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Selective attention to facial emotion and identity in schizophrenia

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Abstract

The selective attention to facial emotion and identity was investigated in 12 patients with schizophrenia and 12 healthy participants. Both patients and controls were required to perform two classification tasks (according either to identity or emotion). Two separate values for identity (person A/person B) and for emotion (fear/anger) were used. When the classification task was on one dimension, the other dimension was either correlated, constant, or orthogonal (Garner WR. The Processing of Information and Structure. Potomac, MD: Erlbaum, 1974, Garner WR. Interaction of stimulus dimensions in concept and choice processes. Cognitive Psychology 1976;8:98–123). Results indicated that both patients and healthy participants had an asymmetrical pattern of performance: they were able to selectively attend to the identity of the face presented, regardless of the emotion expressed on the face, but variation in identity interfered with the classification of facial emotion. Moreover, a correlational study indicated that the identity interference on emotion classification for schizophrenic patients covaried with the severity of their negative symptoms. The selective attention competencies in schizophrenia and the independence hypothesis of emotion and face recognition are discussed in the framework of current face recognition models.

Keywords: Facial emotion; Identity; Schizophrenia

1. Introduction

According to current opinion in face recognition research, the processing of facial emotion and face recognition are independent and parallel processes [17,18,46,62,63]. This postulate rests on various sources of data. The first comes from neuropsychological studies that have shown a dissociation between face recognition and facial emotion processing [61–63]. In the same way, physiological studies in primates and functional neuroimaging in humans have indicated that different parts of the brain process these two kinds of information [35,53]. Finally, several psychological studies have shown that recognition or matching of facial emotion is not influenced by face familiarity [16,19,65] and, accordingly, that recognition or matching of facial identity is not influenced by facial emotion [15,65]. Nevertheless, despite the abundance of data in favour of the independence hypothesis, more recent findings suggest that face recognition and emotion processing interact [50].

A number of neuropsychological studies have failed to confirm the dissociation hypothesis. For example, Young, Hellawell, Van De Wal and Johnson [64] studied a patient with a partial bilateral amygdalectomy who was poor at recognising facial emotions. She was not impaired on identity tasks, except when she had to recognise the same person with two distinct emotional expressions, a situation that resulted in her perceiving the stimuli as two different individuals. Thus, the patient's deficit in facial emotion processing led to a deficit in face identity matching. Several studies have also shown that deficits in face recognition and emotion recognition correlate in many types of patients, such as patients with damage to their right hemispheres [58], right and left lobectomized patients [14], and schizophrenic patients [49]. In neuroimaging studies, the activation of the right fusiform gyrus — considered as a critical region in face recognition [36,37,55] — was

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reported as higher for smiling than neutral faces in a delayed identity matching task [21]. In the same way, the activation of primary visual areas and the amygdala decreased when the faces were familiar rather than unknown, during a task that did not require the processing of identity and familiarity, but of another type of facial information, i.e. gender [23]. Finally, some psychological studies have also indicated interactions between face recognition and facial emotion processing. Notably, smiling increased the feeling of familiarity with familiar and unfamiliar faces [8] whereas familiarity of faces favoured the processing of emotional information [9]. In other studies, facial identity variations were found to interfere with facial emotion classification tasks [51,52]. Thus, identity and emotion are extracted with the help of distinct processes located in separate cerebral areas; however, interactions may occur between these brain regions.

An implication of the independence hypothesis is that healthy participants — as well as patients — are expected to be able to pay selective attentive to one dimension without any interference from the other. This hypothesis was proposed and partially validated by Etcoff [24] with the Garner paradigm [31,32]: a paradigm that was specifically designed to test selective attention abilities. The photographs of two persons with two different facial emotions were used in a task in which it was necessary to classify either identity or emotion. When the classification was on one dimension, the second dimension was correlated (e.g. a person always expressed one emotion and the second person always expressed the second emotion), constant (both persons expressed the same emotion in identity classification or both emotions were expressed by the same person in emotion classification) or orthogonal (both persons expressed the two emotions). Selective attention to one dimension implies that the variation of the second dimension does not interfere with correct classification. In other words, classification is not facilitated in the correlated condition and/or there is no interference in the orthogonal condition. Etcoff [24] observed that both healthy participants and left brain-damaged patients were able to classify faces according to their identity and their emotion without any influence from changes in the other dimension. She concluded that distinct and independent processes must be involved in perceiving identity and emotional expression. Contrary to this conclusion, right hemisphere damaged patients in this study were not able to selectively attend to emotion without interference from identity. Interestingly, however, recent studies [51,52] using this same paradigm with healthy participants, have failed to replicate Etcoff's findings [24]. On the contrary, they have reported that, whereas healthy participants were able to be selectively attentive to facial identity, classification of facial emotions depended on identity. Notably, they observed that healthy participants took more time to classify faces according to the emotion criterion when they had to extract the emotion from identity (i.e. to recognise the same emotion in different faces). These observations suggest that a selective attention process is required to dissociate facial emotion from facial identity.

The study of facial processing abilities in schizophrenia may shed light on the role of selective attention in the processing of the different kinds of facial information. Research studies of individuals with schizophrenia have shown that these patients display an impaired ability to recognise facial emotion [20,22,27,34,41,42,45,56]. This deficit does not appear to be associated with medication (44, 49), but poor performance does seem to be related to the chronicity of illness [43,44,49]. Some other empirical studies have found that schizophrenic patients exhibit diminished observable facial expressiveness in response to emotional stimuli [12,38,40]. An initial question that arose was whether this deficit was related specifically to recognition of facial emotions or to a more generalised deficit in the processing of facial information. Whereas previous studies indicated a differential deficit in emotion processing [47,57], subsequent investigations have shown that schizophrenic patients are impaired on numerous and varied tasks involving the analysis of faces, including familiar and unfamiliar face recognition and identity matching tasks [6,13,33,39,49]. Moreover, Salem et al. [49] observed a correlation between the deficit in a facial emotion recognition task and the Benton Facial Recognition test in schizophrenia [10,11]. More recently, studies of visual scanning behaviours showed that patients have an abnormal pattern of eye movement when undertaking both facial emotion identification [54] and face recognition tasks [59]. Thus more recent studies argue in favour of a generalised deficit of face processing in schizophrenia. Nevertheless, the study of individual cases of schizophrenia has not revealed any consistent pattern of deficit. Some patients are impaired on all facial tasks, whereas others are impaired only on some or on none of these tasks [7,25]. Moreover, a study by Archer, Hay and Young [7] using dynamic video-taped faces showed that schizophrenic patients have a deficit in the arrangement analysis of internal facial features, a deficit which would be exaggerated by an inability to process movement of these facial features. Since the arrangement of internal facial features is essential for emotion processing, patients should be impaired on tasks that require this type of processing, whether or not stimuli are static or dynamic.

Two main hypotheses could explain impaired facial processing in schizophrenia: first, schizophrenic patients would possess a dysfunctional generation of the structural descriptions which normally aid in analysing identity and emotion [6,7]; second, impaired facial processing may be explained by a non-specific attention deficit [2]. Many studies have shown schizophrenic impairment of selective attention, notably in visual tasks [1,26,48,60]. J. Addington and D. Addington [2] observed a significant association between performances on facial tasks (face recognition task, visual affect discrimination and recognition tasks) and on attention tasks (Continuous Performance Test and Span of Apprehension task) in patients with schizophrenia. Additionally, these two hypotheses are supported by studies of eye movement recordings that showed an abnormal pattern of face exploration, characterised by fewer, shorter and abnormal fixations [54,59]. Consequently, it appears that schizophrenic patients do not attend to salient features that, in turn, results in an impaired structural description of the face.

The purpose of the present study was to test the selective attention abilities involved in the accurate perception of facial identity and facial emotion of healthy participants and schizophrenic patients. Garner's paradigm was used because it allows for study of the ability to selectively attend to a single dimension using stimuli that vary along two or more dimensions. Schweinberger and collaborators [51,52], using this paradigm, have suggested that healthy participants would not be able to pay selective attention to emotion when identity was manipulated, but would be able to selectively attend to identity, regardless of what the facial emotion might be. We hypothesised that the attention deficit previously observed in patients with schizophrenia would result in greater difficulties in selectively attending to identity and emotion in patients. This observation would favour an interpretation in term of attention deficit [2] for impairment in facial information processing observed in schizophrenia. Moreover, due to the patients' failure to incorporate others' intentions [28–30], we expected worse patient performance in emotion recognition than in identity recognition, especially in patients suffering from negative symptoms [4], as exhibited by apathy, anhedonia and flat affect.

2. Method

2.1. Participants

Participants were 12 inpatients suffering from schizophrenia (three females and nine males), hospitalised in the Vinatier psychiatric hospital in Lyon (France). They were 21–60 years of age (mean = 38, SD = 12). Mean illness duration was 13.7 years (SD = 12, range, 1–35). Patients met DSM-IV [3] criteria for schizophrenia. The details of their neuropsychological assessment are listed in Table 1. The neuropsychological tests were chosen in order to assess global deterioration (Mattis), working memory and attention (Trail Making Test) and interference (Stroop). This neuropsychological assessment indicate that the attention problems of schizophrenic patients is not homogenous; whereas some patients were severely impaired in attention task (see Stroop, Trail Making Test), some other patients performed quite normally in these tests. This heterogeneity would favour the study of the impact of attention deficit in patients' performances. Patients were also screened for neurological and psychiatric conditions. Exclusion criteria included visual difficulty, history of neurological illness or trauma, alcohol or drug dependence according to DSM-IV criteria, and greater than 65 years of age. All patients were receiving antipsychotic medication (see Table 1), but not anticholinergic medication and were clinically stable at the time of testing. Healthy participants were 12 volunteers (four females and eight males) with no personal or family history of psychiatric illness. Their mean age was 39 years (S.D. = 15). They were matched with schizophrenic patients according to sex ($\chi^2 = 0.38$) and age ($T = 0.17$).

2.2. Materials

Test materials consisted of four coloured photographs of two models' faces expressing two different emotions (fear or anger). Schweinberger and collaborators [51,52] used different emotions (happiness — sadness and happiness — anger). We did not use expressions of happiness, however, because it appears to be an emotion that may be correctly recognised by schizophrenic patients that elsewhere exhibit a deficit in processing facial emotions (see Refs. [6] and [7]). The two models were male, 20 and 22-years old, clean-shaven, with no facial particularities (e.g. scars, eyeglasses) and with the same hairstyle and hair colour. The accuracy of the two emotions expressed by the models was rated by 11 judges. A minimum of 82% of agreement was required to ensure that these photographs really expressed the supposed emotion. All information about background and body were eliminated. The faces were 12 cm high and 7.5 cm in width. The photographs were presented on a computer monitor.

2.3. Procedure and design

The experiment took place over the course of two different sessions. The participants were required to classify faces according to their identity in one session and according to their emotion in the other one. Each session was divided into subsessions that correspond to three conditions: correlated, constant and orthogonal.

2.3.1. Identity classification task

Participants had to press one key when they saw the photograph of person A and another key when they saw person B's photograph. These trials took place during five subsessions: (i) *correlated A* (person A was always expressing fear and person B always had an angry expression); (ii) *correlated B* (person A was always angry and person B was always fearful); (iii) *Constant A* (person A and B were both always fearful); (iv) *Constant B* (person A and B were both always angry); and (v) *Orthogonal* (person A and B had both angry and fearful expressions). Each subsession started with a short training session using eight photographs. The same photographs were used during the training session as those used during the subsessions. Correlated and constant subsessions involved ten presentations of photographs of each model while orthogonal subsessions included 20 presentations of each person (ten fearful and ten angry).

2.3.2. Emotion classification task

Participants were required to press one key when they saw anger and another key when they saw fear. They completed five subsessions: (i) *correlated A* (anger was always expressed by person A and fear by person B); (ii) *correlated B* (fear was always expressed by person A and anger by person B); (iii) *Constant A* (fear and anger were only expressed by person A); (iv) *Constant B* (fear and anger were only expressed by person B) and (v) *Orthogonal* (anger and fear were expressed by both person A and B). Again, each subsession started with a short training session using eight photographs also employed in the later subsessions. Correlated and constant subsessions involved ten presentations of each emotion. Twenty presentations of each emotion (ten person A and ten person B) were utilised for the orthogonal subsessions.

For both tasks, participants sat in front of the computer monitor at an approximate distance of 70 cm with the index finger of each hand on a response key. They were instructed to respond as accurately and as quickly as possible. Half of the participants completed the identity classification task first followed by the emotion classification task while the other half executed these two tasks in reverse order. Similarly, the order of the subsessions and the response hands were alternated across participants.

Table 1
Neuropsychological assessments of patients with schizophrenia

Patient	1	2	3	4	5	6	7	8	9	10	11	12
Schizophrenia symptoms												
SAPS	30	17	61	10	13	23	16	23	26	25	6	30
SANS	10	50	23	58	55	75	44	17	67	58	42	76
illness duration (years)	7	11	11	6	5	14	1	23	6	24	1	11
Mattis												
Attention	37		37	37	36	37	35	37	34			35
initiation	37		25	27	30	37	37	37	31			25
construction	6	nt[a]	6	6	6	6	6	6	5	nt[a]	nt[a]	6
concepts	39		34	39	33	39	34	39	28			29
memory	24		25	25	21	25	25	25	18			18
total	143		127	134	126	144	137	144	116			113
Stroop												
words	74		83	84	73	67	66[c]	114	58[c]			53[c]
colours	69	nt	57	64	51	60	54	81	36[c]	nt[a]	nt[a]	26[c]
words-colours	20*		34	31	23[c]	23[c]	27	41	9[c]			14[c]
Trail Making Task												
A	35	nt[a]	88[c]	69[c]	52	58	65[c]	32	74	nt[a]	nt[a]	101
B	67	nt[a]	138	133	f.[b]	150	f.[b]	f.[b]	f.[b]			f.[b]
Medication												
levomepromazine	200			50	25	25				100		400
chlorpromazine										450		
olanzapine							10					10
amisulpride											200	
clozapine									600			
risperidone	4	6	3	4	2			4				6
haloperidol				4		3						

[a] nt: not tested.
[b] *f.*: failure.
[c] Scores lying below the test norm.

Table 2
Mean percentage (%) and latencies (ms) for correct responses of patients with schizophrenia and controls according to the instruction and the condition

Instruction	Expression			Identity		
Condition	Correlated	Constant	Orthogonal	Correlated	Constant	Orthogonal
Patients with Schizophrenia						
Percentage	98.54	96.88	95.63	95.83	97.29	97.5
(S.D.)	(2.25)	(4.66)	(3.71)	(6.15)	(1.67)	(4.26)
Latencies	842	852	1013	707	715	720
(S.D.)	(351)	(311)	(452)	(279)	(268)	(274)
Normal comparison subjects						
Percentage	98.13	98.33	98.75	98.54	98.13	98.33
(S.D.)	(1.55)	(2.89)	(2.92)	(1.98)	(1.88)	(1.95)
Latencies	517	544	653	504	501	532
(S.D.)	(82)	(86)	(136)	(93)	(58)	(78)

The factors were Group (patients vs healthy participants), Instruction (identity vs expression), and Condition (correlated vs constant vs orthogonal). The first is a between-subjects factor, and the second and the third are within-subjects factors. The dependent variables were accuracy and response times for correct responses. A $2 \times 2 \times 3$ (Group $\times$ Instruction $\times$ Condition) analysis of variance was employed to examine data.

3. Results

Table 2 lists the percentages and latencies for correct responses by condition. No single main effect or interaction was significant for percentage of correct responses. Both healthy participants and schizophrenic patients performed nearly perfectly, probably causing ceiling effects. For latencies, Table 2 reveals that SDs for schizophrenic patients were much larger than those of controls. Thus, we performed a log-transform of the data before undertaking the analysis of variance.

For latencies, the Group factor had a significant main effect: schizophrenic patients responded more slowly than healthy participants (808 ms vs 542 ms; $F(1, 22) = 9.55$, $P < 0.01$). The Instruction factor also had a significant main effect: participants responded more slowly when the task involved emotion rather than identity (737 ms vs 613 ms; $F(1, 22) = 50.86$, $P < 0.0001$). Moreover, the Condition factor also had a significant main effect ($F(2, 44) = 12.64$, $P < 0.0001$) with the participants responding more slowly in the orthogonal condition than in the correlated (729 ms vs 643 ms; $F(1, 22) = 15.15$, $P < 0.001$) and the constant conditions (729 ms vs 653 ms; $F(1, 22) = 14.49$, $P < 0.001$). However, the correlated and constant conditions were not significantly different from each other ($F(1, 22) = 1.70$).

The interaction between Group and Instruction was significant ($F(1, 22) = 6.82$, $P < 0.05$), indicating that the type of instruction had a highly significant effect on schizophrenic patients' latencies (714 ms for identity vs 902 for expression; $F(1, 22) = 47.46$, $P < 0.0001$) and on the latencies of healthy participants, as well (512 ms for identity vs 571 for expression; $F(1, 22) = 10.21$, $P < 0.01$). Moreover, schizophrenic patients responded more slowly than healthy participants regardless of whether the task involved emotion (902 ms vs 571 ms; $F(1, 22) = 11.59$, $P < 0.01$) or identity (714 ms vs 512 ms; $F(1, 22) = 6.88$, $P < 0.05$); Nevertheless, this deficit was more severe for tasks involving emotion than for tasks involving identity (difference between schizophrenic patients and healthy participants: 331 ms for emotion and 202 ms for identity).

The interaction between Instruction and Condition was also significant ($F(2, 44) = 6.22$, $P < 0.01$). This interaction indicated that the Condition factor had no effect when the instruction concerned identity ($F(2, 44) = 1.07$) but a significant effect when the instruction concerned emotion ($F(2, 44) = 14.89$, $P < 0.0001$). For emotional expression, participants responded more slowly in the orthogonal condition than in the correlated (833 ms vs 680 ms; $F(1, 22) = 17.60$, $P < 0.001$) and constant conditions (833 ms vs 698 ms; $F(1, 22) = 18.52$, $P < 0.001$). The correlated and constant conditions did not significantly differ ($F(1, 22) = 1.63$). None of the other interactions were significant (Group * Condition: $F(2, 44) = 0.38$; Group * Instruction * Condition: $F(2, 44) = 0.09$). Consequently, participants were able to pay selective attention to identity regardless of the emotion expressed. Nevertheless, identity interfered with the classification process when it involved emotional expression. This pattern of interference was significant for both schizophrenic patients and healthy participants without any significant difference between these two groups. In other words, schizophrenic patients in this study exhibited a selective attention ability similar to that of the healthy participants, even though, globally, they were slower.

We calculated the Spearman coefficient of correlation between the performances for emotion and identity (see Fig. 1). When all the participants were considered, there was a significant positive correlation between the percentage of correct responses for emotion and for identity ($\rho = 0.42$, $P < 0.05$). Moreover, the correlation between latencies for correct responses for emotion and identity was also significant ($\rho = 0.90$, $P < 0.0001$). Thus, the ability/deficit in classifying face according to identity and emotion are significantly and positively linked.

Another question posed was whether the deficit observed in schizophrenia is associated with the severity of certain types of symptom, e.g. negative or positive symptoms. To test this possibility, we calculated Spearman's coefficient of correlation between the performances of the schizophrenic patients in the emotion and identity classification tasks and their scores on the Scale for the Assessment of Negative Symptoms (SANS; [4]) and on the Scale for the Assessment of Positive Symptoms (SAPS; [5]). If the deficit of schizophrenic patients in facial information processing results from an attentional impairment, the interference from identity in emotion classification would be strengthened by the severity of symptoms. In order to test this hypothesis, we have calculated for each participant the size of the interference from identity in emotion classification by subtracting the mean response time in correlated and constant conditions from the mean response time in the orthogonal condition. The same procedure was used to calculate the size of emotion interference in identity classification. Then we calculated Spearman's coefficient of correlation between this interference size and scores on the SANS and the SAPS.

The performance in emotion classification exhibited by patients was significantly correlated with negative symptoms ($\rho = -0.59$, $P < 0.05$ for accuracy and $\rho = 0.60$, $P < 0.05$ for latencies) but not with positive symptoms ($\rho = 0.33$ for accuracy and $\rho = 0.39$ for latencies). For identity matching, neither the negative nor the positive symptoms correlated with a deficit. Similarly, the identity interference in emotion classification was significantly correlated with negative symptoms ($\rho = 0.63$, $P < 0.05$) but not with positive ones ($\rho = 0.45$). Thus, negative symptoms correlated with both emotion classification deficit and identity interference in emotion classification (see Fig. 2). The emotion interference in identity classification was not significantly correlated with negative or positive symptoms.

4. Discussion

As did Schweinberger and his collaborators ([51,52]), we observed that healthy participants were not able to pay selective attention to emotion without interference from identity. The present research extends this observation to patients suffering from schizophrenia. Elsewhere, both healthy and schizophrenic participants were selectively attentive to facial identity regardless of the emotional expression displayed. Moreover, the ability/deficit in classifying face according to emotion was significantly correlated with the ability/deficit in classifying face according to identity. These observations are not in favour of the independence hypothesis. In contrast, they indicate that identity and emotion processing are interrelated. The ability to respond to only one dimension without considering the other depends on high-level processing, probably related to attention, as proposed by Baudouin and collaborators [9]. This high level process may be damaged in some cases, as suggested in the case reported by Young and collaborators

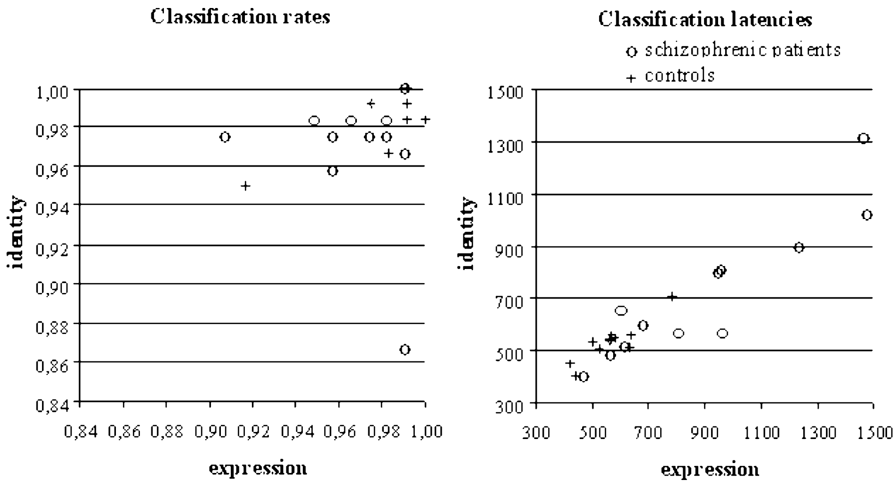

Fig. 1. Scatterplot of expression and identity correct classification rates and latencies for patients with schizophrenia and controls.

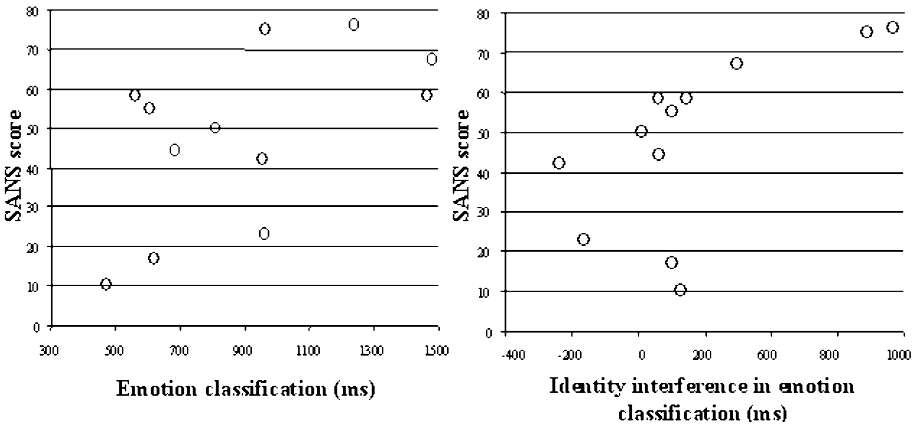

Fig. 2. Scatterplot of total scores of the SANS, latencies (ms) and interference (ms) in emotion classification for patients with schizophrenia.

[64] or the right brain damaged patients studied by Etcoff [24]. Accordingly, the present study indicated that, first, the emotion processing deficit was related to negative symptoms and, second, the inability to selectively attend to emotion was correlated with the severity of schizophrenic negative symptoms. Thus, it appears that the deficit in processing facial emotion in schizophrenia is linked to a disability in selectively attending to emotion. The fact that a greater interference from identity variation in emotion classification was not observed when schizophrenic patients were considered as a group (ANOVA) may result from the great heterogeneity of this kind of patient population, as illustrated by the large SDs listed in Table 2; whereas some patients — with a low SANS score — did not exhibit a greater identity interference, those with a high SANS score did.

Schweinberger and collaborators [51,52] suggested that identity may be selectively processed, whereas emotion processing depends on identity. Nevertheless, the fact that expression does not act on identity, but identity may interfere in the processing of emotion does not demonstrate that there is a unidirectional interrelation. In other words, the absence of an identity effect on emotion classification using the Garner paradigm does not prove that emotion never interferes in identity processing. First, the absence of interference from emotion on identity in the Garner paradigm may simply reflect an asymmetrical interrelation: the influence of emotion on identity processing could be different than the influence of identity on emotion processing. This paradigm may be useful for revealing one type of influence (i.e. identity on emotion), but not another type (i.e. emotion on identity). Second, there are other sources of data that showed an effect of emotion on identity processing. Notably, the activity of the 'face' fusiform gyrus involved in the processing of facial information is more important for emotional faces [21]; the inability to process facial emotion can cause deficits in identity tasks that use expressive faces [64]; and expressive faces increase the feeling of familiarity [8]. Therefore, we have sufficient reasons to believe that the interference of identity in emotion processing is bi-directional; i.e. emotions may interfere in identity processing. Nevertheless, this last influence may differ from the first one in its course and its effects.

In conclusion, the present study strongly supports the hypothesis that emotion and identity are not independently and modularly processed as soon as they are perceived; i.e. some interference may occur. The ability to selectively respond to one dimension probably depends on a high-level processing ability that may be affected by diffuse or local brain damage. Notably, some schizophrenic patients — mainly those who have prominent negative symptoms — may have difficulties processing each dimension without interference from the other dimension. A more precise understanding of the nature of the interrelations between identity and emotion processing, and consequently the understanding of the precise nature of the emotion deficit in schizophrenia, will need further research.

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