EARLY EDUCATION AND DEVELOPMENT, *22*(3), 489–519

ISSN: 1040-9289 print/1556-6935 online
DOI: 10.1080/10409289.2011.574258

Routledge
Taylor & Francis Group

Red Light, Purple Light: Findings From a Randomized Trial Using Circle Time Games to Improve Behavioral Self-Regulation in Preschool

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Research Findings: The present study examined the efficacy of a self-regulation intervention with 65 preschool children. Using circle time games, the study examined whether participating in a treatment group significantly improved behavioral self-regulation and early academic outcomes. Half of the children were randomly assigned to participate in 16 playgroups during the winter of the school year. Behavioral aspects of self-regulation and early achievement were assessed in the fall and spring. Although there was no treatment effect in the overall sample, post hoc analyses revealed that participation in the treatment group was significantly related to self-regulation gains in children who started the year with low levels of these skills. Children in the treatment group also demonstrated significant letter-word identification gains compared to children in the control group. *Practice or Policy:* The findings from this study provide preliminary evidence for the efficacy of the intervention in terms of improving preschoolers' behavioral self-regulation for children low in these skills and improving letter-word identification. Although preliminary, these results have the potential to inform preschool curricula that emphasize behavioral self-regulation as a means of facilitating school readiness.

Every year, many young children transition from preschool to a more structured and academically focused kindergarten environment. Although most children navigate this transition successfully, it can be problematic for those

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who have not developed the self-regulation critical for success in a classroom setting. In recent years, there has been an increasing emphasis on accountability for children's academic achievement in the U.S. public education system, in part because of legislation such as No Child Left Behind. As a result, pressure is being placed on teachers at all grade levels to adopt a stronger academic focus to ensure that children reach required benchmarks on mandated standardized tests (U.S. Department of Education, 2009). Recent research has documented the fact that children are entering kindergarten and elementary school with varying levels of self-regulation and that these skills are key predictors of children's success in early academic achievement (Blair, 2002; Cooper & Farran, 1988; Eisenberg, Smith, Sadovsky, & Spinrad, 2004; McClelland, Cameron, Wanless, & Murray, 2007; Valiente, Lemery-Chalfant, & Castro, 2007). In particular, children who have difficulty with the behavioral aspects of self-regulation may not have the skills necessary to benefit from classroom learning environments (Howse, Lange, Farran, & Boyles, 2003; McClelland, Morrison, & Holmes, 2000). Academic skills learned in early elementary school tend to be cumulative, so children who lack behavioral self-regulation in early childhood may be at risk for poor academic achievement throughout formal schooling (Entwisle & Alexander, 1993). Studies suggest that self-regulation emerges by preschool as an important predictor of academic outcomes, making preschool an ideal time to introduce interventions aimed at improving the behavioral aspects of self-regulation (Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007).

It is clear that behavioral self-regulation is necessary for academic success, but there is relatively little research on how to improve these skills prior to kindergarten entry. Studies have shown that preschool children can improve behavioral self-regulation in individual laboratory training sessions and on computer-based tasks (Dowsett & Livesey, 2000; Rueda, Rothbart, McCandliss, Saccomanno, & Posner, 2005), but few studies have focused on similar interventions using games that are designed for classroom implementation. It is crucial for researchers to develop interventions promoting behavioral self-regulation in preschool that can be easily implemented by teachers to ensure that children enter kindergarten with the skills they need to be academically successful. The present study examined the efficacy of an intervention using circle time games designed to strengthen children's behavioral self-regulation over the prekindergarten year.

DEFINING BEHAVIORAL SELF-REGULATION

The focus of this study is on the behavioral aspects of self-regulation (i.e., attention, working memory, and inhibitory control), skills that are essential

for planning and executing goal-directed activities (Blair, 2002). *Attention* is defined as the ability to switch focus from one object or task to another as well as the ability to ignore distractions (Rothbart & Posner, 2005; Rueda, Posner, & Rothbart, 2004). *Working memory* refers to a child's ability to hold information in memory long enough to complete a task (Adams, Bourke, & Willis, 1999). Working memory is an essential component of following through with instructions, especially when completing a multistep task. *Inhibitory control* is the ability to stop a dominant response (e.g., shouting an answer to a question) in order to demonstrate a less automatic but more adaptive behavior (e.g., raising a hand and waiting to be called on; McClelland, Cameron, Wanless, et al., 2007; Rennie, Bull, & Diamond, 2004). The literature supports the notion that the integration of attention, working memory, and inhibitory control is important for success in classroom settings (Baumeister & Vohs, 2004; McClelland, Cameron, Connor, et al., 2007; McClelland, Cameron, Wanless, et al., 2007). The games tested in this study were intended to help children practice integrating these behavioral aspects of self-regulation.

THE IMPORTANCE OF BEHAVIORAL SELF-REGULATION FOR SCHOOL SUCCESS

Research suggests that children's behavioral self-regulation predicts academic outcomes in preschool (Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007) and elementary school (Liew, McTigue, Barrois, & Hughes, 2008; McClelland, Acock, & Morrison, 2006; McClelland et al., 2000; Valiente et al., 2007) as well as high school graduation and college completion (McClelland, Piccinin, Acock, & Stallings, 2011; Vitaro, Brendgen, Larose, & Tremblay, 2005). Specifically, studies have shown that attention predicts academic achievement, including math and literacy, in preschool and elementary school (Blair & Razza, 2007; Howse, Lange, et al., 2003). Working memory (Gathercole & Pickering, 2000) and inhibitory control skills (Blair & Razza, 2007) have also been found to predict these same academic outcomes in early elementary school students. Although some studies have found that these specific components of behavioral self-regulation (e.g., attention) predict children's abilities to succeed in a classroom setting (Alexander, Entwisle, & Dauber, 1993; Ladd, 2003), many studies (including the present study) have focused on measures of behavioral self-regulation that integrate attention, working memory, and inhibitory control. For example, in one study, kindergarten behavioral self-regulation (as measured by a composite score of teacher ratings on a questionnaire including impulsivity, planning abilities, and attention) predicted children's academic

achievement over the kindergarten year (Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). Another study found that kindergarten learning-related skills (specifically work-related skills, which include aspects of self-regulation such as paying attention to instructions and complying with teacher requests) predicted children's literacy and math skills between kindergarten and sixth grade and growth in literacy and math from kindergarten to second grade (McClelland et al., 2006, 2000). Moreover, children with poor behavioral self-regulation skills exhibited lower performance than their higher rated peers on reading and math between kindergarten and sixth grade, even after child IQ and parent education level were controlled (McClelland et al., 2006). Taken together, the results from these studies suggest that the integration of the behavioral aspects of self-regulation predicts academic success throughout schooling and that children who have difficulties with these skills may be especially at risk for low academic achievement.

BEHAVIORAL SELF-REGULATION IN THE PRESCHOOL YEARS

The preschool years are an important time for the development of behavioral self-regulation for several reasons. First, for many children, preschool is the first classroom environment in which they are asked to demonstrate behavioral self-regulation (Phillips, McCartney, & Sussman, 2006). Prior to school entry, these skills emerge in the context of the family environment. Throughout early childhood, behavioral self-regulation moves from an external process to an internal process (Kopp, 1991) as children learn to regulate behaviors (e.g., sucking on a thumb to self-soothe or turning away from an unwanted stimuli) that were previously regulated by caregivers (e.g., soothing through rocking and patting). Within a school context, children are continually asked to demonstrate regulation of their own behaviors by paying attention, remembering and following through with instructions, and acting appropriately, even when their impulse is to do otherwise.

Second, it is during preschool that a number of developmental changes occur, including brain maturation in the prefrontal cortex, an area associated with the development of the behavioral aspects of self-regulation (Blair, 2002). Changes in behavioral self-regulation abilities accompany this brain maturation. Children begin to increase the length of time that they are able to pay attention, and their ability to plan and allocate attention to goals improves (Landry, Smith, Swank, & Miller-Loncar, 2000; Wellman, Somerville, & Haake, 1979). Working memory becomes more accurate, and children become more consistent at exhibiting inhibitory control skills in appropriate contexts. Studies have shown that each of these skills can be improved with practice (Ford, McDougall, & Evans, 2009; Landry

et al., 2000; St. Clair-Thompson, Stevens, Hunt, & Bolder, 2010). Finding developmentally appropriate and engaging ways to help children practice behavioral self-regulation (e.g., through games in a circle time setting) is critical to helping children who have difficulty with these skills.

Third, research shows that self-regulation in preschool predicts academic achievement in both preschool (Blair & Razza, 2007; McClelland, Cameron, Connor, et al., 2007) and kindergarten (Howse, Lange, et al., 2003). For instance, one study found that preschool children who had difficulty with behavioral self-regulation scored lower on a measure of cognitive achievement than peers with high levels of these skills (Bronson, Tivnan, & Seppanen, 1995). Another study found that behavioral self-regulation, as measured by a direct task, significantly predicted emergent literacy, vocabulary, and math skills over the prekindergarten year. Moreover, gains in preschool behavioral self-regulation significantly predicted gains in these academic measures over the prekindergarten year (McClelland, Cameron, Connor, et al., 2007). Taken together, these studies provide evidence that behavioral self-regulation emerges by preschool as an important predictor of academic success, making preschool an ideal time to introduce interventions aimed at improving these skills prior to kindergarten entry.

Although not all children receive formalized care prior to kindergarten, an estimated 83.2% of children attend early care and education programs before entering kindergarten (Denton Flanagan & McPhee, 2009). Interventions in these settings would reach the majority of children at an important period of behavioral self-regulation development. Furthermore, promoting behavioral self-regulation in preschool may help many children develop the skills needed for the transition to school and for continued success throughout formal schooling.

CHILDREN AT RISK FOR POOR BEHAVIORAL SELF-REGULATION

Numerous studies are showing that children from disadvantaged backgrounds, and especially those experiencing multiple risk factors, perform worse than their more advantaged peers on a variety of language, achievement, and school readiness indicators (Dearing, Berry, & Zaslow, 2006). In particular, research has documented the fact that children from low-income families are less able than their peers to regulate their attention in goal-directed tasks and are especially at risk for entering kindergarten with poor behavioral self-regulation (Evans & Rosenbaum, 2008; Howse, Lange, et al., 2003). In one study, children with an accumulation of risk factors (e.g., children who had low levels of parent education and who were the most economically disadvantaged) were at the highest risk for entering

preschool with low levels of behavioral self-regulation, and these low levels persisted through preschool and into kindergarten (Wanless, McClelland, Tominey, & Acock, 2011). These studies provide evidence that children from disadvantaged backgrounds are especially at risk for entering kindergarten without the behavioral self-regulation needed for academic success. Moreover, studies suggest that behavioral self-regulation may serve as a mediating factor between risk and academic achievement. In one study, kindergarten behavioral self-regulation skills (i.e., attention and inhibitory control) mediated the negative effect between risk factors (e.g., high levels of maternal depressive symptoms and economic disadvantage) and children's first-grade achievement in reading, math, and vocabulary (Sektnan, McClelland, Acock, & Morrison, 2010). Thus, children from disadvantaged backgrounds are an especially important population to target for behavioral self-regulation interventions prior to kindergarten entry. The present study included children from economically diverse backgrounds, and high variability in children's behavioral self-regulation abilities was expected.

MEASURING BEHAVIORAL SELF-REGULATION AND THE HEAD–TOES–KNEES–SHOULDERS TASK (HTKS)

Recent research has focused on a relatively new direct measure of behavioral self-regulation, the Head-Toes-Knees-Shoulders task (HTKS), which measures the integration of children's attention, working memory, and inhibitory control (McClelland, Ponitz, Messersmith, & Tominey, 2010; Ponitz, McClelland, Matthews, & Morrison, 2009). The HTKS is a short and relatively simple game that asks children to pay attention, remember up to four rules, and do the opposite (e.g., touch your head when told to touch your toes). Studies supporting the construct validity of the HTKS have found significant relations between children's scores on the HTKS and both parent- and teacher-rated inhibitory control and attention (McClelland, Cameron, Connor, et al., 2007; Ponitz et al., 2009).

Research has also supported the predictive validity of the task. Specifically, children's scores on the HTKS have significantly predicted children's emergent literacy, vocabulary, and math skills in preschool and kindergarten (Matthews, Ponitz, & Morrison, 2009; McClelland, Cameron, Connor, et al., 2007; Ponitz et al., 2009). Moreover, one recent study found that children's HTKS scores in the fall of kindergarten significantly predicted spring literacy, vocabulary, and math skills at the end of the school year and gains children made in math learning skills from fall to spring (Ponitz et al., 2009). Although research has shown that the HTKS is a reliable and valid measure of children's behavioral self-regulation, relatively little

research has focused on helping children improve these specific behavioral aspects of self-regulation (i.e., the integration of attention, working memory and inhibitory control). The present study examined the efficacy of a set of circle time games that helped children practice these aspects of behavioral self-regulation (as measured by the HTKS).

INTERVENTION RESEARCH

In recent years, there has been growing interest in the development of school readiness interventions. Interventions targeting specific aspects of self-regulation have focused primarily on individualized training sessions in laboratory settings (Dowsett & Livesey, 2000; Rueda et al., 2005); however, these techniques do not translate easily to a classroom context. In addition, many of the interventions that have been implemented in classroom settings have examined broad constructs of socioemotional skills often in combination with academic intervention, rather than focusing specifically on behavioral self-regulation (Raver, 2002). These interventions often require extensive teacher training and materials for implementation. One example is the Tools of the Mind program, which focuses on social, emotional, and behavioral self-regulation skills in addition to a curricular emphasis on literacy and math in preschool. Children participating in Tools classrooms have shown significant improvement on computer-based executive function tasks (Diamond, Barnett, Thomas, & Munro, 2007) and on a teacher-reported problem behavior scale (Barnett et al., 2008). Another example, the Promoting Alternative Thinking Strategies (PATHS) intervention, targets cooperation, emotional awareness and communication, self-regulation, self-esteem, and problem solving in preschool children. Children participating in the PATHS treatment group were rated more socially competent by parents and teachers than were children in the control group (Domitrovich, Cortes, & Greenberg, 2007). Finally, the Kids in Transition to School program examined the impact of playgroups that focused on a wide range of socioemotional, self-regulation, and early literacy skills on foster children and found that children participating in the treatment group exhibited significantly higher levels of social competence and self-regulatory skills than children in the control group (Pears, Fisher, & Bronz, 2007).

Although each of these interventions included self-regulation as part of broader interventions, none focused specifically on improving behavioral self-regulation as a means of improving academic outcomes. Unlike these previous studies, the intervention presented in this article focused on helping children practice specific behavioral aspects of self-regulation (the integration of attention, working memory, and inhibitory control) that have

been shown to predict academic outcomes. In addition, the present study used circle time games that were variations on popular children's games. The games required minimal training for implementation and few materials (e.g., construction paper, children's music CDs, classroom musical instruments), all of which are commonly found in preschool classrooms.

THE PRESENT STUDY

This study investigated whether an intervention using circle time games improved behavioral self-regulation in an economically diverse sample of preschool children. In addition, we examined whether treatment group participation predicted academic gains over the prekindergarten year. The study had two research questions. The first research question was as follows: *Does participation in an intervention lead to greater gains in behavioral self-regulation in a sample of prekindergartners?* Based on research documenting the effectiveness of broader interventions (Diamond et al., 2007; Domitrovich et al., 2007; Pears et al., 2007), we expected that children who were randomly assigned to the treatment group would show significantly greater gains in behavioral self-regulation over the prekindergarten year than children in the control group. The second research question was: *Does intervention treatment group participation relate to academic outcomes over the prekindergarten year?* We hypothesized that participation in the intervention treatment group would predict not only gains in behavioral self-regulation but also gains in academic outcomes. This hypothesis was based on research suggesting that improvements in self-regulation abilities may result in improvements in early achievement (Barnett et al., 2008; Diamond et al., 2007).

METHOD

Participants

Participants were 65 children (out of an initial group of 74 children; see "Attrition") within two child development centers in Oregon. Children were selected based on kindergarten eligibility the following year. Approximately half of the children in the study were from low-income families as measured by enrollment in Head Start ($n = 28$). The average age at the beginning of the study was 54.6 months (range = 44–60 months). Of the children, 39 were female and 26 were male. Mothers of children enrolled in Head Start had an average education level of 12.2 years ($SD = 2.6$) with a range of 6–16 years.

Mothers of children who were not enrolled in the Head Start program had an average education level of 17 years ($SD = 2.7$) with a range of 12–21 years. Three of the children had Spanish as a first language and were administered the tests in Spanish by a native Spanish speaker. Spanish-speaking research assistants translated English instructions into Spanish for children who had Spanish as a first language.

The majority of children in the study ($n = 53$ out of 65) attended preschool in a university child development center and laboratory school. Placement in the center was available to children paying tuition and was also available at no cost to children enrolled in the Head Start program. Approximately half of the children in each classroom paid tuition, and half received care at no cost because of enrollment in Head Start. A small number of children participating in the study ($n = 12$) were attending a program at a second child development center. Across both sites, children were divided among nine classrooms. Information on classroom activities was obtained from classroom teachers. All of the classrooms emphasized play during children's free-choice time, but most of the teacher-facilitated activities were academically focused (e.g., learning letters). Although teachers were familiar with traditional versions of the games used in the intervention, they reported that similar games were rarely implemented in any of the classrooms.

Attrition

Initially, 74 children were recruited for participation in the study. Data were obtained from all 74 children at Time 1 (fall). At Time 2 (spring), data were obtained from only 65 children. The total attrition was nine children: four children moved over the course of the school year, one child left school early for a family vacation, three children declined to participate in the posttest, and one child was withdrawn from the study because of newly diagnosed developmental delays. The children who left the study did not significantly differ from the children who completed the study on age or gender ($ps > .05$). A higher percentage of children who left the study were enrolled in Head Start (67%) as compared to the overall sample (43%), although this difference was not statistically significant ($p > .05$). All analyses were conducted using data from the 65 children who participated in all phases of the study.

Measures

Parent Demographic Questionnaire

In the fall of the prekindergarten year, parents completed a background questionnaire in their native language (English or Spanish) containing

questions regarding child age, child gender, whether the child was enrolled in Head Start, and parent education level.

HTKS

In the fall and the spring, the HTKS was used to assess children's behavioral self-regulation (Ponitz et al., 2009). In the HTKS, children play a game where they are asked to touch their head or toes (or knees/shoulders in the alternate version). They are then asked to do the opposite of what the experimenter says. The game requires children to remember up to four rules, pay attention, and demonstrate inhibitory control. The possible score for each item is 0, 1, or 2: 0 denotes an incorrect response, 1 is a self-correct (child makes a motion toward the incorrect response but then stops and gives the correct response), and 2 points is a correct response without movement toward the incorrect response. There are 20 test items, and scores range from 0 to 40, with higher scores indicating higher levels of behavioral self-regulation. Recent research has shown that the HTKS is a reliable and valid measure of children's behavioral self-regulation in diverse populations and cross-culturally (McClelland, Cameron, Connor, et al., 2007; Ponitz et al., 2008, 2009; Wanless, McClelland, Acock, et al., in press). In the present study, interrater reliability on the HTKS was calculated at kappa = 92. Teacher-rated behavioral self-regulation in the fall was correlated with children's fall HTKS scores ($r = .20$, $p = .09$), and teacher-rated behavioral self-regulation in the spring was correlated with children's spring HTKS scores ($r = .24$, $p = .06$).

Academic Outcomes

In the fall and spring, children's academic outcomes were assessed using three subtests of the Woodcock–Johnson Psycho-Educational Battery–III Tests of Achievement (WJ-III).

Letter-Word Identification. Children's letter skills and developing word-coding skills in English or Spanish were assessed using raw scores from the Letter-Word Identification subtest of the WJ-III (Woodcock & Mather, 2000) or the Batería III Woodcock–Muñoz (Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005). Previous research has shown high reliability for preschool-age children on both the English and Spanish versions of the task (Schrank et al., 2005; Woodcock & Mather, 2000).

Picture Vocabulary. Children's expressive vocabulary skills in English or Spanish were measured using the Picture Vocabulary subtest of the WJ-III or the Batería III Woodcock–Muñoz (Muñoz-Sandoval et al., 2005). Previous research has shown reliability for both versions of the task

with preschool-age children at .81 and .89, respectively (Schrank et al., 2005; Woodcock & Mather, 2000).

Applied Problems. Children's mathematical operations needed to solve practical problems, including counting objects, reading numbers, and basic addition and subtraction picture problems, were measured using the Applied Problems subtest of the WJ-III or the Batería III Woodcock–Muñoz (Muñoz-Sandoval et al., 2005). In previous research, both the English and Spanish versions of the task demonstrated reliability for preschool-age children at .94 and .93, respectively (Schrank et al., 2005; Woodcock & Mather, 2000).

Procedure

In the fall of the prekindergarten year (September), an invitation to participate in the study was mailed to parents of all 4-year-olds at the participating preschools. Consent forms were collected from 74 families. The study was divided into three phases: pretest (November–December), intervention (January–March), and posttest (April–May).

Pretest

During this phase, children's behavioral self-regulation and academic outcomes were assessed over 4 weeks. Children received two of the assessments on each of two different days to prevent fatigue, and the order of assessments was randomized. Parents completed questionnaires at this time.

Intervention

During the intervention phase, half of the children in each classroom were randomly assigned to participate in the intervention treatment group. Random assignment at the individual level within classrooms was chosen because of the high variability in class sizes and diversity in child characteristics across classrooms. In addition, the intraclass correlation on the HTKS in the fall was .06 (see Results), showing that limited variance in scores was due to classroom membership and supporting our decision to randomize at the individual level. Children at both sites were frequently taken out of the classroom to participate in individual and small-group activities, so they were accustomed to leaving the classroom and seeing others leave the classroom throughout the school day. Although there were initial concerns regarding potential contamination effects within classrooms, teachers reported that there was no evidence of children sharing intervention activities with other children in the classroom who were assigned to the control

group. In addition, research has found that when contamination effects occur because of changes in children's behavior, children assigned to the control group are more likely to act like children in the treatment group, making detection of intervention effects more difficult. These types of contamination effects, however, are often found to be small or negligible (Rhoads, 2009; Torgerson, 2001).

Children in the treatment group participated in a total of 16 playgroups over 8 weeks. The playgroup sessions were held twice weekly, and each session was approximately 30 min. Previous research has found significant improvement in children's self-regulation and social competence in interventions of similar durations (Pears et al., 2007). Each playgroup session had five to eight children and two assistant teachers. The playgroups were held on the same days and times each week as part of the regular preschool day and were scheduled at times chosen by the classroom teachers. The same researcher (Shauna Tominey) led all of the playgroups to ensure fidelity. The playgroup leader developed the games and had previously worked as an early childhood education teacher (Tominey & McClelland, 2008). Playgroup attendance was recorded for each child. Children in the intervention group attended an average of 11.3 sessions (range = 5–16). The most common reason for a child to miss a session was an absence due to illness or vacation. Occasionally, a child would decline to participate on a given day because of involvement in other classroom activities. Other reasons for missing sessions included arriving late for school and lacking transportation (to school).

Posttest

During this phase, behavioral self-regulation and academic assessments were readministered to all children. Research assistants were blind to intervention participation; those who assisted with the intervention phase of the study did not test children from classrooms in which they had previously assisted to prevent researcher bias.

Playgroup Session Format

Playgroup sessions were designed to resemble classroom circle times. At the beginning of each session, children sat on mats in a circle and participated in a greeting song that was intended to help children transition to the playgroup setting. Following the greeting song, the playgroup leader introduced and led children in the playgroup activity. At the end of each playgroup session, children sat on mats in a circle and sang a goodbye song before returning to their classrooms. Six activities were presented over the 16 sessions (omitted for blind review). As the playgroup sessions progressed,

additional instructions were added, making the games increasingly complicated. Each game was repeated at subsequent sessions to ensure that children had multiple opportunities to practice and learn both the basic and increasingly complicated versions of the games. Children were also given the opportunity to lead games when appropriate (e.g., select and hold up colors for *Red Light, Purple Light*).

Playgroup Games

In each game, attention and working memory were essential for children to remember and follow through with continually changing multistep instructions. Children practiced inhibitory control by starting and stopping to different cues (oral and visual), performing specific behaviors in response to cues, and performing opposite behaviors. The games used in the present study had been previously piloted in prekindergarten classrooms (Tominey & McClelland, 2008). Teachers reported that these games were easy to implement in a circle time setting with large groups of children with varying developmental levels and self-regulation abilities.

Red Light, Purple Light

Like in the popular children's game *Red Light, Green Light*, a teacher acted as a stoplight by standing at the opposite end of the room from the children and holding 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) as well as to different shapes representing stop and go (e.g., any color circle is go and any color square is stop).

The Freeze Game

Children danced when music played and froze when the teacher stopped the music. Children danced slowly to slow songs and quickly to fast songs, alternating between different slow and fast songs. Children were then asked to respond to opposite cues: dancing quickly to slow songs and slowly to fast songs.

Color-Matching Freeze

In this game, which was related to *The Freeze Game*, children danced when music played and froze when the music stopped; however, children were asked to perform an additional step before freezing. Teachers taped different-colored pieces of construction paper to mats placed on the ground.

When the music stopped, the teacher held up a specific color and children were instructed to find and stand on a mat of that color.

Sleeping, Sleeping, All the Children Are Sleeping

Children pretended to sleep when the teacher sang, "Sleeping, sleeping, all the children are sleeping." While children pretended to sleep, the circle leader gave an additional instruction for children to wake up and act out an animal (e.g., "And when they woke up . . . they were monkeys!"). Additional rules were added to make the game more complicated.

Conducting an Orchestra

The teacher used a dowel rod as a conducting baton to lead children in playing musical instruments (e.g., jingle bells or maracas). When the conductor waved the baton, children played their instruments. When the conductor put the baton down, children stopped. The conductor then instructed children to play their instruments quickly when the baton moved quickly and slowly when the baton moved slowly. Children were also asked to respond to opposite cues. When the conductor waved the baton, children stopped playing their instruments, and when the conductor set the baton down, children played their instruments.

Drum Beats

Children responded to different drum cues with body movements. Teachers chose actions for children to perform while sitting (e.g., clapping or stomping) and while moving around the room (e.g., walking or dancing). For example, children were instructed to walk quickly to fast drumming, walk slowly to slow drumming, and freeze when the drumming stopped. Teachers also asked children to respond to opposite cues (walking slowly to fast drum beats and quickly to slow drum beats) and associated different actions with specific drum cues (e.g., hopping to fast drum beats and crawling to slow drum beats).

RESULTS

Descriptive Statistics

Prior to answering our research questions, we analyzed descriptive statistics and bivariate correlations for the entire sample ($N = 65$; see Table 1). As expected, there was high variability in initial behavioral self-regulation scores. At Time 1, the average HTKS score was 11 points ($SD = 12$,

TABLE 1
Bivariate Correlations for Children in the Overall Sample ($N = 65$)

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1. Child age (months)	—												
2. Child gender[a]	.31*	—											
3. Head Start status[b]	.09	.18	—										
4. Maternal education[c]	−.09	−.31*	−.65***	—									
5. Fall HTKS	−.01	−.17	−.37**	.33*	—								
6. Spring HTKS	−.05	−.02	−.52***	.22	.50***	—							
7. HTKS difference	−.04	.16	−.16	−.12	−.46***	.52***	—						
8. Applied Problems difference	−.20	.03	−.02	.04	.19	−.08	.08	—					
9. Letter-Word Identification difference	−.03	−.12	−.28*	.45***	.29*	.32**	.03	.11	—				
10. Vocabulary difference	−.06	.02	−.15	.14	−.12	−.00	.14	−.03	.06	—			
11. Intervention group[d]	−.11	.05	−.07	.12	.07	.14	.05	.01	.28*	−.04	—		
12. Number of sessions	−.09	.06	−.08	.04	.05	.18	.10	.03	.28*	.01	.94***	—	
13. School absences	−.07	.01	.17	−.13	−.10	−.24†	−.12	−.13	−.05	.01	.07	−.08	—

Note. HTKS = Head–Toes–Knees–Shoulders task.
[a]Child gender: 0 = female, 1 = male.
[b]Head Start status: 0 = not enrolled in Head Start, 1 = enrolled in Head Start.
[c]For correlations including maternal education, $n = 55$.
[d]Intervention group: 0 = control, 1 = treatment.
†$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$.

range = 0–37 points), with skewness of .75 and kurtosis of 2.17. Although the skewness and kurtosis were not indicative of a nonnormal distribution (Kline, 2005), a high number of children scored 0 points on the task at the beginning of the year, indicating likely floor effects. In a previous study examining the HTKS, approximately 30% of children at 48 months had a score of 0 on the task, with this number decreasing to 15% at 54 months (Ponitz et al., 2008). In the present study, 38.5% of children scored at floor level at Time 1 ($n = 25$), and 12.31% of children scored at floor level at Time 2 ($n = 8$). The average HTKS score at Time 2 was 22.3 points ($SD = 13$, range = 0–38). The possibility of ceiling effects on the task was examined but was considered unlikely because no child in the study scored the maximum number of points on the measure at either time point. On average, children gained 11 points on the HTKS over the prekindergarten year ($SD = 13$, range = −10 to 35). Table 2 summarizes the remaining descriptive statistics for the children in the study.

TABLE 2
Means (*SD*) for Children in the Treatment and Control Groups ($N = 65$)

	Overall Sample (N = 65)		
Variable	*Control* (n = 37)	*Treatment* (n = 28)	*Total* (N = 65)
Child age (months)	54.9 (3.9)	54.1 (3.2)	54.6 (3.6)
Child gender[a]	0.38	0.43	0.4
Head Start status[b]	0.46	0.4	0.43
Maternal education[c]	15.1 (3.8)	15.9 (3.1)	15.4 (3.5)
School absences	5.5 (4.3)	6.2 (5.6)	5.8 (4.9)
Fall HTKS	10.2 (12.4)	12 (12.1)	11 (12)
Spring HTKS	20.7 (13.5)	24.4 (12.6)	22.3 (13)
Difference in HTKS	10.4 (12.5)	11.7 (13.8)	10.97 (13)
Fall Letter-Word Identification	7.7 (4.3)	8.6 (5.1)	8.1 (4.6)
Spring Letter-Word Identification	9.8 (5.6)*	12.7 (7.3)*	11.1 (6.5)
Difference in Letter-Word Identification	2.1 (2.5)*	4.1 (4.3)*	2.9 (3.5)
Fall Applied Problems	12.2 (4.2)	13.4 (4.9)	12.7 (4.5)
Spring Applied Problems	14.9 (3.7)	16.2 (4.6)	15.5 (4.1)
Difference in Applied Problems	2.76 (2.5)	2.79 (1.7)	2.77 (2.2)
Fall Vocabulary	15.4 (3.2)	16.4 (3.5)	15.8 (3.3)
Spring Vocabulary	16.7 (2.9)	17.5 (3.6)	17.8 (3.2)
Difference in Vocabulary	1.32 (2.4)	1.14 (2.8)	1.25 (2.6)

Note. HTKS = Head–Toes–Knees–Shoulders task.
[a]Child gender: 0 = female, 1 = male.
[b]Head Start status: 0 = not enrolled in Head Start, 1 = enrolled in Head Start.
[c]For descriptive statistics including maternal education, $n = 55$.
*$p < .05$.

Research Question 1: Does Participation in an Intervention Lead to Greater Gains in Behavioral Self-Regulation in a Sample of Prekindergartners?

To ensure that there were no initial differences between the treatment and control groups at Time 1, we used t tests to examine initial differences between children in the two groups on the following variables: maternal education, child age, school absences, academic achievement scores (letter-word identification, picture vocabulary, and applied problems), and fall HTKS scores. In addition, tests of proportion were used to examine differences between the proportion of children enrolled in Head Start in each group and the proportion of gender in each group. No statistically significant differences were found between the treatment and control group in the overall sample on any of these variables in the fall (see Table 2).

Multiple regression analysis was then used to answer the first research question. The regression analysis examined predicted gains in behavioral self-regulation scores (spring HTKS score minus fall HTKS score) for children based on group assignment (treatment or control). In addition to treatment group, we controlled for the following variables: Head Start status (enrolled in Head Start/not enrolled in Head Start), child age (in months), child gender, and initial HTKS score. We then added an interaction term between initial HTKS score and group assignment to test whether intervention effects varied based on children's initial behavioral self-regulation scores. Previous studies of children's self-regulation have found significantly different intervention effects based on children's initial levels of self-regulation (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008; Connor et al., 2010). Maternal education level was not included as a control variable because of the high correlation between maternal education and Head Start status ($r = .66$). Although children were nested in nine classrooms, the intraclass correlation for the difference in HTKS scores was 0.06, so multilevel modeling was not used in the analyses.

The results of the regression analysis were significant, $F(5,\ 59) = 6.58$, $p < .01$, $r^2 = .36$. Treatment group participation, however, was not a significant predictor of HTKS gains, $t(59) = 0.49$, $p > .05$. Although not significant, the regression coefficient for intervention group was in the expected direction, showing small gains in behavioral self-regulation for children participating in the playgroups (intervention: $B = 1.34$, $\beta = .06$). Of the control variables, Head Start enrollment was the strongest predictor for HTKS gains, $t(59) = -3.49$, $p < .01$, contributing .21 to the explained variance (r^2). The second strongest predictor was initial HTKS score, $t(59) = -5.17$, $p < .001$. Having a higher HTKS score at the beginning of the year predicted smaller gains over the course of the year ($\beta = -.59$), contributing .13 to the

explained variance. The interaction between initial HTKS score and group assignment was not significant, $t(58) = -0.94$, $p > .05$.

Although the interaction was not significant, the high number of children scoring 0 on the task (floor effect) likely contributed to our inability to detect an interaction if one did exist (Lewis-Beck, Bryman, & Liao, 2004). In addition, previous studies have found significant intervention effects for children with poor behavioral self-regulation when no effects were found in the overall sample (Bierman et al., 2008; Connor et al., 2010), so we wanted to investigate this possibility further in our sample. Thus, we conducted post hoc analyses to test for a treatment effect in a subsample of children with low initial HTKS scores ($n = 31$). We selected the 50th percentile (children with HTKS scores less than 6 points) as a cutoff point to maximize our sample size. It was also above this cutoff that negative gain scores appeared on the HTKS, which indicated the possibility of regression to the mean effects and may have contributed to lower overall gain scores experienced by children scoring above the 50th percentile.

The average age of children in the low subgroup was 54.6 months ($SD = 4$). Within this group there were 17 girls and 14 boys. Of the children with low HTKS scores, 19 were in the control group and 12 were in the treatment group. There was little variability in HTKS scores within the low subsample at Time 1 ($M = 0.5$, $SD = 1.3$, range = 0–5). At Time 2, however, there was substantial variability in HTKS scores. Specifically, the average HTKS score at Time 2 was 16.9 points ($SD = 13.6$, range = 0–35), with skewness of .04 and kurtosis of 1.4, indicating a normal distribution (Kline, 2005). Over the course of the year, children with low initial behavioral self-regulation gained an average of 16.3 points ($SD = 13.3$, range = 0–35). In contrast, children scoring above the 50th percentile on the HTKS in the fall gained an average of 6.1 points ($SD = 10.8$, range = −10 to 25).

Results of a regression model examining intervention participation as a predictor of HTKS gains for the low subgroup were statistically significant, $F(4, 26) = 5.26$, $p < .01$, $r^2 = .45$ (see Table 3). In addition to intervention group assignment, we controlled for Head Start enrollment status, child gender, and age. The results suggested that for children with low initial HTKS scores, treatment group participation significantly predicted HTKS gains over the prekindergarten year, $t(26) = 2.23$, $p < .05$, $\beta = .34$, accounting for 11% of the explained variance in HTKS gains. Within this subgroup, children in the treatment group were predicted to gain 9.2 more points over the year on the HTKS than children in the control group, which was a difference of approximately 1 *SD*. Of the control variables, Head Start status was the only statistically significant variable, $t(26) = -3.90$, $p < .01$, $\beta = -.58$, and accounted for 33% of the explained variance.

TABLE 3
Multiple Regression Results Examining Intervention Group and Number of Intervention Sessions to Predict Change in HTKS Score Over the Prekindergarten Year in the Subgroup of Children With Low Initial HTKS Scores ($n = 31$)

	Analysis 1 (Intervention Group)			*Analysis 2 (Dosage)*		
Variable	*B*	*SE B*	*β*	*B*	*SE B*	*β*
Child age (months)	0.82	0.59	.25	0.73	0.56	.22
Child gender[a]	–7.58	4.73	–.29	–7.14	4.56	–.27
Head Start status[b]	–15.14	3.88	–.58**	–14.26	3.83	–.54**
Treatment group[c]	9.21	4.13	.34*			
Number of sessions				0.84	0.33	.37*
R^2		.45			.47	
F		5.26**			5.75**	

Note. HTKS = Head–Toes–Knees–Shoulders task.
[a]Child gender: 0 = female, 1 = male.
[b]Head Start status: 0 = not enrolled in Head Start, 1 = enrolled in Head Start.
[c]Treatment group: 0 = control, 1 = treatment.
*$p < .05$. **$p < .01$.

We conducted an additional post hoc analysis examining whether the number of intervention sessions attended significantly predicted behavioral self-regulation gains in the overall sample of children and for the subgroup of children with low initial HTKS scores. Results of the multiple regression predicting gains in HTKS scores (controlling for Head Start status, child age, gender, and initial HTKS score) for the overall sample ($N = 65$) indicated that the model was statistically significant, $F(5, 59) = 6.71$, $p < .01$, $r^2 = .36$, although the number of intervention sessions attended did not significantly predict HTKS gains. We then ran the same analysis (excluding initial HTKS score as a control) for children with low initial HTKS scores ($n = 31$; see Table 3). This model was statistically significant, $F(4, 26) = 5.75$, $p < .01$, $r^2 = .47$, and indicated that the number of playgroup sessions attended significantly predicted HTKS gains for children with low initial HTKS scores, $t(26) = 2.50$, $p < .05$, $\beta = .37$ (accounting for 13% of the explained variance). Specifically, for each additional intervention session attended, children were expected to gain nearly 1 additional point (0.84 points) on the HTKS over the year. If children attended the average number of intervention sessions (11.3 sessions), they were expected to gain an additional 9.5 points on the task. Head Start status was the only significant control variable in the model, $t(26) = -3.73$, $p < .01$, $\beta = -.54$, accounting for 33% of the explained variance. Thus, although overall intervention effects were not detected, post hoc analyses indicated significant effects of

the intervention for children beginning the year with low HTKS scores. In addition, the number of intervention sessions attended also significantly predicted behavioral self-regulation gains over the school year for children in the low subgroup.

Research Question 2: Does Intervention Treatment Group Participation Relate to Academic Outcomes Over the Prekindergarten Year?

Prior to testing the second research question, we used multiple regression analyses to determine whether children's behavioral self-regulation in the fall predicted fall letter-word identification, applied problems, and vocabulary outcomes. Fall behavioral self-regulation significantly predicted fall academic achievement when child age, gender, and Head Start status were controlled: letter-word identification, $t(60) = 2.09$, $p < .05$, $\beta = .23$; applied problems, $t(60) = 2.54$, $p < .05$, $\beta = .29$; and vocabulary, $t(60) = 4.67$, $p < .001$, $\beta = .53$. Specifically, for each additional standard deviation children scored on the HTKS, they were predicted to score an additional 1.1 points in letter-word identification, 1.3 points in applied problems, and 1.8 points in picture vocabulary in the fall. Head Start status was also a significant predictor of fall scores on letter-word identification, $t(60) = -4.36$, $p < .001$; and applied problems, $t(60) = -3.05$, $p < .01$; but not vocabulary. Children enrolled in Head Start were predicted to score 3.2 fewer points in applied problems and 4.5 fewer points in letter-word identification than children from more advantaged families.

Multiple regression analyses were then used to determine whether intervention treatment group participation predicted gains in academic outcomes (one each for applied problems, letter-word identification, and picture vocabulary). Gains in all academic outcomes were calculated by subtracting children's scores in the fall from their spring scores on the same measure (see Table 2). Child age (in months), gender, and Head Start status (enrolled in Head Start/not enrolled in Head Start) were control variables in all three analyses.

Letter-word identification. The regression model predicting gains in letter-word identification scores was statistically significant, $F(4, 64) = 2.81$, $p < .05$, $r^2 = .15$ (see Table 4). Intervention group assignment significantly predicted gains in children's letter-word identification scores over the prekindergarten year, $t(60) = 2.32$, $p < .05$, and contributed .07 to the explained variance in letter-word identification gains. Children who participated in the treatment group were predicted to gain 2 more points (a difference of 0.57 *SD*) on the letter-word identification assessment than children in the control group. Head Start enrollment also significantly predicted change in

TABLE 4
Multiple Regression Results Examining Intervention Group and Number of Intervention Sessions to Predict Change in Letter-Word Identification Scores Over the Prekindergarten Year in the Overall Sample ($N = 65$)

	Analysis (Intervention Group)		
Variable	*B*	*SE B*	*β*
Child age (months)	0.05	.12	.06
Child gender[a]	–0.76	.90	–.11
Head Start status[b]	–1.72	.85	–.24*
Treatment group[c]	1.97	.85	.28*
Number of sessions			
R^2		.16	
F		2.81*	

[a]Child gender: 0 = female, 1 = male.
[b]Head Start status: 0 = not enrolled in Head Start, 1 = enrolled in Head Start.
[c]Treatment group: 0 = control, 1 = treatment.
*$p < .05$.

letter-word identification score, $t(60) = -2.02$, $p < .05$, and contributed an equivalent amount (.07) to the explained variance. Specifically, children not enrolled in Head Start were predicted to gain 1.72 more points (a difference of 0.5 *SD*) in letter-word identification over the year than children enrolled in Head Start.

Neither the regression model for applied problems nor the model for picture vocabulary was statistically significant. Thus, we found no significant relation between intervention assignment and change over the prekindergarten year in scores for applied problems, $t(60) = -0.20$, $p > .05$; or vocabulary, $t(60) = -0.45$, $p > .05$.

DISCUSSION

The present study focused on a set of circle time games aimed at improving behavioral self-regulation skills that predict children's academic achievement (McClelland, Cameron, Connor, et al., 2007; Ponitz et al., 2009). The games resembled popular children's games and required few materials, making them easy for teachers to implement in a classroom circle time setting. Our primary research questions examined intervention efficacy using a direct measure of behavioral self-regulation and tested the effect of treatment group participation on academic outcomes over the prekindergarten year. Although significant intervention effects were not found for the overall

sample, post hoc analyses indicated significant gains in behavioral self-regulation for children who entered the study with low behavioral self-regulation and who participated in the treatment group. In addition, the number of intervention sessions attended significantly predicted behavioral self-regulation gains over the school year for children with low initial scores. In the overall sample, intervention participation was also significantly related to gains in children's letter-word identification scores.

Treatment Group Participation and Gains in Behavioral Self-Regulation

Contrary to our expectations, there were no significant differences in behavioral self-regulation gains between the treatment and control groups in the overall sample. The absence of a significant treatment effect in the overall sample may have been because there was little variability in behavioral self-regulation gains for children beginning the year with scores above the 50th percentile. Children beginning the year with high scores on the HTKS likely ended the year with high scores (the task ceilings at 40 points) and thus had little variability in gain scores with which we could detect an effect.

Post hoc analyses indicated that participation in the treatment group significantly predicted gains in behavioral self-regulation for children beginning the year with low levels of these skills (below the 50th percentile in the fall). Children who began the year with low scores had the opportunity for more growth and variability in gain scores, and this may have enabled us to better detect an intervention effect in this subgroup that was not detected in the overall sample. For children in the low group, higher rates of attendance in the playgroup sessions also significantly predicted gains in behavioral self-regulation. Intervention studies including behavioral self-regulation have reported intervention attendance (Pears et al., 2007) without examining the impact of dosage on intervention effectiveness. Other studies of early childhood interventions focusing on behavioral outcomes have shown greater short- and long-term benefits from higher levels of participation (Hill, Brooks-Gunn, & Waldfogel, 2003; Reynolds, Temple, Robertson, & Mann, 2001). The significant treatment and dosage effects found within the low subsample add to the finding in the existing literature that behavioral self-regulation can be improved through intervention for children who have difficulties with these skills (Bierman et al., 2008; Connor et al., 2010; Diamond et al., 2007).

The Importance of Family Income for Behavioral Self-Regulation Gains

In the overall sample and in the subsample of children with low behavioral self-regulation, family income was the strongest predictor of behavioral

self-regulation level and gains over the prekindergarten year. Children from low-income families began and ended the year with lower behavioral self-regulation and gained fewer points on a measure of behavioral self-regulation than their peers. These results support previous findings that family income is an important predictor of children's self-regulation (Evans & Rosenbaum, 2008; Howse, Lange, et al., 2003; Sektnan et al., 2010; Wanless, McClelland, Tominey, et al., 2011). In the present study, family income was significantly correlated with maternal education level ($r = .66$), indicating that income may not have been the only factor contributing to low behavioral self-regulation scores for children in the study. Research has shown that children and families who are economically disadvantaged are likely to experience an accumulation of risk factors that affect child outcomes (Dearing et al., 2006). These potential risk factors include fewer family resources (e.g., economic and academic), less parent–child quality time, higher rates of authoritarian parenting and punitive discipline, and higher rates of chronic illness than in more advantaged families (Dearing et al., 2006; Lareau, 2003). Research also suggests that behavioral self-regulation mediates the effect of risk factors on academic outcomes (Dearing, McCartney, & Taylor, 2009; Sektnan et al., 2010), highlighting the importance of targeting children from low-income backgrounds for intervention, as they may be especially at risk for exhibiting poor behavioral self-regulation at school entry (Wanless, McClelland, Acock, et al., in press). In the present study, children who exhibited the greatest self-regulation gains (i.e., children in the treatment group from more advantaged families) may have had the most opportunity to explicitly practice paying attention, remembering instructions, and demonstrating inhibitory control through participating in the intervention and having exposure to resources and family processes that promoted strong self-regulation at home (Dearing et al., 2006; Lareau, 2003).

Behavioral Self-Regulation, Treatment Group Participation, and Academic Outcomes Over the Prekindergarten Year

In the overall sample, prior to the intervention, children's fall behavioral self-regulation predicted fall academic achievement in applied problems, letter-word identification, and picture vocabulary. Specifically, higher levels of behavioral self-regulation predicted higher scores on each of these academic outcomes. These findings add to the growing body of research showing that behavioral self-regulation is an important component of academic success as early as preschool (Matthews et al., 2009; McClelland et al., 2007; Ponitz et al., 2009). In addition, family income significantly predicted fall academic achievement. Children from low-income families began the

year with lower applied problems and letter-word identification levels than their more advantaged peers. Previous research has also documented socioeconomic status as an important predictor of early achievement (Sektnan et al., 2010; Wanless et al., in press).

Although treatment group assignment did not predict behavioral self-regulation gains in the overall sample, participation in the intervention treatment group significantly predicted gains in letter-word identification scores. The intent of the intervention games was to help students practice the integration of attention, working memory, and inhibitory control, skills that have been found to predict academic outcomes in preschool and kindergarten, including letter-word identification (McClelland et al., 2007; Ponitz et al., 2009). The significant gains in behavioral self-regulation made by children in the low subgroup provide preliminary evidence that the circle time games did indeed relate to improved behavioral self-regulation skills for some children, and perhaps improvement in these skills (though not detected in the overall sample) led to an increased ability to benefit from letter-word identification activities in the classroom. It is important to note that children in the treatment group did not receive additional direct instruction in letter-word identification, as none of the playgroup games involved letters, words, or emergent literacy activities of any kind.

It is possible that the significant effect of intervention participation on letter-word identification scores and not the other academic measures was due to the explicit focus on emergent literacy instruction (and specifically letter recognition) in the prekindergarten classrooms. Previous research has demonstrated that children are exposed to more literacy-rich instruction prior to kindergarten compared to instruction in other academic subjects (Connor, Morrison, & Slominski, 2006; Miller, Kelly, & Zhou, 2005; National Institute of Child Health and Human Development Early Child Care Research Network, 2002). In support of this, teachers in the present study reported that letter recognition was often the focus of classroom learning activities, whereas vocabulary and applied problems were rarely explicitly taught.

Although vocabulary and emergent literacy are closely related, children in this study experienced very small gains over the year in picture vocabulary scores in comparison to the gains experienced in letter-word identification. Children did make apparent gains in applied problems scores, which raises questions about the lack of a relation between these gains and intervention participation. One possible explanation is that gains in applied problem scores were in large part due to maturation, not classroom instruction, which would explain the gains experienced by children in both the treatment and control groups. Previous research has found evidence supporting this lack of an instructional effect on the development of math skills in preschool (Christian, Bachman, & Morrison, 2001). Another possible explanation is

that gains in applied problems, whether due to classroom/home learning experiences or maturation, were not aided by participating in the intervention treatment group. Research (including the present study) has found significant relations between behavioral self-regulation and preschool children's applied problems/math abilities (Matthews et al., 2009; McClelland, Cameron, Connor, et al., 2007; Ponitz et al., 2009); however, additional research is needed to investigate the relation between intervention-related gains and gains in math abilities.

Nature and Implementation of Intervention Games

Our implementation strategy resulted in a number of positive and negative consequences, some of which we anticipated and others we did not. As we had intended, the use of music and movement in the intervention games was highly effective at encouraging engagement. The majority of children actively participated in all of the playgroup games, although a few children chose to watch on occasion. In order to involve all children in the activities, especially those who appeared to be withdrawn/shy or easily distracted, we incorporated opportunities for children to lead each activity. For example, each child had a turn choosing which colors represented stop and go and acting as the stoplight in the game *Red Light, Purple Light*. By leading activities, children could watch the responses of other children to their rules and cues and thus practice behavioral self-regulation skills by modeling the correct behaviors and monitoring other children's behaviors. We made sure that every child had an opportunity to lead the activity in every session, and no child ever declined the opportunity to lead an activity.

The decision to remove children from the classroom to participate in the playgroup sessions had both positive and negative consequences. We were concerned about adding to the workload of classroom teachers, and removing children lessened the burden on teachers. This approach also allowed us to control fidelity of implementation. Removing children from classrooms, however, also led to issues we did not anticipate. For example, playgroup sessions were held at times that were chosen by the classroom teachers. The result was that children in some classrooms missed part of free-play time to participate, whereas others missed outdoor play. Occasionally, children would decline to participate in a playgroup session because they did not want to miss one of these activities. In these instances, the response of the classroom teacher significantly impacted whether the child attended the playgroup session. Classroom teachers who encouraged children to go and reassured them that the activity would be available when they returned facilitated participation, whereas classroom teachers who remained uninvolved in these exchanges did not.

LIMITATIONS AND FUTURE RESEARCH

Although the present study supports the preliminary efficacy of a behavioral self-regulation intervention in preschool for children with low initial behavioral self-regulation scores, there are a number of limitations. The primary limitation is the small sample size. Because the study had a final sample size of 65 children, the power to detect a significant effect was limited, although significant effects were still found. Most notably, children with low levels of self-regulation in the fall (below the 50th percentile) benefited from participation in the intervention. The small sample size, however, also limited the ability to perform statistical analyses on subgroups within the treatment and control groups, such as by family income.

Another limitation of the study was that only one measure was used to assess change in behavioral self-regulation over the prekindergarten year. The circle time games were designed to help children practice the skills measured by the HTKS and were selected for use because of face validity and ease of implementation. Although the findings from this study provide preliminary evidence supporting the construct validity of the games in relation to the HTKS, it is critical that future studies of the games incorporate additional measures of behavioral self-regulation to better establish construct validity. Ideally, a combination of direct measures, teacher reports, and classroom observations would be needed to provide a complete picture of how participating in these playgroup games relates to measures of behavioral self-regulation as well as classroom behavior and academic outcomes. In future studies of these games, it may also be beneficial to videotape playgroup sessions in order to observe and code children's responses to the games and watch for specific behaviors (e.g., length of attention) and change in those behaviors.

Moreover, the scope of this intervention was limited to playgroup sessions that included child involvement. It is clear from the results that family income significantly predicted children's behavioral self-regulation and academic scores across the year. The significant effect of family income on child outcomes highlights the need for interventions that extend beyond the child level to include family characteristics. Numerous family factors and processes (National Institute of Child Health and Human Development Early Child Care Research Network, 2003), including parenting (Calkins, 2004) and the home learning environment (McClelland & Wanless, 2006), have demonstrated significant relations with the development of children's self-regulation. Future interventions should include parent and family involvement to maximize gains in self-regulation for all children.

Future studies should also better establish intervention feasibility by implementing the study games in classrooms, led by classroom teachers.

In the present study, the same researcher (who had previously been a classroom teacher) administered the games in small groups outside of the classroom. Although this helped ensure consistency across sessions, future studies should examine fidelity as a variable because ideally classroom teachers will be leading the sessions, which will likely result in varying levels of fidelity and impact intervention effectiveness. Finally, participants should be followed longitudinally with more time points to examine the potential long-term effects of the intervention on children's behavioral self-regulation and academic achievement.

PRACTICAL IMPLICATIONS AND CONCLUSIONS

The results of the present study support the efficacy of a prekindergarten behavioral self-regulation intervention for children with low behavioral self-regulation skills. The results indicate that a set of circle time games was effective in helping children with low initial behavioral self-regulation improve scores on a direct measure of attention, working memory, and inhibitory control, skills that have been found to predict academic outcomes. In addition, participation in the treatment group significantly predicted gains in letter-word identification scores over the prekindergarten year in the overall sample of children. The games used in the study were implemented in playgroup settings with common classroom materials and could be implemented by teachers in small and large groups of children within classrooms. The intervention presented in this study represents a unique opportunity to improve behavioral self-regulation with limited training and without expensive materials, which increases its potential for use on a larger scale.

The present study has the potential to inform preschool curricula that emphasize behavioral self-regulation as a means of facilitating school readiness. The development of interventions that can be translated to classroom settings and easily implemented by teachers is critical to ensure that all children enter school with the behavioral self-regulation skills they need to be ready to learn.

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