



Original article

A Randomized Controlled Trial Examining the Effect of Mindfulness Meditation on Working Memory Capacity in Adolescents


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 A B S T R A C T

Purpose: To investigate the effectiveness of a mindfulness meditation intervention on working memory capacity (WMC) in adolescents via a randomized controlled trial comparing mindfulness meditation to hatha yoga and a waitlist control group.

Methods: Participants (N = 198 adolescents) were recruited from a large public middle school in southwest United States and randomly assigned to mindfulness meditation, hatha yoga, or a waitlist control condition. Participants completed a computerized measure of WMC (Automated Operational Span Task) and self-report measures of perceived stress (Perceived Stress Scale) and anxiety (Screen for Childhood Anxiety Related Emotional Disorders) at preintervention and postintervention/waitlist. A series of mixed-design analyses of variance were used to examine changes in WMC, stress, and anxiety at preintervention and postintervention.

Results: Participants in the mindfulness meditation condition showed significant improvements in WMC, whereas those in the hatha yoga and waitlist control groups did not. No statistically significant between-group differences were found for stress or anxiety.

Conclusions: This is the first study to provide support for the benefits of short-term mindfulness practice, specifically mindfulness meditation, in improving WMC in adolescents. Results highlight the importance of investigating the components of mindfulness-based interventions among adolescents given that such interventions may improve cognitive function. More broadly, mindfulness interventions may be delivered in an abridged format, thus increasing their potential for integration into school settings and into existing treatment protocols.

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IMPLICATIONS AND CONTRIBUTION

This study demonstrates a significant effect of mindfulness meditation on working memory capacity in adolescents. Mindfulness interventions may be feasibly abridged, while still delivering important benefits.

In the last decade, mindfulness research in youth has grown rapidly. Mindfulness involves directing attention to the present-moment experience in a nonjudgmental and accepting way [1]. Mindfulness is often recognized as a “practice” or “training,”

requiring a constant shift from an “automatic pilot” mindset to one that comprises attention and awareness [2].

The term *mindfulness* has been applied to numerous interventions, including multicomponent interventions such as Mindfulness-Based Stress Reduction (MBSR) [1], and to particular forms of mindfulness practice (e.g., mindfulness meditation). In general, mindfulness-based interventions have been shown to be effective in producing beneficial effects on physical and psychological functioning, particularly in adults. Although the methodological rigor of many treatment studies with youth

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remains questionable [2–4], the existing body of research suggests that mindfulness training may be feasibly adapted for use with adolescents in medical and community-based samples. Furthermore, mindfulness interventions have demonstrated beneficial effects on general well-being and physical health among adolescents [4–10].

Although the global benefits of mindfulness on physical and psychological functioning are encouraging, as researchers emphasize the positive outcomes of mindfulness interventions, it is imperative to begin identifying whether *specific* benefits may be uniquely associated with particular forms of mindfulness practice. One specific benefit of mindfulness training that has been explored exclusively in adult samples is the effect of mindfulness meditation on working memory. A growing number of neurologic studies have documented that mindfulness practices have been associated with changes in neural pathways [11–13]. Neurologic changes in the structure of the brain may affect specific cognitive functions such as attention and memory. Research has shown that mindfulness exercises, specifically mindfulness meditation, have a direct effect on higher-order cognitive processes, such as executive functioning [14,15]. There has been particular interest in the impact of mindfulness on working memory because both constructs require moment-to-moment awareness [16]. Working memory is a mental workbench that allows an individual to hold information in awareness long enough for reasoning and comprehension to occur [16]. This cognitive function helps the brain shift information from short-term memory to long-term memory. Working memory also impacts performance on other higher-level cognitive tasks such as reasoning, comprehension, and executive functioning [16].

The adult literature suggests that mindfulness meditation may be used as a tool to enhance working memory capacity (WMC) [17–20]. WMC is implicated in processes such as reasoning ability, mathematical problem solving, language, and reading comprehension, and many other aspects of learning [21,22]. Recent studies suggest that even brief mindfulness meditation training may improve WMC, mind wandering, and standardized test scores in nonclinical and college student samples [19,20]. To date, however, the effectiveness of mindfulness training in improving WMC among adolescents has not been examined, although it would follow that strengthening WMC would be especially valuable during the developmental stage of adolescence, where the majority of the day is spent in an educational setting. Although school-based mindfulness interventions have been conducted [23,24], the incorporation of mindfulness practice in schools is inextricably linked to the availability of adequate resources. Briefly, low-cost programs integrated into existing curricula are likely to be the most feasible, particularly in schools with limited resources. [23].

The present study

The primary objective of this randomized controlled trial was to examine the impact of mindfulness meditation on WMC in adolescents. Based on previous research, we hypothesized that mindfulness meditation would result in significantly greater improvement in WMC compared to a hatha yoga intervention or a waitlist control condition. We chose to compare mindfulness meditation to hatha yoga given that both are formal mindfulness practices used in mindfulness-based interventions (e.g., MBSR [1]). Although theoretically similar in terms of their ability to

enhance awareness of the present-moment, theoretical and experimental research suggests that mindfulness meditation may be particularly effective in promoting executive functioning [17,20]. By comparing mindfulness meditation to hatha yoga, a potentially important *unique* benefit of mindfulness meditation may be revealed. Given the proposed broad psychological benefits of mindfulness practice, our secondary aim was to examine the effectiveness of mindfulness meditation and hatha yoga on perceived stress [25] and anxiety [26]. We hypothesized that adolescents in both the mindfulness meditation and hatha yoga groups would report significantly lower levels of stress and anxiety and greater mindfulness at postintervention compared to the waitlist control group.

Methods

Participants

The clinical trial was approved by the Alliant International University institutional review board and was conducted at a large public junior high school in southern California between March 2013 and July 2013. The school consisted of students who were predominately from low-income minority households. About 80 percent of students were eligible for a free or reduced lunch. All parents or legal guardians provided written informed consent and youth provided assent. Inclusion criteria were (1) current school enrollment, (2) current age between 12 and 17 years, (3) English speaking, and (4) ability to attend weekly study sessions. Exclusion criteria were (1) hearing impairments, (2) injuries, or (3) physical disabilities that would hinder full participation in either intervention.

Study design and interventions

Participants completed a baseline assessment that included all study measures (see *Measures*). Participants were then randomly assigned to mindfulness meditation, hatha yoga, or a waitlist control condition. Participants in both intervention groups (mindfulness meditation and hatha yoga) met a total of eight times: twice weekly for 4 weeks. Each intervention session lasted 45 minutes, resulting in a total of approximately 6 hours of intervention time. Daily home practice was monitored through a written home practice log that was collected once a week during the intervention. Each intervention group comprised 10–13 participants. Both intervention arms were delivered during participants' physical education (PE) class periods. The sitting meditation intervention was held in the school's library, whereas the hatha yoga intervention was held in the school's gym. The waitlist control group attended regular PE classes. After the 4-week intervention period, all participants completed post-intervention/postwaitlist measures. Waitlist control participants were then randomly assigned to receive the mindfulness meditation or hatha yoga intervention.

Mindfulness meditation intervention. Two female instructors with extensive training in mindfulness meditation facilitated the mindfulness meditation groups. Both instructors completed mindfulness-based training programs (i.e., Mindfulness Based Cognitive Therapy, MBSR) at various workshops and retreats, while maintaining their own personal practice. The instructors each had between 5 and 10 years of meditation experience. The curriculum was based on the MBSR program developed by

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