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Action monitoring and perfectionism in anorexia nervosa

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Abstract

To study action monitoring in anorexia nervosa, behavioral and EEG measures were obtained in underweight anorexia nervosa patients ($n = 17$) and matched healthy controls ($n = 19$) while performing a speeded choice-reaction task. Our main measures of interest were questionnaire outcomes, reaction times, error rates, and the error-related negativity ERP component. Questionnaire and behavioral results indicated increased perfectionism in patients with anorexia nervosa. In line with their perfectionism and controlled response style patients made significantly less errors than controls. However, when controlling for this difference in error rates, the EEG results demonstrated a reduced error-related negativity in the patient group. These seemingly contradictory outcomes of improved performance and reduced error monitoring are discussed in relation with indications of anterior cingulate cortex hypoactivity in anorexia nervosa patients.

Keywords: Anorexia nervosa; Perfectionism; Action monitoring; Error-related negativity; Anterior cingulate

1. Introduction

Anorexia nervosa (AN) is characterized in DSM-IV as demonstrating severe weight loss, fear of gaining weight, preoccupation with body appearance, and amenorrhea. Perfectionism is considered to be a key characteristic in AN and to play a role in the etiology and maintenance of the disorder (see e.g. Franco-Paredes, Mancilla-Diaz, Vazquez-Arevalo, Lopez-Aguilar, & Alvarez-Rayon, 2005; Shafran, Cooper, & Fairburn, 2002; Shafran & Mansell, 2001). For example, AN patients score higher on perfectionism, even after long-term weight recovery (Bastiani, Rao, Weltzin, & Kaye, 1995; Casper, 1990; Srinivasagam et al., 1995) and they employ a slow but accurate response style compared to healthy controls (Holliday, Tchanturia, Landau, Collier, & Treasure, 2005; Kaye, Bastiani, & Moss, 1995).

Perfectionist subjects engage in hypervigilant monitoring of outcomes and selectively attend to failure (Shafran et al., 2002). Bulik and co-workers (2003) showed that elevated concern over mistakes is specifically associated with AN. In general, optimal performance requires minimizing the number of errors by continuously monitoring one's actions and their outcomes.

Action monitoring can be investigated in more detail by examining the so-called 'error-related negativity' or ERN (Falkenstein, Hohnsbein, Hoormann, & Blanke, 1991; Gehring, Goss, Coles, Meyer, & Donchin, 1993). The ERN is a negative response-locked event-related potential (ERP) component elicited immediately following an error. Originally, the ERN has been interpreted as the outcome of a generic error-detection mechanism, where the error signal is used as input for a remedial action system, enabling performance adjustments for correction or prevention of future

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errors (see e.g. Coles, Scheffers, & Holroyd, 2001). Alternatively, the ERN has been described as the reflection of response conflict that arises when two incompatible response tendencies are simultaneously activated (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Yeung, Cohen, & Botvinick, 2004). A third interpretation of the ERN attributes a more central role to affective or motivational processes in action monitoring, arguing that the ERN (additionally) reflects an affective evaluation of the error (De Bruijn, Hulstijn, Verkes, Ruigt, & Sabbe, 2005; Gehring & Willoughby, 2002; Luu, Tucker, Derryberry, Reed, & Poulsen, 2003; Pailing, Segalowitz, Dywan, & Davies, 2002; Yeung, 2004). Several source localization studies on ERP data (see e.g. Dehaene, Posner, & Tucker, 1994; Van Veen & Carter, 2002; Holroyd, Dien, & Coles, 1998) and functional Magnetic Resonance Imaging (fMRI) studies (see e.g. Carter et al., 1998; Kiehl, Liddle, & Hopfinger, 2000; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004; Ullsperger & von Cramon, 2001) have indicated the anterior cingulate cortex (ACC) as the likely generator of the ERN. All theories seem to agree that the ERN reflects the outcome of an action-monitoring process in which the signal is used to adjust behavior to improve performance and prevent future errors. In speeded choice-reaction tasks, errors are usually the result of premature responding. A possible performance adjustment is then to slow down on the trial following an error, a phenomenon known as post-error slowing (Rabbitt, 1966).

Alterations in action-monitoring are associated with differences in the response style people employ. Enhanced ERN amplitudes were for instance found in normal subjects with a controlled response style (Pailing et al., 2002), and in non-clinical subjects with obsessive–compulsive characteristics (Hajcak & Simons, 2002). In line with this, patients suffering from obsessive–compulsive disorder (OCD) also showed enhanced ERN amplitudes (Gehring, Himle, & Nisenson, 2000; Johannes et al., 2001). These increased ERN amplitudes coincide with positron emission tomography (PET) and fMRI studies demonstrating increased ACC activity in OCD patients (Adler et al., 2000; Ursu, Stenger, Shear, Jones, & Carter, 2003). Importantly, reviews on the phenomenological and neurobiological links between OCD and AN, and data from family and genetic studies seem to confirm that perfectionism is a, possibly genetically transmitted, common vulnerability factor for AN and OCD (see e.g. Anderluh, Tchanturia, Rabe-Hesketh, & Treasure, 2003; Bulik & Tozzi, 2004; Halmi et al., 2000; Monteleone, Brambilla, Bortolotti, & Maj, 2000). However, neuroimaging studies in the resting condition in AN, rather suggest hypoperfusion in the ACC (Delvenne et al., 1995; Naruo et al., 2001; Takano et al., 2001) for a review, see (Frank, Bailer, Henry, Wagner, & Kaye, 2004), which persists after weight gain (Kojima et al., 2005).

The aim of the current study is to investigate action monitoring in AN patients and in matched controls in more detail. In addition to ERP and behavioral measurements of a speeded choice-reaction task, we obtained results from questionnaires to assess perfectionism. Based on previous research (Bastiani et al., 1995; Casper, 1990; Srinivasagam et al., 1995), we expected questionnaire outcomes and behavioral measures to demonstrate increased perfectionism and a more controlled response style in the AN patients. With respect to the ERN analyses two possible outcomes were predicted. The first prediction was based on the earlier findings of enhanced ERN amplitudes in patients with OCD. When the controlled response style of patients with AN coincides with increased action monitoring as issued by the ACC, larger ERN amplitudes were also expected for this patient group. On the other hand, when perfectionism is not associated with increased action monitoring as issued by the ACC, we expected smaller ERN amplitudes compared to controls. Such reduction in ERN amplitude would be in line with studies demonstrating ACC hypoactivity in AN patients.

2. Materials and methods

2.1. Participants

Thirty-six participants (17 AN patients and 19 controls, matched for sex, age, and educational level) took part in the study. Patients were hospitalized in a specialized treatment center for eating disorders during a 12-month period. Inclusion criteria for the patients were: a diagnosis of AN-restricting subtype according to DSM-IV criteria, a body mass index (BMI) below 17.5 kg/m^2, and absence of psychotic or substance-related disorder. All eligible patients were approached, and none of them refused to participate. Controls were age-matched healthy volunteers showing no indications of an eating disorder during a short interview and on two self-reporting measures (EDI and EDES: see next paragraph) and who had a BMI above 19 kg/m^2. During the interview, controls were also screened for a history of severe head injury, substance abuse and psychiatric referral, which were used as exclusion criteria. All participants gave written informed consent before participation and the study was approved by the ethical committee of the University Center in Kortenberg.

2.2. Clinical assessment

Patients and controls were measured and weighed on the day of testing. Seven patients were taking psychotropic medication: five received selective serotonin reuptake inhibitors (SSRIs), four received a short-acting benzodiazepine as a sleep inductor. The patients did not take this medication within 24 h before testing. All participants completed the following self-report questionnaires: the Symptom Checklist (SCL-90; Derogatis, 1977) and the Beck depression inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) were used to assess a wide array of psychiatric symptoms; The eating disorder inventory (EDI; Garner, Olmsted, & Polivy, 1983) and the eating disorder evaluation scale (EDES; Vandereycken, 1993)