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Mindfulness Meditation – A New Preventive Intervention for ADHD

Yi-Yuan Tang and Rongxiang Tang

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Abstract

Medication and behavioral treatments have been used for ADHD treatments; however, both have limitations. Mindfulness meditation has been shown to improve attention and self-control, (or self-regulation), which could help the core ADHD symptoms of inattention, impulsivity, and hyperactivity. This chapter aims to review the latest literature on the effectiveness of mindfulness meditation on ADHD, to explore the brain mechanism underlying ADHD intervention, and to propose a mindfulness-based preventive intervention for ADHD symptoms and treatments.

Keywords: Mindfulness meditation, attention, self-control, IBMT, brain mechanism

1. Introduction

People with attention deficit/hyperactivity disorder (ADHD) have problems sustaining attention over prolonged periods of time, have difficulty to hold goals and plans in mind, and have difficulty inhibiting a prepotent response. Consequently, this neurodevelopmental disorder is characterized by symptoms of inattention, impulsivity, and hyperactivity and can influence brain structure and function [1]. Medication (mostly stimulants) and behavioral treatments (e.g., cognitive behavioral therapy) have been used for ADHD treatments; however, both have limitations. For example, medication works only short term and often has side effects, and treatment fidelity is often low [2].

Mindfulness meditation is often described as non-judgmental attention to experiences in the present moment [3, 4]. It has been suggested that mindfulness meditation involves a systematic

training of attention and self-control [3]. It is thus reasonable to suggest that the underlying brain mechanisms of mindfulness may involve similar brain regions and networks as these mental processes [3–5]. Mindfulness meditation has been shown to improve attention and self-control [3, 6–10]. Since poor attention functioning is a core symptom of ADHD [11] and executive functioning deficits in ADHD are common [12–14], mindfulness meditation that purportedly strengthen these processes may help the ADHD symptoms and treatments.

In this chapter, we first introduce attention and self-control (or self-regulation) networks and the brain mechanism underlying ADHD intervention. We also summarize the latest literature on the effectiveness of mindfulness meditation on ADHD and then propose a mindfulness-based preventive intervention for ADHD symptoms and treatments.

2. Attention and self-control networks

Attention can be viewed as a system of anatomical areas that consists of three or more specialized networks. These networks carry out the functions of alerting, orienting and executive control, or resolving conflict [15]. Figure 1 illustrates what is known of the anatomy of attention networks that involves in mindfulness practice, especially executive control (attention) network [6,15]. The executive attention network shares with the brain circuits of self-regulation, mainly in the anterior cingulate cortex (ACC) and its adjacent medial prefrontal cortex (mPFC) and striatum/basal ganglia [16–18]. In mindfulness meditation, attentional control is required to stay engaged in the practice, and meditators often report improved attention control as an effect of repeated practice [6, 9]. Research has shown that the executive control (attention) network is heavily involved in mindfulness practice [3–6, 9,10]. In sum, ACC/mPFC and striatum play an important role in attention control and self-control following mindfulness.

3. Brain mechanism involved in ADHD

Functional neuroimaging and structural neuroimaging have identified brain abnormalities involved in ADHD. The hypofunction of the brain regions, including the cingulo-frontal-parietal cognitive attention network, has been consistently observed across studies [19]. Meta-analysis has also shown a ventral-striatal hypo-responsiveness in ADHD [20]. These are major components of neural systems related to ADHD, including attention and self-control networks, motor systems, and reward/feedback-based processing systems. The ADHD neuroimaging research related to these network dysfunction is also associated with the core symptoms of inattention, impulsivity, and hyperactivity. This evidence suggests the biomarkers of diagnosis and treatment in ADHD prevention and intervention. However, these network abnormalities are not the only factors responsible for ADHD; instead, they are only part of the pathophysiology of ADHD [20]. In order to fully characterize the disorder, we should not only consider the dysfunction of prefrontal-striatal circuitry but also consider the large-scale neural

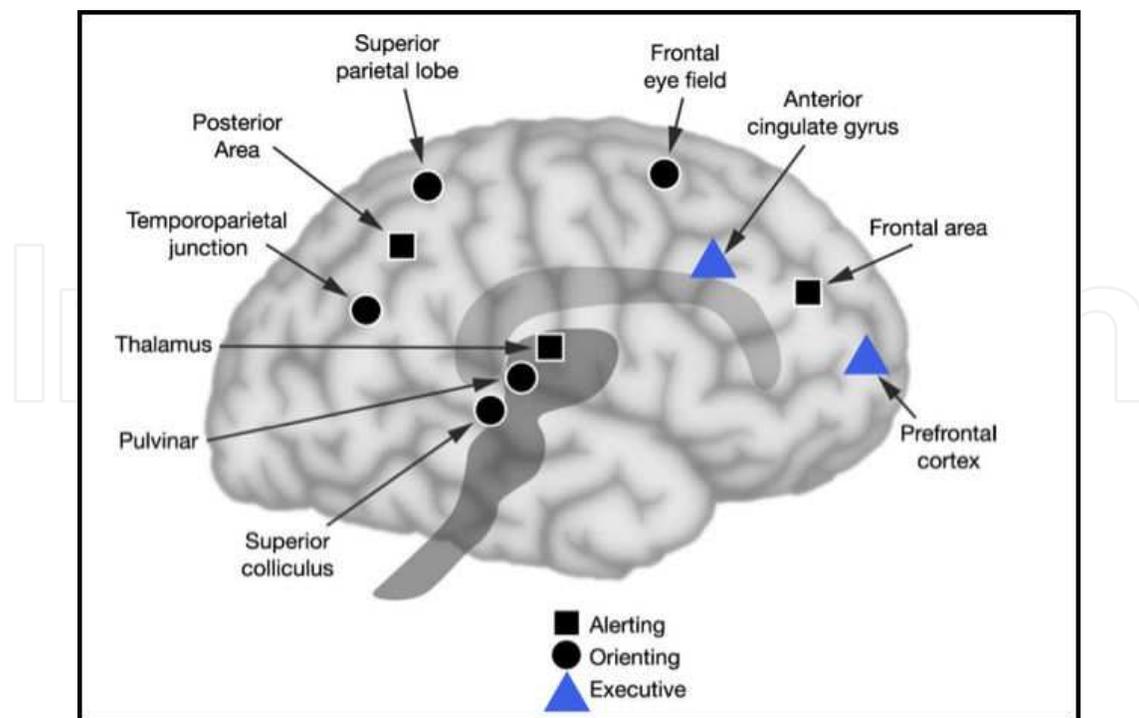


Figure 1. The anatomy of attention and self-control networks. Square, alerting network; circle, orienting network; triangle, executive control network. Executive attention shares with the brain circuits of self-control, mainly in ACC/mPFC. We call this as attention/self-control networks.

systems involved in ADHD based on recent advances in systems neuroscience-based approaches to brain dysfunction [21].

4. Mindfulness-based preventive intervention for ADHD

In addition to the pharmacological and behavioral treatments, mindfulness meditation has also been shown to improve attention and self-control [3, 6–10]. Given that poor attention functioning is a core symptom of ADHD [11] and self-control (executive functioning) deficits in ADHD are common [12–14], mindfulness meditation could strengthen these processes and may help the ADHD symptoms and treatments. We here propose the integrated translational model for mindfulness meditation as prevention strategies on ADHD [3]. As shown in Figure 2, mindfulness meditation includes at least three components that interact closely to constitute a process of enhanced self-regulation: enhanced attention control, improved emotion regulation, and altered self-awareness that targets the core symptoms of ADHD.

Previously in healthy population, we have applied one form of mindfulness meditation, the integrative body–mind training (IBMT) [3, 6], originating from an ancient eastern contemplative tradition, which involves body relaxation, mental imagery, and mindfulness training. Eighty undergraduates were randomly assigned to an experimental group (IBMT) or a control group (relaxation training) for 5 days of short-term training (20 min per day). The IBMT group showed significantly greater improvement of performance in executive attention as measured

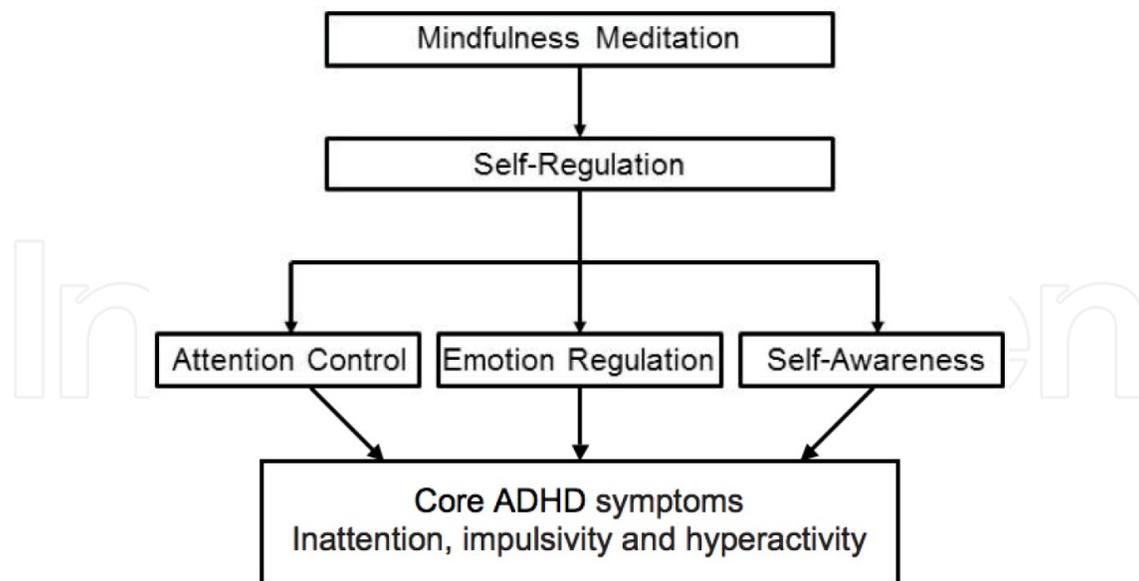


Figure 2. Integrated translational model. Mindfulness meditation includes at least three components that interact closely to constitute a process of enhanced self-regulation: enhanced attention control, improved emotion regulation, and altered self-awareness that targets the core symptoms of ADHD.

by the attention network test (ANT). They also reported lower anxiety, depression, anger, and fatigue and higher vigor. In addition, we found that after a stressful task, IBMT participants showed significantly reduced stress responses, as measured by salivary cortisol, and increased immunoreactivity, as measured by salivary immunoglobulin A [6]. These results indicated that brief mindfulness meditation – IBMT – can improve attention and self-regulation ability. A similar study showed that in comparison with a book listening control group, 4 days of meditation training enhanced the ability to sustain attention [8]. If the participants practiced 1 month of IBMT (10 h in total), we found improved efficiency of executive attention, alertness (sustained attention), and basal cortisol and immune function [3, 22, 23].

We further studied the brain and body mechanisms of IBMT [18]. During and after 5 days of training, the IBMT group showed significantly better physiological responses, including heart rate, respiratory amplitude and rate, and skin conductance response than the relaxation control. In addition, the IBMT group has significant differences in heart rate variability (HRV) and EEG power during and after training, suggesting greater involvement of the autonomic nervous system (ANS). Imaging data demonstrated stronger subgenual/ventral ACC activity in the IBMT group, and ACC theta was correlated with high-frequency HRV, suggesting control by the ACC over parasympathetic activity. These results indicate that after 5 days of training, the IBMT group shows better regulation of the ANS through a ventral midline brain system than does the relaxation group. This altered state probably reflects training in the coordination of body and mind given in the IBMT, but not in the control group [18]. Other studies also showed the ACC involvement [3, 4, 24]. Taken together, these evidences suggest that mindfulness practice is associated with enhanced attention, self-control, and awareness involving neuroplasticity in the ACC/mPFC, striatum, insula, and other brain areas [3, 4]. These biomarkers can be the target of diagnosis and treatment of ADHD.

Children and adolescents with ADHD often receive different formats of mindfulness meditation (e.g., MYmind program), with either the patients receive training only, or the caregivers receive concurrent mindfulness training as well [25, 26]. Overall, results are promising and demonstrate feasibility of mindfulness meditation in ADHD population. However, methodological issues pertaining to small samples, a lack of active comparison groups, and short follow-up periods limit generalizability suggest the need for longitudinal randomized rigorous trials [25, 26].

Studies in adult ADHD samples also provide promising preliminary support for mindfulness meditation (e.g., mindful awareness practices). In addition to mindfulness training, some studies have included mindfulness training as a component also showed the positive results related to ADHD symptoms (e.g., modified dialectical behavior therapy, mindfulness-based cognitive therapy). In sum, existing studies support the acceptability and feasibility in child, adolescent, and adult with ADHD and preliminary effectiveness of mindfulness in the treatment of ADHD [14]. Future studies are required to address methodological limitations of these studies.

5. Other factors in ADHD treatment

As one form of ADHD treatment, mindfulness meditation can be subdivided into methods involving focused attention and those involving open monitoring of present-moment experience [3–5]. These two techniques involve different attention and self-control strategies that may help ameliorate different ADHD symptoms. For example, “attention deficit” means brain hypoactivity that could not support attention functioning (e.g., sustained attention), whereas “attention hyperactivity” indicates overactivity that includes impulsivity. Thus, focused attention and open monitoring mindfulness may sensitize two extremes of attention problems in clinical practice using mindfulness intervention.

Regarding the ADHD different subtypes in responding to mindfulness intervention, clinical observations showed that there are differences in the ease of engaging in mindfulness based on the ADHD subtypes. In general, inattentive subtypes have easier time with quiet sitting practice and combined or hyperactive types struggle more because of restlessness. The latter responds more to body movement-based practice over quiet observation. Once engaged in the mindfulness practices, there also may be differences in outcomes. So far, there has not been enough research (studies with enough power) to tease out the effects of subtypes.

In addition, many other factors such as cultural differences in clinical strategy and social support can further complicate ADHD treatment. For instance, at least 9% school-aged children in the United States have been diagnosed with ADHD and are taking medications because ADHD is thought as a biological disorder with biological causes and the preferred treatment is stimulant medications such as Ritalin [27]. However, only less than 1% kids in France are diagnosed and medicated for ADHD. The drastic difference may due to the fact that in France, ADHD is viewed as a medical condition that has psychosocial and situational causes. Therefore, instead of using medications to treat children, French doctors look for the

underlying social issue that is causing the problematic behavior. The common treatment for these underlying social context problems is psychotherapy or family counseling. This is a very different perspective from the American doctors, who tend to attribute all symptoms to a biological dysfunction such as a chemical imbalance in the child's brain [27].

6. Future directions

ADHD has often been thought to reflect dysfunction of prefrontal–striatal circuitry, but the involvement of other circuits has frequently been largely overlooked. Recent systems of neuroscience-based approaches to brain dysfunction have facilitated the development of models of ADHD pathophysiology, which include a number of different large-scale resting-state networks such as prefrontal–striatal, frontoparietal, dorsal attentional, motor, visual, and default networks. A better understanding of large-scale brain systems in ADHD could greatly advance our diagnosis and treatment of ADHD [21].

Recent commercial claims suggest that computer-based cognitive training (e.g., working memory) can remediate ADHD impairments and provide lasting improvement in attention, impulse control, and other cognitive and social functioning. However, the meta-analysis indicates that training attention or executive functions did not significantly improve attention and the targeted executive functions. The future rigorous RCT cognitive training studies may provide the possibility to improve executive function deficits and benefit ADHD [28]. We term this type of training as “network training” that exercises certain brain circuits using repeated cognitive tasks (e.g., working memory). In contrast, mindfulness meditation focuses on changing brain and body state that can affect many networks; we call it as “state training” [9, 10, 22]. Since network training and state training involve different brain networks, the combination of these two methods may be more effective [10]. In sum, a holistic approach to ADHD preventive intervention could be the trend in the field.

It should be noted that although the empirical evidences have shown the promising effects of mindfulness meditation on attention control, emotion regulation, and impulsivity reduction in healthy and ADHD populations, future research should consider the use of longitudinal randomized clinical trial to validate the effectiveness of mindfulness-based intervention for ADHD [29] and how this intervention could better transfer into school and workplace environment. If supported by rigorous studies, the practice of mindfulness meditation could serve as the treatment of clinical disorders and might facilitate the cultivation of a healthy mind and increased well-being.

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