Combining a Kindergarten Readiness Summer Program with a Self-Regulation Intervention Improves School Readiness

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Duncan, R. J., Schmitt, S. A., Burke, M., & McClelland, M. M. (2018). Combining a kindergarten readiness summer program with a self-regulation intervention improves school readiness. *Early Childhood Research Quarterly, 42*, 291-300. https://doi.org/10.1016/j.ecresq.2017.10.012

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Abstract

Self-regulation and academic skills in kindergarten are strong predictors of later achievement. However, many children enter kindergarten without adequate levels of these skills, often because of limited participation in early childhood education. The current study examined a kindergarten readiness summer program (Bridge to Kindergarten; B2K) that served children with no prior preschool experience. The first study goal was to examine the effects of adding a self-regulation intervention to the B2K program on children's self-regulation, math, and literacy. The second study goal was to compare changes in self-regulation, math, and literacy during the kindergarten transition period for children attending the B2K program with the intervention to expected development. Results from a randomized trial indicated that children who participated in the B2K program that included the self-regulation intervention experienced more gains in self-regulation relative to children who participated in the B2K program alone. There were no significant effects on math or literacy at the end of the program. However, when examining change during the kindergarten transition period, participation in the B2K program with the self-regulation intervention was associated with improved growth in self-regulation, math, and literacy into the fall of kindergarten compared to expected development. Collectively, the findings suggest a kindergarten readiness summer program that incorporates a self-regulation intervention leads to improved school readiness in children at higher risk for later school difficulties.

Keywords: School Readiness, Self-Regulation, Academic Achievement, Early Intervention

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The importance of school readiness is widely recognized, as children's early math and literacy skills are strong predictors of subsequent academic success (Duncan et al., 2007). In addition to academic skills, self-regulation has emerged as a critical component of school readiness and children's ability to learn in the classroom (Blair & Raver, 2015; McClelland & Cameron, 2012). As such, there has been a surge in interest in early childhood programs and interventions that facilitate the development of self-regulation and academic skills in recent years (e.g., Lonigan et al., 2015; Raver et al., 2011). This interest has intensified when studying populations of children that face higher levels of risk for school difficulties or failure (e.g., children who have no previous preschool experience). The current study examines the effects of a kindergarten readiness summer program (Bridge to Kindergarten; B2K), which is designed to boost school readiness skills prior to kindergarten entry for children who have not had previous preschool experiences. Specifically, the study investigates 1) the impact of adding a self-regulation intervention to the B2K program (referred to as B2K+RLPL) on children's self-regulation, math, and literacy, and 2) how growth in self-regulation, math, and literacy differs between children that participated in the B2K+RLPL program compared to expected development during the kindergarten transition period.

School Readiness

Despite theory and evidence that school readiness is comprised of both behavioral and cognitive skills, many early childhood programs focus primarily on teaching children early academic skills in order to promote later school success (e.g., Clements & Samara, 2007; Weiland & Yoshikawa, 2013). These academic skills include understanding numbers and

relations between them (e.g., four is more than three), as well as knowing letters and letter sounds. Across nationally representative samples and controlling for potential confounds (e.g., socioeconomic status), these early academic skills (especially math) are strong predictors of children's later achievement (Duncan et al., 2007). However, early math interventions that have shown short-term positive effects have been plagued with fadeout of these effects at follow-up time points, tempering enthusiasm for their potential to offset longer-term achievement gaps through only improving early math skills (Bailey et al., 2016; Clements, Sarama, Wolfe, & Spitler, 2013). Thus, it is also important to consider the potential impact of improving children's behavioral skills (e.g., self-regulation) for school readiness and later achievement.

Self-regulation is foundational for learning and school success (Blair & Diamond, 2008; Blair & Raver, 2015; McClelland & Cameron, 2012) and is conceptualized as the ability to stop, think, and then act in goal-directed ways (McClelland & Tominey, 2015). These skills draw heavily upon the three components of executive function: working memory, attentional shifting, and inhibitory control (Blair, Zelazo, & Greenberg, 2005). Working memory is the ability to manipulate information while holding it in mind, attentional shifting is the ability to shift focus from one characteristic to another, and inhibitory control is the ability to stop a prepotent response with a secondary, more adaptive response (Garon, Bryson, & Smith, 2008). Children use these skills when they pay attention to teachers, remember rules, follow instructions, interact with peers, and persist with learning activities, all of which contribute to children's short- and long-term academic success (Blair & Raver, 2015; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; McClelland et al., 2013; McClelland et al., 2014).

Taking a skills beget skills theory of human capital (Heckman, 2000), children who are the most prepared for school are the most likely to be successful academically. Moreover, the

early skills needed to beget academic learning are likely both self-regulation and early academic competence (Blair & Diamond, 2008; Duncan et al., 2007). Children that enter school ready to learn are able to develop academic skills at faster rates than their peers, with cumulative advantages building over time. Therefore, boosting skills prior to kindergarten entry may be critical for addressing achievement gaps that largely persist throughout the schooling years (Duncan & Magnusson, 2011).

Risk factors for poor school readiness. Gaps in school readiness skills are associated with both demographic factors and children's preschool experiences. In the current study, having no preschool experience is considered a risk factor for poor school readiness. Previous research has found that a year in preschool is estimated to contribute roughly one-third of a year, on average, of additional leaning in emergent literacy and mathematics (Yoshikawa et al., 2013), with the highest quality programs adding roughly one full year of additional learning (e.g., Weiland & Yoshikawa, 2013). Furthermore, access to high quality prekindergarten may be particularly important for improving early learning for children who are from low-income families and who are dual language learners (Phillips et al., 2017). One of the key aspects of high quality programs is using effective curricula that promote stimulating and supportive interactions between children and their teachers (Yoshikawa et al., 2013). In a population of children at increased risk for school difficulties (i.e., no prior preschool experience), the current study examines if a kindergarten readiness program combined with a self-regulation intervention boosts children's self-regulation and academic skills. Additionally, the study examines these changes conditional on key demographic factors shown to potentially moderate early program effects (e.g., family income, English language learner status).

Self-Regulation Intervention

Evidence suggests that self-regulation is a malleable and teachable set of skills (Blair & Raver, 2015). Recent efforts have focused on developing and evaluating a variety of approaches for improving self-regulation prior to kindergarten entry (e.g., Diamond et al., 2007; Raver et al., 2011), including the Red Light, Purple Light (RLPL) circle time games intervention (Schmitt, McClelland, Tominey, & Acock, 2015; Tominey & McClelland, 2011). The RLPL intervention is a classroom-based, early childhood intervention that consists of circle time games implemented in 16, 20-30 minute sessions. The circle time games explicitly focus on the three components of executive function (i.e., working memory, attentional shifting, and inhibitory control) and allow children to practice self-regulation in a group setting (i.e., children play the games in a group). For more information see Tominey and McClelland (2011) and Schmitt et al. (2015).

The RLPL intervention includes traditional children's games that have been modified to increase in cognitive complexity. An example of one game included in this intervention is called Red Light, Purple Light, which is a variation of the traditional childhood game *Red Light, Green Light*. In this game, 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., orange means clap hands, purple means stop) and then, to make the game more complex, opposite cues with a variety of actions would be introduced over time (e.g., purple is clap, red is stomp, and orange is stop). During this game, children were required to listen to and remember instructions (i.e., working memory), successfully switch from one rule to another (i.e., attentional flexibility), and resist the natural inclination to engage in one action in favor of the correct response (i.e., inhibitory control). As the intervention progressed, activities were repeated and additional rules were introduced to the games increasing their cognitive complexity.

This intervention has been evaluated in two randomized controlled trials (RCTs) as delivered by researchers in preschool classrooms. In the pilot study, participation in the intervention was associated with gains in self-regulation for children with the lowest initial levels of these skills and gains in literacy for the full sample (Tominey & McClelland, 2011). Results from a larger efficacy study with children from low-income families suggested that participation in the intervention was related to gains in self-regulation for the full sample and gains in math for English language learners (Schmitt et al., 2015). In the present study, we examined the effectiveness of the intervention when delivered by teachers as part of an existing kindergarten readiness summer program (i.e., B2K). If researcher-developed interventions are going to be successful at scale, teachers need to be able to successfully implement them in real-world settings. The current study addresses whether adding the self-regulation intervention to a pre-existing kindergarten readiness program has meaningful impacts on children's school readiness.

Bridge to Kindergarten (B2K)

The B2K program is a free kindergarten readiness summer program run by a school district that targets entering kindergarteners that have not had prior preschool experience and may therefore be at risk for school difficulties (Phillips et al., 2017; Yoshikawa et al., 2013). The purpose of the B2K program is to help children develop early academic skills, as well as positive relationships with adults in school settings and strong social-emotional behaviors (e.g., lining up, raising a hand before talking, waiting for a turn). Although the B2K program targeted some aspects of self-regulation, the addition of the RLPL intervention added explicit focus on self-regulation to the curriculum. During B2K, children are exposed to a variety of learning experiences (e.g., large group, small group, and read a-louds) with open-ended exploration of materials that support literacy, math, and social-emotional development. This program also

encourages family engagement in school. The ultimate goal of B2K is to facilitate a positive transition to kindergarten for a population of children at higher risk for school difficulties. Children attend B2K for four hours per day, five days a week for three weeks in July prior to starting kindergarten in September. Starting in 2014, the RLPL intervention was fully integrated into the B2K curriculum for approximately 20-30 minutes each day during the three-week program.

In general, successful early childhood interventions are able to provide relatively large boosts to early skills (Clements & Samara, 2007; Weiland & Yoshikawa, 2013), though evidence for the longer-term effects of early interventions are mixed (Bailey et al., 2016; Blair & Raver, 2014). For example, although a successful math intervention found evidence of fadeout (Bailey et al., 2016; Clements et al., 2013), a kindergarten self-regulation intervention found effects on literacy and vocabulary that got larger at the study follow-up (Blair & Raver, 2014). In addition to estimating the initial, short-term effects of the B2K+RLPL program, the current study focused on trying to understand the extent to which fadeout occurred for any initial boosts in school readiness skills for children that received B2K+RLPL. In other words, follow-up data were used to examine growth of skills into the fall of kindergarten after the initial gains from participating in the program. Understanding whether early childhood programs and interventions show evidence of persisting effects after the end of the program is critical to addressing longer term schooling achievement gaps.

The Present Study

The present study had two goals for understanding the promotion of school readiness skills as a product of participating in the B2K+RLPL program. First, a RCT was conducted to assess the effects of adding the RLPL intervention to the B2K program on changes in self-

regulation, math, and literacy (i.e., B2K versus B2K+RLPL). Children in the B2K program either randomly received the RLPL intervention or not (i.e., business as usual, active control). The largest intervention effects were hypothesized to occur for changes in self-regulation, with the possibility of transfer to literacy and/or math (Schmitt et al., 2015; Tominey & McClelland, 2011). Second, growth in self-regulation, math, and literacy for children attending the B2K+RLPL program was compared to expected development in these skills from the spring of preschool to the fall of kindergarten. During the three-week program period, children in the B2K+RLPL program were hypothesized to have boosts in self-regulation, math, and literacy beyond expected development. However, because fadeout effects have been seen in some early childhood interventions (Bailey et al., 2017) and not in others (Blair & Raver, 2014), it was unclear how changes in skills after the program period would compare to expected development (i.e., faster, slower, or the same).

Method

This study combines three years of data from the B2K site and data from a longitudinal study of expected development from preschool to kindergarten in Oregon. The same direct assessments were collected at both sites; however, the sample participants and the study procedures were otherwise independent. For the B2K site, data were collected at the beginning of the program (July) and three-weeks later at the end of the program (August). In 2014 and 2015, additional follow-up assessments were collected roughly four months later in the fall of kindergarten (November). For the Oregon site, data were collected in the spring of preschool (April and May) and roughly six months later in the fall of kindergarten (October and November). See Figure 1 for a flowchart that details the differences in data collection time periods.

B2K Site

Participants and Procedure. Three cohorts of children participating in the B2K program were included in this study. Initial sample sizes for each year were as follows: $N = 125$ in 2013, $N = 163$ in 2014, and $N = 159$ in 2015 (see Table 1 for descriptive statistics for the 2013 cohort and see Table 2 for descriptive statistics for the 2014 and 2015 cohorts). Children attended the three-week program for free and were selected for participation if they did not have prior preschool experience. Although participants are similar in demographic characteristics across years, we distinguish between the 2013 cohort and the 2014 and 2015 cohorts for the purposes of this study. In 2013, B2K administrators were interested in adding a self-regulation component to the program and subsequently having researchers conduct an external evaluation of the effects. Thus, as part of the program evaluation, teachers in the B2K program were trained to deliver the RLPL intervention and researchers evaluated if the addition of the intervention facilitated growth in self-regulation and academic skills. All teachers in the B2K schools (intervention and active control groups) were teachers from the same school district. Teachers in the B2K+RLPL program received training from trained project staff in a three-hour session before the B2K program started. During the program, teachers in the B2K+RLPL program completed a weekly fidelity and feasibility survey. Results of these surveys indicated that teachers administered the games each week as expected and that children enjoyed the games and asked to play them. Three schools were randomly assigned to deliver the intervention and one school was randomly assigned to serve as the control group (business as usual, actively receiving B2K curricula). The four selected schools were a subsample of the 26 total schools delivering the B2K program. Children were randomly selected from each condition to estimate the intervention effects. Teachers in the intervention group signed agreements indicating they would not share

intervention materials. Although contamination is always a concern, other research on the RLPL games has not found evidence of teachers in control group classrooms playing similar games (e.g., Schmitt et al., 2015; Tominey & McClelland, 2011). In addition, research finds that contamination effects tend to be small overall and when contamination does occur, children in the control group are more likely to behave in ways similar to children in the treatment group, which make it more difficult to find intervention effects (Rhoads, 2009; Torgerson, 2001). Thus, we were less concerned about contamination effects in the present study.

In 2014 and 2015, based on positive results from 2013, B2K staff and administrators gave all children the self-regulation intervention as part of the B2K program (i.e., B2K+RLPL). Thus, after 2013, all schools were given the RLPL program (including the control school in 2013). Similar to 2013, children were randomly selected from two schools in the program to evaluate its effectiveness. In 2014 and 2015, children were assessed pre- and post-program but were also assessed in the fall of kindergarten to estimate the longer-term effects of the program on their school readiness. In 2013, the only demographic information provided for the sample was children's age; however, age, gender, free and/or reduced lunch status, and English language proficiency status were provided in 2014 and 2015 (i.e., because children were tracked into the kindergarten year making it possible to obtain these data).

Oregon

Participants and Procedure. The Oregon site included 407 children in the spring of prekindergarten, although four children were dropped from the analyses that did not have any direct assessment data. All children were a part of a larger study examining children's school readiness and were followed from the fall of preschool through the spring of kindergarten (for more details on the larger study, see McClelland et al., 2014). Children were recruited in the fall

of preschool to participate in the longitudinal study and families received $20 at each wave of data collection for participation. The convenience sample was drawn from urban and rural areas in Oregon, with the consent rate around 50% in the participating early childhood programs. Unlike the children in the B2K program, all children from the Oregon site were enrolled in early childhood preschool programs. Trained research assistants collected data in two to three, 10-15 minute administration periods at each wave. Children were assessed in a quiet area of their school or classroom. Fluent Spanish-speaking research assistants assessed children in Spanish on all assessments if the teacher identified the child's primary language as Spanish.

Measures

Self-regulation. The Head-Toes-Knees-Shoulders (HTKS) was used to assess self-regulation (McClelland et al., 2014). The HTKS has three sections of ten items and is a more complex version of the original Head-to-Toes task (Cameron Ponitz et al., 2008). In the first section, children are told to touch their head (or toes) when asked to touch their toes (or head), or in a different version children are told to touch their shoulders (or knees) when asked to touch their knees (or shoulders). In the second section, both paired rules are included (head/toes opposite and knees/shoulders opposite). In the third section, children are still doing the opposite, but the rules switched, with head and knees paired and shoulders and toes paired. Thus, the task requires working memory to hold the information in mind and remember to do the opposite, inhibitory control to do the opposite of the command, and attentional shifting when the rules change. The task has been validated as a measure of behavioral self-regulation in multiple studies (Cameron Ponitz et al., 2009; McClelland et al., 2014), and demonstrates strong internal and inter-rater reliability with diverse populations of children (McClelland et al., 2014).

Academic Achievement. Academic achievement was assessed using the Woodcock-

Johnson Psycho-Educational Battery – III Tests of Achievement (Woodcock, McGrew, & Mather, 2001) or the Batería Woodcock-Muñoz (Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005). Children's math abilities were assessed by the Applied Problems subtest of the battery. The Applied Problems subtest includes questions assessing children's understanding of quantities and simple calculations, getting progressively more challenging. The Letter-Word Identification assessed children's literacy abilities. The Letter-Word Identification subtest includes questions assessing children's knowledge of letters, letter sounds, and words. Both subtests have been used extensively to measure children's early academic skills and validated in previous work (McGrew & Woodcock, 2001).

Analytic Plan

All analyses were conducted using Stata 14.1 (StataCorp, 2015). To answer our first research question on the effects of adding the RLPL intervention to the B2K program on children's self-regulation, math, and literacy, children's post-test scores were regressed on condition, pre-test scores, and age. We included children that were between four and a half and six years old to focus on the target population of children transitioning to kindergarten. Therefore, one child under four years old and three children older than six years old were excluded from the analyses (one child without age data was also dropped). The inclusion of these children in the analyses did not change the results or conclusions (results available by request). We included control variables and used full information maximum likelihood estimation with robust standard errors for a few reasons. One, randomization was only on four schools (i.e., three treatment and one control) and did not appear to eliminate baseline differences (detailed below), so it was necessary to control for them. Additionally, children receiving the intervention were less likely to have missing data at post-test than children in the

control classroom (b = -1.22, p = .014, OR = .29). Therefore, it was necessary to account for the missing data rather than use listwise deletion in order to reduce potential bias in the estimates (Acock, 2012). No other covariate was significantly related to attrition (i.e., time one scores or age).

For research question two, growth in self-regulation, math, and literacy was compared for children receiving B2K+RLPL to a comparison group from an independent longitudinal study. To estimate the predicted scores, longitudinal multilevel models (observations nested within individual) were estimated. Self-regulation (ICC = .59), math (ICC = .77), and literacy (ICC = .78) scores were all highly correlated within individual, supporting the use of multilevel models that account for this nesting of data. However, additional levels of clustering were not accounted for because of the complicated research design of combining the two samples. That is, children in Oregon were nested within classrooms at the spring of preschool and then different classrooms at the fall of kindergarten (data is available). However, B2K+RLPL children were nested within a B2K+RLPL classroom and school during the summer and then different classrooms in the fall of kindergarten (data is unavailable). Therefore, the standard errors presented may be underestimated due to shared experiences not completely accounted for in our models. However, given that the models account for scores nested within individual, we do not think this is a major threat to the conclusions drawn.

A fully interacted model was estimated with indicators for site (i.e., Oregon versus B2K+RLPL), time point, income status, and English language learner status (ELL). All variables were treated as categorical, therefore no assumption was made about the linearity of change over time. Additionally, because all variables were categorical and modeled with interactions, the reference groups are essential for interpreting the coefficients. For the statistical

tests reported in the results section, the *lincom* command in Stata was used to estimate differences between groups of interest (i.e., fall of kindergarten, low-income, ELL, and B2K+RLPL versus fall of kindergarten, low-income, ELL, and Oregon). These results were also checked by changing the reference groups for each variable so that the effects for site (i.e., Oregon versus B2K+RLPL) were the effects of interest.

In the Oregon sample, low-income status was determined by whether the child was enrolled in Head Start or not, and language status was determined by whether the child was assessed in English or Spanish (i.e., based on teacher recommendation). For the B2K+RLPL cohorts, low-income was based on whether the child qualified for free or reduced lunch meals when in kindergarten, and language status was determined by the school district's English Language Proficiency exam (coded as proficient versus not proficient).

The fully interacted model was estimated in order to get subgroup specific estimates at each time point by site. For our presented results, we focus on the subgroups of children that were coded as low-income and ELL and children that were coded as *not* low-income and *not* ELL. This was done because all ELLs in the Oregon sample were coded as low-income, and only eight children in the B2K sample were low-income and not an ELL in the fall of kindergarten (results for the subgroups not shown in the figures are available by request).

Results

Descriptive Statistics

Descriptive statistics for the 2013 B2K cohort (i.e., the RCT year) are presented in Table 1. Children in the control school had significantly better math and literacy scores at both pre- and post-test. Children in the control school also had significantly better HTKS scores at pre-test, however, children in the intervention schools performed slightly better at post-test (not

statistically different). Descriptive statistics for the 2014 and 2015 B2K+RLPL cohorts and for the Oregon sample are presented in Table 2. The samples were similar in age at the fall of kindergarten, gender, and income status; however, the children in the B2K+RLPL program were significantly more likely to be ELLs (i.e., 69% versus 15%). Overall, the Oregon sample performed significantly better on the HTKS and math in the fall of kindergarten, but not on literacy.

What is the impact of adding the RLPL intervention to the B2K program on children's self-regulation, math, and literacy?

The results from the RCT conducted in 2013 estimating the effects of adding a self-regulation intervention to the B2K program on self-regulation, math, and literacy are presented in Table 3. We found a significant effect of the intervention on the HTKS task at post-test (b = 5.51, p = .01), but no significant effects of the intervention on math or literacy. Based on an independent sample (see McClelland et al., 2014), the effect of the intervention on HTKS scores was approximately equivalent to four months of expected development or one-third of a standard deviation improvement over the three weeks of the program. Post-hoc analyses were conducted to test for the robustness of effects across different subgroups by adding in two separate interactions one at a time (first interaction: intervention effect by initial score, second interaction: intervention effect by age). Neither interaction reached statistical significance suggesting these factors did not statistically moderate the observed treatment effects of the RLPL on self-regulation.

How do changes in self-regulation, math, and literacy differ between children in the B2K+RLPL program compare to expected development during the preschool to kindergarten transition?

For the second research question, children receiving the B2K+RLPL program in 2014 and 2015 were compared to children from an independent, longitudinal study (i.e., the Oregon sample). Overall differences between the groups are reported for the fall of kindergarten in Table 2 and estimates from the multilevel models are reported in the Appendix Table 1. We focus on comparing growth between two demographic subgroups of children: 1) children who were not low-income and not ELL, and 2) children who were low-income and ELL. For both subgroups of children, when we compare growth to the Oregon sample (children receiving business as usual preschool education but not any other intervention), children grew faster-than-expected on math and self-regulation skills during the B2K+RLPL program period and continued to grow faster-than-expected on all skills from the end of the program into the fall of kindergarten, suggesting that initial boosts continued to grow after the program ended.

Self-regulation. For self-regulation, initial gains made from pre- to post-test in the B2K+RLPL program were followed by increases in the HTKS that were faster than expected development (see Figure 2). Overall, children in the B2K+RLPL program who were *not* low-income and *not* ELL, made more rapid growth from pre-test in the summer to the fall of kindergarten compared to children in the Oregon sample. Specifically, those children in the B2K+RLPL program started approximately 17 points lower at the first time point, but only scored 8.30 worse (p = .002) on the HTKS task in the fall of kindergarten. Children in the B2K+RLPL program who *were* low-income and ELL also made more rapid gains over the summer compared to the Oregon sample. Those children in the B2K+RLPL program scored 9.30 points better (p = .001) on the HTKS than the Oregon comparison in the fall of kindergarten, despite starting approximately 2 points behind at the first time point. In summary, children's initial gains on self-regulation from participating in the B2K+RLPL program largely

replicated the RCT findings from the 2013 B2K cohort (research question one), and significant effects documented in a previous RCT with a different sample of children (Schmitt et al., 2015). Furthermore, children in the B2K+RLPL program generally experienced greater gains after the program ended in comparison to expected development observed in the Oregon sample.

Math. Children's initial gains for math from pre- to post-B2K+RLPL were also followed by improved growth into the fall of kindergarten in comparison to expected development seen in the Oregon sample (see Figure 3). For children who were *not* low-income and *not* ELL, children in the B2K+RLPL program started more than 5 points lower at the first time point, but made gains that narrowed the gap so that they were only 3.23 points worse ($p < .001$) on math compared to the Oregon sample at the fall of kindergarten. For children who *were* low-income and ELL, children in the B2K+RLPL program scored 1.28 better ($p = .076$) on math than the Oregon sample in the fall of kindergarten, despite starting approximately half a point lower. In summary, participation in the B2K+RLPL program appears to improve children's growth in math during the program period and the following months in comparison to expected development.

Literacy. The associations between B2K+RLPL participation and literacy growth emerged largely after the program ended (see Figure 4). For children who were *not* low-income and *not* ELL, children in B2K+RLPL program sample started nearly 4 points lower at the first time point compared to children in the Oregon sample, but made gains such that they only scored 1.69 worse ($p = .049$) on literacy than the Oregon sample in the fall of kindergarten. For children who *were* low-income and ELL, children in the B2K+RLPL program scored 4.61 points better ($p < .001$) on literacy than the Oregon comparison in the fall of kindergarten, though the B2K+RLPL children also scored 2 points better at the first time point. However, when

examining the changes in both groups, the B2K+RLPL children are roughly equivalent to where the Oregon sample would be anticipated to be at that point in time (assuming linear development during this period). In relation to expected development, participation in the B2K+RLPL program appears to improve children's literacy performance following the end of the program.

Discussion

The current study examined the effects of integrating a self-regulation intervention into an existing kindergarten readiness summer program for promoting children's school readiness. The first research question was evaluated using a RCT that included teachers delivering the self-regulation intervention as part of the pre-existing B2K program. Results suggested that children who participated in the B2K program with the intervention (i.e., B2K+RLPL) demonstrated greater improvements in self-regulation compared to children who participated in the B2K program alone. There were no effects on children's math or literacy. The magnitude of the effect on self-regulation was in line with previous work where researchers delivered the intervention (Schmitt et al., 2015) and with the B2K+RLPL program effects on self-regulation in 2014 and 2015.

The second research question examined the association between B2K+RLPL participation and children's growth of self-regulation, math, and literacy skills during the transition to kindergarten. Although these analyses did not include a randomized design, children who participated in the B2K+RLPL program appeared to substantially benefit on measures of self-regulation, math, and literacy in comparison to an independent longitudinal sample (i.e., expected development from spring of preschool to the fall of kindergarten, no summer time intervention). In other words, children in the B2K+RLPL program largely experienced initial boosts during the program period on school readiness skills, which were

followed by a four-month period of growth into the fall of kindergarten that was greater than expected. Collectively, these findings suggest that integrating a self-regulation intervention into a kindergarten readiness summer program is one promising strategy for boosting school readiness in children.

Self-Regulation Intervention

Self-regulation is an important and malleable component of school readiness (Blair & Diamond, 2008; Blair & Raver, 2015; McClelland & Cameron Ponitz, 2012). Although there are a number of interventions with documented positive effects (Diamond et al., 2007; Raver et al., 2011), the RLPL intervention may offer some unique benefits for integration into existing early childhood programs and curricula. For instance, the RLPL requires relatively little training and materials and can be flexibly added to classroom routines. Teachers in the B2K+RLPL program indicated that they administered the games without difficulty, and that children enjoyed and requested the games. The positive impacts of the intervention on self-regulation have been documented in two RCTs with diverse populations of preschool-aged children (Schmitt et al., 2015; Tominey & McClelland, 2011). Furthermore, the current study shows that teachers trained by research staff can deliver the intervention with effectiveness, with measureable effects on self-regulation observed in just three weeks.

One potential caveat to our conclusions regarding the intervention effect is the apparent failed randomization due to baseline differences on self-regulation, math, and literacy. However, this is likely not a serious threat to our conclusions for several reasons. First, the gain of roughly five-to-six points during the three-week B2K program in 2013 may have been a conservative estimate. In 2014 and 2015 when all children participated in B2K+RLPL, the gains were roughly 7.50 points each year (i.e., larger than the 2013 RCT year). Second, in the Oregon

sample (i.e., no intervention), children gained approximately one point on the self-regulation task every three weeks. This is very similar to the nearly one-point gain over three weeks observed in the control group during the 2013 B2K cohort. Therefore, the data suggest that the observed self-regulation growth in the control group was in line with expected development in the absence of a self-regulation intervention. Finally, the self-regulation intervention did not have significant effects on math or literacy during the B2K program, which could have been due to both groups experiencing small gains in these skills overall. Thus, the effects on self-regulation are likely not due to children in the treatment group experiencing broadly differential growth in skills in comparison to the control group because effects would have also likely been observed for the academic skills.

Bridge to Kindergarten (B2K)

In addition to self-regulation, it is important that children enter school with the early academic skills needed to succeed (Duncan et al., 2007). The B2K program aims to ease children's transition into formal schooling by introducing them to the expectations of kindergarten (e.g., how to line up) and to academic content in a classroom setting during the summer before school entry. With the addition of the intervention games, B2K+RLPL included an explicit focus on promoting children's self-regulation prior to kindergarten. Although B2K+RLPL was not evaluated with a RCT in the analyses with fall follow-up data, children's performance on self-regulation, math, and literacy was compared to expected growth during the spring of preschool to the fall of kindergarten when no intervention occurred (an independent longitudinal sample). The results suggested that B2K+RLPL participation was associated with improved gains on all three domains during the transition to the fall of kindergarten. In general, children showed greater than expected growth during the B2K+RLPL program period on school

readiness skills, which largely continued during the four months after the program ended.

Notably, the initial gains in self-regulation were not followed by periods of suppressed growth after the program ended. In a recent study, fadeout of a math intervention was related to children's preexisting differences prior to the intervention (Bailey et al., 2016). However, in the current study, there is no evidence that children participating in the B2K+RLPL program returned to where they would have otherwise performed had they not received the program. Based on the comparison sample, the gains that children made during the three weeks of B2K+RLPL were largely followed by continued greater-than-expected growth in skills during the months following the program.

A nearly identical pattern as the self-regulation findings emerged for changes in math skills. There was greater than expected growth during the B2K+RLPL program period compared to the Oregon sample, which largely continued for the four months after the program. However, literacy growth did not appear to be impacted during the B2K+RLPL program period. Children improved slightly over the three weeks of B2K+RLPL, but at very similar rates to expected development. However, the B2K+RLPL children had improved gains during the four-month post-program period in literacy. These findings are consistent with some work that has shown larger effects on vocabulary and literacy at the follow-up of a kindergarten self-regulation intervention than immediately post-intervention (Blair & Raver, 2014). It is plausible that children experienced increased literacy skills accumulating after the program ended because of the learning-related skills (e.g., self-regulation) gained during the program period.

Limitations

A number of limitations are worth noting. First, although a RCT was conducted for the RLPL intervention as part of 2013 B2K program, it could only be done with four schools for

practical reasons. Therefore, it is not surprising that randomization did not appear successful at achieving baseline equivalence. Results did however suggest a significant effect for the intervention that was in line with previous findings (Schmitt et al., 2015; Tominey & McClelland, 2011). Furthermore, the growth that occurred in the control group was roughly the same as expected based on the comparison sample (i.e., one point over the three-week period). Second, the study was limited in terms of the data that were available about the children, families, and schools for the B2K samples. Specifically, the only demographic data received were gender, age, free and/or reduced lunch status, and ELL status; therefore, we could only examine similarities and differences across the samples on these variables. Data on family and school characteristics would have been extremely informative for comparing the samples and future studies should consider additional variables for matching purposes.

Third, study design limitations prevented a RCT examining the longer-term effects of B2K (or B2K+RLPL) participation on school readiness compared to non-participation. The study is limited to using a comparison sample of children attending preschools from a different state that included the same assessments in the spring of preschool and the fall of kindergarten. Although this comparison group allowed us to compare children who participated in B2K+RLPL against a group of children with normative experiences (roughly 70% of children receive some form of early childhood education; Chaudry & Datta, 2017), this did not allow us to estimate growth due to maturation and home factors (i.e., not influenced by prior preschool education). However, the broader context for the intervention is that preschool itself is likely to accelerate growth and work to prepare children for formal schooling, suggesting that our comparison group of children is also a different type of active control group.

In spite of this, in the comparison sample, there were no data on the quality of the

preschool experiences that the children were receiving. However, given the size of the comparison sample, and other early childhood longitudinal research (e.g., Cameron Ponitz et al., 2009), the estimates from the comparison sample are in line with the expected change during this developmental period. Fourth, additional measures and sources of data for school readiness would have added value to the three measures used in the current study. Although the measures are well-validated instruments for assessing self-regulation, math, and literacy, it is unclear if teacher reports or socio-emotional behavioral ratings would have yielded similar findings. Finally, our study was also limited in only following the B2K+RLPL children into the fall of kindergarten. Having additional follow-up data would allow us to understand the extent to which children's improved developmental trajectories were maintained and if the initial boosts persisted. However, it is worth noting that simply improving children's skills prior to school entry may be an important first step to addressing enduring achievement gaps.

Conclusions

Achievement gaps during the schooling years can be largely traced back to differences in performance at school-entry (Duncan & Magnusson, 2011). Therefore, children that enter school behind because of no prior preschool experiences are at risk of never making up the differences. A daily, 20-30 minute self-regulation intervention significantly boosted a critical component of school readiness, self-regulation, in just three weeks when delivered as part of the B2K program. Additionally, the kindergarten readiness summer program combined with the self-regulation intervention was associated with broader improvements in school readiness skills, including early math and literacy skills. The gains made during the B2K+RLPL program were largely followed by continued greater-than-expected growth for the months following the program. Policies and programs that target children without early childhood educational

experiences prior to starting kindergarten may be able to greatly reduce the school readiness gaps and improve children's academic achievement.

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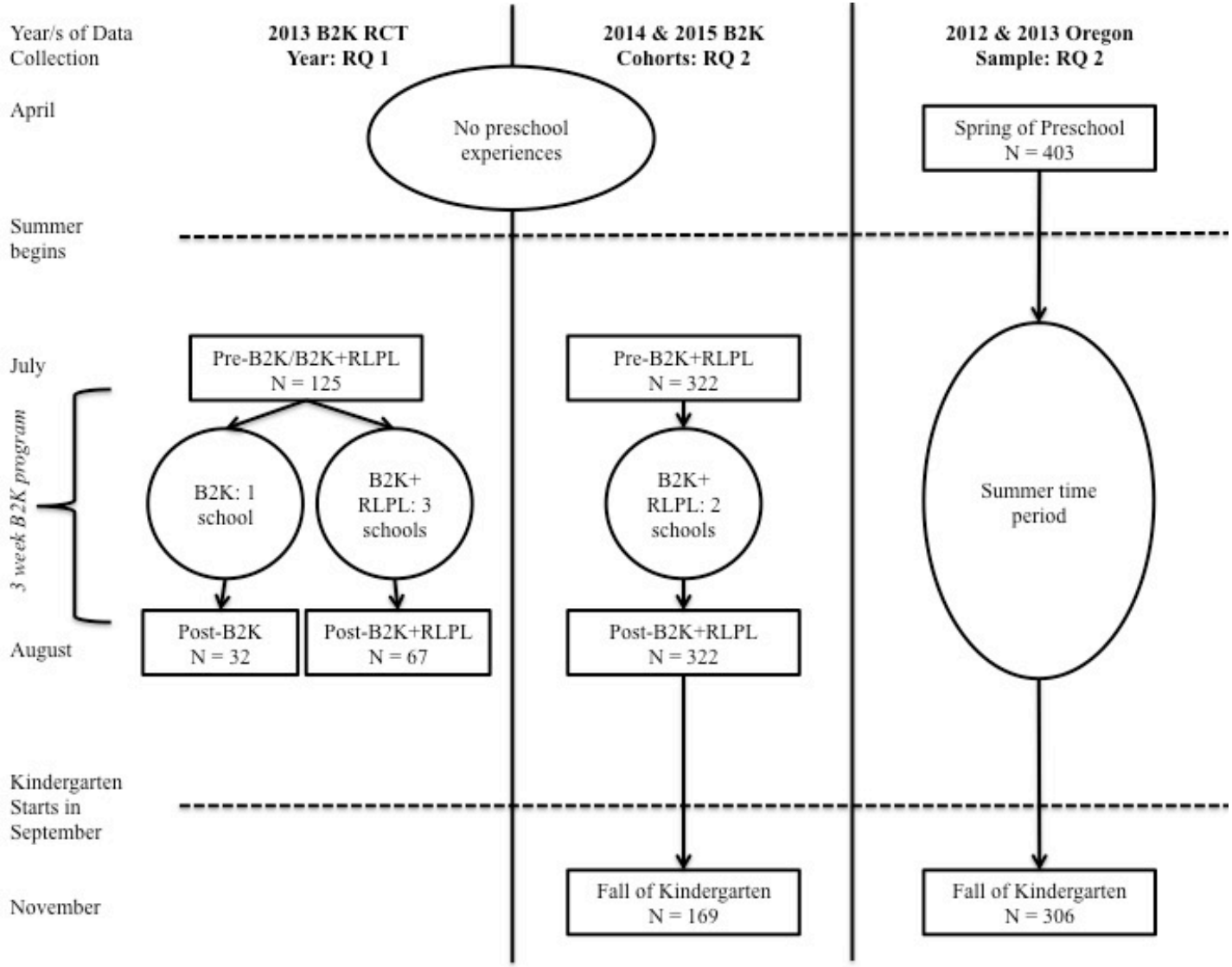

Figure 1. Flowchart of participation involvement and time points for the current study.

Table 1

Descriptive Statistics for the 2013 Bridge to Kindergarten Cohort

	B2K only			**B2K+RLPL**			**T-tests**
	N	*M*	*SD*	*N*	*M*	*SD*	
Age	45	5.29	0.31	75	5.25	0.32	t (118) = 0.69
HTKS Pre-B2K	45	15.60	16.98	74	9.91	13.49	t (117) = 2.02*
HTKS Post-B2K	32	16.53	17.13	65	16.72	15.44	t (95) = -0.06
Math Pre-B2K	45	11.80	5.60	75	9.39	4.75	t (118) = 2.52*
Math Post-B2K	32	13.97	6.18	67	10.75	4.84	t (97) = 2.83**
Lit Pre-B2K	45	9.47	7.72	75	4.71	4.34	t (118) = 4.33***
Lit Post-B2K	32	10.16	6.74	67	5.43	4.68	t (97) = 4.05***

Note. B2K is the Bridge to Kindergarten and B2K+RLPL is Bridge to Kindergarten with the self-regulation intervention.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2

Descriptive Statistics for 2014 and 2015 B2K+RLPL Cohorts and the Oregon Sample

	B2K+RLPL			**Oregon**			**t-tests**
	N	*M or %*	*SD*	*N*	*M or %*	*SD*	
Age at Fall of Kindergarten	141	5.61	0.29	306	5.66	0.31	t (445) = 1.62
Males	273	50.18%		403	51.12%		z = 0.24
Low-income	322	60.56%		403	55.33%		z = -1.41
English language learner	322	68.94%		403	15.38%		z = -14.68***
HTKS Spring of PreK				394	24.89	18.37	
HTKS Pre-B2K+RLPL	322	12.53	16.49				
HTKS Post-B2K+RLPL	322	20.08	19.02				
HTKS Fall of K	169	27.30	18.50	303	33.17	17.72	t (470) = 3.40***
Math Spring of PreK				399	15.35	4.83	
Math Pre-B2K+RLPL	322	11.07	5.26				
Math Post-B2K+RLPL	321	12.69	5.30				
Math Fall of K	169	14.93	4.74	306	17.89	4.54	t (473) = 6.68***

Lit Spring of PreK				399	10.37	5.82	
Lit Pre-B2K+RLPL	322	8.03	6.80				
Lit Post-B2K+RLPL	322	8.77	7.06				
Lit Fall of K	169	13.09	7.65	305	13.91	7.14	t (472) = 1.18

Note. B2K+RLPL is Bridge to Kindergarten with the self-regulation intervention. HTKS is the Head-Toes-Knees-Shoulders. Math is the Applied Problems subtest. Lit is the Letter-Word Identification subtest.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3

Estimated Effects for the RLPL Intervention on Self-Regulation, Math, and Literacy (N = 120)

	HTKS			*Math*			*Literacy*		
	B	*SE*	*P-value*	*B*	*SE*	*P-value*	*B*	*SE*	*P-value*
Pre-test Score	0.67	0.08	.00	0.83	0.08	.00	0.96	0.02	.00
Age	12.43	4.07	.00	0.91	1.01	.37	-0.57	0.50	.26
Intervention	5.51	2.22	.01	-0.33	0.78	.67	-0.13	0.32	.69

Note. Estimates are from structural equation model with Full Information Maximum Likelihood estimators and robust standard errors.

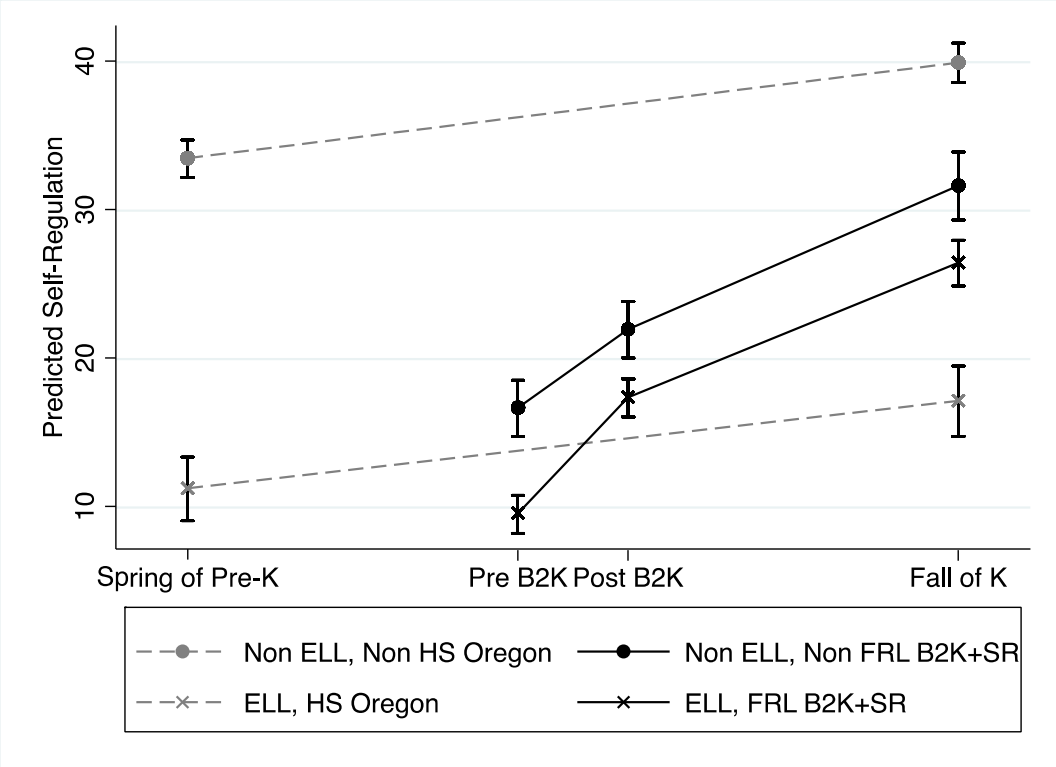

Figure 2. HTKS scores during the transition to kindergarten

Note. Sample sizes at each time point were as follows: Non ELL/ Non HS Oregon (*n* = 178, 151); Non ELL/ Non FRL B2K+RLPL (*n* = 79, 79, 42); ELL/ HS Oregon (*n* = 61, 45); ELL/ FRL B2K+RLPL (*n* = 174, 174, 93).

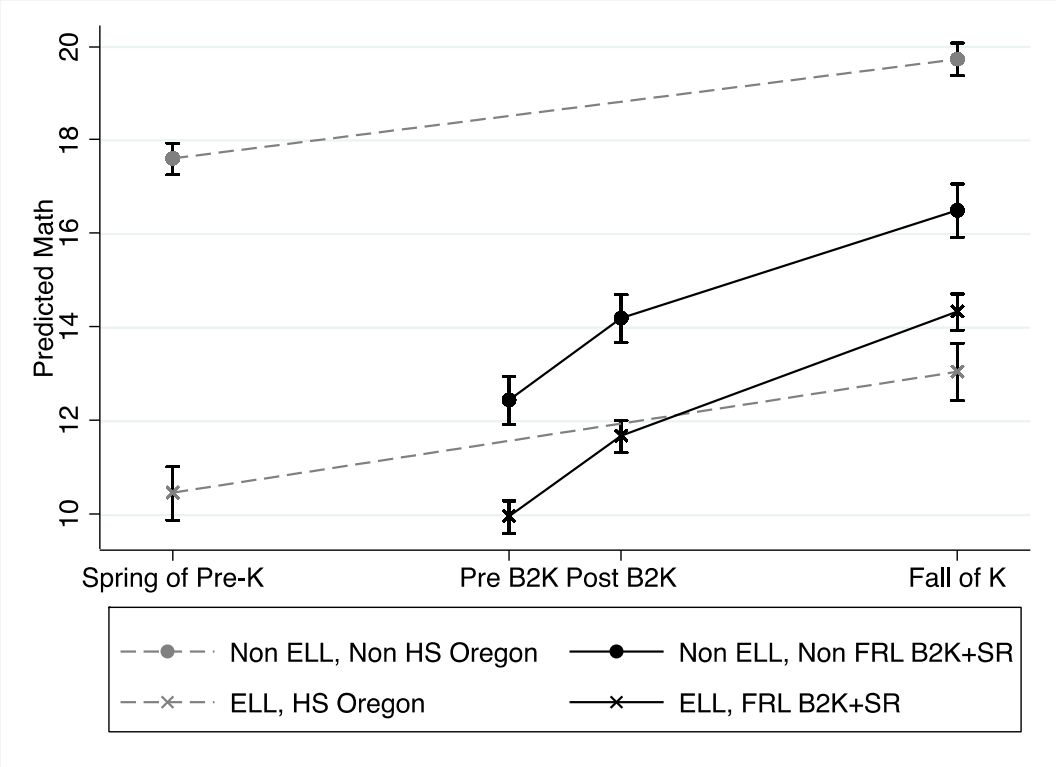

Figure 3. Math scores during the transition to kindergarten

Note. Sample sizes at each time point were as follows: Non ELL/ Non HS Oregon (*n* = 179, 152); Non ELL/ Non FRL B2K+RLPL (*n* = 79, 79, 42); ELL/ HS Oregon (*n* = 62, 45); ELL/ FRL B2K+RLPL (*n* = 174, 174, 93).

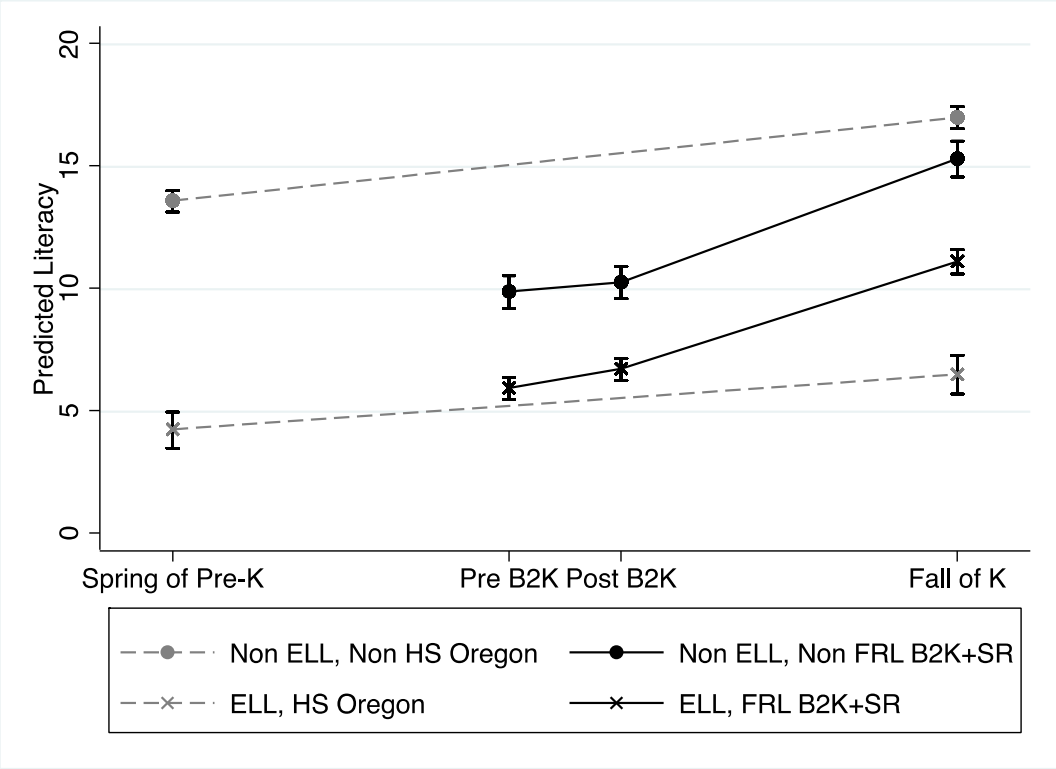

Figure 4. Emergent literacy scores during the transition to kindergarten
Note. Sample sizes at each time point were as follows: Non ELL/ Non HS Oregon (*n* = 178, 152); Non ELL/ Non FRL B2K+RLPL (*n* = 79, 79, 42); ELL/ HS Oregon (*n* = 62, 45); ELL/ FRL B2K+RLPL (*n* = 174, 174, 93).

Appendix Table 1

Estimates from multilevel models predicting self-regulation, math, and literacy at each time-point by income, ELL, and site

		Self-Regulation	**Math**	**Literacy**
		B (SE)	*B (SE)*	*B (SE)*
Main effects	Intercept	39.93 (1.33)***	19.72 (0.35)***	16.98 (0.45)***
	B2K	-8.30 (2.65)**	-3.23 (0.67)***	-1.69 (0.86)*
	ELL	-16.65 (7.01)*	-2.88 (1.73)	-0.97 (2.20)
	Low Income	-9.82 (2.02)***	-3.06 (0.52)***	-4.82 (0.67)***
	Spring of Pre	-6.43 (1.18)***	-2.12 (0.23)***	-3.40 (0.28)***
	Pre-B2K	-14.95 (2.09)***	-4.05 (0.42)***	-5.42 (0.50)**
	Post-B2K	-9.67 (2.09)***	-2.30 (0.42)***	-5.04 (0.50)**
2-way	B2K*ELL	10.20 (5.95)	1.20 (1.46)	-1.20 (1.85)
interactions	B2K*Low-Income	7.40 (5.86)	3.31 (1.43)*	7.50 (1.82)***
	ELL*Low-Income	3.67 (6.42)	-0.73 (1.57)	-4.72 (1.99)*
	Spring of Pre*ELL	3.74 (2.56)	-0.68 (0.51)	0.80 (0.61)
	Pre-B2K*ELL	3.67 (3.38)	0.72 (0.67)	2.25 (0.81)**

	Post-B2K*ELL	6.70 (3.38)	0.28 (0.67)	2.52 (0.81)**
	Spring of Pre*Low-Income	-3.19 (1.81)	0.22 (0.36)	0.35 (0.43)
	Pre-B2K*Low-Income	4.37 (5.10)	1.55 (1.02)	1.49 (1.23)
	Post-B2K*Low-Income	11.23 (5.10)	0.86 (1.04)	3.11 (1.23)*
3-way	Pre-B2K*ELL*Low-Income	-9.97 (5.92)	-2.59 (1.19)*	-3.49 (1.42)*
interactions	Post-B2K*ELL*Low-Income	-17.33 (5.92)**	-1.50 (1.20)	-4.97 (1.42)***

Note. All variables in these models were estimated as categorical, therefore all estimates from these model are relative to the reference groups. B2K (1= B2K+RLPL; 0 = Oregon comparison). ELL (1 = English Language Learner; 0 = not English Language Learner). Low-income (1 = Head Start or Free/Reduced Lunch Meals; 0 = neither). The time-points were estimated as categorical. The intercept is estimated for the Fall of K, with Spring of Pre the spring of preschool for the Oregon sample only, and the Pre-B2K and Post-B2K for the B2K sample only. All interactions not shown were either empty cells or omitted due to collinearity.
* $p < .05$. ** $p < .01$. *** $p < .001$.