Running Head: CSRP’S IMPACT ON LOW-INCOME PRESCHOOLERS’ SCHOOL READINESS

CSRP's impact on low-income preschoolers' pre-academic skills: Self-regulation and teacher-student relationships as two mediating mechanisms

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Abstract

Based on theoretically-driven models, the Chicago School Readiness Project (CSRP) targeted low-income children's school readiness through mediating mechanisms of self-regulation and quality of teacher-student relationship. The CSRP is a multi-component, cluster-randomized efficacy trial implemented in 35 Head Start-funded classrooms (N= 602 children). Two sets of analyses confirm that CSRP improved low-income children's self-regulation skills (as indexed by executive function and attention/impulsivity) as well as quality of teacher-student relationship from fall to spring of the Head Start year. Evidence from these converging sets of analyses suggests significant benefits of CSRP for children's pre-academic skills, as measured by vocabulary, letter-naming, and math skills. Partial support was found for improvement in teacher-student relationship and improvement in children's self-regulation as hypothesized mediators for children's gains in some domains of academic readiness but not others. Implications for programs and policies that support young children's behavioral health and academic success in the context of economic disadvantage are discussed.

Over the past five years, rates of poverty in the United States have risen, with 18% of our nation's children currently living in families earning less than $22,000 a year (Douglas-Hall & Chau, 2008). Two decades of developmental and clinical research suggest that income poverty poses significant threats to young children's social, emotional, and behavioral development, as well as for their chances of school success (see Aber, Jones, & Cohen, 2000; Blair & Peters, 2003; Costello, Keeler, & Angold, 2001; Evans & English, 2002; Morales & Guerra, 2006; Raver, 2004). For example, while many low-income children maintain resilient profiles of school readiness with teachers and peers, others do not appear to fare as well. Past research suggests that young children who persistently exhibit dysregulated and disruptive behavior in the classroom have been found to receive less instruction from teachers, to be less engaged and less positive about their role as learners, and to have fewer opportunities for learning from peers (Arnold et al., 2006; Raver, Garner, & Smith-Donald, 2007). These and other correlational findings provided compelling rationale for the Chicago School Readiness Project (CSRP), an emotionally- and behaviorally-focused classroom-based intervention designed to support low-income preschoolers' school readiness.

The CSRP is a multi-component, cluster-randomized efficacy trial implemented in 35 Head Start-funded classrooms (N= 602 children). Based on theoretically-driven models of basic behavioral processes in the contexts of economic disadvantage, CSRP was designed to support a) low-income children's self-regulation, b) their ability to build emotionally positive relationships with teachers, and c) their opportunities to learn in early educational settings. The CSRP intervention built on existing community resources to support children's optimal development, providing preschool teachers with extensive training and support on improving the emotional climate of their classrooms and their management of children's dysregulated behavior.

Importantly, the intervention did not provide services or training on teachers' instructional styles, nor were curricula provided to support children's language, letter-naming, or math skills. In this way, CSRP intervention services offer a valuable "instrumental variables" approach to testing the causal role of children's social and behavioral competence for their academic achievement (see Gennetian, Magnuson, & Morris, 2008; Raver, 2002).

What might be the mechanisms through which an intervention targeting children's emotional and behavioral skills would have benefits for their pre-academic skills? And what were the results of such an intervention? The present study addresses these questions as well as highlighting the implications of our findings for programs and policies supporting the school readiness of young low-income children. In so doing, our study is part of an emerging area of research at the intersection of developmental psychology and prevention science, where findings from theoretically-driven intervention studies offer the opportunity to examine the modifiability of children's emotional and behavioral processes while also providing tests of the efficacy of new program or policy approaches.

Are Self-regulation and Teacher-student Relationships Modifiable and if so, do They Benefit Children's Pre-academic Skills?

Self-regulation

Converging lines of inquiry from social developmental and neurobehavioral literatures suggest that children enter schools with distinct profiles of emotional and behavioral self-regulation that appear to facilitate or hinder their engagement with other learners, teachers, and the process of learning (Blair, 2002; Bruce, Davis, & Gunnar, 2002; Fantuzzo et al., 2007; Raver et al., 2007). For the purposes of our study, we anchor our discussion of children's self-

regulation in two areas of functioning: children's effortful control and their executive functioning.

Investigators have identified individual differences and growth trajectories in children's ability to handle typical preschool challenges such as modulating frustration and distress, paying attention, and inhibiting their impulses, based on a research tradition focusing on reactivity and regulation (see Calkins & Fox, 2002; Chang & Burns, 2005; Graziano, Reavis, Keane, & Calkins, 2007; McClelland et al., 2007; Rothbart & Bates, 1998). More recently, children's ability to handle classroom challenges has been examined through a second neurobehavioral "lens" with research on children's executive functioning emphasizing the roles of children's working memory, attention deployment, and ability to inhibit prepotent impulses in order to meet external demands (Diamond & Taylor, 1996; Greenberg, Riggs, & Blair, 2007). Using these definitions, numerous investigators have made a compelling empirical case that children's profiles of the ways that they can regulate their attention, emotion, and behavior may potentially benefit their ability to encode and remember information (Quas, Bauer, & Boyce, 2004). In preschool classrooms, children's emotional and behavioral dysregulation may significantly limit the amount of information that children can process (Stieben et al., 2007). Importantly, children's dysregulated and disruptive behavior may also limit the quality and quantity of instruction that teachers can provide, as teachers struggle to maintain classroom order (see Raver et al., 2007 for review).

In support of these hypotheses, recent correlational research suggests that children with higher levels of self-regulatory skills show more proficient acquisition of math and language in early educational settings than do their more impulsive and inattentive peers (Blair & Razza, 2007; Howse, Calkins, Anastopoulos, Keane, & Shelton, 2003). In contrast, children's

difficulties with self-regulation and executive functioning would be expected to disrupt both their own and their peers' opportunities for learning as teachers' time and effort are deflected from instruction to managing acting out or disruptive behavior (Campbell, Shaw, & Gilliom, 2000; Webster-Stratton, Reid, & Stoolmiller, 2008).

On the basis of recent research suggesting that individual differences in children's self-regulation are shaped by early experience as well as temperamental predisposition, children's executive functioning and effortful control have offered prevention scientists a highly promising target for intervention (see Gunnar, 2003; Noble, Norman, & Farah, 2005; Pears & Fisher, 2005; and Riggs, Greenberg, Kusché, & Pentz, 2006 for reviews). Specifically, if intervention were able to boost children's ability to inhibit impulsive behavior and to focus and direct their attention, such an intervention might be able to not only lower their risk for behavioral problems, but might also support children in being better able to listen to, process, and follow teachers' directions, as well as being able to focus on, encode and recall more pre-academic material in small and large group instructional contexts (McClelland, Morrison & Holmes, 2000; Raver, 2002).

Preliminary evidence in support of those linkages suggests that young children's self-regulatory skills predict substantial proportion of variance in concurrent assessments of academic performance, and significant (though smaller) proportions of variance in their acquisition of math and vocabulary skills over time (McClelland et al., 2007). Recent longitudinal findings by Duncan et al. (2007) across 6 large data yield evidence that is more mixed, with less convincing evidence of "crossover effects" of children's regulatory skills for their academic achievement, over time. The discrepancies in these sets of findings may have been due to a range of factors including greater precision in statistical modeling but less valid measurements of children's self-

regulatory and executive functioning skill than have typically been used in lab-based studies (see Duncan et al., 2007, p. 1443). The following study addresses these discrepancies by employing an experimental paradigm that would allow for clearer grounds for causal inference while also utilizing direct assessments of low-income preschoolers' self-regulation (including their attention/impulsivity, their effortful control and their executive functioning) in addition to teacher reports.

Teacher-student Relationship

Children's relationships with teachers have been hypothesized as a second socioemotional "source of provisions" that either help or hurt children's chances of doing well, academically, in school (Ladd, Birch, & Buhs, 1999, p.1375; Pianta, 1999). The opportunity to build emotionally close relationships with nurturing adults in preschool environments has been hypothesized to be particularly important for low-income children who may experience greater instability in other areas of their lives (Owen, Klausli, Mata-Otero & Caughy, 2008; Rimm-Kaufman, LaParo, Downer, & Pianta, 2005; Ritchie & Howes, 2003; Silver, Measelle, Armstrong, & Essex, 2005). Drawing from a tradition of attachment theory, developmental researchers have highlighted ways that some children establish and maintain relationships with teachers that are characterized by a high degree of mutual positive engagement while other children engage in relationships with teachers that are characterized by a high level of conflict (see Justice, Cottone, Mashburn, & Rimm-Kaufmann, 2008, for review). Warm, emotionally positive relationships with teachers have been found to predict children's later academic engagement, liking of school, attendance, and higher academic achievement (Birch & Ladd, 1998; Entwistle & Alexander, 1999; Pianta & Stuhlman, 2004). In contrast, children who engage in high levels of conflict with teachers have been argued to develop more negative attributions

(or internal working models) about teachers as reliable and trustworthy sources of support, about themselves as learners, and about the process of learning (see Hamre & Pianta, 2005; Murray & Greenberg, 2000).

Given this correlational evidence, facilitating positive relationships between teachers and low-income children represents a second important avenue through which intervention might support both socioemotional and pre-academic domains of young children's school readiness. When they feel emotionally closer to their students, teachers may invest more time in providing explicit instruction, they may use classroom time more productively to cover more cognitively engaging material, and they may provide more contingent feedback to their students regarding students' performance (Hamre & Pianta, 2005; Raver et al., 2007; Torgesen, 2002). Longitudinal analyses suggest that teachers' perceptions of emotionally close versus conflictual relationships with students predicts small but significant proportions of variance in children's academic competence over time, even after children's earlier academic competencies have been accounted for (Pianta & Stuhlman, 2004). Higher levels of closeness between teachers and students in early elementary school have also been argued to play a stronger, protective role for children who are at higher academic risk (Burchinal, Peisner-Feinberg, Pianta, & Howes, 2002; Hamre & Pianta, 2005).

Intervention as a Solution to the Problems of Causal Inference

One challenge in examining the hypothesis that children's socioemotional skills have benefits for their academic skills has been the intertwined and bidirectional nature of children's regulatory profiles, their relationships with teachers, and their opportunities for learning. For example, children who are temperamentally prone to be emotionally and behaviorally well-regulated have been found to elicit more positive responses from teachers than do children who

express more anger and distress in the classroom (see for example, Justice et al., 2008). Similarly, children's placement in classrooms with more emotionally supportive teachers and their negotiation of academic as well as social challenges are likely to be at least partially influenced by time-invariant individual and contextual variables that are often "omitted" from models (see O'Connor & McCartney, 2007 for exception and methodological solutions using longitudinal data). In light of these concerns, claims of the role of socioemotional competence for children's later academic achievement have recently received greater scrutiny (Duncan et al., 2007).

It is within this framework that cluster-randomized efficacy trials of interventions targeting children's socioemotional skills could have a major impact to developmental science. First, interventions offer a means of directly testing whether children's self-regulatory skills and social relationships with teachers are environmentally modifiable, over short periods of time. Second, we can test whether programmatic investments in children's socioemotional skills yield additional cognitively-oriented "payoffs" by supporting young children's academic skills (see Greenberg et al., 2007; Kellam, Ling, Merisca, Brown, & Ialongo, 1998; and Ialongo et al. 1999 for further discussion). New evidence from several recently implemented preschool interventions is promising. For example, low-income preschool-aged children receiving the comprehensive preschool REDI intervention designed to improve their socioemotional and pre-academic skills were found to demonstrate stronger levels of self-regulation on a direct assessment of attention and impulsivity at post-test, compared to low-income preschoolers in the control group. These findings are in keeping with recent work by several other research teams, suggesting significant impact of classroom-based intervention on improving children's executive function (Diamond, Barnett, Thomas, & Munro, 2007; Riggs et al., 2006). In short, these findings suggest substantial

evidence for the modifiability of children's self-regulatory skills across the preschool year. This present study extends that line of inquiry to examine whether children in preschools randomly assigned to intervention also show improvements in their relationships with teachers relative to children in the control group. We also ask whether those children exposed to comprehensive emotionally- and behaviorally targeted intervention go on to show improvements in their pre-academic readiness skills, as well.

Given the threat of omitted variables bias, we tackle the challenges of causal inference in two ways. In order to be empirically conservative in our claims, we first test our hypotheses by examining intent-to-treat (ITT) impact estimates of the CSRP intervention to detect a) whether our socioemotionally and behaviorally-oriented intervention had significant impacts on children's self-regulation, their relationships with their teachers, and their pre-academic skills. We then use structural equation models to peer inside the 'black box" of the possible mechanisms that might explain CSRP's treatment impacts, asking questions that are principally more predictive than causal in nature, to learn whether b) experimentally-induced improvements in children's self-regulation and/or improved teacher-student relationships as mediators of improvements in children's pre-academic skills.

Brief Overview of the CSRP Intervention

Based on the theoretically-grounded models outlined earlier, the CSRP was designed to support low-income children's development of optimal self-regulation and to foster the development of emotionally close, positive relationships with teachers. Our concern was that, within the context of relatively few clinical resources and limited staffing support, early childhood classrooms may become chaotic and difficult to manage as children with more emotional and behavioral difficulty engage in escalating, emotionally dysregulating "coercive

processes" with teachers (Arnold, McWilliams, & Arnold, 1998; Conduct Problems Prevention Research Group, 1999; Kellam et al., 1998). Few teachers report receiving pre-service training in handling children's disruptive behaviors, and one concern is that chronic engagement in escalating cycles of conflict might exacerbate children's acting-out, disruptive behavior, as well as leading to teachers' rising feelings of exasperation, disengagement and burnout (Brouwers & Tomic,1998).

Based on this theoretical framework, CSRP provided teachers with intensive training in strategies that they could employ to provide their classrooms with more effective regulatory support and better classroom management (Raver et al., 2008; Webster-Stratton, Reid, & Hammond, 2001; Webster-Stratton et al., 2008). Additional components of ongoing classroom-based and child-focused consultation were provided by a mental health consultant (MHC) who supported teachers while they try new techniques learned in the teacher training (Donohue, Falk, & Provet, 2000; Gorman-Smith, Beidel, Brown, Lochman, & Haaga, 2003). As an additional program component, MHCs also spent a significant portion of the school year conducting stress reduction workshops to help teachers to reduce stress and limit burnout. One critique might be that MHCs bring both "an extra pair of hands" to the classroom in addition to their clinical expertise. To control for improvements in adult-child ratio introduced by the presence of MHCs in treatment classrooms, control group classrooms were assigned a lower-cost Teacher's Aide (TA) for the same amount of time per week.

The principal aim of the CSRP intervention was to marshal these primary programmatic components to improve low-income preschool-aged children's school readiness by increasing their emotional and behavioral adjustment. Our long-term research objectives are to examine whether this emotionally- and behaviorally-focused intervention in preschool has a significant

long-term impact on children's academic achievement in 1st grade (as measured by standardized tests, school records, and teacher reports). Our immediate research aim addressed in this paper, is to test whether this multi-component intervention yields short-term benefits by supporting their self-regulation, their relationships with their teachers, and thereby, their pre-academic skills.

Opportunities, Challenges, and Tradeoffs in Modeling the Impact of Classroom-based Intervention

Following recent statistical innovations in educational psychology and prevention science, we employed a clustered, randomized design, with Head Start sites as the unit of randomization and children as the units of analyses. To adequately take the role of social and institutional contexts of children's early educational programs into account, we examine the impact of our multicomponent classroom-based intervention on low-income preschoolers' school readiness outcomes using hierarchical linear modeling (HLM). HLM models with multiple levels (and a range of alternative specifications) increasingly represent the "industry standard" for testing school-based efficacy trials of intervention impact, as the data are nested and standard errors corrected (Raudenbush & Bryk, 2002).

This allows us to estimate the ITT impact on children's school readiness, and is exceptionally rigorous standard. As such, evidence of impact of socioemotinoal intervention on children's self-regulation and on their relationships with teachers would represent compelling evidence of the modifiability of those domains of children's school readiness. In addition, evidence of the socioemotional intervention on children's pre-academic outcomes represents persuasive case for the hypothesis that making investments in teachers' ability to work with children to help them to better able to modulate and limit their disruptive behavior while also building more positive relationship with them have benefits for children' development of

academic skills such as letter naming, math, and vocabulary. However, while HLM offers these strengths, it does not allow for clear opportunities to look inside "the black box" of potential mechanisms that might underlie treatment impacts[1]. In short, while we can test for direct effects of the intervention on proposed mediators (such as children's self-regulation and quality of teacher-student relationship) and on proposed outcomes (such as children's pre-academic skills), we are constrained in our ability to parsimoniously estimate the magnitude of joint associations between both mediators and multiple outcomes, using HLM analytic approach.

As an alternative, structural equation modeling (SEM) allows for estimation of covariances between treatment and proposed mediators, and then, in turn between proposed mediators and outcomes, with all paths included. In most SEM models (and in those that follow) child-level data are not generally nested within classroom or schools but are instead analyzed at a single level, where children's embeddedness in classroom and site contexts is, in effect, "traded" for the opportunity to examine multiple paths between intervention, proposed mediators, and multiple dependent variables such as multiple pre-academic skills, simultaneously. In our view, differences in choice of analytic approach are also stylistic as much as they may be substantive: SEM is more often used by developmentalists interested in analysis of complex multivariate models and observational data focused on empirical aims of prediction. In light of these tradeoffs, we use HLM to first estimate the presence and magnitude of treatment impacts on proposed mediators including children's self-regulation and relationships with teachers and proposed outcomes, including children's pre-academic skills. We then employ SEM models as "post-hoc" modeling approach to examine the robustness of those associations, to consider whether these might serve as plausible mechanisms operating "inside the black box" of the CSRP intervention's impact on preschoolers' school readiness.

Hypotheses

Our first set of hypotheses is that intervention designed to support well-structured, emotionally positive, and less disruptive classroom climates would have a clear, measurable impact on children's socioemotional and pre-academic readiness. Children in experimental classrooms were expected to develop more effective emotional and behavioral self-regulation and closer relationships to their teachers than their control group-enrolled counterparts, net of their initial behavioral and relationship-based profiles at the start of the Head Start preschool year. These treatment impacts were expected to be detected net of the characteristics of children, teachers and classrooms, and sites. Children in Head Start sites that were randomly assigned to treatment were also expected to gain greater competence in domains of language, literacy, and learning over time, with the hypothesis that children in treatment-enrolled classrooms would have had greater opportunities for learning in classrooms that were supported to become emotionally and behaviorally more positive than children in control-group assigned classrooms.

Our second set of hypotheses were that children's pre-academic outcomes in spring of their Head Start year would be statistically predicted by children's self-regulatory and relationship-based skills during the school year. That is, we hypothesized that paths from treatment to children's letter-naming, early math, and vocabulary gains would be predicted by gains in children's ability to marshal their attention and control their behavior, as indexed by improvements in their directly assessed executive functioning and effortful control scores in the spring of the school year. Similarly, our hypothesis was that participation in CSRP treatment would predict higher levels of children's closeness and lower levels of conflict with their teachers, as reported by the teachers, themselves, as compared to children enrolled in the control group. In addition, we predicted that children experiencing closer relationships with teachers

would, in turn, demonstrate greater pre-academic skills in the spring of their Head Start year than would children with less emotionally positive and more conflictual relationships with teachers. In sum, tests of these hypotheses offer a means of putting theoretical models of program effects to work in "real world" settings of Head Start centers serving low-income, ethnic minority preschoolers.

Methods

Sample

Following recent school-based intervention models, this study used a cluster-randomized design. As such, random assignment occurred at the site-level, with matched pairs of Head Start-funded programs assigned to treatment and control conditions.

School and Subject Selection

In an effort to balance generalizability and feasibility, preschool sites were selected on the basis of (a) receipt of Head Start funding, (b) having two or more classrooms that offered "full day" programming, and (c) location in one of seven high-poverty neighborhoods that were selected on the basis of a set of criteria including high poverty, exposure to high crime, and lower rates of mobility (see Raver et al., 2008 for a detailed discussion of exclusionary criteria). CSRP staff completed block-by-block surveys of all seven neighborhoods, identifying all child-serving agencies that might potentially provide Head Start-funded preschool services. All identified sites were telephoned to determine if they met the additional site selection criteria (including receipt of Head Start funding, etc.). CSRP staff members then contacted and met with eligible sites to offer them the opportunity to self-nominate for participation in the research project. Eighteen sites completed the self-nomination process and were included as CSRP sites. Two classrooms within each site were randomly selected for participation, with a research

coordinator and research staff successfully able to recruit 83% of the children enrolled in classrooms between Labor Day and the assigned enrollment cut-off date in mid-October of the school year. Teacher reports of the quality of their relationship with each of their CSRP-enrolled students were collected for the full sample in spring of the school year. In addition, direct assessments of children's self-regulation and pre-academic skills were collected for a large proportion of the full sample (N = 467).

Randomization

Each site was matched with another "sister" site that most closely resembled it on a range of demographic characteristics of families and site characteristics indicating program capacity and quality (see below). Methods employing sum of squared distances and sum of absolute distances were used to estimate best matches for pairs of sites across 14 site-level demographic characteristics including the availability of a fulltime family worker at the Head Start site, the size of the program (as indexed by the number of children served, ages 3-5), the proportion of the site identified as African American, the proportion of the teachers with Bachelors' degrees and the proportion of teacher assistants with some college education, the proportion of the families served that were single parent families, employed, and reliant on TANF. One member of each pair was randomly assigned to treatment and the other member of the pair was assigned to control group. Within each of the 9 treatment sites, 2 classrooms participated, for a total of 18 treatment classrooms. Across the 9 control sites, there were 17 classrooms (2 classrooms in 8 sites, and 1 classroom in the remaining site which lost one Head-Start funded preschool classroom due to funding cuts). Treatment classrooms received the multiple components of the intervention package across the school year, and control classrooms were paired with teaching assistants as described above. Additional information on the number of hours teachers spent in

training, classrooms received mental health consultation, and teacher assistants spent in control classrooms are reported in a recent paper describing statistically significant classroom-level treatment impacts (Raver et al., 2008; Li-Grining et al., revised and resubmitted).

The CSRP intervention was implemented for two cohorts of children and teachers, with Cohort 1 participating from fall to spring in 2004-05 and Cohort 2 participating from fall to spring in 2005-06. As with other recent efficacy trials implemented with multiple cohorts across time, regions, or racially segregated neighborhoods, the sites enrolled in Cohorts 1 and 2 differed on several program-level and demographic characteristics, and therefore those characteristics were included in all analyses (see, for example, Gross et al., 2003).

Because we planned to model child outcomes as potentially responsive to both the intervention and to teacher- and classroom-level characteristics, teachers were also included as research subjects. As with classrooms, teachers were enrolled in two cohorts which were also pooled into a single dataset (n = 90). A total of 87 teachers participated in CSRP at baseline. The number of teachers increased to 90 by the spring of the Head Start year. This net increase reflected the entry of 7 more teachers and the exit of 4 teachers who either moved or quit during the school year.

At baseline, a total of 543 children participated in CSRP. By the spring, the number of participating children was reduced to 509. Nearly all of the exits were due to children voluntarily leaving the Head Start program, though one child was requested to leave the Head Start program and one parent opted to withdraw her child from participating in CSRP. Of these participants, 273 (54%) were female. Children ranged in age from 26 months to 73 months (age M = 49.4, SD = 8.0). The majority of participants were Black (67%) and Hispanic/Latino (25%) while the remaining participants were White (3%) or of other ethnic categories (5%). Families were

predominantly low income with a mean yearly income of $13,440. Most families (63%) had only one parent living in the home.

The sample for analyses of teacher-report data in this study included 467 children, who had complete data on child and family background characteristics in the fall as well as valid data on measures of pre-academic skills, self-regulation, and teacher-student relationship in the fall and spring. Representativeness analyses revealed no significant differences between children who were in the analytic sample and those children who were excluded due to missing data. Similarly, no significant differences were detected between teachers who were in the analytic sample and those teachers who were omitted due to children's missing data.

General Procedures

In the fall, families with children ages 3-4 were recruited from each of the 35 classrooms to participate in the study, with approximately 17 children in each classroom enrolling in CSRP. Consent forms for each child were signed by his or her parent or guardian, who also completed an interview, which included questions regarding child and family demographic characteristics, such as child's gender and race/ethnicity, as well as parent's preferred home language, marital status, education level, and employment status. We collected data on children's behaviors, their demographic characteristics, and classroom and site characteristics from five sources: parents, teachers, classroom observers, children themselves, and site directors; this parallels recent literature that incorporates multiple reporters to increase the validity and robustness of data (see Cummings, Schermerhorn, Davies, Goeke-Morery, & Cummings, 2006; Graziano, Keane, & Calkins, 2007; Hill et al., 2004). Procedures for data collection from each of these sets of informants are described briefly, below.

Children's self-regulatory skills and pre-academic skills were collected individually from each child who was enrolled in the study by a multiracial group of master's level assessors who had been extensively trained and certified in direct assessment procedures (see Goyette et al., 2006; Li-Grining, Smith-Donald, & Raver, in preparation; and Smith-Donald, Raver, Hayes, & Richardson, 2007 for details of training and certification of assessors). For children's self-regulation, data on CSRP-enrolled children's performance on 8 self-regulation tasks were collected using the Preschool Self-Regulation Assessment (Smith-Donald et al., 2007). In addition to the PSRA, we also collected a cognitively-oriented and federally-mandated assessment of Head Start-enrolled preschoolers' vocabulary, letter naming, and math skills (Zill et al., 2003) as well as assessors global ratings on the PSRA Assessor Report (Smith-Donald et al., 2007). Assessments were conducted with child participants in quiet areas of their Head Start programs during the school day. Data were returned to, and audited by the Assessments Coordinator and the research assistant responsible for data intake. Twenty percent of all assessments were videotaped and were double-coded by a trained assessor to establish inter-rater reliability.

In the spring of the Head Start year teachers were given the Student Teacher Relationship Scale (STRS; Pianta, 2001) as well as a brief survey of teacher demographic information and past teaching experience. CSRP research staff (blind to the treatment status of the classroom) dropped off questionnaire packets to teachers with prepaid postage envelopes for easy return, making follow-up phone calls and visits to collect teacher reports within a 6-week window. Teachers were subsequently reimbursed a nominal subject payment (of $20 per packet) for completing questionnaires during each round of assessment.

To account for classroom-level differences in resources and support for children's social-emotional development, both trained observers and teachers provided classroom-level data in the fall. Trained observers, who were blind to randomization, assessed the quality of children's classrooms using the Classroom Assessment Scoring System (CLASS; La Paro, Pianta, & Stuhlman, 2004) and the Early Childhood Environment Rating Scale, revised edition (ECERS-R, Harms, Clifford, & Cryer, 2003). The team consisted of 12 individuals who each had at least a bachelor's degree. Of the 12 members, 6 were African American and 6 were Caucasian or Asian, thus approximately half the time, the observers' race matched the race of most children. Using the ECERS and CLASS, observers rated overall classroom quality as well as dimensions of emotional climate, including teacher sensitivity, behavior management, and negative climate. While conducting observations, staff noted the number of children and adults in the classroom. In the fall, administrators at each Head Start site also provided CSRP with access to site-level characteristics.

Measures

Mediators

Self-Regulation. The Preschool Self-Regulation Assessment (PSRA; Smith-Donald et al., 2007) was used to capture children's strengths and difficulties in behavioral self-regulation. The PSRA includes two components, where an assessor first administers tasks to a child and then completes the PSRA Assessor Report. The PSRA tasks were selected because they were brief, required few materials, yet yielded useful data for 3- to 5-year-old children using lab-based protocols. Assessors live-coded latencies or performance levels for each task. Importantly, the PSRA has demonstrated measurement equivalence across African American and Latino children, and across boys and girls (Raver et al., 2008). For this paper, four delay tasks were included, and

were adapted from the lab-based work of Kochanska and colleagues to tap children's effortful control: Toy Wrap, Toy Wait, Snack Delay, and Tongue Task (see Murray & Kochanska, 2002). Two additional tasks were included as tasks of executive functioning, including Balance Beam (Maccoby, Dowley, Hagen, & Degerman, 1965; Murray & Kochanska, 2002) and Pencil Tap, which was adapted from the peg-tapping task (Blair, 2002; Diamond & Taylor, 1996). Assessors were trained extensively by the first author and her team members to pass three levels of certification (see Raver, Smith Carter, Smith-Donald, & Goyette, submitted, for additional details regarding certification procedures). Children's performance on the 4 effortful control tasks and on the 2 executive functioning tasks were standardized and then averaged into two composites. In addition, inter-rater reliability was calculated from double-coded videotaped assessments for 20% of the sample. The consistency of the assessor and coder responses on those forms was evaluated for all continuous variables, and Cronbach's alphas ranged from .73 - .99 across all PSRA tasks with an average alpha of .93.

After the tasks were administered, the PSRA Assessor Report was completed (Smith-Donald et al., 2007). Providing a global picture of children's emotions, attention, and behavior throughout the assessor-child interaction, the Assessor Report was adapted from the Leiter-R social-emotional rating scale (examiner version; Roid & Miller, 1997) and the Disruptive Behavior-Diagnostic Observation Schedule coding system (DB-DOS; Wakschlag et al., 2005). The Assessor Report included 28 items, where 15 items were selected from Leiter-R subscales that focused on attention (e.g., "pays attention during instructions and demonstrations"), impulse control (e.g. "thinks and plans before beginning each task"), and activity level (e.g. "remains in seat"). In addition, 9 items included from the DB-DOS coding system capture defiance and noncompliance, the frequency and intensity of negative and positive affect, and the presence or

absence of verbal or physical aggression. When preliminary analysis were run with data collected in the spring of the Head Start year the last four items concerning children's intense feelings of anger, irritability, apprehension or sadness did not load on either scale, therefore were dropped from the final structure. All items included descriptors with clear, behavioral anchors, as used in the DB-DOS coding system. Items were coded using a Likert scale ranging from 0 to 3, with some items reversed-coded to minimize automatic responding.

Factor analyses based on pilot data yielded robust evidence for two factors: Attention/Impulse Control (with 16 items loading > .4) and Positive Emotion (with 7 items loading > .4) (Smith-Donald et al., 2007). These results were largely replicated using data collected as part of the CSRP intervention. Again, two factors representing Attention/Impulse Control and Positive Emotion emerged. The final aggregates for the Attention/Impulse Control subscale are used here, with the subscale demonstrating good internal consistency (α= .92).

Teacher-student Relationships. To assess the impact of the CSRP intervention on children's relationships with their teachers, The Student-Teacher Relationship Scale (STRS; Pianta, 2001) was included in March of the Head Start year. The STRS was developed to measure a teacher's perception of his or her relationship with a particular student. Specifically, the STRS measures teacher-student relationship patterns in terms of conflict, closeness, and dependency, as well as the overall quality of the relationship. The STRS is a 28-item self-report instrument that uses a 5-point Likert-type rating scale to assess a teacher's perceptions of his or her relationship with a student, a student's interactive behavior with the teacher, and a teacher's beliefs about the student's feelings toward the teacher. For brevity, the CSRP retained 15 of the original 28 items; however, these items were not altered. This measure has a high internal consistency (α= .89 to .95) as well as good convergent validity with other questionnaire

measures of anger and anxiety.

Pre-Academic Skills

Before children participated in the cognitively-oriented portion of the assessment, assessors first determined children's comprehension of spoken English by playing a quick game of "Simon Says" (α=.92) (PreLAS Simon Says; Duncan & DeAvila, 1998). Here, the assessor plays the role of "Simon" and directs the children to act out certain movements only when the assessor prompts the child with "Simon says." This game consisted of 10 simple actions in which the assessor could easily gauge how well the child understood spoken English. Children were screened in both September and May of their Head Start year. If children speaking Spanish and English passed this English screener, they were assessed twice, first in Spanish and second in English. We then compared each child's scores based on the Spanish and English assessments and used the child's highest score in analyses. Children who spoke English only were assessed one time in English.

A shortened version of The Peabody Picture Vocabulary Test (α=.78) is a 24-item measure that is administered to the child by the assessor following Simon Says (PPVT-III; Dunn & Dunn, 1997; Zill, 2003b). A parallel Spanish-language version of the PPVT, entitled the Test de Vocabulario en Imagenes Peabody (TVIP; Dunn, Lugo, Padilla, & Dunn, 1986) was administered for Spanish-proficient and bilingual children (see above). During this portion of the assessment children are asked to identify (point to) the one picture out of a group of four that corresponded to the word spoken by the assessor. Children's picture/word vocabulary was assessed during September and May of their Head Start Year.

The letter naming portion (α =.92) of the cognitive development assessment consists of the 26 letters of the English alphabet divided into three groups of 8, 9 and 9 letters (30 letters for

the Spanish assessment). The letters are arranged in approximate order of item difficulty in both their capital or lower case forms. Because the English language has 26 items and the Spanish language assessment has 30 items, the scores were calculated in terms of total percent correct out of 26 or 30, respectively (α=.92). Children were assessed for their knowledge of the alphabet during September and May of their Head Start Year.

The Early Math Skills (α =.82) portion of the cognitive development assessment consists of 19 items. This simple assessment of children's early math skills covers basic addition and subtraction. Children were tested on their early math abilities in September and May of their Head Start Year (Early Math Skills; Zill, 2003a).

Child, Family, and Classroom Characteristics

Child-level demographic characteristics were included in the following analyses. These included (a) child gender, (b) child membership in the race/ethnic category of African American versus Hispanic, (c) parent's self-identification as Spanish-speaking in the home, (d) large family size (with $\geq$ 4 children), (e) single-headed household, and (f) family's cumulative exposure to 3 poverty-related risks (including mothers' educational attainment of less than high school degree, family income-to-needs ratio for the previous year being less than half the federal poverty threshold, and mothers' engagement in 10 hours or fewer of employment per week) (Raver, 2004). Children's scores at baseline collected in fall of the Head Start year were also included as control variables for the corresponding outcome measures in the spring (i.e., Executive Functioning, Effortful Control, Attention/Impulsivity, PPVT, Letter Naming, and Early Math Skills). As the data for STRS Conflict and Closeness scales were not collected at the baseline, children's overall behavioral risk (i.e., a half standard deviation above average BPI scores rated by teachers) in the fall was used as a baseline control for the STRS scales.

A set of teacher characteristics were included as proxy assessments of classroom quality, and were assessed through teacher report. These included teachers' reports regarding their level of education (teacher's attainment of BA as well as TA's attainment of BA), as well as their report on several psychosocial characteristics that might affect teachers' perceptions of children's behavioral difficulty (see Anthony, Anthony, Morrel, & Acosta, 2005), and age. To assess their psychosocial characteristics, teachers' depressive symptoms were briefly assessed at baseline using the 6-item *K6,* a scale of psychological distress developed for the U.S. National Health Interview Survey (Kessler et al., 2002). With a metric of 0 to 4, the K6 items were summed ($\alpha = .65$). In addition, teachers reported job overload on the 6-item "job demands" and 5-item "job control" subscales of the Child Care and Early Education Job Inventory,which had a rating scale of 1 to 5 (Curbow, Spratt, Ungaretti, McDonnell, & Breckler, 2000). Subscales demonstrated adequate internal consistency ($\alpha = .67$ and $\alpha = .56$, respectively) and were based on sum of each set of items. To calculate classroom-level covariates, scores on each variable were averaged across all teachers in each classroom (Gerard & Buehler, 2004).

To control for additional variation in classroom quality, observational measures were collected in fall using the CLASS (La Paro et al., 2004) and the ECERS-R (Harms et al., 2003). CLASS indicators included 7-point Likert scores on negative climate, teacher sensitivity, and behavior management (see Raver et al., 2008). As a 43-item scale, ECERS-R has been widely used to measure early childhood classroom quality (Harms et al., 2003). Three-quarters of the observations were double coded "live" by two observers and intraclass correlation values (α) indicated adequate to high levels of inter-observer agreement (α values ranging from .66 to .87 for all classroom observational measures.

In order to test the role of "settings-level" program characteristics, a limited number of site-level covariates were entered into models, including the availability of a full-time family worker at the Head Start site, the size of the program (i.e., the number of children served, ages 3–5), the proportion of the teachers with BA degrees and the proportion of TAs with some college, and the proportion of the families served who were employed and reliant on TANF.

Overview of analytic plan using HLM

In this study, we first employed Hierarchical Linear Modeling techniques to estimate ITT estimates of CSRP intervention on preschoolers' school readiness. We considered children's effortful control, executive function, and attention/impulsivity, assessed in the spring of the intervention year as dependent measures of CSRP program influence. We then repeated our analyses with children's STRS scores and their pre-academic skills (including PPVT, Letter Naming, and Early Math Skills) as dependent variables.

In our HLM analyses, we employed a multi-level modeling strategy, which allows for the simultaneous estimation of variance associated with individual (within-subjects) and population (between-subjects) change based on the specification of fixed- and random-effect variables in the model (Raudenbush & Bryk, 2002). In the present study, the assessment of children in fall and spring of the Head Start year allowed for estimates of residualized change in school readiness outcomes as an indicator of treatment impact. With these data it is possible to assess the direct impact of CSRP intervention net of person-level (e.g., demographic and ecological characteristics of children and families), classroom/teacher-level, and site-level characteristics.

Specifically, the overall impact of intervention was modeled using three-level equations, with the equation at Level 1 (child level) specified in the following way:

$$Y_{ijk} = \pi_{0jk} + \sum_{m} \pi_{mjk} X_{mijk} + \varepsilon_{ijk}$$

where Y_{ijk} is the school readiness score of child *i* in classroom *j* within CSRP site *k*; $\sum_m \pi_{mjk} X_{mijk}$ represents the sum of *m* child-level covariates, including child's gender, race/ethnicity, baseline scores, family poverty-related risks, single-parent family, four or more children in household, family Spanish speaking at home. ε_{ijk} is a random error term.

Correspondingly, Level 2 (classroom level) was specified in the following way:

$$\pi_{mjk} = \beta_{m0k} + \sum_n \beta_{mnk} C_{mnjk} + r_{mjk}$$

where $\sum_n \beta_{mnk} C_{mnjk}$ is the sum of n teacher and classroom characteristics, including teacher's BA degree, age, K6 score, job demand, and job control; baseline classroom quality scores (as indexed by CLASS and ECERS scores), class size, and number of adults in class

A third equation specifying Level 3 (site level) is then written as:

$$\beta_{m0k} = \gamma_{m00} + \gamma_{001} T_k + \sum_p \gamma_{m0pk} S + u_{m0k}$$

where T_k is treatment/control assignment while $\sum_p \gamma_{m0pk} S$ represents the sum of *p* site-level characteristics, including whether site had additional family support worker on staff, program size, and the proportions of teachers with BA, teacher assistants with some college, families with at least one parent employed, and families receiving TANF. β_{00k}, the adjusted mean level of child school readiness in site *k*, varies as a function of whether or not the site was assigned to the treatment or control group; γ_{000} is the adjusted mean level of school readiness scores across all control group sites; and γ_{001} is the treatment effect. Though not shown here, γ_{100} - γ_{800} represent the pooled within-site regression coefficients for the Level-1 covariates. The magnitude of treatment impact can then be examined, where γ_{001} represents the average difference between

the treatment and control sites, controlling for all other covariates. Effect sizes are calculated by dividing that difference by the standard deviation of the measure in the full sample.

Overview of analytic plan using SEM

Structural equation modeling was then used to take a post-hoc, empirical look inside the "black box" of CSRP's impact on low-income children's school readiness. For those variables that held greatest theoretical significance (and for which there was evidence of significant treatment impact), structural equation modeling was completed using latent growth modeling with LISREL, Version 8.7 (Bollen, 1990) to test whether the hypothesized relationships presented in Figure 1 fit the data. In the center of the figure we display a set of measurement models that link observed teacher-student relationship quality and self-regulation skills to the hypothesized latent constructs representing these relationships ("STRS") and skills ("Self-regulation") in spring of children's Head Start year. Note that the factor loadings for closeness and executive function are fixed to constant values of 1 to provide the metric for interpretation. On the left side of the figure, we display a single variable representing treatment status. The hypothesized effects of this variable on the constructs representing children's relationship quality and self-regulation skills are depicted by arrows, and each pathway is labeled by a corresponding structural regression parameter (γ_{11}, γ_{21}). Finally, on the right side of the path model, we display a construct representing children's pre-academic skills in spring of their Head Start year. In our analyses, these constructs were indexed by a single variable representing vocabulary, letter-naming, or mathematics skills. Again, the impact of treatment on achievement is depicted by an arrow labeled with a structural regression parameter (γ_{13}). We include additional paths that permit the child's relationship quality and self-regulation skills (β_{11} and β_{12}) to predict their achievement sores.

In order to parallel our HLM models as closely as possible, we controlled for an extensive set of child and family, classroom and site level covariates for each of the three outcomes (i.e., direct assessments of children's vocabulary, letter-naming, and mathematics skills). As with our HLM models, we estimated the impact of CSRP very conservatively, by including lagged autoregressive terms for children's initial fall pre-test pre-academic skills scores. Because SEM model-fitting with large numbers of parameters can be prone to failures to attain statistically viable solutions, we took a number of additional steps to achieve models that fit, including a) a standard missing data imputation procedure – *Imputation by Chained Equations* (ICE) – for LISREL version 8.7 (http://www.ats.ucla.edu/stat/stata/library/ice.htm). In addition, b) sequential model-estimation (beginning by controlling for child and family characteristics only, then by adding classroom-level characteristics, and finally by adding site-level characteristics), and c) inclusion of indirect effects of treatment status on children's achievement through relationship quality and self-regulation skills. We inspected the impact of the inclusion of these additional pathways on both the magnitude and direction of effects for pathways already present in the model using general linear hypothesis (GLH) testing.

Results

In this section, we first provide descriptive statistics for the CSRP-enrolled sample on all demographic, mediating, and outcome variables across treatment and control group-enrolled children. We then present the results for each quantitative approach (using HLM and SEM, respectively).

Descriptive Statistics

Table 1 presents descriptive statistics for all predictors of children's school readiness at the site, classroom, and child levels. As can be seen from the descriptive statistics in Table 1,

many measures of child and family background covariates at baseline were slightly different between the treatment and control group. For example, compared to the control group, children in the treatment group were more likely to be boys, have behavioral risks and more family poverty-related risks, and live in sing-parent families; while they were less likely to come from families with four or children in the household or Spanish being spoken at home. The t-statistics were adopted to test the mean differences on these covariates between the treatment and control groups and did not reveal these differences to be statistically significant (Raver et al., 2008). Similarly, fall pre-test scores on self-regulatory, teacher-student relationship, and pre-academic domains of school readiness were slightly higher for CSRP-enrolled children in the treatment group as compared to the control group. But again, these differences, as well as the differences on classroom- and site-level covariates between the treatment and control groups, were not found to be statistically significant. Nevertheless, the heterogeneity among sites and classrooms across the treatment and control groups at baseline, as shown in Table 1, reinforces the importance of including classroom- and site-based covariates when analyzing the treatment impact of small-scale trials.

Results Using HLM

Table 2 presents the results from our HLM analyses regarding the treatment effects of CSRP intervention on children's school readiness, including self-regulation, teacher-student relationship, and pre-academic skills. The coefficients and standard errors of the treatment variable (1 = treated and 0 = controlled) are shown in the second and third columns, while the corresponding effect sizes, calculated by dividing the coefficients by the standard deviation of the respective measures in the full sample, are presented in the last column.

As shown in Table 2, consistent with our hypotheses, overall we found significant treatment effects of CSRP intervention on two out of the three measures of children's self-regulation (i.e., executive functioning and attention/impulsivity), on one out of the two measures of teacher-student relationship (i.e., STRS closeness), and on all three pre-academic skills (i.e., PPVT, Letter Naming, and Early Math Skills) in spring of the Head Start year.

Specifically, children in the treatment group had statistically significantly larger gains in executive functioning (unstandardized B = .28, p = .05, d = .37) and were rated by assessors as manifesting better attention skills and lower levels of impulsivity during the standardized direct assessment (unstandardized B = .20, p = .05, d = .43). No statistically significant differences were found between treatment- and control-group enrolled children's increases in effortful control (unstandardized B = .13, p = .22, d = .20).

Table 2 also presents the findings from two additional models that examined CSRP intervention impact on teacher-student relationship, measured by teacher-reported STRS conflict and of closeness scores in spring of the Head Start year. (Recall that, because the STRS was administered only in spring, we instead included teachers' reports of children's behavioral difficulty as a baseline control variable at level 1). Results in Table 2 suggest that CSRP had a significant impact on teachers' reports of closeness, (unstandardized B = 4.14, p = .04, d = .67). Compared to the control group, children in the treatment group also tended to have few conflicts with teachers, the finding of which, nevertheless, was not statistically significant (unstandardized B = -.86, p = .45, d = -.18).

The results in Table 2 also show that children in the CSRP treatment group had significant gains in all three measures of pre-academic skills in spring of their Head Start year, compared to their peers in the control group. In particular, compared to children in the control

group, those in the treatment group on average gained about 1.5 points (unstandardized *B* = 1.46, p = .04, d = .34) more on the shortened version of the PPVT (or TVIP) from fall to spring of their Head Start year. Additional 3-level HLM models with children's letter-naming and math skills in the spring as dependent variables suggest additional benefits of CSRP intervention for children's pre-academic skills. Compared to the control group, children in the treatment group had significant gains in their letter-naming (unstandardized B = .24, p = .00, d = .63) and early math skills (unstandardized B = 2.21, p = .00, d = .54) from fall to spring of their Head Start year. It is important to emphasize that these gains are net of children's initial baseline performance on these same dimensions of pre-academic skills in fall, and therefore these estimates represent the amount of change in children's school readiness from October to May.

Post-hoc Results Using SEM

Using those variables for which there was evidence of CSRP treatment impact, Structural Equation Modeling was then deployed for post-hoc analyses of mediation. We present in Table 3 parameter estimates and goodness-of-fit statistics from the fitted structural equation models in which we examined the direct and indirect paths of covariance from CSRP intervention services to children's picture vocabulary scores in the spring of the Head Start year. Prior HLM findings were partially replicated, with evidence to suggest that CSRP intervention services directly predicted significantly higher vocabulary scores among children in the treatment group as compared to children in the control group, in the spring of the Head Start year. This was the inclusion of a large number of variables controlling for an extensive set of child-, classroom/ teacher- and site-level covariates (Column III). Estimates of the role of treatment on children's spring vocabulary scores dropped below levels of statistical significance when the more statistically conservative lagged auto-regressive model was run (See Column IV). As with the

HLM findings, SEM results suggest that teachers of children who received the CSRP intervention services also reported significantly higher levels of closeness with study children, net of child-, classroom/teacher- and site-level covariates (Columns III and IV). Mixed evidence was found to support the hypothesis that the CSRP intervention services predicted gains in children's self-regulation skills, with statistically significant paths from CSRP treatment to children's self-regulation, when controlling only for child and classroom/teacher covariates only (Column II). The path from CSRP treatment was no longer statistically significant when including the additional site-level covariates (Column III).

Importantly, both the quality of the teacher-student relationship and children's self-regulation skills were positively and significantly related to their vocabulary scores in the spring of the Head Start year (Columns V and VI). Specifically, children whose teachers reported higher levels of closeness and children who demonstrated greater self-regulation skills outperformed their peers whose teachers reported lower levels of closeness or who exhibited poorer self-regulation skills on the spring direct assessment of their vocabulary. Finally, a post-hoc test of the full mediating model was completed, where SEM results supported our hypothesis that the CSRP intervention services indirectly predict children's vocabulary gains through improvements in teacher-student relationship quality (Table 3, Column V). In contrast, evidence for the mediating, indirect pathways model through children's self-regulation skills did not attain statistical significance.

A second and third set of models examining CSRP intervention impacts were fitted using children's letter naming and mathematics skills in the spring of the Head Start year as the dependent variable. The pattern of findings for both the letter-naming and mathematics structural equation models was quite similar to the pattern of findings for children's vocabulary skills.

Specifically, controlling for child-, classroom/teacher- and site-level covariates, the CSRP intervention predicted statistically significant, higher scores among treatment-enrolled children's letter naming skills ($\gamma = .175$, $p<.001$) and mathematics skills ($\gamma = 1.46$, $p<.001$) as compared to their control group-enrolled counterparts. Importantly, children in the treatment group demonstrated significantly larger gains in letter naming skills ($\gamma = .133$, $p<.001$) and mathematics skills ($\gamma = .738$, $p<.001$), net of their fall scores, than did their control group counterparts. Prior findings of statistically significant paths from CSRP intervention to higher levels of teacher-student relationship closeness were replicated in these additional models, and again, involvement in CSRP intervention significantly predicted treatment-enrolled children's higher self-regulation in spring, but for SEM models that included classroom-level covariates, only.

Regarding paths from proposed mediators to children's pre-academic skills, teacher-student relationship quality was a positive and statistically significant predictor of children's letter-naming ($\beta= .008$, $p<.05$) and mathematics ($\beta = .105$, $p<.05$) skills in the spring of the Head Start year. Moreover, children who were rated by observers has exhibited greater self-regulation skills outperformed their peers who were rated as exhibiting poorer social skills on letter-naming ($\beta = .143$, $p<.001$) and mathematics ($\beta = 2.27$, $p<.001$) tests, controlling for all three sets of covariates. As with the vocabulary SEM models, evidence from these second and third set of post-hoc models supported that hypothesis of indirect influence of CSRP intervention services on both letter naming scores and mathematics scores through the mediating mechanism of higher teacher-student relationship quality. Similar evidence for the indirect mediating role of the latent variable of children's self-regulation was not found. Taken together, HLM and SEM results tell largely overlapping empirical stories, with some significant discrepancies. These are discussed, below.

Discussion

As our nation approaches an era increasing economic uncertainty, our field faces the stark reality that rates of poverty and accompanying levels of educational disparity are likely to continue to rise among young children. Recent research has suggested that "income matters more to families with less," with drops in income associated with deleterious consequences for young children's school readiness (Dearing, McCartney, & Taylor, 2001). The prospect of widening economic and educational disparities among our nation's youngest children represents tremendous incentive for our field to find feasible means of supporting their school readiness.

The descriptive results of our study underscore the cause for our concern: The low-income children in our study are in families facing substantial economic disadvantage, with parents earning, on average, $13,440 a year and with the majority of CSRP-enrolled families living at or below the poverty line. This is in keeping with other developmental studies of low-income preschoolers in Head Starts as well as from larger, survey studies of Head Start enrolled families, where a substantial proportion of enrolled families live well below the income-to-needs threshold of 1.0 and are struggling to make financial ends meet (Owen et al., 2008). Parents in our study were working, and were able to leverage existing community resources in the community-based agencies in their neighborhoods to support their children's optimal development by enrolling their children in Head Start. The children in our sample demonstrate both the strengths and the struggles faced by low-income preschoolers, where, as a group, children demonstrated considerable self-regulatory competence, closeness with teachers, and academic skills. That said, low-income children were also at significant risk, with vocabulary skills, math skills, and letter naming skills that place them in significant jeopardy relative to their more affluent peers.

As such, early childhood programs such as Head Start represent an important avenue through which young low-income children can be supported (Duncan, Ludwig & Magnuson, 2007; Fantuzzo et al., 1997; Zigler & Muenchow, 1997). One key question is whether teachers who are already meeting extensive health, nutritional, and educational needs of the children they serve can also engage in a multi-component intervention that targets children's behavioral and social skills. The evidence from our study suggests that they can, and that children benefit substantially, as a result.

Results of our HLM analyses suggest clear evidence of the benefits of a comprehensive classroom-based intervention for children's self-regulation and their relationships with teachers. Children enrolled in Head Start programs that were randomly assigned to treatment showed substantial improvements in their performance on executive functioning tasks from fall to spring of their preschool year, relative to children enrolled in those Head Start programs assigned to the CSRP control group. Similarly, low-income preschoolers in the CSRP treatment group were observed to show considerably improved attention skills and lower levels of impulsivity on the PSRA Assessor Report during their individual standardized direct assessments, than were children in CSRP's control group. The magnitude of improvement in CSRP-enrolled children's self-regulatory skills is substantial (with effect sizes ranging d = .37 to d = .43). Our finding are similar in magnitude to the self-regulatory benefits of other cluster-randomized interventions targeting young children's school readiness (Bierman, Nix, Greenberg, Blair, & Domitrovitch, 2008; Diamond et al., 2007; Webster-Stratton et al., 2008).

CSRP intervention impacts were also found for Head Start teachers' relationships with their students, with treatment-assigned teachers reporting substantially closer relationships with the children in their classrooms than did control group-assigned teachers (with an effect size of d

= .67). It is important to note that these benefits of intervention were found, net of the large number of classroom and site-level factors (including teachers' own experiences of feeling overwhelmed by the stressors associated with their jobs) that might bias adults' perceptions of child behavior. These findings are in keeping with our own recently reported findings of improvements in independent observations of teachers' sensitivity in managing their classrooms and with improvements found in teachers' use of emotion coaching, overall classroom management, and behavioral support in other school readiness interventions (Domitrovitch, Gest, Gill, Bierman, Welsh, & Jones, revised and resubmitted; Raver et al., 2007; Pianta, Mashburn, Downer, Hamre, & Justice, submitted).

How do we interpret these CSRP intervention findings? From a developmental standpoint, these findings highlight the modifiability of the quality of adults' relationships with young children, as reported by the adults, themselves. These findings also highlight the modifiability of low-income preschoolers' ability to marshal their attention and impulsivity, and the potential of a comprehensive set of structured environmental supports in shaping young children's development of effective self-regulation (see Blair, 2002; Pears & Fisher, 2005; Pollack, 2003; Riggs et al., 2006). Together, our findings have substantial policy implications when searching for promising strategies for supporting the emotional and behavioral well-being of children who face a host of significant poverty-related stressors. This may be particularly important in a period of rapid expansion of early childhood classrooms where policy professionals may struggle to expand the quantity of preschool slots without sacrificing the classroom quality of the programs in which those "slots" are offered (Blau, 2002; Magnuson, Meyers, & Waldfogel, 2007; Zigler, Gilliam, & Jones, 2006).

The findings of our study also suggest that the emotionally and behaviorally oriented intervention increased children's opportunities for learning, as evidenced by treatment-enrolled children's significant gains in vocabulary, letter-naming and math, relative to similar children enrolled in Head Start classrooms randomly assigned to the control group. Our HLM analyses indicate that CSRP services targeting children's self-regulation and social skills through classroom-based processes led to statistically significant increases in low-income preschoolers' vocabulary, letter-naming, and in their early math skills, with effect sizes ranging from d = .34 to d = .63. Importantly, because we did not provide any assistance or materials to teachers on ways to improve their instructional practices on academic domains, we have confidence in asserting that the statistically significant impacts on children's academic outcomes can be attributed to our socioemotionally-oriented intervention. Our experimental findings lend support to the claims made in previous longitudinal, non-experimental studies that the social, emotional and behavioral contexts of young children's early educational experiences "matter" for their opportunities to learn (Berndt & Keefe, 1995; Birch & Ladd, 1997; Fantuzzo et al., 2007; McClelland & Morrison, 2003; Murray & Greenberg, 2000; Burchinal et al., 2002; Pianta & Stuhlman, 2004; Raver, 2002)

In short, we found strong evidence to contradict the claims made by Duncan et al. (2007) that socioemotional domains have relatively little to offer children's language and math skills. Important caveats to this claim are that our study's findings are short-term in nature, spanning the preschool year, only. It is important that our findings are not construed to suggest an "either/or" approach to investments in both academic and socioemotional/behavioral domains, but rather that it provides evidence for ways that children's socioemotional competence is key rather than peripheral to their opportunities for learning, in early childhood contexts.

Post-hoc examination of the covariances between these outcomes using an SEM approach point us in promising directions in understanding potential mechanisms that might explain children's academic gains. Our evidence suggests that estimates of program impacts are smaller, though they continue to be statistically significant and of meaningful magnitude for most (but not all) hypothesized paths. While we found evidence of the mediating role of teachers' reports of emotional closeness with students, evidence for the mediating role of children's self-regulation was more sparse. Our suspicion is that our likelihood of finding a linkage between intervention and the latent variable for children's self-regulation was lowered hen we opted to combine children's effortful control (for which there was no evidence of treatment impact in the HLM analyses) with children's executive functioning (for which there was evidence of treatment impact) as two observed indicators, in our models. In addition, we may be pushing the statistical limit of the number of paths we can test, with such a large number of child-, classroom- and site-level covariates included in our SEM models. With those caveats in mind, we found the post-hoc models to be conceptually and empirically informative. For example, our analyses have led us to ask new questions, such as whether clearer evidence of the path from treatment to children's self-regulation might be found, if we were to consider experimentally-induced improvements in classroom emotional climate as a key mediator or moderator. These questions will be pursued in future analyses.

Limitations

This study's conclusions are constrained by several limitations. A key limitation is that the current analyses are restricted to assessments of children's school readiness at the end of the school year in which programs were randomly assigned to treatment or control groups. For more robust estimates of CSRP's efficacy, it will be important to see whether evidence of the benefits

of our classroom-based intervention extend into children's kindergarten year (Flay et al., 2005). A second key limitation is that the analyses presented above were sufficiently complex that they have not yet been extended to include tests of the moderating role of children's race/ethnic category membership or gender. We plan to address these limitations in subsequent papers, focusing on the equivalence of our models across subsamples of children differing by race/ethnicity, English Language Learner status, and gender. Finally, this study's external validity is significantly constrained: We relied on the generosity of staff, teachers, and families at 18 Head Start sites in 7 neighborhoods of concentrated economic disadvantage on Chicago's South and West sides that were willing to be randomly assigned to the receipt of two different types of services (comprehensive, multi-component intervention vs. receipt of a teacher's aide, 1 day a week). We can only be cautiously optimistic until these findings have been replicated in other studies, in other locales, and with other intervention teams.

Future Directions

With those limitations in mind, what are the implications of these hypothesized and demonstrated short-term gains in children's executive function, effortful control skills, relationships with teachers, and pre-academic skills? An optimistic hypothesis might be that children with improved profiles of school readiness may be placed on a more positive developmental trajectory, better able to capitalize on future opportunities for learning in kindergarten and early elementary years. A less optimistic hypothesis is that these behavioral and pre-academic gains will be sustained only as long as children continue to have access to the conditions and classroom practices that supported the development of executive function and adaptive self-regulation within the intervention year. Our next step is to analyze follow-up data

through kindergarten and early elementary school to detect whether these short-term gains are sustained.

In the short term, however, it is important to highlight that this study's news is good: These findings, combined with the findings of significant improvements at the classroom level (Raver et al., 2008) suggest that significant investment in workforce development, coaching of caregivers, and mental health consultation yields improvement in classroom quality and in children's gains. Our results provide experimental evidence to counter the claim that past "behavioral interventions succeed at improving behavior but not achievement," (Duncan et al., 2007, p. 1430), suggesting instead that behaviorally oriented intervention may have significant "crossover" benefits for young children's opportunities for learning, at least in the short-run (in the course of a single preschool year).

Equally important, perhaps, is that our approach is not limited to child-specific models of development, but rather, we consider our emphasis on children's behavioral development to be classroom- and context-dependent. In keeping with observations by Duncan et al (2007) and others that children's behavioral problems may disrupt classroom activities, affecting others' students' achievement more than a disruptive child's own academic trajectory, other interventions (including ours) have targeted support of children's optimal behavioral regulation at the classroom level, rather than at the child level (Diamond et al., 2007; Ialongo, Poduska, Werthamer, & Kellam, 2001; Riggs et al., 2006). In short, we pursued an approach where children were viewed as deeply embedded in fundamentally social contexts and relationships with adults and with peers, and it was those contexts and relationships that were primarily targeted for change. Our findings are consistent with other recent studies on the efficacy of teacher-training programs with older children. The CSRP drew from the strengths of previous

models emphasizing the importance of providing significant adults in children's lives with the knowledge, skills, and support to effectively support children's self-regulation and reduce their behavior problems (see Jones, Raver, Metzger, & Silver, in press, for review). As with those programs, CSRP placed central importance on intervention staff serving as coaches to teachers, to aid in building new relationships with students using more adaptive strategies of management and engagement (Donohue et al., 2000; Gilliam, 2005; Gorman-Smith et al., 2003; Green, Simpson, Everhart, Vale, & Gettman, 2004). In sum, our results contribute to a growing literature in prevention research that suggests ways teacher training and mental health consultation efforts can be extended "downward" to settings where an increasingly large fraction of preschool children are served. These services show significant promise for Head Start-funded programs serving low-income, ethnic minority preschoolers in neighborhoods of concentrated disadvantage.

Translational Implications

In the period of high-stakes testing implemented after 1996, more than 25% of Chicago's 24,000 third graders were not able to pass their school district's gated proficiency standards, and subsequently faced high levels of long-term educational risk (Roderick & Nagaoka, 2005). This stark statistic serves as a powerful reminder of the importance of detecting whether intervention approaches such as CSRP improve children's odds of academic success. In era of rising economic difficulty for families with children in the U.S, this study highlights the ways we can test means of supporting low-income children's social and behavioral development as well as maximizing chances of success in academic sphere, within preschool settings where communities are deeply dedicated to supporting the optimal development of low-income children. In our view, recent federal investments in cluster-randomized preschool efficacy trials

represents a "watershed" moment in prevention science research: A new set of intervention studies has recently provided compelling evidence and guidelines for the steps that programs can take to substantially improve children's chances of succeeding in school (U.S. Department of Health and Human Services, 2008). In our view, CSRP is part of this growing trend, demonstrating the multiple steps agencies and early childhood programs can take to support school readiness.

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Footnotes

1) Those efforts can only be approached through designs that have multiple treatment arms or cells, which are beyond the scope, size and budgets of most efficacy trials.

Table 1

Descriptive Statistics in Full Sample and Treatment and Control Groups

	Full Sample (n = 467)	Treatment Group (n = 238)	Control Group (n = 229)
Outcome Variables in Spring			
Executive functioning score	0.04(0.81)	0.08(0.85)	-0.01(0.76)
Effortful control score	0.03(0.66)	0.00(0.65)	0.05(0.67)
Attentive/impulse control	2.29(0.52)	2.29(0.55)	2.29(0.49)
STRS closeness	33.63(5.10)	33.84(3.79)	33.42(6.18)
STRS conflict	12.15(5.12)	12.85(5.22)	11.42(4.92)
PPVT score	13.55(4.33)	13.81(4.30)	13.27(4.36)
Letter naming score	0.46(0.39)	0.50(0.39)	0.42(0.38)
Early math skill score	10.02(4.01)	10.06(3.85)	9.98(4.19)
Baseline Scores in Fall			
Executive functioning score	-0.01(0.83)	0.06(0.82)	-0.09(0.84)
Effortful control score	-0.00(0.68)	0.05(0.66)	-0.06(0.69)
Attentive/impulse control	2.18(0.59)	2.22(0.56)	2.14(0.62)
Child overall behavioral risk	0.29(0.45)	0.31(0.46)	0.27(0.44)
PPVT Score	10.68(3.88)	11.00(3.67)	10.36(4.06)
Letter naming score	0.22(0.30)	0.24(0.31)	0.19(0.29)
Early math skill score	7.49(3.78)	7.80(3.51)	7.18(4.03)
Child Characteristics			
Boy	0.48(0.50)	0.52(0.50)	0.43(0.50)
Child race/ethnicity (Black)	0.66(0.48)	0.67(0.47)	0.64(0.48)
Child race/ethnicity (Hispanic)	0.26(0.44)	0.27(0.45)	0.25(0.44)
Child race/ethnicity (Other)	0.08(0.27)	0.06(0.24)	0.10(0.31)
Family poverty-related risks	1.08(1.00)	1.15(1.00)	1.01(1.00)
Single-parent families	0.68(0.47)	0.71(0.45)	0.65(0.65)
Four or more children in household	0.26(0.44)	0.25(0.43)	0.28(0.45)
Parent Spanish speaking	0.19(0.39)	0.17(0.38)	0.21(0.40)
Teacher and Class Characteristics			
Teacher BA	0.65(0.54)	0.71(0.57)	0.59(0.49)
Teacher age	40.72(11.86)	38.42(12.37)	43.11(10.81)
Teacher K6 score	2.57(2.07)	3.19(1.64)	1.91(2.27)
Teacher job demand	2.67(0.59)	2.86(0.63)	2.47(0.47)
Teacher job control	3.29(0.70)	3.36(0.70)	3.21(0.68)
Teacher behavior management	4.91(1.03)	4.65(1.05)	5.19(0.93)
Classroom emotional climate	16.24(2.69)	15.58(2.65)	16.92(2.56)
Classroom overall quality	4.71(0.79)	4.48(0.73)	4.95(0.78)
Class size	16.42(2.65)	16.61(2.68)	16.22(2.61)
Number of adults in class	2.40(0.69)	2.52(0.77)	2.28(0.56)
Site Characteristics			
Family support worker on staff	1.24(2.44)	0.39(0.49)	2.12(3.22)
Number of children aged 3-5	111.84(120.14)	94.07(50.46)	130.31 (161.81)
Proportion of teachers with BAs	0.45(0.40)	0.52(0.37)	0.38(0.42)
Proportion of teacher assistants with college	0.49(0.37)	0.37(0.33)	0.62(0.38)
Proportion of families employed	0.73(0.27)	0.80(0.22)	0.66(0.29)
Proportion of families receiving TANF	0.35(0.34)	0.30(0.33)	0.41(0.35)

Note. Means with standard deviations in parentheses

Table 2

CSRP Treatment Effects on Children's School Readiness: Results from HLM Analyses (n = 467)

	Coefficient	Standard Error	Effect Size
	Self-regulation		
Executive Functioning	0.28*	0.13	0.37
Effortful Control	0.13	0.10	0.20
Attention/Impulsivity	0.20*	0.09	0.43
	Teacher-student Relationship		
STRS Conflict	-0.86	1.10	-0.18
STRS Closeness	4.14*	1.70	0.67
	Pre-academic Skills		
PPVT	1.46*	0.60	0.34
Letter Naming	0.24**	0.05	0.63
Early Math Skills	2.21**	0.51	0.54

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

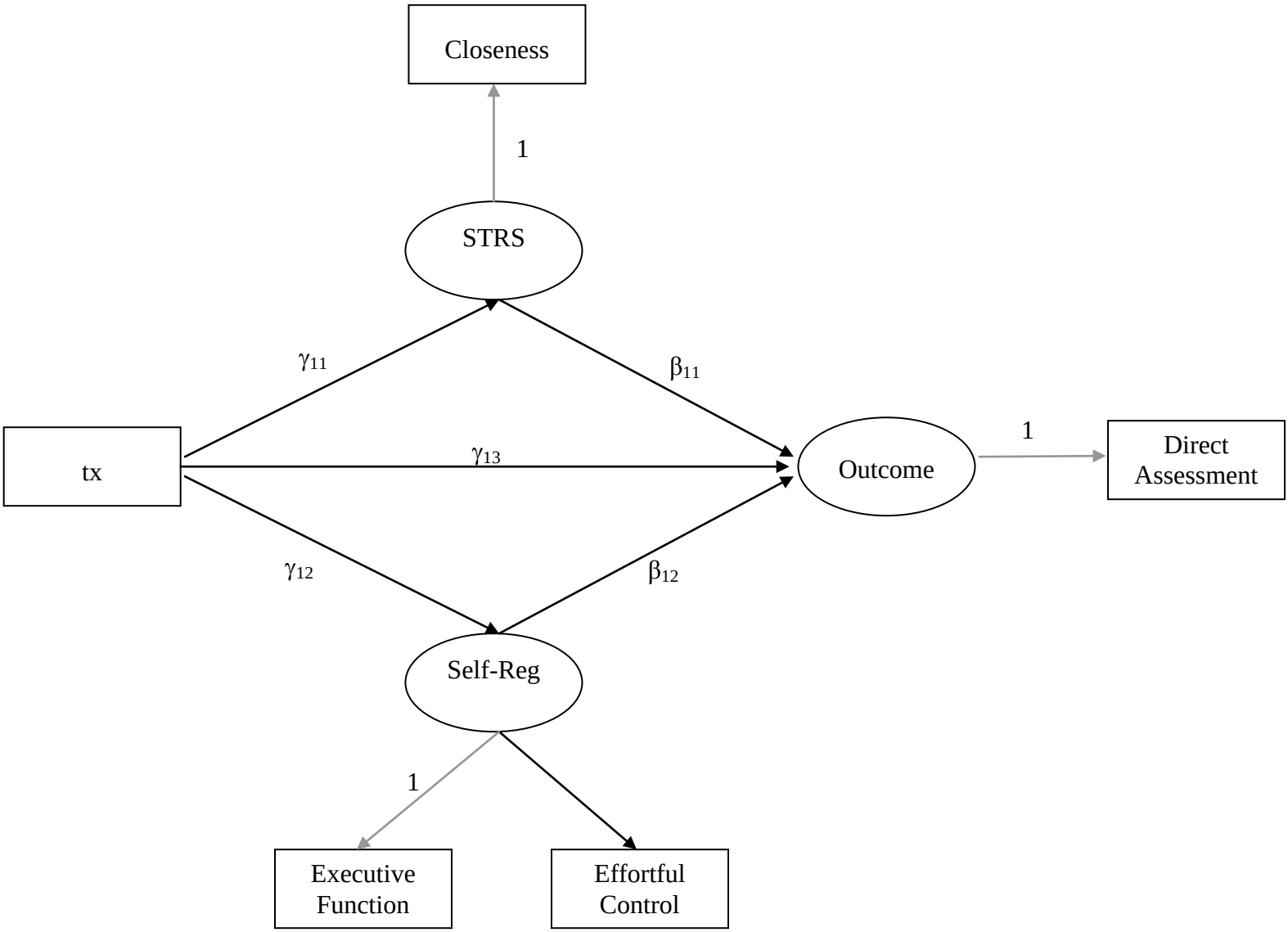
Table 3
Selected Parameter Estimates from a Taxonomy of Fitted Structural Equation Models (*n*=602)

The Role of Treatment for PPVT, STRS and Self-Reg Scores At Time 2							
		Child Controls I	+ Classroom Controls II	+ Site Controls III	+ Time 1 PPVT IV	All Ctrls + STRS IDE	All Ctrls + SR IDE
Direct Effects							
TX → PPVT	γ_{11}	.972** (.377)	1.38*** (.439)	1.15* (.515)	.588 (.407)	.737 (.515)	999* (.480)
TX → STRS	γ_{21}	.781 (.472)	1.51** (.515)	2.40*** (.593)	2.39*** (.593)	2.39*** (.590)	2.38*** (.593)
TX → SR	γ_{31}	.071 (.048)	.121* (.056)	.093 (.066)	.093 (.066)	.093 (.066)	.094 (.067)
STRS → PPVT	β_{12}					.177*** (.040)	
SR → PPVT	β_{13}						1.90*** (.211)
Indirect Effects							
TX → STRS → PPVT						.424*** (.142)	
TX → SR → PPVT							.178 (.128)
Goodness of Fit Indices							
χ^2 (df)		160.36 (45)	161.33 (97)	159.69 (132)	184.59 (150)	145.11 (131)	77.64 (255)
RMSEA		.065	.033	.019	.020	.013	.00

Note. Standard errors in parentheses; * $p < .05$; ** $p < .01$

Figure Captions

Figure 1. A mediating model of CSRP's impact on low-income children's pre-academic skills


Closeness
1
STRS
γ11
β11
tx
γ13
Outcome
1
Direct Assessment
γ12
β12
Self-Reg
1
Executive Function
Effortful Control