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Mindfulness-based cognitive therapy (MBCT), cognitive style, and the temporal dynamics of frontal EEG alpha asymmetry in recurrently depressed patients

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ABSTRACT

Mindfulness-based cognitive therapy (MBCT), a meditation-based maintenance therapy, reduces the relapse risk in individuals suffering from major depressive disorder (MDD). However, only a few studies investigated the psychophysiological mechanisms underlying this protective effect. We examined effects of MBCT on trait rumination and mindfulness, as indicators of global cognitive style, as well as on residual depressive symptoms in a group of recurrently depressed patients ($n = 78$) in remission. Additionally, alpha asymmetry in resting-state electroencephalogram (EEG) was assessed. Alpha asymmetry has been found to be predictive of affective style and a pattern indicative of stronger relative right-hemispheric anterior cortical activity may represent a trait marker for the vulnerability to develop MDD.

In line with previous findings, residual depressive symptoms and trait rumination decreased, whereas trait mindfulness increased following MBCT, while no such changes took place in a wait-list control group. Mean values of alpha asymmetry, on the other hand, remained unaffected by training, and shifted systematically toward a pattern indicative of stronger relative right-hemispheric anterior cortical activity in the whole sample. These findings provide further support for the protective effect of MBCT. In the examined patients who were at an extremely high risk for relapse, however, this effect did not manifest itself on a neurophysiological level in terms of alpha asymmetry, where a shift, putatively indicative of increased vulnerability, was observed.

1. Introduction

One of the major challenges in the treatment of major depressive disorder (MDD) is the prevention of relapse after recovery from a major depressive episode (MDE; Keller, 2003; Kennedy et al., 2003). This is due to the fact that MDD is a dynamic disorder, in which successive episodes become increasingly autonomous from external life stressors, and their probability progressively increases with every episode (Solomon et al., 2000). The risk for relapse is attributed to the fact that patients who have experienced MDE differ from never-depressed individuals in their cognitive vulnerability (Teasdale and Dent, 1987; Teasdale et al., 2002). In particular, the repeated co-occurrence of negative thought patterns and depressed mood during MDE seems to result in learning an association between the two (Segal and Ingram, 1994). In the subsequent remitted state, this association appears to enable relatively mild dysphoric mood to activate thought patterns characteristic of MDE (Segal et al., 1999). For individuals in remission, this learnt association can therefore be a major threat, since the triggering of depressogenic thought patterns may yield relapse. In support of this assumption, it has been shown that cognitive reactivity, the tendency to react to sad mood provocations with increased dysfunctional attitudes, predicts depressive relapse (Segal et al., 2006). An additional important factor of depressive vulnerability is rumination, a method of coping with negative mood, which involves self-focused attention and repetitive, passive focusing on one's negative emotions (Nolen-Hoeksema et al., 2008).

Mindfulness-based cognitive therapy (MBCT; Segal et al., 2002), a derivative of mindfulness-based stress reduction (MBSR; Kabat-Zinn, 1990) and classical cognitive behavior therapy (CBT; Beck, 1979), is a highly economic intervention designed to prevent depressive relapse. In several controlled studies, MBCT has been shown to reduce the relapse risk particularly in patients who have experienced three or more MDE (Godfrin and van Heeringen, 2010; Ma and Teasdale, 2004; Teasdale et al., 2000). In MBCT, patients practice various forms of mindfulness meditation in a group setting and learn to apply these techniques during daily life. Core elements of MBCT are refining attentional skills and cultivating mindfulness, i.e. the skill to attentively relate to the experience of the present moment purposefully and in a non-judgmental manner (Kabat-Zinn, 1990). In turn, patients become more aware of their physical sensations and feelings, and can identify potentially

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harmful thought patterns before they become a threat. Recent studies suggest that structured mindfulness training attenuates residual depressive symptoms and ruminative tendencies, and increases trait mindfulness, which is associated with a lower risk for depressive relapse and lower cognitive reactivity (Kingston et al., 2007; Michalak et al., 2008; Raes et al., 2009; Ramel et al., 2004).

Despite such findings on psychological mechanisms of mindfulness training, to date only few studies have been conducted to explore the psychophysiological mechanisms underlying the prophylactic effect of MBCT. In this context, a putatively relevant physiological phenotype may be frontal alpha asymmetry.

1.1. Alpha asymmetry, depression and mindfulness training

Several neurophysiolgical anomalies have been observed in depression, including abnormal brain laterality (Gotlib et al., 1998; Henriques and Davidson, 1990, 1991). According to the approach-withdrawal model of hemispheric asymmetry, anterior asymmetry reflects motivational direction (Davidson and Irwin, 1999). In particular, it has been observed that the behavioral disposition of approach-related, appetitive responses is associated with stronger relative left-hemispheric anterior cortical activity, whereas the tendency for withdrawal-related, aversive responses is related to stronger relative right-hemispheric anterior activity (Coan and Allen, 2004; Harmon-Jones et al., 2010; Keune et al., 2011). Asymmetry in the alpha band (8–13 Hz) in resting-state electroencephalogram (EEG) is often utilized as an indicator of asymmetric activity, based on the rationale that alpha power is inversely related to underlying cortical activity (Allen et al., 2004b).

For individuals with a history of depression as well as those with a current episode, a pattern of alpha asymmetry indicative of withdrawal has repeatedly been observed (Gotlib et al., 1998; Henriques and Davidson, 1990, 1991). This pattern has also been suggested as an endophenotype for depressive risk, supposedly independent from clinical status (Allen et al., 2009). Smit et al. (2007) argued that alpha asymmetry as an endophenotype for depression should possess several features. In particular, it should be stable, heritable and correlated with the phenotype of interest. Several studies have provided support for these premises (Allen et al., 2004a; Coan and Allen, 2004; Davidson and Irwin, 1999; Smit et al., 2007; Vuga et al., 2006).

Recently, the capability model of frontal alpha asymmetry was introduced as an extension of the classic approach-withdrawal model (Coan et al., 2006). This model extends the conceptualization of alpha asymmetry as an indicator of global response dispositions by taking into account interactions between situation-specific emotional demands and the capability to regulate emotions in challenging situations. Accordingly, it is assumed that individual differences in alpha asymmetry become more salient during emotional challenges as compared to neutral circumstances at default rest. Implementing emotional challenges in empirical studies is also thought to reduce the influence of random factors on individual differences, i.e. to attenuate measurement error, and to amplify the association between alpha asymmetry and criterion variables. Finally, test–retest stability of individual differences in alpha asymmetry is assumed to be higher during emotional challenges than at rest. While support has been provided for the first three assumptions (Coan et al., 2006), the question of enhanced test–retest stability remains to be addressed. A recent study by Stewart et al. (2011) has illustrated the relevance of the capability model for the relation of alpha asymmetry and depression. In the latter study, an asymmetry pattern indicative of withdrawal, observed during an emotional challenge posited by a facial emotion task, discriminated individuals with a life-time history of MDD and never-depressed controls.

The capability model offers a promising approach which goes beyond the classic model emphasizing static behavioral dispositions. Nevertheless, to date the majority of studies related to alpha asymmetry and depression has been conducted in the context of the classic approach. As indicated, several of these studies have found support for the assumption that alpha asymmetry indicative of stronger relative right-hemispheric anterior cortical activity reflects an endophenotype for depression. However, conflicting results in relation to some of the criteria suggested by Smit et al. (2007) have been reported as well. Reid et al. (1998) did not observe significant differences in alpha asymmetry in two studies which compared depressed individuals to healthy controls. This negative result indicates that depressed individuals are not necessarily characterized by a pattern indicative of stronger withdrawal tendencies than healthy controls. Consequently, it challenges the criterion of the association of alpha asymmetry with the phenotype of interest, i.e. depression. Disconfirming results with regard to the assumption of stability have also been obtained. Debener et al. (2000) observed temporal instability of anterior alpha asymmetry in depressed patients over a period of 2–4 weeks, whereas stability was present in a healthy control group, suggesting that increased variability in this phenotype might be a feature characteristic of depression. In another small study, Barnhofer et al. (2007) showed that in formerly depressed patients, a shift toward stronger relative right-hemispheric anterior cortical activity may occur over time. In the latter study, remitted, previously suicidal patients with a relapse likelihood of 90% (American Psychiatric Association, 2000) were assorted to either a condition in which they received maintenance treatment through MBCT, or treatment as usual (TAU). Participation in the MBCT course was associated with the retention of a stable pattern of alpha asymmetry. In contrast, members of the TAU group showed a shift toward stronger relative right-hemispheric anterior cortical activity, putatively indicative of increased vulnerability. The results were interpreted as evidence for a manifestation of the prophylactic effect of MBCT on a neurophysiological level.

It should be noted that the indicated studies were methodologically limited in several respects. Debener et al. (2000) included patients who were starting phramacotherapy and, similar to the study by Barnhofer et al. (2007), examined only a small sample. Both aspects limit conclusions to be drawn about the instability of alpha asymmetry and mindfulness training as an influencing factor. Further, Barnhofer et al. (2007) conducted assessments of resting-state EEG only during a neutral condition, and not following a mood manipulation. It therefore remained unclear whether putative treatment effects generalize to aversive circumstances. Despite these limitations, results reported by Barnhofer et al. (2007) suggest that a further exploration of the plasticity of alpha asymmetry in relation to mindfulness training in high-risk patients is warranted.

1.2. Aim of the current research

The current work was intended to further explore the psychological and psychophysiological effects of MBCT in recurrently depressed patients. In particular, the intention was to replicate established findings about the beneficial effect of MBCT on rumination and mindfulness as indicators of global cognitive style, as well as on depressive symptomatology (Kingston et al., 2007; Michalak et al., 2008; Ramel et al., 2004). In addition, the goal was to explore whether the prophylactic effect of MBCT manifests on a neurophysiological level reflected in stable alpha asymmetry, as suggested by Barnhofer et al. (2007), or whether it may even be associated with a decrease in relative right-hemispheric activity, putatively indicating decreased withdrawal tendencies.

In order to address these issues, 78 recurrently depressed patients with a history of at least three MDE, who were in remission when admitted to the study, either took part in an MBCT