Title: Enhancing Cognitive and Social-Emotional Development Through a Simple-to-Administer School Program

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Abstract: We hypothesized that a theoretically-coherent elementary school program involving mindfulness and doing for others (social responsibility) would enhance cognitive control, reduce stress, and produce better school outcomes. To test this, four classes of combined 4th and 5th graders were randomly assigned to receive the above program versus the regular social responsibility school program. Children who received the above program (a) showed greater improvements in cognitive control, stress regulation, optimism, and empathy, (b) showed greater decreases in depression and aggression, (c) were rated by peers as more trustworthy and helpful, and (d) had better math grades at the end of the school year. The results suggest that children's positive development can be fostered and their negative behaviors deterred via an inexpensive and easy-to-use program delivered by regular teachers in regular elementary school classrooms. This addresses a lacuna in the scientific literature – identifying strategies not only to diminish children's deficits but to help children thrive.

One Sentence Summary: Fourth and fifth graders randomly assigned to a program that teaches mindfulness techniques in addition to caring for others improved more in cognitive control and empathy, and showed a better diurnal rhythm of stress regulation than their peers in a program that taught caring for others but without a mindfulness component; the combined program produced children that are more optimistic and helpful, better liked by peers, and who seem better positioned to succeed both in school and in life.

Main Text:

What are ways that we can decrease children's mental health problems and promote their well-being, including their happiness and optimism? How can we cultivate positive human qualities such as empathy and compassion in the citizens of tomorrow? Would taking the time in school to do this compromise how far or fast children advance cognitively, or might cognitive development be enhanced by schools explicitly addressing children's social-emotional development and mental health? It has long been recognized that effective education includes practices that bolster students' social-emotional competencies in tandem with their academic knowledge. In recent years addressing the social-emotional health of children in North America has become a top priority (*1*). Epidemiological reports highlight increased childhood mental health disturbances, with approximately one in five children and adolescents experiencing psychological disorders severe enough to warrant mental health services (*2*). The Institute of Medicine's 2009 report indicated that the "annual quantifiable cost of such disorders among young people was estimated in 2007 to be $247 billion" and emphasized that prevention and the use of empirically-supported interventions are essential strategies for reducing mental illness and promoting social-emotional health (*3*). 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. Given competing demands on time and resources, it is essential that educators find and implement evidence-based curricular approaches that optimize learning and social adaptation, while proving to be cost-effective (*4*).

There has been a recent call to develop new approaches to promote children's

health and well-being and deter the effects of everyday stress and adversity by drawing from recent innovations in neuroscience (*5*). Mounting evidence suggests that executive functions (EFs) and self-regulation (i.e., the ability to control and focus attention and inhibit inappropriate and impulsive responses) play critical roles in forecasting children's long-term outcomes (*6*), success in school, and in their social-emotional competence above and beyond IQ *(7, 8*). EFs are cognitive control abilities depending on the prefrontal cortex (PFC) that organize, sequence, and regulate behavior and play a crucial role in everyday activities such as self-control, planning, problem solving, reasoning, multi-tasking, and maintaining cognitive flexibility. EF skills strengthen significantly throughout childhood and adolescence and reflect maturation that also extends throughout childhood and peaks in early adulthood (*9, 10)*.

One potentially effective way to support EFs and self-regulation is through practicing mindfulness. Both theory and empirical research indicate that mindfulness practices increase awareness of one's internal experience and promote reflection, self-regulation, and caring for others (*11*). Mindfulness, a theoretical construct that is also referred to as mindful attention training, originated from Eastern contemplative practices and refers to disciplining your attention to stay on target, being aware of whatever thoughts, feelings, or perceptions might arise but not letting them distract or derail you (i.e., "bringing one's complete attention to the present experience on a moment-to-moment basis") (*12*). Being mindful requires cognitive discipline versus "going on automatic pilot." Instead of being at the mercy of strong stimuli, emotions, or habits of mind or behavior, mindfulness involves choosing a focus and not being dissuaded from that. Mindfulness training typically involves exercises such as sitting, listening, or

walking meditations that are designed to cultivate self-control and executive attention coupled with a nonjudgmental attitude toward that experience (*13*).

Decades of research support the benefits of mindfulness training in adult populations showing that mindfulness interventions lead to sustained improvements in attention and awareness (*14-16*), health and stress-related medical conditions (*17*), and positive emotions and compassion (*18*). Despite this empirical support for mindfulness training with adults, however, the question of whether mindfulness training shows equivalent benefits for children is still unanswered. The relatively meager research examining mindfulness training with school-age children has yielded promising findings, but to date has focused mostly on reducing rumination and symptoms associated with anxiety and depression typically in clinical populations (*19*, *20*), and has not been applied to improving positive emotions and behaviors. Moreover, little is known about how a mindfulness program could help children regulate emotions and cognitions and promote their mental health and caring for others. This is particularly true for typically-developing children in regular elementary school classrooms.

Developing a classroom-based mindfulness practice program for elementary school children designed to promote cognitive control abilities along with optimism and caring for others promises both theoretical insights and empirically-based guidance for school-based programs that aim to decrease problem behaviors and increase well-being and positive development in children. This might be especially well-suited for the late elementary years where increased problems coincide with developmental changes in cognitive and social-emotional competencies (*21*) hence offering an ideal time to examine if an intervention can interrupt this downward cascade and prevent subsequent

psychopathology.

The current study was undertaken to determine whether a mindfulness-based practice curriculum (*MindUp*) aimed at fostering children's self-regulation, optimism, and empathy would lead to improvements in EFs, emotional control, stress regulation, academic achievement, and well-being in 4th and 5th grade children. We examined the effects of the *MindUp* program on multiple outcomes, including EFs, hypothalamic-pituitary-adrenocortical (HPA) regulation, grades, school absenteeism, and social-emotional competence. Drawing from existing theory and research in the areas of mindfulness (*11-18*) and positive psychology (*22, 23*), *MindUp* is a simple-to-administer mindfulness-based education program that consists of 12 lessons taught approximately once a week, with each lesson lasting approximately 40 – 50 minutes. The core mindfulness practices in the *MindUp* program (done every day for 3 minutes 3 times a day) consist of focusing on one's breathing and attentive listening to a single resonant sound. Each component of the program moves children from sensory experiences (e.g., mindful smelling and tasting) to cognitive experiences (e.g., learning optimism), ending with students reflecting on what they are grateful for in their own lives, and enacting random acts of kindness and community service.

Data were obtained by objective assessments as well as self- and peer reports (e.g., 1. cognitive control tasks, 2. diurnal salivary cortisol, 3. school grades, 4. school absenteeism 5. self-reports and, 6. peer behavioral assessments). To our knowledge, there are no studies in which neuropsychological, biological, and social-emotional competence indices have been examined jointly in one study examining the effectiveness of a mindfulness-based program for children. All measures, with the exception of school

grades and absenteeism, were collected both before the program began and after the program had ended. To reduce potential confounds due to teacher characteristics, teachers similar on several important dimensions (years of teaching, educational level) were recruited for both *MindUp* and control classrooms.

Four classrooms of combined $4^{th}/5^{th}$ grade children ($N = 99$) in four public elementary schools were randomly assigned to receive either the *MindUp* curricula or the district program that focused on the promotion of social responsibility following strategies delineated by the Ministry of Education (*24*). Teachers began to teach the *MindUp* lessons or the social responsibility approach in early March and finished in mid-June. No differences were found on demographic characteristics between the two conditions, suggesting that the randomization process worked. The average income for the neigborhoods in which each of the four schools was located approximated the median income for Canada ($52,800 CAD) (*25*).

To assess cognitive control, a computerized Hearts and Flowers version of the Dots task from the Directional Stroop Battery, and the Flanker task were administered individually to children (*26, 27;* see SOM) by two research assistants blind to experimental condition. These measures are appropriate for ages 4 through adults, require the prefrontal cortex (PFC), and assess all 3 core EF skills: (i) inhibitory control (resisting prepotent responses or distractions), (ii) working memory (mentally holding and using information), and (iii) cognitive flexibility (adjusting to change). HPA axis activity was assessed by measuring free cortisol in saliva (a neuroendocrinological marker for chronic HPA activation) collected at morning arrival (9 am), pre-lunch (11:45 am), and afternoon pre-departure (2:45 pm) at both pre- and posttest. Students' final grades in Math and total

number of days absent from school were obtained from school records. Children also completed a battery of measures assessing dimensions of social-emotional competence and well-being, and peers completed behavioral assessments of classmates' prosocial and aggressive behaviors (see SOM).

To examine program effects on EFs, we used Multi-level Modeling (MLM) with reaction time (RT) as the dependent variable and group condition as a predictor, controlling for pretest RT, age, gender, and ESL (see SOM). In all analyses, we calculated effect size (ES; Cohen's *d*). Results revealed that *MindUp* children outperformed controls in all three executive control tasks (see Fig. 1). In the most difficult Flanker condition that requires both inhibition and working memory, *MindUp* children were significantly faster than control children [$F(1, 92) = 4.32$, $P = 0.04$, ES = -0.21]. Furthermore, regardless of task condition, *MindUp* children outperformed controls on incongruent Flanker and reverse Flanker trials, indicating a greater ability to selectively attend and inhibit distraction [$F(1, 92) = 5.54$, $P = 0.02$, ES = -0.31]. This finding was consistent with children's performance on the Hearts and Flowers task. Again, the *MindUp* children were significantly faster on trials in the Hearts and Flowers-incongruent condition than control children [$F(1, 87) = 4.00$, $P = 0.04$, ES = -0.22].

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 9am to mean log 3 pm cortisol), taking into account time since awakening. In healthy persons not exposed to chronic stress, cortisol displays a robust diurnal rhythm, with values highest in the morning and gradually decreasing throughout the day. Higher (less

negative) values indicate a flatter diurnal cortisol slope, while lower (more negative) values indicate a steeper diurnal cortisol slope. We used 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 (*28*). At pretest, *MindUp* and control children exhibited a similarly steep slope [*Means* = -.05 and -.06, *SDs* = .05 and .05, respectively; $F(3, 94) = 1.31$, *NS*]. Analysis of Covariance (ANCOVA) with group (intervention vs. controls) as the independent variable and difference in slope from pretest to posttest as the dependent variable (controlling for age, gender, and ESL), revealed that *MindUp* children's average slope stayed healthy and well-regulated, changing little from pre- to posttest (*Mean* = -.003, *SD* = .06), whereas the average slope for controls changed from a steeper and better regulated diurnal pattern to a flatter and less-regulated pattern [*Mean* = .032, *SD* = .07] [$F(3, 94) = 5.90$, $P = 0.02$, ES = 0.51]. Fig. 2 illustrates the diurnal pattern at posttest for *MindUp* children relative to controls.

End of the year Math grades and school absenteeism were obtained from school records. Analysis of final Math grades on a grade metric ("A+" = 9, "A" = 8, . . . "C-" = 1) showed a trend toward higher year end Math grades for children in the *MindUp* program [*Mean* = 6.12, SD = 2.17) than for controls [*Mean* = 5.25, *SD* = 2.46] [$t(87) = 1.76$, $P = 0.07$, ES = 0.38)]. Additionally, children in *MindUp* tended to be absent from school fewer days (*Mean* = 7.84, SD = 6.59) than controls [*Mean* = 10.35, *SD* = 7.52] [$t(89) = 1.70$, $P = 0.09$, ES = - 0.35].

Effects of the *MindUp* program on children's self-reports of social and emotional competence were tested via a series of ANCOVAs with group as the independent variable, and pre-post differences as the dependent variables (controlling for age, gender,

and ESL, see SOM). Children in *MindUp* showed significant improvements from pre- to posttest in empathy [$F(1, 97) = 4.42$, $P = 0.03$, ES = 0.42], perspective-taking, [$F(1, 97) = 4.17$, $P = 0.04$, ES = 0.40], optimism [$F(1, 97) = 5.40$, $P = 0.02$ ES = 0.48], emotional control [$F(1, 97) = 8.78$, $P = 0.004$, ES = 0.59], school self-concept [$F(1, 97) = 5.60$, $P = 0.02$, ES = 0.50], mindfulness [$F(1, 97) = 7.94$, $P = 0.006$, ES = 0.55], and significantly decreased depressive symptoms [$F(1, 97) = 4.14$, $P = 0.04$, ES = -0.45] (see Fig. 3). The reverse was true for children in the comparison curriculum that focused solely on social responsibility – they showed significant decreases in all of these social-emotional measures (see Fig. 3). No difference between the groups was expected or found on a social responsibility measure [$F(1, 97) = .30$, *NS*]; both groups improved.

Differences from pre- to posttest for peer-rated prosocial and aggressive behaviors for *MindUp* children and controls are shown in Fig. 4. Consistent with the self-report data, compared to controls, children in the *MindUp* program improved on almost every dimension of prosocial behavior: sharing [$F(1, 97) = 4.42$, $P = 0.04$, ES = 0.42]; trustworthiness [$F(1, 97) = 13.44$, $P = 0.001$, ES = 0.76]; helpfulness [$F(1, 97) = 13.05$, $P = 0.001$, ES = 0.72]; taking others' views [$F(1, 97) = 18.90$, $P = 0.001$, ES = 0.87]; kindness, $F(1, 97) = 3.14$, $P = 0.06$, ES = 0.36]. *MindUp* children also showed significantly less aggressive behavior [starts fights, $F(1, 97) = 13.95$, $P = 0.001$, ES = -0.71; breaks rules, $F(1, 97) = 8.07$, $P = 0.006$, ES = -0.55]. 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, the reverse was true for children in the *MindUp* classrooms $F(1, 97) = 3.93$, $P = 0.05$, ES = 0.44] (see SOM).

These findings demonstrate that a relatively simple-to-administer curriculum including mindfulness training added onto the regular curriculum for a period of only 4 months can yield noteworthy positive behavioral and cognitive change. *MindUp* children showed significant improvements in EFs, neuroendocrinological and self-report measures of stress, and self- and peer-reported social-emotional competence. They also tended to miss fewer days of school and to show better math performance (the only subject for which grades were provided by the school) relative to controls. Particularly noteworthy is the convergence of results across multiple-levels of functioning from objective computerized measures of attention and biological measures reflecting neuroendocrine regulation to observational measures of both positive, prosocial behaviors and aggression (*29*).

How did a seemingly easy intervention produce such robust effects? First, empirical evidence suggests that school-based programs that promote children's social-emotional competence can yield significantly improved behavior, and academic achievement. In a recent meta-analysis of 213 school-based, universal social and emotional learning (SEL) programs involving 270,034 students from kindergarten through high school, compared to controls, students in SEL programs demonstrated significantly improved social-emotional skills, attitudes, and behavior, *and* academic performance with an average effect size of .31 (*4*). Of particular note, the mean effect size of the social, emotional, and behavioral outcomes (.44) was not only larger than effects observed in academic school-based programs, but was roughly equivalent to the results of a meta-analysis of eighty-seven school-based interventions (*30*).

How does this translate into the practical benefits of *MindUp*? 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 intervention and control groups (*31*). We found a 24% gain in positive social behaviors from participation in the *MindUp* program, a gain of 15% in math achievement, a gain of 20% in self-reported social-emotional competencies and skills, and a reduction of 24% in aggressive behaviors. Put another way, the average student in the control group would demonstrate a 24 percentile increase in positive social behaviors, a 15 percentile increase in math, a 20 percentile increase in social-emotional skills, and a 24 percentile decrease in aggression if they had participated in the *MindUp* program.

Second, several models have been proposed for understanding the mechanisms that protect or buffer for mental health difficulties and problem behaviors in children. Previous research with adults has shown that cognitive processes associated with PFC, known collectively as EFs, are improved through regular mindfulness attention training (*11, 14-16*). Consistent with those studies, using objective neurocognitive measures of attention, we found that *MindUp* children in our study outperformed comparison children on the most difficult EF tasks requiring inhibition. There has been considerable theorizing and some data indicating that EFs, and in particular inhibitory control, is especially relevant to the development of emotional regulation during childhood. We contend that the 3 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. We would also suggest that it is may not only be mindfulness training that leads to increased caring and kindness; indeed it is the combination of mindfulness training with opportunities for reinforcement to practice that promotes optimism and perform acts of kindness for others that leads to positive changes in well-being and behavior.

Third, school settings can be stressful for all students regardless of age. However, for students in the upper elementary grades, the school environment involves an extra degree of stress not experienced by younger students because of declines in teacher supportiveness (*32*) and increases in peer exclusion and aggression that transpire from the beginning to the end of the school year. For instance, several recent studies have found that *social aggression* – a nonconfrontational form of aggression that involves harming others indirectly through the social community – increases in the 4^{th} and 5^{th} grades over the course of a regular school year (*33*). These decreases in social relatedness and positive feelings about the school environment lead to an ever-worsening recursive cycle of stress that is accompanied with concomitant increases in aggressive and antisocial behaviors alongside decreases in prosocial behaviors and self-esteem. Although our research was conducted during only the last 4 months of the school year versus the entire school year, a downward trajectory in adjustment in the control group is indicated by (i) the significant decreases in self-reports of well-being and increases in peer-reports of aggression and antisocial behaviors, and (ii) the change from a healthy diurnal rhythm of cortisol levels (i.e., steep decline from am to pm) to an attenuated diurnal decrease in cortisol from morning to afternoon. This latter pattern represents a flattening or loss of expected daily cortisol rhythm and has been recognized as indicating a significant poor

HPA axis functioning (*34*) and has been found among children experiencing chronic stress (*35*). These patterns of decreased well-being and increased aggression were not seen in the intervention students suggesting that the *MindUp* program disrupted elementary school students' typical trajectory of increased stress and decreased peer supportiveness by engaging students in activities that improve their ability to self-regulate, think about the perspectives of others, take time to reflect on those things for which they are grateful, and collectively engage in regular activities that benefit others.

As past research suggests, mindfulness training leads to (a) increased ability to regulate distress and (b) enhanced self-reports of well-being (*36*). In the real world, reduced stress has a number of beneficial effects, including reductions in the tendency to ruminate on negative thoughts, improved health, and decreased aggression (*37*). Our findings demonstrate that giving children mindfulness attention training in combination with opportunities to practice optimism, gratitude, perspective-taking, and kindness to others can improve not only 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. Any assessment of what a program accomplishes should take into account not just the program's benefits but also its costs. The costs of the *MindUp* program are relatively small. The program costs approximately $7.00 per child – including the costs of the curriculum materials and teacher training– a minimal expense when taking into account the multiple benefits on both cognitive and social-emotional development. 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, it appears that the inclusion of mindfulness practices into a classroom-based

social and emotional learning program may represent a “value-added” component to the regular school curriculum that can result in multiple benefits.

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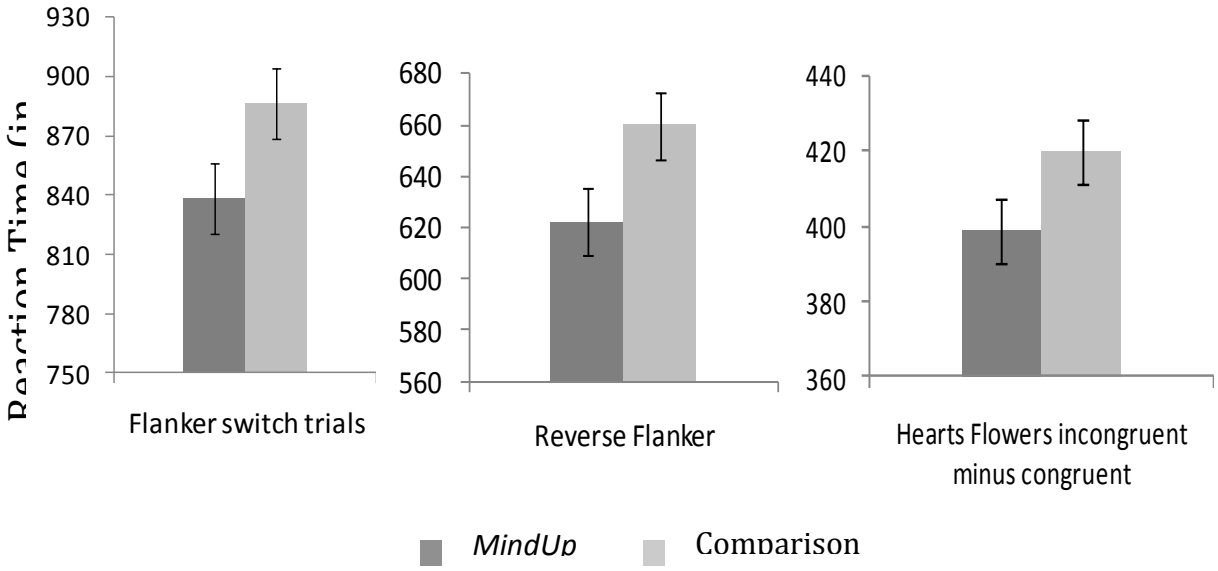

Fig. 1. MindUp children (dark grey) performed better on measures of EF than children in the comparison group (light grey). The dependent measure is reaction time (RT) at the posttest, adjusted for RT at pretest. Bars represent the main effect for 'group' for all task conditions. **(A)** Flanker switch trials require switching the rule that is applied in response to the stimulus, while the side of the expected response remains the same. Those trials are amongst the most demanding task conditions, taxing all three EFs. **(B)** Reverse Flanker trials (responding based on the direction in which the outside stimuli are pointing, ignoring the distracting Flanker in the center) tax all three EFs, more than do Flanker trials (responding based on the inside stimulus, ignoring the flanking stimuli to the left and right). **(C)** Dots-incongruent trials (responding to the stimulus by pressing the key on the opposite side) tax inhibitory control and working memory; Dots-congruent trials (responding to the stimulus by pressing the key on the same side) tax working memory only.

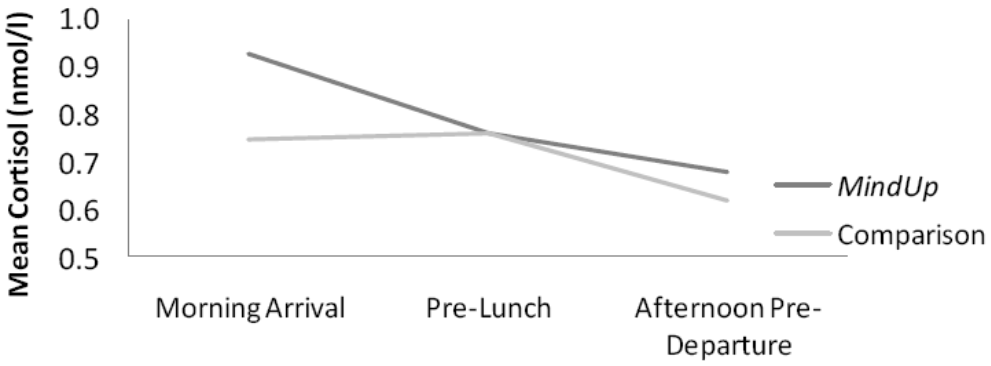

Fig. 2. At posttest, MindUp children have a steeper slope of cortisol downward regulation throughout the day than children in the comparison group. The glucocorticoid hormone cortisol, the primary hormonal product of the hypothalamic-pituitary-adrenocortical (HPA) system, is part of the typical daily stress regulatory system that is typically higher in the morning just after awakening and gradually declines over the day. Dependent measure is the average log-transformed cortisol level in both groups, controlling for time since awakening at each point of cortisol collection. Further analyses and statistics are reported in SOM.

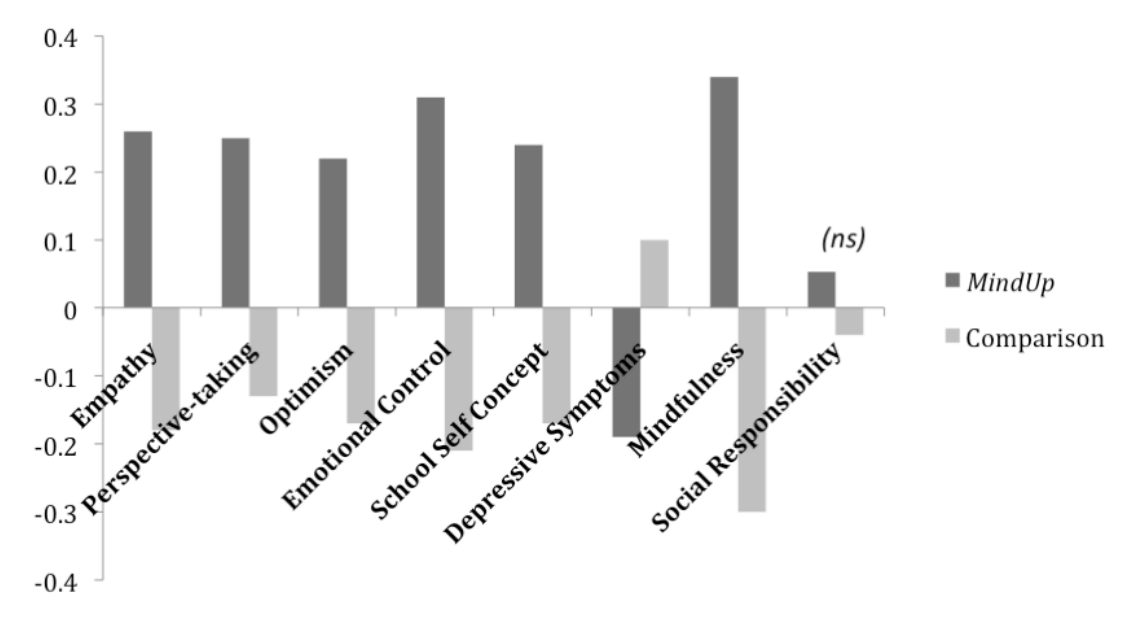

Fig. 3. Results for social and emotional competence measures. Children completed a battery of measures of social and emotional competence and well-being. *MindUp* program children's scores were more improved from pre- to posttest than control children for all measures, with the exception of social responsibility, where there was no difference.

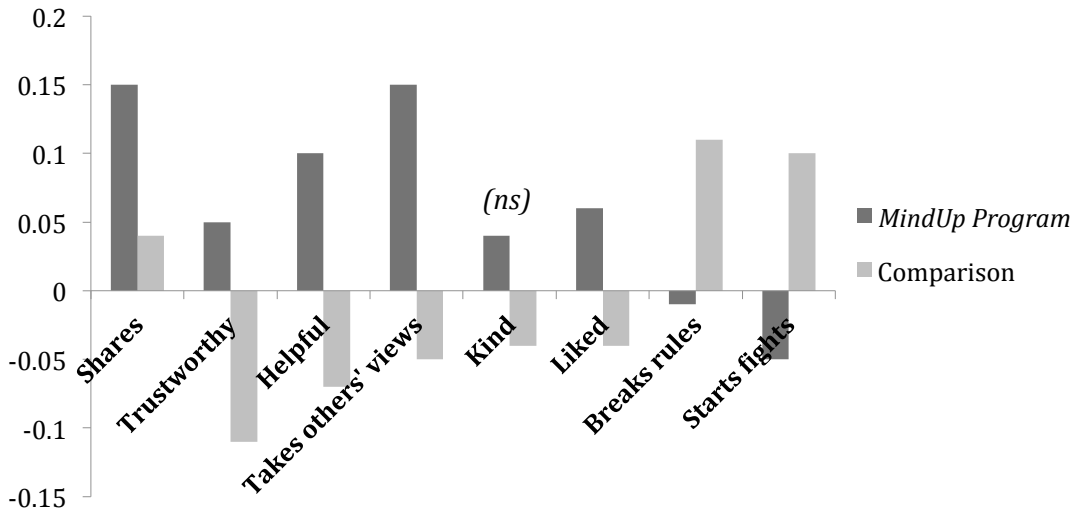

Fig. 4. Results for peer behavioral assessments of prosocial and antisocial/aggressive behaviors and peer liking. For each behavior, students were given a roster of their classmates and were asked to circle the names of any whose behavior fit the description; students could circle as many or as few names as they wanted. Scores were computed as the proportion of students who circled that student's name among those who responded to the item, and then standardized within each classroom. *MindUp* program children's scores were more improved at post-test than comparison children on every dimension assessed.