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Cognitive reappraisal of facial expressions: Electrophysiological evidence of social anxiety

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HIGHLIGHTS

- ERPs differentiate the face processing of the high- and low-socially anxious groups.
- Reappraisal cues enlarge SPN amplitude only for low-socially anxious individuals.
- The reduced P2-N2 for low-social anxiety implies the attention deployed to reappraisal.
- The early emotional processing of faces is not influenced by anxiety and reappraisal.

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ABSTRACT

The present study investigates the effect of cognitive reappraisal on emotion regulation in socially anxious individuals. Twenty-eight female subjects were divided into high-socially anxious (HSA) and low-socially anxious (LSA) groups. All subjects viewed threatening faces under cognitive reappraisal and passive viewing conditions, with subjective emotion ratings and event-related potentials (ERPs) recorded. Although the HSA and LSA groups reported similar amounts of reduction in emotion ratings while reappraising threatening faces, ERP data showed the LSA group generated a significantly larger stimuli-preceding negativity (SPN) than the HSA group when viewing the reappraisal cue word. Additionally, the LSA group, but not the HSA group, exhibited reduced P2-N2 peak-to-peak values for the reappraisal condition relative to the passive viewing condition. These results suggest that the LSA subjects paid more attention to and prepared better for the upcoming emotion-regulating task than the HSA subjects. Unlike subjects in the HSA group, subjects in the LSA group could modulate face processing by reappraisal. In conclusion, cognitive reappraisal can be an effective emotion regulation strategy for socially anxious people, and a different neural mechanism may be involved for people who are not socially anxious.

1. Introduction

Social anxiety is characterized by extreme fear of negative evaluation by others during social interaction [13]. Researchers in previous studies have explored the process of face perception among socially anxious individuals and found that they abnormally process socially threatening information displayed in facial expressions of others [11]. In order to develop effective treatment strategies for socially anxious individuals, it is important to further investigate and understand the emotion regulation mechanisms that are involved in face perception.

Cognitive reappraisal, which involves rethinking the meaning of an emotion-eliciting stimulus, such as seeing a threatening face, and altering the upcoming emotional activities, plays an important role in emotion regulation [9]. Relative to passive viewing, reappraising negative stimuli can change emotional activities associated with behavioral, physiological, and neural correlates (e.g., [5,9]). Studies using functional magnetic resonance imaging (fMRI) have found although anxious participants could use reappraisal to modify their feelings of emotion just as non-anxious participants did, but their brain regions that were active during reappraisal were different [7]. More recently, Goldin et al. [8] further found that

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cognitive behavioral therapy (CBT) enhanced reappraisal-related prefrontal cortex responses for patients with social anxiety disorder. The researchers concluded that reappraisal-related brain responses might be important neural activities that contribute to the effectiveness of CBT for social anxiety. Based on these findings, we inferred that cognitive reappraisal could be an effective emotion regulation strategy for people with social anxiety. The present study, therefore, further investigated the effects of cognitive reappraisal of threatening faces in high- and low-socially anxious subjects.

It remains unclear whether the electrophysiological responses can reveal the neural modification process of face perception induced by cognitive reappraisal among socially anxious individuals. Hence, the current study used Event-related potential (ERP) techniques to record electrophysiological responses of socially anxious subjects during reappraisal of emotional faces.

Multiple ERP components that correlate with neural processes of face perception were analyzed in the present study. First of all, we recorded N170, which has been identified as a face specific component that is sensitive to negative faces [25]. Kolassa and Miltner initially observed that a larger N170 component emerged when socially anxious subjects viewed angry faces [14]. Moreover, Han et al. found a larger N170 amplitude in non-shy participants compared with shy ones during viewing of neutral faces [10]. However, two recent ERP studies did not show such N170 changes among socially anxious participants [16,18]. Thus we further investigated the role of N170 in face perception among socially anxious individuals. Secondly, P2 component has been found to reflect facial structural identification in a previous study [3]. A larger P2 wave has also been found while viewing positive faces compared with threatening faces in socially anxious participants [16]. Therefore, we also measured P2 during face viewing in the current study. Thirdly, Rossingol et al. found a diminished N2 component when socially anxious subjects viewed angry faces [18]. We, accordingly, measured the frontal N2 component in the present study [16]. Fourthly, Moser et al. reported that viewing threatening faces evoked larger late positive potentials (LPP) than viewing positive faces in high-socially anxious but not in low-socially anxious individuals [16]. We sought to replicate their finding in the present study and thus also examined the LPP wave. Furthermore, the stimuli-preceding negativity (SPN) wave reflects attentional orientation toward forthcoming stimuli [22]. Larger SPN amplitudes have been found during reappraisal in previous studies [17,22]. Therefore, SPN could be a physical marker of emotion regulation. Thus we analyzed cue-locked SPN in addition to the aforementioned ERP components. In short, the measurement of ERP components in the present study expands our knowledge of face processing in socially anxious subjects.

2. Methods

2.1. Subjects

Twenty-eight female volunteers participated in the present study. They were divided into two groups based on their PRCA-24 scores (24 items Personal Report of Communication Apprehension) [15]. PRCA-24 is widely used in social anxiety research. According to the normative data of PRCA-24, high-social anxiety is defined as a score of 79 and above, and low-social anxiety is defined as a score of 52 and below. Thus 15 subjects (mean age 20.47 ± 1.85; PRCA-24 = 97.60 ± 6.49) were in the high-socially anxious group (HSA), and 13 subjects (mean age 20.00 ± 2.58; PRCA-24 = 48.92 ± 4.21) were in the low-socially anxious group (LSA). All subjects gave written informed consent prior to the study and received RMB 60 upon finishing.

2.2. Stimulus

Stimuli consisted of 100 grayscale face photographs (50 male faces) from the NimStim Emotional Face Stimuli database [23]. Half were neutral expressions (including neutral and calm faces), and the other half were threatening expressions (including angry faces). The faces occupied 506×650 pixels in the center of a 19-in monitor with a screen resolution of 1024×768 pixels.

2.3. Procedure

After the subjects were seated in front of the screen with a viewing distance of 60 cm, they were attached with electroencephalograph (EEG) sensors. Then, detailed task instructions were given, and 6 practice runs were performed. Formal trials began after subjects fully understood the task.

On each trial, a fixation cross was presented for 500 ms in the center of the screen at the beginning of the trial. Following the cross presentation, a regulation cue ("LOOK" or "DECREASE") was displayed for 2000 ms, indicating the task during the upcoming picture viewing. The "LOOK" cue signaled to participants to view and respond naturally to the picture. The "DECREASE" cue signaled to them to decrease their emotional response to the picture using cognitive reappraisal.[1] The "LOOK" cue was paired with 50 neutral (look-neutral condition) and 50 threatening faces (look-threatening condition). The "DECREASE" cue was paired only with 50 threatening faces (decrease-threatening condition). Therefore, the threatening faces were viewed twice, and there were a total of 150 trials. Then, a blank screen was presented a random duration between 500 and 800 ms. Subsequently, face photographs were presented for 4000 ms. Immediately after viewing the face, subjects rated the face on a 6-point scale assessing arousal based on the strength of their emotional response (6 = strongly negative; 1 = not negative at all). After the emotional rating, a blank screen was displayed for 1000 ms at the end of the trial. The formal experiment included a total of 5 blocks. Each block contained 10 look-neutral, 10 look-threatening and 10 decrease-threatening trials. The trials were randomly ordered.

2.4. Electrophysiological recording

An electro-cap with Ag/AgCl electrodes was used to record continuous EEG signals from 64 scalp electrodes based on the international 10–20 system [12]. Four additional electrodes were placed around the orbital regions to monitor vertical and horizontal ocular movements. Another two electrodes were placed on the bilateral mastoids. EEG data were grounded midway between FPz and Fz. Impedances of all electrodes were kept below 5 kΩ. The EEG was amplified by a SynAmps2 amplifier (Neuroscan®) and was digitized at 1000 Hz with a band-pass filter of DC to 100 Hz. All scalp electrodes were referenced to the left mastoid. Offline, the EEG was re-referenced to the average of the left and right mastoids when calculating P2, N2, LPP and SPN components. Because analysis of N170 is usually performed on electrodes near mastoids [12], the EEG was re-referenced to an average reference for N170 analysis.

[1] The instructions for decrease-threatening trials were adapted from Moser and collegues [17] as follows: "When the 'DECREASE' cue is displayed, you should think about the following face in a way that makes you feel your negative emotions less strongly. For example, you could view the face as a detached, third person who is a complete stranger to the people in the photograph. You could also consider that the person is pretending to be angry and it is a fake expression. You could also imagine that the person will calm down and soon do not feel angry. The only thing I ask that you do not do is to simply think about something unrelated to the face. For example, do not simply think some other things that make you happy. Just reappraise the face photographs as I have just instructed you in order to make yourself feel better."