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Mood effects on the ERP processing of emotional intensity in faces: A P3 investigation with depressed students

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Abstract

This study examined mood-relevant emotion processing in depression using event-related potentials (ERPs). Cognition in depression has been characterized as having attention and memory biases for negative (or mood relevant) information and away from positive (or mood incongruent) information, however, the time course and specificity of this processing during the perception of emotional expressions is not well known. In order to index specific information processing stages a visual oddball task with facial stimuli was utilized, with neutral expressions as the standard and targets varying on valence (happy and fear) and intensity (40%, 70% or 100% emotive) dimensions. Participants were 36 university students grouped according to their BDI-II scores; 18 non-depressed controls (BDI-II $\leq$ eight; $M=4.1$) and 18 depressed (BDI-II ≥ 15, $M=25.5$), age- and sex-matched between groups. Mixed model ANOVAs revealed interactions between control and depressed participants with happy and fearful stimuli showing significantly reduced P3 amplitudes and P3 latencies for happy faces as well as significantly delayed P3 latencies specifically for 40% happy faces in depressed participants. These findings are interpreted as evidence for a diminished cognitive processing ability during emotion discrimination for low-intensity mood incongruous (happy) faces in depression.

Keywords: Depression; Emotion; ERPs; P3

1. Introduction

Cognitive processing in depression is characterized with negative schemata that distort one's view of the world, the self, and the future (Beck, 1976) along with a concurrent information processing bias that affects attention to and memory for negative information (Gotlib and Krasnoperova, 1998). These schemata affect information processing by increasing the salience of negative events and even diminishing the salience of positive events, as experiments using attention and memory tasks have shown (Gotlib and Neubauer, 2000). Many studies use emotional stimuli but little is known about how affective characteristics of stimuli are influenced by regional brain activity during perceptual processes and how these may contribute to a mood-related attention bias in depression. An understanding of the detailed time course of cognitive processing during the perception of emotional stimuli could help delineate which specific cognitive processes are affected by mood-related biases.

Investigations into information processing time courses have frequently utilized event-related potential (ERP) measurements to examine discrete stimulus processing on a temporal scale of milliseconds. Using stimuli that differ from each other elicits a late cognitive waveform component, the P3, which represents stimulus evaluation, attentional allocation and context updating (Polich and Comerchero, 2003; Polich and Kok, 1995; Coles et al., 1990). ERPs provide a temporally accurate measurement to investigate the time course and specificity of emotionally biased perceptual processing in depression, yet few studies have utilized ERP measurements for this purpose.

Depressed patients have shown reduced P3 (Roschke and Wagner, 2003) and N2 amplitudes (Ogura et al., 1993) in

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auditory oddball paradigms, indicating specific deficits in neuronal resource allocation and mismatch detection. Pierson et al. (1996) found reduced amplitudes and delayed latencies at P3a and P3b in blunted-affect depressed patients, yet faster latencies and larger amplitudes at P3b for anxious-agitated patients between control and depressive subtype groups in an active choice task. These studies have provided evidence for the phenomenon of differential cognitive processing in depression, also indicating how subtypes can influence perceptual processes.

However, in order to capture emotion-specific cognitive biases, affective stimuli are often utilized. Depressed patients have shown lower P3 amplitudes for negatively valenced words (Blackburn et al., 1990) and also higher frontal amplitudes in the 250–500 ms temporal range for negatively valenced words (Dietrich et al., 2000), both interpreted as indexes of a negativity bias. A similar negativity bias was evidenced with depressed patients displaying lower right parietal P3 amplitudes to pictures of diseased dermatological faces (Kayser et al., 2000), supporting Heller's (1990, 1993) theory of a hypoactive right parietotemporal cortex in depression. Although these studies provide some electrophysiological evidence for negativity biases in depression, region-specific effects and affective dimensions need to be further dissociated for a thorough understanding of this phenomenon.

Deldin et al. (2000) found a reduced N2 amplitude in the right parietal cortex in depressed participants when viewing already seen happy faces (but not positive words), also supporting the theory of a hypoactive parietotemporal cortex (Heller, 1990, 1993) and providing evidence of region-specific diminished processing for happy faces. A similar mood-relevant effect was also observed in a reduced P3 amplitude for control (but not depressed) participants for previously viewed happy faces and words (collapsed together), interpreted as a positivity bias in controls that is not present in depressed participants (Deldin et al., 2001). Since facial stimuli have been shown to elicit region- and valence-specific ERP effects in depressed populations, the current study will utilize facial stimuli to examine the time course of biased perceptual processing.

In order to examine the effect of cognitive biases on emotion perception in depression, this study used facial stimuli with varying intensities (40%, 70%, and 100% emotive) of positive (happy) and negative (fear) expressions. Emotional faces functioned as target stimuli in a visual oddball design with neutral expressions as the standards. Latencies and amplitudes of the P3 component provided measurements of processing speed and neuronal resource allocation during evaluative stages of biased emotion perception. It was hypothesized that depressed participants would have slower and lower P3s to emotional stimuli, especially happy faces. The use of different levels of intensity of expressions should indicate if multiple dimensions of emotion interact in mood-relevant biased processing. Accordingly, data were analyzed to primarily investigate the interaction between stimulus intensity and valence, and secondarily to identify any cortical areas with differential processing.

2. Methods

2.1. Participants

Participants were students from San Francisco State University that received course credit or volunteered their time. All participants were informed about the study procedures and signed a written informed consent prior to participation in the study. Participants were grouped according to scores on the Beck Depression Inventory-II (BDI-II: Beck et al., 1996) with the control group scoring eight or below and the depressed group scoring 15 or higher. It is important to note that these groups were only differentiated by their scores on the BDI-II and the participants in the 'depressed' group have not been diagnosed with Major Depressive Disorder or any other affective disorders reported to the experimenters. Each group included 12 females and six males from 18 to 30 years old who were right handed, fluent in English and free of any past neurological trauma. Controls were free of psychoactive drugs, and three participants from the depressed group were using prescription drugs: (1) Wellbutrin, (2) Celexa and Wellbutrin, and (3) Lithium and Zoloft.

2.2. Materials and task

Prior to ERP testing, participants took the BDI-II, the State-Trait Anxiety Inventories (STAI-S, STAI-T: Spielberger et al., 1970), the Behavioral Inhibition System/Behavioral Acquisition System scales (BIS/BAS: Carver and White, 1994) and a demographic questionnaire that included a Likert scale asking how depressed do you feel right now, at this moment on a scale of 0 (not depressed) to 10 (very depressed). See Table 1 for questionnaire means and correlations with BDI-II scores.

Facial stimuli were taken from the Facial Expression of Emotion: Stimuli and Tests (FEEST: Young et al., 2002)

Table 1
Means (standard deviations) for demographic and questionnaire variables and Pearson's r correlations with the BDI-II ($n=36$)

Variable	Control ($n=18$)	Depressed ($n=18$)	Correlation (r) with BDI-II
Age	22.3 (3.0)	21.6 (3.4)	–
BDI-II	4.1 (2.9)	25.5 (9.0)	–
State Depression	1.1 (1.9)	4.0 (2.3)	+0.72*
STAI-T	33.7 (8.2)	53.5 (10.6)	+0.77*
STAI-S	32.1 (9.6)	48.3 (8.2)	+0.74*
BIS	19.6 (3.0)	22.2 (3.5)	+0.33
BAS	43.0 (5.1)	38.3 (5.4)	−0.49*

* $p<0.01$.