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Enhancing Cognitive and Social–Emotional Development Through a Simple-to-Administer Mindfulness-Based School Program for Elementary School Children: A Randomized Controlled Trial

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Abstract

The authors hypothesized that a social and emotional learning (SEL) program involving mindfulness and caring for others, designed for elementary school students, would enhance cognitive control, reduce stress, promote well-being and prosociality, and produce positive school outcomes. To test this hypothesis, 4 classes of combined 4th and 5th graders (N = 99) were randomly assigned to receive the SEL with mindfulness program versus a regular social

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responsibility program. Measures assessed executive functions (EFs), stress physiology via salivary cortisol, well-being (self-reports), prosociality and peer acceptance (peer reports), and math grades. Relative to children in the social responsibility program, children who received the SEL program with mindfulness (a) improved more in their cognitive control and stress physiology; (b) reported greater empathy, perspective-taking, emotional control, optimism, school self-concept, and mindfulness, (c) showed greater decreases in self-reported symptoms of depression and peer-rated aggression, (d) were rated by peers as more prosocial, and (e) increased in peer acceptance (or sociometric popularity). The results of this investigation suggest the promise of this SEL intervention and address a lacuna in the scientific literature—identifying strategies not only to ameliorate children's problems but also to cultivate their well-being and thriving. Directions for future research are discussed.

Keywords

social and emotional learning; well-being; mindfulness; intervention; prosociality

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It is increasingly being recognized that effective education includes practices that bolster students' social–emotional competencies in tandem with their academic knowledge (Committee on Defining Deeper Learning and 21st Century Skills, 2012; Schonert-Reichl & Weissberg, 2014). Recent years have witnessed increased empirical attention to the school-based promotion of students' social and emotional competence as educators, parents, policymakers, and other societal agencies contemplate solutions to persistent problems during late childhood and early adolescence such as poor academic motivation (Eccles & Roeser, 2009; Roeser & Eccles, 2014), school dropout (Battin-Pearson et al., 2000), school bullying and aggression (Swearer, Espelage, Vaillancourt, & Hymel, 2010), and mental health problems (Committee on the Prevention of Mental Disorders and Substance Abuse Among Children, Youth, and Young Adults: Research Advances and Promising Interventions, 2009). The reality is that today's schools are facing increased pressure to improve academic performance, while also giving attention to children's social–emotional needs, and are thus expected to do more than ever before with diminishing resources (Jones & Bouffard, 2012). Given competing demands on time and resources, it is essential that educators find and implement relatively short-term, evidence-based curricular approaches that optimize learning and social adaptation while also proving to be cost-effective (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011).

Social–Emotional Learning, Executive Function, and Mindfulness

Several models have been proposed for understanding the mechanisms that mitigate problems and promote resilience in children. The bulk of the current theoretical and empirical literature supports a social–emotional competence perspective in which children with positive social and emotional skills demonstrate resiliency when confronted with stressful situations (e.g., Durlak et al., 2011; Luthar & Brown, 2007). Such competencies and protective factors include self-awareness, self-management, social awareness, relationship skills, and responsible decision making (Collaborative for Academic, Social, and Emotional Learning, 2013). A meta-analysis of school-based social and emotional

learning (SEL) programs provided evidence that such programs can develop the skills and outcomes of interest in the present study—social and emotional competencies and their influence on well-being and academic success (Durlak et al., 2011).

One approach to promoting children's well-being is based on recent innovations in developmental neuroscience and, specifically, the importance of executive function for resilience and developmental success (Shonkoff, Boyce, & McEwen, 2009). Mounting evidence suggests that *executive functions* (EFs: cognitive control abilities depending on the prefrontal cortex [PFC] that organize, sequence, and regulate behavior) and *self-regulation* (i.e., the ability to regulate resources in the service of achieving goals) predict children's altruistic behavior (Aguilar-Pardo, Martínez-Arias, & Colmenares, 2013), school achievement and social–emotional competence (Diamond, 2012), and long-term life success (Moffitt et al., 2011). EF skills strengthen significantly throughout childhood and adolescence and can be influenced by environmental enrichment (Best & Miller, 2010; M. C. Davidson, Amso, Anderson, & Diamond, 2006).

One proposed way to support the development of EFs and self-regulation during childhood is through practicing mindfulness (Zelazo & Lyons, 2012). Defined as a mental state or trait, as opposed to a set of practices (Roeser, in press), *mindfulness* refers to an ability to focus on thoughts, feelings, or perceptions that arise moment to moment in a cognitively nonelaborative, and emotionally nonreactive, way (i.e., “paying attention in a particular way, on purpose, in the present moment, and nonjudgmentally,” Kabat-Zinn, 1994, p. 4). Being mindful requires the cognitive control strategies described earlier as EFs and can be contrasted with nonconscious attention and acting on the basis of “automatic pilot” (e.g., Langer & Moldoveanu, 2000). Mindfulness, conceived of as a set of practices to cultivate this state of mind, typically includes meditation exercises and the bringing of mindful awareness to daily activities like eating. These practices are designed to cultivate focused attention and EF, coupled with a nonjudgmental, curious attitude toward moment-to-moment experience (Kabat-Zinn, 2003). Both theory and empirical research indicate that mindfulness practices in adults can increase awareness of moment-to-moment experience and promote reflection, self-regulation, empathy, and caring for others (Hölzel et al., 2011). Moreover, mindfulness training has been found to improve adults’ regulation of stress and its underlying physiology (Marcus et al., 2003; Tang et al., 2007).

Despite this empirical support for mindfulness training with adults, the question of whether mindfulness training shows equivalent benefits for children remains largely unanswered. The relatively meager research examining mindfulness training with school-age children has yielded promising findings (for reviews, see Greenberg & Harris, 2012; Zoogman, Goldberg, Hoyt, & Miller, 2014). To date, however, this work has focused mostly on reducing mental health problems like depressive symptoms (Biegel, Brown, Shapiro, & Schubert, 2009; van de Weijer-Bergsma, Formsma, de Bruin, & Bögels, 2012). Less research has examined mindfulness training in relation to improving stress regulation, well-being, learning, or prosocial behaviors among typically developing children in regular elementary school classrooms.

Accordingly, in this study, we examined how a classroom-based SEL program (MindUP; Hawn Foundation, 2008) that incorporates mindfulness practices may promote children's cognitive control abilities and regulation of stress, well-being, and prosocialty. The MindUP curriculum is derived from psychological theory and informed by research in the fields of developmental neuroscience (Diamond, 2009, 2012), contemplative science and mindfulness (Roeser & Zelazo, 2012), SEL (Greenberg et al., 2003), and positive psychology (Lyubomirsky, Sheldon, & Schkade, 2005). The curriculum includes 12 lessons, and each component of the program builds on previous skills learned, moving children from focusing on subjective sense-based experiences (e.g., mindful smelling, mindful tasting) to cognitive experiences (e.g., taking others' perspectives), to actions such as the practice of gratitude and the doing of kind things for others in the home, classroom, and community. To date, little is known about the effectiveness or "value-added" benefits of an SEL program that incorporates mindfulness practices, self-reflective exercises, and actions involving caring for others with regard to the development of children's EFs, regulation of stress physiology, school achievement, or enactment of prosocial behavior.

Late Childhood Period

We focus on late childhood and the upper elementary school grades in this study. Collins (1984) suggested that it is during this developmental period that children's personalities, behaviors, and competencies begin to consolidate into forms that persist into adolescence and adulthood. We know that the late childhood years, just before the transitional period of puberty, are a time of considerable synaptic overproduction in the prefrontal cortex and that this appears to set the stage for advances in EFs during and following this period (Giedd, 2008). Relatedly, research also suggests these years are an important time in the transformation of so-called "top-down" and "bottom-up" information processing strategies in the regulation of behavior (Zelazo & Carlson, 2012). Changes in neural/mental organization leading up to puberty, for instance, are associated with significant changes in self-regulatory and self-reflective capacity (Zelazo & Carlson, 2012), the abstract nature of self-representations that comprise the self system (Harter, 2006; Roeser & Pinela, 2014), and moral reasoning (e.g., Nucci & Turiel, 2009). We know, for instance, that it is during these years that children become less egocentric and are able to consider the feelings and perspectives of others—they develop a sense of right and wrong and have the capacity to act prosocially in accordance with their higher levels of self- and social understanding (Eisenberg, Fabes, & Spinrad, 2006).

Providing enrichment activities that support the development of healthy forms of self-regulation and reflection, malleable self-representations (e.g., one's intellectual ability as modifiable through effort), and prosocial dispositions could ameliorate or even prevent some of the mental health and school-linked problems that often arise around the transition to secondary school and puberty (see Eccles & Roeser, 2009). Indeed, SEL interventions that include mindfulness practices might be especially well suited for such a task by familiarizing young people with their changing bodies and minds and by affording them conscious and compassionate ways of relating to their changing natures and those of their peers (e.g., Roeser & Pinela, 2014). Indeed, SEL programs that offer these skills to all students in classroom settings may be instrumental in creating more caring communities of

learning by having students and teachers model these qualities for one another. Yet to date there have been no studies of sufficient scope to examine this premise. Thus, in the present study, we relied on peer reports of others' behaviors in addition to teacher, self-, and behavioral/biological measures.

Present Study Design

The present randomized controlled trial study was conducted to test whether an SEL program that incorporates mindfulness practices (MindUP; Hawn Foundation, 2008) would lead to improvements in EFs, stress regulation, social–emotional competence, and school achievement in fourth and fifth grade children. An active control group of fourth and fifth grade children who received a *business as usual* (BAU) social responsibility program were used as a comparison. We examined group differences between treatment and BAU conditions on multiple outcomes, including EFs, hypothalamic–pituitary–adrenocortical (HPA) regulation, social–emotional competence, and end-of-year math grades. To our knowledge, there are no studies in which neuropsychological, biological, and social–emotional competence measures have been examined simultaneously in relation to the effectiveness of an SEL program for children. We hypothesized that when compared with students in the BAU condition, MindUP program students would show positive changes from pretest to posttest on all measures, with the exception of a measure of social responsibility. We hypothesized that the groups would not differ on a measure of social responsibility given a focus on this construct in both conditions.

Method

School Selection and Randomization

The evaluation took place in a public school district serving approximately 35,000 students in a suburban, predominantly middle-class community near a large western Canadian city. Four elementary schools in the district—equivalent on school size, achievement level, socioeconomic status (SES), and ethnic and racial diversity—were first identified as potential sites for the study because of their focus on the promotion of students' social responsibility. The neighborhoods in which schools were located were considered to be of similar population density and SES.

The research protocol was described to the four principals and the teachers of combined fourth and fifth grade classrooms at each school. Given the potential for diffusion effects (Craven, Marsh, Dubes, & Jayasinghe, 2001), only one classroom in each school was considered eligible for participation. Teachers were aware that once they decided to participate, their classroom had a 50% chance of being randomized as a comparison classroom. All principals and teachers agreed to participate. After the collection of baseline data, randomization was done by a coin flip that assigned two of the four classrooms to receive the MindUP curriculum and two to receive the district program that focused on the promotion of social responsibility (BAU condition).

Participants

Children—The recruited sample included 100 fourth and fifth grade children in classrooms in which approximately half of the children were from Grade 4 and half from Grade 5. One child moved away prior to posttest data collection, resulting in a final sample size of 99 children. Participants' ages ranged from 9.00 to 11.16 years (M = 10.24, SD = 0.53). The average income for the neighborhoods in which each of the four schools was located approximated the median annual income for Canada ($52,800 CAD; Statistics Canada, 2006). Regarding children's family composition, 84% reported living in two-parent homes (including both biological and step-parent families), 9% reported living with mother only, and the remainder reported living in dual-custody arrangements (i.e., half time with mother, half time with father). With regard to language, 66% of the children reported that English was their native language. For the remaining children, the majority reported that their language at home was of East Asian origin (25%; e.g., Korean, Mandarin, Cantonese), and the remaining 10% indicated a range of other languages (e.g., Spanish, Russian, Polish). This range of language backgrounds in the sample is reflective of the cultural and ethnic diversity of the Canadian city in which this research took place. Following randomization, analyses indicated that the children did not differ across study conditions on baseline demographic characteristics, suggesting that the randomization process was successful (see Table 1). Of the children recruited for participation, 98% received parent or guardian consent and gave assent themselves.

Teachers—The four participating teachers represented comparable experiential and cultural backgrounds. All of the teachers had over 5 years of teaching experience, had obtained a bachelor's degree in education, and had received similar levels of professional development in the promotion of students' social responsibility in their school district. All four teachers reported their ethnic/cultural heritage as European-Canadian.

Interventions

MindUP program—MindUP is a simple-to-administer mindfulness-based education SEL program that consists of 12 lessons taught approximately once a week, with each lesson lasting approximately 40–50 min. The core mindfulness practices in the program (done every day for 3 min three times a day) consist of focusing on one's breathing and attentive listening to a single resonant sound. The curriculum includes lessons that promote EFs and self-regulation (e.g., mindful smelling, mindful tasting), social–emotional understanding (e.g., using literature to promote perspective-taking skills and empathy), and positive mood (e.g., learning optimism, practicing gratitude). In addition, the MindUP curriculum includes lessons that involve performing acts of kindness for one another and collectively engaging in community service learning activities. These activities are aimed at changing the ecology of the classroom environment to one in which belonging, caring, collaboration, and understanding others is emphasized to create a positive classroom milieu (e.g., Noddings, 1992; Staub, 1988). Also incorporated in the MindUP intervention model is an ecobehavioral systems orientation (Weissberg, Caplan, & Sivo, 1989) in which teachers generalize the curriculum-based skills throughout the school day and support children's use and internalization of skills to support a positive classroom environment. A more complete description of the MindUP program can be found in the supporting online material.

Social responsibility program—The social responsibility program that represented the BAU condition in this study was informed by guidelines and resources provided by British Columbia's (BC's) Ministry of Education (see ttp://www.bced.gov.bc.ca/perf_stands/social_resp.htm). Since 2001, social responsibility has been identified as one of four performance standards considered to be "foundational" for students in BC (the other performance standards are reading, writing, and numeracy). The framework for BC's Social Responsibility Performance Standards includes a common set of expectations for the development of students along four categories: (a) contributing to classroom and school community (e.g., sharing responsibility for their social and physical environment), (b) solving problems in peaceful ways (e.g., using effective problem-solving steps and strategies), (c) valuing diversity and defending human rights (e.g., treating others fairly and respectfully, showing a sense of ethics), and (d) practicing democratic rights and responsibilities (e.g., knowing and acting on rights and responsibilities [local, national, global]). Further information about the Social Responsibility Performance Standards can be found in the supporting online material.

Procedure

Trained research assistants, blind to teacher and student study conditions, administered all assessments and collected diurnal cortisol samples from students at pre- and posttest. Teacher measures of children's achievement in math were also collected, although teachers, of course, were not blind to the study conditions of students. Administration of EF computer tasks and collection of cortisol samples took place the same week that the surveys were administered. Children were told that they were participating in a research study that was aimed at understanding "children's experiences in school" and "their attitudes and beliefs about their classmates and themselves." Self-report and peer behavioral assessments were administered to students during one 45-min regular class period, and each item on the questionnaire was read aloud while students completed the measures to control for any differences in reading abilities.

Implementation Measures

To assess implementation dosage and quality, teachers implementing the MindUP program were asked to complete surveys. Dosage was assessed by asking teachers to report how many of the 12 MindUP lessons they had completed and detail any omitted part(s) of each lesson. In addition, teachers were asked to track and record daily implementation of the MindUP core practices (breathing and listening) via a lesson daily diary. Teachers implementing the Social Responsibility Performance Standards of the district were also asked to report on the number of activities that they completed each week.

Outcome Measures

Children's outcome measures were derived from five independent sources: (a) behavioral assessments of EF, (b) biological assessments of children's salivary cortisol, (c) child self-reports of well-being and prosociality, (d) peer nominations of prosociality, and (e) year-end teacher-rated math grades collected from school records.

EF measures—To assess EFs, the flanker task and the hearts and flowers version of the dots task were administered (M. C. Davidson et al., 2006; Diamond, Barnett, Thomas, & Munro, 2007). These measures are appropriate for ages 4 through adults and assess all three dimensions of core EF skills. Tasks were presented on a laptop computer using the Presentation program by Neurobehavioral Systems (Berkeley, CA) to present stimuli and record responses. Responses were collected via two input keys on either side of the keyboard. Participants were positioned approximately 50 cm from the screen. The task consisted of three different conditions. Each condition began with specific instructions and a short block of four practice trials. If necessary, the practice trials were repeated to ensure that the participant had understood the task and the condition-specific requirements.

Flanker task—The task consisted of three conditions: (a) standard flanker, (b) reverse flanker, and (c) mixed trials. In the standard flanker condition, the fish were blue. Children were instructed to press the key on the side of the keyboard that represented the direction in which the middle fish was facing, ignoring the two distractor fish on either side of the middle (target) fish. This task required remembering the rule for the task, regulating attention on the task, and inhibiting distraction from the flanker fish on either side of the target stimuli. In the reverse flanker condition, the fish were pink. In contrast to the previous task, children were instructed to press the key that represented the direction in which the four fish on either side of the central fish were facing. Not only did this task require remembering the new rule for the task and selective attention, it also required the cognitive flexibility needed to change from the strategy used for the standard flanker task. In the third condition, standard flanker (blue fish) and reverse flanker (pink fish) tasks were randomly intermixed, requiring flexible application of the rules for each. This task put a heavy demand on all three core EFs. It required first recalling which rule applied; then focusing one's attention on only the relevant stimuli, registering which direction the relevant fish was or were facing; and finally choosing the correct response. A successful response was followed by positive feedback (cheers such as “yummy” or “yippee” produced by the computer program), whereas an incorrect response was followed by negative feedback (e.g., “oops”). The stimulus presentation time was 1,500 ms, the feedback interval was 1,000 ms, and the interstimulus interval was 500 ms.

Hearts and flowers task—We also administered the hearts and flowers task to measure students’ working memory, response inhibition, and cognitive flexibility (Diamond et al., 2007; Wright & Diamond, 2014). This task required students to learn and follow a rule and then to switch to a second rule. Stimulus presentation time was 750 ms, and the interstimulus time interval was 500 ms. In all conditions of this task, a red heart or flower appeared on the right- or left-hand side of the screen. In the congruent condition, one rule applied (“press the key on the same side as the heart”). The incongruent condition required students to remember another rule (“press the key on the side opposite the flower”). However, the incongruent trials also required students to inhibit the natural tendency to respond on the side where the stimulus appeared. In the mixed condition, incongruent and congruent trials were intermixed (taxing all three core EFs).

Scoring of EF tasks—Scores for both accuracy (percentage of correct responses calculated by dividing the number of correct responses by the total number of responses) and reaction time (RT) in milliseconds were calculated. Anticipatory responses—that is, responses that were faster than 200 ms—were considered too fast to be a response to the stimulus (M. C. Davidson et al., 2006) and were thus excluded from the analyses. A response was considered correct if the participant correctly applied the condition-specific rule by pressing the appropriate button on the keyboard and if this occurred no faster than 200 ms after the trial stimulus had appeared and before the trial stimulus had disappeared. Practice trials and the first trial following the practice trials of each block were excluded from analyses. We calculated accuracy and RT for three sets of trials that demanded the greatest EFs in terms of inhibitory control, working memory, and flexiblity: (a) flanker switch trials, (b) reverse flanker trials, and (c) incongruent hearts and flowers trials.

Salivary cortisol—HPA axis activity was assessed by measuring free cortisol in saliva three times within 1 day, relative to awakening, at both pretest and posttest. This method of salivary cortisol collection is consistent with Murray-Close, Han, Cicchetti, Crick, and Rogosch (2008), who examined the association between daily cortisol patterns and aggression using the average of three cortisol samples (morning, prelunch, and afternoon) obtained from school-age children (6–12 years of age) attending a week-long day camp. Note that we assessed children after the cortisol awakening response and, therefore, when cortisol was naturally decreasing in the body. Although additional time points (e.g., awakening, later evening) would have better defined the diurnal pattern, the young age of these children and the emphasis on limiting the assessment burden on them and their caregivers guided the selection of only three time points during the school day.

The salivary cortisol collection was facilitated by research assistants who came into in the participants' classrooms to assist them throughout the collections at 9 A.M., 11:30 A.M., and 2:30 P.M. Participants were instructed to avoid food intake and high physical activity at least a half an hour prior to saliva collection. Teachers modified their classroom schedule and eliminated any physical activity and snacking on the days of cortisol collection. At each assessment period, children were given a short diary to document their time of awakening, last food and liquid consumption, and medication taken that day. To collect the saliva samples, research assistants directed children to put a dental cotton roll in their mouth for 1 min and saturate it in saliva (Salimetrics Oral Swab, State College, PA [https://www.salimetrics.com/]). Research assistants instructed children on how to place the roll into a protective tube using latex gloves to avoid contamination. Cortisol samples were shipped to the Kirschbaum laboratory at the Dresden University of Technology, Dresden, Germany, for analyses. Cortisol concentrations were then determined using a commercial chemiluminescence immunoassay (IBL International, Hamburg, Germany). This assay has a sensitivity of 0.16 ng/ml and intra- and interassay coefficients of variation of less than 12%. The lower concentration limit of this assay was 0.44 nmol/L; intra- and interassay coefficients of variance were less than 8%. Any sample over 50 nmol/L was repeated.

The cortisol data were screened to ensure that each case had complete data for cortisol samples and time since awakening at all time points. We calculated average cortisol output at each of the three time points. Following the procedures outlined by Stetler and Miller

(2008), after the cortisol values had been log-transformed, the pattern of cortisol secretion was computed as a linear slope. In this procedure, the cortisol values at each time point were regressed on the number of hours awake. Higher (less negative) values indicated a flatter slope, whereas lower (more negative) values indicated a steeper slope.

Child self-report measures—Child self-report measures included a battery of measures assessing children's empathy and perspective-taking, optimism, emotional control, school self-concept, depressive symptoms, mindfulness, and social responsibility.

Demographic information—To obtain demographic information about the participants, students completed a demographic questionnaire asking them about their grade level, birth date, family composition, and first language learned in the home.

Empathy and perspective-taking—Participants' empathy and perspective-taking were assessed via the Interpersonal Reactivity Index (IRI; Davis, 1983), which had been modified for children (Schonert-Reichl, Smith, Zaidman-Zait, & Hertzman, 2012). The IRI is a self-report measure comprising four seven-item subscales (perspective-taking, fantasy, empathic concern, personal distress), each of which taps a separate dimension of empathy. Because we were interested in examining intervention effects on dimensions related to social awareness and caring for others, only the empathic concern and perspective-taking subscales were used in the present study. The empathic concern scale assesses the tendency to feel concern for other individuals (e.g., "I often feel sorry for people who don't have the things I have"), whereas the perspective-taking subscale measures the tendency to consider things from others' viewpoints (e.g., "Sometimes I try to understand my friends better by imagining how they think about things"). Participants rated each item on a five-point rating scale (1 = *never*, 5 = *very often*). Scores were computed by averaging item scores within subscales so that higher scores signified greater empathic concern and perspective-taking, respectively. Supportive evidence for the construct validity and reliability of the empathic concern and perspective-taking subscales of the IRI has been obtained in previous research (Davis, 1983), including significant correlations with related constructs in expected directions (Schonert-Reichl et al., 2012). In the present study, Cronbach's alphas at pretest and posttest for the empathy subscale were .80 and .78, respectively, and for the perspective-taking subscale were .65 and .76, respectively.

Optimism—We assessed participants' optimism using a sub-scale from the Resiliency Inventory (RI), created by Noam and Goldstein (1998) and later modified by Song (2003). The RI was developed specifically as a measure of resilience in adolescents (Noam & Goldstein, 1998) and has also been demonstrated to be cross-culturally robust (Song, 2003). The optimism subscale consists of nine items assessing children's positive perspective on the world and the future in general (e.g., "More good things than bad things will happen to me"). Children were asked to rate each item on a five-point Likert-type scale (1 = *not at all like me*, 2 = *a little bit like me*, 3 = *kind of like me*, 4 = *a lot like me*, 5 = *always like me*). Ratings are averaged, with higher scores representing higher levels of optimism. Previous research has found support for the validity and reliability of the optimism subscale (Noam &

Goldstein, 1998; Thomson, Schonert-Reichl, & Oberle, 2014). For the present study, Cronbach's alpha for the optimism subscale was .69 at pretest and .73 at posttest.

Emotional control—Emotional control was assessed with a subscale of the RI, described earlier. The emotional control sub-scale consists of five items assessing the degree to which the respondent feels he or she has some control over his or her emotional reactivity and emotional displays (e.g., “I stay calm even when there's a crisis”). Ratings on the five items are averaged, with higher scores representing higher levels of emotional control. Evidence supporting the reliability and validity of the emotional control subscale of the RI has been reported (Noam & Goldstein, 1998; Song, 2003). In the present study, Cronbach's alphas for the emotional control subscale in the present study at pretest and posttest were .57 and .60, respectively.

School self-concept—The school self-concept subscale from Marsh's Self-Description Questionnaire (SDQ; Marsh, Barnes, Cairns, & Tidman, 1984) was used to measure students’ self-rated abilities, enjoyment, and interest in school subjects. This subscale includes items such as “I am good at school subjects” and “I look forward to all school subjects.” Items are rated on a five-point scale (1 = *never*, 5 = *always*). Ratings are averaged, with higher scores indicating higher levels of school self-concept. Evidence supporting the validity of the SDQ has been reported, and internal consistencies (Cronbach's alphas) for each of the subscales in the questionnaire have ranged from .80 to .92 (Marsh et al., 1984). In the present study, Cronbach's alphas at pretest and posttest for this subscale were .82 and . 83, respectively.

Depressive symptoms—Students’ depressive symptoms were measured using the Seattle Personality Questionnaire for Children (SPQC; Kusché, Greenberg, & Beilke, 1988). The scale comprises four constructs: (a) conduct problems, (b) anxiety, (c) somatization, and (d) depressive symptoms. For the purposes of the present study, we used only the 11-item depressive symptoms subscale (e.g., “Do you feel unhappy a lot of the time?”). Items are scored on a four-point Likert-type scale (1 = *not at all*, 4 = *always*). Ratings are then averaged, with higher scores representing higher levels of depressive symptoms. Evidence exists supporting the validity and reliability of the depressive symptoms subscale of the SPQC (Kusché et al., 1988). In the current sample, Cronbach's alphas at pretest and posttest were .80 and .84, respectively.

Mindfulness—The Mindful Attention Awareness Scale adapted for children (MAAS-C; Lawlor, Schonert-Reichl, Gader-mann, & Zumbo, 2014) was used to assess individual differences in the frequency of mindful states over time. In developing the original version of the MAAS for adults (Brown & Ryan, 2003), the authors proposed that “statements reflecting mindlessness are likely more accessible to most individuals, given that mindless states are much more common than mindful states” (p. 826). Hence, items on the MAAS reflect mindless states (e.g., “I could be experiencing some emotion and not be conscious until sometime later,” “I do jobs or tasks automatically without being aware of what I am doing”). The MAAS-C is a 15-item measure that has been modified for use with younger populations by (a) altering language to be age appropriate and (b) changing the six-point

Likert-type scale to read in a more child-friendly format (1 = *almost never*, 2 = *not very often at all*, 3 = *not very often*, 4 = *somewhat often*, 5 = *very often*, 6 = *almost always*). On analysis, items were reverse-scored and averaged, with higher scores indicating higher mindfulness. Lawlor et al. (2014) reported the MAAS-C to be a reliable and valid instrument for children, with a reported internal consistency of .84 as assessed via Cronbach's alpha. For the present investigation, Cronbach's alpha was good, with pretest and posttest alphas both equaling .84.

Social responsibility—Social responsibility was assessed with a subscale of the Social Goals Questionnaire (Wentzel, 1993). The Social Goals Questionnaire comprises two subscales measuring prosocial goals and social responsibility. In the present study, only the seven-item social responsibility subscale was used because of the focus on social responsibility promotion in the MindUP and BAU conditions. Items on the subscale assess, among other things, how students try to "keep promises [they] have made to other kids," "be nice to other kids when something bad has happened to them," and "be quiet when other kids are trying to study" Students indicate their answers on a Likert-type scale (1 = *never*, 5 = *always*), with higher scores indicating higher social responsibility goals. Previous research has found support for the validity and reliability of the social responsibility subscale in early adolescents (Wentzel, 1993). In the present study, Cronbach's alphas at pretest and posttest were .60 and .73, respectively.

Peer-Report Measures

Peer nominations of prosociality—Following the procedures outlined by Parkhurst and Asher (1992), peer nominations were used to obtain independent assessments of prosociality, whereby children nominated their classmates who fit particular behavioral characteristics. This methodology is consistent with published investigations in which peers' ratings of behaviors are considered to be a reliable and valid way in which to assess students' social behaviors in a school context (Schonert-Reichl et al., 2012; Went-zel, Barry, & Caldwell, 2004).

Unlimited and cross-gender peer nominations were used to obtain independent assessments of children's social behavior. Five types of *prosocial* behaviors ("shares and cooperates," "trustworthiness," "helps other kids when they have a problem," "kind," "understands other kids' point of view") and two types of *aggressive*/*antisocial* behaviors ("breaks rules," "starts fights") were assessed. For each question, children were asked to "circle the names of any of your classmates who" fit each of the behavioral descriptions. Below each written question, children were given a roster of all their classmates participating in the research. Children could circle as many or as few names as they wanted. Children's nominations were standardized within each classroom, and a proportional nominations score was calculated per child for each of the behaviors. Because data collection took place midway into the school year, it was reasonable to assume that students knew one another well enough to make valid nominations.

Peer nominations of peer acceptance—Children's level of acceptance by peers (one item: "would like to be in school activities with") was assessed using the same nomination

sociometric procedure used for obtaining measures of behaviors (e.g., Oberle, Schonert-Reichl, & Thomson, 2010). Level of acceptance was scored in the same manner described earlier.

Achievement measure—Math achievement was assessed via students' end-of-the-school-year math grades obtained from school records. The schools provided only math grades for 89 of the 99 participating students. Grades were recorded on a continuous scales (1 = *C*–, 9 = *A*+).

Analytic Plan

To assess changes in students' EFs over time by condition, we examined both accuracy and speed of responding (RTs in ms) as dependent measures. Because accuracy data are binary at the individual trial level, a generalized estimating equation using a binary logistic equation was used to compare the difference in accuracy between the MindUP and BAU children, with covariates for pretest accuracy, age, gender, and English as a second language (ESL). RT at posttest was examined via multilevel modeling (MLM) analyses, because the response trials in the EF tasks were nested under different blocks that represented different response rules (see the EF task descriptions), with covariates for group, RT at the pretest, accuracy at pretest, age, gender, ESL, block condition, Group × Block interaction, and accuracy of the response (correct/incorrect). All covariates were entered as fixed effects in the model. The parameters were estimated via restricted maximum likelihood. The covariance structure was set to compound symmetry. Individual trials within the tasks were modeled as repeated effects.

To assess changes in students' regulation of stress physiology over time by condition, we used analyses of covariance (ANCOVAs) to examine changes in students' patterns of daily cortisol computed as linear slopes.

To address changes in the sets of measures we collected from student self-report and peer nomination, and to do so in a way that accounted for multicollinearity in these measures by informant, we used multivariate analyses of covariance (MANCOVAs), followed by ANCOVAs. When significant omnibus intervention effects were found with MANCOVA on these various sets of measures from different informants, we then used generalized linear model analyses of covariance in which difference, or "change," scores served as the dependent variable. Statistically comparable to performing a repeated measures analysis, change scores provide an unbiased estimate of true change regardless of baseline value (Zumbo, 1999). Change scores can be used as the dependent variable in an analysis of variance (ANOVA) and are seen as an alternative to ANCOVA when the researcher is interested in examining the direction of change from pretest to posttest, as was the case here (Tabachnick & Fidell, 2001).

Because we only had teacher-reported math grades from the end of the school year, we examined differences between groups via an ANCOVA, in which math grades served as the dependent variable, and group (MindUP vs. BAU) served as the independent variable. In all analyses, children's gender, age, and ESL status were controlled as potential confounds. Where appropriate, effect sizes (Cohen's *d*s) were calculated to provide information about

the magnitude of program effects. According to the criteria proposed by Cohen (1988), an effect size of .20 is considered small, .50 is considered medium, and .80 is considered a large effect.

Results

Implementation Data

Review of implementation surveys and implementation diaries at the end of the school year indicated that the two teachers implementing the MindUP program had completed all 12 (100%) of the MindUP lessons. With regard to core breathing practices, which are recommended to be done three times a day (morning, after lunch, end of day): Teacher 1 reported completing an average of 81% of the practices in a given week, and Teacher 2 reported completing an average of 95% of the practices in a given week. The two teachers in the BAU condition also reported implementing activities from the social responsibility program for each of the 12 weeks.

Outcome Data

EFs—The two dependent measures for EFs were percentage of correct responses (accuracy) and RT in ms. Analyses of baseline differences in accuracy revealed no significant difference between that the MindUP and BAU children on the flanker switch trials (86% [*SE* = .16] and 87% [*SE* = .15], respectively), $\chi^2(1, N = 99) = 0.06$, *ns*; flanker versus reverse flanker trials (91% [*SE* = .09] and 91% [*SE* = .00], respectively), $\chi^2(1, N = 99) = 0.02$, *ns*; or hearts and flowers congruent versus incongruent trials (84% [*SE* = .11] and 80% [*SE* = .13], respectively), $\chi^2(1, N = 99) = 2.32$, *ns*. Analysis of posttest differences in accuracy (controlling for pretest accuracy, gender, age, and ESL [note that percentages reported are adjusted means]) revealed similar nonsignificant differences between groups: flanker switch trials (73% [*SE* = .23] and 80% [*SE* = .17], respectively), $\chi^2(1, N = 99) = 3.15$, *ns*; flanker versus reverse flanker trials (81% [*SE* = .17] and 85% [SE = .13], respectively), $\chi^2(1, N = 99) = 2.31$, *ns*; and hearts and flowers congruent versus incongruent trials (82% [*SE* = .12] and 79% [*SE* = .13], respectively), $\chi^2(1, N = 99) = 1.45$, *ns*.

Pretest, posttest, and adjusted posttest means and standard deviations for the EF RTs by group are provided in Table 2. An overview of the estimated means and the results of the hypotheses tests are presented in Table 3. MLM of the EF data revealed that MindUP children were faster, but no less accurate, than comparison children on all three EF tasks at posttest (see Figure 1). For the flanker switch trials task at posttest, MindUP children showed significantly shorter RTs than comparison children, $F(1, 92) = 4.32$, $p = .04$, $d = –.21$, and outperformed comparison children on incongruent flanker and reverse flanker trials as well, indicating a greater ability to selectively attend and inhibit distraction, $F(1, 92) = 5.54$, $p = .02$, $d = –.31$.

Similar results were obtained for the hearts and flowers task: At posttest, the MindUP children showed significantly shorter RTs on trials in the hearts and flowers incongruent condition than did comparison children, $F(1, 87) = 4.00$, $p = .04$, $d = –.22$ but were not less accurate, as reported earlier.

Salivary cortisol—A series of ANCOVAs were conducted to check for mean baseline differences between the MindUP and BAU children on cortisol output at morning arrival, prelunch, and predismissal, controlling for age, gender, and ESL. No significant differences were found (see Table 4). To examine intervention effects on HPA axis activity over the course of a school day, we calculated the cortisol change across the day (slope) as the coefficient of a single child's cortisol measures regressed on time of cortisol data collection (i.e., mean log 9 A.M. to mean log 3 P.M. cortisol), taking into account time since awakening.

We used slope difference scores (posttest mean minus pretest mean) as our dependent variable because of our interest in examining the *direction of change* and not simply differences at posttest (Zumbo, 1999). At pretest, MindUP and BAU children exhibited a similarly steep slope (*M*s = –.05 and –.06, *SD*s = .05 and .05, respectively), $F(3, 94) = 1.31$, *ns*. ANCOVA with group (intervention vs. BAU) as the independent variable and difference score in slope from pretest to posttest as the dependent variable (controlling for age, gender, and ESL) revealed that MindUP children's average slope changed little from pre- to posttest (difference score: $M = –.003$, $SD = .06$), whereas the average slope for comparison children changed from a steeper to a flatter diurnal pattern, (difference score: $M = .032$, $SD = .07$), $F(3, 94) = 5.90$, $p = .02$, $d = .51$. These cortisol results at posttest for each group are illustrated in Figure 2. In addition to examining slope, we also examined posttest differences between MindUP and BAU children on cortisol secretion at morning arrival, prelunch, and predismissal, controlling for age, gender, and ESL (see Table 4). No significant differences were found between the two groups for cortisol secretion at either prelunch cortisol secretion or predismissal; however, MindUP children had significantly higher cortisol secretion at morning arrival than did BAU children at posttest (see Table 4).

Child self-report—Baseline differences were examined between the MindUP and BAU group children on all child-report prosociality and well-being outcomes namely empathy, perspective-taking, optimism, emotional control, school self-concept, mindfulness, depressive symptoms, and social responsibility using MANCOVAs with intervention status as the independent variable, controlling for age, gender, and ESL. Results for the effect of group across all the child self-report measures at baseline were nonsignificant, $F(7, 88) = 1.32$, *ns*.

To examine potential intervention effects of the MindUP program on children's self-reports, a MANCOVA for the entire set of child self-report measures was conducted, with difference scores (posttest minus pretest) as the dependent measures and intervention status (MindUP vs. BAU) as the independent variable, controlling for age, gender, and ESL. Results showed a significant main effect for group, $F(7, 88) = 2.14$, $p = .04$. Pretest and posttest means, standard deviations, and difference scores for all child self-report measures by group are reported in Table 5.

Follow-up ANCOVAs indicated that, in contrast to children in the BAU group, children in MindUP showed significant improvements from pre- to posttest in empathy, $F(1, 97) = 4.42$, $p = .03$, $d = .42$; perspective-taking, $F(1, 97) = 4.17$, $p = .04$, $d = .40$; optimism, $F(1, 97) = 5.40$, $p = .02$, $d = .48$; emotional control, $F(1, 97) = 8.78$, $p = .004$, $d = .59$; school self-

concept, $F(1, 97) = 5.60$, $p = .02$, $d = .50$; and mindfulness, $F(1, 97) = 7.94$, $p = .006$, $d = .55$; and significantly decreased depressive symptoms, $F(1, 97) = 4.14$, $p = .04$, $d = –0.45$ (see Figure 3). The reverse was true for children in the comparison curriculum that focused solely on social responsibility—they reported significant decreases in all of these social–emotional well-being measures (see Figure 3). As hypothesized, no significant difference between the groups was found for self-reported social responsibility, $F(1, 97) = 0.30$, *ns*; both groups improved.

Peer nominations—A MANCOVA conducted to examine baseline differences between MindUP and BAU children on all peer nominations of prosociality yielded a significant multivariate effect for intervention, $F(8, 87) = 10.41$, $p = .001$. To examine baseline differences between MindUP and BAU children, a series of simple ANCOVAs (controlling for age, gender, and ESL) were next conducted. Despite randomization, results revealed significant baseline differences on each of the prosocial dimensions favoring comparison children; shares, $F(1, 94) = 14.11$, $p = .0001$; trustworthiness, $F(1, 94) = 11.29$, $p = .001$; helpful, $F(1, 94) = 14.11$, $p = .001$; takes others' views, $F(1, 94) = 19.28$, $p = .001$; and kind, $F(1, 94) = 13.46$, $p = .001$. Moreover, MindUP children were found to have significantly higher baseline scores on the dimensions of starts fights, $F(1, 94) = 7.17$, $p = .009$, and breaks rules, $F(1, 94) = 11.29$, $p = .001$. No other significant baseline differences were found between groups on our assessment of peer acceptance (i.e., liked by peers) were found, $F(1, 94) = .001$, *ns*.

To assess intervention effects on these measures, a MANCOVA for the entire set of peer nominations of prosociality was next conducted, with difference scores as the dependent measures and intervention as the independent variable, controlling for age, gender, and ESL. Results showed a significant multivariate effect for intervention across all measures, $F(7, 88) = 4.36$, $p = .001$. Given these results, we proceeded with ANCOVA analyses of the difference scores. Pretest and posttest means, standard deviations, and difference scores by group are reported in Table 5.

Difference scores for peer-nominated prosocial and aggressive behaviors and peer liking for children in the MindUP versus children BAU condition are illustrated in Figure 4. Children in the MindUP program, despite initial differences on many of these measures, were more likely to improve from pretest to posttest on almost every dimension of peer-nominated prosocial behavior: sharing, $F(1, 97) = 4.42$, $p = .04$, $d = .42$; trustworthiness, $F(1, 97) = 13.44$, $p = .001$, $d = .76$; helpfulness, $F(1, 97) = 13.05$, $p = .001$, $d = .72$; and taking others' views, $F(1, 97) = 18.90$, $p = .001$, $d = .87$. The findings for peer ratings of kind were not significant but were in the expected direction, $F(1, 97) = 3.14$, $p = .06$, $d = .36$. In addition, children in the MindUP condition showed significant decreases in peer-nominated aggressive behavior from pretest to posttest for breaks rules, $F(1, 97) = 8.07$, $p = .006$, $d = –.55$, and starts fights, $F(1, 97) = 13.95$, $p = .001$, $d = –.71$. Finally, whereas comparison children were liked less by their classmates at posttest in June than they had been at pretest in March as assessed via our peer sociometric procedure (i.e., peer-rated popularity), the reverse was true for children in the MindUP classrooms, $F(1, 97) = 3.93$, $p = .05$, $d = .44$.

Math grades—Analysis of final math grades on a grade metric (9 = *A*+, 8 = *A* = 8, . . . 1 = C–) were analyzed via ANCOVA, controlling for age, gender, and ESL. Analysis showed a trend toward higher year-end math grades for children in the MindUP program ($M = 6.12$, $SD = 2.17$) than for BAU children ($M = 5.25$, $SD = 2.46$, $t(87) = 1.76$, $p = .07$, $d = .38$.

Interpreting Obtained Effects in Context

To provide more information on the value added of bringing a school program that incorporates mindfulness attention training and caring for others to the regular school curriculum, we calculated Cohen's U_3 "improvement" index to reflect the average difference between the percentile rank of the MindUP and BAU groups (Institute of Education Sciences, 2008). We found a 24% gain in peer-nominated positive social behaviors from participation in the MindUP program, a gain of 15% in math achievement, a gain of 20% in self-reported well-being and prosociality, and a reduction of 24% in peer-nominated aggressive behaviors. Put another way, the average student in the BAU condition would demonstrate a 24 percentile increase in positive social behaviors (as rated by peers), a 15 percentile increase in math achievement, a 20 percentile increase in self-reported well-being and prosociality, and a 24 percentile decrease in aggression if he or she had participated in the MindUP program.

Discussion

These preliminary findings suggest that a relatively simple-to-administer SEL curriculum including mindfulness training added onto the regular curriculum for a period of only 4 months can yield promising and noteworthy findings with regard to positive behavioral and cognitive change in children. MindUP children, in contrast to children in a social responsibility program, showed significant improvements in EFs, self-report measures of well-being, and self- and peer-reported prosocial behavior. They also tended to show better math performance (the only subject for which grades were provided by the school) relative to children who received the regular school district social responsibility program. Our findings for cortisol are open to differing interpretations. We discuss each set of findings in turn.

Previous research with adults has shown that cognitive processes associated with PFC, known collectively as EFs, are improved through regular mindfulness attention training (R. J. Davidson et al., 2003; Hölzel et al., 2011; Jha, Krompinger, & Baime, 2007). Consistent with those studies, using behavioral measures of attention, we found that MindUP children in our study outperformed comparison children on the most difficult EF tasks requiring response inhibition, working memory, and cognitive flexibility. There has been considerable theorizing and some data indicating that EFs, and in particular inhibitory control, are especially relevant to the development of emotional regulation during childhood. The results of this study suggest the possibility that the three-times-daily mindfulness practices could have led to the increased inhibitory control, which in turn led to the improved emotional control and decreased aggression that was observed in the MindUP children. It may also be the case that it was not only the mindfulness training that led to increased caring and kindness among students but also the opportunities for promoting optimism and performing

acts of kindness for others that are part of the MindUP curriculum. Future research is needed to replicate the findings on EF and also to identify the “active ingredients” in the curriculum leading to these specific outcomes.

With regard to our findings on cortisol, they were ambiguous and open to differing interpretations. On the one hand, despite no differences in the diurnal rhythm of cortisol between MindUP children and BAU children at pretest (both exhibited a similar decline in cortisol secretion from morning arrival to predismissal), we found that MindUp children's average slope changed little from pre- to posttest, whereas the average slope for comparison children changed from a steeper to a flatter pattern. In healthy people not exposed to chronic stress, cortisol displays a robust diurnal rhythm, with values highest in the morning 30 min after awakening and gradually decreasing throughout the day (Miller, Chen, & Zhou, 2007; Shirtcliff & Essex, 2008; Stetler & Miller, 2008). During this part of the diurnal rhythm, higher (less negative) values indicate a flatter diurnal cortisol slope, whereas lower (more negative) values indicate a steeper diurnal cortisol slope. The change from a healthy diurnal rhythm of cortisol levels (i.e., decline from A.M. to P.M.) to an attenuated diurnal decrease in cortisol from morning to afternoon has been recognized as indicative of neuroendocrine dysregulation (Gunnar, 2000; Gunnar & Vazquez, 2001) and has been found among children experiencing chronic stress (Bevans, Cerbone, & Overstreet, 2008). On the other hand, we found that MindUP children actually showed *higher* morning arrival cortisol secretion at posttest than BAU children (despite no differences at pretest on this measure); this pattern of elevated levels of A.M. cortisol has been found to be associated with increased stress in children (Gunnar, 1992). The fact of the matter is that we know very little about normative cortisol regulation across the day in healthy samples of elementary schoolchildren (for a review, see Quas, 2011). Thus, the nature of program effects on cortisol in this study remains ambiguous. Clearly more research is needed to shed further light on the effects of mindfulness practices on cortisol regulation in late middle childhood and early adolescence.

Overall, the results of this study are in accord with other research evaluating the effectiveness of well-designed SEL interventions. For instance, in a meta-analysis of 213 school-based, universal SEL programs involving 270,034 students from kindergarten through high school, compared with controls, students in SEL programs demonstrated significantly improved social–emotional skills, attitudes, and behavior *and* academic performance, with an average effect size of .31 (Durlak et al., 2011). Of particular note is that the average effect size of the social, emotional, and behavioral outcomes in the present study was .55. Hence, the present study adds to the growing literature on SEL programs and provides initial evidence that mindfulness practices can provide an added value to an SEL program.

One question that arises with regard to teachers implementing the MindUP program is what changes might have occurred in them as a result to implementing the program. That is, could the MindUP program have led to changes in the teachers themselves? Anecdotally, the teachers reported that they also participated in the three-times-daily mindful breathing practices with their students. Could this have led to differences in their own stress regulation in the classroom? Recent evidence indicates that efforts to improve teachers’ knowledge about SEL alone are not sufficient for successful SEL implementation. Indeed, teachers’

own SEL competence and well-being appears to play a crucial role in influencing the infusion of SEL into classrooms and schools (Jones, Bouffard, & Weissbourd, 2013). Clearly, future research is needed that examines changes that occur in *teachers* as a result of implementing an SEL program that integrates mindfulness practices.

Study Limitations

There were various limitations to this study. First, analyses were conducted at the individual child level even though randomization to condition was done at the classroom level. This limits the causal inferences to be drawn from this initial study of the program. Unfortunately, the small number of classrooms did not provide sufficient statistical power to use MLM. The clustering of children within classrooms results in the nonindependence of subjects, which could bias the statistical tests used to identify intervention effects. This is a major challenge to evaluations of universal, school-based interventions when insufficient resources exist to recruit large numbers of classrooms or schools (Stoolmiller, Eddy, & Reid, 2000). Nonetheless, as noted by Slavin (2008), although analyzing data at the child level when randomization was done at the classroom level is discouraged by methodologists, because the findings can exaggerate statistical significance, “their effect sizes are unbiased . . . and therefore are of value” (p. 9). The effect sizes in this study do suggest the promise of this program in producing change in child attention and well-being.

Second, despite randomization to treatment, significant differences were found between MindUP and comparison children at baseline on one of the child self-report measures (empathy) and most of the peer behavioral assessment indices. It should be noted that finding baseline differences between a treatment and control group is a common occurrence in studies like ours in which there is a small-to-moderate sample size (Shadish, Cook, & Campbell, 2002). Nonetheless, the success of our random assignment procedure, as evidenced by the lack of any significant demographic differences between MindUP and comparison children, gives us confidence that our results represent an internally valid test of intervention effects on child outcomes. Moreover, because the pattern of change for almost every one of our dimensions of peer behavioral assessments was one in which MindUP students significantly and positively improved and control children decreased or became worse, this provides further evidence that the MindUP program was successful in improving children's behaviors as rated by their peers. Indeed, as noted by Shadish et al. (2002), this crossover pattern (i.e., one in which the trend lines cross over and the means are reliably different in one direction at pretest and in the opposite direction at posttest for the treatment and control groups) represents a pattern that is particularly amenable for asserting causal claims regarding treatment effects, because the plausibility of other alternative interpretations for the findings (e.g., ceiling effects, selection-maturation effects) is significantly reduced.

Third, with regard to our teacher and peer assessments, raters were not blind to treatment condition. Although peers as participant observers can provide important sources of information about their classmates’ behaviors both inside and outside of the classroom, our peer behavioral assessment measure of prosocial and aggressive/antisocial behaviors may have been influenced by peers’ knowledge about the experimental condition. We speculate

here that peers' ratings of classmates' behaviors would be less likely than teachers' to be influenced by knowledge of the intervention status, given that it is unlikely that children would be able to generate specific a priori hypotheses of the study. Nonetheless, we have no data to support such a claim, and future investigations of the MindUP program would benefit from collecting data from observers blind to intervention status to allow for a more objective measure of children's behaviors. Similar concerns arise with respect to using teacher report measures of students when teachers are not blind to the condition to which a classroom has been assigned in a field experiment.

Conclusions

This small study is among the few that have examined the effectiveness of an SEL program for children using an array of cognitive–behavioral, neurophysiological, and psychological indicators for multiple sources. The findings demonstrate that giving children mindfulness attention training in combination with opportunities to practice optimism, gratitude, perspective-taking, and kindness to others can not only improve cognitive skills but also lead to significant increases in social and emotional competence and well-being in the real-world setting of regular elementary classrooms. Whether or not a mindfulness-training component plays a direct or indirect role in fostering the development of both cognitive control skills and social–emotional competence and well-being, this study provides promising evidence that the inclusion of mindfulness practices in a classroom-based SEL program may represent a value-added component to the regular school curriculum that can result in multiple benefits.

What are the implications of this study for future research? We would argue that rigorously designed experimental studies that are grounded in strong developmental theory; that include multimethod, multiinformant approaches; and that follow up children after a program has ended are clearly warranted to advance the field. Similarly, these studies should be conducted by teams of researchers from multiple disciplines (e.g., developmental neuro-science, contemplative science, health, education, sociology) to shed light on the effects of these interventions across multiple levels of functioning—biological, cognitive, and contextual. Such research will add greatly to the field and help advance the science and practice of mindfulness-based SEL preventive interventions that will help all children thrive and flourish.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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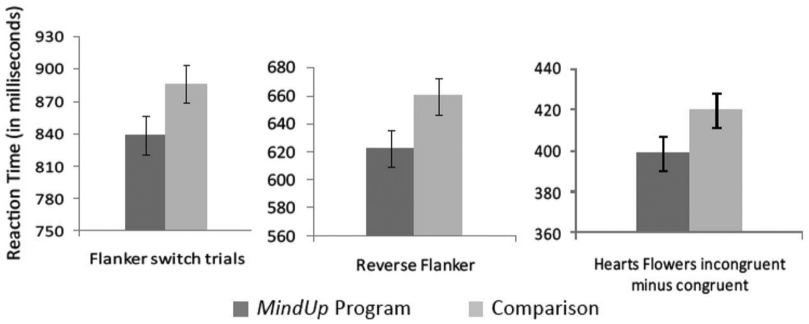

Figure 1.

Reaction time (RT) results for executive function tasks. Adjusted means at posttest in RT on EF tasks for MindUP and business as usual (BAU [comparison]) conditions, with covariates for group, RT at pretest, accuracy at pretest, age, gender, English as a second language, block condition, Group × Block interaction, and accuracy of response (correct/incorrect).

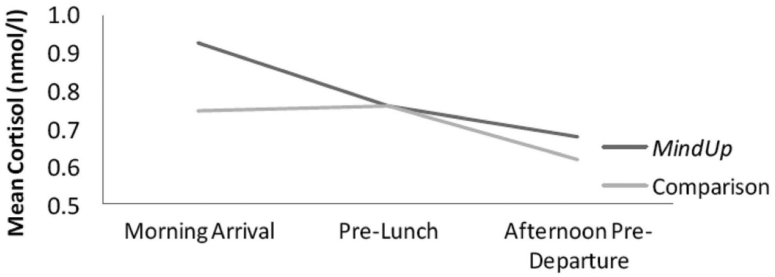

Figure 2.

Results for cortisol at posttest. Means for cortisol over the school day at posttest for MindUP and business as usual (BAU [comparison]) children.

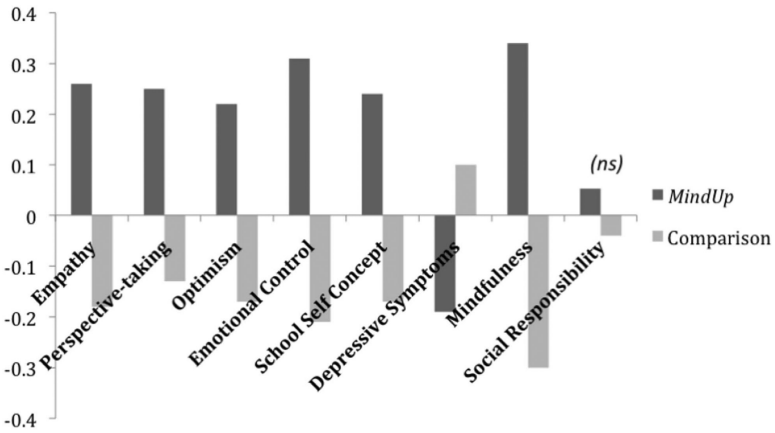

Figure 3.
Results for children's self-reported social and emotional competencies.

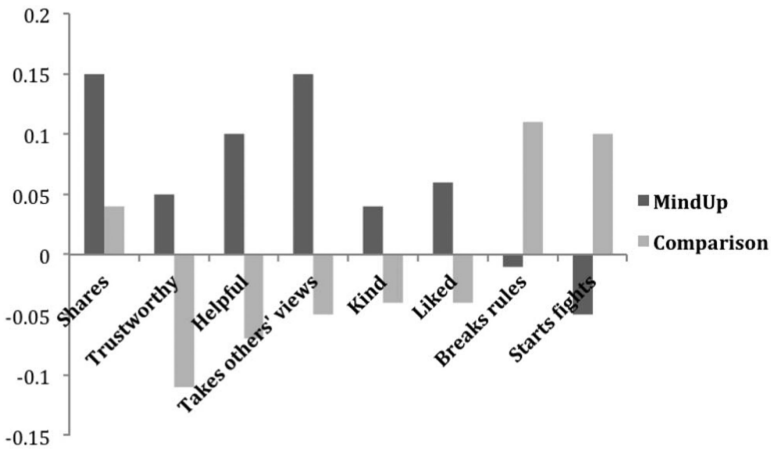

Figure 4.

Results for peer nominations of prosocial and aggressive behavior and peer liking. Mean change scores across indices of peer nominations of prosocial and antisocial/aggressive behaviors and peer liking by condition.

Table 1

Summary of Demographic Information by Condition

Variable	MindUP	BAU	Total
Participants (n)	48	51	99
Age (years)			
M	10.16	10.31	10.24
SD	0.52	0.52	0.53
Gender			
Female	46%	42%	44%
Male	54%	58%	46%
First language learned (%)			
English	63	68	66
East Asian	27	22	25
Other	10	10	10
Family composition (%)			
Two parents	77	89	84
Single parent	10	7	9
Half mother, half father	10	4	7

Note.

BAU = business as usual.

Table 2

Descriptive Statistics (Means and SDs) For Reaction Time Measures On EF Tasks by Condition

	MindUP (*n* = 48)						BAU (*n* = 51)					
	Pretest		Posttest		Adjusted posttest		Pretest		Posttest		Adjusted posttest	
Task	***M***	***SD***	***M***	***SD***	***M*** [a]	***SE***	***M***	***SD***	***M***	***SD***	***M*** [a]	***SE***
Flanker switch	871.58	245.93	811.22	208.02	844.48	16.58	943.64	246.47	864.75	227.68	879.86	19.30
Flanker vs. reverse flanker	616.64	169.11	577.65	148.28	622.03	13.10	703.70	201.84	625.51	149.72	659.71	12.84
Hearts and flowers congruent vs. incongruent	395.57	100.51	389.63	88.79	398.82	8.48	440.29	124.94	412.18	98.06	419.55	8.43

Note.

BAU = business as usual.

[a]Estimated marginal mean.

Table 3

Results of Executive Function Analyses for Reaction Time (RT)

	Flanker switch trials			Flanker vs. Reverse Flanker			Hearts and Flowers congruent vs. incongruent		
Covariate	**Estimate**	***t***	***p***	**Estimate**	***t***	***p***	**Estimate**	***t***	***p***
Group	–48.10	–2.08	.04	–55.66	16.56	.001	–24.89	–2.29	.02
RT pretest	.10	4.70	<001	.14	10.92	.001	.11	6.63	–.001
Age	–37.98	–1.73	*ns*	–2.33	–0.15	*ns*	2.91	0.28	*ns*
Gender	–35.38	–1.49	*ns*	–24.05	–1.47	*ns*	3.12	0.32	*ns*
ESL	23.65	0.96	*ns*	16.22	0.96	*ns*	11.53	1.06	*ns*
Accuracy	116.26	6.02	<001	89.54	7.09	<.001	21.91	2.58	.01
Block	—	—	—	- 44.04	–7.66	<.001	–52.53	–11.31	<.001
Block × Group	—	—	—	35.97	4.36	<.001	8.31	1.33	*ns*

Note.

Dashes in cells indicate that no analyses were conducted for these cells. ESL = English as a second language

Table 4

Summary of Analyses of Pretest and Posttest Cortisol Assessments by Condition

	MindUP (*n* = 48)		BAU (*n* = 51)			
Cortisol (g/dl)	***M***	***SD***	***M***	***SD***	***F***	***p***
Pretest						
Morning arrival	0.83	0.20	0.89	0.24	2.18	*ns*
Prelunch	0.62	0.18	0.70	0.16	4.13	*ns*
Afternoon predeparture	0.56	0.19	0.59	0.24	0.22	*ns*
Posttest						
Morning arrival	0. 97	0.23	0.76	0.21	11.87	.001
Prelunch	0.76	0.15	0.75	0.16	0.34	*ns*
Afternoon predeparture	0.69	0.16	0.62	0.22	3.04	*ns*

Note.

Analyses controlled for age, gender, and English as a second language. BAU = business as usual.

Table 5

Child Self-Reports of Well-Being and Prosociality and Peer-Nominations of Prosociality and Aggression by Condition

	MindUP (*n* = 48)						BAU (*n* = 51)					
	Pretest		Posttest		Difference score		Pretest		Posttest		Difference score	
Measure	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Self-report												
Empathy	3.48	0.7)	3.74	0.68	0.27	1.07	3.86	0.63	3.68	0.81	–0.19	1.05
Perspective-taking	2.99	0.64	3.24	0.67	0.25	0.89	3.24	0.60	3.11	0.67	–0.14	1.02
Optimism	3.66	0.63	3.88	0.64	0.22	0.82	3.85	0.55	3.68	0.02	–0.17	0.81
Emotional control	3.39	0.73	3.70	0.63	0.31	0.85	3.49	0.64	3.30	0.68	–0.21	0.91
School self-concept	3.65	0.66	3.89	0.62	0.23	0.87	3.79	0.58	3.61	0.59	–0.17	0.78
Mindfulness	4.34	0.82	4.68	0.82	0.34	1.22	4.56	0.76	4.26	0.74	–0.30	1.10
Social responsibility	4.01	0.55	4.07	0.59	0.06	0.85	4.23	0.48	4.19	0.55	–0.04	0.69
Depressive symptoms	2.04	0.48	1.85	0.51	–0.19	0.72	1.92	0.51	2.02	0.48	0.10	0.55
Peer behavioral assessment												
Shares	.42	.17	.57	.21	.15	.26	.54	.14	.58	.17	.04	.26
Trustworthy	.30	.15	.35	.15	.05	.19	.40	.16	.29	.18	–.11	.23
Helpful	.34	.14	.44	.18	.10	.22	.49	.14	.42	.20	–.07	.25
Takes others' views	.30	.14	.45	.17	.15	.22	.43	.14	.38	.21	–.05	.24
Kind	.55	.16	.59	.18	.04	.21	.66	.14	.62	.19	–.04	.24
Liked by peers	.32	.16	.38	.17	.06	.22	.32	.16	.28	.16	–.04	.23
Starts fights	.13	.18	.08	.14	–.05	.19	.06	.10	.16	.20	.10	.23
Breaks rules	.14	.19	.13	.21	–.01	.24	.04	.07	.15	.18	.11	.19

Note.

BAU = business as usual.