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Do the Effects of Head Start Vary by Parental Preacademic Stimulation?

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Abstract

Data from the Head Start Impact Study (*N*=3,185, age = 3–4 years) were used to determine whether one year of Head Start differentially benefited children from homes with high, middle, and low levels of parental preacademic stimulation on three academic outcome domains – early math, early literacy, and receptive vocabulary. Results from residualized growth models showed positive impacts of random assignment to Head Start on all three outcomes, and positive associations between parental preacademic stimulation and academic performance. Two moderated effects were also found. Head Start boosted early math skills the most for children receiving low parental preacademic stimulation. Effects of Head Start on early literacy skills were largest for children receiving moderate levels of parental preacademic stimulation. Implications for Head Start are discussed.

Keywords

Head Start; parenting; preacademic stimulation; differential effects

Caregiving for young children in the United States is often provided by both parents and child care settings. Close to 40% of children under five years of age who have regular child care arrangements are in center-based child care settings (Laughlin, 2013). In 2012, the federally funded Head Start program served over 825,000, or 20%, of all the children in these center-based care settings (Barnett, Carolan, Fitzgerald, & Squires, 2012). Low-income children typically enter school a half to a full standard deviation below higher-income children in academic domains such as vocabulary, cognition, and literacy skills (Duncan & Magnuson, 2013), however, those who experience high-quality early childhood programs have been found to enter kindergarten with academic skills closer to those of higher-income children (e.g., Barnett, 2011; Karoly, Kilburn, & Cannon, 2005; Ramey & Ramey, 2006; Schweinhart, 2006).

In the 1998 reauthorization of Head Start, Congress mandated that the U.S. Department of Health and Human Services (DHHS) determine whether the program contributed to key outcomes in children's learning and development. The resulting Head Start Impact Study (HSIS) gathered data from a large, nationally representative sample of children assigned at random to Head Start centers or a comparison group between 2002 and 2006. The Final

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Report of the HSIS (2010) found statistically significant academic gains for Head Start children over control children after one year with effect sizes (ES) ranging from .09 – .26. Larger impacts were found for the language and literacy outcomes of the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997; ES = .14) and the Woodcock-Johnson III (WJ) Letter-Word Identification test (Woodcock, McGrew, & Mather, 2001; ES = .24) than the early math outcome of the WJ Applied Problems test (ES = .12), suggesting that Head Start may be affecting some preacademic skills more than others (U.S. DHHS, Final Report, 2010).

The HSIS report also provided some evidence of differential program effects among key subgroups on these particular outcomes. On the PPVT, Head Start impacts were larger for Dual Language Learners than monolingual English speakers, and for children of mothers with no depressive symptoms than children of depressed mothers. On the WJ Letter-Word and Applied Problems tests, Head Start impacts varied in non-monotonic ways. In particular, impacts were larger for children of mothers with mild depressive symptoms compared with either no symptoms or moderate or severe symptoms, and for children living with moderate household risk compared with either no risk or high risk. These findings are important because they suggest different types of moderated effects in the HSIS across outcomes. The purpose of the current study is to extend the examination of the differential effects of Head Start by asking if the quality of parenting prior to the beginning of Head Start also moderates program effects. In particular, we ask if the effects of Head Start on early academic skills are moderated by the level of preacademic stimulation in the home and for which outcomes.

Parental Role in Fostering Preacademic Skills

One of the important ways that parents foster school readiness in early childhood is through providing their children with preacademic stimulation (e.g., Bakermans-Kranenburg, van IJzendoorn, & Bradley, 2005; Leventhal, Martin, & Brooks-Gunn, 2004). Such stimulation includes reading to children, helping them write their name, helping them to recognize and pronounce letters and words, and helping them with math skills such as counting objects. Associations between these types of activities and academic success in early childhood have been well documented (e.g., Bradley & Caldwell, 1995; Melhuish et al., 2008), stressing the important role of parental preacademic stimulation at home. Studies have shown that low-income children, on average, receive less preacademic stimulation at home than do children in higher-income families (e.g., Bradley et al., 1989; Klebanov, Brooks-Gunn, McCarton, & McCormick, 1998), although there is wide variability within both types of households. In the current study, we ask if effects of Head Start vary for children who receive different levels of academic stimulation at home prior to the beginning Head Start.

Potential Synergistic Effects of Head Start and Parental Preacademic Stimulation

Theoretical Framework

Bioecological theory posits that human development results from the interplay of *Process* x *Person* x *Context* x *Time* (Bronfenbrenner & Morris, 2006). The core of the model is

Process, which constitutes interactions between an organism and their environment known as proximal processes. The effects of these proximal processes on developmental outcomes systematically vary based on the characteristics of the person and their surrounding environmental context. In the case of the current study, we consider interactions between proximal processes of parental preacademic stimulation and the context of Head Start versus no Head Start over time.

The rationale for our study is guided by bioecological theory with the expectation that children and their families are not homogeneous, and hence will respond in varying ways to the program treatment environments they encounter (i.e., treatment effect heterogeneity). Particularly with an environment like Head Start, and the economically disadvantaged families and children it serves, bioecological theory would predict that the program will not affect all children in the same way, since the fit between what the program provides and what the family provides to the child is likely to differ across families, children, and outcomes. Thus, given the powerful effect of proximal processes (parental preacademic stimulation) in generating systematic variation in development as a function of both the individual person (child) and the context (Head Start), we investigate several competing hypotheses involving the effects of stimulation in the home and child care environments on varying child outcomes.

The *compensatory* hypothesis posits that Head Start will have the largest impacts on children from the most disadvantaged home environments (Sameroff & Chandler, 1975) because they are likely to receive the least preacademic stimulation at home. The compensatory hypothesis is consistent with the stated goals of Head Start (Zigler & Styfco, 2010) to serve the children who are most in need of its services, and this hypothesis has received empirical support in prior child care research. McCartney, Dearing, Taylor, and Bub (2007), for example, found that high quality early childhood settings had larger effects for children growing up in poverty.

A contrasting *accumulated advantages* hypothesis posits that children from more advantaged home environments will derive greater benefit from Head Start than their less advantaged peers (Coleman, 1990) because they come better prepared to capitalize on the learning experiences of the program. Child care studies have provided some empirical support for this hypothesis as well. The Sure Start program in the U.K. was less effective for children of teenage mothers or single parents than for other children (Belsky, Melhuish, Barnes, Leyland, & Romaniuk, 2006), indicating that children raised in more advantaged environments benefitted the most from the program.

A third possibility, which we call the “*Goldilocks*” hypothesis, posits that Head Start will be most effective for children with neither too much nor too little preacademic stimulation at home. Children with low levels of preacademic stimulation may lack sufficient support at home, while children with high levels of parental preacademic stimulation may not need the additional help offered by Head Start. Support for the “Goldilocks” hypothesis has been found in other studies of child outcomes in low-income populations, particularly when investigating the match between welfare-to-work policies and worker needs (e.g., Huston et al., 2003; Yoshikawa, Magnuson, Bos, & Hsueh, 2003). In these studies, antipoverty employment programs differentially benefitted children of mothers who were moderately hard-to-employ rather than children of mothers who were the most or least likely to be employed.

Figure 1 illustrates the differences among the three hypotheses. For the compensatory hypothesis, Head Start is expected to have the largest effect on children's academic skills when they receive low levels of parental preacademic stimulation prior to Head Start. In contrast, the accumulated advantages hypothesis predicts that Head Start will have the largest effect on children's academic skills when they receive high levels of parental preacademic stimulation prior to Head Start. For the "Goldilocks" hypothesis, Head Start is expected to have the largest effect for children whose parental preacademic stimulation is in the middle ranges as opposed to either high or low levels.

Prior Research

Two recent studies examined the synergistic potential of child care programs and home learning environments. Bradley, McKelvey, and Whiteside-Mansell (2011) analyzed the Early Head Start Research and Evaluation (EHSRE) study and asked if the 14-month Home Observation for Measurement of the Environment (HOME) Learning Stimulation subscale score moderated the effects of Early Head Start. Consistent with the compensatory hypothesis, they found larger effects of Early Head Start on the Bayley Scales of Infant Development at 36 months and the WJ Letter-Word test at 60 months for children from homes low in cognitive stimulation at 14 months. They did not test for the kinds of non-linear relations predicted by the "Goldilocks" hypothesis. Our study investigated these non-linear possibilities.

Similarly, Watamura, Phillips, Morrisey, McCartney and Bub (2011) analyzed the NICHD Study of Early Child Care and Youth Development (SECCYD) to examine children experiencing variation in the quality of their home and child care environments. They found children from low quality home environments differentially benefitted from exposure to high quality child care, providing support for the compensatory hypothesis. While these results are consistent with prior research, the data are non-experimental and thus unable to eliminate the possibility of selection bias due to omitted variables.

Testing for interactions

Two common approaches to testing interactions between baseline moderators and treatment assignment are to treat moderators in continuous or categorical form. If parental preacademic stimulation is represented as a continuous variable, its interaction with treatment tests whether the relationship between assignment to Head Start and child outcomes varies systematically with each unit increase in parental stimulation. A second approach to testing for interactions has been the use of categorical variables, which provides a more flexible, non-linear test of whether the relationship between assignment to treatment and child outcomes varies systematically for families providing low, middle, or high levels of parental stimulation. Defining categories in this approach can be based on either substantive judgments of activity counts (e.g., 0–2, 3–7, 8–10) or a more statistical division of the sample corresponding to percentiles (e.g., 25^{th}, 75^{th}) of the distribution in preacademic stimulation.

In a recent paper examining maternal sensitivity and child care using the NICHD SECCYD, Burchinal, Vandell, and Belsky (2013) tested for interactions with both the continuous and categorical approaches. They found categorical interactions of child care and high maternal sensitivity, based on a substantive division of 5.5–7 on the maternal sensitivity scale, to be the most predictive of adolescent outcomes. In this paper we make use of both substantive and distributional interaction model specifications.

Present Study

The present study extends the investigation of possible synergistic relationships between Head Start and parental preacademic stimulation. To our knowledge, this is the first study to address this issue using the HSIS, which randomly assigned children to Head Start or a control condition. Our principal research question is: After one academic year, do the effects of Head Start on three academic domains – early math, early literacy, and receptive vocabulary – vary by the amount of parental preacademic stimulation at baseline? If so, which of the three moderating hypotheses – compensatory, accumulated advantages, or "Goldilocks" – is supported by the data? Further, what is the non-experimental association between parental preacademic stimulation and children's achievement?

Because support for all three hypotheses has been found in studies with low-income samples, we explicitly test all three hypotheses for each of the outcomes. In addition, we hypothesize that parental preacademic stimulation will be positively associated with higher preacademic skills, and we expect to find positive main effects of Head Start consistent with those reported in the Final Report (2010). Since Head Start, but not preacademic stimulation, was randomly assigned, only the Head Start impact estimates benefit from the experimental nature of the study.

We consider three different academic domains – early math, early literacy, and receptive vocabulary – because bioecological theory predicts that proximal processes may vary systematically depending on the developmental outcome (Bronfenbrenner & Morris, 2006). Consistent with this stipulation, the main effect patterns in the HSIS differed across outcomes as outlined in the Final Report (2010). Therefore, in testing for moderation we might also expect effects to vary across the different outcomes because the interaction between Head Start and parental preacademic stimulation may depend on the match between the skills parents impart to their children and those provided by the Head Start program. In fact, the HSIS Final Report (2010) found differential impacts of the Head Start program among subgroups consistent with all three hypotheses across different outcomes.

For receptive vocabulary as measured by the PPVT, Head Start impacts were larger for Dual Language Learners than monolingual English speakers, consistent with a compensatory relationship. Head Start impacts were also larger for children of mothers with no depressive symptoms than children of depressed mothers, consistent with an accumulated advantages relationship. For early literacy as measured by the WJ Letter-Word test and early math as measured by the WJ Applied Problems test, the HSIS found evidence of a "Goldilocks"

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pattern of moderation in that Head Start impacts were larger for children of mothers with mild depressive symptoms compared with either no symptoms or moderate or severe symptoms, and for children living with moderate household risk compared with either no risk or high risk. Other prior literature, however, demonstrates that parents provide relatively little math instruction or support at home (e.g., Blevins-Knabe, Berghout, Musun-Miller, Eddy, & Jones, 2000; Young-Loveridge, 1989), suggesting the likelihood of a compensatory relationship for early math.

Thus, there is evidence for all three patterns of moderation on the extent to which Head Start complements or substitutes for parental preacademic stimulation in the acquisition of later skills. As a consequence, we cannot clearly predict the relationship pattern between preacademic stimulation and Head Start, since all three hypotheses are plausible and have some empirical support. Indeed, the HSIS called their examination of subgroup findings "exploratory" (U.S. DHHS, Final Report, 2010, p. 322). The dearth of detail on the nature of the relation between Head Start and low, middle, and high preacademic stimulation levels, and for which outcomes, is the primary motivation for this paper.

Method

Participants

We analyzed data from the HSIS, a nationally representative sample of 84 Head Start grantee and delegate agencies and nearly 5,000 newly entering, eligible three and four-year-old children. Children were randomly assigned to either: (1) a Head Start group that had access to Head Start program services; or (2) a control group that was not eligible to enroll in the Head Start center to which they applied for the lottery, but could enroll in other early childhood programs or services selected by their parents, including other Head Start centers not in the study (U.S. DHHS, Final Report, 2010).

The study employed a multi-stage sampling process to select a representative group of Head Start programs and children. It began with a list of 1,715 grantee and delegate Head Start agencies that were operating in Fiscal Year (FY) 1998–99. This pool was then organized into 161 geographic clusters across 25 strata in order to ensure variation across region of the country, urban and rural location, race and ethnicity, and state pre-kindergarten and child care policies. One cluster was then randomly selected from each of the 25 strata yielding 261 grantee and delegate agencies. Agencies were eliminated that had recently closed, merged, or were serving all eligible children in their communities, and smaller agencies were grouped together. Approximately three grantee and delegate agencies were then randomly selected from each of the 25 strata, yielding a final 84 grantee and delegate agencies.

These 84 Head Start agencies generated lists of 1,427 individual centers that were expected to be in operation for the 2002–03 school year. After individual programs were eliminated because they had recently closed, merged, or were serving all eligible children in their communities, and groups of centers were stratified along the same dimensions as the geographical agency clusters, 383 individual centers remained (U.S. DHHS, Final Report, 2010). An average of four centers was selected from each Head Start agency with a range of 1–7 centers (C. Heid, personal communication, 10 April, 2013).

Once the centers were selected, a lottery process was used to determine which children were and were not assigned a place in Head Start. The goal was to randomly select 27 children from each center – 16 to be assigned to Head Start and 11 to the control condition. In total 4,442 children were randomly selected – 2,646 for Head Start and 1,796 for the control condition. Data collection took place from fall 2002, at the time the treatment group entered Head Start, until spring 2006, at the end of first grade (U.S. DHHS, Final Report, 2010). The resulting sample was roughly split into thirds by child's race – black, Hispanic, and white or other. Further, about half the sample was male and about one-quarter of the sample was classified as a Dual Language Learner at baseline. About one-third of the mothers in the sample had less than a high school education, about 15% were teenage mothers, and about 40% were classified as moderately to severely depressed by the CES-D Depression scale (Radloff, 1977). Descriptive statistics for the sample are displayed in Table 1, including tests for the treatment-control group differences.

Measures

Parental preacademic stimulation—In the fall of 2002, the primary caregiver was administered a baseline interview by project staff, which was designed for the U.S. DHHS's Head Start Family and Child Experiences Survey (FACES) and HSIS studies. The primary caregiver was considered the person living with and most responsible for the care of the child, and three-quarters of the respondents were the biological or adoptive mothers. Because almost one-third of the sample spoke Spanish as their primary language at home, parent interviews were conducted by interviewers fluent in the parents' language and were available in both English and Spanish versions (U.S. DHHS, Technical Report, 2010).

During this interview, the primary caregiver was asked to report on the use of ten educational activities in the past week: the number of times they read to their child; helping their child with letters, numbers, and words; practicing writing the alphabet with their child; helping their child with songs or music; working on arts and crafts with their child; helping their child practice writing their name; practicing rhyming words with their child; counting objects with their child; talking about size with their child; and talking about the calendar with their child. These questions were based loosely on Caldwell and Bradley's (1984) HOME measure, and specifically the Learning Stimulation and Language Stimulation subscales. The HOME is one of the most widely used measures assessing characteristics of a child's home environment, and we included all such similar questions. Reviews of the HOME have found it to be a reliable and valid measure (Bradley, 1994; Bradley & Caldwell, 1988; Elardo & Bradley, 1981), even in low-income and diverse populations (Bradley, Corwyn, Pipes McAdoo, & García Coll, 2001; Bradley, Corwyn & Whiteside-Mansell, 1996).

Scoring was done exactly as it is in the HOME with a binary choice (yes or no) format. A variable was coded "0" if the parent interviewed indicated they had *not* done the activity with the child in the past week and "1" if they indicated they had. In the case of the activity "how many times the parent read to their child in the past week" which was reported on a 1–

4 scale from 1 “never” to 4 “everyday”, the item was recoded to have a 0–1 scale like the other activities with 0 “never”, .33 “once or twice”, .67 “three or more times”, and 1 “everyday.” The variables were then summed to create a composite scale of parental preacademic stimulation varying from 0 “has done none of these activities in the past week” to 10 “has done all of these activities in the past week” (α = .71). Factor analysis yielded only one factor from the ten items, confirming the utility of summing these items for one omnibus parental stimulation measure. A complete list of descriptive statistics for the individual items as well as the composite parental preacademic stimulation measure is reported in Table 2. Figure 2 displays a histogram of the composite parental preacademic stimulation measure.

Academic achievement outcomes—Both at baseline and after one academic year in the treatment or control condition, children were administered a battery of assessments including the Woodcock Johnson (WJ) III Applied Problems and Letter-Word tests (Woodcock, McGrew, & Mather, 2001), and the Peabody Picture Vocabulary Test, Third Edition (PPVT; Dunn & Dunn, 1997) as measures of academic achievement. The WJ Applied Problems test measures a child’s ability to analyze and solve math problems (α = .92). The WJ Letter-Word test measures a child’s reading identification skills of letters and words (α = .91). The PPVT measures a child’s receptive vocabulary (α = .95). All three assessments are norm-referenced (*M* = 100, *SD* = 15) (U.S. DHHS, Technical Report, 2010). We chose these specific outcome domains given their respective critical importance for later academic success (Duncan et al., 2007; Whitehurst & Lonigan, 2003; Yesil-Dagli, 2011), as together they form the building blocks of academic competence. A complete list of descriptive statistics for these outcomes at baseline and one academic year later is reported in Table 2.

Children requiring baseline assessments in Spanish were administered a bilingual child assessment in fall 2002 that included Spanish-version equivalents of the WJ tests and the PPVT (U.S. DHHS, Technical Report, 2010). We used the scores from these Spanish equivalents as measures of a child’s baseline achievement in place of their scores on the English versions. In spring 2003 and in all subsequent data collection periods, children were given only the complete English assessment battery (U.S. DHHS, Technical Report, 2010), so we used these English-version scores in our analyses.

Covariates—In order to sharpen the standard errors of our point estimates and to adjust for departures from randomization, several child and family covariates were included in the model. We used the same set of covariates as was used in the Final Report of the HSIS (2010), which included a broad set of key child and family demographic characteristics. Child covariates included: number of elapsed weeks from September 1, 2002 until the spring 2003 assessment; age in weeks at the spring 2003 assessment; gender; race or ethnicity; whether the child was classified as having a disability; and the language of baseline testing. Family covariates included: caregiver age in years; an indicator of caregiver depression; highest level of maternal education; whether the mother was a recent immigrant to the United States; primary language used at home; and three family structure variables including whether both biological parents lived with the child, whether the mother was married, and whether the mother was teenaged at the child's birth. A lagged dependent variable was also included in the model to control for the child's baseline level of achievement. For purposes of analyses, all the covariates were centered at their mean.

Non-response—As with any longitudinal dataset, there was non-response in the HSIS. In particular, spring 2003 child assessment response rates were correlated with treatment or control status as well as child gender and race. To control for this potential bias, we weighted all our analyses using the spring 2003 child assessment final child weight (CHSPR2003WTCA), which included a weight for probability of sample selection at every stage multiplied by a weight adjusted for non-response. The weight included in our analyses helped control potential non-response bias by compensating for different data collection response rates across these demographic groups of children. Weights are important in complicated multi-stage sampling studies such as HSIS because they allow us to make inferences to the relevant general population, and they account for differential selection probabilities and differential non-response (U.S. DHHS, Technical Report, 2010). As a robustness check, we also ran multiple imputation for missing data and found that the results of our analyses did not change significantly. Hence below we report the weighted case results (N=3,185).

Results

Descriptive Analyses

Tables 1 and 2 display the descriptive statistics for the covariates as well as the main independent variable of parental preacademic stimulation, respectively. Table 1 reveals that balance was achieved between treatment and control on the covariates, with no significant differences between the groups, except on two measures. Not surprisingly due to its stated commitment to serving children with disabilities and its purposeful reservation of at least 10% of eligible enrollment slots for these children (U.S. DHHS, Final Report, 2010), Head Start was more likely to serve children with disabilities as opposed to the control condition ($p < .05$). Second, caregivers of children enrolled in Head Start were significantly more likely to be diagnosed as depressed by the CES-D Depression scale than caregivers of control group children ($p < .05$). Table 2 reports the mean of parental preacademic stimulation was 6.61 on a scale of 0 to 10, indicating the distribution is slightly skewed in the negative direction.

Preliminary Analyses

Our investigation of the best model specification for our data was an iterative conceptual and empirical process. It began with both linear and quadratic specifications for the preacademic stimulation interactions with the Head Start treatment variable. We discovered that a non-linear relation fit the data better than a linear relation, with larger effects at the middle of the sample distribution than at the tails. We then searched systematically for cut-points in the distribution of preacademic stimulation that corresponded to meaningful activity counts on the preacademic stimulation scale and provided the best fit to the data. Neither terciles nor quartiles produced significant interactions. However, when we used substantive divisions of "low" levels of preacademic stimulation, defined as 0–2 activities on our composite measure and corresponding roughly to the bottom 10% of the HSIS sample, and "high" levels of preacademic stimulation, defined as 8–10 activities on our composite measure and corresponding to roughly the top 10% of the HSIS sample, we found the strongest evidence of interactions. Thus, similar to Burchinal et al.'s (2013) results, we found interactions that were based on substantive divisions to be the strongest predictors of child outcomes.

Residualized growth models were used to estimate the effect of parental preacademic stimulation on academic achievement above and beyond what can be explained by the lagged dependent variable and what can be predicted based on covariates. Using the survey commands in Stata, we first ran regressions testing for main effects of preacademic stimulation and Head Start for all three academic outcomes, followed by regressions that included the interaction terms between the variables. The full regression model was:

$$Y_t=\beta_0+\beta_1 Y_{t-1}+\beta_2(HIGH\ STIMULATION)_{t-1}+\beta_3(LOW\ STIMULATION)_{t-1}+\beta_4 TX+ \beta_5(HIGH\ STIMULATION_{t-1}\times TX)+\beta_6(LOW\ STIMULATION_{t-1}\times TX)+\gamma COVARIATES+e_t,$$

where Y_t was the outcome variable of interest after one year; Y_{t-1} was the lagged outcome variable at baseline; *HIGH/LOW STIMULATION* $_{t-1}$ were the dummy variables indicating whether a child came from a home high or low in preacademic stimulation at baseline; *TX* was the dummy variable for assignment to Head Start; *HIGH/LOW STIMULATION* $_{t-1}$ *x TX* were the interactions of parental stimulation at baseline and assignment to Head Start; *COVARIATES* was the vector of child and family covariates described above that were used the model; and e_t was an error term.

Regression Analyses

Table 3 displays the three sets of regression results. For each domain – early math as measured by the WJ Applied Problems test, early literacy as measured by the WJ Letter-Word test, and receptive vocabulary as measured by the PPVT – the first model estimates the main effects of high and low preacademic stimulation (compared with the reference group of middle ranges of stimulation) and the Head Start treatment effect, while the second model adds interactions between the Head Start treatment and each of the stimulation dummy variables. Also included are a full set of covariates, which are listed in the table's footnote.

Results for Model 1 (columns 1, 3, and 5) show that children from homes low in preacademic stimulation scored close to a 1/3 of a SD lower than children receiving middle ranges of stimulation on early math (b= −4.49, p < .001), over a 1/5 of a SD lower on early literacy (b= −3.29, p < .01), and about .07 SD lower on receptive vocabulary (b= −1.06, p < .01). In contrast children with high parental preacademic stimulation did not differ significantly from children receiving middle ranges of preacademic stimulation, indicating a non-linear pattern for the outcomes as parental preacademic stimulation increased from low to middle and from middle to high levels. Head Start impacts in Model 1 are consistent with those reported in the HSIS Final Report (2010), with Head Start children scoring about .17 SD higher on early math (b= 2.46, p < .001), over 1/5 of a SD higher on early literacy (b=

3.44, $p < .001$), and almost .10 SD higher on receptive vocabulary (b= 1.40, $p < .001$) compared with the control children.

Model 2 (columns 2, 4, and 6) tests for moderation. When the interaction variables are included, the main effects of parental preacademic stimulation are those of control group children. Consequently, for each outcome we first discuss the results for control group children and then the Head Start children. Further, to better understand these interactions and to compare them to the idealized patterns in Figure 1, Figures 3–5 show predicted scores computed from the coefficient estimates in Model 2. The Head Start children are indicated by the light gray line, while the control group children are indicated by the dark gray line. To determine the magnitude of the differences between them, we differenced the treatment and control group scores at each stimulation level and standardized them to calculate Head Start treatment effect sizes at each level of preacademic stimulation. These effect sizes are indicated by "*d*". The asterisks indicate whether the treatment-control difference at low or high parental stimulation is statistically different from the treatment-control difference at the middle ranges of stimulation.

For early math (column 2 and Figure 3), control group children from homes with low parental preacademic stimulation scored over .46 SD lower (b= −6.93, $p < .001$) compared with children in the middle ranges of parental stimulation. However, there was no parallel increase in score for control children by moving from middle to high parental stimulation, as evidenced by a non-significant slope.

We compare the scores for Head Start children from homes with low parental preacademic stimulation to those for Head Start children receiving middle ranges of stimulation by adding the significant point estimates for the main and interaction effects of low stimulation. Head Start children from homes low in parental preacademic stimulation had a more muted response than did controls from such homes, scoring about .12 SD lower (b= −1.78) on early math compared with Head Start children from homes receiving middle ranges of stimulation. In contrast, there was no significant difference in the Head Start effect between children from middle and high stimulation homes, so the pattern of the movement from middle to high stimulation was essentially the same for the treatment and control groups. The Head Start effect for early math, therefore, is largest for children receiving low preacademic stimulation at home as indicated in Figure 3, which is consistent with the compensatory effect pattern illustrated in Figure 1.

For early literacy (column 4 and Figure 4), control group children from homes with low parental preacademic stimulation scored about .15 SD lower (b= −2.20, $p < .10$) compared with children in the middle ranges of parental stimulation while control group children from homes with high parental preacademic stimulation scored close to .30 SD higher (b= 4.39, $p < .05$) compared with children in the middle stimulation ranges. Thus, there is a consistent upward trend in score for the control children as parental preacademic stimulation increased from low to middle to high levels.

Using the same calculation method as above in adding the significant main and interaction effects, Head Start children from low stimulation homes scored close to .30 SD lower (b=

−4.36) on early literacy compared with children from middle stimulation homes. Repeating a similar calculation, Head Start children from homes with high parental preacademic stimulation scored .02 SD lower (*b*= −0.32) compared with children receiving middle ranges of stimulation. As indicated in Figure 4, the positive effect of Head Start on early literacy was strongest for children receiving stimulation that was neither too little nor too much, but instead in the middle ranges of parental preacademic stimulation. This matches the "Goldilocks" effect pattern shown in Figure 1.

For receptive vocabulary (column 6 and Figure 5), as parental stimulation increased from low to middle levels, there was no statistically significant increase in score for control group children. However, control group children from homes high in parental preacademic stimulation scored about .14 SD higher (*b*= 2.16, $p < .01$), compared with children in the middle ranges.

For Head Start children, there was also no statistically significant difference in score between low and middle stimulation levels. However, Head Start children from homes high in parental preacademic stimulation scored about .02 SD lower (*b*= −0.31) on receptive vocabulary compared with children receiving middle ranges of stimulation when we added the point estimates for the main and interaction effects of high stimulation. Thus, as shown in Figure 5, children assigned to Head Start from homes with low and middle levels of stimulation experienced essentially a flat main effect of treatment on receptive vocabulary, whereas children from homes with high levels of stimulation experienced no Head Start effect. These results are not fully consistent with any of the three hypotheses.

Robustness Checks

Because only Head Start was randomly assigned, and not parenting practices, we sought to ensure that the stimulation interactions that we found were not picking up the effects of correlated predictors. To do this, we reran all of our models including interactions between all of our covariates and the Head Start treatment indicator. Our primary interaction variables (low stimulation X treatment) and (high stimulation X treatment) retained their significance in these fully-interacted models. We also interacted our primary interaction variables with all of our covariates (a three-way interaction between treatment, high or low parental preacademic stimulation, and the covariates one by one), and in no case was this interaction statistically significant. Results of these analyses are available from the first author upon request. These robustness checks confirmed our findings that parental preacademic stimulation moderated the Head Start treatment, and that this interaction did not further vary by any of the other covariates including maternal education.

Alternative Formulations of Preacademic Stimulation

Several analyses were conducted to examine alternative conceptualizations of parental preacademic stimulation. First, a factor analysis of our parental preacademic stimulation items revealed one omnibus factor, confirming our measure's utility in discerning the overall level of parental preacademic stimulation at baseline. We then ran follow up analyses testing for interactions between the parent report of the math stimulation items and Head Start on the early math outcome, and similarly just the literacy and vocabulary stimulation items and

Head Start on the early literacy and receptive vocabulary outcomes. These analyses did not yield any significant interactions further confirming the advantage of summing all the items for one omnibus parental stimulation measure.

Discussion

This paper used the HSIS data to test for both main effects of parental preacademic stimulation and Head Start as well as three moderating hypotheses involving the differential effects of Head Start for children receiving low, middle, and high levels of parental preacademic stimulation prior to the program on three academic domains – early math as measured by the WJ Applied Problems test, early literacy as measured by the WJ Letter-Word test, and receptive vocabulary as measured by the PPVT. We found Head Start treatment main effects to be consistent with those reported in the HSIS Final Report (2010). Head Start children scored higher on all three outcomes compared with control group children. We also found non-linear effects of baseline parental pre academic stimulation on the three academic domains. Children from homes in which mothers reported low amounts of preacademic stimulation scored lower on all three outcomes compared with children whose mothers reported middle ranges of stimulation. However, the scores of children from homes with reportedly high parental preacademic stimulation did not differ significantly from the scores of children whose mothers reported preacademic stimulation in the middle ranges.

Our primary analyses concentrated on testing for three types of moderated effects. We found the differential effects of Head Start to depend on the domain of interest. For the domain of early math, we observed a moderately-sized compensatory effect of Head Start in that children from homes in which mothers reported low preacademic stimulation experienced the largest Head Start treatment effect. In contrast, the Head Start treatment effect was virtually the same for children from homes with middle and high levels of preacademic stimulation. This more muted treatment effect pattern is consistent with previous literature on parental numeracy activities with their children (e.g., Blevins-Knabe et al., 2000; Young-Loveridge, 1989), and it appears that the intensive time spent learning early math concepts in Head Start has a particularly strong impact for children whose parents reported low preacademic stimulation at home.

For the domain of early literacy, we found a non-linear relationship rendering results more consistent with a “Goldilocks” effect in that the group of children reportedly receiving the middle ranges of parental stimulation received the largest score boost from the Head Start treatment. This finding for early literacy resonates with the growing belief in social science research that interventions must take into account both the characteristics of the program and the individual needs of the child (Duncan & Vandell, 2012). Similar to previous literature on welfare-to-work policies as well as the HSIS Final Report (2010) subgroup analyses, early childhood programs like Head Start may be least effective in the early literacy domain for children whose parents reported low preacademic stimulation because they do not receive proper support at home to complement what they learn in the program, as well as for children whose parents reported high preacademic stimulation because they have little need for the additional support in the program. Instead, children who receive just enough preacademic stimulation both at home and in school appear to benefit the most from Head Start.

For the domain of receptive vocabulary, similar to the differing patterns of moderation found in the HSIS subgroup analyses (2010), we found evidence of moderation that was not fully consistent with any of our three hypotheses. A modest-sized Head Start main effect was observed for children whose parents reported low and middle ranges of preacademic stimulation, but none was observed for children whose parents reported high levels of preacademic stimulation. Although no Head Start effect was observed for children from homes high in parental preacademic stimulation, we found a particularly strong gain in scores for control children when parental preacademic stimulation increased from middle to high levels. In fact, as demonstrated by Figures 3–5, the control group children's achievement increased as the amount of preacademic stimulation increased for all outcomes.

Thus, higher parental preacademic stimulation appears to foster resiliency in Head Start eligible children who do not have the program available to them, particularly in the domains of early literacy and receptive vocabulary. Consistent with Rutter's (1987) ideas surrounding protective mechanisms, higher parental preacademic stimulation can be a protective factor for children not assigned to Head Start. Watamura et al. (2011) had similar findings of resiliency in children from high quality home environments on caregiver-reported measures, regardless of the quality of the child care environment. The differing effects we observed across outcome domains largely converge with the types of relationship patterns reported in prior literature. They are also consistent with what bioecological theory would predict as the match between the skills parents impart to their children as measured by our stimulation scale and how much the Head Start program complements or substitutes for such parental stimulation is likely to systematically vary according to the developmental outcome.

Limitations and Future Directions

Some study limitations should be noted. First, though our measure is a reliable indicator of global baseline parental stimulation at home, closer inspection of the individual items shows there are more early literacy-related items than items for either vocabulary or math. A factor analysis revealed one omnibus factor and follow up analyses did not find specific interactions between just the math items and Head Start on the early math outcome and just the literacy and vocabulary items and Head Start on those outcomes respectively. This confirms our measure's utility in discerning the overall level of parental preacademic stimulation at baseline. However, this omnibus measure may not be sufficiently sensitive to capture how the individual stimulation items affect some outcomes more than others.

Additionally, our scale measures preacademic stimulation as defined by these ten items. It is possible that if parents were asked about additional ways they support their children's learning at home, beyond the ten items of the scale, different patterns might emerge. This raises issues about the cultural sensitivity of the scale, and what constitutes preacademic stimulation in diverse household settings. Nonetheless, because as the basis for this measure the HOME was found to be reliable in low-income and diverse populations (Bradley, Corwyn, Pipes McAdoo, & García Coll, 2001; Bradley, Corwyn & Whiteside-Mansell, 1996), we believe our scale to be an appropriate, albeit limited, measure of baseline preacademic stimulation.

Lastly, because the HSIS did not conduct home observations, it is possible that the items relating to parental preacademic stimulation may not reflect the actual quality of such stimulation. Parents may have answered the interview questions on the basis of what they perceived to be socially acceptable responses, rather than based on actual behavior. Yet such responses would have introduced measurement error, biasing our coefficients down toward zero. Thus, our findings are likely conservative estimates of the true magnitudes involved.

In sum, we have found that baseline parental preacademic stimulation and Head Start have synergistic impacts on children's development above and beyond what can be predicted solely on the basis of maternal and child characteristics. Our results use a relatively new data set to increase understanding of differential effects of Head Start on children receiving varying levels of parental preacademic stimulation. In particular, we found support for the compensatory and "Goldilocks" patterns of Head Start effects on early achievement outcomes. We found no support for the accumulated advantages hypothesis, suggesting that Head Start should continue targeting children at highest risk as well as those at more moderate risk.

Our findings underscore the interplay between Head Start and baseline parental preacademic stimulation as they combine to produce early math, early literacy, and vocabulary skills for low-income children. These results are helpful for future interventions surrounding the match between child care programs and parenting, and suggest that it is particularly important that Head Start be made available to those children whose parents do not report providing high levels of preacademic stimulation. Despite the current political climate surrounding funding for early education, it is vital that Head Start continue to serve children at highest and moderate risk as, on average, the program aids their development even when parents do not report providing high levels of stimulation.

Our study also suggests that children's academic achievement may benefit from programs targeted at helping parents increase preacademic stimulation in the home. An important goal of Head Start is to increase family functioning and engagement as these factors also directly impact children's school readiness (Zigler & Styfco, 2010). Parents may change their stimulation practices over the course of participation in Head Start in response to program services, further helping their children with the transition to kindergarten. Working with parents is thus an important pathway through which Head Start may contribute to children's outcomes. While our study focused on parental stimulation at baseline, a next research step would be to investigate whether parents change their behaviors and respond differentially to Head Start themselves to affect children's development. Future research studies should examine this possibility and the mechanisms that may influence it.

Finally, we see considerable value in our attempt to create divisions of baseline parental preacademic stimulation based on substantively meaningful rather than purely distributional divisions based on statistical criteria. In the Head Start sample, "low" preacademic stimulation, defined as 0–2 activities on the stimulation scale, and "high" preacademic stimulation, defined as 8–10 activities on the stimulation scale, corresponded roughly to the bottom and top deciles of the Head Start sample distribution. We posit that the critical point is not the relative score (i.e., top 10% or bottom 10%), but the substantive amount of stimulation as designated by the activity counts. In a more representative sample than the HSIS, half of the children might experience "high" amounts of preacademic stimulation in home based on this substantive division. We would therefore expect to see a considerably larger fraction of the sample in the "high" category and a smaller fraction in the "low" category. We hypothesize that interactions with early education treatments will be stronger with substantively-defined rather than distributionally-defined groups. We look forward to future work confirming this hypothesis.

Acknowledgments

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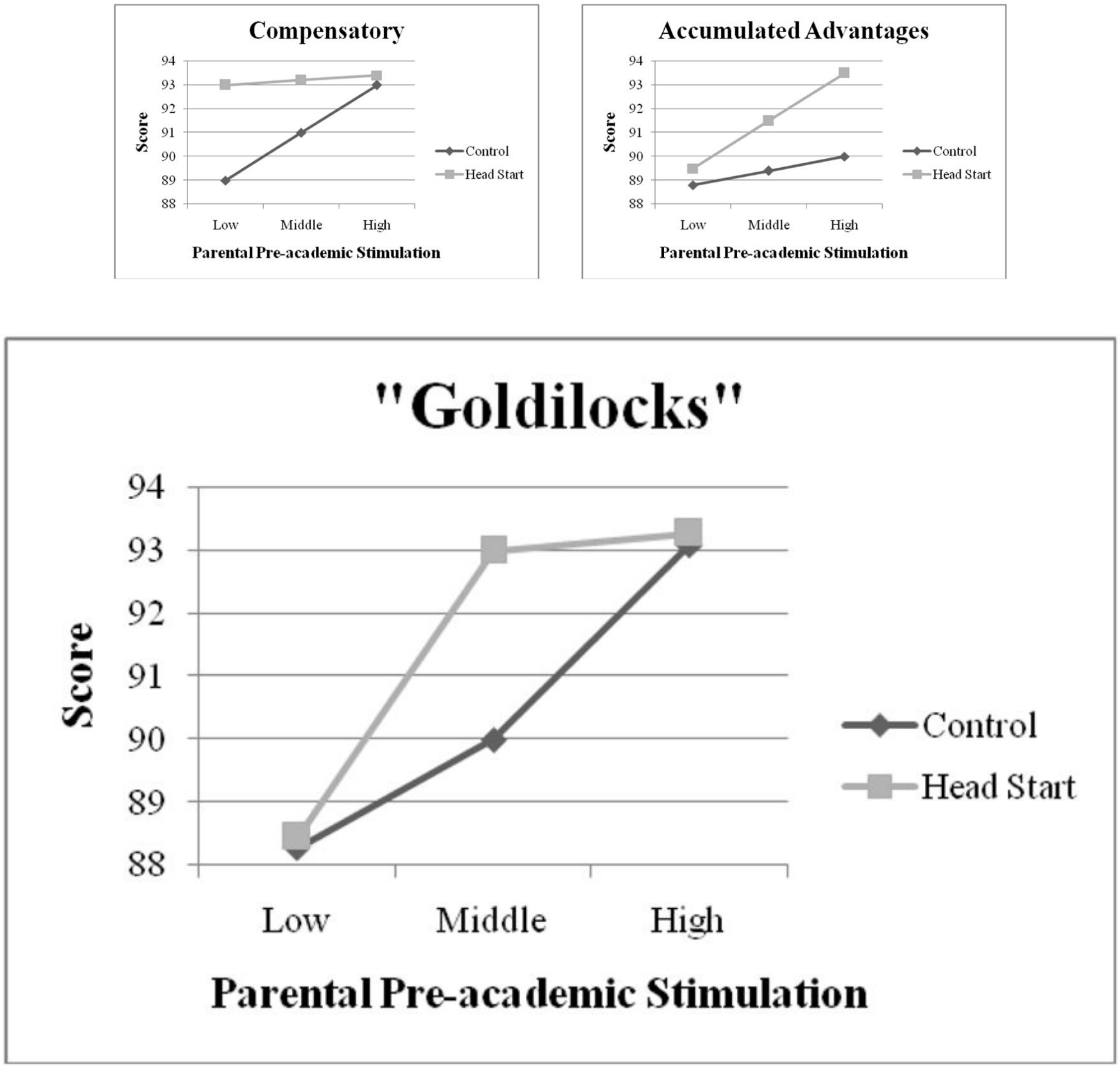

Figure 1.
Idealized graphical models of the three hypotheses surrounding Head Start and parental preacademic stimulation.

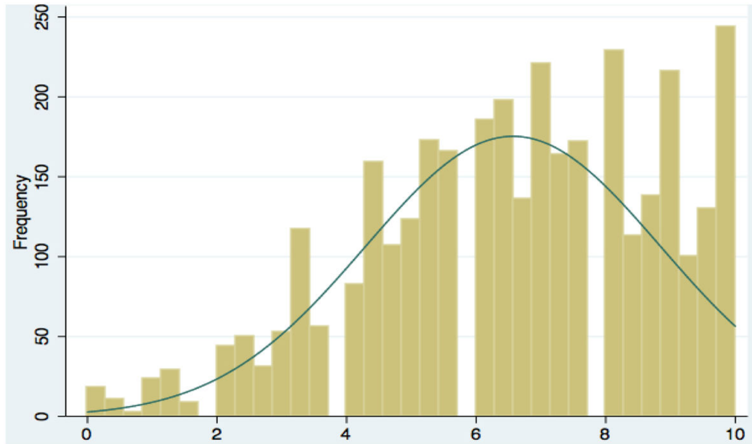

Figure 2.
Histogram of composite parental preacademic stimulation measure with normal overlay.

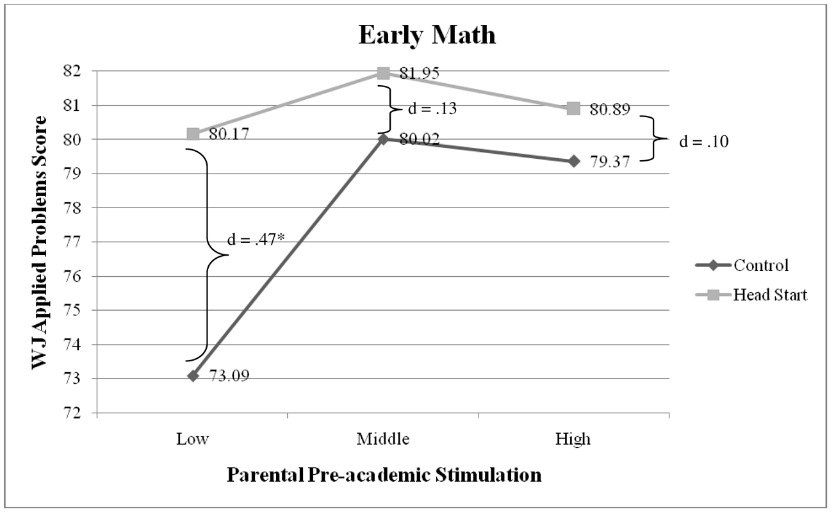

Figure 3.

Predicted Head Start treatment effect for early math, consistent with a compensatory pattern. Head Start effect sizes calculated at each level of parental preacademic stimulation, indicated by “d”. Asterisks indicate the treatment-control difference at low parental stimulation to differ significantly from the treatment-control difference at middle parental stimulation. (* $p < 0.05$)

WJ = Woodcock-Johnson III

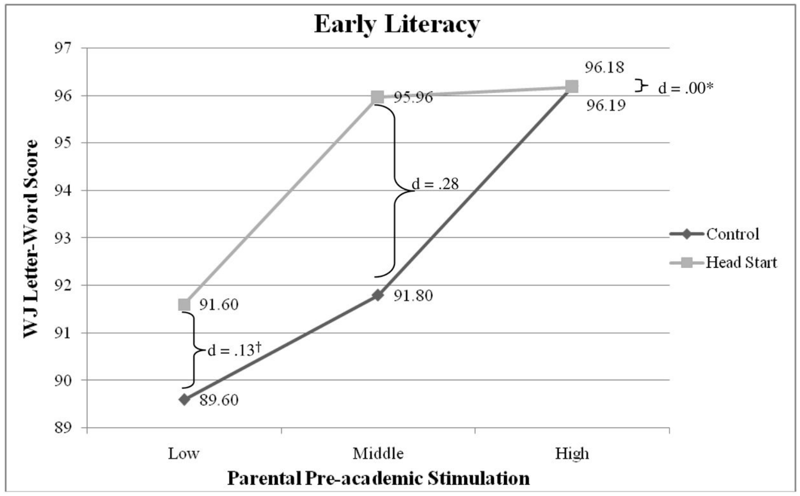

Figure 4.

Predicted Head Start treatment effect for early literacy, consistent with a “Goldilocks” pattern. Head Start effect sizes calculated at each level of parental preacademic stimulation, indicated by “d”. Asterisks indicate the treatment-control difference at low and high parental stimulation to differ significantly from the treatment-control difference at middle parental stimulation. ($^{\dagger}p < 0.10$ * $p < 0.05$)

WJ = Woodcock-Johnson III

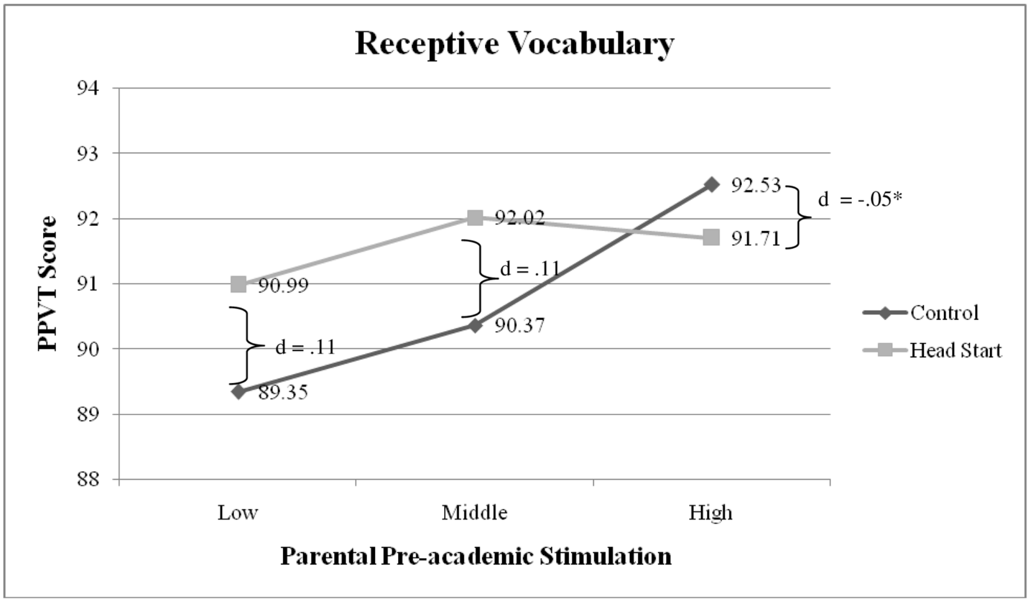

Figure 5.

Predicted Head Start treatment effect for receptive vocabulary, not fully consistent with any hypothesis pattern. Head Start effect sizes calculated at each level of parental preacademic stimulation, indicated by “d”. Asterisks indicate the treatment-control difference at high parental stimulation to differ significantly from the treatment-control difference at middle parental stimulation. (* $p < 0.05$)

PPVT = Peabody Picture Vocabulary Test

Table 1

Descriptive Statistics - Background and Demographic Controls, Full Sample

	Treatment			Control		
	N	**Mean / % of Sample**	**Standard Deviation**	**N**	**Mean / % of Sample**	**Standard Deviation**
Child Characteristics - Baseline (Fall 2002)						
Age at Spring 2003 assessment in weeks	2292	236.02	31.38	1341	236.13	27.06
Age-3 cohort	2292	0.54		1341	0.55	
Gender - Male	2292	0.49		1341	0.49	
Race	2292			1341		
Black		0.32			0.29	
Hispanic		0.36			0.36	
White & Other		0.33			0.35	
Spanish as baseline testing language	2292	0.24		1341	0.23	
Disability	2292	0.13		1341	0.11*	
Family Characteristics - Baseline (Fall 2002)						
Caregiver age	2292	29.37	8.06	1341	29.08	6.31
Maternal Education	2292			1341		
Less than high school		0.36			0.39	
High school diploma / GED		0.34			0.33	
Beyond high school		0.31			0.28	
Married Mother	2292	0.45		1341	0.46	
Teenage Mother	2292	0.15		1341	0.15	
Parents lived together	2292	0.50		1341	0.51	
Immigrant mother	2292	0.19		1341	0.18	
Home language Spanish	2292	0.28		1341	0.29	
Maternal Depression[a]	2292	0.44		1341	0.36*	

Note. *p* level of treatment/control difference:

* $p < .05$.

** $p < .01$.

*** $p < .001$.

T-tests for differences in means were conducted for continuous variables, chi-square tests for categorical variables.

[a] = Composited from CES-D Depression Scale. Weight used = CHSPR2003WTCA.

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Table 2

Descriptive Statistics - Key Independent Variable and Outcomes

	N	Mean / % of Sample	Standard Deviation
Preacademic Stimulation - Baseline (Fall 2002)			
Number of times child is read to in a week	3305		
Never		0.07	
Once or twice		0.32	
Three or more times		0.27	
Everyday		0.35	
Helped with letters, words, numbers	3305	0.91	
Practiced writing the alphabet	3300	0.63	
Helped with songs or music	3297	0.84	
Worked on arts and crafts	3288	0.62	
Practiced writing or spelling name	3295	0.71	
Practiced rhyming words	3281	0.38	
Counted things or objects	3298	0.80	
Talked about size	3300	0.49	
Talked about calendar	3304	0.58	
Sum of preacademic stimulation activities	3239	6.61	2.25
Academic Achievement - Baseline (Fall 2002)			
WJ Letter Word	3577	91.46	16.82
WJ Applied Problems	3577	89.82	16.16
PPVT	3577	91.55	8.78
Academic Achievement - End of First Year Treatment (Spring 2003)			
WJ Letter Word	3633	92.75	17.32
WJ Applied Problems	3633	89.20	17.99
PPVT	3633	92.28	9.57

Note. WJ = Woodcock-Johnson. PPVT = Peabody Picture Vocabulary Test.

Weight used = CHSPR2003WTCA.

Table 3

Relationship Between Parental Preacademic Stimulation, Assignment to Head Start, and their Interaction

	Outcomes					
	Early Math: WJ Applied Problems		Early Literacy: WJ Letter-Word		Receptive Vocabulary: PPVT	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Low Preacademic Stimulation (Dummy Bottom 10%)	−4.49*** (1.21)	−6.93*** (1.74)	−3.29** (1.00)	−2.20† (1.33)	−1.06** (0.42)	−1.02 (0.64)
Middle Preacademic Stimulation (Dummy 10–90% - REFERENCE)						
High Preacademic Stimulation (Dummy Top 10%)	−0.97 (1.04)	−0.65 (1.75)	1.34 (0.99)	4.39* (1.77)	0.54 (0.48)	2.16** (0.75)
Treatment (Dummy Assignment to H.S.)	2.46*** (0.68)	1.93* (0.76)	3.44*** (0.63)	4.16*** (0.72)	1.40*** (0.29)	1.65*** (0.32)
Low Preacademic Stimulation × Treatment		5.15* (2.32)		−2.16† (1.25)		−0.01 (0.83)
High Preacademic Stimulation × Treatment		−0.41 (2.14)		−4.71* (2.09)		−2.47* (0.97)
Intercept	81.08	80.02	88.80	91.80	89.58	90.37
N	3185	3185	3185	3185	3185	3185
R^2	0.32	0.33	0.32	0.33	0.57	0.57

Note. Standard errors in parentheses calculated using jackknife replicate weights.

$^{†}p < 0.10$.

$^{*}p < 0.05$.

$^{**}p < 0.01$.

$^{***}p < 0.001$.

WJ = Woodcock-Johnson. PPVT= Peabody Picture Vocabulary Test. Covariates (centered at mean): lagged DV, cohort, maternal education, race, gender, maternal marital status, caregiver depression, teenage mother status, caregiver age, child disability status, maternal immigration status, age at spring 2003 assessment, number of weeks elapsed between 09/01/02 and spring 2003 assessment, and if baseline assessment in Spanish. Weight used = CHSPR2003WTCA.