

Greater Impairment in Negative Emotion Evaluation Ability in Patients with Paranoid Schizophrenia

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To explore whether or not patients with schizophrenia display a more profound impairment of negative emotion processing, we assessed the implicit evaluation of positive and negative emotional stimuli. Twenty patients with schizophrenia (9 paranoid, 11 non-paranoid) and 22 normal controls were instructed to classify emotional pictures according to the intrinsic valence if the pictures were black and white. If the stimuli were color-filtered, participants were instructed to press the positive/negative response key according to the extrinsic valence (assigned valence of color). The error rates of the color-filtered stimuli were used as dependent measures. Normal controls made more errors on trials of the positive pictures when the correct response was the negative response key than when the correct response was the positive response key. The reverse was true on trials of the negative pictures. Patients with schizophrenia, especially paranoid schizophrenia, committed more errors in trials of the positive pictures when the correct response key was the negative response key. However, the reverse was not true on trials of the negative pictures. These findings suggest that patients with paranoid schizophrenia might suffer from an impaired ability to evaluate negative emotions and have a loosening of association within their negative emotional networks.

Key Words: Schizophrenia, positive emotion, negative emotion

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INTRODUCTION

A considerable number of reports have been published on the subject of emotional evaluation impairment, which is a core component of the psychopathology in schizophrenia.¹⁻³ Several researchers have suggested that there is greater impairment in the ability to evaluate negative emotions than there is for positive emotions.⁴⁻⁸ Others reported the existence of generalized deficits which encompass all types of emotions.⁹⁻¹¹ The specific impairment of negative emotion evaluation ability is thought to stem from the repeated social withdrawal that results from negatively- arousing stimuli; social withdrawal is one of the typical symptoms of schizophrenia.^{2,12,13} In contrast, the generalized emotion recognition deficit is due to part of the global reduction in cognitive function, which is also common in schizophrenia.²

These inconsistent findings may be influenced by the differences in emotional stimuli, experimental and control tasks, subjects' characteristics, and other variables. Several attempts have been made to investigate the evaluation of emotions in the specific subtypes of schizophrenia. Schizophrenic patients with positive symptoms such as delusion and hallucination were reported to show negative emotion-specific impairment, while patients with negative symptoms such as affective flattening exhibited a generalized emotion-recognition deficit.¹⁴ Patients with paranoid schizophrenia have been reported to display less impairment in identifying emotions,¹⁵ especially

negative emotions,¹⁶ than patients with non-paranoid schizophrenia, although there has been a contrary report.¹⁷ Recently, paranoid schizophrenics were reported to show negative (sad, fear) emotion-specific impairment in comparison with residual schizophrenics as well as normal controls, while disorganized schizophrenic patients displayed an impairment in generalized emotion-recognition.¹⁸

It is supposed that another possible source of these inconsistent findings is due to the use of self-reporting measures to assess the function of emotional evaluation. The self-report may be affected by a variety of distortions and biases due to the social norms, investigators' expectations, allocations of attention, and other factors.¹⁹

To be free from these distortions and biases, an Implicit Association Test (IAT) was developed, which is a well-known indirect measurement technique used in social cognition research.²⁰⁻²⁴ In addition, the IAT has already been used to study various forms of psychopathology such as social anxiety,^{25,26} depression,²⁷ and alcoholism.^{28,29} The IAT assesses the relative strength of an association between a target and an attribute by considering the accuracy or reaction time with which subjects can employ two response keys when each has been assigned a dual meaning.²⁴ For example, in the Greenwald et al.²² flower-insect IAT, subjects were asked to pair two concepts (e.g., flower and good, or insect and good). The more closely-associated the two concepts are, the easier it is to respond to them as a single unit. Thus, if there was a stronger association between "flower" and "good" than between "insect" and "good", it would be easier to respond faster and with more accuracy when subjects are requested to give the same response than it would be when "insect" and "good" are paired. Recently, the Extrinsic Affective Simon Task (EAST) was developed by De Houwer as a modified version of the IAT.^{30,31} Compared to the IAT, the EAST has a moderate or strong effect size (IAT: usually Cohen's $d > 0.6$). In addition, the EAST can provide separate estimates of the emotional evaluations of positive and negative emotional categories simultaneously.^{30,31} Based on the above sources, we considered that it should be possible to investigate the separate estimates of associations within positive and negative emo-

tional processing using the EAST, which is less likely to be biased or distorted.

The aim of the present study was to determine whether patients with schizophrenia had more impairment in their ability to evaluate negative emotions than did normal controls. We hypothesized that patients with schizophrenia would be more profoundly impaired in negative emotion evaluation, and that the diagnostic subtype of schizophrenics would be related to the ability to recognize emotion. We measured the emotional evaluation performance by using the EAST in patients with schizophrenia and in normal controls. We propose that this approach could be a better way to assess the separate estimates of the strength of associations within positive or negative emotional networks than a traditional approach, which may be influenced by subjects' intentions or control.¹⁹

MATERIALS AND METHODS

Subjects

A consecutive series of 21 stable outpatients (Department of Psychiatry, Severance Mental Health Hospital, Yonsei University College of Medicine, Korea) with schizophrenia diagnosed by the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV)³² were enrolled in the present study. All schizophrenia patients were clinically judged to have been stable for more than two consecutive months prior to the study. Twenty-two healthy control subjects were recruited through a local newspaper advertisement.

All subjects fulfilled the inclusion criteria, which consisted of their being between the ages of 18 and 50, having completed more than 12 years of education, and being right-handed. Handedness was assessed using the revised version of Annett's Hand Preference Questionnaire.^{33,34} All subjects were assessed using a comprehensive psychiatric evaluation by means of the Structured Clinical Interview for the DSM-IV (SCID).^{35,36} The diagnosis of schizophrenia and its subtypes was made by psychiatrists (SJH) using the SCID according to the DSM-IV criteria. The psychopathology of patients with schizophrenia was assessed by a

psychiatrist (LE) using the Positive and Negative Syndrome Scale (PANSS).³⁷ Subjects with additional Axis I or II disorders, neurological disorders, a past history of loss of consciousness, or relevant visual defects were excluded. This investigation was carried out in accordance with the Declaration of Helsinki. The study was reviewed and approved by the Institutional Review Board of Severance Mental Health Hospital. All subjects signed a written informed consent form.

One patient did not complete the session because of poor task compliance and was therefore excluded, which resulted in the final study population consisting of 20 patients and 22 normal controls.

Stimuli

Five positive and five negative emotional stimuli were presented in the color trials, and another five positive and five negative stimuli were presented in the black and white trials. All stimuli were selected from the International Affective Pictures System (IAPS)³⁸ and from our own collection, and were then transformed into 27 × 20 cm-sized black and white pictures. To use pictures of comparable levels of valence, arousal and gray color intensity, 60 black and white transformed pictures were selected across a whole range of valence and arousal. To avoid any differences in the filtering effect due to variable gray color intensity across these 60 pictures, 35 pictures were chosen within the range of -0.8 - +0.8 standard deviation of the average calculated mean level of gray color intensity of each picture using a histogram constructed with Adobe Photoshop 7.0. Then, 10 positive and 10 negative stimuli were selected according to the ranks of mean valence ratings of the 35 pictures by another 20 laypersons using the Self-Assessment Manikin (SAM).³⁹ Finally, each positive and negative picture was classified according to valence and used in the black and white trials (the following pictures from the IAPS were used: 2091, 2352.1, 2550, 5831, 8496 for the positive stimuli and 1301, 2053, 2375.1, 9320 for the negative stimuli), and in the color trials (the following pictures from the IAPS were used: 1710, 4626, 4653, 4599, as well as a roller coaster picture (valence = 7.05 ± 1.53 , arousal =

5.28 ± 2.28 , according to the ratings by another 20 subjects) from our own collection for the positive stimuli and 2455, 2700, 3170, 3350, 6212 for the negative stimuli).

In the color trials, the pictures had either a blue or a green-colored filter placed over them. The green or blue filtering was created by setting the red, green and blue values at 0, 100 and 60 or at 0, 60 and 100, respectively, in the MGI Photo Suite III program. Each stimulus was presented in random order in all blocks, with the restriction that the same picture should not appear in two or more consecutive trials and that the response keys should not be the same in four or more consecutive trials. The inter-trial interval was 1,500 ms.

Procedures

The procedure used for the EAST was essentially the same as that used in De Houwer's study,³¹ which demonstrates the reliability and validity of the EAST as a tool for assessing emotional evaluation ability. The subjects were seated in front of a computer monitor at an eye-to-screen distance of approximately 40 cm. Subjects were requested to classify the emotional pictures by pressing the positive response key (i.e. the "p" key) or the negative response key (i.e. the "q" key) according to the intrinsic valence of black and white stimuli or to the assigned valence of color (extrinsic valence). In the black and white trials, they were told to press the positive response key (p) in response to the positive pictures and to press the negative key (q) for the negative pictures. In the color trials, however, they were instructed to press the positive (p) or negative (q) key according to the color (Table 1). Half of the subjects were instructed to press the positive key (p) for the green-filtered pictures, and to press the negative key (q) for the blue-filtered pictures, while this color assignment was inverted for the other half of the subjects. Next, subjects were informed that if they performed an error, a white 'x' would appear below the picture until the correct response was performed. The subjects were requested to respond as accurately, but also as quickly, as possible. Finally, subjects were informed that they were to perform three practice blocks of 20 trials (one black and white block, two

Table 1. Emotional Pictures and Tasks

Intrinsic stimulus valence	Black and white trials	Color trials (Extrinsic valence)	
		Positive*	Negative*
Positive	Positive pictures	Green-filtered (Congruent trials)	Blue-filtered (Incongruent trials)
Negative	Negative pictures	Green-filtered (Incongruent trials)	Blue-filtered (Congruent trials)

*Half of the subjects were instructed to press the positive key for the green-filtered pictures, and to press the negative key for the blue-filtered pictures, while for the other half of the subjects this color assignment was inverted.

color blocks) and four test blocks of 30 trials (10 black and white trials, 20 color trials). All experimental procedures were performed by a psychiatrist (KJI) or a psychologist (JJH), who sat about one meter away from the subject.

To verify the appropriateness of all emotional stimuli after the EAST session, all subjects were asked to rate the valence and arousal of all stimuli (five positive and five negative black and white pictures, and five positive and five negative color-filtered pictures) using the SAM.³⁹

Data reduction and statistical analysis

We analyzed the results of the test trials in which the color-filtered stimuli were presented and only took into account the accuracy of the initial response and the reaction time. The reaction time was recorded as the elapsed time from the stimulus onset until the correct response was given, which is a common measure strategy of the IAT.²² According to the handling procedure of Greenwald et al.,²² latencies below 300 ms or above 3,000 ms were rounded to 300 ms and 3,000 ms, respectively, and the reaction time was then log-transformed. Next, the percentage of errors and the mean log-transformed reaction times were calculated separately according to the intrinsic valence and the extrinsic valence (assigned valence of color) of the color stimuli. The congruent trial of positive pictures was the response when the correct response was the positive response key. The congruent trial of negative pictures was the response when the correct response was the negative response key. The incongruent trial of positive pictures was the

response when the correct response was the negative response key, and the incongruent trial of negative pictures was the response when the correct response was the positive response key.

A repeated-measures analysis of variance (ANOVA) was carried out on error rates and log-transformed reaction times, with intrinsic valence (positive and negative) and extrinsic valence (positive and negative; assigned color response) of color stimuli being the repeated measures and groups (normal controls and schizophrenia patients) as the between-group factors. The Wilcoxon signed rank test was performed on the percentage of error, and a paired t-test was carried out on the log-transformed reaction time within-group differences of congruent trials and incongruent trials for each positive and negative color-filtered picture, in each group as a post-hoc analysis. We also repeated these analyses on the error rates and reaction times using three groups (normal controls, paranoid schizophrenics and non-paranoid schizophrenics). The effect size of each positive and negative trial in each group was calculated by taking the difference between the mean error rates on congruent and incongruent trials dividing them by the pooled standard deviation of each positive and negative color trial, respectively.

To verify the appropriateness of the emotional stimuli, paired t-tests on the ratings of valence and arousal of all color-filtered pictures within each group (controls, schizophrenics as a whole, paranoid schizophrenics, and non-paranoid schizophrenics) were carried out. Independent t-tests between groups (normal controls and schizophrenics) and a one-way ANOVA between groups

(normal controls, paranoid schizophrenics, and non-paranoid schizophrenics) were also performed. The demographic and clinical profiles were compared using a one-way ANOVA, an independent t-test, and a χ^2 test. The criterion for significance was set to $p < 0.05$, and to indicate a trend p had to be less than 0.10.

RESULTS

Demographic and clinical profiles

Demographic and clinical profiles are summarized in Table 2. The subjects in the control and patient groups were well-matched in age, sex and education level. All schizophrenic patients were receiving antipsychotic medication (atypical = 12, typical = 5, and both typical and atypical = 3).

Post-hoc groups based on specific type (paranoid and non-paranoid) were also broadly similar in terms of demographic and clinical characteristics except for the positive symptoms score on the PANSS37 (paranoid 13.9 ± 6.7 , non-paranoid 8.0 ± 1.6 ; $t = 2.6$, $df = 8.7$, $p = 0.030$). There was no significant difference in age, sex, or education

level between the normal controls, paranoid schizophrenics, and non-paranoid schizophrenics.

Verification of the emotional stimuli

The paired t-test showed that the valence ratings using the SAM of positive and negative pictures used in the color-filtered trial were significantly different in both the normal controls (6.3 ± 2.3 for the positive pictures vs. 2.6 ± 1.5 for the negative pictures, $p < 0.001$), and in patients with schizophrenia (for all patients, 6.3 ± 2.4 for the positive pictures vs. 2.6 ± 1.7 for the negative pictures, $p < 0.001$; paranoid patients, 6.2 ± 2.4 for the positive pictures vs. 2.9 ± 2.0 for the negative pictures, $p < 0.001$; non-paranoid patients, 6.4 ± 2.4 for the positive pictures vs. 2.3 ± 1.5 for the negative pictures, $p < 0.001$). There was no significant difference between the arousal ratings of the positive and negative pictures in either the normal controls (6.3 ± 1.9 for the positive pictures vs. 6.2 ± 1.9 for the negative pictures, $p = 0.969$) or in the schizophrenia group (for all patients, 6.1 ± 2.3 for the positive pictures vs. 5.9 ± 2.4 for the negative pictures, $p = 0.574$; paranoid patients, 5.7 ± 2.5 for the positive pictures vs. 5.4 ± 2.5 for the negative

Table 2. Sociodemographic and Clinical Profiles of Normal Controls and Patients with Schizophrenia

	Normal (n = 22)	Schizophrenia (n = 20)	p value
Age (yr)	31.3 ± 6.2	30.3 ± 7.9	0.642
Sex (M/F)	10/12	10/10	0.768
Education (yr)	14.8 ± 2.5	14.1 ± 1.7	0.312
Onset age (yr)	-	25.2 ± 6.2	
Illness duration (Months)	-	63.2 ± 49.4	
Subtype (paranoid/undifferentiated/residual)	-	9/3/8	
PANSS*	-		
Positive	-	10.7 ± 5.4	
Negative	-	12.1 ± 3.6	
General psychopathology	-	21.8 ± 5.2	
Chlorpromazine equivalent dose (mg/day) [†]	-	518.8 ± 330.4	

Data are shown as mean \pm standard deviation.

The p values are calculated by t-tests or χ^2 tests.

*PANSS, positive and negative syndrome scale.

[†]Doses are calculated according to the guidelines of the American Psychiatric Association.

pictures, $p = 0.599$; non-paranoid patients, 6.3 ± 2.1 for the positive pictures vs. 6.2 ± 2.2 for the negative pictures, $p = 0.780$). There were no significant differences of valence and arousal of positive and negative pictures between normal controls, patients with paranoid schizophrenia, and patients with non-paranoid schizophrenia. These findings mean that controls and schizophrenia patients as a whole, as well as normal controls, paranoid schizophrenics, and non-paranoid schizophrenics recognized the positive and negative pictures as positive and negative stimuli with comparable arousal levels.

Emotional task performance

A repeated-measures ANOVA was carried out on error rates and reaction times, with intrinsic valence (positive and negative) and extrinsic valence (positive and negative; assigned color response) of color stimuli as the repeated measures and groups (normal controls and schizophrenia patients) as the between-group factors. Results for error rates indicated a significant main effect of intrinsic valence [$F(1,40) = 5.45$, $p = 0.025$], extrinsic valence [$F(1,40) = 8.39$, $p = 0.006$], groups (normal controls and schizophrenics) [$F(1,40) = 14.63$, $p < 0.001$], and significant interaction effects between intrinsic valence and extrinsic valence [$F(1,40) = 19.74$, $p < 0.001$], and more importantly, intrinsic valence, extrinsic valence, and group interaction effects [$F(1,40) = 4.23$, $p = 0.046$]. There

was a trend-level interaction effect between extrinsic valence and group [$F(1,40) = 3.79$, $p = 0.059$]. In addition, there were no other significant or trend-level interaction effects. The Wilcoxon signed rank tests were conducted to examine the within-group differences of congruent trials and incongruent trials for each positive and negative picture in each group (Table 3). These Wilcoxon signed rank tests revealed that normal controls committed more errors on the incongruent trials than the congruent trials for positive stimuli (8.18 ± 8.39 v.s. 2.05 ± 3.98 , $Z = 2.62$, $p = 0.009$) and for negative stimuli (4.32 ± 5.83 v.s. 1.36 ± 2.75 , $Z = 2.36$, $p = 0.018$). The effect sizes of positive and negative stimuli were 0.93 and 0.65, respectively, for the normal controls (Fig. 1). All Patients with schizophrenia did not make more errors on the incongruent trials (17.75 ± 22.80) than in the congruent trials (13.50 ± 18.29) for negative stimuli ($Z = 0.54$, $p = 0.591$), while they made more significant errors on the incongruent trials (29.25 ± 26.12) than in the congruent trials (8.75 ± 9.58) for positive stimuli ($Z = 3.42$, $p = 0.001$). The effect sizes of positive and negative stimuli were 1.04 and 0.21, respectively, in patients with schizophrenia (Fig. 1).

Repeated-measure ANOVA results for reaction times indicated a significant main effect of intrinsic valence [$F(1,40) = 21.50$, $p < 0.001$], extrinsic valence [$F(1,40) = 17.0$, $p < 0.001$], and group (normal controls and schizophrenia patients) [$F(1,40) = 20.21$, $p < 0.001$], and also suggested significant

Table 3. EAST Performances of Normal Controls and Patients with Schizophrenia

Intrinsic valence	Normal (n = 22)				Schizophrenia (n = 20)			
	Extrinsic valence				Extrinsic valence			
	Positive	Negative	t/Z	p value	Positive	Negative	t/Z	p value
Positive								
Error rate (%)	2.05 ± 3.98	8.18 ± 8.39	2.62	0.009	8.75 ± 9.58	29.25 ± 26.12	3.42	0.001
Reaction times (ms)	839.4 ± 188.6	964.5 ± 298.3	3.21	0.004	1,153.5 ± 363.7	1,413.5 ± 387.5	4.66	< 0.001
Negative								
Error rate (%)	4.32 ± 5.83	1.36 ± 2.75	2.36	0.018	17.75 ± 22.80	13.50 ± 18.29	0.54	0.591
Reaction times (ms)	819.0 ± 151.9	866.7 ± 250.3	-1.47	0.157	1,214.1 ± 499.7	1,168.9 ± 289.9	0.13	0.899

EAST, Extrinsic Affective Simon Task.

Data are shown as mean ± standard deviation.

ms, milliseconds.

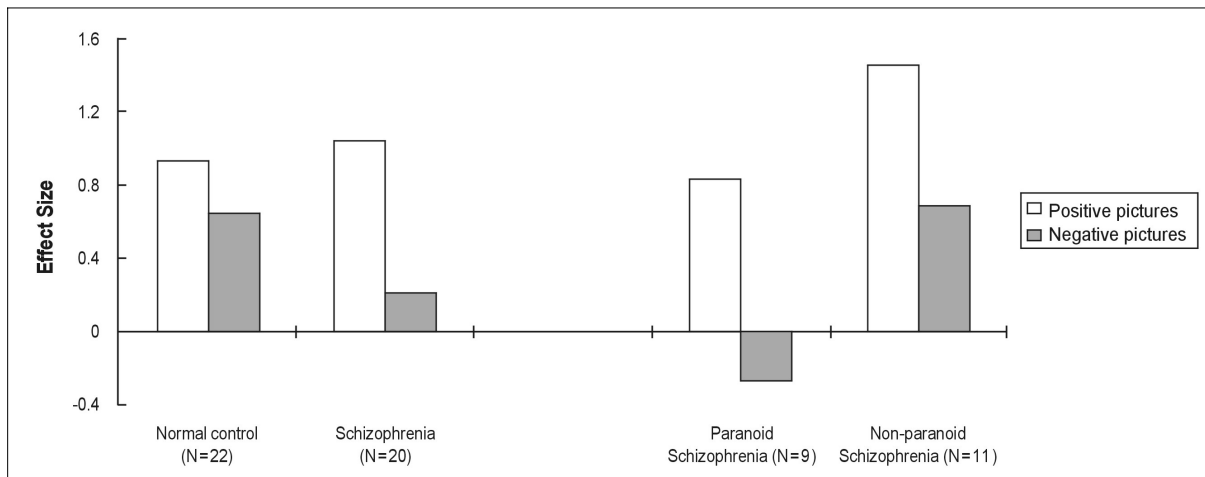


Fig. 1. Effect size of positive and negative evaluations in normal controls, schizophrenia, paranoid schizophrenia, and non-paranoid schizophrenia. The effect sizes of the positive and negative pictures in each group were calculated using the difference between the mean error rates on congruent and incongruent trials dividing them by the pooled standard deviation of each emotional stimulus.

interaction effects of intrinsic valence and extrinsic valence [$F(1,40) = 13.47, p = 0.001$]. There was also a trend-level interaction effect between intrinsic valence, extrinsic valence and group [$F(1,40) = 3.28, p = 0.078$]. There were no other significant or trend-level interaction effects. The paired t-tests were conducted to examine the within-group differences of congruent trials and incongruent trials for each positive and negative picture in each group (Table 3). These paired t-tests revealed that there was a greater delay on the incongruent trials than in the congruent trials for positive stimuli, which was not seen for the negative stimuli in normal controls and patients with schizophrenia.

When these analyses were repeated on the error rates in the three groups (normal controls, paranoid schizophrenics, and non-paranoid schizophrenics), a significant main effect of intrinsic valence [$F(1,39) = 5.50, p = 0.024$], extrinsic valence [$F(1,39) = 13.47, p = 0.001$], and group [$F(2,39) = 7.28, p = 0.002$] was seen, and significant interaction effects of intrinsic valence and extrinsic valence [$F(1,39) = 22.27, p < 0.001$], extrinsic valence and group interaction effect [$F(2,39) = 4.63, p = 0.016$], and more importantly an interaction effect between intrinsic valence, extrinsic valence and group [$F(2,39) = 3.36, p = 0.045$] was also observed. There was no other significant or trend-level interaction effect. The Wilcoxon signed rank tests were conducted to examine the within-group dif-

ferences for each positive and negative picture for each group. These Wilcoxon signed rank tests revealed that non-paranoid schizophrenics made more errors on the incongruent trials than in the congruent trials for positive stimuli (27.27 ± 17.80 vs. $7.78 \pm 6.84, Z = 2.53, p = 0.012$) and for negative stimuli (21.36 ± 24.50 vs. $8.64 \pm 9.24, Z = 1.79, p = 0.074$). The effect sizes of positive and negative stimuli were 1.45 and 0.69, respectively, in patients with non-paranoid schizophrenia (Fig. 1). However, patients with paranoid schizophrenia did not make more errors on the incongruent trials (13.33 ± 21.07) than in the congruent trials (19.44 ± 24.81) for negative stimuli ($Z = -1.63, p = 0.104$), while they made more significant errors on the incongruent trials (31.67 ± 34.73) than in the congruent trials (10.0 ± 12.5) for positive stimuli ($Z = 2.25, p = 0.024$). The effect sizes of positive and negative stimuli were 0.83 and -0.27, respectively, in patients with paranoid schizophrenia (Fig. 1). Repeated-measure ANOVA results for reaction times indicated a significant main effect of intrinsic valence [$F(1,39) = 20.02, p < 0.001$], extrinsic valence [$F(1,39) = 16.95, p < 0.001$], and group (normal controls, paranoid patients and non-paranoid patients) [$F(2,39) = 11.48, p < 0.001$], and also significant interaction effects of intrinsic valence and extrinsic valence [$F(1,39) = 15.14, p < 0.001$]. There were no other significant or trend-level interaction effects.

DISCUSSION

This study revealed that normal controls made more errors in trials of the positive pictures when the correct response was the negative response key. The reverse was true for trials of the negative pictures. Patients with schizophrenia, especially paranoid schizophrenia, committed more errors on trials of the positive pictures when the correct response key was the negative response key. However, the reverse was not true in trials of the negative pictures. These findings suggest that patients with schizophrenia, especially paranoid schizophrenia, might suffer from a greater impairment in the ability to evaluate negative emotions.

The performances of normal controls showed a more significant error rate on the incongruent trials than the congruent trials for both positive and negative stimuli. In addition, the effect sizes in both positive and negative emotions were robust according to Cohen's criteria.⁴⁰ These findings were grossly compatible to the previous EAST report using emotional words,³¹ which showed that the EAST could measure a separated estimate of emotional evaluation within each target category and retain the robust effect size.

However, when taking reaction time into account, the present study found that there was a significantly longer delay in the incongruent trials than the congruent trials for positive pictures, but not for the negative pictures in both subject groups, while De Houwer's³¹ findings were that there was a significant delay in the analysis of reaction times for both positive and negative trials. Since the stimuli in De Houwer's study³¹ were not pictures but words, a direct comparison is not possible. One of the probable reasons for the discrepancy in the reaction time analysis is that subjects may base their responses more on reaction time than on accuracy. This might be an inherent characteristic of the procedural structures of the EAST with pictures used in the present study, although all subjects were instructed to press the key as accurately, but also as quickly, as possible. Although the precise reason for this discrepancy is not yet clear, it seems reasonable to suppose that in taking the error rates of the response into account, EAST using emotional pictures provides separate evaluative estimates of

each positive and negative emotional category. In addition, the effect sizes of positive and negative emotions in the present study were so robust that they allowed for the comparison of the performances of normal controls and patients with schizophrenia.

Patients with schizophrenia made significantly more errors on the incongruent trials than congruent trials for positive pictures, but not for negative pictures. This finding suggests that schizophrenics may suffer from a greater impairment in their ability to evaluate negative emotions. This is also compatible with previous studies in that there was a greater impairment of the evaluation of negative emotions than positive emotions in schizophrenics.^{4,8}

When splitting schizophrenics into two groups (paranoid and non-paranoid), there was a relationship between the diagnostic subtype and the ability to evaluate emotions. Paranoid schizophrenic patients made more significant errors for positive pictures but not for negative pictures, while non-paranoid patients had significantly more errors for positive pictures and a trend-level of more errors for negative pictures in the incongruent trials than in the congruent trials. These findings mean that paranoid schizophrenic patients show more profound impairments in the evaluation of negative stimuli, while non-paranoid patients do not show emotional processing impairment of the positive or negative stimuli. The paranoid schizophrenics were reported to show negative emotion recognition impairment while residual patients displayed no impairment in negative or positive emotion recognition.¹⁸ To the extent that our non-paranoid patients were residual schizophrenics ($n = 8$) and undifferentiated schizophrenics ($n = 3$) who have nearly remitted positive symptoms, our main findings are compatible with previous findings.¹⁸

The main findings of greater impairment in negative emotion processing in paranoid schizophrenics seem to be incompatible to those of the previous emotional Stroop tests.^{41,42} However, these previous Stroop studies to measure pre-attentive emotional processing found that delusional schizophrenic patients demonstrated a selective delay in response time to the threatening words,^{41,42} which means that there is a heightened

pre-attentive bias to threatening, highly-arousing negative stimuli. One of the possible explanations of this apparent inconsistency is the difference in stimuli. In the present study, most of the negative stimuli were complex pictures depicting social events, while in the previous studies^{41,42} the stimuli were simple emotional words depicting threatening ideas. Another more plausible explanation is the difference in construct of each task. The emotional Stroop test measures the pre-attentive bias to specific emotional contents, while the EAST measures the strength of an association within each emotional category.

The main finding of a negative emotion-specific deficit in paranoid schizophrenics in the present study is compatible with the results of previous priming studies and is quite informative about the issue of emotional impairment in schizophrenia. In previous emotional priming studies,^{43,44} there was a significant negative judgment shift of the target stimuli, which suggested that patients with schizophrenia could not control or suppress the negative emotional information at the automatic processing stage. However, whether positive emotion processing is impaired or not could not be determined because there was a strong tendency to judge the stimuli to be positive even when there had been priming with neutral stimuli in these previous studies. Based on the assumption that each estimate of the strength of association within each positive and negative emotional network could be indexed by the EAST methods,^{30,31} our findings suggest that patients with paranoid schizophrenia might suffer from an impairment within the negative emotional association network, and were less likely to have an impairment within the positive emotional category. This loose association within the negative emotional network could result in the inability of patients with schizophrenia to regulate the spreading of activation to the negative emotional prime, which was manifested by a negative judgment shift to prime in previous studies.^{43,44}

This loose association within the negative emotional category in paranoid schizophrenia might also have resulted from the disrupted connectivity between nodes in the prefrontal-thalamic and temporolimbic or cerebellar circuit.^{45,46} Furthermore, a recent functional Magnetic Resonance

Imaging (fMRI) study⁴⁷ using fearful faces as threatening stimuli suggested that there is a functional disconnection in the autonomic and central systems for the processing of threatening stimuli in paranoid schizophrenia.

There were some limitations in the present study. Firstly, all patients were on medication. However, in previous studies on this issue, no evidence was found of any adverse effects caused by antipsychotics on the emotional task performances in schizophrenics.^{1,15,48} Thus, the medication effect seemed to be small, although the possibility of there being some such effect could not be ruled out. Another more important limitation is that the color-filtered negative stimuli might simply be more difficult than the positive stimuli for patients with schizophrenia,³ instead of there being any specific relationship to negative emotion. However, in this EAST task the evaluation of the intrinsic emotion of color-filtered stimuli was done implicitly, not explicitly. There has been no accumulation of knowledge about whether it is more difficult to implicitly evaluate negative stimuli than positive stimuli. In addition, it was found in the present study that between normal controls and patients with schizophrenia, and between normal controls, paranoid patients, and non-paranoid patients according to emotional valence, there was no significant difference of reaction time, which may reflect the difficulty required to perform the task. Thus, the main finding of the present study may not be well-explained by the greater difficulty in the recognition of negative stimuli in schizophrenia, although the possibility could not be ruled out.

In conclusion, our findings support the hypothesis that patients with paranoid schizophrenia might suffer from a greater impairment in the ability to evaluate negative emotions, and this deficit would imply that there may be a loosening of association within the negative emotional network in patients with paranoid schizophrenia.

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