Internet-Based Mindfulness Meditation and Self-regulation: A Randomized Trial with Juvenile Justice Involved Youth

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Abstract

There is mounting evidence that the traumas disproportionately faced by incarcerated youth outside of custody are barriers to the healthy development of self-regulation, compounding their risk for poor social and developmental outcomes. To address this risk, a randomized controlled trial was conducted comparing the impact of Internet-based mindfulness meditation and guided relaxation on self-regulation in juvenile justice–involved youth. Multiple regression analysis was used to assess the differences between treatment and control groups on posttest scores, controlling for pretest scores, with age group included as a moderator in an interaction term with treatment group. Treatment youth in the oldest age group (age 19 to 23) scored significantly higher on interpersonal self-restraint at posttest than similarly aged youth in the control group. Differences were found in the interaction model, but not in the main effects model indicating that, had age been included as a control variable only, treatment effects would not have been found due to the increased variation of age groups analyzed together. These findings support (a) the use of Internet-based mindfulness meditation as a method of fostering the development of self-regulation in incarcerated youth, and (b) the use of age as a moderator in analyses of treatment effects when outcomes are self-regulatory in nature (i.e., delinquency).

Introduction

Youth incarcerated in the juvenile justice system are disproportionately exposed to stressors outside of custody known to increase the risk for physical violence, delinquency, and self-injurious behaviors (Duke, Pettingell, McMorris, & Borowsky, 2010). Such stressors include parental incarceration (Phillips, Burns, Wagner, Kramer, & Robbins, 2002; Simons, Simons, Chen, Brody, & Lin, 2007), violent victimization and exposure to violence (Hawkins et al., 2000), as well as poverty and family disruption (Snyder & Sickmund, 2006). These stressors, which are enduring factors in the lives of incarcerated youth prior to and after incarceration, are considered what the Centers for Disease Control has termed Adverse Childhood Experiences (ACE).[1] ACEs have been associated with increased risk for depression, substance use

[1] www.cdc.gov/nccdphp/ace

disorders, personality disorders, conduct disorders, attention deficit hyperactivity disorder (ADHD), and anxiety (Adams, 2010). Long-term outcomes associated with ACEs include poor anger control, high perceived levels of stress, relationship problems, risk of perpetrating or being a victim of domestic violence (Larkin, Shields, & Anda, 2012), delinquency, and violence perpetration (Duke et al., 2010). Although an estimated 34% of youth in the United States experience some type of ACE, it is an experience shared by 75% to 93% of youth entering the juvenile justice system (Adams, 2010).

ACEs have also been implicated as barriers to the healthy development of self-regulation (Allen, 2011; Hein, Cohen, & Campbell, 2005), a critical developmental process of the adolescent period and a skill whose maturation is associated with the reduction of normative risk-taking (Eshel, Nelson, Blair, Pine, & Ernst, 2007; Steinberg, 2008) and the increase in cognitive control of behavior in emotionally charged situations (Luna, Padmanabhan, & O'Hearn, 2010; Nelson, Leibenluft, McClure, & Pine, 2005). Incarcerated youth are thus a population at risk for poor social and developmental outcomes due to their disproportionate exposure to circumstances that not only act as barriers to healthy development, but also contribute to and exacerbate the high rate of emotional problems and recidivism found in this population. If the juvenile justice system is to successfully reduce recidivism among incarcerated youth, facility programming must support the healthy development of self-regulation while youth are in custody and find ways to maintain that support when youth are again faced with the traumas endemic to their lives outside of custody.

Background and Significance

An estimated 130,000 youth are incarcerated in juvenile justice facilities in the United States (Puzzanchera, Adams, & Sickmund, 2010). It is well documented that these youth experience disproportionately high rates of emotional, educational, and substance use problems. For instance, 90% of youth leaving state custody in 2003 reported experiencing an emotional problem such as anger management difficulties (81%), anxiety (61%), depression (59%), substance abuse (68%), suicidal ideation (27%) or suicide attempts (21%), with a vast majority (71%) reporting multiple problems (Sedlak & McPherson, 2010; Snyder & Sickmund, 2006). In addition, 22% of incarcerated youth have more recently reported at least one past suicide attempt, four times the national average, as well as high rates of substance use, with 84% (vs. 30% in the general population) reporting marijuana use, 59% reporting being high or drunk the week prior to their arrest, and 68% reporting problems and blackouts stemming from their substance use (Sickmund, 2010).

Incarcerated Youth as an Adolescent Population

Although incarcerated youth are a special population given their disproportionate exposure to individual, family, and community adversity, they are also, by definition, a group in the midst of a critical developmental period. Central to this period is the neural development of key brain systems involved in self-regulation, which continues through the teens and into the early 20s. There is ample evidence to indicate that the development of connections in and between three of these key areas, the Medial Prefrontal Cortex (MPFC), the Ventrolateral Prefrontal Cortex (VLPFC), and the Anterior Cingulate Cortex (ACC), occur on a predictable developmental timeline while at the same time being responsive to experience, particularly during the adolescent period (Casey, Getz, & Galvan, 2008, p. 67; Cauffman, Steinberg, & Piquero, 2005). Accompanying the maturation of the MPFC, VLPFC, and ACC are increases in response inhibition, planning ahead, weighing risks and rewards, and simultaneously considering multiple sources of information (Steinberg, 2008).

There is mounting evidence that ACEs influence the development of the prefrontal cortex

and the neural pathways between the prefrontal cortex and the amygdala (Anda, et al., 2006; Bremner, 2003), which has implications for the healthy development of self-regulation, given the involvement of those pathways in the cognitive control of emotional impulses (Fareri, Martin, & Delgado, 2008). Given that youth incarcerated in the juvenile justice system are disproportionately exposed to ACEs, identifying interventions that support the development of self-regulation is vital to reducing the poor social and developmental outcomes associated with exposure to ACEs while decreasing the likelihood of repeat offending and further incarceration. One intervention that has been associated with positive mental health outcomes and increases in self-regulation is mindfulness meditation.

Mindfulness Meditation

Mindfulness meditation is a practice that is based in the Buddhist Vipassana, or insight meditation tradition, which "encourages the cultivation of nonjudgmental, moment-to-moment awareness both during formal meditation practice and in everyday life" (Jain, et al., 2007, p. 11). Successful integration of mindfulness meditation into individual practice has been found with programs ranging from 45-minute sessions once a week for 4 weeks (Jain et al., 2007) to 2-hour sessions once a week for 8 weeks (Ramel, Goldin, Carmona, & McQuaid, 2004). Mindfulness meditation may be an effective intervention for incarcerated youth because the mechanisms through which mindfulness meditation affect the practitioner include an increase in self-regulation, which is negatively associated with delinquent and other risk behaviors (Steinberg, 2008). Mindfulness meditation is an intervention that is amenable to experimentation, feasible with incarcerated youth, and appropriate as an intervention to address the issues that incarcerated youth face both in and out of state custody.

There are three main components common to most definitions of mindfulness meditation practice. The first, *present awareness*, refers to having one's awareness in the present moment. The second, *nonjudgmental awareness*, refers to being aware of but not judging the emotions, thoughts, or events of the present moment as good or bad. The third component, *acceptance*, refers to accepting the emotions, thoughts, or events of the present moment as they are (Biegel, Brown, Shapiro & Schubert, 2009; Burke, 2010; Ivanovski & Malhi, 2007). The experience of these components in practice has been described in the following way:

> When thoughts or feelings come up in your mind, you don't ignore them or suppress them, nor do you analyze or judge their content. Rather, you simply note any thoughts as they occur as best you can and observe them intentionally but nonjudgmentally, moment by moment, as the events in the field of your awareness. Paradoxically, this inclusive noting of thoughts that come and go in your mind can lead you to feel less caught up in them and give you a deeper perspective on your reaction to everyday stress and pressures. By observing your thoughts and emotions as if you had taken a step back from them, you can see much more clearly what is actually on your mind. You can see your thoughts arise and recede one after another. You can note the content of your thoughts, the feelings associated with them, and your reactions to them. You might become aware of agendas, attachments, likes and dislikes, and inaccuracies in your ideas (Kabat-Zinn, 2011, p. 1).

Positive Mental Health Outcomes and Behavior Change

Mindfulness meditation has been found in randomized controlled trials to have significant effects on positive states of mind and stress reduction (Broderick, 2005; Jain et al., 2007), as well as reduced rumination, which mediated reductions in maladaptive cognitive content and affective symptoms (Ramel et al., 2004). Other studies using qualitative and correlational designs

have found a positive relationship between mindfulness meditation and reduced substance abuse in a population of incarcerated adults (Bowen et al., 2006), and increased self-control and self-awareness and decreased stress and anger in adolescent sex offenders (Derezotes, 2000). Mindfulness meditation has also been combined with existing therapies, such as cognitive behavioral therapy and dialectical behavior therapy, as a treatment for children with anxiety (Semple, Reid, & Miller, 2005) and for the prevention of suicidal behavior in patients with past suicidal ideation (Williams, Duggan, Crane, & Fennell, 2006). A review of research spanning the years 2003 to 2008 found the associated effects of mindfulness meditation practice to include lowered anxiety, depression, anger, and worry; a greater sense of well-being; increased emotional control; lowered levels of cortisol; and an increased ability to reduce harmful behaviors such as binge eating, smoking, and substance use (Greeson, 2009).

Mindfulness Meditation with Adolescents

In recent years, meditation, particularly in the Buddhist tradition, has increasingly become a part of popular culture in America, reflected in movies such as the *Matrix* trilogy; in interviews with celebrity practitioners in professional sports (e.g., NBA players); music (Beastie Boys, Red Hot Chili Peppers, and hip hop guru Russell Simmons); and in the youth movement, Dharma Punx, which is made up of meditation groups in 14 American cities, including Philadelphia, Seattle, Washington, New York, San Francisco, San Diego, and Hollywood.

Although studies have been conducted on the effects of mindfulness meditation on adolescents, much of that research has been of generally low quality, using pre/post designs with no control group (Burke, 2010), suggesting a need for additional research with adolescent populations. However, studies that have been conducted with adolescent samples using control or comparison groups have found increases in positive outcomes for adolescents who practiced mindfulness meditation. For instance, Biegal et al. (2009) found significantly lower levels of reported anxiety, stress, depressive symptoms, interpersonal problems, and obsessive symptoms and significantly higher levels of self-esteem and sleep quality in mindfulness meditation participants compared to a control group. Similarly, Huppert and Johnson (2010) found significantly higher levels of psychological well-being in treatment group youth who practiced the mindfulness meditation intervention more frequently outside of class than others in the treatment group who practiced less often, although there were no significant differences found overall between treatment and control groups.

These studies, regardless of design, indicate that adolescents are both able to and interested in learning mindfulness meditation. In addition, these studies provide evidence for the feasibility of providing mindfulness meditation training to adolescents in a variety of settings, including school (Huppert & Johnson, 2010; Semple et al., 2005) and clinical settings (Biegel et al., 2009; Derezotes, 2000), with no indications of unintended negative effects.

Mindfulness meditation may be uniquely suited for use in the juvenile justice system because it has been found to be effective as a treatment for behavioral and emotional problems similar to those reported by youth leaving custody, including suicidal ideation, anger management, anxiety, and depression (Biegal, et al., 2009; Semple, et al., 2005; Snyder & Sickmund, 2006; Williams, et al., 2006). There is also indication that mindfulness meditation may enhance the development of those specific brain areas that are both affected by childhood trauma and directly implicated in delinquent and other risk-taking behaviors.

Neuropsychosocial Model

Brain-imaging studies have found that mindfulness meditation affects those areas of the brain that are both involved in self-regulation (Creswell, Way, Eisenberger, & Lieberman, 2007; Holzel, et

al., 2011; Holzel, et al., 2007) and are undergoing significant change during the adolescent period (Ernst, Pine, & Hardin, 2005; Fareri et al., 2008; Giorgio, et al., 2010). Neural-imaging studies of adults with various levels of mindfulness meditation experience have consistently found increased activity in the medial prefrontal cortex (MPFC) and parts of the neural network of which the MPFC is a part, with significantly greater activity in the MPFC of experienced meditators compared to nonmeditators (Holzel et al., 2007). In addition, an 8-week mindfulness meditation intervention study found significant increases in treatment versus control groups in synaptic connections in several areas of the brain that form a neural network with the MPFC and are involved in considering the future and taking the perspective of others (Holzel, et al., 2011). Finally, a correlational study measuring the relationship between brain activity and levels of mindfulness found that higher levels of mindfulness were associated with higher levels of activity throughout the prefrontal cortex, particularly in the VLPFC and MPFC (Creswell, et al., 2007).

Overall, these findings indicate that mindfulness meditation increases synaptic connections and neural activity in areas that (a) are still developing in the adolescent brain, and (b) are involved in self-regulation. This increase in synaptic connections and the predicted increase in myelination associated with the rise in neural activity may well translate into enhanced neural functioning in those prefrontal areas that moderate emotional and reward systems, the predicted effect of which would be an increase in the ability to self-regulate.

The intersection of neurodevelopmental and mindfulness literature introduces two contrasting possibilities related to mindfulness meditation and the methods by which self-regulation matures (i.e., experientially and developmentally). The first is the possibility that mindfulness meditation could enhance self-regulation through the experiential aspect of self-regulatory maturation; the second is the possible developmentally determined limitations of that enhancement. To explore these possibilities, two hypotheses guided the design and analysis of this mindfulness meditation intervention with incarcerated youth:

1. Mindfulness meditation will be associated with increased self-regulation among adolescents who practice it, when compared to a Guided Relaxation intervention.
2. The impact of mindfulness meditation on self-regulation will be moderated by age, used as a proxy for level of neurological development, such that the 15 to 17 year-old age group will experience smaller increases in self-regulation than those in the 18 to 23 year-old age group.

Methods

To test these hypotheses, a randomized-controlled trial was conducted in which participants were randomly assigned to either mindfulness mediation or guided relaxation.

Participants

One hundred and twenty-one youth incarcerated in a long-term juvenile justice facility were recruited for the study, with all but two consenting or assenting to participate. A total of 58 youth who consented/assented did not attend the pretest/randomization session. Twenty-three of these youth were under the age of 18 and were unable to participate due to a lack of consent by a parent or guardian. The remaining 35 did not participate for a variety of reasons, including refusal to attend the pretest session, lockdown on the day of the pretest, release from custody, or transfer to another facility. A total of 61 young men attended the pretest session and were randomized to eight sessions of mindfulness meditation or eight sessions of guided relaxation. Of the 61 participants who started the study, 44% (n = 27) completed the study through the posttest and were included in the analysis of treatment effects. Attrition from the study and thus exclusion from the final analysis was most often due to

being out of custody at the time of the posttest (n = 19, 31%), followed by withdrawal from the study (n = 8, 13%), and being on lockdown (not allowed to leave the housing unit) on the day of the posttest (n = 3, 5%). Three additional youth from the control group who completed both the pretest and posttest were excluded from analysis of treatment effects due to exposure to the treatment (contamination) and one youth from each of the groups was dropped from both the baseline and final analysis due to an excessive number of missing answers on pretest measures of self-regulation.

Procedure

A randomized controlled trial was conducted in which participants were randomly assigned to either eight 1-hour weekly sessions of mindfulness meditation or guided relaxation. A male research assistant used prerecorded mindfulness meditation or guided relaxation instructions to facilitate treatment and control group sessions.

Consent interviews were conducted with youth 18 and over and assent interviews were conducted with youth 17 and under. Facility staff members were given parental consent forms, which they sent to the parents/guardians of all youth under the age of 18 who assented to participate. Randomization was done at the individual level within housing unit groups, with youth from housing units A, B, and C randomly assigned to either treatment or control groups meeting on Thursday nights and youth from housing units D, E, and F randomly assigned to either treatment or control groups meeting on Friday nights. Housing units were combined by the facility administrators based on those that normally mixed in other facility activities. The randomization process utilized a list of numbers, with even numbers representing mindfulness meditation assignment and odd numbers representing guided relaxation assignment. Each number was written on an individual piece of paper, folded, and placed in a small paper bag. At the end of the pretest session, as each participant turned in his completed questionnaire, he was asked to pick a piece of paper out of the bag. The number chosen indicated his group assignment. All study activities were approved by the University of Pennsylvania Institutional Review Board (IRB).

Treatment Group: Mindfulness Meditation

The mindfulness meditation treatment sessions used recordings of lectures and guided meditation by Noah Levine, a Buddhist practitioner who has extensive training and experience in teaching meditation to incarcerated youth and adults, as well as to nonincarcerated youth recovering from drug and alcohol addiction. All audio recordings used in the study are available for free at Mr. Levine's website, http://www.dharmapunx.com/htm/mp3.htm. Each session began with a lecture-like presentation of mindfulness-related topics, such as compassion, patience, and mindfulness in everyday life followed by guided meditation encouraging relaxed, nonjudgmental awareness of thoughts and feelings while focusing on the breath.

Comparison Group: Guided Relaxation

The comparison group for this study participated in an alternative intervention, guided relaxation. Guided relaxation was chosen as the control group activity for its adaptability to an MP3 delivery and its ability to mimic the mindfulness meditation class setup; that is, participants in both classes simply sat at tables for the duration of the class and listened to audio instructions. Guided relaxation, also called progressive muscle relaxation, includes very simple instructions in shifting awareness through different muscle groups in a conscious attempt to relax the body and reduce cognitive and physiological stress (Pawlow & Jones, 2005). The practice has been found to significantly lower levels of salivary cortisol after a single 1-hour session (Pawlow & Jones, 2005) and, in meta-analysis, to have a medium-high effect on anxiety, particularly for young people (Manzoni, Pagnini, Castelnuovo, & Molinari, 2008). Although guided relaxation and

meditation have both been found to significantly reduce anxiety, the practice of mindfulness meditation is also associated with "important shifts in cognition, emotion, biology, and behavior" (Greeson, 2009, p. 15). It is this change in behavior, cognition, emotion, and biology that is hypothesized for the treatment group but not for the control group.

Internet Delivery

The study utilized MP3 (audio file) downloads from the Internet instead of employing a teacher trained in mindfulness meditation for several reasons. First, this approach to the delivery of adolescent interventions recognizes the centrality of technology in adolescents' daily lives (Nelson & Nelson, 2010), which may increase the interest of participants. Second, this method of delivery increases assurance of the integrity of intervention delivery (i.e., fidelity) while testing a novel approach to meditation instruction. Third, this method of delivery provides an intervention that youth can continue to practice both in and out of custody with the same structure as that provided during the intervention, recognizing that most of these youth will return to impoverished families and communities (Bailey et al., 1999; Bjerk, 2007; Carlson, 2006) that cannot always provide the guidance they need once they are out of custody.

Measuring Self-Regulation

A self-reported measure of self-regulation was completed prior to and after the 8 weeks of treatment and control sessions using the Restraint-Weinberger Adjustment Inventory (RWAI). Two of the four RWAI subscales were used to measure complimentary dimensions of self-regulation: the Suppression of Aggression subscale, which assesses interpersonal self-restraint and the Impulse Control subscale, which assesses intrapersonal self-restraint (Weinberger, 1996). Internal consistency of the subscales has been found to range from 0.79 to 0.82 for the Suppression of Aggression scale and 0.66 to 0.69 for the Impulse Control scale (Feldman & Weinberger, 1994). Construct validity has been demonstrated in studies of clinical and non-clinical samples of children and youth (Farrell & Sullivan, 2000; Weinberger, 1997). Internal reliability with the current sample was found to equal 0.82 for the Self-Regulation composite, 0.73 for the Impulse Control subscale, and 0.81 for the Suppression of Aggression subscale.

Together, the two subscales comprise 15 items that include questions such as: "If someone tries to hurt me, I make sure I get even with them;" "I'm the kind of person who will try anything once, even if it's not that safe;" and "I do things without giving them enough thought." Response options for both subscales range from 1 (Never) to 5 (Almost Always), or 1 (False) to 5 (True), with degrees of application in between (e.g., Sometimes, Often or Somewhat False, Somewhat True).

Data Analysis

In recognition of possible differences in the capacity to increase levels of self-regulation via experience due to that part of self-regulation that is developmentally determined, age as a proxy for neurological development was included in analysis as a moderator of the relationship between mindfulness meditation intervention effects and self-regulation. Age groupings were used based on common developmental subdivisions in brain-imaging studies of self-regulation (Luna, Padmanabhan, & O'Hearn, 2010). Based on the age makeup of the sample and to allow for contrast with multiple referent groups of similar sizes (Gordon, 2010), the final age groupings used for the analysis were: age1 (age 16 to 17), age2 (age 18), and age3 (age 19 to 23). The study used multiple regression analysis to test for intervention effects on self-regulation using (a) a Main Effects model, which included pretest scores, a treatment dummy variable, and two of three age group dummy variables; and (b) an Interaction model, which added a treatment x age group interaction term.

Results

The mean age of the overall sample was age 18 years (*sd* = 1.30), with 17 youth (28%) in the age 16 to 17 group, 24 youth (40%) in the age 18 group, and 19 youth (32%) in the age 19 to 23 group. The age range for the sample was skewed to the higher age groups compared to the population of male youth in residential placement in New Jersey's juvenile justice system, where 57% are age 16 to 17 and 30% are age 18 and older.[2] The difference between the overall population of youth in residential placement and this sample is directly related to the number of parents who did not return consent forms rather than to a lack of interest in participation by youth under the age of 18.

All participants took the Self-Regulation pretest, with higher scores reflecting higher levels of self-regulation and lower scores reflecting lower levels. Pretest scores for the Self-Regulation composite ranged from 25–66 out of a possible range of 15–75, with a sample mean of 44 (*sd* = 9.2); the Impulse Control scores ranged from 14–36 out of a possible range of 8–40, with a sample mean of 24.5 (*sd* = 5.48); and the Suppression of Aggression scores ranged from 10–34 out of a possible range of 7–35, with a sample mean of 5.35 (*sd* = 5.35). Descriptive analysis of each measure, along with subscales and bivariate relationships among variables, are provided in Table 1.

Table 1. *Summary of Self-Regulation Pretest Scores*

	Self-Regulation Composite	Impulse Control	Suppression of Aggression
Self-Regulation Composite	1.00		
Impulse Control	0.85*	1.00	
Suppression of Aggression	0.85*	0.45*	1.00
N	59	59	59
Mean	43.93	24.50	19.43
SD	9.20	5.48	5.35

*$p<0.05$

[2] Easy Access to the Census of Juveniles in Residential Placement: 1997-2010 http://ojjdp.gov/ojstatbb/ezacjrp/asp/Age_Sex.asp

Equivalence Check and Fidelity Assessment

Of the 59 participants with complete self-regulation pretest data, 29 were randomized into the treatment group and 30 were randomized into the control group. Rates of attrition, baseline equivalency between those included and excluded from the final analysis (Tables 2 and 3), and baseline equivalency between the final treatment and control groups

Table 2. *Baseline Comparisons of Mean Self-Regulation Scores at Pretest of Cases Included vs. Excluded from Final Analysis*

	Excluded *M (SD)*	Included *M (SD)*	t-test (df)	2-tailed *p*-value
Self-Regulation Composite	44.23 (9.87)	43.57 (8.52)	0.27 (57)	0.79
Impulse Control	24.70 (5.75)	24.26 (5.23)	0.31	0.76
Suppression of Aggression	19.53 (5.97)	19.31 (4.60)	0.15	0.88

Table 3. *Baseline Comparison of Age Groups: Cases Excluded vs. Included in Final Analysis*

Age Group	Excluded *n*	Included *n*
1 (16-17)	10	7
2 (18)	13	11
3 (19-23)	10	9

$\chi^2(2) = 0.15$ $p = 0.93$

Table 4. *Baseline Comparisons of Mean Self-Regulation Scores at Pretest: Final Control vs. Final Treatment*

	Final Control *M (SD)*	Final Treatment *M (SD)*	t-test (df)	2-tailed *p*-value
Self-Regulation Composite	43.65 (8.71)	43.50 (8.67)	0.05 (25)	0.96
Impulse Control	24.00 (6.14)	24.50 (4.45)	-0.24	0.81
Suppression of Aggression	19.65 (3.56)	19.00 (5.52)	0.36	0.72

Table 5. *Comparison of Age Groups: Final Control vs. Final Treatment*

Age Group	Final Control	Final Treatment
1 (16-17)	2	5
2 (18)	5	6
3 (19-23)	6	3

$\chi^2(2) = 2.34$ $p = 0.31$

used in analysis (Table 4 and 5) were made with no significant differences found between groups.

To measure the fidelity of the treatment and control sessions to the intended intervention and research plans, session summary sheets and field notes were analyzed, which indicated that only 6%—or 6 out of 102 sessions (i.e., mindfulness meditation class sessions, guided relaxation class sessions, pretest/randomization sessions, and posttest sessions across three rounds of the study)—deviated in any way from the treatment plan or the research design.

Posttest Suppression of Aggression: Treatment Versus Control

As reported in Table 6, there were several significant differences in mean posttest Suppression of Aggression scores between treatment and control conditions and between age groups within the treatment condition using the Interaction model. First, older youth in the age3 treatment group scored, on average, almost 6 points higher ($p < 0.05$) on the Suppression of Aggression posttest than the age3 control group. Second, the age3 treatment group scored 11 points higher ($p < 0.05$), on average, than the age1 treatment group, and 8 points higher ($p < 0.05$), on average, than the age2 treatment group. Finally, in the age1 group, youth in the control group outperformed youth in the treatment group by an average of 5 points ($p < 0.05$). No differences were found between treatment and control groups in the Main Effects model for the Suppression of Aggression scale, nor in either model for the Impulse Control or Self-Regulation Composite scores.

Table 6. *Suppression of Aggression Mean Posttest Scores*[1]

	Suppression of Aggression	
	Main Effects *B (SE)*	**Interaction** *B (SE)*
Pretest	1.08 (0.25)*	1.06 (0.20)*
Treat v Control	-0.551 (1.53)	
Treat v Control Age 1		-5.38 (2.47)*[1]
Treat v Control Age 2		-2.72 (1.78)[2]
Treat v Control Age 3		5.75 (2.08)*
Age 1	-1.96 (2.08)	3.63 (2.48)
Age 2	0.631 (1.90)	3.84 (1.90)
Age 1 × Treat		-11.13 (3.19)*
Age 2 × Treat		-8.47 (2.71)*
Intercept	0.191 (5.37)	-1.51 (4.30)
N	27	27
Adj ^2R	0.48	0.67
F-Value	$F(4, 22) = 6.94$*	$F(6, 20) = 9.79$*
Δ *Adj* ^2R		0.22
F-Value		$F(2,20)=7.33$*

*$p<0.05$
[1] Intercept: $B=2.13$, $SE=5.26$, $p>0.05$
[2] Intercept: $B=2.33$, $SE=3.65$, $p>0.05$

Discussion

This randomized controlled trial supports the use of an Internet-based mindfulness meditation intervention to increase *interactional* self-regulatory capacities of incarcerated youth. These findings also indicate, as hypothesized, that this ability is most pronounced in older youth, with the largest mean differences between treatment groups occurring in the oldest age group and, within the treatment group, between the oldest and the youngest age groups, with diminishing differences between the oldest and middle age groups. It is important to note that without the addition of an interaction term, which allowed for the comparison of treatment effects within each age group, these results would have been lost in the developmental variation of age groups analyzed together. This is evident in the main effects model, in which age was included as a control variable only and where no significant differences were found between treatment and control groups.

One significant difference between groups that was not hypothesized was in Suppression of Aggression posttest scores between treatment and control youth in the youngest age group (age

[1] Additional calculations were conducted to provide coefficients and significance levels for the dummy variable reference categories in Table 6 for the sake of convenience in discussing the models.

16 to 17), where youth in the guided relaxation control group outperformed youth in the mindfulness meditation treatment group. While guided relaxation has not been associated in previous research with increases in self-regulation, it has been associated with reductions in stress, making it plausible that the source of the difference between the groups may have been based on differences in stress levels. Changes in interpersonal aggression due to changes in stress levels would be consistent with studies correlating stress with aggression in interpersonal relationships (Shortt, Capaldi, Kim, & Tiberio, 2013) and the ability to self-regulate emotions in interpersonal interactions (Chan & Wan, 2012). It may be that guided relaxation is more effective in reducing stress than mindfulness meditation, or that guided relaxation, because it is more physical in nature (tightening and relaxing muscles groups), is more engaging for younger youth than the more passive, cognitively based practice of mindfulness meditation.

The causal mechanism underlying changes in Suppression of Aggression scores, therefore, may be different for different age groups. Changes in stress levels from the practice of guided relaxation may underscore differences in Suppression of Aggression scores in the younger group in whom, theoretically, there is no limit in the ability to experience decreases in stress, but in whom, theoretically, there are limitations in the ability to experience increases in self-regulation. Alternatively, changes in stress levels and self-regulation may underscore differences in Suppression of Aggression in the older group where theoretically those in the mindfulness meditation group would have the benefit of both the reduction in stress associated with mindfulness meditation and the increase in self-regulation.

Impulse Control

Neither the main effects model nor the interaction model indicated any significant differences between the treatment and control groups in any of the age groups, nor between age groups within the treatment group, for intrapersonal self-regulation as measured by the Impulse Control scale. Therefore, hypotheses one and two were not supported when self-regulation is operationalized as *intra*personal self-restraint.

The difference in treatment effects between the two types of self-regulation may be explained by differences in exposure to situations within the juvenile justice facility setting that call for intra- versus interpersonal self-restraint. It is plausible that the opportunity to practice *intra*personal restraint is more limited in the correctional setting, making examples of having or not having intrapersonal restraint less salient or harder to bring to mind when considering Impulse Control items such as, "When I'm doing something for fun (for example, partying, acting silly), I tend to get carried away and go too far." Memories of such instances may be more likely to be of experiences outside of custody, with little opportunity to bring to mind more recent experiences that might indicate a change in behavior while in custody.

In contrast, more recent experiences of interpersonal restraint as assessed by the Suppression of Aggression scale may be easier to bring to mind when considering such statements as, "If someone does something I really don't like, I yell at them about it." Many opportunities are likely to exist in the juvenile justice setting for youth to experience such situations, providing the opportunity to bring to mind more recent examples of, and changes in, the extent to which one identifies with the statement or the frequency with which one reacts in such a manner.

Self-Regulation Composite

The Self-Regulation score was a composite of intra- and inter-personal self-restraint such that it was the combination of Impulse Control and Suppression of Aggression scores. Changes in the composite measure of self-regulation were assessed using the combined posttest scores. Neither the main effects model nor the interaction model found any significant differences

between the treatment and control groups in any of the age groups on the Self-Regulation composite posttest scores, nor were significant differences found between age groups within the treatment group. Therefore, hypotheses one and two were not supported when self-regulation is operationalized as a composite measure of intrapersonal and interpersonal self-restraint. One plausible explanation for the differences in treatment effects between a measure of interpersonal self-restraint (i.e., the Suppression of Aggression scores) and a composite of interpersonal and intrapersonal self-restraint may be that although the two scales have been found in general population studies to be complementary (Feldman & Weinberger, 1994; Weinberger, 1996), they may not have been so in this sample due to differences in the opportunity to exercise and thus bring to mind instances of intrapersonal and interpersonal self-restraint in the juvenile justice setting. Thus, a composite of the two scales as currently scored may not be a valid indicator of self-regulation in this population.

Challenges

Measuring the impact of juvenile justice interventions is an important part of ensuring the efficient use of program participants' time and the resources expended in program provision. Establishing a valid estimate of the impact of a program or intervention involves more than simply measuring the program outcomes before and after participation, given that many other factors may arguably contribute to measured changes. Therefore, to establish the true causal impact of a program, changes experienced by program participants must be compared to what those same outcomes would have been had those same people not experienced the program, a hypothetical situation called the counterfactual (i.e., what it would have been without; Bloom, Michalopoulos & Hill, 2006). This study attempted to establish the counterfactual via the random assignment of youth to either a mindfulness meditation treatment group or a guided relaxation control group. Creating the counterfactual, as well as conducting mindfulness meditation and guided relaxation class sessions with youth in a residential juvenile justice facility was, as would be expected, an awesome experience rife with challenges.

Posttest Attrition

A primary challenge in conducting this study was the retention of participants through the 8 weeks of classes to the posttest at week 9. The relatively high rate of attrition between the pretest and posttest was not, by all indications, due to a lack of interest in the classes, but was most often due to the release from custody or transfer of participants to other facilities. Overall, the study's attrition rate between randomization and the posttest was 55%, leaving a small sample size of $n = 27$ for analysis. While all possible attempts were made to avoid the attrition of participants, the primary source of attrition (release or transfer) was outside the control of the principal investigator. Analysis of baseline scores, however, indicated that neither the external validity (i.e., generalizability) nor the internal validity (i.e., equivalency of treatment and control groups) of the study was compromised as a result of study attrition.

The primary challenge of using a small sample in analysis of intervention effects is the increased likelihood of making a Type II error due to the reduced power to detect an effect. The findings here suggest that the reduced power did not lead to a Type II error, given that an effect was found in several comparisons of mean scores. In addition, the ability to find an effect in studies of mindfulness meditation with such a small sample is supported by previous studies of mindfulness meditation using randomized controlled trials, in which effect sizes ranged from medium to large (Biegel, et al., 2009; Jain, et al., 2007; Burke, 2010), with studies finding significant differences between groups with samples as small as $n = 25$ per group (Davidson et al., 2003), $n = 18$ per group (Holzel, et al., 2011), and samples even smaller than the one used here (Ditto, Eclache, & Goldman, 2006, $n = 10$ per group).

Conclusion

The purpose of this study was to evaluate an intervention for incarcerated youth, the design and evaluation of which were informed by neuropsychosocial theories of development and out-of-custody contexts, in an effort to more effectively support youths' healthy development both in and out of custody. The successful implementation and positive outcomes found here provide support for several new directions in the field of juvenile justice intervention research.

First, findings from this study provide support for a new intervention for incarcerated youth, mindfulness meditation, which has been shown here to increase the ability of older youth to suppress unwanted reactions in interpersonal contexts. The use of mindfulness meditation in juvenile justice facilities may also serve to support other juvenile justice interventions, given that self-regulation is often a mechanism by which many interventions attempt to reduce delinquency (i.e., by targeting or attempting to increase the ability of youth to delay gratification, consider the consequences of their actions, or control their emotional responses to situations). Utilizing the Internet to deliver the intervention as was done here also increases the ability of juvenile justice facilities to provide a longer period of transitional support for youth leaving custody such that the Internet-based mindfulness meditation program is freely accessible from any computer, giving youth the opportunity to continue to practice intervention skills after they are released.

Second, findings from this study provide support for the use of age as a moderator in the relationship between intervention effects and self-regulation outcomes. Without the use of age as a moderator, treatment effects on self-regulatory outcomes (e.g., delinquency) may be obscured in analyses, similar to the main effects model reported here. Considering that the use of age as an additive control variable in the analysis of juvenile justice intervention effects has been the most common use of age in the literature (Evans-Chase, Kim, & Zhou, 2013), it may be that there are many interventions that have been determined to have no effect on self-regulatory outcomes when, in fact, the true effect has been lost in the "noise" of variation that comes from combining differing levels of neuropsychosocial development in analysis.

Future Studies

This study is but a beginning to what should be the continued investigation of both the use and delivery of mindfulness meditation via the Internet with youth in the juvenile justice system and the use of neuropsychosocial principles to establish intervention effects in juvenile justice intervention research. Future studies of the use of MP3 downloads in the delivery of mindfulness meditation should explore additional samples, locations, and variations in class design to fill in the gaps and address the challenges of the current study.

Future research should include samples of girls and young women in juvenile justice facilities and special populations of youth not represented here (i.e., those in substance use and mental health treatment units). Future studies should also explore the efficacy of a shorter intervention period, with multiple classes per week across fewer weeks to address the high rate of attrition due to changes in custody status (i.e., release or transfer to a different facility) endemic to an 8-week intervention in the juvenile justice system, while maintaining the overall number of structured practice times demonstrated here to be effective. In addition, future studies should explore the efficacy of individual delivery via personal ipods as a complement to classroom delivery, to allow for the inclusion of juvenile justice–involved youth who are not safe within group settings.

Support for a moderating impact of age on the relationship between treatment effects and self-regulatory outcomes also opens up the possibility that re-analyzing data from previous studies,

whose treatment effects may have been lost due to the misspecification of age in the original analysis, may provide new information about effective interventions while saving the time and expense of additional studies requiring new data collection. Finally, the testing of interaction effects in future studies using age groups that reflect neuropsychosocial levels of development may help to establish treatment effects with more precision, thus moving the field of juvenile justice intervention research forward by identifying best practices to support one of the most vulnerable and traumatized populations of youth in our country: those incarcerated in our juvenile justice system.

About the Author

Michelle Evans-Chase received her PhD from the School of Social Policy and Practice at the University of Pennsylvania where her focus was on the design and evaluation of interventions for youth in the juvenile justice system informed by neuropsychosocial development and the impact of trauma on self-regulation. Dr. Evans-Chase received her Master's degree in Social Psychology from San Francisco State University, where she also worked for the Public Research Institute on field studies in the criminal justice system. She is currently working for the National Center for Homelessness Among Veterans as the head researcher of a national, longitudinal evaluation of the Department of Veteran Affairs' Veterans Justice Programs.

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