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Mindfulness Meditation Training in Adults and Adolescents With ADHD

A Feasibility Study

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Objective: ADHD is a childhood-onset psychiatric condition that often continues into adulthood. Stimulant medications are the mainstay of treatment; however, additional approaches are frequently desired. In recent years, mindfulness meditation has been proposed to improve attention, reduce stress, and improve mood. This study tests the feasibility of an 8-week mindfulness training program for adults and adolescents with ADHD. **Method:** Twenty-four adults and eight adolescents with ADHD enrolled in a feasibility study of an 8-week mindfulness training program. **Results:** The majority of participants completed the training and reported high satisfaction with the training. Pre–post improvements in self-reported ADHD symptoms and test performance on tasks measuring attention and cognitive inhibition were noted. Improvements in anxiety and depressive symptoms were also observed. **Conclusion:** Mindfulness training is a feasible intervention in a subset of ADHD adults and adolescents and may improve behavioral and neurocognitive impairments. A controlled clinical study is warranted.

Keywords: *ADHD; meditation; mindfulness; feasibility pilot; neurocognitive measures*

The management of ADHD across the lifespan is a topic of both scientific and public debate, with much discussion centering on optimal mulitmodal treatments (Greydanus, Pratt, Sloane, & Rappley, 2003). Stimulant medications are the most effective treatment for ADHD as shown in numerous randomized clinical trials (Biederman & Faraone, 2005). Yet there is a continued interest in novel nonpharmacological interventions in ADHD to optimize outcomes for patients who (a) do not respond or only partially respond to pharmacologic treatments, (b) experience intolerable side effects, and (c) are responsive to medications but seek additional modalities to help alleviate their symptoms. As with many chronic

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conditions, an approach that increases patients' self-management skills is desired.

Mindfulness meditation has emerged as a new approach for stress reduction and an important innovation in treating psychiatric disorders (Baer, 2003). Mindfulness is a type of meditative technique that emphasizes an observant and nonreactive stance toward one's thoughts, emotions, and body states. Mindfulness meditation involves experiential learning via silent periods of sitting meditation or slow walking and purposeful attention to daily activities (for example, mindfulness of eating). Relaxation, although often induced during the training, is not the sole goal of this practice; rather, the main activity is a cognitive and intention-based process characterized by self-regulation of attention to the present moment with an open and accepting orientation toward one's experiences (Bishop et al., 2004). Verbal instructions are used to outline the technique, but the bulk of training is experiential, consisting of intentional shifts of attention and perception. Incorporation of this technique with other methods, particularly cognitive–behavioral therapy, has led to the development of a number of mindfulness-based treatments for stress, depression relapse, borderline personality disorder, anxiety disorders, and substance abuse (Baer, 2003; Segal, Williams, & Teasdale, 2002).

Increasingly, meditation is also recognized as a mental training that could regulate attention and brain function (Bishop et al., 2004; Brown & Ryan, 2003; Davidson et al., 2003; Lazar et al., 2005; Schwartz & Begley, 2002; Segal et al., 2002). Recent research demonstrated that mindfulness meditation training can modify attentional networks (Jha, Krompinger, & Baime, 2007) and improve response on an attentional blink test (Slagter et al., 2007) in nonclinical samples. Other research suggests that meditation can alter perception (Carter et al., 2005; Valentine & Sweet, 1999), change neural activity (Newberg et al., 2001), alter neurotransmitter (dopamine) levels (Kjaer et al., 2002), modulate EEG patterns (Davidson et al., 2003; Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004), and potentially increase cortical thickness (Lazar et al., 2005).

Mindfulness Meditation in ADHD—Treatment Rationale

ADHD is a behavioral disorder associated with cognitive impairments and brain alterations (structural and functional; Bush, Valera, & Seidman, 2005). Increased rates of comorbid psychiatric symptoms and secondary impairments such as work or relationship difficulties are commonly reported in ADHD (Wilens, Biederman, & Spencer, 2002). Overall, research indicates that ADHD is a complex behavioral disorder influenced by multiple genetic and environmental factors, with likely diverse etiological components contributing to the clinical presentation. Cognitive deficits in executive functioning, including attention, working memory, and inhibition (Seidman, 2006), have been widely noted, as have difficulties in arousal, motivation, and emotional regulation (Nigg & Casey, 2005). Many of these differences can be categorized under self-regulation impairments (Barkley, 1997b) and may be subject to change, in part, through training of awareness and self-regulatory abilities. Mindfulness meditation is a self-regulatory practice that is multifaceted but appears to improve self-regulation of attention and emotion (Teasdale, Segal, & Williams, 1995). The practice involves decreasing arousal and training attention to the present experience with an open, curious, and accepting stance. The rationale for using a mindfulness-based approach in ADHD is built on several levels of potential impact, including behavioral symptoms of inattention and impulsivity, associated neurocognitve deficits of attention and inhibition, and secondary impairments of stress, anxiety, and depression. For example, mindfulness training could be thought of as a type of attention/cognitive exercise program similar to that proposed for working memory training in ADHD (Klingberg et al., 2005) or cognitive remediation treatments in schizophrenia (Wexler, 2007). The primary practice (sitting or walking meditation) involves three steps: (a) bringing attention to an "attentional anchor" (usually a sensory input such as breath), (b) noting that distraction occurs and letting go of the distraction, and (c) refocusing or reorienting attention back to the "attentional anchor." This sequence is repeated many times during the course of meditation practice. As attention is stabilized in the primary practice, open awareness or "hovering attention" is introduced and other aspects of attention may be emphasized. In between sessions, the participants are asked to "pay attention to attention" and bring their attention to the present moment frequently throughout their daily routine. These activities are likely to engage diverse aspects of attention (e.g., alerting, orienting, and conflict attention), metacognition, inhibition, and working memory. Animal research (Nudo, Milliken, Jenkins, & Merzenich, 1996) and research with memory training in ADHD (Olesen, Westerberg, & Klingberg, 2004) support the idea that repetition of the same activity can activate corresponding brain regions and potentially strengthen the underlying circuitry and mindfulness could help rehabilitate aspects of attention and executive function. This possibility is further supported by prior studies of meditation, which implicate activation of the anterior cingulate and the prefrontal cortex (Cahn & Polich, 2006).

In addition, emotional regulation is proposed as a mechanism or an outcome of mindfulness practice (Brown & Ryan, 2003). Emotional regulation deficits are implicated in ADHD (Braaten & Rosen, 2000; Rapport, Friedman, Tzelepis, & Van Voorhis, 2002), and the disorder is associated with increased rates of comorbid psychiatric disorders, such as anxiety, depression, oppositional defiant disorder, and substance abuse (Biederman, 2004; Kessler et al., 2006). During mindfulness training, participants learn to reduce arousal through breathing and relaxation exercises and to bring an openness and acceptance to their emotional experiences. This practice teaches engagement in emotional states in a way that is neither avoidance, flooding, nor dissociation but rather "mindfully observing and being with the emotion." In addition, shifting attention to a neutral focus (breath or soles of the feet) can be used to disengage from particularly intense emotional states. Reduction in negative affective reactivity and volatility in response to aversive visual stimuli (Arch & Craske, 2006) or emotionally provocative events (Broderick, 2005) have been reported with the induction of a mindfulness state. In clinical research, this approach has been shown to prevent relapse into depression (Teasdale et al., 2001) and help improve emotional regulation and impulsive behavior in patients with borderline personality disorder (Bohus et al., 2004). A small study recently indicated that a mindfulness-based intervention can reduce aggressive behavior in adolescents with history of conduct disorder (Singh et al., 2007). Overall, this practice may improve emotional functioning in ADHD and potentially decrease vulnerability to other psychiatric symptoms.

Prior Research With Meditation and ADHD

Meditation has been suggested as an alternative treatment for ADHD (Arnold, 2001), and a few early studies suggest that it might be effective. Two small studies (n = 23 to 24) of individual meditation training (the type of meditation unspecified) were conducted in children 12 years of age and younger and both yielded support for meditation to improve behavior in ADHD (Kratter, 1983; Moretti-Altuna, 1987). In addition, a pilot study (n = 8) investigated effects of a structured skills training program for adults with ADHD (Hesslinger et al., 2002). The program was based on the principles of dialectical behavioral therapy, which incorporates modified mindfulness training, and was delivered in a group setting. Improvements in ADHD, depression, and attentional tests were reported; however, because the treatment comprised multiple components, it is difficult to tease out the relative contribution of mindfulness training.

To our knowledge, this is the first study of mindfulness training in ADHD adolescents and adults to evaluate the feasibility of this approach and explore its impact on ADHD symptoms, comorbid behaviors, and cognitive performance. We hypothesized that mindfulness training will be well received and show positive changes in ADHD symptoms, cognitive processes of attention regulation, and associated symptoms of anxiety and depression.

Method

Participants

Participants with a primary *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) diagnosis of ADHD were recruited through UCLA clinical and research programs for ADHD and via local advertising. Interested adults or parents of adolescents were phone screened. The phone screen explained the Mindful Awareness Practices (MAPs) for ADHD program and asked participants about prior psychiatric diagnoses. To be included in the study, patients had to be 15 years of age or older, previously diagnosed with ADHD, informed of best-treatment practices (i.e., informed about medications being the first line of treatment but not required to have been in prior treatment), and able to attend the first session of the program and a minimum of four out of eight training sessions. Exclusion criteria were substance dependence within the past 6 months, a history of psychotic illness, Bipolar I disorder, mental retardation, borderline or antisocial personality disorder, conduct disorder, and chronic suicidal or self-injurious behavior. Participants currently receiving outside mental health treatments were encouraged to continue their treatments throughout the study but were required to report any changes on a weekly review form. All participants signed written informed consent forms approved by the UCLA Institutional Review Board.

Diagnostic Evaluation

The study evaluation consisted of semistructured clinical interviews by trained research clinicians: Schedule for Affective Disorders and Schizophrenia–Lifetime Version for adults (Fyer, Endicott, Mannuzza, & Klein, 1995) and Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime Version (Kaufman et al., 1997) for adolescents (sequential interviews, first with a parent and then with the adolescent). Each adult was given the behavioral disorder section of Schedule for Affective Disorders and

Schizophrenia for School-Age Children–Present and Lifetime Version to assess the diagnosis of ADHD in childhood and currently. Self-report and observer (spouse or friend for adults; parent for adolescents) behavioral ratings were collected using the ADHD-IV scale (adults) or Swanson, Nolan and Pelham Scale (SNAP-IV; adolescents). All information was included in determining the best-estimate diagnoses (Leckman, Sholomskas, Thompson, Belanger, & Weissman, 1982), following a procedure used by the UCLA ADHD Genetics Study in the past 10 years (McGough et al., 2005; Smalley et al., 2000). Participants falling one symptom or criterion short of a full *DSM-IV* diagnosis but demonstrating impairment were included in the study and given a "probable ADHD" designation. Impairment in at least two areas of functioning was required for all ADHD diagnoses, as determined by a research clinician's assessment and a review with our senior diagnostician (C.P.).

Assessment Measures

The study assessments included measures of participant characteristics, feasibility assessments, and pre- and posttest measures of psychiatric symptoms and cognitive functioning. Socioeconomic status was calculated using the Hollingshead four-factor index (Hollingshead, 1975). Feasibility was assessed via attendance and weekly review forms that asked about at-home meditation practice, concurrent outside treatment, and overall mental health. The pre- and posttest assessments included individual self-report scales of ADHD, depression, and anxiety symptoms and several cognitive tests administered to participants while off stimulant medications (last dose at least > 12 hr). ADHD symptoms were assessed via the ADHD Rating Scale IV (adults) (DuPaul, 1990) and comparable items from the SNAP-IV scale (adolescents) (Swanson, 1995) that measure the severity of each of the 18 individual *DSM-IV* criterion symptoms of ADHD. Self-report of anxiety and depression was assessed via the Beck Anxiety (Beck, Epstein, Brown, & Steer, 1988) and Beck Depression Inventories (BDIs; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) for adults and the Child Depression Inventory (Kovacs, 1992) and the Revised Children's Manifest Anxiety Scale (RCMAS; Reynolds & Richmond, 1978) for adolescents. Attention was assessed via the Attention Network Test (ANT), a computerized test measuring three aspects of attention: alerting (maintaining a vigilant state of preparedness), orienting (selecting a stimulus among multiple inputs), and conflict (prioritizing among competing tasks; Fan & Posner, 2004). In addition, we used the Stroop task, which also measures attentional conflict (ANT; Golden, 1978); the Trail Making Test, which assesses attentional set-shifting and inhibition (Reitan, 1979); the Digit Span, which measures working memory (Wechsler, 1981, 1991); and the vocabulary subtest of the Wechsler Adult Intelligence Scale–Revised or Wechsler Intelligence Scale for Children–Third Edition, which measures verbal IQ (Wechsler, 1981, 1991). A 10-interval visual analog scale assessed overall satisfaction with the training.

Mindfulness Training: MAPs for ADHD

The MAPs for ADHD program was informed by existing clinical models of mindfulness training (Kabat-Zinn, 1990; Segal et al., 2002) and the long-standing tradition of mindfulness meditation. The mindfulness training was adapted to meet the unique challenges of ADHD symptoms and included a psychoeducational component about ADHD. The 8-week program consisted of once-per-week evening sessions lasting 2.5 hr and daily at-home practice. Each weekly session followed a similar format that began with a short opening meditation, followed by discussion of at-home practice, the introduction and practice of new exercises, a group discussion, a review of the next week's at-home practice, and a closing sitting meditation. The at-home practice consisted of gradually increasing formal meditation and various "mindful awareness in daily living" exercises. The participants received three CDs containing guided sitting meditations ranging in length from 5 min (Weeks 1 to 2), 10 min (Weeks 3 to 5), and 15 min (Weeks 6 to 8).

MAPs were adapted to ADHD in the following ways: (a) psychoeducation on the clinical symptoms, neurobiology, and etiology of ADHD was provided; (b) sitting meditation periods were shorter than required in other similar programs (typically 45 min of at-home practice is recommended) and walking meditation could be substituted for sitting meditation; (c) mindful awareness in daily living was emphasized; (d) didactic visual aids were used to explain mindful awareness concepts; and (e) a loving–kindness meditation (an exercise of wishing well to self and others) was incorporated at the end of each session to address the low-self esteem problems often associated with ADHD. The ADHD psychoeducation discussed the impairment or "deficit" aspects of ADHD characteristics alongside the view of ADHD as a "neurobiological difference," an extreme on a continuum of functioning (much like dyslexia and reading ability), that may or may not always lead to impairment. This reframing presents ADHD as a complex trait reflective of population neurodiversity in general with both nonadaptive and potentially adaptive aspects (Jensen et al., 1997;

Table 1
Participant Characteristics

Characteristic	Adults ($N = 24$)		Adolescents ($N = 8$)	
	n	%	*n*	%
Male	9	38	3	38
Current stimulant use	15	63	4	67
Current ADHD subtype				
Inattentive	10	42	3	38
Hyperactive	2	8	0	0
Combined	12	50	5	62
Lifetime *DSM-IV* psychiatric comorbidity[a]				
Any mood disorder	20	83	5	63
Any anxiety disorder	8	33	3	38
Oppositional defiant disorder	7	33	1	13
Any comorbid disorder	22	92	6	75
	M	*SD*	*M*	*SD*
Age (years)	48.5	10.9	15.6	1.1
Current self-reported psychiatric symptoms[b]				
ADHD[c]	31.5	10.1	18.6	6.3
Depression[d]	31.5	10.5	25.1	1.6
Anxiety[e]	9.8	9.9	7.2	3.4

Note: *DSM-IV = Diagnostic and Statistical Manual of Mental Disorders* (4th ed.).

a. Based on *DSM-IV* criteria obtained via semistructured clinician interviews.

b. Data for some of the self-report symptoms are missing for up to three participants.

c. Combined ADHD *DSM-IV* checklist and Swanson, Nolan and Pelham Scale items.

d. Beck Depression Inventory scale for adults and Children's Depression Inventory scale for adolescents.

e. Beck Anxiety Inventory scale for adults and Revised Children's Manifest Anxiety Scale for adolescents.

Stein, Fan, Fossella, & Russell, 2007). Throughout the program, participants' concerns or comments were related to challenges commonly seen with ADHD. In both study groups, instruction was carried out by an experienced mindfulness instructor (D.W.) and ADHD researchers (L.Z. and S.S.).

Statistical Analyses

Data were analyzed using statistical software SAS Version 8.2 (SAS Institute, 2001). Means and standard deviations were calculated for the variables of interest, and a paired *t* test statistic was used to compare variables pre- (Time 1, or T1) to post- (Time 2, or T2) treatment. Within-subject change scores were generated from the difference in values pretreatment to posttreatment (i.e., T2 to T1). Following the convention used in medication trials, improvement in ADHD symptoms was defined as a reduction in the ADHD Rating Scale score of 30% or better. Statistically significant pre–post changes were further evaluated using linear regression models testing the effects of age, gender, current use of stimulant medication, and time spent weekly on meditation practice while controlling for baseline score. Because of the large number of cognitive tests and self-reported symptom scales, we used a conservative level of significance of $p < .01$ to select outcomes for further analysis using linear regression models.

Results

Participants

Forty-nine adults and 21 adolescents were phonescreened for inclusion and exclusion criteria. Among those, 33 adults and 10 adolescents were found eligible and were invited for the formal preassessment interview. A common reason for exclusion after the phone screen was an inability to attend the first training session (9 out of 16 excluded adults and 10 out of 11 excluded adolescents). During the formal preassessment interview, an additional 9 adults and 2 adolescents failed to meet study inclusion criteria. Five adults (21% of the adult group) were designated "probable ADHD" and were still included in the study. The final study sample consisted of 24 adults and 8 adolescents. Participant characteristics are summarized in Table 1.

As shown in Table 1, there were more females than males in both groups (62.5%), and a majority of participants were taking stimulant medications (more than 63%) and had a lifetime history of at least one comorbid disorder (more than 75%). Among adults, 6 participants endorsed current moderate to severe depression (BDI score greater than 19), and 3 reported moderate levels of anxiety (Beck Anxiety Inventory [BAI] score greater than 21). Among adolescents, all participants endorsed current significant depression (Children's Depression Inventory score greater than 19) but not significant anxiety (RCMAS total anxiety score greater than 19). The mean socioeconomic status rank as defined by Hollingshead (1975) was 2.4 ($SD = 1.0$) for the overall study sample. Among the adult participants, 71% had attained a college- or graduate-level education. All adolescents were currently in high school.

Feasibility Assessment

Twenty-five participants (18, or 75% of adults, and 7, or 87% of adolescents) completed the study, indicating

Table 2
Pre- to Posttraining Changes in the Self-Report ADHD Symptoms and Neurocognitive Tests

		Pretest (T1)		Posttest (T2)			
	n[a]	*M*	*SD*	*M*	*SD*	*t*	p[b]
ADHD symptoms							
Inattentive	23	17.13	4.62	12.91	4.08	4.41	< .01
Hyperactive	23	11.96	7.22	8.52	5.32	2.70	.01
Combined	23	29.09	10.74	21.43	8.17	3.74	< .01
Cognitive measures							
ANT alerting	24	38.46	20.83	46.42	25.19	–1.64	.11
ANT orienting	24	50.29	23.28	62.46	28.94	–1.83	.08
ANT conflict	24	142.46	45.51	102.00	33.87	4.62	< .01
Stroop color	25	43.12	8.75	45.12	7.74	–2.09	.05
Stroop word	25	46.08	8.09	48.28	8.74	–1.50	.15
Stroop color–word	25	47.36	11.14	51.40	9.86	–4.51	< .01
Digit Span	25	12.44	3.09	12.00	2.97	1.19	.25
Digit Span backward	25	5.68	1.52	5.56	1.33	0.45	.66
Digit Span forward	25	7.36	1.19	7.32	1.25	0.18	.86
Trails A	25	32.35	9.91	26.31	8.30	4.47	< .01
Trails B	24	61.89	19.59	52.43	10.55	2.81	< .01
Vocabulary	25	14.08	3.11	14.64	2.56	–1.83	.08

Note: ANT = Attention Network Test.

a. Includes adult and adolescent data pooled; for some variables, sample size falls below 25 because of an extreme outlier (n = 1 on Trails B) or failure to complete ADHD forms (n = 2) or ANT task (n = 1).

b. Results of paired *t* test.

an overall 78% adherence rate. Four adults dropped out after one session (unknown reason for dropout, as the participants failed to return our calls), one dropped out after four sessions (family emergency), and one failed to complete the postintervention assessment (illness). One adolescent dropped out after four sessions because of conflicts with schoolwork. There were no differences between completers and dropouts based on ADHD subtype, self-reported severity of ADHD symptoms, or current stimulant use (all $p > .05$).

There were no adverse events reported. During the course of the study, one adult reported adding modafinil to his medication regimen, one adult reported reducing his or her methylphenidate dose, and one adult reported starting atomoxetine. One adolescent reported an increase in her methylphenidate dose. No other significant changes in outside treatment were noted. Because of the naturalistic type of this pilot study, everyone who completed at least 4 weeks of training and completed the postintervention assessment was included in the analyses.

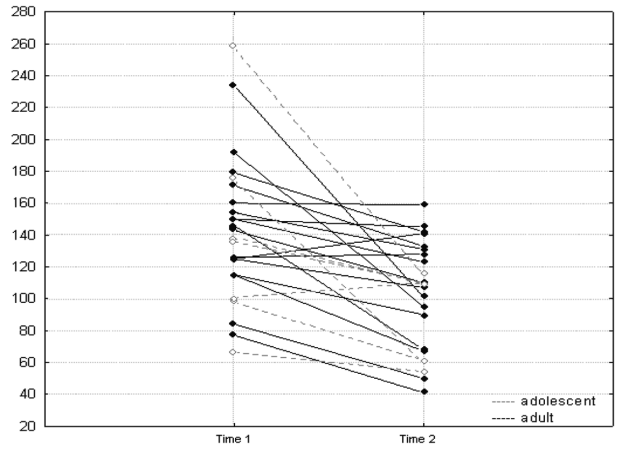
On average, participants attended seven of the eight sessions, with a range of six to eight (in both adult and adolescent groups). The adult group reported an average of 90.3 (*SD* = 57.9; range = 10.3 to 194.4) min per week of at-home meditation practice and an average of 4.9 (*SD* = 1.6; range = 1.5 to 7) days of practice per week. The adolescent group reported an average of 42.6 (*SD* = 15.4; range = 23.7 to 68.9) min per week of at-home practice and an average of 4.02 (*SD* = 0.93; range = 2.4 to 5.6) days of practice per week. Adults practiced significantly more minutes per week than adolescents ($p = .03$). On the visual analog scale measuring satisfaction from 1 (*least satisfied*) to 10 (*most satisfied*), satisfaction level was high among both adults (*M* = 9.40, *SD* = 0.80) and adolescents (*M* = 9.35, *SD* = 1.04).

Exploratory Pre- and Posttraining Assessment

Adult and adolescent ADHD self-report (comparable *DSM-IV* criteria items from ADHD Rating Scale–IV and SNAP-IV) and neurocognitive data were combined to examine pre–post training changes. As shown in Table 2, there were significant pre- to posttest improvements in ADHD self-reported symptoms and performance on several neurocognitive tasks.

Eighteen of the 23 (78%) participants reported a reduction in their total ADHD symptoms, with 7 of the 23 (30%) participants reporting at least a 30% symptom reduction (considered a clinically significant improvement). On neurocognitive task performance, significant improvements were found for measures of attentional conflict

Figure 1
Individual ANT Conflict Scores at Time 1 and Time 2



Note: ANT = Attention Network Test.. The graph shows the individual response times on the conflict attention subset of ANT at pre- (Time 1) and posttraining (Time 2) assessments. Adults are represented by black circles and solid lines, and adolescents are represented by open circles and dashed lines. For comparison purposes, mean ANT conflict scores are found to be 132.2 ms (*SD* = 40.1) in adolescents with ADHD, 111.8 ms (*SD* = 39.4) in control adolescents (S. Smalley, personal communication, June 26, 2006), and 84 ms (*SD* = 25) in a normative sample of adults (Fan et al., 2002).

(ANT conflict and Stroop color-word) and set-shifting (Trails A and B) (all $p < .01$) but not for measures of working memory. To further illustrate the observed changes, we plotted individual performance on the ANT conflict task (Figure 1) and compared them to the average scores for other ADHD samples and/or the general population. Of note, the mean posttraining ANT score in our ADHD sample is comparable to mean scores found elsewhere in non-ADHD adult (Fan, McCandliss, Sommer, Raz, & Posner, 2002) or adolescent samples (S. Smalley, personal communication, June 26, 2006).

In adults, improvements were found in depression (mean BDI at T1 = 14.9, *SD* = 11.1, and mean BDI at T2 = 7.3, *SD* = 5.2; $t = 2.6$, $p < .01$) and anxiety (mean BAI at T1 = 7.2, *SD* = 3.1, and mean BAI at T2 = 4.1, *SD* = 2.6; $t = 2.6$, $p = .02$). Six adults who endorsed clinically significant depression at baseline (BDI score greater than 19) no longer reported significant depression after the training, whereas one adult, previously not reporting significant depression, endorsed moderate depression. In adolescents, there were negligible changes in depression (mean Children's Depression Inventory score at T1 = 25.0, *SD* = 1.8, and mean Children's Depression Inventory score at T2 = 24.3, *SD* = 1.9) or anxiety (mean RCMAS at T1 = 7.3, *SD* = 4.0, and mean RCMAS at T2 = 5.0, *SD* = 2.6), and small sample size precluded statistical testing.

We used linear regression models to evaluate the effects of age, sex, stimulant medication status, and at-home meditation practice time (in minutes per week) on changes showing significant improvement (i.e., ADHD symptoms, cognitive measures of ANT conflict and set-shifting, and adult mood and anxiety symptoms). Baseline score was a significant predictor of all change scores (data not shown); therefore, all regression models included the baseline score in an attempt to control for regression to the mean. Age was found to be inversely associated with improvement in Trails A ($p = .03$) (i.e., younger age = more improvement), and at-home practice time was marginally associated with improvement in ANT conflict ($p = .07$). No other significant relationships at $p < .05$ were found for any other dependent variables.

Discussion

We report the results of a feasibility pilot study of mindfulness training for adults and adolescents with ADHD. The training is adapted to ADHD and administered in a group setting. MAPs for ADHD was well received by participants in both age groups as evidenced by high overall training adherence rate (78%), no reports of adverse effects, and high measures of participant satisfaction (9/10 on a visual analog scale). Our recruitment data suggest that many adults and adolescents who wanted to participate could not enter the study because of their own (e.g., frequent afterschool activities) or our scheduling restrictions (e.g., our training was offered only once on specific dates and we requested participation in the first training session and a minimum of four sessions). This suggests that the ease of access to the program and schedule flexibility is critical when offering this group training, especially in adolescent samples. Our exploratory pre- to postassessment indicates that our program may lead to reduced self-reported ADHD symptoms and improved performance on selected tests of associated neurocognitive impairments. In summary, the study supports feasibility and potential utility of mindfulness meditation in at least a subset of adults and adolescents with ADHD.

We hypothesized that mindfulness training may improve attention and emotion regulation in ADHD. In an exploratory investigation of efficacy, we measured various aspects of attention and set-shifting. The neurocognitive findings suggest that mindfulness may specifically improve conflict attention and set-shifting in ADHD. This type of attention appears to play a role in

the development of inhibition and self-regulation (Rueda, Posner, & Rothbart, 2004)—two constructs also proposed to be key deficits in ADHD (Barkley, 1997a). Mindfulness training also engenders qualities such as acceptance of experience, nonreactivity, willingness/effort, and friendly attitude toward self and is likely to facilitate emotional regulation. In the adult group, both anxiety and depression scores improved. It is likely that the intensity of practice, prior meditation experience, and diagnostic status may result in differential effects of this training on the attentional or emotion regulation systems. Clearly, more studies with additional measures of attentional and emotional functioning are needed to elucidate this relationship.

The study results must be viewed in light of methodological limitations. Being a pilot study with a small sample size, the study findings have limited generalizability. Our study sample was also atypical in that the majority of our participants were female, White, educated, and from medium to high socioeconomic status. Although we did not formally measure IQ, the high average vocabulary scores obtained suggests average to high average IQ range. In addition, our sample included several adults with "probable ADHD" and had more lifetime mood disorders (mostly depression and dysthymia) and less lifetime oppositional defiant disorder than most ADHD adult (Kessler et al., 2006) or adolescent (Wolraich et al., 2005) samples. These characteristics suggest that our sample represents individuals with higher rates of comorbidity yet perhaps greater levels of overall functioning than what is commonly seen in the ADHD samples (e.g., average or higher levels of IQ, education, or socioeconomic status). The demographics of the area surrounding our university (higher than average socioeconomic status), inclusion of "probable ADHD," and our exclusion criteria (e.g., exclusion of conduct disorder) may have influenced the make-up of our sample. Of note, current literature suggests that female gender, being White, and high socioeconomic status are factors associated with complementary and alternative medicine use among the general population (Tindle, Davis, Phillips, & Eisenberg, 2005), and these factors may have also influenced our study sample. Future research is needed to determine the efficacy of MAPs in the general ADHD population and whether this approach may be more appropriate for certain groups within ADHD.

It is important to note that the MAPs program is delivered in a group setting and social support may have contributed to the overall positive response. The psychoeducation component was designed to reframe ADHD as a "neurobiological difference" along continua of functioning, and this also may have led to increased satisfaction and favorable self-report of psychiatric symptoms. Accordingly, future studies should compare the effects of mindfulness with effects of psychoeducation and group support.

Overall, the reported pre–post changes in behavioral and neurocognitive measures should be considered exploratory given the absence of a control group and reliance on self-report measures of psychiatric symptoms. The pre–post changes could reflect effects of the intervention, regression to the mean, placebo effect, or practice effect (neurocognitive measures). In future studies, a control group and multi-informant measures would be important to confirm the current preliminary results. However, the findings of improvement on some, but not all, cognitive tasks and specifically measures of conflict attention and set-shifting suggest that MAPs may improve certain aspects of cognition and not others.

Overall, results of this pilot study support the feasibility of mindfulness meditation in a subset of ADHD adults and adolescents and encourage future controlled studies of MAPs for ADHD. This approach, seen as self-regulation training, offers a novel and potentially useful tool in the multimodal treatment of this condition.

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