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Review

Mindfulness meditation improves emotion regulation and reduces drug abuse

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ABSTRACT

Background: The core clinical symptoms of addiction include an enhanced incentive for drug taking (craving), impaired self-control (impulsivity and compulsivity), emotional dysregulation (negative mood) and increased stress reactivity. Symptoms related to impaired self-control involve reduced activity in anterior cingulate cortex (ACC), adjacent prefrontal cortex (mPFC) and other brain areas. Behavioral training such as mindfulness meditation can increase the function of control networks including those leading to improved emotion regulation and thus may be a promising approach for the treatment of addiction.
Methods: In a series of randomized controlled trials (RCTs), we tested whether increased ACC/mPFC activity is related to better self-control abilities in executive functions, emotion regulation and stress response in healthy and addicted populations. After a brief mindfulness training (Integrative Body-Mind Training, IBMT), we used the Positive and Negative Affect Schedule (PANAS) and Profile of Mood States (POMS) to measure emotion regulation, salivary cortisol for the stress response and fMRI for brain functional and DTI structural changes. Relaxation training was used to serve as an active control.
Results: In both smokers and nonsmokers, improved self-control abilities in emotion regulation and stress reduction were found after training and these changes were related to increased ACC/mPFC activity following training. Compared with nonsmokers, smokers showed reduced ACC/mPFC activity in the self-control network before training, and these deficits were ameliorated after training.
Conclusions: These results indicate that promoting emotion regulation and improving ACC/mPFC brain activity can help for addiction prevention and treatment.

Contents

1. Background

Emotion regulation refers to strategies that can influence which emotions arise and when, how long they occur, and how these emotions are experienced and expressed (Gross, 2014). A range of

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implicit and explicit emotion regulation processes has been proposed (Gross, 2014). Research indicates that the anterior cingulate cortex (ACC) is involved in both cognitive control and emotional regulation. Neuroimaging studies show that the ventral part of ACC and its adjacent medial prefrontal cortex (mPFC) are mainly associated with emotional regulation (Bush et al., 2000; Posner et al., 2007; Rudebeck et al., 2008).

In current clinical and research contexts, mindfulness meditation is often described as non-judgmental attention or regulation to the present experiences (Hart, 1987; Kabat-Zinn, 1990). Improvements in emotion regulation associated with mindfulness meditation have been investigated through self-report, physiology and neuroimaging methods (Tang and Posner, 2014). Mindfulness-based emotion regulation may involve a mix of the implicit and explicit processes (Tang et al., 2015a). Studies indicate increased positive emotion and decreased negative emotion (Holzel et al., 2011; Jain et al., 2007; Tang et al., 2007; Robins et al., 2012; Ding et al., 2014).

The core clinical symptoms of addiction include an enhanced incentive for drug taking (craving), impaired self-control (impulsivity and compulsivity), emotional dysregulation (negative mood) and increased stress reactivity. Symptoms related to impaired self-control involve reduced activity in ACC and adjacent mPFC. One mechanism for addiction has been shown to involve a deficit in a self-control network involving ACC and mPFC. Thus, improving ACC/mPFC activity may improve emotion regulation and thus better addiction prevention and treatment (Goldstein and Volkow, 2011; Tang et al., 2007, 2013, 2015b). A large body of literature suggests that behavioral training such as mindfulness meditation can improve self-control through better emotion regulation and may thus be a promising approach for the treatment of addiction (Holzel et al., 2011; Tang et al., 2015b).

In this article, we will focus on one of the key factors in drug abuse-emotional dysregulation and explore its underlying brain mechanisms. Our goal is to show how improved emotion regulation could help addiction prevention and treatment. We take one form of mindfulness meditation-integrative body–mind training (IBMT) as an example to demonstrate how brief IBMT improves emotion regulation, reduces stress (cortisol) and increases ACC/mPFC activity related to better self-control abilities in healthy and addicted population.

IBMT involves systematic training of attention and self-control with an attitude of acceptance and openness to internal and external experiences (Tang et al., 2007, 2009, 2015a). IBMT has been tested in several randomized controlled trials (RCTs) that indicate a very rapid change in the central and autonomic nervous systems including reduced stress hormone, improved positive mood states and induced brain functional and structural changes (Tang et al., 2007, 2009, 2015a). The control group was given a relaxation training that is often used as a part of cognitive behavioral therapy. Because IBMT shares key components with other forms of mindfulness meditation, we expect other mindfulness methods will show the similar effects in addiction prevention and treatment through improved self-control ability (Tang et al., 2012a, 2015b; Bowen et al., 2014).

2. Emotion regulation and mindfulness meditation

In order to discuss this relationship, it is necessary to first examine the neural correlates of emotion regulation. Studies have shown that the bilateral prefrontal regions of the brain including mPFC/ACC (medial prefrontal cortex/anterior cingulate cortex) are primarily responsible for the regulation of emotion through modulating limbic system activity, and at the same time, making sure current strategies meet the regulatory goals (Etkin et al., 2011; Kim and Hamann, 2007). There are different strategies when it comes to regulating one's emotion, and each strategy involves shared and distinct neural networks. In a study that compared cognitive reappraisal and emotion-expression suppression techniques, participants were found to have an increased activity in cognitive control PFC regions and decreased amygdala and insula responses when employing reappraisal strategy, suggesting the down-regulation of amygdala and insula reactivity to negative emotional stimuli; whereas the suppression strategy not only activated the PFC, but also engaged visual-sensory multimodal association (posterior occipito-temporal lobes) and visual-spatial (precuneus and occipital areas) processing (Goldin et al., 2008). Although there are subtle differences among various control strategies, the ACC/mPFC regions are consistently involved in the regulation and inhibition of emotion responses (Bush et al., 2000; Tang et al., 2015a).

Negative emotion often implicates the need for effective emotion control. Impulsivity is recognized as a risk factor for many problems, including the initiation of drug use and drug abuse vulnerability. Growing evidence indicates that emotional dysregulation and impulsivity interact in important ways that can inform strategies to prevent and treat drug abuse. For example, emotional dysregulation can engender impulsive behaviors during adolescence and young adulthood, and mood-based rash action is both predictive of addiction, as well as predictive of treatment outcomes. Thus, improving emotion regulation is important to the prevention and treatment of addictions (Tang et al., 2015b).

In one study, Chinese college students were randomly assigned to an IBMT ($N = 40$) or a relaxation training group ($N = 40$) for 5 days of short-term training (20 min per day). The IBMT group showed significantly greater improvement of performance in executive control as measured by the Attention Network Test (Fan et al., 2002) than did the relaxation group. Individuals in the IBMT condition also had lower negative affect and fatigue, and higher positive feelings on the Profile of Mood States (POMS; Tang et al., 2007); see Fig. 1. In addition, a few hours of IBMT can also decrease levels of the stress hormone cortisol and increase immune reactivity (Tang et al., 2007). Using the measurement of Positive and Negative Affect Schedule in the same RCT design, short-term IBMT showed the significantly better positive mood states compared to relaxation (Ding et al., 2014). A similar study showed that in comparison with a waitlist control group, an 8-week mindfulness training program significantly reduced negative moods (Robins et al., 2012). These results indicated that mindfulness meditation can improve self-control such as emotion regulation effectively.

How does mindfulness enhance emotion regulation? Evidences suggest that the present-moment awareness and nonjudgmental acceptance cultivated by mindfulness are crucial in promoting self-control because they increase sensitivity to affective cues in the experiential field and improve response to incipient affective cues that help signal the need for control such as effective emotion regulation (Teper et al., 2013). It should be noted that emotion regulation is not always deliberate, but can also operate in non-conscious or implicit levels. These implicit processes may allow people to decide whether or not to engage in emotion regulation, guide people in selecting suitable emotion regulation strategies, and facilitate the enactment of emotion regulation strategies (Koole et al., 2015; Tang et al., 2015a). It should be noted that in addition to ACC/mPFC involved in emotion regulation, other brain areas such as dorsal lateral PFC, amygdala, insula and hippocampus also participate the top-down and bottom-up control networks of emotion regulation (Ochsner et al., 2012; Rive et al., 2013).