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Investigating cognitive flexibility as a potential mechanism of mindfulness in Generalized Anxiety Disorder



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ABSTRACT

Background and objectives: Research suggests mindfulness-based treatments may enhance efficacy of CBT for Generalized Anxiety Disorder (GAD). One hypothesized mechanism of mindfulness is cognitive flexibility; however, research findings to date are mixed as to a) whether cognitive inflexibility represents a characteristic of GAD, and b) whether mindfulness impacts cognitive flexibility. It is proposed that limitations in study methodology may partially account for these mixed findings. The present study investigated cognitive flexibility as a potential mechanism of mindfulness in a sample with elevated GAD symptoms using a modified emotional Stroop switching task while attempting to control for limitations of previous research. The purpose of the study was: 1) to explore cognitive inflexibility as a potential characteristic of GAD, and 2) to examine whether a brief mindfulness induction has measurable impact on cognitive flexibility.

Methods: A total of 66 participants (53 with elevated GAD symptoms, and 13 non-anxious) were randomized to a mindful-breathing, music-assisted relaxation, or thought wandering condition prior to completing an emotional Stroop and emotional Stroop switching task.

Results: Results suggest that GAD may be characterized by an inflexible style of responding, and exposure to mindfulness and relaxation result in partial improvements in cognitive flexibility.

Limitations: Limitations of this study include small sample size, brief induction period, and use of an analog sample.

Conclusions: The present findings suggest that mindfulness may be associated with partial improvement in cognitive flexibility.

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1. Introduction

Theory and research suggest that the integration of mindfulness with CBT may be a promising avenue to enhance treatment outcome for Generalized Anxiety Disorder (GAD) (Roemer, Orsillo, & Salters-Pedneault, 2008). However, CBT packages for GAD have been criticized on the grounds that the multiple components obscure our understanding of the active ingredients for change (Gould, Safren, Washington, & Otto, 2004). Although mindfulness shows promise as a clinical intervention embedded in a treatment package, carefully examining the hypothesized mechanisms of mindfulness and how it might target specific psychopathological processes could inform future treatment development and refinement.

Mindfulness is broadly defined as “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (Kabat-Zinn, 1994, p. 4). This definition emphasizes the central role of self-regulation of attention (Bishop et al., 2004; Kabat-Zinn, 1994), which involves three specific cognitive functions: sustained attention, attention switching, and inhibition. The concept of inhibition is conceptualized as a cognitive control strategy where attention is regulated to resolve a conflict between two competing stimulus dimensions (Fan, Flombaum, McCandliss, Thomas, & Posner, 2003; Miller & Cohen, 2001), as in the widely used Stroop task where stimulus dimensions (ink color and word meaning) are in conflict (Bush, Luu, & Posner, 2000). Attention switching has been defined as the switching of mental sets (Jersild, 1927). For example, with mindfulness of the breath meditation, attention is sustained and focused on the breath, and when attention wanders from the breath we *inhibit* the focus of our attention from wherever it was drawn, and *switch* attention back to the breath. Based on these conceptual definitions, then, cognitive flexibility appears to be inclusive of both inhibition and switching.

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This practice may be particularly beneficial to individuals with GAD as this disorder is characterized by difficulties with inhibition and cognitive inflexibility (Hazlett-Stevens, 2001, August; Mathews & MacLeod, 1985; Salters-Pedneault, Suvak, & Roemer, 2008). Research demonstrates that individuals with GAD have greater difficulties with inhibition on conflict monitoring tasks when naming the color of words with a threatening meaning on an emotional Stroop task compared with non-anxious individuals (Becker, Rinck, Margraf, & Roth, 2001; Mathews & MacLeod, 1985; Mathews, Mogg, Kentish, & Eysenck, 1995). Although these findings are fairly robust (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007), they have been criticized on the grounds that many studies fail to control for important lexical characteristics (Larsen, Mercer, & Balota, 2006). In contrast, findings using a well established performance-based measures of set shifting (i.e., Wisconsin Card Sorting Task; Heaton, Chelune, Talley, Kay, & Curtiss, 1993) have produced mixed findings (Hazlett-Stevens, 2001, August; Salters-Pedneault et al., 2008), which could be due to the low ceilings of these instruments.

Research examining the impact of mindfulness on cognitive flexibility has also produced mixed findings which may be due to the different methodologies used across experiments including variations in the sensitivity of measures (Jha, Krompinger, & Baime, 2007), lengthy experimental protocols (Anderson, Lau, Segal, & Bishop, 2007; Lykins, Baer, & Gottlob, 2012), the absence of controls for practice effects (Zylowska et al., 2008), and the secondary relaxation effects that may be associated with mindfulness (Wenk-Sormaz, 2005; Zylowska et al., 2008). Although different performance-based measures have been used to measure changes in attention resulting from mindfulness, the use of Stroop-type formats may have several benefits. The Stroop test is considered a 'gold standard' in attention research as it yields a large and statistically significant effect when administered (MacLeod, 1992). As the measure of unit is time, it has an acceptable ceiling to detect effects should they exist, and it can also be adapted to include valenced stimuli which may be most relevant when examining inhibition in those with anxiety-related disorders (Williams, Mathews, & MacLeod, 1996). Finally, Delis, Kaplan, and Kramer (2001), based on the work of Bohnen, Jolles, and Twijnstra (1992), have made modifications to the Stroop task to include a condition that focuses specifically on switching. In this condition, the participant is to switch between naming the ink color and reading the word based on the presence of a contextual cue. However, it has not been widely used for research generally, and has not been adapted for use with individuals reporting GAD symptoms specifically.

Although the impact of mindfulness training on Stroop performance has been examined, some studies have embedded this measure in a larger assessment protocol with considerable cognitive demands (Anderson et al., 2007; Lykins et al., 2012; Semple, 2010). It is conceivable that under these conditions participant fatigue may negatively influence performance (Lezak, Howieson, & Loring, 2004), potentially obscuring the true impact of mindfulness practice on cognitive flexibility. Further, any effects that exposure to mindfulness may have on cognitive ability in novices may be fleeting and short-lived (Semple, 2010). It is notable that one study using a cognitively demanding experimental protocol only found changes associated with mindfulness from the performance task that was not counterbalanced and was always administered first (Semple, 2010). Thus, using a brief experimental protocol that would minimize participant fatigue from completing cognitive tasks may enhance the potential to detect any changes in inhibition and/or switching should they exist.

Another shortcoming of this literature is that many studies have examined the impact of mindfulness on cognitive functioning among unscreened and/or generally healthy volunteers using

neutral stimuli (e.g., Jha et al., 2007; Moore & Malinowski, 2009; Semple, 2010; Wenk-Sormaz, 2005; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), which limits the generalizability of these findings to populations for whom valenced stimuli may be salient (Williams et al., 1996). Moreover, most of these studies fail to use a comparison group to control for the potentially confounding effects of the relaxation that often is associated with mindfulness (Lykins et al., 2012; Zylowska et al., 2008).

In summary, studies examining cognitive inflexibility associated with GAD and those examining the impact of mindfulness training on cognitive flexibility have both yielded inconsistent outcomes. Variations in methodological design across studies make the cross-study comparison of findings challenging. In an attempt to clarify these disparate findings and to extend previous research, this study examined the impact of a brief mindfulness induction compared to a relaxation condition and a no intervention thought wandering condition on emotional Stroop measures of inhibition and switching in meditation naïve individuals with elevated GAD symptoms. In order to account for the possibility that improvement in Stroop performance post-mindfulness practice could be attributable to the anxiety reducing, rather than the flexibility enhancing effects of mindfulness practice in an anxious sample, we included a relaxation condition. Although both relaxation (Hayes-Skelton, Roemer, & Orsillo, 2013) and mindfulness (e.g., Hofmann, Sawyer, Witt, & Oh, 2010) have been demonstrated to reduce anxiety, research suggests that they work through different mechanisms (Feldman, Greeson, & Senville, 2010; Jain et al., 2007) and are associated with unique EEG patterns (Dunn, Hartigan, & Mikulas, 1999). Moreover, whereas relaxation is aimed at reducing physiological anxiety and tension, mindfulness is focused on the observation and directing of attention. We included a thought wandering condition to control for the effects of instruction in either mindfulness or relaxation. Drawing from previous research (e.g., Arch & Craske, 2006), we hypothesized that allowing anxious participants to let their minds wander would result in unfocused attention or worry. In order to address the specific research questions of this study and preserve power, we elected to focus on within-group comparisons of individuals with elevated GAD symptoms, and between-group comparisons between non-anxious individuals and individuals with elevated GAD symptoms.

The first goal of the study was to examine cognitive inflexibility among individuals with elevated GAD symptoms using a self-report questionnaire of cognitive flexibility and performance on a modified emotional Stroop switching test. It was hypothesized that individuals with elevated GAD symptoms would report greater difficulties with cognitive flexibility and exhibit diminished performance on an emotional Stroop and a modified emotional Stroop switching task compared with non-anxious individuals. Second, we examined the impact of mindfulness compared to relaxation on the emotional Stroop performance of individuals with elevated GAD symptoms. It was hypothesized that a brief mindfulness-type breathing induction would result in better performance on the emotional Stroop and emotional Stroop switching tasks, compared with a relaxation or thought wandering condition. Additionally, we predicted that the mindfulness and relaxation inductions would result in lower reports of state anxiety from pre- to post-induction, and that the mindfulness induction would result in increases in reports of state mindfulness.

2. Materials and methods

2.1. Participants

Advertisements for research participation in a study of mindfulness and psychological flexibility were posted throughout a New

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