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Strengthening school readiness for Head Start children: Evaluation of a self-regulation
intervention

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Abstract

The present study examined the efficacy of a self-regulation intervention for children experiencing demographic risk. Utilizing a randomized controlled design, analyses examined if children ($N = 276$ children in 14 Head Start classrooms; M age = 51.69, $SD = 6.55$) who participated in an 8-week self-regulation intervention demonstrated greater gains in self-regulation and academic achievement over the preschool year compared to children in a control group. In addition, indirect intervention effects on achievement outcomes through self-regulation were explored and differential intervention effects for English language learners within a sample of children from low-income families were tested. Results indicated that children in the intervention group demonstrated stronger levels of self-regulation compared to the control group in the spring of the preschool year. Group comparisons also revealed that the intervention was related to significantly higher math skills for children who were English language learners. In other words, English language learners who participated in the intervention demonstrated stronger levels of math in the spring of preschool in comparison to children in the control group and relative to English speakers who also participated in the intervention. The present study provides support for the efficacy of a school readiness intervention in promoting self-regulation and achievement in young children, especially English language learners.

Key words: intervention, school readiness, self-regulation, academic achievement

Strengthening school readiness for Head Start children: An evaluation of a self-regulation intervention

In the United States, more than one in five children live in poverty (U.S. Census Bureau, 2011). A great deal of research suggests that poverty adversely affects many aspects of children's development (Bradley & Corwyn, 2002; Duncan & Brooks-Gunn, 2000). Socio-demographic risk can be particularly detrimental for the development of young children's self-regulation skills (Mistry, Benner, Biesanz, Clark, & Howes, 2010), skills that are critical for academic success (Blair & Razza, 2007; McClelland, Acock, & Morrison, 2006). Research highlights that self-regulation may be a malleable and teachable mechanism for improving school success, especially for young children from disadvantaged backgrounds; however, little is known about targeted, systematic approaches to improving these skills prior to kindergarten entry. Even less is known about how participating in self-regulation interventions might have differential effects on subgroups of children and how intervention-related self-regulation gains impact academic outcomes. The present study evaluated a game-based, self-regulation intervention aimed at improving self-regulation for children enrolled in Head Start. In addition to examining the effects of intervention participation on self-regulation gains over the year, we examined the impact of intervention participation on academic achievement within subgroups of children (i.e., children from low-income families who were English language learners).

Theoretical and Conceptual Framework

Self-regulation has been conceptualized in various ways depending on the discipline; however, it is generally recognized as a multidimensional construct that includes aspects of emotion, cognition, and behavior (McClelland, Cameron Ponitz, Messersmith, & Tominey, 2010). In the present study, we focus on the behavioral aspects of self-regulation most salient in

classroom contexts, which are informed by three underlying executive function processes (Best & Miller, 2010; Miyake et al., 2000): working memory (holding information in mind; Gathercole, Pickering, Knight, & Stegmann, 2004), attentional flexibility (maintaining focus and adapting to changing goals; Rueda, Posner, & Rothbart, 2005), and inhibitory control (stopping a dominant response in favor of a more adaptive one; Dowsett & Livesey, 2000). We define self-regulation in the present study as the integration of these three executive functions into overt behavior (McClelland et al., 2010).

Self-regulation involves environmental and developmental processes as indicated by recent theoretical work (Blair & Raver, 2012; (McClelland, Geldhof, Cameron, & Wanless, in press). For example, psychobiological models posit that the quality of caregiving that children experience is a key mediator linking early environmental inputs (e.g., poverty) and self-regulation (Blair & Raver, 2012a, 2012b). Intervention research suggests that self-regulation demonstrates relative plasticity throughout the life span (Diamond & Lee, 2011), and that early childhood may be a sensitive period for the development of self-regulation (Carlson, Zelazo, & Faja, 2013). Thus, self-regulation during preschool may be an important mechanism to target for improving children's school readiness.

Self-Regulation and Academic Achievement

Research suggests that early childhood is an important period for the development of self-regulation (Carlson et al., 2013). It is during preschool that children experience significant growth in the prefrontal cortex, the area of the brain most closely associated with self-regulation. Moreover, evidence suggests that self-regulation is foundational for school success in that it helps children navigate structured learning environments, avoid distractions, pay attention, stay on task, and persist through difficulty (McClelland et al., in press). Thus, it is no surprise that

self-regulation is related to academic achievement in early childhood and beyond (Blair & Razza, 2007; McClelland et al., 2007). For example, children with strong self-regulation (measured by teacher report and direct assessments) in preschool and elementary school also score higher on measures of achievement (Cameron Ponitz et al., 2009; McClelland et al., 2006; McClelland, Morrison, & Holmes; 2000). In addition, early self-regulation predicts long-term academic achievement, such as high school and college completion (Breslau et al., 2009; McClelland, Acock, Piccinin, Rhea, & Stallings, 2013). Together, this research highlights the importance of self-regulation for academic success, and indicates that improving self-regulation in preschool may have long term effects.

The Impact of Risk on Self-Regulation Development

Demographic risk, such as poverty, can have negative consequences for a range of developmental outcomes (Duncan & Magnuson, 2005; Evans & Rosenbaum, 2008; Komro et al., 2011; McClelland et al., 2000; Mistry et al., 2010; Sektnan, McClelland, Acock, & Morrison, 2010). Decades of research underscore the negative relation between poverty and academic achievement (Duncan & Magnuson, 2005), and more recent work indicates similar negative impacts on children's self-regulation (Raver, Blair, & Willoughby, 2013; Wanless, McClelland, Tominey, & Acock, 2011). For example, in one study, children from low-income families demonstrated poorer self-regulation skills in the fall of the preschool year relative to their more advantaged peers (Wanless, McClelland, Tominey, et al., 2011). Indeed, poverty can put insurmountable stress on families, and recent psychobiological models indicate that poverty-related adversity can inadvertently affect self-regulation through reductions in the quality of the home environment (Blair & Raver, 2012). Specifically, poverty-related stress can impact parents' abilities to provide stimulating home environments that encourage children to practice

the skills related to strong self-regulation (e.g., paying attention, remembering rules, controlling impulses; Bradley et al., 1989; Hart & Risley, 1995; McClelland et al., 2000).

When paired with poverty, being an English language learner (ELL) can also have negative consequences for the development of self-regulation and academic outcomes (Wanless, McClelland, Tominey, et al., 2011). Many Latino children (65%) live in homes where Spanish is the primary language (Lopez, Barrueco, & Miles, 2006), and can be considered ELLs. In the United States, ELLs tend to come from poorer and less educated families (U.S. Census Bureau, 2006), and these compounded risks (in comparison to ELL status alone) can negatively influence academic outcomes (Galindo & Fuller, 2010; Han, 2012) and self-regulation (Wanless, McClelland, Tominey, et al., 2011). For example, parents who are poor and have low levels of education are less likely to engage in behaviors in the home that support early numerical development (e.g., counting, quantity comparisons) than parents who are high-income and have higher levels of education (Vandermaas-Peeler, Nelson, Bumpass, & Sassine, 2009). Although a growing body of literature indicates that children who show bilingual fluency are at an advantage for academic achievement due to greater cognitive flexibility and abstract thinking skills (Bialystok, 1988; Bialystok & Herman, 1999), children who are learning English as a second language and have limited English proficiency do not share these benefits (Gándara, Rumberger, Maxwell-Jolly, & Callahan, 2003).

These studies suggest that children experiencing demographic risk, particularly those experiencing cumulative risk (e.g., being low-income and learning English), may be an important population to target for intervention. Moreover, given the noted variability in self-regulation skills across different levels of socioeconomic disadvantage, it is possible that early childhood interventions could have differential effects for children experiencing varying levels of risk.

Indeed, past research has reported that children who are the most disadvantaged benefit the most from early intervention (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008).

Self-Regulation Interventions

The number of comprehensive preschool interventions including self-regulation components has grown over the years as a result of a large body of evidence suggesting that these skills are critical for academic success (Diamond & Lee, 2011). Many of these interventions have shown substantive results (Barnett et al., 2008; Bierman et al., 2008; Diamond, Barnett, Thomas, & Munro, 2007; Pears, Fisher, & Bronz, 2007; Raver et al., 2011). For example, the Kids in Transition to School Program (KITS), which focuses on increasing school readiness has been effective in improving self-regulation and decreasing behavior problems in children living in foster care (Pears et al., 2007; Pears, Kim, & Fisher, 2012). The Tools of the Mind program integrates multiple facets of development, (e.g., cognitive, socio-emotional), and although mixed, there is some evidence that participating in this program leads to improvements in self-regulation (Barnett et al., 2008; Diamond et al., 2007). The Promoting Alternative Thinking Strategies (PATHS) curriculum (Kusche & Greenberg, 1994), utilized in the Head Start REDI (Research-Based, Developmentally Informed) intervention, has also been effective in improving preschool children's socio-emotional competence and self-regulation (Bierman et al., 2008; Domitrovich, Cortes, & Greenberg, 2007). Finally, the Chicago School Readiness Project (CSRP), a comprehensive intervention focused on training teachers to use specific classroom strategies (e.g., effective classroom management) and utilize mental health consultants, has shown promise in promoting self-regulation skills and academic achievement in children from low-income families (Raver et al., 2011).

In addition to the direct effects found in the PATHS and CSRП efficacy trials, indirect intervention effects were also reported for academic achievement working through self-regulation (Bierman et al., 2008; Raver et al., 2011). In analyses of PATHS, intervention effects on phonological awareness and print knowledge were partially mediated through a measure of task orientation, which included self-regulation (Bierman et al., 2008). Similarly, Raver and colleagues (2011) reported significant mediating effects of self-regulation on the relation between the CSRП intervention and children's early literacy and math skills.

Although these interventions have shown substantive effects, many require extensive resources (e.g., time and expense) and may not be easily replicated in the absence of these resources. Furthermore, many of these programs do not *explicitly* target self-regulation, making it impossible to untangle which components of the interventions relate directly to observed outcomes. Developing a targeted intervention that focuses specifically on self-regulation could help identify activities that can most easily be integrated into classroom routines and help identify intervention components that are most effective in producing positive outcomes.

The few targeted interventions that exist use individualized sessions that include repeated practice (Dowsett & Livesey, 2000) and/or computerized training in laboratories (Thorell, Lindqvist, Nutley, Bohlin, & Klingberg, 2009). Although there is some evidence that these approaches have increased self-regulation, these interventions are not particularly salient for success in classroom contexts. Finding time to hold individual training sessions with children is not practical in most classroom settings and there is little or no evidence that improving children's scores using computer-based tasks translates to changes in classroom behavior or academic achievement (Diamond & Lee, 2011; Melby-Lervåg & Hulme, 2013).

In the present study, we examined the impact of a targeted self-regulation intervention, using classroom-based movement and music games to help children practice integrating working memory, attentional flexibility, and inhibitory control. The intervention required few materials and was cost-effective compared to other curricula-based programs. A previous evaluation of the intervention from a small randomized-controlled study with 65 children indicated that for children with low initial levels of self-regulation (the majority of whom were also from low-income families), participation in the intervention predicted self-regulation gains over the school year (Tominey & McClelland, 2011). In addition, for the whole sample, children in the intervention group made greater gains in literacy over the school year than children in the control group. The present study sought to expand and replicate the intervention developed by Tominey & McClelland (2011) to include a larger sample of children from low-income families (including a subsample of children who were ELLs) and to address some of the limitations in previous iterations of the intervention.

We addressed three limitations of the previous study: 1) *children* in the (reference omitted for blind review) efficacy trial were randomly assigned to intervention or control groups, rather than classrooms, 2) implementation occurred outside of the classroom, and 3) only one measure of self-regulation was used to examine intervention effects on these skills. Although the first and second limitation facilitated consistency and fidelity across sessions, a critical next step was to explore the efficacy of the intervention as a classroom-based program. Thus, in the present study, we randomized at the classroom level in order to evaluate the efficacy of the intervention as implemented in typical classroom settings and used multiple measures of self-regulation to assess effectiveness and to better understand the validity of the games.

A Targeted Self-Regulation Intervention

The intervention took place over the course of eight weeks. Children participated in two 20-30 minute playgroups per week. Playgroups took place in the regular classrooms in which children were enrolled. Children were first asked to sit in the area of the classroom typically used for large-group circle-time. The group leader began each session with a greeting song. Following the greeting song, the group leader introduced and engaged children in playgroup activities. The playgroups consisted of circle-time movement and music-based games that encouraged children to practice self-regulation skills (for a complete description of the intervention games, see Tominey & McClelland, 2011). One example of a game used in the intervention is called *Red Light, Purple Light*. Similar to the children's game *Red Light, Green Light*, a researcher acted as a stoplight and held up different-colored construction paper circles to represent stop and go. Children responded to specific color cues (e.g., purple is stop and orange is go) and then opposite cues (e.g., purple is go and orange is stop) with a variety of actions (e.g., clapping). During this game, children were required to listen to and remember instructions (i.e., working memory), attend to the researcher by watching the cues and successfully switching from one rule to another (i.e., attentional flexibility), and resist the natural inclination to engage inappropriately in an action (i.e., inhibitory control). As the intervention progressed, activities were repeated and additional rules were introduced to the games increasing their cognitive complexity. To end each session, children sang a good-bye song.

The Current Study

Utilizing a randomized controlled design, the current study evaluated a classroom-based self-regulation intervention in a sample of children enrolled in Head Start. Three research questions were examined: *1) Does participation in the intervention lead to stronger self-regulation skills and academic achievement over the preschool year compared to a control*

group? Based on preliminary findings (Tominey & McClelland, 2011), we hypothesized that children's participation in the intervention would lead to greater gains in self-regulation skills and academic achievement over the preschool year relative to a control group. Based on previous research, but utilizing a larger sample with more statistical power, we expected that children's participation in the intervention would significantly predict spring emergent literacy, math, and vocabulary scores as previous research has shown significant relations between self-regulation abilities and these skills (McClelland et al., 2007); 2) *Does self-regulation mediate the relationship between intervention participation and academic scores at the end of the preschool year?* Based on previous intervention studies documenting indirect relationships between interventions and academic outcomes through self-regulation, we expected that indirect effects would emerge such that the intervention would be indirectly related to spring achievement through self-regulation (Bierman et al., 2008; Raver et al., 2011); and 3) *Do the effects of a self-regulation intervention vary for children who are ELLs within a low-income sample?* Based upon previous research that children who come from low-income families and are ELLs demonstrate slower growth in self-regulation during the prekindergarten year relative to their English-speaking peers (Wanless, McClelland, Tominey et al., 2011) and that children with low levels of self-regulation skills benefit the most from intervention (Diamond & Lee, 2011), we expected that children identified as ELLs who participated in the intervention would show the greatest improvements in self-regulation and academic achievement over the preschool year. This hypothesis was also based upon previous findings that suggest that children who come from low-income families and are ELLs start the prekindergarten year with lower academic scores than their more advantaged peers, but show the greatest gains after minimal exposure to academic instruction (Reardon & Galindo, 2009).

Method

Participants

The current sample consisted of 276 children (49% boys) enrolled in 14 Head Start classrooms across nine sites located in a Pacific Northwest city. Each site was part of a public school district's Head Start program. Across control and intervention classrooms, baseline head teacher education was equivalent (i.e., in both control and intervention groups four teachers had bachelor's degrees and three teachers had master's degrees). Children and families were recruited through letters in an enrollment packet sent during the summer prior to the preschool year. All children attended half-day programs. Although we do not have information about other child care programs that children participated in, the majority of children rode the bus to and from the program, rather than to another childcare program. Signed consent was obtained from 24 teachers and from a parent of all children in the study, and all participants were given \$20 gift cards. Teacher (assistant and head teachers) educational levels were: high school (9%), some college (17%), Associate's degree (4%), Bachelor's degree (39%), and Master's degree (31%). Participants ranged in age from 37.98 to 66.04 months ($M = 51.69$, $SD = 6.55$), and 33% were English language learners (ELLs). Parent education (primary reporter) ranged from 2 to 16 years ($M = 11.15$, $SD = 2.70$). Although we did not have a direct measure of income, all families were eligible for Head Start with income levels below 100% of the poverty threshold.

Teachers identified 88 children as ELLs, although there was no assessment of language fluency/proficiency administered as part of the study. All of the children who were ELLs spoke Spanish as their primary language. For these children, Spanish was also the primary language spoken in the home as indicated by administration data provided by the school district. Children who were ELLs ranged in age from 37.98 to 61.44 months ($M = 52.02$, $SD = 6.28$), and parent

education ranged from 2 to 15 years ($M = 9.45$, $SD = 3.41$). Preliminary analyses revealed that children who were ELLs did not significantly differ from English speakers on age or fall self-regulation scores (see Table 1), which replicates previous studies including low-income samples (Wanless, McClelland, Tominey, et al., 2011). Similar to results in previous studies (Galindo & Fuller, 2010; Han, 2012), however, children from low-income families who were ELLs entered prekindergarten with significantly lower math, $t(241) = 3.81$, $p < .01$, $d = .51$, and vocabulary scores, $t(245) = 5.80$, $p < .01$, $d = .77$, than their English-speaking peers. In contrast to previous findings (Han, 2012), children who were ELLs scored significantly higher than English speakers on early literacy, $t(240) = -2.26$, $p < .05$, $d = .30$. In addition, children from low-income families who were ELLs differed significantly from low-income English speakers on education levels, $t(170) = 7.38$, $p < .01$, $d = 1.05$, such that the parents of children who were ELLs reported lower levels of education ($M = 9.45$ years) than low-income English speakers ($M = 12.19$ years). It should be noted that 27% of the data on parent education for the ELL sample was missing and 40% of the data on parent education was missing for the English-speaking sample.

Procedure

All direct assessments were administered by trained research assistants in the fall (pretest) and spring (posttest) of the preschool year. Assessments were given over two sessions in quiet spaces and each session lasted approximately 15 minutes. Children identified as ELLs by their teachers were assessed in Spanish. On the rare occasion that Spanish-speaking children responded correctly to an item in English, they were credited with a correct response.

Pretest. In the fall of the preschool year (prior to the intervention), direct assessments of children's academic achievement and self-regulation were obtained. In addition, parents and

teachers completed demographic questionnaires, and teachers rated children on their self-regulation in the classroom.

Intervention. In the winter of the preschool year, 14 classrooms across nine sites were randomly assigned to the intervention group ($n = 7$; children = 126) or the control group ($n = 7$; children = 150) to evaluate the intervention as a classroom-based program. Three sites had one classroom each randomly assigned to the intervention, and 3 sites had one classroom each randomly assigned to the control group. Two sites had one classroom randomly assigned to the intervention group and one classroom randomly assigned to the control group. One site had two classrooms randomly assigned to the intervention and two classrooms randomly assigned to the control group.

Children in the intervention and control classrooms were not significantly different from one another on demographic characteristics (parent education, gender, ELL status) or baseline self-regulation and academic achievement scores (see Table 2). On average, 20 children were enrolled in each intervention classroom and 19 children were enrolled in each control classroom. Randomizing at the classroom level reduced the potential for contamination effects and helped avoid children in close proximity (e.g., in the same classroom) from sharing intervention information (e.g., teaching each other intervention games) with their peers in control groups (Keogh-Brown et al., 2007), which could bias study results. Although unlikely due to geographical differences (i.e., many classes were in separate buildings or were scheduled at differing times of the day), contamination across intervention and control classrooms was possible through teachers sharing intervention game information. To avoid this possibility, teachers in intervention classrooms were asked not to provide any information on the intervention games to teachers in control classrooms. Over the course of eight weeks, children in

control classrooms participated in the same daily activities, routines, and curricula that preceded study participation (i.e., business-as-usual), and children in the intervention group participated in playgroups. This intervention duration has been effective in improving children's self-regulation in previous studies (Pears et al., 2007). In the current study, the average attendance rate was 13 sessions, and 66% of children participated in 80% of the sessions or more. Playgroups were integrated into the normal classroom schedule on the same two days every week, and were led by one trained research assistant (group leader). There were a total of three group leaders (all female and Caucasian), all of whom had previously worked with young children from disadvantaged families in classroom settings. Two of the group leaders had master's degrees in Child Development and one had a bachelor's degree in Psychology. Prior to implementing weekly intervention sessions, group leaders attended a training workshop led by the intervention developer. Group leaders facilitated playgroups in the same classrooms over the course of the intervention. All instructions for playgroup games were delivered in English and immediately translated into Spanish by either an assistant teacher or a native, Spanish-speaking research assistant for all classrooms with Spanish-speaking children. In addition to the group leader, 3-5 undergraduate research assistants participated in all intervention sessions to engage children's participation during the playgroups.

Implementation fidelity. Fidelity of implementation (i.e., adherence and quality) was monitored weekly. To assess adherence, the three group leaders were asked each week whether or not they completed the session and what activities were completed. To ensure quality of implementation, the three group leaders met prior to delivering weekly sessions to discuss implementation and watch training videos. Detailed lesson plans were also created that included

specific delivery instructions, and research assistants followed these plans to ensure consistent implementation.

Posttest. Similar to the pretest, in the spring of the preschool year (after the intervention), the same direct assessments of children's academic achievement and self-regulation were obtained. All assessors were blind to treatment and control group membership. Teachers were also asked to rate children on their self-regulation in the classroom.

Attrition

Over the duration of the study, the sample decreased from 276 to 241 (a 14.5% decrease). The percentage of attrition was greater for the control group (19% attrition for the control group; 5% attrition for the intervention group). To test for differential attrition between the groups, t-tests were conducted based on demographic characteristics (child age, gender, ELL status, parent education, marital status, maternal age) and baseline self-regulation and achievement scores. No significant differences emerged between the groups suggesting that although attrition was higher in the control group, there were no significant differences between the groups in demographic characteristics at baseline.

Seven children switched classrooms during the study period, however, six of these children changed classrooms after the intervention had taken place and one of the children moved from one control classroom to another during the intervention. Although the chance of crossover effects (children moving to a control group post-intervention could influence peers' regulation in their new classroom and vice versa) were possible, because so few children moved from one classroom to another, they were less likely.

Measures

Parent demographic questionnaire. Parents completed a demographic questionnaire in English or Spanish that included questions about children's age, gender, ethnicity, prior schooling/child care, native language, and parent education level.

Teacher ratings of behavioral self-regulation. Prior to and after the intervention phase, teacher ratings of self-regulation were assessed using the Child Behavior Rating Scale (CBRS; Bronson, Tivnan, & Seppanen, 1995). The CBRS assesses each child's task behavior and social interactions in the classroom. Similar to other studies (Cameron Ponitz et al., 2009; Wanless, McClelland, Acock, Chen, & Chen, 2011), 10 items on a 5-point scale (1 indicating children *never* displayed certain behaviors, 5 indicating that children *always* displayed certain behaviors) from the CBRS were used to determine children's self-regulation in classroom contexts. Example items include: "Attempts new challenging tasks" and "Responds to instructions and then begins an appropriate task without being reminded." Similar to prior research (Bronson et al., 1995; McClelland et al., 2007; McClelland & Morrison, 2003; Wanless, McClelland, Acock, Chen et al., 2011), in the current sample, this measure demonstrated high reliability in the spring and the fall (Cronbach's alpha = .96). Previous research has also found that the CBRS is significantly related to children's academic achievement in diverse samples (McClelland et al., 2007; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, Cameron Ponitz et al., 2011).

Direct measures of behavioral self-regulation. The Head-Toes-Knees-Shoulders Task (HTKS), a behavioral assessment of self-regulation, was administered in English or Spanish. This task taps the integration of working memory, attentional flexibility, and inhibitory control (McClelland et al., 2014; McClelland & Cameron, 2012). During the first phase of the task, children were asked to respond naturally to a command (e.g., "Touch your head"). Then children were asked to do the opposite of the original instruction. In subsequent phases,

additional commands were added and rules were changed, increasing the cognitive complexity of the task. The measure consists of 30 items, with a range in scores of 0 to 60. Children were given a score of 0 for an incorrect response; a 1 for a self-corrected response; and a 2 for a correct response. Inter-rater reliability was tested and achieved (weighted Cohen's $\kappa = 0.84$). These results are consistent with past research documenting high inter-rater reliability ($\kappa > .90$) and validity of the HTKS in assessing children's behavioral self-regulation with economically and culturally diverse samples (McClelland et al., 2007; McClelland et al., 2014; von Suchodoletz et al., 2013; Wanless, McClelland, Acock, Chen et al., 2011).

A Card Sorting task that was based on the Dimensional Change Card Sort (DCCS; Frye, Zelazo, & Palfai, 1995), a measure of children's cognitive or attentional flexibility was also administered in English or Spanish. Administration procedures were similar to those in Hongwanishkul, Happaney, Lee, and Zelazo (2005). The Card Sorting task consists of up to 24 items, with each sorting trial having 6 items. During this task, children were asked to sort colored picture cards of a dog, fish, or bird on the basis of three dimensions: color, shape, and size. Four sorting boxes with target cards (either a dog, fish, bird or frog) affixed on them were placed directly in front of children. The same target and test cards were used for all trials. Children were given one practice trial prior to testing trials. During all test trials, children were given a test card (that had the same picture on it as one of the target cards) and asked the question, "Where does this one go?" and they were to place the card in one of the boxes. No feedback was given. For the first six items (pre-switch trial), children were to sort on the basis of shape (e.g., the dog cards go in the sorting box with the dog card affixed). For the second six items (post-switch trial), children were told they were going to play a new game and would now sort on the basis of color. For the third six items (post-switch trial), children were told they were going to play a new

game and would now sort on the basis of size. If children scored five or more points on the third section, a fourth set of items were administered which consisted of a new rule: when the card had a black border on it, children were to sort on the basis of size, and when the card did not have a black border, children were to sort on the basis of color. Scoring was non-standard in that all items were weighted equally (including pre-switch trial items). Children were given a score of 0 for an incorrect response and 1 for a correct response, with scores ranging from 0 to 24. This measure has shown strong reliability in previous research (Hongwanishkul et al., 2005) and demonstrated strong reliability in the current sample (fall: Cronbach's $\alpha = .84$; spring: Cronbach's $\alpha = .77$).

Academic outcomes. Prior to and after the intervention phase, three subtests of the Woodcock Johnson Psycho-Educational Battery-III Tests of Achievement (WJ-III; Woodcock & Mather, 2000) or the WJ-III or the Bateria III Woodcock-Muñoz (Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005) were used to assess children's academic achievement in English or Spanish. Large-scale studies using rigorous methods (i.e., IRT) have equated the English and Spanish WJ-III measures and indicate that they assess the same competencies (Woodcock & Muñoz-Sandoval, 1993, 1996). Moreover, recent findings indicate no significant differences on scores between the English or Spanish versions of the WJ-III (Hindeman, Skibbe, Miller, & Zimmerman, 2010). Although internal reliability on the WJ-III subtests was not available in the present sample, the WJ-III is widely used, normed, and standardized, and has strong psychometric properties for the Applied Problems, Letter-Word Identification, and Picture Vocabulary subtests in preschool children (McGrew & Woodcock, 2001). Previous research has demonstrated strong reliability (Cronbach's $\alpha > .80$) in preschool samples for all of the following subtests (Schrank et al., 2005; Woodcock & Mather, 2000).

Early math skills. Depending on children's native language, either the Applied Problems subtest of the WJ-III or the Bateria III Woodcock-Muñoz (Muñoz-Sandoval et al., 2005) was used to measure early mathematical skills, including counting and addition and subtraction problem solving. For children ages two to seven, the subtest has a test-retest reliability of .90 for a less than 1-year interval and .85 for a 1- to 2-year interval, and a median split-half reliability of .92 for children four to seven years old (McGrew & Woodcock, 2001).

Emergent literacy Skills. Depending on children's native language, either the Letter-Word Identification subtest of the WJ-III or the Bateria III Woodcock-Muñoz (Muñoz-Sandoval et al., 2005) was used to measure early literacy skills, such as letter recognition and reading out loud. For children ages two to seven, the subtest has a test-retest reliability of .96 for a less than 1-year interval and .91 for a 1- to 2-year interval, and a median split-half reliability of .98 for children four to seven years old (McGrew & Woodcock, 2001).

Early vocabulary skills. Depending on children's native language, either the Picture Vocabulary subtest of the WJ-III or the Bateria III Woodcock-Muñoz (Muñoz-Sandoval et al., 2005) was used to assess children's early vocabulary skills. The subtest has a median split-half reliability of .73 for children four to seven years old (McGrew & Woodcock, 2001).

Control variables. Baseline self-regulation or early academic scores, age (in months), and English language learner (ELL) status were used as control variables in all models. In past research, these variables have been related to self-regulation and academic achievement (Cameron Ponitz et al., 2009; Wanless, McClelland, Tominey et al., 2011). Gender and parent education have also been identified as indicators of these outcome variables in past work (Cameron Ponitz et al., 2009; Matthews, Cameron Ponitz, & Morrison, 2009), however, in the current study, they were not significantly related to the outcomes. Therefore, to preserve

parsimony, gender and parent education were trimmed from the final models. Moreover, the parent education variable was problematic, which limited its utility in our statistical models. First, our sample was fairly homogenous in terms of parent education, which was reflected in the restricted range and variance of the variable ($SD = 2.7$ years). This restricted variance limited our power in detecting the effect of maternal education. Second, there was a significant amount of missing data on parent education variable (>35%). For these reasons and the non-significant relations to the outcomes, parent education was not utilized as a covariate in the current study.

Results

In the present study, we explored if children in an intervention group demonstrated stronger self-regulation and academic achievement over the preschool year compared to children in a control group. In addition, we explored whether gains in self-regulation mediated the effect of the intervention on spring academic outcomes. Finally, we tested for potential differential intervention effects for children who were ELLs within a low-income sample.

Analytic Strategy

Data analyses were conducted using Stata 12.1 (StataCorp, 2011). Due to the nested structure of the data (children nested in classrooms), a multilevel framework was utilized to test the effects of the intervention ($ICCs$ representing classroom variance in spring self-regulation and achievement outcomes ranged from .009 to .11). Separate models were run for each self-regulation and academic achievement measure to test intervention effects on each. Intervention condition was entered as a between-level variable. It should be noted that separate multilevel models were run for children who were ELLs. A similar pattern of results emerged for the ELL subsample as for the full sample (with the exception of early math), and thus, full models including children who were ELLs are reported. All models take into account baseline outcome

scores, children's age and ELL status. To test for differential intervention effects, an interaction variable representing intervention*ELL status was added to the models.

In order to calculate effect sizes, residual variances were used to calculate standard deviations, which were then divided into the difference in means (Feingold, 2009). Because our sample size of classrooms was relatively small ($N = 14$), our ability to detect variance at the classroom level may have been limited. Thus, OLS regressions were also conducted and similar patterns of results emerged (results from these analyses are not presented here, but are available upon request).

An intent-to-treat (ITT) analysis was employed to handle attrition such that children were analyzed as if they remained in the group to which they were originally assigned (Fisher et al., 1990). This is thought to be a conservative and practical approach for handling attrition (Newell, 1992), and is meant to test the likely effects of interventions in "real-world," less controlled environments (Shadish, Cook, & Campbell, 2002).

Missing data. Data were missing on the HTKS (13% at time 1; 17% at time 2), Card Sorting (10% at time 1; 16% at time 2), CBRS (6% at time 1; 15% at time 2), WJ: Applied Problems (12% at time 1; 17% at time 2), WJ: Letter Word (12% at time 1; 16% at time 2), and WJ: Picture Vocabulary (11% at time 1; 17% at time 2). These missing values resulted from attrition, as well as other extraneous circumstances (e.g., child was sick during scheduled testing sessions).

Data were assumed to be missing at random (MAR), which requires that all variables associated with missingness are included in the imputation model and that all other patterns of missingness are random (Schafer & Graham, 2002). There is no definitive test of the MAR assumption, however, in the present study, logistic regressions were run to determine whether

auxiliary variables not included in analysis models were related to missingness (e.g., ethnicity, parent education, marital status, maternal age, parent employment status, and residential mobility). No significant predictors of missingness emerged suggesting patterns of missingness were not systematic, and thus, it was reasonable to assume that data were missing at random (Acock, 2012). To handle missing data, full information maximum likelihood (FIML) estimation in Stata 12.1 (StataCorp, 2011; Muthén & Muthén, 2012) was used under MAR to test all hypotheses. The FIML process estimates a likelihood function for each individual study participant utilizing all available data. This estimation method is the most appropriate option when missing values are present on one or more variables (Little & Rubin, 2002; Acock, 2013).

Descriptive statistics. Descriptive statistics are provided in Table 1 (English speakers and children who were ELLs) and Table 2 (full sample). It should be noted that there were floor effects for the HTKS, particularly at time 1 (48% of the sample scored 0). Bivariate correlations can be found in Table 3. Two sample t-tests of paired differences in means indicated that the intervention was not related to time 1 variables. The intervention was significantly correlated with spring self-regulation (i.e., HTKS). The intervention was not significantly related to any of the achievement outcomes.

Hypothesis Testing. Our first research question was: *does participation in the intervention lead to stronger levels of self-regulation skills and academic achievement in the spring of the preschool year compared to a control group?* Controlling for baseline self-regulation, child age, and ELL status, results (see Table 4) indicated that children who participated in the intervention demonstrated stronger spring self-regulation, as measured by the HTKS (Cohen's $d = .32$) and the Card Sorting task (Cohen's $d = .16$). Significant intervention effects did not emerge for the teacher-rated CBRS or directly-assessed achievement outcomes.

Our second research question was: *does self-regulation mediate the link between intervention participation and academic scores at the end of the preschool year?* Path models were conducted to test for indirect effects between the intervention and achievement through self-regulation. In all models, self-regulation did not emerge as a significant mediator when controlling for baseline academic scores, child age, and ELL status.

Our final research question was: *do the effects of a self-regulation intervention vary for children who were ELLs within a low-income sample?* Interaction terms representing intervention*ELL status were entered into multilevel models to test for potential differential intervention effects. Although no significant interactions emerged in models exploring self-regulation as an outcomes, a significant interaction was found between intervention participation and ELL status on spring math such that children who were ELLs who participated in the intervention were predicted to score 10.39 more points in math in the spring of the preschool year compared to the English speakers in the intervention (see Figure 1). On average, from fall to spring, children who were ELLs in the intervention gained approximately 22 points on the math assessment. These gains experienced over roughly a 6-month period of time were equivalent to approximately one year of normative, age equivalent gains in math as calculated by the Woodcock-Johnson III Compuscore and Profiles Program (Woodcock, McGrew, & Mather, 2006). To further explore this finding, multilevel regressions were run for the ELL sample only exploring direct effects on math. Significant direct intervention effects were found for math gains in this subgroup of children ($d = .44$).

Discussion

In the present study, we expanded upon and evaluated a self-regulation intervention in a sample of children enrolled in Head Start. Findings indicated that intervention participation

predicted self-regulation on two assessments in the spring of the preschool year. In addition, direct effects of intervention participation on applied problems (early math scores) were found for a subgroup of children who were ELLs. These findings have potential implications for the inclusion of curricula specifically targeting the development and practice of self-regulation to promote academics in early care and education programs, especially for children experiencing risk factors. Moreover, they point to the potential cost-effectiveness of including curricula that target aspects of self-regulation.

Intervention Participation and Self-Regulation

The current study adds to findings from past work suggesting that early intervention can be effective in improving children's self-regulation, especially for those who enter preschool with low levels of regulatory skills (Bierman et al., 2008; Diamond & Lee, 2011). In the present study, children who participated in an intervention using music and movement-based games demonstrated stronger self-regulation skills in the spring of the preschool year compared to children in the control group. Our effect sizes are (in general) comparable to those in similar intervention studies that have included self-regulation measures, thus, supporting their practical and substantive significance (Hill, Bloom, Black, & Lipsey, 2008). For example, Bierman and colleagues (2008) reported an effect size of .20 on the Card Sorting task from participation in the PATHS curriculum, and Raver and colleagues (2011) reported an intervention effect size of .37 on a composite of two direct assessments of self-regulation in their efficacy trial of the CSRP. In the current sample, all children were from low-income families, as measured by Head Start eligibility. Typically, children from low-income families have more difficulties with self-regulation in preschool than their more advantaged peers (Wanless, McClelland, Tominey et al., 2011), and thus, curricula that target these skills may be especially important for these children

(Bierman et al., 2008).

The current study replicated previous work by demonstrating that the intervention was effective in improving self-regulation on the HTKS (a direct assessment of self-regulation) (Tominey & McClelland, 2011), and also extended these findings to show intervention-related change on a second direct measure of self-regulation, the Card Sorting task. Finding evidence of intervention-related growth in multiple measures of self-regulation is an important step in expanding our understanding of the construct validity of the games used in the intervention. Additionally, the intervention showed substantive effects as a classroom-based program implemented by trained researchers, suggesting that the intervention may have potential to be effective as a program delivered in classroom settings by trained teachers. Although these games are limited in that they are specifically targeted to self-regulation development, they are cost-effective and require little training to implement. Moreover, participation in these intervention games demonstrates stronger effects than other large studies of comprehensive curricula, such as Tools of the Mind (Farran, Wilson, & Lipsey, 2013). In sum, the feasibility and inexpensive nature of the targeted self-regulation intervention could have practical implications for program policy aimed to improve children's school readiness.

The lack of a significant intervention effect on teacher ratings of children's self-regulation warrants further discussion and exploration. One possible explanation is that direct measures of self-regulation are more ecologically valid and better able to measure children's abilities and change in these abilities than teacher ratings, an explanation supported by the recent emphasis on the development and use of direct measures (McClelland & Cameron Ponitz, 2012). A second explanation is that intervention-related changes in self-regulatory skills did not translate into changes in classroom behavior that were detected by classroom teachers. Because

there was no significant difference between teacher-rated self-regulation on the CBRS between the fall and spring, it seems likely that the first explanation is the most plausible (direct measures are better able to detect change in these skills), although future studies should explore the impact of intervention participation on observable classroom behaviors.

Intervention Participation and Academic Achievement

The primary goal of the intervention was to help children practice the integration of working memory, attentional flexibility, and inhibitory control, a set of self-regulation skills predictive of academic success (McClelland et al., 2007). The intent was that by facilitating growth in self-regulation, children would be better able to benefit from explicit math, literacy, or vocabulary instruction during everyday classroom activities. Indeed, previous research has supported this hypothesis (Bierman et al., 2008). For example, utilizing the same classroom games as in the current study, Tominey & McClelland (2011) found that children who participated in the intervention experienced greater gains in emergent literacy skills than children in the control group.

In the present study, children in both the intervention and control groups experienced gains in all academic domains over the preschool year (e.g., average gains of 17 points in math, 14 points in literacy, and 7 points in vocabulary across groups); however, in the overall sample, intervention participation did not directly relate to these gains. The similar achievement gains experienced by children in both the intervention and control groups are likely indicative of maturation effects, classroom and home experiences, or a combination. Indeed, longitudinal studies suggest that children will make age-related gains during the preschool year on academics even without interventions that focus on improved self-regulation (McClelland et al., 2007).

Even though there was no evidence in the full sample that intervention participation

significantly impacted academic scores, there was evidence in the subgroup of children who were ELLs, which was our third research question. For children who were ELLs, the significant relationship between intervention participation and applied problems scores indicated that participating in the intervention promoted growth in self-regulatory skills that enabled children who were ELLs to better benefit from applied problems instruction. In fact, by the end of the year, children who were ELLs had experienced the greatest gains in applied problems scores compared to children in the control group and to their English-speaking peers in the intervention group. Specifically, children who were ELLs in the intervention group gained an average of nearly 22 points on our math assessment (English speaking children in the intervention gained an average of 14 points), which is substantial and not only statistically significant, but also substantive from a practical standpoint. It should be noted that children who were ELLs were tested in their native language (Spanish) so these gains cannot be credited to gains in English language abilities.

These findings raise several questions. The first question is why did children who were ELLs experience gains in applied problems, but not gains in the other academic domains? A preponderance of literature documents a robust link between self-regulation and math (Bull, Espy, & Wiebe, 2008; Cameron Ponitz et al., 2009; McClelland et al., 2007), and self-regulation has been shown to be as strong of a predictor of math skills in children who are ELLs as it is for English-speaking children (McClelland & Wanless, 2012). These links could suggest a potential explanation as to why an intervention that targets self-regulation skills explicitly was effective in improving math skills for children who were ELLs, but not literacy or language skills. Another possible explanation is that applied problems skills are less dependent on linguistic abilities than the other academic skills measured and thus, a change in self-regulation could be more readily

observed in applied problems skills.

The second question that arises is: why did children with English as their native language in the intervention group not experience the same benefits for applied problems as children who were ELLs? A possible explanation is that differential effects, particularly for children who are most at risk, are common in the intervention literature (Diamond & Lee, 2011). In our sample, children who were ELLs were the most at-risk as indexed by baseline academic skills and parental education. Children who were ELLs started the preschool year with lower math and vocabulary scores compared to English speakers indicating that these children had more room to grow academically. In addition, on average, the highest level of education that parents of children who were ELLs reported was 9th grade, whereas the highest average grade reported by English-speaking parents was 12th grade. Extant literature documents parental education as an indicator of risk and links low parental education with poor developmental outcomes (Downer & Pianta, 2006; Sektnan et al., 2010). Children who are from low-income families and have parents with low levels of education may be particularly at-risk for poor math outcomes. Indeed, parents are more likely to promote early literacy skills compared to early math skills (LeFevre, Polyzoi, Skwarchuk, Fast, & Sowinski, 2010) and parents with the lowest levels of education may be especially less likely to promote early math skills (Vandermass-Peeler et al., 2009). For example, in one study, compared to high-socioeconomic parents (middle- to high-income, high education), low-socioeconomic parents (low-income, low education) were less likely to engage in behaviors in the home that support math skills (e.g., counting, quantity comparisons; Vandermaas-Peeler et al., 2009).

These elevated risk factors indicate that children who were ELLs who are also low-income may benefit more from a self-regulation intervention, which appeared to be the case in

the current study for gains in math skills. Understanding the mechanisms through which growth in self-regulation and academic achievement occur in diverse samples of children is a critical next step toward creating interventions and classroom practices that effectively promote school readiness.

The lack of significant intervention effects for achievement in the overall sample may be because our analyses of intervention effects were limited to a relatively short period of time (fall to spring of the preschool year). Self-regulation is often thought of as a necessary precursor for successful learning in that it allows children to take advantage of learning opportunities in classroom contexts (McClelland et al., in press; Raver et al., 2011). In other words, self-regulation helps children learn *how* to learn, rather than *what* to learn, and lays the foundation for academic trajectories. Longitudinal studies have supported the notion that early self-regulation is critical for later achievement outcomes (McClelland et al., 2006; McClelland et al., 2013). Although other comprehensive interventions (CSRP; Raver et al., 2011) were able to detect significant intervention effects on children's academic skills in the spring of the same year, it is possible that in the current study, measuring the effects of a targeted self-regulation intervention on achievement shortly after the intervention ended (approximately 1-2 months) impeded our ability to detect significant direct effects. Perhaps the regulatory skills that children gained from the intervention were not yet translating into increased abilities to benefit more from explicit academic instruction in the classroom. Future research should explore this possibility further by following children longitudinally to determine if facilitating the development of self-regulation in preschool through intervention has long-term effects on children's academic skills.

Limitations and Future Directions

Although this study contributes to existing literature on school readiness interventions,

limitations must be noted. One key limitation is that research assistants, rather than teachers, implemented the intervention games, and also, that parents were not involved in implementation. In addition to one group leader, 3-5 research assistants participated in intervention games to encourage and measure child engagement, which was somewhat resource-intensive. Although this facilitated fidelity and engagement across sessions and is a necessary starting point before scaling up, a critical next step is to examine if teachers are able to embed the intervention games into their everyday curricula with fidelity. Indeed, Jones and Bouffard (2012) argue for new approaches that help teachers integrate opportunities to practice self-regulation into academic curricula, rather than detract from it. Jones and Bouffard also propose an organizational framework for early social and emotional learning interventions that incorporates self-regulation, emotional regulation, and social/interpersonal skills as interdependent constructs, as well as one that takes into account the multiple levels of environmental influence on these skills and behaviors. In addition, to assess fidelity of implementation we relied on the reports of intervention group leaders. Although there were only three group leaders, which made fidelity of implementation relatively easy to track and maintain, future studies should utilize outside observers to assess implementation in addition to group leader report. In addition, although teachers in intervention and control classrooms were asked to conduct their classrooms as “business as usual,” there was no measure of other activities that teachers were participating in with their classes. For example, although both intervention and control teachers reported that they did not play intervention games during the study period, it is possible that they engaged in other similar activities altering implementation fidelity, and potentially enhancing intervention effectiveness or diluting intervention effects (Hulleman & Cordray, 2009). It will be important for future studies to develop careful implementation measures to ensure intervention fidelity.

Moreover, developing components of the intervention that include parents will be necessary. A large literature supports the notion that parents are integral in their children's development, and specifically their self-regulation (Roskam, Stievenart, Meunier, & Noël, 2014), and previous interventions that include home activities (e.g., PATHS "take-home" packets; Bierman et al., 2008) in addition to a classroom program have been effective in promoting school readiness.

As has been documented in other papers, there were floor effects of the HTKS especially for low-income children, which is a second limitation of the present study (Caughy et al., 2013; McClelland et al., 2007). This may have limited our ability to detect variability in self-regulation on this measure for children with low levels of these skills. Despite these floor effects, previous studies have documented significant and substantive relations between HTKS scores and a range of academic outcomes in diverse samples (McClelland et al., 2007, 2014; Wanless et al., 2011). The inclusion of additional measures of self-regulation (e.g., Card Sorting, CBRS) is critical for examining variability in self-regulation in children who have not yet developed the skills necessary to score on the HTKS.

A third constraint of the current study is that it was limited to a focus on self-regulation development in classroom contexts, facilitated at the child-level (i.e., by helping children explicitly practice working memory, attentional flexibility, and inhibitory control). Although limited in focus, results suggest that the intervention may still be a key ingredient in more comprehensive strategies to improve social and emotional learning in young children.

A fourth limitation is that the validity of our results is constrained to 14 Head Start classrooms in the Pacific Northwest. Although the demographics of the children in our sample closely resembled that of a national sample of children eligible for Head Start (U.S. Department of Health and Human Services, 2010), future work is needed to replicate this study in multiple

regions and with multiple research teams to determine if our findings generalize to a broader Head Start population.

A final limitation is that we were only able to collect pre-test data at one time point (fall of the preschool year). With more than one baseline data point, a more reliable estimate of the starting level of each child would have been accomplished. Although this design was similar to other intervention studies (Bierman et al., 2008; Raver et al., 2011), it will be important for future efficacy studies to include multiple baseline data points.

Conclusions

The current study supports the initial efficacy of a targeted intervention in improving low-income children's self-regulation through circle-time games. Additionally, intervention participation was particularly beneficial for the early math skills of children who were ELLs. Recent educational policies have focused on improving academic achievement in the United States, and shape the experiences that children have in classroom contexts. The results of the current study suggest that playing fun, well-designed, circle-time games may be an effective and low-cost strategy for improving both self-regulation and academic outcomes during the preschool year. Children experiencing socioeconomic disadvantage are often in need of extra supports for school readiness and healthy development, and quality early care and education programs could be potential avenues for the provision of these supports. Thus, investing in early education and school readiness interventions for disadvantaged children can level the educational and economic playing field and therefore, create a more equitable and productive society (Heckman, 2011).

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Table 1

Means and Standard Deviations for English Language Learners and English Speakers

	English language learners			English speakers			T-tests	
	Full sample (<i>N</i> = 88)	Intervention group (<i>n</i> = 44)	Control group (<i>n</i> = 44)	Full sample (<i>N</i> = 188)	Intervention group (<i>n</i> = 82)	Control group (<i>n</i> = 106)	<i>t</i> ^a	<i>d</i> ^c
Covariates								
Child age (in months)	52.02 (6.28)	51.19 (6.30)	52.85 (6.22)	51.53 (6.70)	51.02 (6.76)	51.93 (6.65)	<i>t</i> (267) = -.58	.08
Baseline scores								
HTKS	4.76 (8.83)	5.56 (10.32)	3.95 (7.09)	6.13 (10.13)	5.41 (9.06)	6.71 (10.92)	<i>t</i> (238) = 1.03	.14
Card Sorting	8.04 (4.25)	8.00 (3.91)	8.08 (4.62)	8.74 (4.91)	8.73 (4.84)	8.76 (4.98)	<i>t</i> (247) = 1.11	.15
CBRS	34.72 (7.80)	35.64 (8.24)	33.76 (7.29)	32.8 (8.46)	33.85 (8.45)	31.92 (8.40)	<i>t</i> (257) = -1.76	.24
Applied problems	369.56 (32.42)	370.34 (32.87)	368.83 (32.40)	385.17 (28.47)	386.85 (27.37)	383.80 (29.42)	<i>t</i> (241) = 3.81***	.51
Letter-word identification	315.41 (24.89)	316.85 (26.42)	314.00 (23.57)	308.25 (22.17)	306.61 (21.12)	309.54 (23.00)	<i>t</i> (240) = -2.26*	.30
Picture vocabulary	442.75 (17.77)	443.26 (18.38)	442.25 (17.37)	455.34 (14.96)	456.32 (14.58)	454.59 (15.28)	<i>t</i> (245) = 5.80***	.77
Spring scores								
HTKS	8.11 (12.08)	11.05 (13.70)	4.66 (8.86)	12.95 (15.73)	13.53 (16.21)	10.97 (15.23)	<i>t</i> (222) = 2.01	.50
Card Sorting	9.96 (5.80)	10.27 (5.96)	9.61 (5.68)	11.09 (6.15)	11.48 (6.02)	10.69 (6.29)	<i>t</i> (224) = 1.33	.19
CBRS	36.80 (8.11)	37.00 (9.02)	36.58 (7.08)	33.99 (7.73)	34.95 (7.91)	33.05 (7.47)	<i>t</i> (227) = -2.57*	.35
Applied problems	389.01 (28.53)	391.93 (31.34)	385.69 (24.98)	401.05 (23.70)	400.43 (25.94)	401.68 (21.32)	<i>t</i> (221) = 3.36***	.46
Letter-word identification	328.99 (27.27)	329.39 (27.67)	328.51 (27.18)	322.65 (21.83)	323.89 (21.20)	321.37 (22.54)	<i>t</i> (222) = -1.86	.26
Picture vocabulary	452.28 (18.92)	452.56 (19.52)	451.94 (18.50)	461.70 (11.97)	462.01 (13.05)	461.38 (10.86)	<i>t</i> (221) = 4.54***	.59

Note. HTKS = Head-Toes-Knees-Shoulders task; CBRS = Child Behavior Rating Scale; There were no significant differences between intervention and control groups on demographic variables or baseline self-regulation and academic achievement.

^a*t*-tests comparing ELL and English-speaking full samples.

^c*d* equal to the average of the absolute value of the differences in means divided by the pooled *SD*.

Table 2

Baseline and Spring Means and Standard Deviations for Full Sample and Intervention and Control groups

	Full sample (<i>N</i> = 276)	Intervention group (<i>n</i> = 126)	Control group (<i>n</i> = 150)	<i>t</i> ^b	<i>d</i> ^c
Covariates					
ELL status ^a	.33 (.47)	.36 (.48)	.30 (.46)	<i>t</i> (267) = -.89	.13
Child age (in months)	51.69 (6.55)	51.08 (6.58)	52.21 (6.51)	<i>t</i> (267) = 1.41	.17
Baseline scores					
HTKS	5.68 (9.72)	5.47 (9.49)	5.85 (9.95)	<i>t</i> (238) = .30	.04
Card Sorting	8.52 (4.71)	8.47 (4.53)	8.56 (4.87)	<i>t</i> (247) = .14	.02
CBRS	33.44 (8.28)	34.49 (8.39)	32.49 (8.09)	<i>t</i> (257) = -1.95	.24
Applied problems	380.16 (30.61)	381.25 (30.24)	379.23 (31.01)	<i>t</i> (241) = -.51	.07
Letter-word identification	310.58 (23.29)	310.21 (23.52)	310.90 (23.18)	<i>t</i> (240) = .23	.03
Picture vocabulary	451.31 (16.93)	451.77 (17.11)	450.93 (16.84)	<i>t</i> (241) = -.38	.05
Spring scores					
HTKS	10.67 (14.60)	12.53 (15.33)	8.75 (13.62)	<i>t</i> (227) = -1.97*	.26
Card Sorting	10.64 (6.01)	10.97 (5.98)	10.31 (6.04)	<i>t</i> (231) = -.83	.11
CBRS	34.94 (7.95)	35.75 (8.29)	34.14 (7.54)	<i>t</i> (234) = -1.56	.20
Applied problems	396.47 (26.06)	397.45 (28.03)	395.46 (23.94)	<i>t</i> (226) = -.57	.08
Letter-word identification	324.28 (23.87)	325.51 (23.71)	322.99 (24.06)	<i>t</i> (229) = -.80	.11

Picture vocabulary	458.40 (15.30)	458.68 (16.09)	458.11 (14.52)	$t(228) = -.28$.04
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Note. HTKS = Head-Toes-Knees-Shoulders task; CBRS = Child Behavior Rating Scale; There were no significant differences between intervention and control groups on demographic variables or baseline self-regulation and academic achievement

^aELL status: 0 = English speaker, 1 = English language learner

^b*t*-tests comparing intervention and control groups at baseline.

^c*d* equal to the average of the absolute value of the differences in means divided by the pooled *SD*.

Table 3

Partial correlations among all study variables (controlling for age; N = 276)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Intervention	—													
2. Child age ^a	-.09	—												
3. ELL status ^b	.05	.04	—											
4. Fall HTKS	-.01	.20**	-.08	—										
5. Spring HTKS	.17*	.42**	-.17*	.40**	—									
6. Fall Card Sorting	.02	.29**	-.08	.28**	.31**	—								
7. Spring Card Sorting	.11	.41**	-.11	.24**	.31**	.63**	—							
8. Fall CBRS	.15*	.33**	.11*	.18**	.20*	.24**	.20*	—						
9. Spring CBRS	.13	.38**	.16*	.16**	.18*	.23**	.26**	.70**	—					
10. Fall applied problems	.07	.46**	-.28**	.26*	.35**	.37**	.49**	.31**	.30**	—				
11. Spring applied problems	.07	.45**	-.27**	.20**	.28**	.39**	.44**	.27**	.33**	.70**	—			
12. Fall letter-word identification	.01	.29*	.15*	.18**	.11	.23*	.22*	.15**	.15**	.26**	.29**	—		
13. Spring letter-word identification	.06	.18**	.12	.08	.12	.26**	.25**	.22**	.21**	.34**	.32**	.62**	—	
14. Fall Vocabulary	.05	.34**	-.38**	.05	.25**	.26**	.33**	.08	.09	.54**	.45**	.24**	.22**	—
15. Spring Vocabulary	.04	.26**	-.31**	.06	.26**	.25**	.35**	.04	.12	.46**	.48**	.25**	.29**	.67**

Note. HTKS = Head-Toes-Knees-Shoulders task; CBRS = Child Behavior Rating Scale^aChild age measured in months; ^aELL status: 0 = English speaker, 1 = English language learner.* $p < .05$; ** $p < .01$

Table 4

Full Model Results on Spring Self-Regulation

	HTKS			Card Sorting		
	<i>B</i>	<i>SE</i>	<i>d</i>	<i>B</i>	<i>SE</i>	<i>d</i>
Intervention	4.88**	1.68	.32	1.29*	.61	.17
Baseline score	.53**	.08	--	.78**	.07	--
Age	.83**	.13	--	.23**	.05	--
ELL status	-4.27*	7.75	--	-.69	.61	--

Note. HTKS = Head-Toes-Knees-Shoulders task.

** $p < .01$; * $p < .05$.

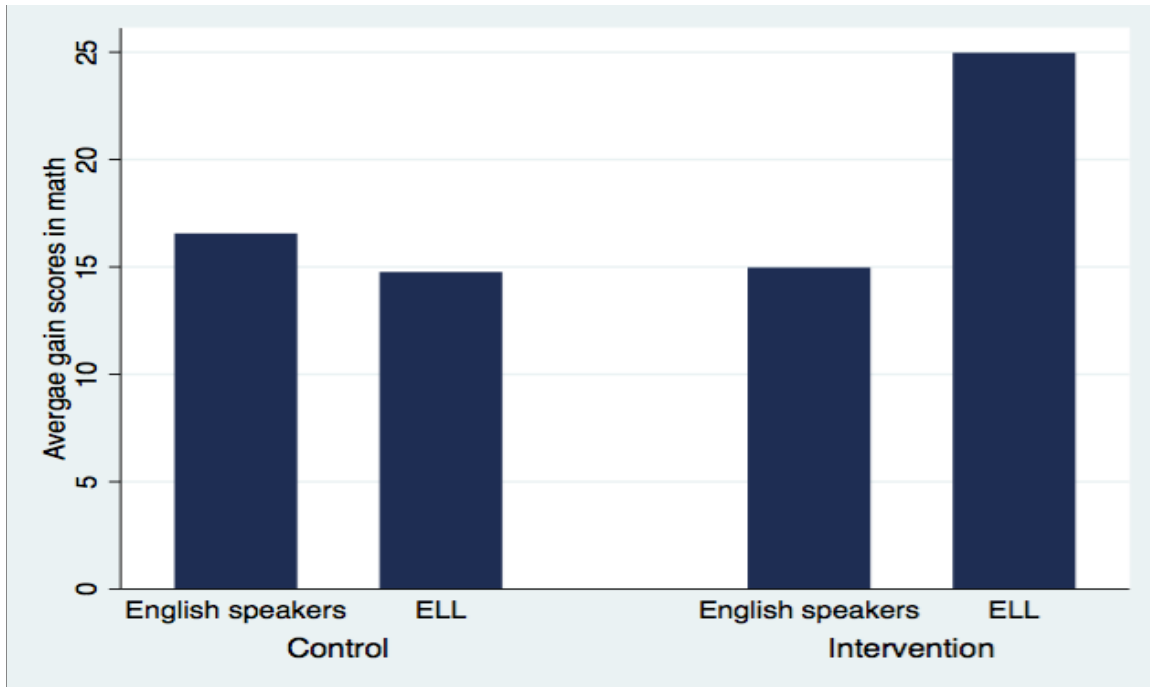


Figure 1. Differential relationship between intervention participation and math for English Language Learners: Average gain scores in math by ELL status and intervention group