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Evaluation of facial expressions in women with major depression: is there a negative bias?

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Abstract

Major depression is a disorder with a high prevalence in women and is associated with biological, affective, and cognitive changes. In the present study we evaluated the pattern of recognition and emotional attribution in women with major depressive disorder and healthy volunteers. Facial expressions of four basic emotions (happiness, fear, sadness, and anger) that were presented at four intensities (25, 50, 75, and 100%) and neutral faces were used as stimuli. Compared with healthy volunteers, women who were diagnosed with depression showed a negative bias in emotional processing. The clinical group showed greater recognition of sadness with the lowest emotional intensity (25%) compared with the control group ($p = .013$). With regard to emotional attribution, the analysis revealed a statistically significant difference between groups ($\chi^2 = 10.30$) in which women with major depression tended to assign the emotion of sadness to neutral faces more often ($p < 0.01$). The results indicate that depressive symptoms are associated with cognitive and emotional bias, which may affect interpersonal functioning in women with major depressive disorder. **Keywords:** facial expression, depression, emotion, face, bias.

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Introduction

Major depression is characterized by feelings of sadness, anhedonia, and isolation. It is more prevalent and recurrent in women and considered a disease that causes substantial disability in women (Kessler, 2003). When depressive symptoms are pronounced, women may experience biological, cognitive, and affective changes that ultimately affect social skills and bias the processing of negative emotional stimuli (Lunsky, Bradley, Gracey, Durbin, & Koegl, 2009; Essau, Lewinsohn, Seeley, & Sasagawa, 2010; Chester, Chaplin, Tsakanikos, McCarthy, Bouras, & Craig, 2013). Women are generally more reactive to emotional

stimuli and more accurate in recognizing emotions than men (Montagne, Kessels, Frigerio, de Haan, & Perrett, 2005; Whittle, Yücel, Yap, & Allen, 2011).

The study of the perception of facial expressions may provide important information about the social and emotional aspects of depression and contribute to a better understanding of brain function (Bourke, Douglas, & Porter, 2010). Inaccurate assessments of emotional signs can lead to the misjudgment of social cues, making the process of social interaction difficult (Trautmann, Fehr, & Herrmann, 2009). Research can focus on the accuracy of emotional recognition or investigate attentional bias toward emotional content. Although these processes may be related, they have important differences (i.e., attentional and emotional recognition) with different experimental tasks that are used for their assessment.

In emotional recognition studies, abnormalities have been found in the identification of facial expressions in patients with major depression (Joormann & Gotlib, 2006; Milders, Bell, Platt, Serrano, & Runcie, 2010). The clinical condition of major depression may be responsible for a generalized deficit in the recognition of facial expressions (Mandal & Bhattacharya, 1985; Hale, 1998). Some studies, however, have shown that deficits in emotional recognition do not occur for all emotions, rather only

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for specific ones. For example, Lemoult, Joormann, Sherdell, Wright, and Gotlib (2009) investigated the identification of facial expressions in healthy volunteers and non-depressed participants who had a history of recurrent major depression (RMD) by using a negative mood induction task. They found that individuals with a history of depression and controls had similar performance in the recognition of sad and angry faces. However, in the recognition task, the RMD group required a greater emotional intensity to correctly identify happy expressions. Similar results were found by Joormann and Gotlib (2006) who found that depressed participants required less emotional intensity to identify sad and angry expressions compared with controls and individuals with social phobia but required a greater intensity to recognize happy expressions. Other studies indicated an opposite pattern of results. For example, Mandal and Bhattacharya (1985) found that depressed patients committed more errors than controls when identifying sad faces.

Attentional studies have demonstrated a bias toward attending to specific emotional content in depression. Joormann and Gotlib (2007) used a dot-probe task and found that current and formerly depressed patients selectively attended to sad faces, whereas controls avoided sad faces and oriented attention toward happy faces. Suslow, Junghanns, and Arolt (2001) applied a face-in-the-crowd task to stabilized-depressed patients and normal subjects using schematic faces. They found no difference between groups in the detection of negative faces, but individuals with depression were significantly slower in responding to positive faces compared with controls, suggesting an association between depressive symptoms and reduced attention to positive expressions.

Compared with healthy individuals, people with major depression generally present an attentional bias toward negative stimuli, which may play a significant role in the development and maintenance of depression (Joormann & Gotlib, 2006; Milders *et al.*, 2010). When clinically affected by depression, individuals remember negative content more than positive content (Mathews & MacLeod, 2005), which resembles the negative bias of the memory of emotional material (Milders *et al.*, 2010). They also exhibit increased attention to and vigilance for negative facial expressions (Liu, Huang, Wang, Gong, & Chan, 2012). Thus, they have a tendency to form cognitive schemas that make them more vulnerable to depression (Scher *et al.*, 2005) in which they get used to a ruminant cognitive style whereby both they and their environment are processed in a negative way (Beck, 1967).

According to cognitive theories, neutral or ambiguous stimuli may play a causal role in the maintenance of depression and therefore are more affected by the clinical condition (Bourke *et al.*, 2010). In these cases, stimuli can be interpreted as sad (Surguladze *et al.*, 2005; Yoon, Joormann, & Gotlib,

2009). Among studies on the attribution of emotions, Leppänen, Milders, Bell, Terriere, and Hietanen (2004) assessed the response to facial expressions in patients with major depression. They found that depressed patients recognized neutral faces less accurately than happy and sad faces, whereas controls showed no differences in the recognition of happy, sad, and neutral faces. Moreover, patients with depression were particularly slow to identify neutral faces compared with controls. Leppänen *et al.* (2004) also found that patients in remission had more false sad responses to neutral faces and also more false happy responses compared with controls. According to these authors, the results indicated that depression-prone individuals are more likely to perceive neutral faces as ambiguous emotional signals.

Although studies have indicated a negative response bias toward sadness in depression (for review, see Bourke *et al.*, 2010), the influence of the sex of the participant is not commonly taken into account. In other disorders such as social phobia the attribution of emotions to neutral faces varies with sex (Alves, Rodrigues, Souza, & Sousa, 2012). Women generally tend to attribute sadness to neutral faces, whereas men tend to attribute anger to the same stimuli. Different biases in women and men may be associated with the psychopathological background of the disorder in each sex.

Interestingly, women are prevalent among patients with major depressive disorder (Lunsky, Bradley, Gracey, Durbin, & Koegl, 2009). Gender differences may occur because women are more likely to report physical and psychological complaints, and they experience more stressful events than men (Piccinelli & Wilkinson, 2000). Women are also clinically affected by hormonal factors in the maintenance of emotional homeostasis. Depressive symptoms are more evident after puberty and increase during hormonal fluctuations (Thase, Entsuah, Cantillon, & Kornstein, 2005). Moreover, evidence indicates that men and women differ with regard to the processing of emotional information (Gohier *et al.*, 2013; Torro-Alves, Bezerra, Claudino, & Pereira, 2013).

In the present study we investigated the recognition of facial expressions of happiness, fear, anger, and sadness and the emotional attribution to neutral faces in a sample of women with major depressive disorder and control volunteers. Our hypothesis was that women with depression would present a bias toward recognizing sadness and attribute this emotion more frequently to neutral faces.

Material and methods

Participants

The study involved the participation of 20 women who were divided into two groups: (1) 10 women diagnosed with major depression (clinical group; mean age, 25.1 years; SD = 5.9 years) and (2) 10 volunteers

in the control group (mean age, 24.3 years; SD = 3.2) who did not have neuropsychiatric disorders and were not taking medication or psychotropic substances. The participants in the clinical group were diagnosed with Major Depressive Disorder by a psychiatrist according to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, text revision.

Before beginning the study, both groups answered a semi-structured interview to determine the characteristics of the sample and underwent a visual acuity test (Raskin). According to resolution No. 196/96 of the National Health Council (1996), participation in the study was voluntary and approved by the Ethics Committee in Research of the Center for Health Sciences at the Federal University of Paraíba, João Pessoa, PB, Brazil (protocol no. 0288).

Instruments

A Dell Studio S40 (Intel Core 225 GHz, 4 GB) computer with a Dell monitor (D2201c, 21.5 inches), mouse, and keyboard was used for the design and application of the experiment. The photographic stimuli of facial expressions were taken from the NimStim Emotional Face Stimuli Database (Tottenham et al., 2009). A total of 80 stimuli were presented, corresponding to the expressions of happiness, fear, sadness, anger, and neutral faces of two men and two women (database codes: 01F_NE_C, 01F_NE_O, 16F_NE_Cand16_NE_O, 37M_NE_C, 37M_NE_O, 41M_NE_Cand41M_NE_O).

Through a morphing technique, the photos were manipulated in Morpheus Photo Morphing Software to generate faces with different emotional intensities. Thus, the facial expressions showed variations in the neutral face with incremental 25% advances in intensity until the faces reached a maximum emotional intensity of 100%.

The experimental sessions were conducted individually with the participants. Each participant had to sit at the computer and was positioned approximately 70 cm from the center of the monitor. The session began with instructions that facial expressions with different emotions and different intensities would be presented randomly on the computer screen, and the participant should indicate the emotion that corresponded to the face on the numeric key pad of the computer's keyboard after each presentation. Each face was presented for 1 s, and the participant then had free time to judge and respond. Soon after each response, a new face was presented (Figure 1). The participants were not informed that neutral faces would be used in the study in an attempt to exploit the bias of emotional attribution.

Data analysis

Data compilation and the statistical analysis were performed using Microsoft Excel 2007 and SPSS 20.0 software. GraphPad Prism 6.0 was used to generate the graphs. The data were subjected to three analyses:

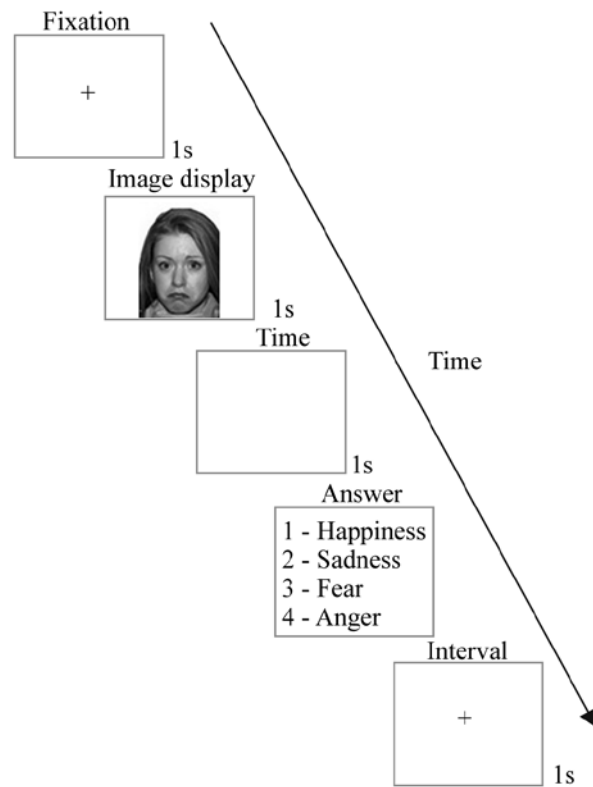


Figure 1: Schematic of stimulus presentation.

(1) analysis of indices of facial emotion recognition, (2) analysis of reaction time in the recognition of facial expressions, and (3) analysis of the frequency of emotion attribution to neutral faces.

Results

Recognition of emotional facial expressions

The means of accurate answers were subjected to a repeated-measures analysis of variance (ANOVA; Group [major depression and control] \times Emotion [happiness, sadness, fear, and anger] \times Intensity [25%, 50%, 75%, and 100%]). The ANOVA revealed a statistically significant effect of Intensity ($F_{3,54} = 121.89$, $p = .001$; effect size = .871, power analysis = 1.000) but not Group ($F_{1,18} = 1.124$, $p = .303$; effect size = .059, power analysis = .171) or Emotion ($F_{3,54} = .288$, $p = .83$; effect size = .16, power analysis = .094). Interactions were found between Emotion and Intensity ($F_{3,3} = 4.847$, $p = .002$; effect size = .212, power analysis = .933) and between Emotion, Intensity, and Group ($F_{1,18} = 2.430$, $p = .013$; effect size = .119, power analysis = .645). The Bonferroni *post hoc* test was used to analyze the three-way interaction, indicating that participants with major depression performed superior to controls in the recognition of facial expression of sadness with an intensity of 25% (Figure 2). The other interactions were not significant: Emotion \times Group ($F_{3,18} = .202$, $p = .89$; effect size = .011, power analysis = .081) and Intensity \times Group ($F_{3,18} = .307$, $p = .820$; effect size = .017, power analysis = .090).

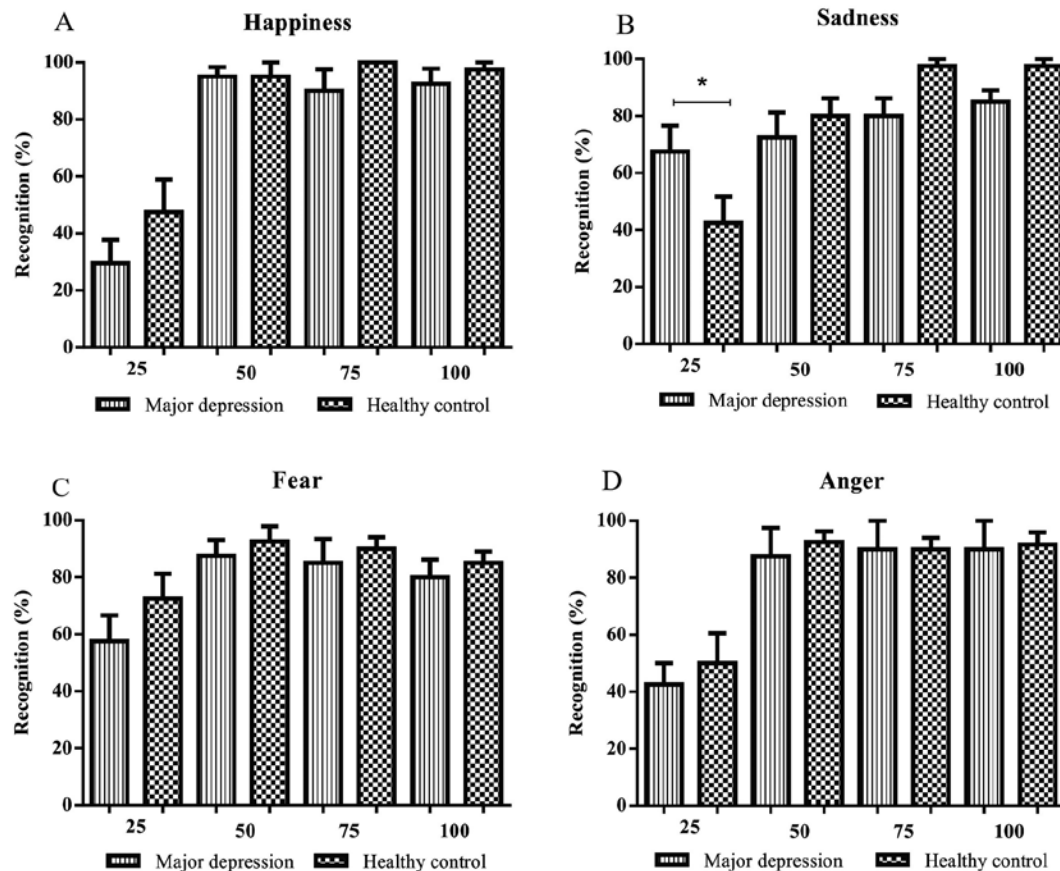


Figure 2. Means and standard errors of the recognition of happiness (A), sadness (B), fear (C), and anger (D) with the four emotional intensities (25%, 50%, 75%, and 100%) in the major depression group and healthy volunteers. * $p = 0.013$, major depression group compared with healthy control group in the recognition of sadness with 25% intensity.

Analysis of reaction time

The reaction times for the recognition of emotions were analyzed by ANOVA: Group (major depression and control) \times Emotion (happiness, sadness, fear, and anger) \times Intensity (25%, 50%, 75%, and 100%). The ANOVA revealed no statistically significant effects of the main factors or interactions ($p > .05$).

Attribution of emotions to neutral faces

The frequency of attributions of emotions to neutral faces were subjected to an independent χ^2 test: Group (major depression \times control) \times Emotion (happiness, fear, sadness, and anger). The analysis revealed a statistically significant difference in the attribution of emotions between groups ($\chi^2 = 10.30$, $p < .01$, Cramer's $V = .20$).

Figure 3 shows the frequency of attributions of emotions to neutral faces. Women with Major Depressive Disorder more often attributed the emotion of sadness to neutral faces (46%) compared with controls (16%). The control group had a tendency to more often ascribe the emotion of fear to neutral faces (58%) compared with the clinical group (37%). The happiness and anger emotions showed a lower percentage of attribution, with a similar trend in both groups.

Discussion

In the present study we evaluated the recognition of emotions of happiness, fear, sadness, and anger and the pattern of emotional attribution to neutral faces in women with depressive disorder and a healthy control group. Women with major depressive disorder generally showed bias in the evaluation of facial emotions. Compared with the voluntary control group, they were more accurate in the recognition of emotion in expressions of sadness with a 25% intensity. The three-way interaction between Group, Emotion, and Intensity was not observed for the other facial expressions (happiness, fear, and anger), suggesting the presence of a differential tendency toward the emotional evaluation of sadness in women with the disorder.

These results support the hypothesis that women with major depression exhibit a bias toward negative stimuli. Bourke et al. (2010) found evidence of increased vigilance and selective attention toward sad expressions and away from happy expressions but less evidence of a reduction of accuracy in the recognition of general or specific emotions in depression. The facilitation of recognizing subtle facial expressions of sadness (25% emotional intensity) may be related to

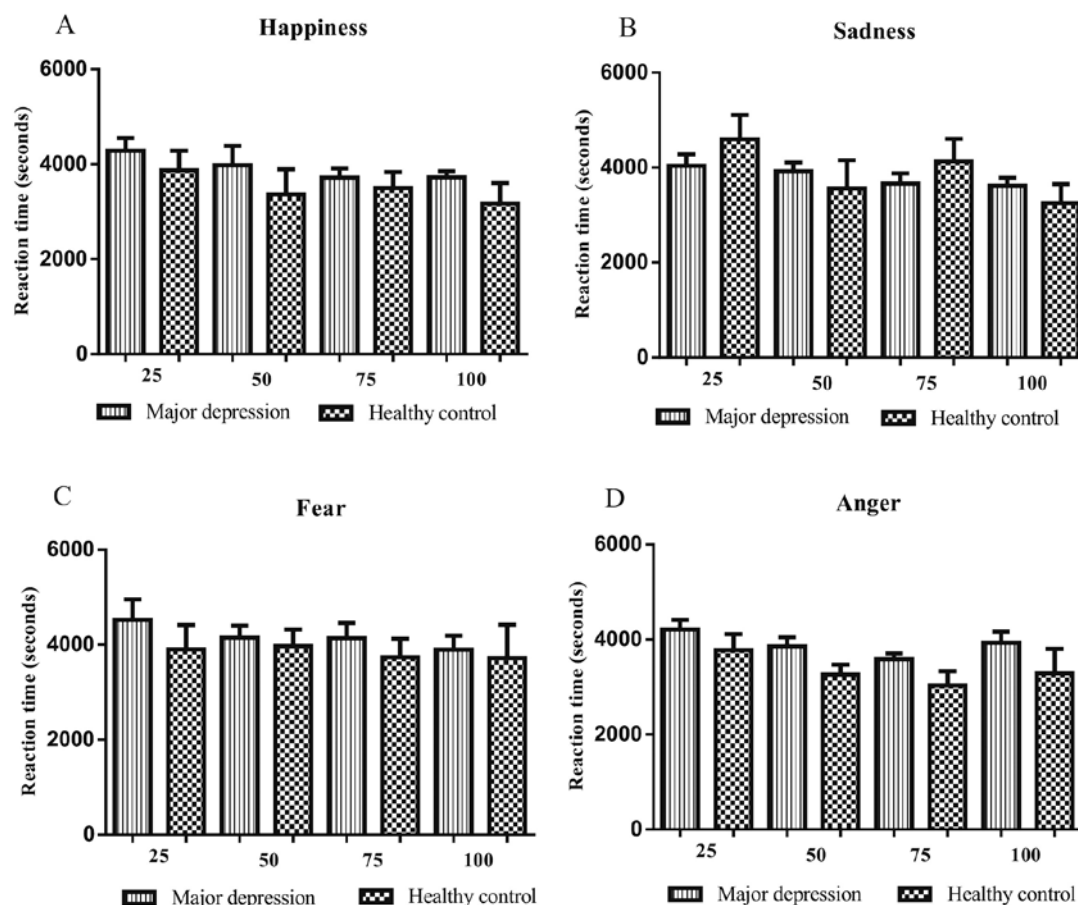


Figure 3. Means and standard errors of time reaction to recognize happiness (A), sadness (B), fear (C), and anger (D) with the four emotional intensities (25%, 50%, 75%, and 100%) in the major depression group and healthy volunteers. $*p < .05$.

certain patterns of brain activation in response to this kind of stimulus. Lawrence et al. (2004) found that patients with depression exhibited a relative increase in the activation of cortical regions (i.e., the hippocampus and parahippocampal gyrus) when viewing less intense facial expressions of sadness compared with happiness and fear.

In an attentional study, Gotlib, Krasnoperova, Joormann, and Yue (2004) reported a bias toward attending to sadness compared with happiness and anger in patients with depression, which was not observed in people with generalized anxiety disorder or controls. Such results may be related to the presence of cognitive schemas and associative networks for negative stimuli in information processing (Gotlib et al., 2004).

Differences in emotional recognition most likely do not reflect a visuoperceptual deficit but rather bias toward negative content (Asthana, Mandal, Khurana, & Nizamie-Haque, 1998). This is an important finding, given that deficits in social skills and interpersonal interactions are vulnerability factors for the precipitation of new depressive episodes (Joiner & Timmons, 2008). Moreover, negative mood influences responses to events in daily life that may aggravate the symptoms of the disorder (Gotlib & Joormann, 2010).

According to cognitive theories, some mechanisms are implicated in the relationship between the bias of cognitive processing and emotion dysregulation. Among these are rumination, negative memory bias, and low self-esteem (Mathews & MacLeod, 2005). Individuals with depression often have persistent, unintentional, and recurrent thoughts that guide attention to the negative affect associated with a particular event. This ruminant characteristic of the clinical profile induces a negative mood, generalizing selective attention to negative stimuli, and the generation of a deficit in inhibiting the negative material (Joormann, 2010). In women, emotional changes in depression may be intensified compared with men. Whittle et al. (2011) found that anterior limbic structures (i.e., the anterior cingulate, caudate, and medial prefrontal cortex) are active during the emotional experience of sadness in women. Depressive episodes can leave residual effects that are able to increase the probability of new episodes and recurring negative evaluation (Essau et al., 2010).

Depression can facilitate the negative evaluation of other ambiguous situations that more frequently tend to be interpreted as negative (Bourke et al., 2010). People with major depression reported autofocus and concentration on negative thoughts, in addition to remembering and paying more attention to negative

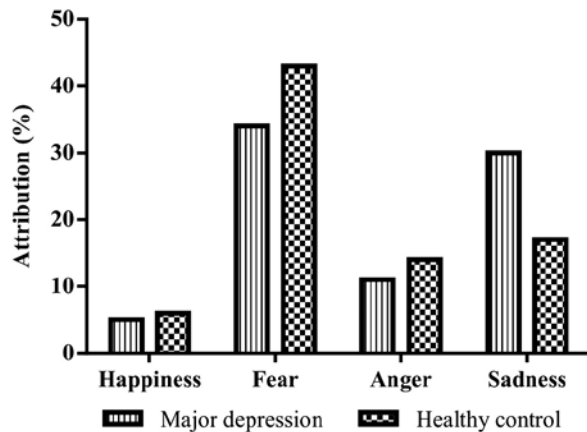


Figure 4. Attribution of happiness, fear, anger, and sadness to neutral faces in women with depression and control volunteers.

material (Mathews & MacLeod, 2005). Thus, changes in facial expression evaluation feature a bias in the processing of social cues.

In the present study we also used the forced-choice procedure for the attribution of emotions to neutral faces in women with major depressive disorder and the control group. Similar to findings with social anxiety (Alves et al., 2012), depressive symptoms affected the judgment of neutral faces. We found that women with major depression tended to more often attribute the emotion of sadness to neutral faces, which may reflect hypervigilance for negative stimuli in the disorder. Therefore, symptomatological aspects of depressed mood may be a key element in the high attribution of sadness to neutral faces. We found a tendency toward the attribution of sadness to neutral faces in women with depression, whereas control volunteers attributed predominantly fear to neutral faces. This pattern of emotional attribution requires further exploration in future studies and may reflect a particularity of women compared with men, especially when considering differences between genders in the processing of emotional information (Gohier et al., 2013). Such a pattern of attribution may also be a characteristic of healthy people, regardless of sex. According to Alves et al. (2012), neutral faces are ambiguous stimuli and are able to evoke emotional content. In their study they found that control participants of both genders attributed predominantly the emotions of fear and sadness to neutral faces.

Despite the relatively small sample size of our study, the results were sufficiently robust to indicate a bias in the evaluation of facial expressions of sadness, confirmed by the high power analysis value (.915) in the interaction between the factors Emotion, Intensity, and Group. The present experimental protocol, when compared with others (Bourke et al., 2010), appears to be adequate for emotional assessment in depression and other psychiatric disorders. However, the power analysis value for the factor Group was low (.171) and associated with a small effect size (.059). Therefore, we

cannot discard the possibility that a larger sample might lead to statistically significant differences between the control and clinical groups using a main factor analysis.

Conclusions

The findings suggest that depressive symptoms may affect the recognition of facial expressions. The clinical group performed better in recognizing expressions of sadness with reduced intensity and showed a tendency toward attributing the emotion of sadness to neutral faces more often compared with the control group.

The interpretation of neutral faces by the participants supports the hypothesis that neutral faces can evoke emotional responses. These biases toward identifying the facial expression can, in turn, influence interpersonal functioning in women with major depressive disorder. A better understanding of emotional processing may play a crucial role in prevention, evaluation, and intervention for clinical depression and other psychiatric disorders.

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