

Effects of Head Start REDI on Children's Outcomes 1 Year Later in Different Kindergarten Contexts

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One year after participating in the Research-based, Developmentally Informed (REDI) intervention or “usual practice” Head Start, the learning and behavioral outcomes of 356 children (17% Hispanic, 25% African American; 54% girls; $M_{\text{age}} = 4.59$ years at initial assessment) were assessed. In addition, their 202 kindergarten classrooms were evaluated on quality of teacher–student interactions, emphasis on reading instruction, and school-level student achievement. Hierarchical linear analyses revealed that the REDI intervention promoted kindergarten phonemic decoding skills, learning engagement, and competent social problem-solving skills, and reduced aggressive–disruptive behavior. Intervention effects on social competence and inattention were moderated by kindergarten context, with effects strongest when children entered schools with low student achievement. Implications are discussed for developmental models of school readiness and early educational programs.

Children from disadvantaged backgrounds often show a lag in school readiness at kindergarten entry, initiating an achievement gap that grows over time and contributes to large, long-term disparities in educational attainment, employment, and earnings (Ryan, Fauth, & Brooks-Gunn, 2006). School readiness delays are evident in the cognitive skills that underlie emergent literacy, such as vocabulary, phonological awareness, and print knowledge (Lonigan, 2006) and also in the social competencies and self-regulation skills needed for school success, including the capacity to focus attention, comply with rules, inhibit aggression, and sustain positive relationships with teachers and peers (McClelland, Acock, & Morrison, 2006). To

promote the school readiness of children growing up in poverty and thereby reduce the educational disparities associated with early disadvantage, Head Start was established in 1965 (Administration for Children and Families, 2010).

Recent evaluations of Head Start, using a randomized-controlled design (the Head Start Impact Study, Administration for Children and Families, 2010) or quasiexperimental regression-discontinuity methods (Ludwig & Miller, 2007; Zhai, Brooks-Gunn, & Waldfogel, 2011), document benefits for children attending Head Start compared to children attending other preschools or receiving alternative forms of care. The effect sizes at the end of Head Start are generally small, in the range .13–.34 for emergent literacy skills and .14–.16 for social competence and learning behaviors. In addition, the effects often dissipate in the early elementary years (McKey et al., 1985). For example, follow-up assessments in the recent Head Start Impact Study found no significant differences in the achievement levels or behavioral adjustment of children in the Head Start versus community control groups at the end of kindergarten; however, children who received Head Start had higher vocabulary scores at the end of first grade ($d = .09$, Administration for Children and Families, 2010). Currie and Thomas (1995) found sustained Head Start gains in early elementary

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school for European American children, but not for African American children.

With the goal of improving the impact of Head Start on child school readiness, a number of recent studies have focused on incorporating evidence-based curricula and enhancing professional development support for teachers (Griffin, 2010). The strategy is to take advantage of the well-established delivery system of Head Start and its capacity to reach children living in poverty, but to improve its impact on child school readiness by improving the quality of instructional materials and curriculum and/or by promoting higher quality teaching practices. This approach is based on a set of efficacy studies that document the power of evidence-based program enrichment to enhance the pace of emergent literacy skill acquisition and social-emotional adjustment during the prekindergarten year. For example, dialogic reading programs, which encourage teachers to read interactively and engage children in discussions about the story, have successfully enriched language use in Head Start classrooms and accelerated gains in child vocabulary and oral comprehension skills (Wasik, Bond, & Hindman, 2006; Whitehurst et al., 1999). In addition, the use of carefully sequenced learning activities has enhanced preschool children's phonological awareness and letter knowledge in Head Start (Adams, Foorman, Lundberg, & Beeler, 1998; Lonigan, 2006).

Follow-up studies of these preschool school readiness interventions are rare, but a handful of studies show a mixed pattern of sustained effects after the transition into elementary school. For example, in a longitudinal evaluation of a prekindergarten dialogic reading and phonological awareness intervention, Whitehurst and colleagues (Whitehurst et al., 1999) found sustained effects on oral language skills, but not print concepts, in kindergarten. A longitudinal follow-up of a preschool intervention promoting phonological awareness found specific, lasting effects on phonological awareness skills (e.g., rhyming, phoneme segmentation) in first and second grades, although the program did not affect oral language skills, such as comprehension or vocabulary (Lundberg, Frost, & Peterson, 1988). More recently, findings from the Preschool Curriculum Evaluation Research Consortium (PCERC; 2008) found sustained effects in areas of both oral language and letter-word skills for one preschool program (e.g., the DLM Early Childhood Express with Open Court Reading Pre-K), but preschool gains without sustained kindergarten effects for another (e.g., Bright Beginnings).

Child social-emotional school readiness has also been enhanced with the use of evidence-based curricula and professional development support for teachers in Head Start classrooms. For example, the Chicago School Readiness Project combined the Incredible Years Teacher Training Program with in-class mentoring and mental health consultation to promote a more positive and productive classroom climate. At the end of the prekindergarten year, children in intervention classrooms showed reduced behavior problems and enhanced self-regulation skills, relative to the comparison group (Raver et al., 2011). Initial analyses of children's outcomes in kindergarten and first grade did not reveal any sustained intervention effects on children's learning behaviors or academic progress for the whole sample (Li-Grining & Haas, 2010). However, a more recent study suggests that positive intervention effects on literacy skills and reduced behavior problems were sustained for a subgroup of children who attended kindergarten in schools serving higher achieving students (Zhai, Raver, & Jones, 2012). Using a social-emotional learning approach that included classroom lessons and extension activities, the Preschool PATHS curriculum (Domitrovich, Greenberg, Cortes, & Kusche, 2005) promoted child social-emotional competence among children in Head Start intervention compared to randomized "usual practice" classrooms (Domitrovich, Cortes, & Greenberg, 2007). To date, no longitudinal data are available regarding the impact of Preschool PATHS (or other similar preschool social-emotional learning programs) on student adjustment after the transition into elementary school. Taken together, however, these studies suggest that enriching Head Start with evidence-based curriculum components and teaching practices has the potential to increase the impact on child school readiness skills during the prekindergarten year. These studies also indicate the critical importance of conducting follow-up studies to determine the extent to which these gains are sustained after the transition into elementary school.

The Research-Based, Developmentally Informed (REDI) Intervention Program

In 2003, the Interagency School Readiness Consortium was established by several federal agencies to encourage further rigorous study of preschool interventions designed to enhance the school readiness of at-risk children (Griffin, 2010). A specific goal was to move away from piecemeal interventions that focused narrowly on specific skill

domains and to consider more comprehensive approaches that addressed both the cognitive and social-emotional skill delays of children affected by poverty and related disadvantages. Funded by this consortium, the REDI program integrated evidence-based curricula and teaching practices in the dual-focus areas of language-emergent literacy skills and social-emotional skills. The basic hypothesis was that by integrating support for improved instruction and teaching across these domains, children would benefit in a broader array of outcome areas, and might also show more sustained effects based on the synergistic benefits of this dual-focus intervention approach (see also Nix, Bierman, Domitrovich, & Gill, in press). To enhance language and emergent literacy skills, REDI utilized three curriculum components, which included dialogic reading, phonological awareness training, and systematic support for letter knowledge acquisition (Lonigan, Farver, Phillips, & Clancy-Menchetti, 2011; Wasik et al., 2006). To support the development of social-emotional skills, REDI included the Preschool PATHS program (Domitrovich et al., 2007). REDI provided Head Start teachers with explicit curricula in each of these areas, with the scope and sequence of lessons ordered developmentally, along with enhanced professional development support. The goal was to maximize the impact of Head Start on child school readiness outcomes by enriching programs with a comprehensive set of evidence-based components and providing the professional development support needed to implement those components with fidelity.

Initial evaluations conducted during the prekindergarten year revealed that teachers implemented the REDI curriculum components with moderate to strong fidelity. At the end of the year, observer ratings documented statistically significant and moderate to large improvements in teacher language use ($d = .62-.72$) and positive classroom management practices, including positive emotional climate ($d = .42$) and positive discipline ($d = .66$) in REDI compared with "usual practice" classrooms (see Domitrovich et al., 2009, for more detail).

At the end of the prekindergarten year, positive intervention effects were also evident on child outcomes in areas of both cognitive and social-emotional school readiness (Bierman et al., 2008). In language and emergent literacy skills, children in REDI classrooms outperformed children in "usual practice" classrooms in areas of vocabulary acquisition ($d = .15$), phonological sensitivity ($ds = .35-.39$), and print awareness ($d = .16$). In the social-emotional domain, significant intervention effects

were evident on improved emotion knowledge and social problem-solving skills ($ds = .21-.35$), decreased aggression ($d = .28$), and improved learning engagement based on observer ratings ($d = .29$). This study examines the sustained effects of the REDI intervention, after children transitioned into kindergarten.

The Challenge of Sustaining Gains Associated With Prekindergarten Enrichment

As noted earlier, existing research suggests that the gains in school readiness produced by Head Start or by evidence-based curricular enhancements often diminish or fade out over time as children leave preschool and enter kindergarten (Administration for Children and Families, 2010; Li-Grining & Haas, 2010; Lundberg et al., 1988; PCERC, 2008; Whitehurst et al., 1999). At the same time, few follow-up studies are available, and the findings are uneven across studies, raising questions about the factors associated with the fade out versus sustainability of preschool intervention effects. With regard to Head Start, one hypothesis is that poor children often attend low-quality schools, which fail to capitalize on or sustain the gains children made in Head Start (Currie & Thomas, 1995; Lee & Loeb, 1995). Another possibility, suggested recently by Magnuson, Ruhm, and Waldfogel (2007), is that some disadvantaged children attend higher quality schools, in which children with lower skill levels show accelerated learning in kindergarten, thus reducing the gap between them and their classmates who received Head Start or other preschool intervention. In both cases, the development of children converges, causing a fade out of early intervention effects; however, in the first hypothesis, the fade out occurs primarily in low-quality school environments that dampen the growth of Head Start attenders, whereas in the second hypothesis, the fade out occurs primarily in high-quality school environments that accelerate the growth of non-Head Start attenders. A better understanding of the impact of the kindergarten context on the sustainability (or fade out) of preschool intervention effects is important, given that the policy and practice implications are different if sustained effects occur primarily in higher quality or lower quality school contexts.

Dimensions of the Kindergarten Context

To better understand possible effects of the kindergarten context on the sustainability of child

gains associated with the REDI intervention, three dimensions of the kindergarten context were assessed in this study. These three dimensions were selected based on prior research indicating their potential effects on the pace of children's academic and social-emotional skill acquisition after school entry: the quality of teacher–student interactions, the degree of emphasis on reading instruction, and the achievement level of other students attending the school.

Quality of teacher–student interactions. Research suggests that high rates of positive teacher–student interactions foster the development of self-regulation and conflict management skills, thereby reducing student aggression (Howes, James, & Ritchie, 2003). In addition, high-quality teacher–student interactions around instructional activities increase the productive learning engagement of students, thereby enhancing academic progress (Connor, Morrison, & Katch, 2004; Crosnoe & Cooper, 2010). Observations reveal considerable variability across kindergarten classrooms in the quality of teacher–student interactions (including both emotional and instructional support), which may have implications for children's learning engagement, social behavior, and academic progress (Pianta, Belsky, Vandergrift, Houts, & Morrison, 2008).

Emphasis on reading instruction. Kindergartens also vary considerably in the emphasis placed and time spent on instructional activities targeting emergent literacy skills (Bryant, Clifford, & Peisner, 1991). Using data from the Early Childhood Longitudinal Study, Magnuson et al. (2007) found that the amount of language arts instruction in kindergarten, along with class size, moderated the sustained gains associated with preschool intervention. They found that children who did not attend preschool “caught up” with preschool attenders in reading and math achievement when they entered kindergartens with strong language arts instruction and small class size. However, children who did not attend preschool remained delayed in achievement when they entered poor quality kindergartens, creating a preschool intervention effect that was significant only in low-quality kindergarten contexts. Interestingly, preschool attenders did equally well, regardless of the quality of the kindergarten context they entered, suggesting that preschool attendance fostered resilience that allowed children to progress adequately even when placed in low-quality kindergarten contexts.

Student achievement levels. The overall quality of the school experience for each child is also affected by the average level of student achievement in the

school context, which is highly correlated with student poverty (Currie & Thomas, 2000; Lee & Loeb, 1995). Compared to schools serving many low-achieving students, schools serving higher achieving students are more likely to attract and retain high-quality teachers and are enriched with greater educational resources. Neidell and Waldfogel (2010) found that at-risk students benefited when they were placed in elementary classrooms that contained a higher density of competent peers and hypothesized that teachers may have concentrated their efforts on bringing the skills of these “lagging” students up to the classroom mean.

The Present Study

This study provides a unique opportunity to compare the kindergarten outcomes of children who experienced Head Start enriched with the REDI evidence-based curricula and teacher support with the adjustment of children who received “usual practice” Head Start. The children who participated in the REDI project attended rural, suburban, and urban schools, creating considerable variation in the kindergarten contexts they experienced. Measures of the kindergarten context (e.g., quality of teacher–student interactions, curriculum emphasis on reading instruction, and school-level student achievement) enabled an exploration of the degree to which kindergarten context affected the sustainability or fade out of REDI intervention effects, determining which effects were moderated by kindergarten context and whether the amplification (or attenuation) of intervention effects occurred in higher quality or lower quality kindergarten contexts. Moreover, the randomized-controlled design provided one of the strongest methods possible to test direct and moderated program effects on sustained child outcomes at the end of kindergarten. We hypothesized that the REDI intervention would produce main effects in the dual domains of language-emergent literacy skills and social-emotional skills that were targeted by the program. We sought to determine whether those intervention effects were more likely to be sustained when REDI children matriculated into higher quality or lower quality kindergarten contexts.

Method

Participants

At the start of the study, 44 classrooms in 24 Head Start centers in three Pennsylvania counties

were stratified on location, length of program (half day vs. full day), and student demographics, and randomized into the REDI intervention or “usual practice” conditions. Classrooms within a center were assigned to the same condition. All 4-year-olds were invited to participate in the study, and the parents of 86% of them agreed to do so. A total of 356 children (17% Latino, 25% African American, 58% European American; 54% girls) were enrolled at the beginning of their prekindergarten year ($M_{\text{age}} = 4.59$ years old, $SD = .32$, range = 3.87–5.82 at initial assessment). They were assessed after transition into 202 kindergarten classrooms at 82 schools in 33 school districts, with data collected for 94% of the original intervention sample ($N = 180/192$) and 96% of the original control sample ($N = 158/164$).

Of the primary caregivers, 89% were mothers, 4% were fathers, and 7% were grandparents, relatives, stepparents, or foster parents; 40% were single parents. In terms of education, 31% of the primary caregivers had less than a high school education, 60% graduated from high school or received a general education diploma, 8% completed a technical degree, and 2% completed a college degree. According to the Hollingshead (1975) classification system, 79% of the families fell into the unskilled or semi-skilled labor categories. The average income-to-needs ratio was .88, indicating that many families were living in poverty. These characteristics are typical of the socioeconomically disadvantaged families and children for whom Head Start is intended.

REDI Intervention Design

The REDI intervention was delivered by Head Start teachers and integrated into their ongoing classroom programs. It included three intervention components designed to strengthen child language and emergent literacy skill development. An interactive reading program (modeled after interventions designed by Wasik et al., 2006; Whitehurst et al., 1999) included two books per week, scripted with open-ended questions, and linked with a list of targeted vocabulary words, physical props, and illustrations. Teachers were asked to plan a daily reading lesson (four times per week), presenting each book in one session, and reviewing it in the next. The program also included two extension activities each week to further enhance discussion of the vocabulary words and theme. Teachers also led “sound games” three times per week, which were organized with a developmental scope and sequence progressing from easier to more challeng-

ing skills (e.g., listening, rhyming, alliteration, words, sentences, syllables, and phonemes) to promote phonological awareness (Adams et al., 1998). Teachers were provided with a set of activities to use in their alphabet centers to promote letter knowledge, and they were given materials to assist them in tracking the children’s progress acquiring letter names. They were asked to open the alphabet center daily (four times per week) and monitor children’s knowledge acquisition once a week. In addition, teachers received mentoring in language coaching strategies, such as expansions, to support children’s language development in the classroom (Dickinson & Smith, 1994).

To promote children’s social-emotional skills, teachers delivered the weekly lessons and extension activities of the Preschool PATHS Curriculum (Domitrovich, Greenberg, Kusche, & Cortes, 2005; Domitrovich et al., 2007). The 33 lessons in this curriculum included modeling stories and discussions, and utilized puppet characters and teacher role plays to introduce skills in four domains: (a) prosocial friendship skills, (b) emotional understanding, (c) self-control, and (d) problem-solving skills. Hands-on extension activities included cooperative projects and games that provided skill practice opportunities. Teachers were asked to present a PATHS lesson and use an extension activity each week. To integrate the language-emergent literacy and social-emotional components of REDI, most of the books used for interactive reading focused on PATHS themes. Teachers also used positive classroom management strategies, emotion coaching, and induction strategies throughout the day to encourage student self-regulation and learning engagement.

Finally, REDI provided take-home materials for parents, including three brief modeling DVDs describing key REDI program concepts (e.g., the importance of positive support, emotion coaching, and interactive reading) with parenting tips and learning activities to use at home. In addition, parents received PATHS curriculum handouts with suggestions for home activities.

Teachers received detailed manuals and kits containing all materials needed to implement the intervention. They participated in a 3-day professional training in August before the start of intervention, and a 1-day booster training in January. All teachers received weekly mentoring provided by REDI trainers who were experienced master teachers supervised by project-based senior educational trainers. REDI trainers spent an average of 3 hr per week in each classroom observing teachers and

providing feedback and suggestions. They also met for 1 hr per week with teachers to review program concepts and provide ongoing feedback and support regarding program delivery.

Teachers reported completing most lessons, with average weekly implementation rates of 6.08 (of 7 maximum) dialogic reading activities, 2.57 (of 3 maximum) weekly sound games, 3.56 (of 4 maximum) alphabet center activities, and 1.77 (of 2 maximum) PATHS lessons and extension activities. REDI trainers provided monthly ratings of the fidelity and quality of implementation, and the sample mean fell in between ratings indicating *adequate* to *strong* implementation (see Bierman et al., 2008, for details).

Data Collection Procedures

Parent interviews were conducted at a time and location that were convenient for the parents, most often at their homes. A trained interviewer met privately with the primary caregiver and read all questions to avoid problems related to low literacy levels. Some interviews were conducted in Spanish. Preintervention assessments were conducted during the fall of the Head Start school year, and follow-up assessments were conducted at the end of the child's kindergarten year. Parents were compensated \$20 for each of the 30-min interviews.

Child assessments were conducted individually at school by trained interviewers. Preintervention assessments (October–November) and postintervention assessments (April) during the Head Start year consisted of two 30- to 45-min sessions. Follow-up assessments (March–April) during the kindergarten year involved a single 45- to 60-min session. Teacher ratings were collected at the same time as the child assessments. Teachers were compensated \$20 to provide information about themselves and their classrooms, and \$7 per child for completing the ratings. Classroom observations were conducted in March–April of the kindergarten year.

Measures

A multimethod, multi-informant assessment battery was used to assess child kindergarten outcomes in four skill domains targeted directly by the REDI intervention: (a) language and emergent literacy skills, (b) learning engagement, (c) social competence, and (d) aggressive behavior. Direct assessments of the children, teacher ratings, and parent ratings evaluated the intervention effect in school and home settings. Measures of kindergarten context

were based on classroom observations of teacher–student interaction quality, teacher reports of reading instruction emphasis, and state records of school-based student achievement levels.

Language and emergent literacy skills. Four tests were administered to assess child language and emergent literacy skills. The Expressive One-Word Picture Vocabulary Test (EOWPVT; Brownell, 2000) required children to state the word that best described pictures they were shown ($\alpha = .94$); total raw scores were used in the analyses. The Letter-Word Identification subscale of the Woodcock–Johnson Tests of Achievement III–Revised (Woodcock, McGrew, & Mather, 2001) provided a nationally normed, standardized test of letter recognition and basic sight word knowledge; total raw scores were used in the analyses ($\alpha = .90$). On the Test of Word Reading Efficiency (TOWRE; Torgesen, Wagner, & Rashotte, 1999), the Sight Word Efficiency subscale measured the number of words read accurately within 45 s, and the Phonemic Decoding Efficiency subscale measured the number of nonwords sounded out accurately within 45 s (test–retest reliability reported by the developers of .85–.90).

Learning engagement. Teachers completed a measure of learning behaviors developed for the REDI project, the School Readiness Questionnaire. Fourteen items assessed self-regulation and learning motivation (e.g., “Can follow rules and routines,” “Seems enthusiastic about learning new things”), rated on a 6-point scale, with response options ranging from *strongly disagree* to *strongly agree* ($\alpha = .96$). The average item score was used in the analyses. Both teachers and parents rated attention problems (e.g., “Is easily distracted,” “Has trouble staying focused”), using the Attention Deficit Hyperactivity Disorder Rating Scale (DuPaul, 1991), which included eight items, each rated on a 4-point scale, with response options ranging from *not at all* to *very much* (α s = .95 and .92 for teachers and parents, respectively). Average item scores were used in analyses.

Social competence. Competent social problem-solving skills were assessed using an open-ended version of the Challenging Situations Task (Denham, Bouril, & Belouad, 1994). Children were presented with four scenarios describing peer problems and asked how they would respond (e.g., “If you wanted to play Legos and someone said ‘No,’ what would you do?”). Responses were coded as *competent*, *aggressive*, or *inept* by the interviewer and later checked for interrater reliability ($\kappa = .94$). The number of competent solutions, reflecting appropriate assertion or calm negotiation, was summed across the four scenarios ($\alpha = .68$). In

addition, teachers and parents completed the 13-item Social Competence Scale (Conduct Problems Prevention Research Group, 1995). Items that reflected prosocial behaviors (e.g., sharing, understanding other's feelings) and emotion regulation (e.g., can calm down when excited or upset) were rated on a 6-point Likert scale (α s = .95 and .88 for teachers and parents, respectively). Average item scores were used in the analyses.

Aggressive-disruptive behaviors. Aggressive social problem-solving tendencies were assessed with the Challenging Situations Task (Denham et al., 1994). Solutions involving verbal/physical antagonism or intimidation were summed across the four scenarios (α = .77). In addition, teachers completed seven items from the Teacher Observation of Child Adaptation-Revised (TOCA-R; Werthamer-Larsson, Kellam, & Wheeler, 1991) describing overt aggression and disruptive behavior (e.g., stubborn, yells, fights), and six items from the Preschool Social Behavior Scale-Teacher Form (Crick, Casas, & Mosher, 1997) describing relational aggression (e.g., "Tells other kids he/she won't be their friend unless they do what he/she wants"). All items were rated on a 6-point Likert scale and combined to form a total aggression score (α = .92). Parents also completed seven items from the TOCA-R (α = .86) to assess aggressive behavior at home. Average item scores were used in the analyses.

Kindergarten context. Observers used the Classroom Assessment Scoring System (CLASS; La Paro & Pianta, 2003) to rate kindergarten classrooms on 10 dimensions of teacher-student interaction quality, including emotional support, instructional support, and organization. Research assistants, trained by certified CLASS trainers, conducted four 20-min observation sessions in each classroom, usually over a period of 2-3 hr. Items were rated on a 7-point Likert scale after each session, and averaged across the four sessions (Pianta et al., 2008). Total CLASS scores were used (α = .87). Two staff members independently rated 20% of all sessions (intraclass correlation coefficient = .76), scoring within 1 point for 88% of the ratings.

To assess the quantity of reading instruction, teachers rated the degree to which they used each of 12 didactic literacy instructional practices (e.g., "Learning sight words"), using a 4-point Likert scale (α = .74; Stipek & Byler, 2004). Inspection of the distribution of ratings revealed a positive skew, with nearly 75% of the teachers rating themselves near the ceiling (e.g., at or above an average item score of 3.5 on a 4.0-point scale), reflecting a strong emphasis on literacy instruction in kindergarten.

The other 25% were spread across the scale, ranging from an average score of 3.4 to a 1.1. Given the distribution of this measure, a dichotomous score was used to differentiate classrooms where didactic reading instruction was or was not used; 73% of the study children were in classrooms that emphasized didactic reading instruction.

A third dimension of kindergarten context examined in this study was school student achievement levels, which were retrieved from standardized test records compiled by the state. We used third-grade scores, the lowest grade level available, and computed an average of the percentage of children in each school in the "below basic" category for reading and math proficiency. This measure provided an index of the achievement levels of the students attending schools with the REDI study participants. The distribution of this average percentage score was bimodal. Some schools included many children who were failing academically with 20%-38% of the student body scoring below basic proficiency; other schools had relatively few children (0%-15% of the student body) who were below basic proficiency. Thus, rather than using the average percentage score, we created a dichotomous indicator that more accurately reflected the two kinds of schools in the sample. These two groups of schools also differed significantly on other risk indices, with more students who qualified for free or reduced-price lunch (63% vs. 48%), more African American and Latino students (61% vs. 12%), and more English language learners (11% vs. 1%) in schools with many low-achieving students. In the REDI sample, 83 children (28% of the sample) were in low-achieving schools, and the other 211 children (72% of the sample) were in adequately achieving schools.

The three indices of kindergarten context were uncorrelated: CLASS and didactic reading instruction, r = .10, *ns*; CLASS and school-level achievement, r = .05, *ns*; and didactic reading instruction and school-level achievement, r = .01, *ns*. Hence, we examined the contribution of each of these dimensions of kindergarten context separately.

Covariates controlling for preintervention child functioning and cognitive ability. To model change associated with intervention, we included the preintervention measure of each study outcome as a covariate. When exact measures were not available, we used preintervention assessments of closely related constructs. For example, we used Elision, Blending, and Print Awareness scores from the Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen, & Rashotte, 2007) as preintervention covariates for emergent literacy outcomes

(e.g., Letter-Word Identification, Sight Word Efficiency, and Phonemic Decoding Efficiency). We used parent ratings of child behavior as preintervention covariates for both teacher-rated and parent-rated outcomes. (Because the REDI intervention began the 1st day of classes but teachers could not complete ratings until they got to know the children 6–8 weeks later, the fall teacher ratings of child behavior could not be used as preintervention covariates.) To account for the impact of initial cognitive ability on school progress and adjust for the possibility that children with lower cognitive ability might attend lower quality schools, preintervention measures of cognitive ability were used as control variables in all analyses. These included Block Design from the WPPSI-III (Wechsler, 2002), vocabulary (EOWPVT; Brownell, 2000), and executive functioning, including Backward Word Span (Davis & Pratt, 1996), Peg Tapping (Diamond & Taylor, 1996), Dimensional Change Card Sort (Frye, Zelazo, & Palfai, 1995), Walk-a-Line Slowly (Kochanska, Murray, Jacques, Koenig, & Vandegest, 1996), and the Adapted Leiter-R Assessor Report (Smith-Donald, Raver, Hayes, & Richardson, 2007).

Results

Means and standard deviations for child kindergarten outcomes, kindergarten context measures, and family demographic characteristics for the intervention and control groups are presented in Table 1. Correlations among the study variables are presented in Table 2. To rule out the possibility that children in the intervention and control groups selected into different kinds of kindergarten contexts, preliminary analyses compared intervention and control groups on the three measures of context. No significant group differences emerged on kindergarten teacher–student interaction quality, $t(321) = 1.32$; curriculum emphasis on reading instruction, $\chi^2(1) = 3.23$; or school-level student achievement, $\chi^2(1) = 1.28$. These findings indicated that children in the intervention and control groups experienced comparable kindergarten contexts.

Plan for Analyses

Cross-classified hierarchical linear models (HLM; Raudenbush & Bryk, 2002) were used to analyze child outcomes. These multilevel models accounted for the nonindependence of data in the Head Start classrooms, where the REDI intervention was delivered, and in school districts in which kindergartens were located, treating these as Level 2 ran-

dom effects. Family income-to-needs ratio, child age, gender, race, preintervention assessments of the outcome, and preintervention assessments of cognitive ability served as Level 1 covariates; county and cohort served as Level 2 covariates. All measures were standardized, so that the coefficient for the intervention effect on each outcome represents the difference in average expected scores between children in the intervention and control groups as a proportion of a standard deviation; this is comparable to an effect size (Cohen, 1977) that controls for all other variables in the model.

To assess sustained REDI effects and the impact of kindergarten contexts, the main effects of the REDI intervention and three dimensions of kindergarten context (classroom teacher–student interaction quality, reading instruction emphasis, and school-level student achievement) were estimated for each outcome. These main effects are presented in the four left columns of Table 3. Then, to test whether the sustained effects of the REDI intervention varied as a function of kindergarten context and to explore whether there were other intervention effects that were evident only among children in particular kindergarten contexts, interaction terms were added to those models (e.g., intervention status by each dimension of kindergarten context). Only the interaction terms that were statistically significant were retained ($p < .05$) and contrasts were used to understand the specific nature of the moderation. Interactions from the second stage of data analyses that were statistically significant are shown in the two right columns of Table 3 and are depicted in Figures 1 and 2. In the final phase of analyses, the HLMs were rerun controlling for children’s postintervention functioning at the end of Head Start, to examine the changes that occurred in the kindergarten year only. These results are in Table 4.

Language and Emergent Literacy Skills

Four measures assessed child outcomes in the domain of language and emergent literacy skills. As presented in Table 3, cross-classified HLMs revealed a main effect of REDI on one of these measures, Phonemic Decoding Efficiency, $\beta = .25$, $p < .05$, reflecting a positive impact of intervention 1 year later. No other intervention effects emerged on the language and emergent literacy measures. Three main effects emerged for kindergarten context. Children’s gains in literacy (Letter-Word Identification and Sight Word Efficiency) were associated with better quality teacher–student interactions, extent of reading

Table 1
Means and Standard Deviations of Kindergarten Outcomes and Contexts by Condition

	Condition	Head Start— pretreatment			Head Start— posttreatment			Kindergarten— follow-up		
		<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
Child language/emergent literacy										
vocabulary (EOWPVT)	Control	161	84.30	(13.82)	157	85.00	(13.08)	157	87.77	(12.31)
	Treatment	190	84.88	(14.00)	178	86.64	(13.52)	176	88.96	(13.95)
Print awareness/letter-word (WJ-R) ^a	Control	161	7.97	(8.31)	157	16.49	(12.59)	157	104.87	(10.41)
	Treatment	190	8.86	(9.43)	179	18.84	(12.84)	176	105.00	(11.29)
Blending/phoneme decoding (TOWRE) ^a	Control	161	11.53	(4.30)	157	13.04	(4.30)	157	1.52	(3.04)
	Treatment	190	11.58	(4.26)	179	14.71	(4.33)	176	1.95	(3.59)
Elision/sight word reading (TOWRE) ^a	Control	161	7.71	(3.43)	157	9.61	(3.58)	157	8.15	(7.71)
	Treatment	190	8.21	(3.49)	179	11.19	(4.02)	176	7.53	(8.16)
Child learning engagement										
Learning behaviors (SRQ)	Control	164	4.91	(0.89)	161	4.97	(0.90)	154	4.56	(1.05)
	Treatment	191	4.86	(0.88)	182	5.07	(0.85)	167	4.81	(1.03)
Attention problems—teacher (ADHD)	Control	164	0.78	(0.70)	164	0.73	(0.66)	154	0.92	(0.73)
	Treatment	191	0.73	(0.69)	191	0.66	(0.63)	167	0.79	(0.73)
Attention problems—parent (ADHD)	Control	64	1.28	(0.62)	156	1.21	(0.66)	155	1.21	(0.65)
	Treatment	191	1.24	(0.67)	177	1.01	(0.65)	171	1.08	(0.68)
Child social competence										
Competent problem solving (CST)	Control	161	2.37	(2.05)	157	2.28	(2.05)	157	2.95	(2.41)
	Treatment	190	2.52	(2.16)	178	3.16	(2.55)	176	3.61	(2.56)
Social competence—teacher (SCS)	Control	164	3.96	(0.89)	161	3.97	(0.88)	154	4.02	(0.98)
	Treatment	191	4.03	(0.80)	182	4.15	(0.82)	167	4.31	(1.01)
Social competence—parent (SCS)	Control	164	3.59	(0.76)	156	3.66	(0.84)	155	3.66	(0.83)
	Treatment	191	3.59	(0.83)	177	3.73	(0.79)	171	3.78	(0.81)
Child aggressive behavior										
Aggressive problem solving (CST)	Control	161	2.01	(2.30)	157	2.06	(2.55)	157	1.59	(1.94)
	Treatment	190	1.97	(2.27)	178	1.53	(2.21)	176	1.55	(2.18)
Aggression—teacher (TOCA-R)	Control	164	2.01	(0.94)	161	2.07	(0.89)	154	1.96	(0.83)
	Treatment	191	1.85	(0.81)	182	1.91	(0.83)	167	1.73	(0.85)
Aggression—parent (TOCA-R)	Control	164	2.93	(0.94)	156	2.86	(0.97)	155	2.87	(0.98)
	Treatment	191	2.88	(1.02)	177	2.79	(0.99)	171	2.67	(0.96)
Kindergarten context										
Teacher—student interactions (CLASS)	Control							152	5.13	(0.68)
	Treatment							166	5.09	(0.72)
Reading curriculum emphasis	Control							154	3.67	(0.37)
	Treatment							167	3.66	(0.26)
School achievement (% below basic)	Control							145	11.24	(7.51)
	Treatment							150	11.87	(7.22)
Additional pretreatment covariates										
Family socioeconomic status	Control	164	21.47	(10.17)						
	Treatment	191	22.42	(9.75)						
Family income-to-needs ratio	Control	152	0.88	(0.53)						
	Treatment	183	0.88	(0.67)						

Note. Standard deviations are in parentheses. For kindergarten reading emphasis, control group $N = 31$ (22%) low, $N = 113$ (78%) high; intervention group $N = 46$ (31%) low, $N = 104$ (69%) high. For kindergarten school achievement, control group $N = 36$ (25%) low, $N = 108$ (75%) high; intervention group, $N = 47$ (31%) low, $N = 103$ (69%) high. EOWPVT = Expressive One-Word Vocabulary Test; WJ-R = Woodcock-Johnson Tests of Achievement III-Revised; TOWRE = Test of Word Reading Efficiency; SRQ = School Readiness Questionnaire; ADHD = Attention Deficit Hyperactivity Disorder Rating Scale; CST = Challenging Situations Task; SCS = Social Competence Scale; TOCA-R = Teacher Observation of Child Adaptation-Revised; CLASS = Classroom Assessment Scoring System.

^aPrint Awareness, Blending, and Elision were used as the Head Start covariates (listed in the table in the pretreatment and posttreatment columns) for the WJ-R Letter-Word Identification and TOWRE, which were not administered until kindergarten, and are listed in the follow-up assessment (kindergarten) column.

Table 2
Correlations Among Kindergarten Outcome Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Vocabulary	—												
2. Letter-word	.42	—											
3. Phonemic decoding	.30	.63	—										
4. Sight word	.34	.86	.64	—									
5. Learning behavior	.26	.42	.25	.38	—								
6. Attention problems—T	-.12	-.26	-.15	-.25	-.73	—							
7. Attention problems—P	-.10	-.10	-.13	-.14	-.36	.40	—						
8. Competent SPS	.21	.23	.20	.21	.24	-.16	-.07	—					
9. Social competence—T	.16	.23	.16	.23	.73	-.67	-.38	.16	—				
10. Social competence—P	.11	.13	.12	.17	.30	-.25	-.60	.05	.35	—			
11. Aggressive SPS	.00	-.16	-.12	-.10	-.11	.17	.04	-.39	-.08	.00	—		
12. Aggression—T	-.07	-.09	-.06	-.12	-.45	.57	.34	-.03	-.67	-.26	.03	—	
13. Aggression—P	-.11	-.13	-.15	-.16	-.33	.29	.67	-.05	-.37	-.72	.01	.33	—
Family/kindergarten context													
Family SES	.21	.05	.13	.05	.07	.02	-.16	.03	.05	.15	.08	.02	-.15
Income to needs	.16	.05	.06	.04	.02	-.01	-.05	.01	.02	.01	.02	.01	-.07
CLASS total	.13	.17	.11	.15	.06	-.09	-.02	.02	.13	-.00	.00	-.09	-.02
Reading emphasis	.08	.18	.08	.15	.07	.00	.08	.06	.06	-.12	.00	.05	.13
School achievement	.14	.04	-.06	.00	-.11	.08	.04	-.05	-.04	.01	-.04	-.03	-.01

Note. Coefficients > .10 are $p < .05$. SPS = social problem-solving skills; T = teacher; P = parent; CLASS = Classroom Assessment Scoring System; SES = socioeconomic status.

Table 3
Effects of Research-based, Developmentally Informed (REDI) Intervention and Kindergarten Context on Child Outcomes

	Main effects				Intervention moderation		
	REDI intervention	Teacher–student interactions	Reading curriculum emphasis	School achievement	REDI* teacher–student interactions	REDI* reading emphasis	REDI* school achievement
Child language/emergent literacy							
Vocabulary	.10 (.09)	.08 (.04)	.13 (.09)	.00 (.10)			
Letter-word identification	.03 (.11)	.14 (.05)**	.43 (.12)**	.31 (.14)*			
Phonemic decoding	.25 (.12)*	.10 (.06)	.22 (.13)	-.04 (.14)			
Sight word efficiency	-.04 (.13)	.13 (.06)*	.33 (.13)*	.09 (.15)			
Child learning engagement							
Learning behaviors	.28 (.12)*	-.01 (.06)	.27 (.12)*	-.10 (.14)			
Attention problems—teacher rating	-.21 (.13)	-.01 (.06)	-.20 (.14)	-.02 (.16)			.75 (.27)**
Attention problems—parent rating	-.15 (.10)	.03 (.05)	.10 (.12)	-.04 (.13)			.46 (.23)*
Child social competence							
Competent problem solving	.40 (.14)**	-.03 (.07)	.13 (.15)	.36 (.17)*	.27 (.13)*		
Social competence—teacher rating	.26 (.15)	.05 (.06)	.28 (.14)*	-.11 (.16)			-.94 (.26)**
Social competence—parent rating	.16 (.12)	-.01 (.05)	.07 (.12)	.02 (.14)			
Child aggressive behavior							
Aggressive problem solving	-.04 (.12)	.11 (.06)	-.12 (.14)	-.30 (.16)*			
Aggression—teacher rating	-.26 (.12)*	-.02 (.07)	.04 (.15)	.01 (.16)			.79 (.28)**
Aggression—parent rating	-.22 (.09)*	.07 (.05)	.11 (.11)	.01 (.11)			

Note. Nonsignificant interactions were removed from models.

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

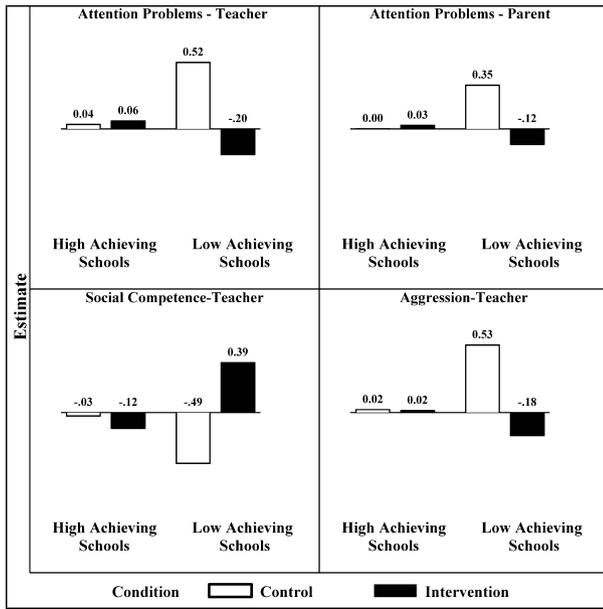


Figure 1. Moderation of Research-based, Developmentally Informed (REDI) intervention effects by school achievement levels.

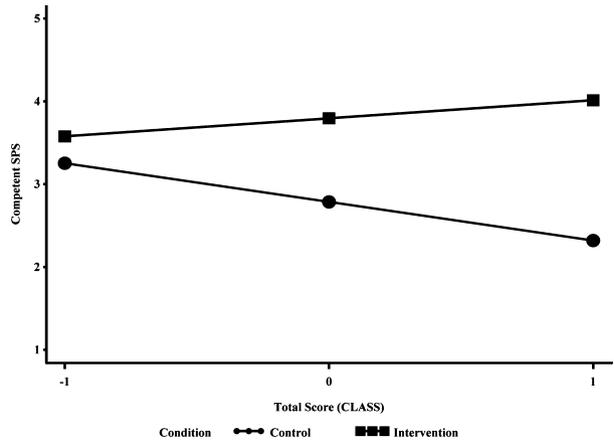


Figure 2. Moderation of intervention effects by kindergarten Classroom Assessment Scoring System Score. SPS = social problem-solving skills.

Table 4

Effects of Research-Based, Developmentally Informed (REDI) Intervention and Kindergarten Context on Child Outcomes Controlling for Posttreatment Scores

	Main effects				Intervention moderation		
	REDI intervention	Teacher-student interactions	Reading curriculum emphasis	School achievement	REDI* teacher-student interactions	REDI* reading emphasis	REDI* school achievement
Child language/emergent literacy							
Vocabulary	.05 (.09)	.05 (.04)	.13 (.10)	.00 (.10)		-.40 (.19)*	
Letter-word identification	-.06 (.12)	.14 (.05)**	.37 (.12)**	.26 (.14)†			
Phonemic decoding	.22 (.12)†	.10 (.06)	.22 (.13)	-.04 (.15)			
Sight word efficiency	-.09 (.13)	.13 (.06)*	.29 (.13)*	.03 (.14)			
Child learning engagement							
Learning behaviors	.23 (.12)†	-.01 (.05)	.25 (.13)*	-.14 (.14)			
Attention problems—teacher Rating	-.18 (.13)	-.01 (.06)	-.20 (.13)	.02 (.15)			.64 (.26)*
Attention problems—parent rating	-.02 (.07)	.04 (.03)	.13 (.08)	-.01 (.09)			
Child social competence							
Competent problem solving	.31 (.14)*	-.03 (.07)	.12 (.15)	.36 (.17)*	.25 (.13)†		
Social competence—teacher rating	.24 (.15)	.04 (.06)	.28 (.14)*	-.11 (.17)			-.96 (.27)**
Social competence—parent rating	.09 (.11)	.02 (.05)	-.03 (.11)	.06 (.13)			
Child aggressive behavior							
Aggressive problem solving	.02 (.12)	.12 (.06)	-.07 (.14)	-.36 (.15)*			
Aggression—teacher rating	-.19 (.13)	-.03 (.07)	.01 (.15)	.04 (.16)		-.64(.29)*	.85 (.28)**
Aggression—parent rating	-.13 (.09)	.05 (.05)	.14 (.10)	.04 (.11)			

Note. Nonsignificant interactions were removed from models. †*p* < .10. **p* < .05. ***p* < .01.

emphasis in the kindergarten curriculum, and, for Letter-Word Identification only, school-level student achievement. No significant interaction effects emerged between intervention and kindergarten context, suggesting that the intervention impact on phonemic decoding was robust across kindergarten contexts.

Learning Engagement

Three measures assessed child outcomes in the domain of learning engagement. As presented in Table 3, cross-classified HLMs revealed a main effect of the REDI intervention on one of these measures, children's learning behaviors, $\beta = .28, p < .05$. Kindergarten teachers rated children who received Head Start REDI as more engaged and motivated in classroom academic activities than children who received "usual practice" Head Start. In addition to that main effect of the REDI intervention, there was a main effect for one measure of kindergarten context, such that children's learning behaviors were higher in kindergarten classrooms where reading instruction was emphasized.

Tests of moderation revealed intervention effects on two additional measures of children's learning engagement that were evident in only a subset of kindergarten contexts. Significant interactions between intervention and school-level student achievement emerged on teacher ratings of attention problems, $\beta = .75, p < .01$, and on parent ratings of attention problems, $\beta = .46, p < .05$. The upper left panel of Figure 1 shows that when Head Start children attended elementary schools with few low-achieving classmates, mean intervention group levels of teacher-rated attention problems were, on average, only about one sixth of a standard deviation lower than the control group (*ns*). In contrast, when Head Start children attended schools with many low-achieving classmates, teacher-rated attention problems were about one half of a standard deviation lower for intervention versus control group children ($p < .05$), indicating a significant sustained effect for the REDI intervention. The upper right panel of Figure 1 shows similar differences in parent ratings of attention problems, with significant intervention-control group differences only in schools serving many low-achieving students.

Social Competence

Among the three measures of social competence, there was a main effect of the REDI intervention on one—children's competent social

problem-solving skills, $\beta = .40, p < .01$. Children who participated in REDI offered more competent solutions to hypothetical problems than children in the "usual practice" control group. Children in schools characterized by higher student achievement also offered more competent solutions than children in schools characterized by low student achievement.

Tests of moderation revealed a statistically significant interaction between the REDI intervention and teacher-student interaction quality, as measured with the CLASS, on competent social problem-solving skills, $\beta = .27, p < .05$. This was the only instance in which intervention and control group differences were amplified in positive kindergarten contexts; intervention-control group differences were greater in classrooms characterized by higher CLASS scores (see Figure 2). Tests of moderation also revealed a statistically significant interaction between the REDI intervention and school-level student achievement on teacher ratings of social competence, $\beta = -.94, p < .01$. In this case, the effects of the REDI intervention on teacher-rated social competence were significant for children who attended schools with many low-achieving students. As depicted in the lower left panel of Figure 1, the intervention group scored, on average, one sixth of a standard deviation higher on teacher-rated social competence than the control group in schools with higher achieving students (*ns*) and almost two thirds of a standard deviation higher in schools with many low-achieving students ($p < .05$).

Aggressive-Disruptive Behavior

Among the three measures that assessed aggressive-disruptive behavior at the end of kindergarten, main effects for the REDI intervention emerged for both teacher and parent reports, $\beta = -.26, p < .05$, and $\beta = -.23, p < .05$, respectively. Children who received the REDI intervention showed sustained reductions in aggression at both school and home 1 year after the end of the intervention. There was one main effect for kindergarten context on aggressive-disruptive behavior, as children in schools with high-achieving students offered fewer aggressive solutions to social problems.

Tests of moderation revealed that intervention effects on teacher ratings of aggressive-disruptive behavior were amplified in schools serving many low-achieving students, $\beta = .79, p < .01$. As depicted in the bottom right panel of Figure 1, the intervention group had lower aggression than the control group at a mag-

nitude of one fourth of a standard deviation in schools with higher achieving students (*ns*) and almost two thirds of a standard deviation in schools with many low-achieving students ($p < .05$).

Controlling for Postintervention Functioning at the End of the Head Start Year

As a final step in the analyses, each HLM examining kindergarten outcomes was rerun with the respective postintervention score at the end of the Head Start year included as a covariate. By controlling for these postintervention scores, these new HLMs were able to isolate the change that occurred during the kindergarten year. In these analyses, presented in Table 4, four of the five nonmoderated main effects of REDI were reduced from significant effects to marginally significant ($p < .10$) trends (for phonemic decoding and learning behaviors) or nonsignificance (teacher and parent ratings of aggression). This suggests that the group differences contributing to these main effects of intervention occurred primarily during the Head Start year, and then were sustained in kindergarten. In contrast, controlling for postintervention scores had relatively little impact on REDI effects that were moderated by kindergarten context. Moderated effects on teacher-rated attention problems, social competence, and aggression all remained significant; the effect on competent social problem solving was marginally significant. Only one moderated effect, on parent-rated attention problems, was reduced to nonsignificance when postintervention scores were controlled. In addition, two new moderated effects emerged in these analyses that controlled for postintervention scores. Contrasts indicated that among children placed in kindergarten classrooms that deemphasized reading instruction, those who had received REDI showed greater growth in vocabulary during kindergarten than children who had received "usual practice" Head Start. Among children in kindergarten classrooms that emphasized reading instruction, children who had received REDI showed greater reductions in aggression during kindergarten than those in the "usual practice" Head Start control group. Overall, these findings, in which postintervention scores were controlled, suggest that the moderating impact of the kindergarten context on intervention-control differences occurred during kindergarten, and was not confounded by group differences that existed at the end of Head Start. In addition, and as expected, the main effects of the kindergarten context on child outcomes remained unchanged when end of Head Start scores were controlled in these analyses.

Discussion

The REDI intervention is one of several recent attempts to strengthen the effects of Head Start on child's school readiness by enriching classrooms with evidence-based curricula and providing professional development support. At the end of the prekindergarten intervention year, children who received REDI outperformed children in "usual practice" Head Start classrooms on multiple measures in both academic and social-emotional domains (Bierman et al., 2008). This study evaluated child outcomes 1 year later, after children transitioned into kindergarten. Sustained effects of the preschool intervention were evident, but some effects had dissipated and some were moderated by the kindergarten context. In the following sections, we review the findings, compare them with the sustained effects of other similar intervention studies, discuss the moderating impact of the kindergarten context and implications for practice, and identify areas for future research.

Sustained Impact of the REDI Intervention

Of the 13 child outcomes examined at the end of kindergarten, 5 showed statistically significant main effects favoring children who received the REDI intervention during Head Start; 2 of these main effects were moderated by kindergarten context. In addition, 3 other child outcomes were significant for the subgroup of children attending schools with low-achieving students. The intervention-control group differences were small to moderate, with effect sizes ranging from .22 to .40 for the significant main effects.

In the domain of language and emergent literacy skills, initial intervention effects were evident at the end of Head Start in areas of vocabulary, print awareness, and phonological sensitivity. In kindergarten, a sustained intervention main effect emerged only for phonemic decoding, likely building on the prekindergarten effects on phonological sensitivity and print awareness, which were direct targets of the REDI Sound Games and Alphabet Center intervention components.

In the social-emotional domain, sustained REDI intervention effects were evident in areas of enhanced learning engagement, improved social competence, and reduced aggression. Four measures showed main effects for the REDI intervention in kindergarten with effect sizes that were equivalent to or, in some cases, stronger than the postintervention effects at the end of Head Start: (a) teacher ratings of learning behaviors ($d = .11$ in prekindergarten,

$d = .28$ in kindergarten), b) children's competent social problem-solving skills ($d = .35$ in prekindergarten, $d = .40$ in kindergarten), c) teacher-rated aggression ($d = -.28$ in prekindergarten, $d = -.25$ in kindergarten), and (d) parent-rated aggression ($d = -.13$ in prekindergarten, $d = -.20$ in kindergarten). Three additional measures showed moderated effects, with significant intervention-control group differences in kindergarten evident only for the subgroup of children attending schools with low student achievement. Of these, teacher-rated social competence showed a main effect of intervention that was equivalent in kindergarten and at the end of Head Start ($d = .24$ in prekindergarten, $d = .26$ in kindergarten); however, the group difference was statistically significant only for children attending schools with low student achievement. Teacher-rated attention problems (which had not shown a significant treatment effect in Head Start) and parent ratings of attention problems (which showed a marginally significant treatment effect in Head Start) each showed significant intervention effects in kindergarten, but only for the subgroup of children attending schools with low student achievement.

In general, the sustained effects of the REDI intervention were concentrated in the social-emotional domain. Most of the REDI effects that were evident on social-emotional outcomes at the end of Head Start were sustained in kindergarten and amplified among children who entered low-achieving schools. Given that kindergarten teachers had no knowledge of children's prekindergarten intervention condition, and given the consistency of effects across parent and teacher ratings, these findings are quite robust. This improved functioning in the social-emotional domain likely reflects the impact of the Preschool PATHS curriculum used in REDI, which focused directly on promoting social and self-regulation skills. These effects might also reflect the impact of the REDI dialogic reading, which focused on stories with social-emotional and self-regulation themes that were chosen to increase synergy with PATHS. In addition, it is possible that the preschool improvements in language and emergent literacy skills fostered by REDI also enhanced some kindergarten gains in the social-emotional domain, particularly learning engagement (see Nix et al., in press). Finally, it is possible that the improved teaching quality in Head Start classrooms associated with the REDI intervention created a prekindergarten classroom context that promoted social-emotional development (see Domitrovich et al., 2009).

Critical Research Questions About Long-Term Preschool Intervention Effects

When REDI was funded in 2003 by the Interagency School Readiness Consortium (Griffin, 2010), critical research concerns had shifted away from *whether* preschool was beneficial to children at risk, and began to focus instead on the *characteristics* of preschool programs that could produce the greatest benefits for children at risk. Prior research had documented that intensive, high-quality, "model" early intervention programs (such as the Perry Preschool and Abecedarian projects) could have long-term educational benefits compared to no preschool (Barnett, 2011). But, by the early 2000s, 45 of the 50 states in the United States offered state-funded prekindergarten programs (National Association for the Education of Young Children [NAEYC], 2006) and 69% of 4- and 5-year-olds were enrolled in a center-based early childhood programs (U.S. Department of Education, 2007), making comparisons with "no preschool" less useful. Instead, studies such as the Head Start Impact Study (Administration for Children & Families, 2010) focused concerns on how preschool programs, particularly Head Start, could improve upon their current performance and promote lasting reductions in the school readiness gap associated with poverty. In this new era of preschool research, a large number of rigorous randomized trials were launched, comparing "usual practice" preschool to preschool with enhanced curriculum components and/or teaching practices and a focus on sustained effects (Griffin, 2010; PCERC, 2008).

Promoting language and emergent literacy skills. Initial studies focused primarily on promoting language and emergent literacy skills in preschool, with a subset including follow-up measures in elementary school. For example, Lundberg et al. (1988) and Byrne and Fielding-Barnsley (1995) each implemented preschool programs targeting phonological awareness and found sustained gains in phonological awareness skills through second grade for children in the intervention compared to the "usual practice" preschool control group. These programs provided a model for the REDI sound games. The sustained REDI kindergarten effects on phonemic decoding parallel the earlier findings documented by Byrne and Fielding-Barnsley. Focused on oral language skill enhancement, Whitehurst et al. (1999) implemented a dialogic reading program in preschool and found sustained effects on oral language skills in kindergarten; this became a model for the REDI dialogic reading program. However, in each of

these studies, effects were domain specific, as the phonological awareness programs did not generalize to broader improvements in oral language skills, and the dialogic reading program did not enhance kindergarten print concepts. By 2000, researchers were combining these strategies into multifaceted programs to support language and emergent literacy skill development. Fourteen such programs were studied as part of the 2002 PCERC project. Of those, only the DLM Early Childhood Express with Open Court Reading Pre-K produced statistically significant effects on multiple measures of emergent literacy skills and oral language in preschool that sustained through kindergarten (PCERC, 2008). Another program (Bright Beginnings) produced preschool gains in emergent literacy skills without sustained kindergarten effects, whereas two programs produced significant effects in kindergarten without evidence of significant impact in preschool—Curiosity Corner on letter-word identification, and Early Literacy and Learning Model on vocabulary and syntax skills (PCERC, 2008).

No doubt that some of the difference in long-term effectiveness of the DLM Early Childhood Express with Open Court Reading Pre-K was due to program characteristics; however, other factors also likely affected the attainment of preschool effects and their sustainability, and these factors deserve closer attention in future research. For example, research is increasingly illuminating the important role that implementation quality and intensity/frequency (dose) of intervention have on child outcomes in early childhood programs (Bierman et al., in press). It seems likely that variations in the success with which programs are delivered in the field may account for variations in impact at the end of preschool and sustained effects into kindergarten. As interventions become increasingly multifaceted, it becomes more challenging to assure that each component is implemented with sufficient fidelity and intensity to promote a sustainable impact on the targeted skills.

It also seems likely that expectations about effect size have been overly optimistic when intervention enhancements are tested in “real-world” settings and compared to “usual practice” preschool (as opposed to no treatment control conditions). Hence, many trials may not be powered sufficiently to detect intervention effects that exist in preschool or kindergarten. For example, in the PCERC trials, minimal detectable effects were in the moderate range (.34–.69), which may be insufficient to detect the smaller effects that curriculum enhancements are yielding. Measurement challenges and the qual-

ity and focus of teaching in the “usual practice” control group may also affect the likelihood of documenting sustained effects, particularly in the emergent literacy skill domain. For example, it is possible that deficits in basic emergent literacy skills such as print awareness are remediated for a majority of disadvantaged children as they move through “usual practice” kindergartens, leading to “ceiling effects” on those measures. Notably, West, Malone, Hulse, Aikens, and Tarullo (2010) found that Head Start children reach national norms (mean score of 107) on the Woodcock–Johnson Letter-Word Identification test by the spring of kindergarten, which is comparable to the REDI sample mean of 105. The overall picture that emerges from the REDI study and similar studies is that the “usual practice” in Head Start and kindergarten programs increasingly includes an explicit focus on enhancing children’s language and emergent literacy skills. This makes it important for intervention studies to assess the nature of programming and teaching quality in the “usual practice” prekindergarten contexts that represent the control condition during the preschool trials, as well as features of the kindergarten context that affect the progress of children as the transition into kindergarten.

In summary, in addition to focusing on preschool intervention content, future intervention studies should also attend to implementation quality and dose, to measurement and research design issues, and to factors associated with the “usual practice” comparison preschool programming and kindergarten context that may affect the rate of child skill acquisition.

Promoting social-emotional skills. Very little is known about the degree to which evidence-based preschool programs designed to support social-emotional skill development affect child outcomes in elementary school. Although a number of social-emotional enhancement programs have demonstrated a capacity to improve social-emotional behavior in preschool (see Bierman, Domitrovich, & Darling, 2009, for a review), follow-up assessments in elementary school are very rare. One exception is the Chicago School Readiness Program, which produced significant reductions in teacher-rated externalizing and internalizing behavior problems during the preschool year, and then followed children into kindergarten. Although “intent to treat” analyses did not reveal sustained intervention effects (Li-Grining & Haas, 2010), a separate analysis found sustained reductions in behavior problems among a subgroup of children who attended kindergarten in schools with high student achievement (Zhai, Raver, &

Jones, 2012). These findings are notably different from those of REDI, where sustained main effects were found in multiple behavioral domains (social problem solving, learning engagement, reduced aggression at home and school) and moderated effects (on social competence and reduced attention problems) were amplified among children who attended low-achieving schools. It is not clear how to reconcile these different findings, as they may reflect differences in the preschool intervention programs that were implemented, differences in the children who participated in each program, or differences in the absolute levels of school risk in the very different demographic regions in which the studies took place. From a theoretical standpoint, REDI might promote sustained gains in children's social-emotional skills because of the heavy curriculum emphasis on emotional understanding, self-control, and social problem solving that were not a part of the Chicago School Readiness Program, which focused more on teacher classroom management skills (Durlak, Weissberg, Dymnicki, Taylor, & Schellinger, 2011).

In the REDI program, it appears that the social-emotional skills that children gained during the preschool intervention were particularly helpful to children who experienced more adversity in the kindergarten school context, as intervention effects on social competence and attention problems were amplified among children who attended low-achieving schools. These skills might have been needed less by children in more protective elementary school contexts, but promoted resilience for children faced with greater challenges in the school context.

Developmental theorists have argued that it may be particularly important for early education to enhance the social-emotional development of at-risk children because self-regulation skills normatively develop during the preschool years and provide a core foundation for later school adjustment in elementary school (McClelland et al., 2006). The development of attentional control and adaptive learning engagement may be particularly important for later achievement (Duncan et al., 2007), and other non-cognitive skills (such as social competence and aggression control) may enhance school engagement, improve the likelihood of high school graduation, and contribute to later employment and work productivity (Levin, 2012). In their follow-up analyses of the Chicago Child-Parent Center program, Reynolds and Ou (2011) found that preschool intervention effects on social-emotional skills, such as student motivation and social adjustment, served

as partial mediators of longer term intervention effects on educational attainment and adult well-being (see also Barnett, Young, & Schweinhart, 1998; Gormley, Phillips, Newmark, Welti, & Adelstein, 2011). Additional follow-up study is needed to evaluate the longer term effects of the social-emotional gains students made in the REDI program.

Kindergarten Context and Fade Out of Preschool Intervention Effects

The current findings suggest that greater attention to the elementary school context may be critical for understanding the long-term effects of preschool interventions. Whitehurst et al. (1999) speculated that the quality of emergent literacy instruction provided to children after they transition into elementary school has a strong effect on the pace of their literacy skill acquisition, overshadowing the effects of gains promoted in preschool interventions. Learning to read is a cumulative process involving both mastery of new skills and improving existing abilities. Thus, the impact of early educational experiences may be conditioned heavily by the ongoing quality of school learning experiences in kindergarten and first grade (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Magnuson et al., 2007).

Historically, the prevailing concern has been that Head Start effects fade out because economically disadvantaged children attend lower quality schools than their advantaged peers. It is recognized that a time-limited preschool experience cannot offset the slower pace of academic skill acquisition that occurs after matriculating at lower quality schools, so that Head Start children "fall back" to the level of peers who did not receive early educational enrichment (Lee & Loeb, 1995; McKey et al., 1985). More recently, Magnuson et al. (2007) showed that the initial benefits of attending preschool persisted only for children who entered schools with low instructional quality because preschool nonattenders "caught up" with preschool attenders when they entered schools with smaller class sizes and better instruction. Determining whether preschool enrichment designed for low-income children has its greatest sustained effects for children who enter higher versus lower quality elementary schools is important because the policy and practice implications may be quite different.

In the REDI project, in almost all of the cases in which kindergarten context moderated the intervention effects, the sustained intervention effects were amplified in schools that served many low-

achieving students, whereas intervention effects were attenuated in schools with few low-achieving students. The mechanisms of action accounting for this moderation by school context remain unclear. The pattern of findings is consistent with the hypothesis that disadvantaged peers “catch up” with children who received preschool enrichment when they enter higher quality elementary schools. However, the pattern of findings is also consistent with resilience models, in which improved preschool social-emotional skills are most beneficial to children who face greater adversity in the school context. In schools with low-achieving students, children with greater social-emotional skills may cope more effectively with learning and social challenges, whereas children with lower social-emotional skills may be overwhelmed and more adversely affected by those challenges. Given that low levels of academic achievement among the students at a school may be a proxy for a number of different factors, such as the instructional resources available at particular schools or other school- or community-level risk factors, it remains unclear what factors underlie this effect.

In this study, higher quality classroom-level teacher–student interactions, reading instruction emphasis, and school-level student achievement were each associated with the children’s skill acquisition over the course of the kindergarten year. However, somewhat surprisingly, these three dimensions of kindergarten context were uncorrelated. In this study, CLASS teacher–student interaction quality and curricular emphasis on reading instruction were each uniquely associated with gains in children’s emergent literacy skills. These findings align with prior research that suggests that curriculum (e.g., exposure to systematic literacy instruction) and teaching quality may each foster the kind of accelerated learning needed by children who enter kindergarten with low levels of cognitive readiness (Connor et al., 2004; Crosnoe & Cooper, 2010). School-level student achievement levels were also associated with child literacy skill acquisition in this study, perhaps because teachers tend to pitch their instruction to the modal level of student functioning. Possibly, the level of challenge and complexity in teachers’ instructional discourse is lower in schools serving many low-achieving students, producing a slower pace of learning (Morrison & Connor, in press). Likewise, peer skill levels may affect student progress. For example, in preschool contexts (Mashburn, Justice, Downer, & Pianta, 2009) and early elementary classrooms (Foorman, York, Santi, & Francis, 2008) children

made greater gains in language and emergent literacy skills when they were in classrooms containing more peers with higher language and emergent literacy skill levels. These studies point to an advantage for children who are placed with high-achieving peers, as the level of instruction and peer modeling effects may both encourage accelerated learning.

Study Strengths and Limitations

Several strengths of the study warrant mentioning. The use of multiple informants enhances confidence in the validity of the findings. Most measures were completely unbiased, as kindergarten teachers did not know there was an intervention, and child interviewers did not know intervention group status. Children in the comparison group received the “usual practice” High/Scope or Creative Curriculum in Head Start; thus, this study was able to demonstrate the specific effects of the REDI program enrichment on child outcomes. Unlike observational studies that cannot fully account for selection biases in terms of which parents send which children to which preschools, this study relied on a randomized-controlled design to draw inferences about the effects of the preschool experience on children’s elementary school adjustment. Moreover, this study had considerable variability in the kindergarten contexts children experienced, making possible the exploration of moderation of sustained intervention findings by kindergarten context.

The study also had limitations that qualify the findings. Although intervention condition was randomly assigned, kindergarten context was not. As a result, findings regarding the impact of kindergarten context are based on correlations, and causal interpretations are unwarranted. In addition, the measures of kindergarten context were relatively unrefined. For example, assessments of teaching quality were limited to a single 2- to 3-hr observation period, teacher self-reports were used to assess literacy instruction, and school test scores from third graders were used to estimate student-level achievement in kindergarten. In addition, given the dispersion of children and resource limitations, measures of core outcomes were often based on relatively brief direct assessments and rating scales. Finally, without a control group of children who did not attend Head Start, this study design likely underestimates the overall impact of enriched Head Start on children’s kindergarten adjustment; the total impact of the prekindergarten experience would include the combined impact of Head Start

and REDI enrichments, and only the enrichments were evaluated here. Finally, because REDI was a multicomponent program, it is not possible to determine which components were critical to producing specific outcomes.

Summary and Future Directions

Recent years have witnessed a notable increase in rigorous, randomized evaluations of preschool programs targeting socioeconomically disadvantaged children. Follow-up assessments after the transition to school are critical to determine how well these early intervention effects translate into long-term gains. Evidence-based curriculum components and teaching strategies each offer promise in boosting the pace of early learning for at-risk students and thereby closing the achievement gap associated with poverty. However, strategic efforts to sustain early gains need to consider the quality of educational experiences across both preschool and early elementary school. Enriching school quality in the early elementary years, as well as in preschool, may help reduce disparities associated with socioeconomic disadvantage. Conversely, preschool enrichment may be particularly important when later schooling is likely to be poor or uneven in quality.

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