practice trials. Happy, sad, and neutral faces were presented in these practice trials in random order and they were also included in the main experiment. This ensured that participants understood the task instructions and familiarized themselves with the task.

Participants sat approximately 50 cm from the computer screen. The size of all facial background stimuli was 848 × 1060 mm presented in the center of the screen. The grayscale intensity, as a percentage (where 0% means pure white and 100% means black) of the happy images was 72.35 ± 13.62% , that of neutral 70.05 ± 14.34%, and that of sad was 71.19 ± 16.56%. There was no statistical difference in grayscale intensity across happy, neutral, and sad [$F(2,12) = 1.32$, $p = 0.30$]. The width and height of the number stimuli was 6 × 10 mm in Arial Regular Sharp font. We set the grayscale intensity of the numbers to 40% instead of 0% to increase the perceptual difficulty of the AX-CPT with emotional face as background.

### 2.3. Assessments of valence and arousal of background facial expressions

After the main experiment, all subjects were asked to rate the levels of valence and arousal of the background facial stimuli using the Self-Assessment Manikin (SAM) (Lang et al., 1998). We asked subjects to rate how they 'felt,' rather than rating about the stimulus itself, after seeing each background facial stimulus for 6 s (Kring and Moran, 2008). Valence was rated on a nine-point scale ranging from −4 (very negative/unpleasant) to 4 (very positive/pleasant) and arousal ranged from 1 (very low) to 9 (very high).

### 2.4. Data analysis

We calculated $A'$ as a signal detection sensitivity index. Because our data included the hit rate of 1.0 and false alarm rate of 0, calculating $d'$ would produce the problem of division by zero (Pollack and Norman, 1964). To avoid the problem of division by zero, it is necessary to adjust hit and false alarm rates. However, it is controversial, as there were several different ways of doing so. In the current study, we used $A'$ *as* suggested by Snodgrass and Corwin (1988):

$$A' = 0.5 + (H-F)(1 + H-F) / 4H(1-F) \text{ when } H \geq F, \text{ or}$$
$$A' = 0.5-(F-H)(1 + F-H) / 4F(1-H) \text{ when } F > H.$$

The sensitivity measure $A'$ refers to the sensory dimension of stimulus recognition, i.e., the ability to distinguish target from non-target. A higher $A'$ value indicates better performance.

We first present 3-way repeated measure ANOVA results for $A'$ and reaction time. We then performed emotion (happy vs. neutral vs. sad) by time (blocks 1–3) interaction analyses for patients and controls as hypothesized. To assess the relationship of $A'$ and reaction time with clinical variables, Pearson correlation coefficients were used. $p$-values less than 0.05 (two-tailed) were considered significant in all analyses. Effect sizes were reported as partial eta square values ($\eta_p^2$).

**Table 1**
Demographic and clinical variables.

| Characteristic | Control subjects ($N = 21$) | | Schizophrenia subjects ($N = 19$) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Age (years)[a] | 25.3 | 4.7 | 27.5 | 4.4 |
| Education (years)[b] | 13.7 | 2.8 | 12.8 | 2.2 |
| Duration of illness (years) | | | 5.3 | 3.7 |
| Number of hospitalization (years) | | | 1.8 | 1.1 |
| Antipsychotic dose | | | 391.2 | 189.1 |
| Positive and Negative Syndrome Scale (PANSS) [c] | | | | |
| Positive symptoms | | | 15.0 | 5.4 |
| Negative symptoms | | | 18.3 | 5.0 |
| General psychopathology | | | 35.4 | 9.2 |

[a] $t = -1.55$, $df = 38$, NS.
[b] $t = 1.44$, $df = 38$, NS.
[c] Data were normally distributed (skewness statistics: 0.82 for positive, −0.05 for negative, and −0.08 for general psychopathology scores).