

Emotion recognition in patients with schizophrenia: The role of sex

Mar Fernández-Modamio¹, David Gil-Sanz², Marta Arrieta-Rodríguez², Juan Gómez de Tojeiro-Roce²,
Rosario Bengochea-Seco², and Eduardo González-Fraile³

¹ Instituto de Investigación Sanitaria IDIVAL, ² Centro Hospitalario Padre Menni, and ³ Universidad Internacional de La Rioja

Abstract

Background: Despite the abundant research on emotion recognition in schizophrenia, there are still some issues about which there is no conclusive data. The present study examined one these issues: the role that sex plays in emotion recognition. **Method:** The sample consisted of 440 participants, 220 patients with schizophrenia and 220 controls. Measures of the six basic emotions, psychopathology, and cognitive functioning were taken. The data were analyzed by repeated measures analysis of variance. **Results:** Controls perceived all emotions, except happiness, better than patients. In the patient group three main results were obtained: 1) men recognized disgust and neutral expressions better than women; 2) happiness and sadness were better recognized on female faces, while disgust and neutral expressions were better recognized on male faces; and 3) a significant interaction was seen between the stimulus sex and the participant sex only for the fear emotion. **Conclusions:** The results obtained support the hypothesis that deficits in the recognition of emotions is a core feature of schizophrenia that affects both men and women to the same extent. There is no clear pattern of interaction between the sex of the perceiver and the sex of the photograph used as a stimulus.

Keywords: Schizophrenia, psychosis, emotion processing, sex.

Resumen

Reconocimiento de emociones en pacientes con esquizofrenia: el papel del sexo. Antecedentes: a pesar de haber abundante investigación sobre el reconocimiento de emociones en esquizofrenia, hay algunas cuestiones sobre las que no hay datos concluyentes. El presente estudio valoró una de esas cuestiones: el papel del género en el reconocimiento de emociones. **Método:** la muestra estuvo compuesta por 440 sujetos, 220 pacientes con esquizofrenia y 220 controles. Se tomaron medidas de las seis emociones básicas, psicopatología y funcionamiento cognitivo. Los datos se analizaron mediante un ANOVA de medidas repetidas. **Resultados:** los controles percibieron todas las emociones mejor que los pacientes, excepto la alegría. En los pacientes destacaron tres resultados: 1) los hombres reconocieron mejor el asco y la expresión neutra; 2) las emociones de alegría y tristeza se reconocieron mejor en caras femeninas, y el asco en masculinas; 3) se observó un efecto de interacción entre el género de la fotografía y del participante solo para la emoción de miedo. **Conclusiones:** los resultados apoyan que el déficit en el reconocimiento de emociones es un rasgo característico de la esquizofrenia, que afecta tanto a hombres como a mujeres. No se observa un patrón claro de interacciones entre el género del participante y el género de la imagen usada como estímulo.

Palabras clave: esquizofrenia, psicosis, procesamiento de emociones, género.

Impairment in emotional processing appears to be a core feature in schizophrenia, which involves difficulties in recognizing and identifying negative emotions (both in facial expressions and in prosody), integrating emotional information from different channels (facial expression, voice, and body language), and managing one's own and others' emotions (Savla, Vella, Armstrong, Penn, & Twamley, 2013). This deficit may increase the vulnerability to developing schizophrenia (Phillips & Seidman, 2008), and it has been observed in high-risk subjects, in patients with a first episode, and in non-affected first-degree relatives (Aminger et al., 2012; Mote & Kring, 2016). In addition, it has been related to the social and occupational functioning of patients, the ability to live independently, and to greater severity of negative

symptoms (Chan, Li, Cheung, & Gong, 2010; Kohler et al., 2003; Leszczynska, 2015). Despite the abundant research on the subject, there are several questions that remain without a definitive answer. One is the role of sex in the differences in the recognition of emotions, and another relates to whether emotions are better recognized on female faces, and whether there is an interaction between the subject's sex and the sex of the photographs used in the emotion recognition. In other words, whether emotions are better recognized on faces of the same sex or in those of the opposite sex. Regarding the first question, in the studies carried out with non-clinical population, there is some consensus about the superiority of women in the facial recognition of emotions, especially those of a negative type (Erol, Putgul, Kosger, & Ersoy, 2013; Merten, 2005; Scholten, Aleman, Montagne, & Khan, 2005; Vaskinn et al., 2007; Williams et al., 2009). A recent study has found that this advantage is constant for females across the lifespan, although it decreases in magnitude as age increases (Olderbak, Wilhelm, Hildebrandt, & Quidbach, 2018). However, some authors find that this superiority occurs only for the identification of positive emotions and neutral expressions, while no differences are

obtained for the recognition of negative emotions such as anger or disgust (Lambrecht, Kreifelts, & Wildgruber, 2014). Contrary to these data, another set of studies finds no differences according to sex (Calvo & Lundqvist, 2008; Kohler et al., 2003; Palermo & Coltheart, 2004), and even that men recognize specific emotions such as anger better than women (Schneider et al., 2006).

In the clinical population, Mote and Kring (2016) performed a systematic review on the perception of facial emotions in schizophrenia. They reviewed a total of 134 articles, of which only 38 examined the differences in the perception of emotions according to sex in three different groups: patients with chronic schizophrenia (with a duration of greater than 2 years), patients with recent-onset schizophrenia and first-degree relatives that were not affected. Of the 38 articles, 30 did not find statistically significant differences in the recognition of emotions related to sex in any of the three groups. Taken together, these results suggest that both men and women, in the case of both patients with schizophrenia and unaffected family members, recognize facial emotions equally, and in all cases worse than healthy control subjects. Of the eight remaining studies, six found that women perform better than men on facial recognition tests, and only in two studies did men achieve better results. Other studies not included in the review have concluded that women are better than men at recognizing emotions. Vaskinn et al. (2007, 2016) observed that women were better at recognizing negative emotions, expressed both facially and vocally, but not through body language. This advantage in the recognition of negative emotions has been proposed as one of the causes for women with schizophrenia having better social adjustment than men with the same diagnosis (Scholten et al., 2005). Some studies have found that women with schizophrenia recognize emotions with the same accuracy as control subjects, both men and women, so they conclude that the idea that there is a deficit in emotion recognition in schizophrenia could be wrong and that it would be more correct to speak of a specific deficit that only affects men with schizophrenia (Erol et al., 2013; Scholten et al., 2005). If these data were confirmed, it would be important to take them into account for the development of emotion recognition training programs. The literature indicates that these types of programs are effective in improving facial recognition of emotions, and that this improvement translates into an improvement in social functioning (Javed & Charles, 2018). However, if the deficit in the recognition of emotions affects only men, women with schizophrenia would not need this type of training. Consistent with this idea, Mote and Kring (2016) note that in schizophrenia studies women are often underrepresented compared to men, in some cases only constituting 5% of the total sample. Longenecker et al. (2010) have found that the samples are usually composed of men in a ratio of 2 to 1, which would indicate that the knowledge we have about schizophrenia comes from studies conducted mainly (or exclusively in some cases) on men. Consequently, Mote and Kring (2016) recommend that the numbers of men and women included in future research be balanced.

Regarding the second issue, there is no clear agreement on whether emotions are better recognized on male or female faces, and different results are found depending on the emotion evaluated. For example, some authors consider that both men and women are better at perceiving negative emotions, such as anger, sadness or disgust, in female faces (Kohler et al., 2003; Palermo & Coltheart, 2004). However, it has also been observed that anger is better recognized on male faces (Calvo & Lundqvist,

2008), as well as fear and neutral expression (Kohler et al., 2003). These studies conclude that there is no interaction between the sex of the perceiver and the sex of the photograph used in the perception task (Lambrecht et al., 2014; Pinkham et al., 2008). On the contrary, Kohler et al. (2003) found that the emotion of disgust is better identified in faces of the same sex, whereas the emotion of happiness is better identified in faces of the opposite sex. The same results were obtained for control subjects and for patients with schizophrenia. That is, patients also better recognized the emotions of happiness, sadness, and anger in female faces, and the emotion of fear and neutral expression in male faces. Furthermore, both men and women better-identified disgust in faces of the same sex and happiness in faces of the opposite sex. Pinkham et al. (2008) could not replicate these results, finding any interaction between the sex of the stimulus photograph and the sex of the perceivers.

From the literature review, there is no unequivocal answer regarding the recognition of emotions in patients with schizophrenia, or the role played by sex in recognition. To try to shed light on this important issue, four specific aims are set in the present investigation: a) to determine whether there are differences in the recognition of emotions between patients with schizophrenia and the general population, b) to analyze the differences between men and women in the recognition of emotions, c) to establish whether emotions are better recognized when the faces of women or men are used as a stimulus, and d) to determine whether emotions are better recognized when the stimulus faces are of the same or different sex than the perceiver, i.e., to see if there is an interaction between the sex of the perceiver and the sex of the stimulus face. As has been shown in the previous literature review, these four issues do not currently have a unanimous response, so we believe that the present work can provide relevant data in this field of research, with implications that are both basic and applied, clinical and professional. For the study of these objectives, we used a sample of control subjects and patients with schizophrenia in which both sex were represented in the same proportion. In the sample of patients with schizophrenia, the aim of analyzing the relationships between emotion recognition and symptoms and cognitive variables is also raised.

Method

Participants

The sample consisted of 440 participants, 220 patients with schizophrenia and 220 controls. Each group was composed of the same number of men and women. In the case of the patients, the diagnosis was made by their referral psychiatrist within the Spanish National Mental Health System and was confirmed using the Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1996). The majority of the subjects had primary school studies (48.8%) and a mean age of 46.17 years. Regarding the clinical characteristics, they were chronic patients with a mean of 23.61 years of illness duration and a low level of symptomatology, both positive and negative. The subjects were recruited from 25 different centers. As for the control subjects, the majority had university studies (69.98%) and an average age of 39.80 years. The controls were selected from the sample of a previous study (Gil-Sanz et al., 2017). The characteristics of both groups are specified in Table 1.

Table 1

Characteristics of the healthy control subjects and patients with schizophrenia

	Healthy controls		
	Men	Women	
Educational level			
Primary School	3 (2.72%)	1 (0.90%)	$\chi^2 = 6.18$
High-School	32 (29.10%)	28 (25.46%)	
University	75 (68.18%)	81 (40.53%)	
Age	39.07 ± 12.12	40.53 ± 10.20	$t = -0.96$
	Patients with schizophrenia		
Educational level			
No studies	8 (7.27%)	15 (13.64%)	$\chi^2 = 6.06$
Primary School	59 (53.64%)	49 (44.54%)	
High-School	37 (33.64%)	33 (30%)	
University	6 (5.45%)	13 (11.82%)	
Age	45.84 ± 9.58	46.50 ± 11.40	$t = -0.46$
Age at onset	22.69 ± 6.83	22.87 ± 6.82	$t = -0.19$
Illness duration	23.15 ± 11.44	24.07 ± 10.87	$t = -0.59$
BPRS: Positive	8 ± 3.41	8.45 ± 3.47	$t = -0.97$
BPRS: Negative	8.91 ± 4.49	8.13 ± 4.26	$t = 1.31$
BPRS: Total	37.18 ± 10.61	36.31 ± 10.60	$t = 0.61$
SCIP			
Immediate verbal learning	27.82 ± 25.78	32.86 ± 30.85	$t = -1.24$
Working memory	46.46 ± 31.17	32.28 ± 29.31	$t = 3.31^*$
Verbal fluency	41.99 ± 26.55	45.79 ± 29.26	$t = -0.95$
Delayed verbal memory	34.23 ± 29.45	39.62 ± 31.67	$t = -1.24$
Processing speed	33.14 ± 23.77	30.98 ± 22.38	$t = 0.65$
Total score	31.85 ± 23.96	31.29 ± 27.67	$t = 0.15$
* $p < .05$			
BPRS: Brief Psychiatric Rating Scale			
SCIP: Screen for Cognitive Impairment in Psychiatry			

Ethical aspects

The study was approved by the Clinical Research Ethics Committee of Cantabria (code 2015.044). The 440 participants received an information sheet with the objectives of the study and signed an informed consent document, in which they gave their authorization to participate in the study freely and for their data to be used for research purposes. None of the subjects—neither the patients nor the controls—received any type of financial remuneration or any other type of compensation for participating in the study.

Instruments

Emotion recognition. All participants were given the Prueba de Evaluación del Reconocimiento de Emociones [Emotion Recognition Assessment Test] (PERE, Gil-Sanz et al., 2017). This is a test composed of 56 color photographs that assess the six basic emotions: happiness, sadness, anger, surprise, fear, and disgust. There are eight photographs for each emotion and eight with a neutral expression: four for men and four for women. The PERE has shown adequate data of accuracy (above 0.89) and test-retest reliability (between 0.80 and 1), both in control subjects and in patients with schizophrenia. Subjects can look at each photograph for as long as they need, and a forced multiple-choice response system is used. The test offers an individual score for each emotion, ranging from 0 to 8. For the present study, the male and female faces for each emotion were analyzed independently, so the score range was from 0 to 4.

Psychopathology. The Brief Psychiatric Rating Scale (BPRS; Overall & Gorham, 1988) was used to assess psychopathology. This is a test composed of 18 items, which assesses the presence of positive, negative and general symptomatology. It is based on the clinician's interview with the patient and observations of the patient's behavior over the previous 2-3 days. All symptoms are assessed on a Likert scale, ranging from 1 (not present) to 7 (extremely severe). The BPRS has shown good inter-observer reliability and internal consistency (Nicholson, Chapman, & Neufeld, 1995), as well as validity data (Bell, Milstein, & Beam-Goulet, 1992).

Cognitive functioning. Cognitive functioning was assessed using the Screening of Cognitive Impairment in Psychiatry (SCIP-S; Purdon, 2005). The SCIP was designed to provide a rapid assessment of cognitive deficits presented by people with mental illness, especially those who suffer from psychotic or affective disorders. It includes five tests that evaluate verbal learning, working memory, verbal fluency, and processing speed. Its administration time is approximately 10-15 minutes and it has three parallel forms to avoid the learning effect. Furthermore, it has age and education corrected norms. The Spanish version (Pino et al., 2006) has shown good test-retest reliability and validity (Pino et al., 2008).

Procedure

The data for the present study were obtained from two different investigations. As previously mentioned, data on control subjects were selected from the study conducted for the validation of PERE (Gil-Sanz et al., 2017). On the other hand, the sample of patients with schizophrenia belongs to a wider research in which the effectiveness of a social cognition training program has been assessed, the results of which are being published. In this research, the emotion recognition was one of the target variables. The results of the PERE of the pre-treatment assessment were used for the present study. In both cases, controls and patients, the photographs that make up the PERE were shown by computer and the same application conditions were followed in terms of time to see each image and the response system used.

Data analysis

First, we analyzed whether there were differences between the group of patients and the group of control subjects in the variables age and educational level, using the t-test for difference of means for independent samples and the chi-square respectively. The t-test for independent samples was also used in the patient group to analyze the differences between men and women in symptomatology and cognitive functioning. To assess whether there were differences in emotion recognition between the group of healthy controls and the patient group, between men and women in each group, and according to participant sex and stimulus sex, a repeated-measures ANOVA was used (Vallejo, Fernández-García, Livacic, & Tuero, 2018), with two within-subject factors: stimulus sex (male or female) and emotion (happiness, sadness, anger, surprise, disgust, fear and neutral), and two between-subject factors: group (control or patient) and participant sex. Individual differences were analyzed by Bonferroni adjustment for multiple comparisons. In addition, we analyzed relationships between emotion recognition and symptoms and cognitive variables in the patient group by the Pearson correlation coefficient. Statistical analyses were carried out with SPSS 22.0.

Results

Between and within-group differences

There were significant differences between healthy controls and patients both in age ($t(434) = -6.12, p < .001$) and educational level ($\chi^2(3) = 185.88, p < .001$). Therefore, we decided to include these variables as covariates in the ANOVA. In the healthy control group, there were no significant differences between men and women in either age or educational level. In the patient group, there were no significant differences according to sex in either the demographic or clinical variables, except in working memory on the SCIP test. Results are shown in Table 1.

Results by aims

The first aim of the work was to determine whether there were differences in emotion recognition between patients with schizophrenia and the general population. There was a significant main effect for group, demonstrating that control subjects had better emotion recognition than patients with schizophrenia (mean = 3.79 and mean = 3.04, respectively; $F(1) = 228.44, p < .001$; partial-eta-square [η^2] = 0.35). The Bonferroni adjustment for multiple comparisons showed that control subjects recognized all emotions better than patients, except for happiness, both in male and female faces ($p < .001$ in all emotions, see Table 2). The differences in favor of the control subjects were maintained when the results were analyzed by sex.

The second aim involved the study of differences in emotion recognition in men and women. In the control group, there were no differences between men and women in the recognition of any of the assessed emotions ($F(1) = 0.16, p = .682$). In the case of the patient group, men recognized disgust and neutral expression better than did women. There were no significant differences in any other emotion (Table 3).

The third aim was to determine whether emotions are best recognized on male faces or on female faces. In the control group, there was no significant interaction between emotion and stimulus sex. All emotions were recognized with the same accuracy both on male faces and on female faces. In the patient group, conversely,

happiness and sadness were better recognized on female faces, while disgust and neutral expression were better recognized on male faces (Table 4).

Finally, the fourth aim was to establish whether emotions are best recognized on faces of the same sex or the opposite sex. In the control group, the interaction between stimulus sex and participant sex was not significant either. In the patient group, only one significant interaction was obtained between stimulus sex and participant sex in the emotion of fear. Women recognized this emotion better on male faces, and men on female faces. The results showed that there was no significant interaction between the emotion and the variables age ($F(6) = 1.72, p = .111$) or educational level ($F(6) = 1.35, p = .229$).

Relationships between emotion recognition and symptoms and cognitive variables

No significant relationships were obtained between any emotion and symptomatology. Regarding the cognitive variables, processing speed, working memory, and delayed verbal learning were the most related to emotion recognition. The total score of the SCIP was related to all emotions, except for happiness (Table 5).

Discussion

The present work attempts to shed light on different issues in the field of emotion recognition in patients with schizophrenia and the general population. Specifically, four aims were proposed: a) to determine whether there are differences in the recognition of emotions between patients with schizophrenia and the general population, b) to analyze the differences between men and women

Table 2

Differences in emotion recognition between controls and patients

	Controls (M ± SD)	Patients (M ± SD)	F	η^2
Happiness-M	3.89 ± 0.31	3.83 ± 0.39	0.39	
Happiness-W	3.93 ± 0.30	3.91 ± 0.32	0.35	
Sadness-M	3.83 ± 0.40	2.41 ± 1.01	57.53***	0.29
Sadness-W	3.78 ± 0.49	2.68 ± 1.17	21.70***	0.13
Anger-M	3.92 ± 0.26	3.11 ± 1.01	18.49***	0.11
Anger-W	3.91 ± 0.31	3.08 ± 0.90	20.63***	0.12
Surprise-M	3.92 ± 0.27	3.30 ± 0.08	12.19***	0.07
Surprise-W	3.86 ± 0.38	3.18 ± 1.06	10.91***	0.07
Disgust-M	3.93 ± 0.28	3.13 ± 1.02	12.53***	0.08
Disgust-W	3.94 ± 0.24	3 ± 1.18	18.99***	0.12
Fear-M	3.72 ± 0.57	1.83 ± 1.14	76.02***	0.35
Fear-W	3.73 ± 0.56	1.81 ± 1.24	63.27***	0.31
Neutral-M	3.89 ± 0.38	3.25 ± 1.14	8.23***	0.05
Neutral-W	3.83 ± 0.48	2.95 ± 1.22	14.69***	0.09

*** $p < .001$

Table 3

Differences in emotion recognition in patient group

	Men (M ± SD)	Women (M ± SD)	F	η^2
Happiness	3.89 ± 0.03	3.91 ± 0.03	0.31	
Sadness	2.66 ± 0.07	2.59 ± 0.07	0.56	
Anger	3.10 ± 0.06	3.20 ± 0.06	1.34	
Surprise	3.28 ± 0.06	3.29 ± 0.06	0.01	
Disgust	3.34 ± 0.07	3.02 ± 0.07	10.86**	0.02
Fear	1.93 ± 0.08	1.90 ± 0.08	0.06	
Neutral	3.37 ± 0.08	3.01 ± 0.08	10.95**	0.02

** $p < .01$

Table 4

Differences in emotion recognition in the patient group according to stimulus sex

	Male faces (M ± SD)	Female faces (M ± SD)	F	η^2
Happiness	3.86 ± 0.03	3.94 ± 0.03	6.69*	0.01
Sadness	2.48 ± 0.06	2.77 ± 0.07	16.70***	0.04
Anger	3.17 ± 0.06	3.13 ± 0.06	0.49	
Surprise	3.35 ± 0.05	3.22 ± 0.06	3.81	
Disgust	3.27 ± 0.06	3.09 ± 0.06	7.46**	0.02
Fear	1.90 ± 0.07	1.93 ± 0.08	0.18	
Neutral	3.35 ± 0.07	3.03 ± 0.07	23.35***	0.05

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 5
Relationships between emotions and cognitive variables

SCIP	Happiness	Sadness	Anger	Surprise	Disgust	Fear	Neutral
IVL	0.09	0.14*	0.11	0.08	0.11	0.17**	0.10
WM	0.12	0.09	0.10	0.09	0.17**	0.12*	0.15*
VF	0.11	0.17**	-0.02	0.04	0.11	0.03	0.13*
DVL	0.07	0.07	0.11	0.17**	0.10	0.16*	0.14*
PS	0.07	0.15*	0.14*	0.19**	0.25***	0.02	0.11
Total score	0.11	0.20**	0.14*	0.14*	0.20***	0.18**	0.18***

IVL: Immediate verbal learning; WM: Working memory; VF: Verbal fluency; DVL: Delayed verbal learning;
PS: Processing speed
* $p < .05$, ** $p < .01$, *** $p < .001$

in the recognition of emotions, c) to establish whether emotions are better recognized when faces of women or men are used as stimuli, and d) to determine whether there is an interaction between the sex of the perceiver and the sex of the stimulus faces used.

In relation to the first aim, numerous studies have shown that patients with schizophrenia recognize emotions worse than do control subjects, especially negative emotions, so the deficit in emotion recognition is considered a characteristic feature of schizophrenia. However, some authors qualify this data and believe that it is a deficit that affects only male patients. They base this conclusion on the fact that in their studies women with schizophrenia show performance similar to that of control subjects (Erol et al., 2013; Scholten et al., 2015). They also argue that in the research on schizophrenia there is usually an overrepresentation of the male sex, so it could be that what we know about the disease can be applied especially to men with schizophrenia and we lack data on women who suffer from this disorder (Longenecker et al., 2010; Mote & Kring, 2016). For this reason, in the present study, we decided to include the same number of men and women, both in the sample of control subjects and in the sample of patients with schizophrenia. Furthermore, we controlled that in the patient group there were no significant differences between sex in demographic or clinical variables that could explain the possible differences in their ability to recognize emotions.

The results obtained did not confirm the idea that only men with schizophrenia show a deterioration in their ability to recognize emotions since women with schizophrenia also obtained a worse performance than the control men and women. These data, therefore, support that the deficit in the recognition of emotions is a characteristic feature of schizophrenia that affects both sex to the same extent (Mote & Kring, 2016).

Furthermore, our results confirm that there is a specific deficit for the recognition of emotions of a negative type since the patients recognized happiness with the same accuracy as the control subjects. Previous studies have found that identification of several negative emotions, such as sadness or anger, were not impaired in schizophrenia (Kohler et al., 2003); however, the data obtained in the present study show a clear difference between control subjects and patients in all negative emotions, as well as in neutral expression.

The second aim was to verify the differences between men and women in emotions recognition. The studies with non-clinical population seem to indicate that women are better at recognizing emotions than men, especially negative emotions (Erol et al., 2013; Olderbak, 2018; Merten, 2005; Scholten et al., 2005; Vaskinn et

al., 2007; Williams et al., 2009). However, there is no general agreement on this issue, and some authors even suggest that it is men who better identify specific emotions such as anger (Schneider et al., 2006). Contrary to these approaches, our results confirm that both sex recognize with the same degree of accuracy all emotions, both positive and negative (Calvo & Lundqvist, 2008; Kohler et al., 2003; Palermo & Coltheart, 2004). As we have seen, the deficit in the emotions recognition affects men and women with schizophrenia equally and, as in the case of the control subjects, there were no significant differences observed between them. Both men and women obtained similar scores in the recognition of all emotions, except for disgust and neutral expression. Taken together, these results are in line with those obtained by Mote and Kring (2016), who also concludes that there are no relevant differences according to sex.

The third aim was to clarify whether emotions are better identified in faces of the same or the opposite sex. Studies that have analyzed these issues in the control population have not obtained conclusive results, although there seems to be some evidence that negative emotions are better perceived in female faces (Calvo & Lundqvist, 2008; Kohler et al., 2003; Palermo & Coltheart, 2004). However, in the present study, the control subjects recognized all emotions with the same precision in both male and female faces, so our results do not confirm that negative emotions are better identified in female faces. The absence of differences (and in relation to the fourth aim) also implies that there is no interaction effect between the subject's sex and the sex of the photograph (Lambrecht et al., 2014; Pinkham et al., 2008). Analyzing the data for the whole sample, patients with schizophrenia perceived happiness and sadness better in female faces and disgust and neutral expression in male faces (Table 3). These results were found for both men and women, so in this case, there was no interaction effect between the subject's sex and the sex of the photograph. Therefore, our data do not confirm the findings of other authors (Kohler et al., 2003), who conclude that the emotion of happiness is better perceived in faces of the opposite sex and the emotion of disgust in faces of the same sex. In our study, it was the emotion of fear that was best recognized in faces of the opposite sex. Compared to the other emotions, fear was the emotion that was recognized the worst (Table 2). If we also consider that it is better recognized in faces of the opposite sex, we can conclude that patients with schizophrenia present a severe deterioration in their ability to identify fear in their own sex.

Contrary to previous studies (Chan, Li, Cheung, & Gong, 2010; Kohler et al., 2003; Leszczynska, 2015), we have not found any relationships between emotion recognition and positive or negative

symptomatology. Regarding relationships between emotion recognition and cognitive variables, previous studies have found correlations between measures of attention, verbal fluency, verbal learning, and processing speed and tests of emotion recognition (Deckler, Hodgins, Pinkham, Penn, & Harvey, 2018; Yong et al., 2014). Our data are in agreement with these studies and could suggest that the emotion recognition deficit in schizophrenia depends on the deficit in basic neurocognition processes (Fanning, Bell, & Fiszdon, 2012).

Taken together, the results obtained can provide useful information for the design of emotion recognition training programs in patients with schizophrenia: 1) it seems that both men and women can benefit from these programs, since a deficit is observed in both sex; 2) it does not seem necessary to train the recognition of happiness; 3) the recognition of the emotion of sadness in male faces, of the emotion of disgust in male faces and of fear in faces of the opposite sex should be emphasized.

To summarize, the data obtained in this study allow us to conclude that a) patients with schizophrenia have a specific deficit in the recognition of negative emotions, b) no significant differences are observed according to sex, either in the control group or in patients with schizophrenia, c) in the control group, emotions are recognized equally in both male and female faces, and d) in patients, there is no clear pattern of interaction between the sex of the perceiver and the sex of the photograph used as a stimulus.

These results should be interpreted considering several limitations. Firstly, the group of patients with schizophrenia was composed mostly of long-term patients in the stable phase; therefore, it would be necessary to validate the results obtained in patients with other characteristics, such as high-risk patients, patients with a first episode or in acute phases of the disease. Regarding the control group, it must be borne in mind that the PERE test is designed for use in the clinical population and all the photographs included have a degree of accuracy greater than

89%. Therefore, a ceiling effect may occur with the control group, which could explain to a certain degree the lack of sex differences. Another limitation that may affect the recognition of emotions in the control group is that there are no data on the presence of subclinical psychopathology of the subjects that integrated this sample.

Likewise, in future research a regression analysis could be carried out in order to assess the influence of sociodemographic, clinical and neurocognitive variables on the ability to recognize emotions in patients with schizophrenia.

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