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Research report

Electrophysiological evidence of a typical cognitive distortion in bipolar disorder

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ABSTRACT

Patients suffering from bipolar disorder often report negative thoughts and a bias towards negative environmental stimuli. Previous studies show that this mood-congruent attentional bias could mediated by dysfunctions in anterior limbic regions. The Error-Related Negativity (ERN), which originates in the anterior cingulate cortex (ACC), has been used to research this negativity bias in depressed patients, and could also help to better understand the underlying mechanisms causing the negativity bias in bipolar patients.

In this study we investigated error processing in patients with bipolar disorder. Acute depressive bipolar patients ($n = 20$) and age-matched healthy controls ($n = 20$) underwent a modified Eriksen Flanker Task to assess test performance and two error-related event-related potentials (ERPs), i.e., the ERN and Error Positivity (Pe) were measured by EEG. Half of the patients were measured again in a euthymic state.

We found similar ERN amplitudes in bipolar patients as compared to healthy controls, but significantly reduced Pe amplitudes. Moreover, acutely depressed bipolar patients displayed an ERN and Pe even if they responded accurately or too slow, which indicates that correct responses are processed in a way similar to wrong responses. This can be interpreted as a psychophysiological correlate of typical cognitive distortions in depression, i.e., an erroneous perception of personal failures. This biased error perception partially remained when patients were in a euthymic state.

Abbreviations: ERN, Error-related negativity; Pe, Error-related Positivity; ACC, anterior cingulate cortex; MADRS, Montgomery Asperger Depression Rating Scale; YMRS, Young Mania Rating Scale.

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Together, our data indicate that aberrant error processing of bipolar patients may be regarded a trait marker possibly reflecting a risk factor for depressive relapses in bipolar disorder.

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1. Introduction

Bipolar disorder is a severe mental disorder with a variety of affective, cognitive and behavioral symptoms. During acute depressive episodes almost every bipolar patient reports cognitive distortions which consist of irrational and dysfunctional overestimations of failure and blame (Beck, 1963). In contrast, patients have grandiose beliefs and unrealistic perceptions of their own abilities and interpersonal relationships during episodes of manic episodes (Morriss, van der Gucht, Lancaster, & Bentall, 2009; Van der Gucht, Morriss, Lancaster, Kinderman, & Bentall, 2009). In most cases, those symptoms resolve after remission, the bias towards negative experiences present during depressive episodes and the seeking of positive experience during manic episodes ease. However, recent research shows that, for example, errors in reasoning, especially the depressive pattern of thought, sometimes may persist even in euthymic bipolar patients and correspond to a high risk of relapse (Alloy, Abramson, Walshaw, Keyser, & Gerstein, 2006; Scott & Pope, 2003). To date, the underlying neuronal mechanisms of such cognitive distortions in bipolar disorder (and other affective disorders) are not fully understood.

Psychological studies repeatedly show enhanced sensitivity towards negative environmental cues during depressive episodes and suggest a reduced responsiveness to pleasant stimuli and other positive reinforcements (Jongen, Smulders, Ranson, Arts, & Krabbendam, 2007). In contrast, patients show an increased responsiveness to positive and rewarding stimuli during an acute (hypo-)manic episode (Chen et al., 2006; Wessa & Linke, 2009). This mood-congruent attentional bias seems to be mediated by a dysbalanced activity in anterior limbic regions (Green, Cahill, & Malhi, 2007; Phillips, Ladouceur, & Drevets, 2008). This is underlined by functional magnetic resonance imaging (fMRI) findings which consistently reveal deviant activation in the anterior cingulate cortex (ACC), the amygdala and the ventral striatum (Adler, Levine, DelBello, & Strakowski, 2005; Phillips, et al., 2008; Strakowski, Delbello, & Adler, 2005) in bipolar disorder. Additionally, a meta-analysis of voxel-based morphometry (VBM) findings in bipolar disorder confirmed gray matter reductions in the left ACC (Bora, Fornito, Yucel, & Pantelis, 2010). The ACC is associated with the integration of cognitive and emotional processes in support of goal-directed behavior, and its dysfunction may represent a primary neurobiological basis for the cognitive and emotional abnormalities observed in bipolar and depressive disorder (Cerullo, Adler, Delbello, & Strakowski, 2009).

Besides these findings, an increasing number of studies use event-related potentials (ERP) to neurophysiologically investigate anterior limbic alterations in affective disorders. The error-related negativity (ERN) (Gehring, Goss, Coles, Meyer, Donchin, 1993) or error negativity (Ne) (Falkenstein, Hohnsbein, Hoormann, & Blanke, 1991) is a commonly used ERP for the assessment of error-processing and action monitoring. The ERN is a negative deflection in the electroencephalogram (EEG), which peaks 50–100 msec after the commitment of an error (Falkenstein, et al., 1991). The ERN is generated in the ACC (Dehaene, Posner, & Tucker, 1994; Gehring et al., 1993; Segalowitz & Dywan, 2009), which is active during response monitoring and the commission of errors (Carter et al., 1998; Mathalon, Whitfield, & Ford, 2003). The ERN is followed by a later positive deflection, i.e., error positivity (Pe), which peaks 200–500 msec after an erroneous response (Falkenstein, Hoormann, Christ, & Hohnsbein, 2000; Nieuwenhuis, Ridderinkhof, Blom, Band, & Kok, 2001). This component has a centro-parietal distribution and seems to reflect further action monitoring, especially conscious error perception (Falkenstein, et al., 2000).

In order to understand the functional impact of the ERN and Pe, some theoretical models have been developed. Some authors suggest that the ERN reflects error-detection (Falkenstein, et al., 1991), whereas others assume general conflict-detection processes (Yeung, Botvinick, & Cohen, 2004) or reinforcement and reversal learning as crucial mechanisms (Holroyd & Coles, 2002). Irrespective of these considerations, there is increasing evidence that the ERN relates to motivational and affective variables and correlates with personality traits (Hoffmann, Wascher, & Falkenstein, 2012) and given incentives (Santesso & Segalowitz, 2008; Segalowitz & Dywan, 2009). Recent investigations suggest that task engagement as common underlying factor predicts the amplitude of the ERN, which in turn is influenced by personality traits such as concern about social evaluation and the outcome of events (Tops & Boksem, 2010). In line with these considerations are the findings of ERN and Pe alterations in mental disorders. Patients suffering from depression and anxiety disorders show a larger ERN and Pe deflection as compared to healthy controls (Chiu & Deldin, 2007; Holmes & Pizzagalli, 2008, 2010; Olvet & Hajcak, 2008), which was interpreted as an increased sensitivity to errors. Accordingly, an fMRI study revealed enhanced error-related rostral ACC activity in depressed patients (Steele, Meyer, & Ebmeier, 2004). Several studies demonstrated heightened error monitoring processes (increased ERN and Pe amplitudes) in patients with obsessive-compulsive disorder (Endrass, Klawohn, Schuster, & Kathmann, 2008; W. J. Gehring, Himle, & Nisenson, 2000), anxiety (Moser, Hajcak, & Simons, 2005) and generalized anxiety disorder (Weinberg, Olvet, & Hajcak, 2010). On the other hand, patients suffering from externalizing disorders such as substance abuse and impulsive personality were

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