Hyperactive performance monitoring as a transdiagnostic marker: Results from health anxiety in comparison to obsessive–compulsive disorder

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ABSTRACT

Hyperactive error-related brain activity has been found in individuals with obsessive-compulsive disorder (OCD), generalized and social anxiety as well as depression and has been proposed as a transdiagnostic marker. The specific phenotype to which it is related is still debated and anxious apprehension, threat sensitivity and checking have been proposed as promising candidates. To validate the idea that hyperactive performance monitoring is shared by anxiety and anxiety-related disorders and to refine our knowledge about its specificity, data from further anxiety and anxiety-related disorders are required. We examined performance monitoring in 24 participants with health anxiety and 24 healthy participants. Further, we compared results to performance monitoring data from 24 patients with OCD taken from a previously published study (Riesel et al., 2014). The three groups were matched with regard to age, gender and level of education. The error-related and correct-related negativity (ERN, CRN) derived during a flanker task served as neural indicators of performance monitoring. Participants with health anxiety showed enhanced ERN amplitudes compared to healthy controls and did not differ from OCD patients in ERN. The Health anxiety and healthy control group did not differ in CRN amplitudes, while OCD patients showed enhanced CRN amplitudes. The results suggest that health anxiety is characterized by hyperactive error-monitoring that seems to represent a common information processing dysfunction in health anxiety and OCD. This validates the idea that hyperactive error-monitoring cuts across diagnoses and seems to be a transdiagnostic trait shared by individuals that are highly sensitive to the commission of errors.

1. Introduction

The monitoring of one's own performance is a fundamental behavioral function that is essential to human learning and adaptive behavior. Its central role is reflected in the fact that abnormalities in performance monitoring have been implicated in multiple forms of psychopathology (Weinberg et al., 2015a). The error- (ERN, Falkenstein et al., 1991; Gehring et al., 1993) and correct-related negativity (CRN, Ford, 1999) represent two well-validated event-related potentials (ERPs) of performance monitoring.

These ERPs peak over frontocentral electrodes shortly after an erroneous or correct response in response-conflict tasks. Despite a substantial body of research, the functional role of ERN and CRN is still debated. The mismatch, conflict and reinforcement learning theories share the assumption that these components signal the need to increase cognitive control to improve future performance (Botvinick et al., 2001; Falkenstein et al., 1991; Gehring et al., 1993; Holroyd and Coles, 2002). The relation of both components is still discussed. It has

been suggested that both components refer to one process, which is differentially active after correct and incorrect responses (Vidal et al., 2000) or that they represent two different processes, with the ERN being an error-specific signal (Coles et al., 2001; Yordanova et al., 2004). As a third possibility it has been proposed that ERN and CRN share a common monitoring process, which in case of an error is accompanied by an additional error signal (Endrass et al., 2012a; Falkenstein et al., 2000; Klawohn et al., 2014).

Besides these more cognitive functions there is growing evidence that modulations in the ERN are related to affective, motivational, and individual difference variables (e.g., Luu et al., 2000; Olvet and Hajcak, 2008; Weinberg et al., 2012). The ERN has been shown to be enhanced in anxiety traits and disorders (e.g., Weinberg et al., 2015a) and is enhanced when errors are more salient (e.g., Falkenstein et al., 2000; Gehring et al., 1993; Hajcak et al., 2005). Enhanced ERN amplitudes have been repeatedly found in obsessive-compulsive disorder (OCD, Endrass and Ullsperger, 2014b; Gehring et al., 2000), generalized anxiety disorder (GAD, Carrasco et al., 2013a; Weinberg and Hajcak,

2010; Weinberg et al., 2015b; Xiao et al., 2011), separation anxiety (Carrasco et al., 2013a), social anxiety (Endrass et al., 2014) and less consistently in depression (e.g., Chiu and Deldin, 2007; Georgiadi et al., 2011; Holmes and Pizzagalli, 2008) as well as in nonclinical individuals showing associated traits (e.g., Hajcak and Simons, 2002; Weinberg et al., 2012). In contrast to the ERN, results regarding the CRN and its association to anxiety and motivational manipulations are less often reported and less consistent (e.g., Endrass and Ullsperger, 2014). Enhanced CRN amplitudes have been reported for OCD (e.g., Endrass et al., 2008; Hajcak and Simons, 2002; Riesel et al., 2011) and for social anxiety (Endrass et al., 2014a) but not for other anxiety disorders like GAD (e.g., Weinberg and Hajcak, 2010) or depression (e.g., Chiu and Deldin, 2007). Overall, anxiety has more closely and consistently been related to hyperactive error-monitoring.

Disorders that are characterized by hyperactive error monitoring are frequently comorbid (e.g., Kessler et al., 2008; Krueger and Markon, 2006; Ruscio et al., 2010) and share clinical features, including negative affect (Hajcak et al., 2003; Mineka et al., 1998), worry (Dar and Iqbal, 2015; Yook et al., 2010) and increased intolerance of uncertainty (Holaway et al., 2006; Tolin et al., 2003). These similarities in symptoms and comorbidity implicate a partly overlapping etiology, and suggests that overactive error-monitoring may represent a transdiagnostic marker. The corresponding phenotype to which enhanced ERN amplitudes are related to is still debated and anxious apprehension (Moser et al., 2013), threat sensitivity (Weinberg et al., 2012), uncertainty (Cavanagh and Shackman, 2014) and checking (Weinberg et al., 2015b) have been proposed as promising candidates. Importantly, all explanations suggest that enhanced ERN amplitudes reflect a transdiagnostic phenomenon that is not limited to certain categorial diagnoses (Weinberg et al., 2015a). This view is in line with the Research Domain Criteria (RDoC) Initiative that aims to establish biologically meaningful dimensions that are essential for psychological functioning and dysfunctions irrespective of categorical diagnosis (Insel et al., 2010). In order to validate the ERN as a transdiagnostic marker and to refine our knowledge about the specificity of hyperactive error-monitoring, data from more anxiety and anxiety-related disorders are required. Especially, given the growing scientific debate on the limited reproducibility of empirical findings (Gawronski et al., 2015; Open Science, 2015) further empirical validation of the ERN as a transdiagnostic marker is essential.

The aim of the present study was to examine ERPs of performance monitoring in individuals with health anxiety. It was focused on health anxiety since it shares clinical features with OCD and anxiety disorders that show elevated ERN amplitudes such as checking behavior, reassurance seeking, worry, intolerance of uncertainty and overestimation of threat (Abramowitz et al., 2007; APA, 2013). Health anxiety refers to a dimensional construct that includes persistent worries and anxiety about illness and ranges from mild to severe forms, including the former DSM-IV diagnosis of hypochondriasis.[1] The lifetime prevalence of a full-blown hypochondriasis has been reported to be very low, generally under 1% (Gureje et al., 1997; Looper and Kirmayer, 2001; Martin and Jacobi, 2006). However, less restrictive defined forms of hypochondriasis are also associated with a clinically relevant degree of distress, disability and health care utilization and are more common in the general population with prevalence estimates around 2–6% (Gureje et al., 1997; Looper and Kirmayer, 2001; Martin and Jacobi, 2006; Noyes et al., 2000; Sunderland et al., 2013). Further, excessive health anxiety is a central feature of hypochondriasis but it is also found in somatoform, anxiety and mood disorders (Bailer et al., 2016) and there is an ongoing debate whether health anxiety should be considered a somatic symptom, or an anxiety, OCD spectrum or mood

disorder (Bienvenu et al., 2000, 2011; Gropalis et al., 2012; Scarella et al., 2015). Similar psychological mechanisms have been proposed to be involved in health anxiety and most anxiety disorders (Abramowitz et al., 2007). Similarly, neuroimaging studies have pointed to common neural circuits including frontal-striatal networks in health anxiety, OCD, and panic disorder (Radua et al., 2010; van den Heuvel et al., 2011, 2005) and further strengthen the idea of transdiagnostically shared mechanisms. To our knowledge, no study examined performance monitoring in health anxiety. Following similarities in symptoms, psychological and neurobiological mechanisms between health anxiety, anxiety disorders and OCD, we hypothesize to find enhanced ERN amplitudes in health anxiety compared to healthy participants. Besides, health anxious individuals we included performance monitoring data from patients with OCD taken from a previously published study (Riesel et al., 2014) to allow comparison of the observed effects in health anxiety to OCD. We do not expect to see differences in ERN amplitude between individuals with OCD and health anxiety. Results regarding the relationship of CRN and anxiety are less consistent. As has been shown in the previously published study OCD patients showed enhanced CRN amplitudes (Riesel et al., 2014) and we have no predictions regarding CRN effects in health anxiety.

2. Material and methods

2.1. Participants

Twenty-four individuals with health anxiety and 24 healthy comparison participants participated in the current study. Results were compared to data from 24 patients with OCD, taken from a large OCD sample that has been published previously (Riesel et al., 2014). Thus, OCD results reported in this paper do not represent an independent test of alteration in performance monitoring in OCD and behavioral and electrophysiological data on performance monitoring in these patients has been published previously (Riesel et al., 2014). Groups were matched with regard to gender, age and years of education (see Table 1). All participants were aged between 18 and 65 years, had normal or corrected-to-normal vision, and reported no history of head trauma or neurological disease. Further, all participants were screened and diagnosed for psychiatric disorders using the Structural Clinical Interview for DSM-IV before study inclusion (SCID-I, German version, Wittchen et al., 1997). Lifetime diagnosis of psychotic or substance-related disorders were exclusion criteria for all participants in the three groups. All participants completed the Beck-Depression-Inventory II (BDI-II, Steer et al., 1997) and Obsessive-Compulsive Inventory-Revised (OCI-R, Foa et al., 2002).

High health anxious and healthy participants were recruited from a large sample of 1145 individuals who completed an online version of the Illness-Attitude Scale (IAS, Hiller and Rief, 2004) and the Whiteley Index (WI, Hiller and Rief, 2004). The IAS is a self-report measure assessing health anxiety and illness behavior. The WI contains 14 dichotomous items assessing hypochondriacal concerns. Both questionnaires have retained excellent psychometric properties (Hiller and Rief, 2004; Hiller et al., 2002). Twenty-four individuals with scores above seven in the WI and above 45 in the IAS were recruited for the high health anxiety group. These cut-off scores have been suggested to be optimal in terms of sensitivity and specificity (Hiller and Rief, 2004; Hiller et al., 2002). The healthy participants reported IAS and WI scores below the cut-offs. Furthermore, psychopharmacological treatment, psychotherapy and a current mental disorder were additional exclusion criteria for healthy participants, only. Thus, participants in the health anxiety or OCD group were allowed to have a current comorbid diagnosis (except for psychotic or substance-related disorders), be in psychotherapy or to take psychopharmacological medication. For the health anxiety group a lifetime diagnosis of OCD was an additional exclusion criterion.

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[1] Hypochondriasis was replaced by two diagnostic entities in DSM-V (APA, 2013): illness anxiety disorder and somatic symptom disorder. Both diagnoses are characterized by health anxiety but somatic symptom disorder requires additional somatic symptoms.