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Facial Emotion Recognition in Bipolar Disorder and Healthy Aging

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Abstract: Emotional face recognition is impaired in bipolar disorder, but it is not clear whether this is specific for the illness. Here, we investigated how aging and bipolar disorder influence dynamic emotional face recognition. Twenty older adults, 16 bipolar patients, and 20 control subjects performed a dynamic affective facial recognition task and a subsequent rating task. Participants pressed a key as soon as they were able to discriminate whether the neutral face was assuming a happy or angry facial expression and then rated the intensity of each facial expression. Results showed that older adults recognized happy expressions faster, whereas bipolar patients recognized angry expressions faster. Furthermore, both groups rated emotional faces more intensely than did the control subjects. This study is one of the first to compare how aging and clinical conditions influence emotional facial recognition and underlines the need to consider the role of specific and common factors in emotional face recognition.

Key Words: Aging, bipolar disorder, emotion recognition, emotion regulation, facial expressions

Bipolar disorder (BD), one of the most debilitating illnesses in society, is characterized by episodes of clinically significant mood dysregulations. Moreover, recent empirical evidence suggests that BD and normal and pathological aging also show considerable overlap in neurobiological characteristics, evident in physiological, neurostructural, cellular, and molecular studies (Gualtieri and Johnson, 2008; Isaacowitz

et al., 2013; Rizzo et al., 2014), as well as similarities in patterns of emotion processing and cognitive difficulties (Weisenbach et al., 2014). For instance, BD and aging both appear to involve elevated positive affective traits and may involve similar emotional reactivity to positive stimuli (Gruber, 2011; Mather, 2012).

Nonetheless, aging and BD may have specific physiological and molecular mechanisms despite the apparent similarities because bipolar patients and older adults show differences in many other aspects of their phenotypes.

Most importantly, few studies have yet investigated the differences in emotional face recognition and the similarities and/or differences found in BD and aging. This last aspect seems important especially because available evidence suggests that measures of emotion processing and recognition may be potential indexes for identifying shared and/or specific neurocognitive phenotypes in BD and aging.

Accordingly, the present study aims to compare emotional face recognition changes and deficits in bipolar euthymic patients, older adults, and younger control subjects in order to determine what aspects of emotional face recognition change with aging and whether BD patients and older adults show similarities in their patterns of performance.

Face perception, one of the most well-developed visual skills in human beings and crucial to social communication (Haxby et al., 2000), is a skill present from the very early stages of life (Johnson et al., 1991). Faces reveal a large amount of information to the perceiver, and based on them, we describe feelings, intentions, motivations, impressions, and, above all, emotions. In fact, facial expressions communicate at least 6 of the many emotions expressed by the human species. Indeed, happiness, fear, surprise, anger, disgust, and sadness are identified with extreme precision, both when these emotions are shown in static or dynamic images (Buck et al., 1972; Ekman et al., 1987; Howell and Jorgensen, 1970; Wagner et al., 1986). Face recognition, therefore, seems to be one of the most important visual skills and is well known to play an adaptive role. Nonetheless, face recognition appears to be sensitive to aging and clinical conditions.

For instance, there is increasing evidence that face recognition is impaired in older adults. Studies investigating the effects of aging on face perception using different tasks such as face detection (Norton et al., 2009), face identification (Habak et al., 2008), and emotion recognition (Calder et al., 2003) have shown that older adults perform more slowly and less accurately on these face perception tasks (Hildebrandt et al., 2013; Hildebrandt et al., 2011). More importantly, aging induces both quantitative changes and qualitative changes in face recognition (eg, reaction time, accuracy, etc). Moreover, different fields of psychology, such as perception and memory, have shown that older adults seem to show a preference for positive emotional stimuli, a phenomenon referred to in literature as the positivity effect. This effect is widely documented in literature (Fairfield et al., 2015a), and many studies on memory and aging have shown enhanced memory for positive autobiographical events (Kennedy et al., 2004) and better

performance in remembering positive images (Mikels et al., 2005) compared with younger adults. In addition, studies on trait impression from face perception have shown that older adults tend to judge faces as being more positive than younger adults and to perceive faces not only as more trustworthy but also as less hostile and less dangerous, especially for the most threatening-looking faces (Castle et al., 2012; Ruffman et al., 2006; Zebrowitz et al., 2013). On the contrary, few studies have found increased emotional response to negative stimuli in older adults. In particular, older adults demonstrated deficits in experiencing and recognizing angry facial emotions (Ruffman et al., 2009; Vanyukov et al., 2014), but there may be qualitative differences hidden by static face recognition. Thus, it seems important to test whether older adults would have difficulties recognizing angry faces using a more dynamic paradigm.

Recent literature has shown that mood disorders such as BD also have a strong impact on how individuals perceive facial expression (Samamé et al., 2012; Ruocco et al., 2014; van Rheenen and Rossell, 2013). Several studies with bipolar patients have shown how they are less accurate and slower at identifying facial expressions compared with control subjects, and contrary to the positive effect shown for older adults, these patients show a negative bias in face perception (Bozikas et al., 2006; Getz et al., 2003; Rocca et al., 2009).

For instance, bipolar I patients typically are less accurate and slower than control subjects in identifying fear, disgust (Lembke and Ketter, 2002), and angry facial expressions (Bozorg et al., 2014). Moreover, other studies also found that patients had more difficulty with misinterpreting expressions of sadness (Hoertnagl et al., 2011) and anger (Goghari and Sponheim, 2013), as well as fear. In addition, generalized impairments are found in euthymic BD patients as well, suggesting that these deficits are an aspect of the disease and not related to disease severity (Bozikas et al., 2006; Derntl et al., 2009).

However, results are mixed, and the extent to which emotion recognition varies with the state of illness in BD remains an important unanswered question.

Traditionally, tasks used to assess emotion perception adopt static facial stimuli representing happy, fear, and neutral expressions, yet a potentially important factor influencing visual emotion perception concerns the role of dynamic information (van Rheenen et al., 2015). Interestingly, various studies have shown that healthy control subjects improve in emotion recognition with dynamic over static point-light displays (Atkinson et al., 2004). Dynamic stimuli therefore present an interesting index for investigating emotion perception in aging and patients with BD. Although some studies have attempted to profile sensitivity thresholds for emotion in BD, few have assessed the intensity threshold at which emotions are most consistently identified. The former use paradigms in which respondents themselves alter the intensity of an expression until it reaches a level at which it is recognizable (Gray et al., 2006; Schaefer et al., 2010; Summers et al., 2006; Venn et al., 2004).

Here, to clarify whether normal aging and BD show similar patterns of emotional face recognition and reduced perceptual processing of emotional cues, we adopted an online task composed of dynamic videos of faces in which facial expressions changed from neutral to happy or from neutral to angry. We measured reaction times (RTs) during facial expression recognition in 3 groups of participants (younger control subjects, older adults, and BD patients). In line with facial expression recognition literature, we expected older adults and BD patients to perform slower than younger control subjects. In addition, to investigate the direction of emotions (ie, positivity effect for older adults and the negative bias for BD patients), we asked to participants to rate angry, negative, and hybrid faces on a visual analog scale from positive to negative. We predicted that older adults would rate faces more positively than would younger ones and that patients would rate faces more negatively than would younger control subjects.

METHODS

Participants

Participants included 16 individuals who had a diagnosis of BD type I, currently remitted for an average of 11.25 (SD, 15.22)months. Two comparison groups were also recruited in order to compare BD-specific findings. These included a healthy control group (control subjects) comprising 20 younger adults and a comparison group of 20 older adults, recruited from the local community, who did not meet current or past criteria for any Axis I disorder as defined in the DSM-IV. Bipolar disorder diagnoses were confirmed using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) by licensed clinical psychologists (Structured Clinical Interview for DSM-IV) (First et al., 1995). Exclusion criteria for all participants included report of a history of severe head trauma, stroke, neurological disease, severe medical illness, or alcohol or substance abuse in the past 6 months. All participants reported normal or corrected-to-normal visual and auditory acuity, and younger and older adults reported being in good health. Current symptoms of mania were measured using the Young Mania Rating Scale (YMRS) (Young et al., 1978). Current symptoms of depression were measured using the Hamilton Depression Rating Scale (HAM-D) (Hamilton, 1960). The YMRS is an 11-item, clinician-rated measure of current manic symptoms. Scores range from 0 to 60. Scores 7 or greater represent clinically significant manic symptom levels. The HAM-D is a 17-item clinician-administered multiple-choice measure of depression symptom severity. A total HAM-D score of 7 or less after treatment is a typical indicator of remission. In addition, healthy older adults scored high on the Mini-Mental State Examination (Folstein et al., 1975). Demographic and clinical characteristics of participants are presented in Table 1. All participants gave written informed consent after the procedures were fully explained. The present study is in accordance with the Helsinki Declaration and was approved by the local institutional review board.

Stimuli

We created 10 dynamic videos from 2 versions of 20 different faces selected from the “Karolinska Directed Emotional Faces”
(Lundqvist et al., 1998) portraying the same actor. The first version was neutral, whereas the second was happy or angry (sex of the actors and emotions were balanced across trials). These 2 versions were then morphed to obtain 98 hybrid faces with an increasing percentage of happiness or anger, and these 100 pictures were presented, from the neutral to the happy/angry, for 40 milliseconds in order to generate the video (Di Domenico et al., 2015).

Procedure

The recognition phase was split into 2 identical sessions to avoid fatigue. In each session, participants watched 10 videos in the center of the screen and then complete a forced choice recognition test. During the videos, an initially neutral face gradually changed to assume an expression of happiness or anger. Each video, preceded by a 200-millisecond fixation point, lasted 4000 milliseconds. Participants pressed the space bar as soon as they were able to identify the emotional expression the face was assuming. Participants subsequently pressed the “l” key if the face had assumed a positive expression or the “a” key if the face had assumed a negative one. Recognition accuracy was calculated as the proportion of correct recognitions for positive and negative faces.

Participants rated 24 new faces according to valence. Six faces were happy, 6 faces were angry, and 12 faces were hybrid. Each hybrid face was created starting from 2 pictures of the Karolinska Directed Emotional Faces portraying the same actor; the first picture was happy and the second was angry (sex of actors was balanced across trials). Each face, preceded by a 200-millisecond fixation point, was presented in the center of the screen for 1000 milliseconds. Participants were then instructed to evaluate, using a visual analog scale (ie, a line presented horizontally in the center of the screen), how positive or negative the face seemed by moving a slider along the line with the mouse. The ends of the scale represented “extreme positive” (+50) and “extreme negative” (−100). The center of the scale represented neutrality (0). The direction of the continuum positive/negative or negative/positive was
balanced across participants.

RESULTS

As seen in Table 1, BD patients, older adults, and control subjects did not differ significantly with respect to sex ($\chi 2 = 0.09$) or education ($F2,54 = 1.03$; $p = 0.1$). Although all groups scored below YMRS
and HAM-D cutoffs, BD participants scored higher than did control participants on the YMRS ($F2,54 = 3.8$; $p < 0.001$) and HAM-D ($F2,54 = 1.6$; $p < 0.001$). The groups also differed for age ($p < 0.05$).

The analysis of variance (ANOVA) on recognition accuracy did not show significant differences ($F2,54 = 1.36$; $p = 0.265$) between older adults (mean, 0.96 [SD, 0.07]), younger adults (mean, 0.97 [SD, 0.04]), and patients (mean, 0.93 [SD, 0.13]), suggesting that all 3

groups were equally able to process and recognize facial expressions (Table 2). In order to evaluate differences between groups in the temporal processing of the facial expression changes, we submitted RTs to a 2 (emotion: happy, angry) × 3 (group: younger control subjects, older adults, BD) ANOVA. The ANOVA revealed a main effect of group ($F_{2,54} = 43.2$; $p < 0.001$) and a significant 2-way emotion × group interaction ($F_{2,54} = 7.9$; $p < 0.001$). The post hoc analysis on the main effect group confirmed that patients (mean, 2539.5 [SD, 1172.5]) were slower than older adults (mean, 886.4 [SD, 472.2]; $p < 0.001$) and younger control subjects (mean, 690.5 [SD], 419.8; $p < 0.001$). The post hoc analysis on the emotion × group interaction confirmed that older adults recognized changes from neutral to happy faster (mean, 577 [SD, 151]) than neutral to angry (mean, 1195.4 [SD, 483.5]; $p < 0.005$). Furthermore, BD patients recognized changes from neutral to angry faster (mean, 2263.2 [SD, 876.1]) than neutral to happy (mean, 2815.7 [SD, 1380.5]; $p < 0.05$). Younger control subjects did not show any temporal preferences for emotional face recognition ($p = 0.98$).

Finally, in order to examine the differences between groups in facial expression rating, we submitted the face judgment ratings to a 3 (emotion: happy, hybrid, angry) × 3 (group: younger control subjects, older adults, patients). The ANOVA evidenced a main effect of emotion ($F_{2,54} = 481.1$; $p < 0.001$) and a significant 2-way emotion × group interaction ($F_{4,108} = 3.3$; $p < 0.05$). The post hoc analysis confirmed that older adults rated negative facial expressions more negatively than did younger control subjects ($p < 0.01$) and positive facial expressions more positively than did younger ones ($p < 0.01$). Older adults also rated the hybrid faces as being more positive than the patients did ($p < 0.05$). There were no differences between ratings in patients and younger control subjects (Table 3).

Additional Analyses

We examined 2 potential confounders: illness duration and current mood symptoms. First, in BD, there is an association of cognitive performance with overall illness duration (Kravariti et al., 2009), so we examined whether performance on the facial emotion recognition task was influenced by illness duration. Duration of illness did not correlate with accuracy of negative ($p > 0.7$) or positive ($p > 0.3$) facial expressions, and no significant correlations were found with mean RTs of the negative ($p > 0.2$) and positive ($p > 0.5$) expressions, and no significant correlations with mean rating scores for negative ($p > 0.1$) and positive faces ($p > 0.4$) were found. Second, because the BD group scored higher in subsyndromal depressive (HAM-D) and manic (YMRS) symptoms as compared with control groups, we examined whether observed group differences were influenced by depressive and manic symptoms. The HAM-D scores of the patients, older adults, and control subjects did not correlate with accuracy of negative or positive facial expressions, and no significant correlations were found with mean RT of the negative or positive or with mean rating scores for negative or positive faces (all, $p > 0.05$). Similarly, the YMRS scores of the

3 groups did not correlate with accuracy of negative or positive facial expressions, and no correlations were found with mean RT for negative or positive or with mean rating scores for negative or positive faces (all $p > 0.05$).

DISCUSSION

Bipolar disorder and aging exhibit similarities in cognitive deficits and brain alterations; however, the pattern and severity of shared alterations may differ between the 2 disorders. The aim of this article was to compare aspects of emotional face recognition in euthymic patients and older adults using a novel emotion recognition task that combines a dynamic emotion recognition processing phase with a more general static facial rating in order to compare qualitative and quantitative similarities and differences. To the best of our knowledge, this study is one of the first to compare older adults and patients with BD with respect to the recognition of facial expressions. Interestingly, in our study, older adults and BD patients did not differ in accuracy of facial expression recognition, but we did find qualitative temporal differences. Accuracy data indicate preserved emotional face recognition abilities across the 2 groups in terms of being able to perform our task. However, when we analyzed RTs, we found that older adults and patients showed different temporal patterns of recognition within each group. Older adults, in fact, were faster at detecting happy expressions, whereas patients were faster at detecting angry expressions.

Regarding the rating phase, we found that both older adults and BD patients evaluated emotional faces of both valences as more intense than control subjects. Faster recognition of angry expressions in BD patients supports previous studies showing a similar pattern of response during the perception of facial expressions with negative emotional valence.

Euthymic patients with BD have been found to show enhanced recognition for facial expressions of fear (Lembke and Ketter, 2002) and disgust (Harmer et al., 2002) compared with matched control subjects. Moreover, previous studies with stable BD I patients found that patients had more difficulty with all expressions compared with control subjects and specifically with misinterpreting expressions of sadness and disgust as anger, which could reflect an anticipation of interpersonal rejection or social threat (Hoertnagl et al., 2011). Several studies have demonstrated that patients with BD may be less accurate than nonpsychiatric participants in recognizing negative facial expressions, including anger, fear, and disgust (Rocca et al., 2009) when using static facial stimuli. Therefore, 1 possible explanation for the apparent differences between these studies and our results might be that the information provided by dynamic stimuli is richer than that from static displays and makes it easier for patients to recognize stimuli (Garrido-Vásquez et al., 2011).

In our study, patients' performance did not correlate with duration of illness or with residual manic or depressive symptoms, suggesting that these abnormalities in emotion recognition might reflect a state or trait marker of BD. In contrast to BD patients, older adults exhibited

enhanced recognition of happy expressions. This finding is consistent with a large body of literature showing that older adults prefer positive emotional stimuli (Bozorg et al., 2014; Di Domenico et al., 2014; Mammarella et al., 2012; Mammarella et al., 2013). One of the possible explanations for these emotional effects is that age-related motivational changes guide the processing of emotional information. In fact, normal aging seems to be associated with superior emotional self-regulation, and older adults tend to focus more on maintaining positive emotions and decreasing negative emotions linked to perceived time limitations that lead to motivational shifts and direct attention to emotionally meaningful goals (Carstensen, 1995; Fairfield et al., 2013; Fairfield et al., 2015b). On the contrary, younger control subjects typically perceive time as more expansive and consequently prioritize goals related to knowledge acquisition (Carstensen, 1995). Accordingly, they are typically motivated toward knowledge-related goals, whereas older adults perceive the future as being limited and are more motivated to keeping emotional states balanced. There is some evidence that both BD patients and older adults have elevated affective experience and more intense emotion than control subjects and may perhaps involve emotional reactivity to positive stimuli (Degabriele et al., 2011; Henry et al., 2008; Mather, 2012). However, in our study, the difference between BD and aging in the recognition of emotion of facial expressions clearly evidenced how different regulation strategies shape emotion processing. That is, older adults show a preference toward positive information, whereas BD patients show a preference toward negative information.

The marked difference between BD and aging found in this study may be a reflection of distinct pathophysiologies underlying these 2 conditions. Several studies indicate that BD is characterized by diminished connectivity of prefrontal cortex regions with the amygdala while evaluating positive stimuli as well as elevated amygdale activity and diminished activation of the prefrontal cortex during exposure to negatively valenced stimuli (LeDoux, 1996; Perlman et al., 2012; Wang et al., 2009). Together, these studies indicate that BD is characterized by increased reactivity to emotionally negative stimuli, coupled with deficits in the ability to regulate responses to negative information. On the other hand, diminished amygdala activity in response to negative stimuli or increased activity in response to positive stimuli as well as activation within prefrontal regions associated with cognitive control suggests that older adults are able to recruit neural resources necessary for successful emotion regulation (Mather and Carstensen, 2005). Thus, older adults seem able to use their regulatory abilities to minimize negative responses, and these regulatory abilities appear to have parallels in neural functioning. In contrast, the positive affectivity observed in BD appears in the context of deficits in regulatory ability. Indeed, neural data suggest an inability to regulate responses to negative information.

The findings of our study should be interpreted in the light of its limitations such as small sample size and age differences. Future studies

should also compare similarities in a group of participants matched for age with BD patients to exclude biases specific to middle-aged participants. A second limitation of our study is that we did not assess in BD patients comorbid personality disorders that may have a significant impact on facial emotion recognition capacities (Daros et al., 2013; Daros et al., 2014). Moreover, the majority of patients with BD in the present study were receiving medication with approved effect on controlling aggression and irritability. This factor might have affected the profile of emotion recognition. However, previous studies of individuals with BD found no differences in performance between medicated and unmedicated participants (Bozorg et al., 2014; Rich et al., 2008). In conclusion, our data suggest that BD patients may adopt different emotional regulation strategies when processing faces compared with older adults and control subjects. These findings may have implications for clinical treatment in terms of developing new facial emotion recognition training programs.

TABLE 1. Demographic and Clinical Participant Characteristics

	Older Adults	BD	Control
n	20	16	20
Age, y	71.2 (8.3)	46.2 (10.6)	24.0 (4.1)
Sex, % female	50	56	50
Education, y	11.5 (0.7)	12.0 (1.1)	12.2 (1.2)
YMRS	1.18 (0.5)	2.19 (1.7)	1.19 (0.6)
HAM-D	3.07 (2.2)	5.12 (1.2)	2.2 (1.7)
Mini-Mental State Examination	29.1 (1.1)		
Age at onset, y		33.7 (9.2)	
Illness duration, y		12.2 (9.8)	
No. of comorbid disorders		0.45 (1.5)	

Values are means (SDs) or as otherwise indicated.
BD indicates BD group; older adults, healthy older group; control, healthy control group; No. of comorbid disorders, number of current Axis I comorbidities (including anxiety disorders, eating disorders).

TABLE 2. Recognition Means

	Accuracy	SD	RT Positive	SD	RT Negative	SD
Older adults	0.96	0.07	577.33	151.04	1195.37	483.48
Younger adults	0.97	0.04	693.17	419.47	687.88	431.09
Patients	0.93	0.13	2815.74	1380.50	2263.17	876.12

TABLE 3. Rating Means

	Negative Faces	SD	Hybrid Faces	SD	Positive Faces	SD
Older adults	−34.51	8.52	2.79	9.32	37.47	7.15
Younger adults	−26.07	10.36	−1.40	9.26	29.34	11.27
Patients	−30.84	13.73	−3.13	12.67	33.27	9.79