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# The role of configural information in facial emotion recognition in schizophrenia

Valérien Chambon ; Jean-Yves Baudouin & Nicolas Franck

*The schizophrenia deficit in facial emotion recognition could be accounted for by a deficit in processing the configural information of the face. The present experiment was designed to further test this hypothesis by studying the face-inversion effect in a facial emotion recognition task. The ability of 26 schizophrenic patients and 26 control participants to recognize facial emotions on upright and upside-down faces was assessed. Participants were told to state whether faces expressed one of six possible emotions (happiness, anger, disgust, fear, sadness, neutrality) in two sessions, one with upright faces and the other with upside-down faces. Discriminability and the decision criterion were computed. The results indicated that the schizophrenic patients were impaired in upright facial emotion discrimination by comparison with the controls. They also exhibited an inversion effect similar to the controls. However, whereas controls tended to adopt a more conservative criterion for all emotions and a liberal criterion for neutrality when the faces were upside-down, schizophrenic patients presented a decision criterion pattern that was similar for the two orientations and similar to controls in upside-down emotion recognition. The lack of a decision criterion shift was associated with positive symptoms such as delusions, hallucinations, and bizarre behavior. Moreover, positive and negative symptoms were associated with inversion effect on discriminability; the more severe the symptoms, the weaker the inversion effect. We conclude that individuals with schizophrenia do process the configural information of the face. However, further investigations are needed to assert whether this information is of good quality in schizophrenia.*

## 1. Introduction

A broad range of deficits in interpersonal skills characterizes schizophrenia. A natural way to tackle these deficits is to explore the ability of schizophrenic patients to process stimuli that have a well-established psychosocial content: faces, for instance. In particular, facial expressions are known as a powerful vector of social interaction: when facial information processing is impaired, the possibility for patients with schizophrenia to engage in proper interactions is jeopardized and their sense of social worth is reduced (Walker, McGuire, & Bettes, 1984). Deficits in facial emotion recognition and discrimination have been studied extensively, and most investigators have pointed out that schizophrenic patients perform less well than nonpatients and psychiatric controls on facial emotion recognition tests (e.g., Borod, Martin, Alpert, Brozgold, & Welkowitz, 1993; Cutting, 1981; Mandal, 1986; Morrison, Bellack, & Mueser, 1988). The use of a differential design combining emotional and non-emotional facial judgment tasks (i.e., control task) has also revealed the existence of additional deficits in facial recognition, familiar and non-familiar face matching, and age recognition (Archer, Hay, & Young, 1992; Berndl, von Cranach, & Grusser, 1986; Feinberg, Rifkin, Schaffer, & Walker, 1986; Kerr & Neale, 1993; Kohler, Bilker, Hagedoorn, Gur, & Gur, 2000). Furthermore, a significant correlation between abnormal performance and negative and positive symptom subgroups has been revealed in numerous studies, indicating that this deficit in facial emotion recognition is a function of symptom severity (Addington & Addington, 1998; Kohler et al., 2000; Loughland, Williams, & Gordon, 2002a; Schneider, Gur, Gur, & Shtasel,

1995). The abnormal performance of schizophrenic patients in facial recognition tasks could be due to an inability to process and integrate typical features that convey a social meaning or that involve an affective appraisal (Frith, Stevens, Johnstone, Owens, & Crow, 1983). Many recent studies have tried to relate this hypothesis with the incorrect information intake due, for example, to an abnormal visual scanning (Loughland et al., 2002a; Loughland, Williams, & Gordon, 2002b; Manor et al., 1999; Streit, Wolwer, & Gaebel, 1997; Williams, Loughland, Gordon, & Davidson, 1999). Loughland et al. (2002a) addressed the possibility that the schizophrenic deficit in facial emotion recognition results from a breakdown in the neurocognitive strategies that underlie the processing of face stimuli. Overall, this deficit might reflect failure to integrate salient features, probably due to deficient local processing of relevant information and a dysfunction in the networks that synchronize local and global processing of face stimuli. According to this account, the abnormal visual scanpath of schizophrenics reflects over reliance on sequential visual search strategies, perhaps to compensate for an earlier problem in the configural processing of faces (e.g., relational or gestalt processing). Configural processing has been shown to be crucial for healthy participants to acquire facial expertise (for a review, see Maurer, Le Grand, & Mondloch, 2002) and facial expression recognition (Calder, Young, Keane, & Dean, 2000). Schwartz, Rosse, Johri, and Deutsch (1999) reported that control participants made more saccades of less than 50 ms to upright than to upside-down faces, and assumed that the processing of configural information was disturbed for upside-down faces. Schizophrenic patients did not differ across face orientations. Therefore a specific disturbance in access to facial configural information could account for the differences between the visual scanpath of schizophrenics and that of healthy or psychiatric patient controls. The restricted visual scanpaths reported for both emotion processing and face recognition may reflect a tendency to pay more attention to some components of the face and less attention to information on configuration (Loughland et al., 2002a). On the other hand, Schwartz, Marvel, Drapalski, Rosse, and Deutsch (2002) reported observations indicating that schizophrenic patients processed facial configural information. They observed a classic inversion effect for object recognition and emotion recognition that tended to be stronger for faces than for houses, as it was reported for healthy participants (Yin, 1969). They also found a composite effect in face recognition similar to the one reported with healthy participants by Young, Hellawell, and Hay (1987). In line with these results, Schwartz et al. (2002) concluded that the facial emotion processing deficit in schizophrenia cannot be accounted for by a deficit in configural information processing.

The present experiment was designed to further test this hypothesis by studying the face-inversion effect in a facial emotion recognition task. A set of photographs of expressive faces was shown to 26 healthy participants and 26 schizophrenic patients in two conditions, upright and upside-down. If the schizophrenic deficit in facial recognition does indeed result from a problem in processing configural information, then inverting faces – which generally impairs this type of processing – should not disturb them as much as healthy participants. For instance, the performance of the schizophrenic group in the upside-down condition might differ little or not at all from their performance in the upright condition, suggesting that patients develop the same analytic strategy for upright and upside-down faces. This strategy is essentially based on the processing of “componential information” (information about the physical characteristics of the face’s components). We then assessed participants’ performance in emotional recognition: (i) for upright faces and (ii) the influence of inverting those faces on discriminability measures. We also looked at whether the recognition of facial emotions and the inversion effect were associated with a particular symptomatology, i.e., whether

performance was correlated with the severity of negative and/or positive symptoms of schizophrenia, as assessed by the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983) and the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984).

## 2. Method

### 2.1. Participants

Twenty-six patients with schizophrenia (6 females, 20 males; mean age: 32.15 years, range 21–48) and 26 healthy participants (8 females, 18 males; mean age: 32.6 years, range 21–53) volunteered to participate in the study. All patients were hospitalized at the Vinatier Psychiatric Hospital in Lyon, France. The patients subjects were recruited if their current diagnosis according to DSM-IV (American Psychiatric Association, 1994) criteria was schizophrenia, with no other psychiatric comorbidity on DSM-IV Axis I. Exclusion criteria included visual difficulty, history of neurological illness or trauma, alcohol or drug dependence according to DSM-IV criteria, and age older than 65 years. All patients were receiving antipsychotic medication (principally olanzapine and risperidone) and were clinically stable at testing time (mean illness duration: 9.65 years, S.D. = 26, range 2–28). SAPS (Andreasen, 1984) and SANS (Andreasen, 1983) were used to obtain ratings for positive and negative symptoms in the schizophrenia sample (the mean scores are presented in Table 1). None of the controls reported neurological diseases or psychiatric problems. They were matched with schizophrenic patients on sex, age, and years of education (see Table 1). All participants reported normal or corrected-to-normal visual acuity. None of them was paid for taking part in the study.

### 2.2. Materials

The test materials consisted of 48 colored photographs of faces expressing 6 different emotions (happiness, fear, sadness, anger, disgust, and neutrality), with 8 photographs for each emotion. The photographs were of 29 females and 19 clean-shaven males, with no facial particularities (e.g., scars, eye glasses, jewellery).

Table 1  
Demographic characteristics of patients and control participants: means  $\pm$  standard deviations (means (bold)  $\pm$  standard deviations (italic))

	Schizophrenia	Controls
Men	<b>20</b>	<b>18</b>
Women	<b>6</b>	<b>8</b>
Age (years)	<b>32.1</b> $\pm$ 7.8	<b>32.6</b> $\pm$ 11.8
Education (years)	<b>11.8</b> $\pm$ 2.8	<b>12.9</b> $\pm$ 2.6
Duration of illness (years)	<b>9.6</b> $\pm$ 5.3	–
SANS <sup>a</sup> score	<b>33</b> $\pm$ 24.6	–
SAPS <sup>b</sup> score	<b>44.6</b> $\pm$ 17.3	–

<sup>a</sup> Scale for the Assessment of Negative Symptoms.

<sup>b</sup> Scale for the Assessment of Positive Symptoms.

The emotional valence of the faces was verified via a pretest on emotion category and intensity. For the pretest, a comparison group of eleven students was asked to say whether the photographed faces were happy, fearful, angry, sad, disgusted, neutral, or other. After having selected a category, they had to rate the intensity of the emotion from 0 to 10. The photographs chosen for use in the experiment were the ones that had been categorized in the same emotional category by at least 10 of

the participants, with an intensity of at least 4.5 out of 10. ANOVAs revealed no significant difference between the emotions on percentage of choice or intensity (all  $F_s < 1$ ). All information about background and body was eliminated. The faces were 8.50 cm high and 6.20 cm wide when presented on a computer monitor (19 in.). Short definitions of each emotion derived from Ekman and Friesen (1971) were printed on a sheet of paper and given to the participants during the test.

### *2.3. Procedure and design*

The experiment took place in two sessions. The participants were required to: (i) identify the emotion expressed on a set of 48 upright faces, and (ii) identify the emotion expressed on a set of 48 upside-down faces. The presentation order of the 48 faces was randomly rearranged on each session, and the order of the two sessions was alternated across participants: half of the participants completed the "upright" task first followed by the "upside-down" task, while the other half executed these two tasks in the opposite order. Every participant always performed both tasks one after the other the same day, which involved 96 emotional judgments in all. For both tasks, participants sat in front of the computer monitor at an approximate distance of 70 cm. Patients and controls were instructed to respond aloud, as accurately and as quickly as possible (reaction times were not recorded, however). The experimenter entered the participant's answers on a computer connected to the test monitor. Each session began with a blank screen lasting three seconds. Next, a fixation point appeared in the center of the screen and then disappeared after one second. After a second blank screen lasting one second, the first face appeared in the middle of the screen and remained there until the participant responded. This exact sequence was run for each of the 48 faces in both sessions.

### **3. Results**

The mean response percentages in each experimental condition are presented in Table 2. A visual inspection of this table suggests that there was some bias in the participants' responses. For example, the answer "neutral" was incorrectly given more often than the others, especially in the upside-down condition. So for each participant in each experimental condition, we computed the  $A'$  and  $B''$  indexes from signal detection theory (Grier, 1971). The rationale for using these indexes is that when some participants tend to respond more often for a particular emotion (e.g., neutral), the false alarm rate ("neutral" answer for other emotions) for that emotion will be high and the hit rate could also increase by comparison to other emotions. This means that a high percentage of correct recognitions for a given emotion can indicate either high accuracy or a bias toward that emotion. The  $A'$  and  $B''$  indexes take both hits and false alarms into account.  $A'$  is an index of discriminability; it indicates a participant's ability to discriminate the target emotion among other emotions.  $A'$  ranges from 0 to 1, with 1 corresponding to the case where the participants recognized the emotion each time it was presented without "recognizing" it in other emotions and .5 corresponding to chance-level performance (i.e., the participant "recognized" the emotion as often on a face that really expressed that emotion as on faces that expressed another emotion).  $B''$  is an index of bias; it indicates the participant's decision criterion, which can be liberal (the participant has a tendency to "recognize" the emotion) or conservative (the participant has a tendency to not recognize the emotion).  $B''$  ranges from -1 (liberal criterion) to 1 (conservative criterion), with the value 0 indicating a neutral criterion.

Table 2  
Mean percentage of responses for each emotion on upright and upside-down facial emotions, by group

Group		Response						
Orientation	Emotion	Happy	Angry	Disgusted	Fearful	Sad	Neutral	
Controls								
Upright	Happiness	<b>98.1</b>	.0	.0	.5	.0	1.4	
	Anger	.0	<b>81.7</b>	9.1	3.4	4.8	1.0	
	Disgust	.5	5.8	<b>85.1</b>	1.9	4.8	1.9	
	Fear	4.3	1.0	2.4	<b>90.4</b>	.5	1.4	
	Sadness	.0	1.0	4.8	4.3	<b>85.1</b>	4.8	
	Neutrality	3.8	1.0	.0	.5	8.2	<b>86.5</b>	
	Upside-down	Happiness	<b>95.2</b>	.0	2.4	.0	1.0	1.4
		Anger	3.4	<b>66.8</b>	4.3	1.0	1.4	22.6
		Disgust	5.8	8.7	<b>68.8</b>	1.0	11.5	4.3
		Fear	2.9	1.0	1.0	<b>75.5</b>	2.4	17.3
Sadness		1.9	2.4	5.8	2.9	<b>35.6</b>	51.0	
Neutrality		9.6	1.0	1.4	.5	8.7	<b>78.4</b>	
Schizophrenic patients								
Upright	Happiness	<b>90.4</b>	.5	.5	.0	2.9	5.8	
	Anger	4.3	<b>70.2</b>	10.6	1.4	5.3	8.2	
	Disgust	9.1	12.0	<b>55.8</b>	5.3	12.5	5.3	
Upright	Happiness	<b>90.4</b>	.5	.5	.0	2.9	5.8	
	Anger	4.3	<b>70.2</b>	10.6	1.4	5.3	8.2	
	Disgust	9.1	12.0	<b>55.8</b>	5.3	12.5	5.3	
	Fear	6.7	5.3	8.7	<b>68.8</b>	1.9	8.7	
	Sadness	1.0	1.4	13.9	5.8	<b>68.3</b>	9.6	
	Neutrality	4.8	1.0	2.4	1.0	10.6	<b>80.3</b>	
	Upside-down	Happiness	<b>82.2</b>	1.4	2.4	1.0	1.0	12.0
Anger		9.6	<b>51.4</b>	8.7	3.4	4.3	22.6	
Disgust		15.4	6.7	<b>44.7</b>	5.3	19.7	8.2	
Fear		7.2	4.8	5.3	<b>53.4</b>	5.8	23.6	
Sadness		8.2	3.8	7.2	7.2	<b>21.6</b>	51.9	
Neutrality		6.3	3.8	2.9	3.4	5.3	<b>78.4</b>	

Bold values correspond to the correct response.

### 3.1. Discriminability ( $A'$ )

$A'$  values for each group in each experimental condition are presented in Fig. 1. We performed a  $\log_{10}$  transform on these values and then input them into a  $2 \times 2 \times 6$  ANOVA with group (schizophrenic patients versus controls) as a between-subject factor, and orientation (upright versus upside-down) and emotion (happiness versus anger versus disgust versus fear versus sadness versus neutrality) as within-subject factors. The main effect of group was significant; the discriminability of emotions was lower for schizophrenic patients than for controls (.85 versus .93,  $F(1, 50) = 14.03$ ,  $p < .001$ ). The main effect of orientation was also significant, with lower discriminability for emotions on upside-down than on upright faces (.85 versus .93,  $F(1, 50) = 61.36$ ,  $p < .0001$ ). The interaction between orientation and group was not significant ( $F(1, 50) = 1.39$ ), indicating a similar orientation effect for both schizophrenic patients and controls. Moreover, the interaction between orientation, emotion, and group was not significant ( $F(5, 250) = 1.34$ ), suggesting that the orientation effect was similar for schizophrenic patients and controls, whatever the emotion. The main effect of emotion was significant ( $F(5, 250) = 17.58$ ,  $p < .0001$ ), but it was qualified by an interaction between emotion and orientation ( $F(5, 250) = 12.48$ ,  $p < .0001$ ). Linear comparisons indicated that orientation had a significant effect on all emotions (lowest  $F$ :  $F(1, 50) = 4.55$ ,  $p < .05$ ), but for emotions on upright faces, by emotion, orientation, and group different extents. Discriminability dropped the most for sadness (difference between upright and upside-down faces = .20), followed by neutrality (difference = .07), anger (difference = .06), disgust (difference = .05), fear (difference = .04), and happiness (difference = .03). The interaction between emotion and group was also significant ( $F(5, 250) = 2.78$ ,  $p < .05$ ). Linear comparisons indicated that emotion discriminability was lower for

schizophrenic patients than for controls, for all emotions (lowest  $F$ :  $F(1,50) = 7.17, p < .05$ ) except neutrality ( $F(1, 50) = 1.87$ ). The lack of an interaction between orientation, emotion, and group (see above) suggests that this pattern was similar for emotion on upright and upside-down faces. The significant interaction between emotion and group in the previous analysis, combined with the lack of a significant interaction between orientation, emotion, and group, indicated that: (i) the difference between schizophrenic patients and controls was not the same for all emotions, and (ii) this difference pattern was similar for the two orientations. In order to determine whether schizophrenic patients have a different deficit for different emotions, we performed a  $2 \times 6$  ANOVA on the  $A'$  values for upright faces only, with group (schizophrenic patients versus controls) as a between-subject factor and emotion (happiness versus anger versus disgust versus fear versus sadness versus neutrality) as a within-subject factor.  $A'$  values for upside-down faces were not included in the analysis because our purpose was to test the deficit in emotion recognition for schizophrenic patients. Despite a non-significant interaction, data for upside-down facial emotion could have contaminated some effects, i.e., some effect could be significant or not only because of their inclusion in the analysis. The main effects of group ( $F(1, 50) = 10.72, p < .01$ ) and emotion ( $F(5, 250) = 6.82, p < .0001$ ) were both significant, but they were qualified by a significant interaction between group and emotion ( $F(5, 250) = 3.44, p < .01$ ). Linear comparisons indicated that the emotion effect was non-significant for controls ( $F(5, 250) = .81$ ) but was significant for schizophrenic patients ( $F(5, 250) = 9.45, p < .0001$ ). For the schizophrenics, linear contrasts showed that the discriminability of happiness (.96) was significantly higher than for the other emotions ( $F(1, 50) = 40.36, p < .0001$ ), and the discriminability of disgust (.82) was significantly lower than for the other emotions ( $F(1, 50) = 11.82, p < .01$ ). Anger (.91), fear (.89), sadness (.88), and neutrality (.90) did not differ significantly ( $F(3, 150) = .94$ ). When we considered the group effect for each emotion, the discriminability was lower for schizophrenic patients than for controls on each emotion (lowest  $F$ :  $F(1, 50) = 7.06, p < .05$ ) except neutrality ( $F(1, 50) = 3.08$ ). For the emotions, the difference between controls and schizophrenic decreased in the following order: disgust (.13), fear and sadness (.07), anger (.04), and happiness (.03). To summarize, emotions were: (i) less discriminable for schizophrenic patients than for controls, and (ii) less discriminable when the faces were upside-down. The decrease in emotion discriminability on upside-down faces was greater for sadness, and also neutrality. Moreover, this inversion effect was similar for the two groups of participants, suggesting that schizophrenic patients are impaired to the same extent as controls, and for the same emotions.

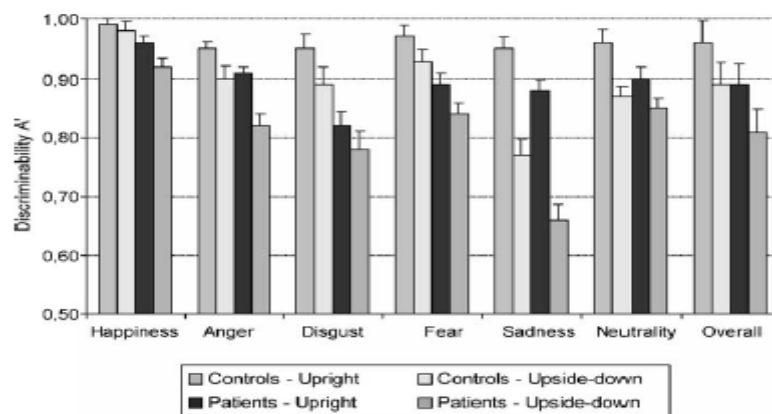


Fig. 1. Discriminability ( $A'$ ) for emotions on upright faces, by emotion, orientation, and group (error bars correspond to standard errors).

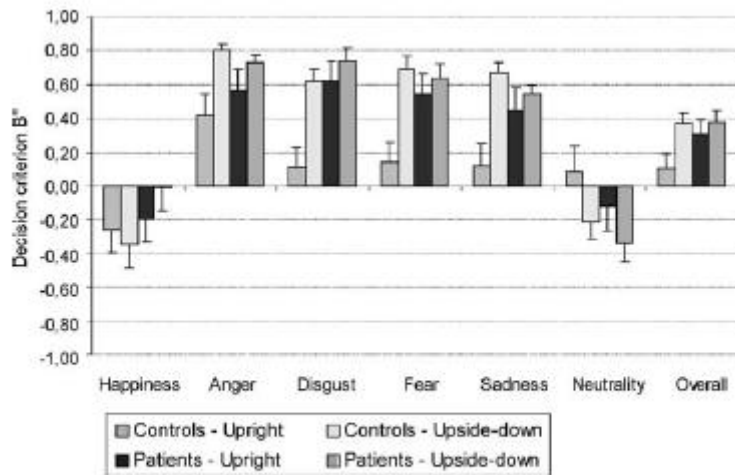


Fig. 2. Decision criterion ( $B''$ ) for emotions on upright faces, by emotion, orientation, and group (error bars correspond to standard errors).

### 3.2. Decision criterion ( $B''$ )

The  $B''$  values for each group in each experimental condition are presented in Fig. 2. We performed a  $\log_{10}$  transform on these values after having added 10 to each one. Then, we analyzed them in a  $2 \times 2 \times 6$  ANOVA with group (schizophrenic patients versus controls) as a between-subject factor, and emotion (happiness versus anger versus disgust versus fear versus sadness versus neutrality) and orientation (upright versus upside-down) as within-subject factors. The main effect of group was significant; the criterion was more conservative for schizophrenic patients than for controls (.35 versus .24,  $F(1, 50) = 10.59, p < .01$ ). The main effect of orientation was also significant, with a more conservative criterion for upside-down than for upright faces (.38 versus .21,  $F(1, 50) = 32.80, p < .0001$ ). The interaction between orientation and group was also significant ( $F(1, 50) = 10.53, p < .01$ ), indicating an orientation effect for controls, whose criterion was more conservative for upside-down faces (.37 versus .10 for upright faces,  $F(1, 50) = 40.24, p < .0001$ ), but not for schizophrenic patients (.38 versus .31,  $F(1, 50) = 3.08$ ). Thus, the criterion was more conservative for schizophrenic patients than for controls when the faces were upright (.31 versus .10,  $F(1, 50) = 16.31, p < .001$ ), but not when they were upside-down (.38 versus .37,  $F(1, 50) = .16$ ). The main effect of emotion was significant ( $F(5, 250) = 30.60, p < .0001$ ), but it was qualified both by an interaction between emotion and orientation ( $F(5, 250) = 5.30, p < .001$ ), and by an overall interaction between emotion, orientation, and group ( $F(5, 250) = 2.34, p < .05$ ). The post hoc LSD of Fisher test ( $p < .05$ ) indicated that, for controls recognizing upright facial emotions, the criterion was liberal for happiness (-.26), and neutral to conservative for the other emotions (from .09 to .42), with significant differences between happiness and the other emotions. The criterion was also significantly more conservative for anger (.42) than for neutrality (.09), disgust (.11), and sadness (.12). No other differences were significant. When the faces were upside-down, the criterion was liberal for both happiness (-.35) and neutrality (-.21), but conservative for the other emotions (from .62 to .80). All of the differences between liberal and conservative criteria were significant, but no differences within each set were significant. When the criteria for upright and upside-down faces were contrasted, controls adopted a significantly more conservative criterion for negative emotions on upside-down faces, and a significantly more liberal criterion for neutrality, with a non-significantly different criterion for happiness. Whatever the orientation, schizophrenic patients tended to adopt the same



criteria that controls recognizing upside-down facial emotion. When the groups were contrasted on upright faces, schizophrenic patients had a significantly more conservative criterion for disgust, fear, and sadness. The other differences were non-significant. For upside-down faces, the only significant difference was for happiness, with controls using a liberal criterion (-.35) and schizophrenic patients using a more neutral criterion (-.01). Interestingly, the criterion was not different for controls recognizing upright emotions and schizophrenic patients recognizing upside-down emotions, no matter what emotion was expressed on the face. When the criteria for upright and upside-down facial emotions were contrasted for schizophrenic patients, none of the differences were significant, i.e., the criterion was not significantly modified by inversion, whatever the emotion. In sum, whereas controls exhibited a more conservative criterion for upside-down than upright facial emotions, schizophrenic patients adopted the same criterion for both orientations, which was equal to the conservative criterion used by controls for upside-down facial emotions. Looking at the criteria by emotion showed that controls recognizing upright emotions adopted a liberal criterion for happiness and a neutral-to-conservative criterion for the other emotions. After inversion, controls adopted a more conservative criterion for negative emotions and a more liberal criterion for neutrality. Schizophrenic patients did not change their criterion after inversion. More interestingly, they tended to adopt the same criterion pattern for upright and upside-down facial emotions as the controls did for upside-down emotions; i.e., a conservative criterion for negative emotions and a liberal one for neutrality and happiness.

### 3.3. Correlations between SAPS/SANS scores or subscores and discriminability ( $A'$ ) or the decision criterion ( $B''$ ) for schizophrenic patients

In order to find out if the impaired performance of schizophrenic patients is associated with the severity of their symptoms, we computed Spearman coefficients of correlation between their scores and subscores on the SANS and SAPS scales (Andreasen, 1983, 1984), their discriminability and decision criterion indexes for upright and upside-down facial emotions, and the inversion effect. The inversion effect on discriminability was computed by subtracting discriminability for upside-down facial emotions from discriminability for upright facial emotions; the greater the difference, the stronger was

Table 3  
Spearman correlation coefficients between SAPS and SANS scores or subscores and discriminability ( $A'$ ) or decision criterion ( $B''$ ) for upright facial emotions, upside-down facial emotions, and inversion effect

SAPS and SANS scores and subscores	Upright		Upside-down		Inversion	
	$A'$	$B''$	$A'$	$B''$	$A'$	$B''$
SAPS	-.45 <sup>a</sup>	.47 <sup>a</sup>	-.17	-.12	-.42 <sup>a</sup>	-.58 <sup>b</sup>
Hallucinations	-.57 <sup>b</sup>	.52 <sup>b</sup>	-.35	-.14	-.42 <sup>a</sup>	-.58 <sup>b</sup>
Delusions	-.41 <sup>a</sup>	.45 <sup>a</sup>	-.13	-.16	-.48 <sup>a</sup>	-.61 <sup>b</sup>
Bizarre behavior	-.48 <sup>a</sup>	.34	-.30	.32	-.02	-.03
Thought disorder	-.10	.28	.09	-.12	-.26	-.44 <sup>a</sup>
SANS	-.23	-.06	.02	-.17	-.39 <sup>a</sup>	-.08
Affective flattening	-.33	.11	-.02	-.13	-.45 <sup>a</sup>	-.24
Alogia	-.10	-.11	.09	-.06	-.27	.05
Avolition/apathy	-.11	-.19	-.09	-.10	-.18	.13
Anhedonia/associability	.00	.05	.13	-.31	-.26	-.29
Attention	-.52 <sup>b</sup>	.08	-.18	-.02	-.46 <sup>a</sup>	-.08

<sup>a</sup>  $p < .05$ .

<sup>b</sup>  $p < .01$ .

the interference due to inversion. The inversion effect on the decision criterion was computed by subtracting the decision criterion for upright facial emotions from the decision criterion for upside-down facial emotions; the greater the difference, the stronger the shift to a conservative criterion after inversion. The coefficients of correlation are reported in Table 3 (see also Fig. 3). The SAPS scores

co-varied significantly and negatively with discriminability of emotions on upright faces and with inversion, but not with discriminability of emotions on upside-down faces.

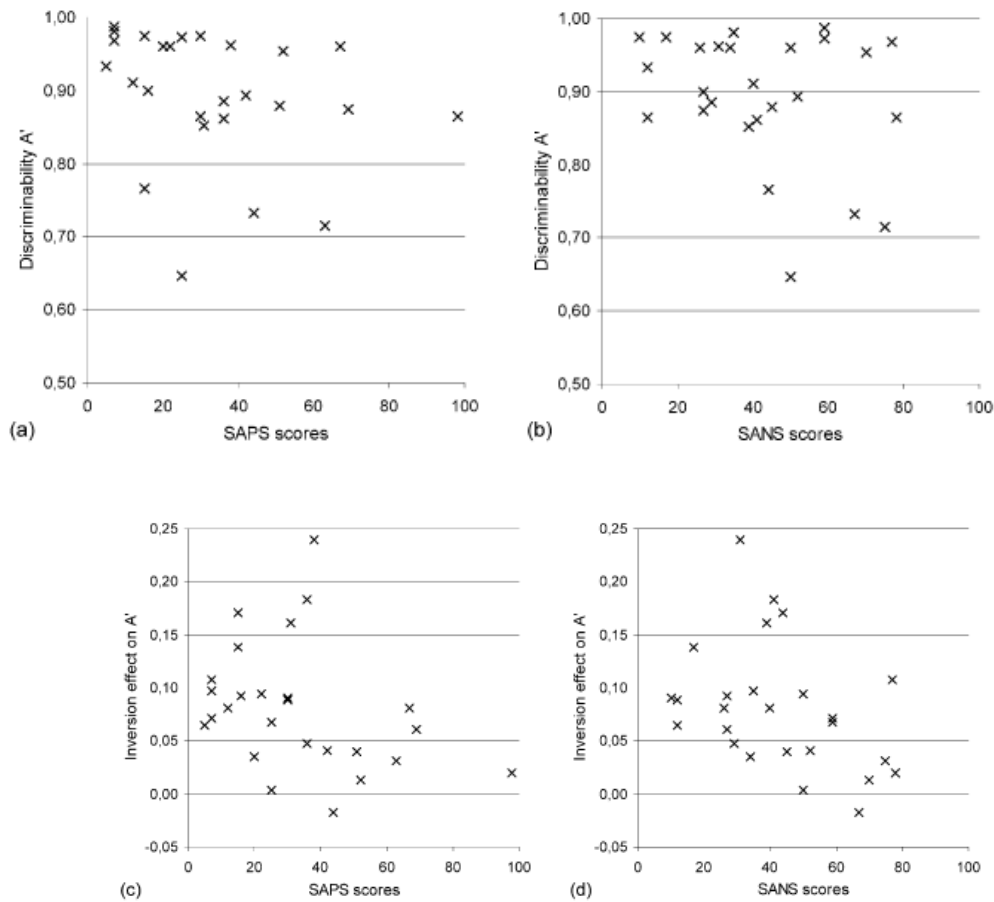


Fig. 3. Scatterplots of discriminability  $A'$  and SANS scores (a), discriminability  $A'$  and SANS scores (b), inversion effect on discriminability  $A'$  and SANS scores (c), and inversion effect on discriminability  $A'$  and SANS scores (d).

Thus, the more the patients exhibited positive symptoms, the less the emotions were discriminable and the less the inversion effect was strong. The subscore coefficients indicated that the discriminability of upright facial emotions and the inversion effect were mainly associated with delusions and hallucinations in both orientations, but also with bizarre behavior for upright facial emotions. For the decision criterion, the SANS scores co-varied with both the decision criterion on upright facial emotions (but not upside-down ones) and inversion. Schizophrenic patients who tended to have more severe positive symptoms also tended to adopt a more conservative criterion for upright facial emotions. An increase in the severity of positive symptoms was also associated with a lesser tendency to shift to a more conservative criterion after inversion. Analysis of the subscores indicated that, as above for discriminability, these associations mainly concerned hallucinations and delusions. The only co-variation with the SANS scores was the inversion effect on discriminability; the more severe the negative symptoms, the weaker the inversion effect. The subscores nevertheless indicated that both upright discriminability and inversion covaried with attention deficits. Thus, the deficit in facial emotions discriminability in schizophrenia, as well as the absence of a decision criterion shift after inversion, appears to be mainly linked to the positive symptom severity. More particularly, patients who tended to discriminate emotions less easily also experienced more hallucinations and delusions, and exhibited more bizarre behaviors. The

emotion discriminability deficit was also associated with an attentional deficit. Moreover, correlation analyses on discriminability measures showed that, despite an inversion effect similar to that of controls when they were considered as a group (see previous results), schizophrenic patients who tended to have more severe negative and positive symptoms also tended to have a weaker inversion effect.

#### **4. Discussion**

The results of the present study replicated earlier observations indicating that schizophrenic patients are impaired in facial emotion processing. This impairment concerns all emotions, even if some – notably disgust – appear to be altered more than others. Thus, schizophrenic patients do not have a specific deficit for certain emotions only although the severity of the deficit varied across emotions. Schizophrenic patients also differed from controls in their decision criterion; they adopted a more conservative criterion overall, which means they tended to say “no” when they had to match a perceptual emotion stimulation to its corresponding mental representation. The criteria they adopted for the different emotions also differed considerably from that of controls (in fact, it corresponded to the criteria used by controls when recognizing upside-down emotions), with a liberal criterion for happiness and neutrality, and a conservative criterion for negative emotions. Consideration of the symptomatology further indicated that the deficit in emotion recognition was not associated with a single kind of symptom. Overall, no link between this deficit and negative symptoms was observed in the present study, but some subscores (e.g., attention) of the SANS scale were correlated with the magnitude of the deficit. The role of attention in schizophrenia has been well documented in the literature (e.g., Addington & Addington, 1998). It has been proposed that an attention deficit may be a cause of schizophrenic patients’ deficit in face processing: schizophrenics are thought to not pay attention to relevant facial information and be hindered by other facial information (Baudouin, Martin, Tiberghien, Verlut, & Franck, 2002; Bediou et al., 2005; Martin, Baudouin, Tiberghien, & Franck, 2005). This suggests that the various kinds of facial information are not extracted automatically but need attention. The attention deficit of schizophrenics would therefore generate their face processing impairment. A strong association between the deficit and positive symptoms was also found in the present study. In particular, emotion discriminability and the shift to a more conservative criterion for upside-down facial emotions were lower when hallucinations, delusions, and bizarre behaviors were more prominent and higher in the opposite case. Thus, it appears that some symptoms may result from (or cause?) the deficit in emotion recognition. Notably, the difficulties schizophrenic patients have in recognizing facial emotions, and their tendency to not recognize negative emotions, may favor the emergence of socially inadapted behavior, like hallucinations, delusions, and bizarre behaviors. Regarding the configural processing of emotions, the results showed first that schizophrenic patients were as disturbed by inversion as controls, and also to the same extent. Thus, no particular disturbance for schizophrenic patients was evidenced with discriminability indexes. However, both the decision criterion analyses and correlation analyses modulated this conclusion. Based on the decision criterion, we found that, overall, controls adopted a more conservative criterion for assessing emotions on upside-down faces. When the emotions were analyzed separately, we saw that inversion resulted in a more conservative criterion for negative emotions, but a more liberal criterion for neutrality. Thus, the tendency of controls to respond “no” to negative emotions and “yes” to neutrality was accentuated by face inversion. The disruption of configural processing brought about by face inversion seems to have caused controls to change their

decision criterion. This change was not observed for schizophrenic patients, who exhibited the same decision criterion pattern for the two orientations. Moreover, their pattern was similar to that of controls when recognizing upside-down facial emotions. In short, for upright emotions, schizophrenic patients acted as if configural information processing was disrupted, in the same way as controls did after inversion. Correlation analyses further showed that the size of the inversion effect for discriminability was modulated by both positive and negative symptoms. More particularly, schizophrenic patients with higher subscores of hallucinations, delusions, affective flattening, and attention deficits were less sensitive to inversion. So, the greater the severity of these symptoms, the lower the sensitivity to configural information. This last observation suggests that schizophrenic patients with more severe symptoms tended to process both upright and upside-down faces in the same way, i.e., componentially. A possible explanation to these observations could be that schizophrenic patients do in fact process configural information, but in an incorrect way. It has been reported that some prosopagnosic patients (patients who are unable to recognize a person from their face) process configural information but incorrectly (e.g., De Gelder & Rouw, 2000). In this case, the problem does not result from the absence of configural processing but from the fact that the configural information extracted is of poor quality. In schizophrenia, an abnormal pattern of exploration of faces has been reported (e.g., Streit et al., 1997; Williams et al., 1999), as well as a composite effect (Schwartz et al., 2002). One can thus hypothesize that schizophrenic patients extract configural information, and that such information will automatically interfere with the processing of local parts of the face. This could explain both the composite effect and the inversion effect reported by Schwartz et al. (2002), and the inversion effect in emotion recognition in the present study. Nevertheless, configural information would not need to be of good quality to interfere; we can suppose, indeed, that even low quality configural information will influence the processing of local parts of faces (see De Gelder & Rouw, 2000). So, we could hypothesize that the extracted configural information will be of low quality in schizophrenia, due to an inappropriate exploration of faces. Schizophrenic patients would then rely more on other kind of information (e.g., local or componential information) to recognize facial emotions. This assumption, however, remains to be tested.

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