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Do academic preschools yield stronger benefits? Cognitive emphasis, dosage, and early learning

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ABSTRACT

Earlier research details how quality preschool offers sustained benefits for children from poor families. But the nation's typical program yields tepid effects for the average middle-class child. We ask whether pre-k impacts range higher when teachers spend more time on activities emphasizing language, preliteracy, and math concepts. Stronger effects are observed for children attending academic classrooms: up to about 0.27 *SD* in preliteracy and math concepts, compared with peers in home-based care at 52 months of age (n = 6,150). Black children enjoy strong benefits from academic pre-k, up to 0.39 *SD* for math concepts. Estimated benefits equal 0.43 *SD* for the average child attending academic pre-k after about eight months. Gains persist through kindergarten. Results stem from a national sample of children, employing a quasi-experimental method to account for confounders related to family practices and children's earlier proficiencies. Future work might focus on the interplay of academic activities with social dimensions of instructional support.

We know after a half-century of research that high quality preschool yields sustained benefits for many poor children (Duncan & Magnuson, 2013; Pungello et al., 2010; Reynolds, Temple, Ou, Arteaga, & White, 2011; Yoshikawa et al., 2013). But the developmental benefits from attending a typical preschool for the average American child remain small to modest, often fading in elementary school (Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Magnuson, Ruhm, & Waldfogel, 2007; NICHD, 2005).

This paper asks whether preschool results in more robust child development when teachers focus time on classroom activities that foster oral language, preliteracy and math skills, what we label *academic-oriented preschool*. We test whether longer exposure to such classrooms raises the magnitude of effects, benefits that may span cognitive and social domains, and whether children from particular ethnic groups enjoy stronger gains. Our core expectations stem from earlier results showing that many pre-k classrooms offer warm settings for children, while lacking coherent and engaging learning activities (for review, Hamre, 2014). When preschool teachers spend more time on academic-oriented activities, as one specific facet of classroom quality, we expect to observe stronger developmental effects, drawing on a national sample of children and their classrooms.

Theorized within a developmental-risk framework, we know that young children in homes and nonparental settings are variably exposed to rich oral language and cognitively challenging tasks, along with exposure to print material and math concepts (e.g., Livas-Dlott et al., 2010; Gopnik, 2016; Pianta & Stuhlman, 2004). To the extent that such activities offer cognitive facilitation or impart preliteracy competencies inside pre-k classrooms, we expect to observe stronger effects. We draw on a national sample of children (n = 6150, the Early Childhood Longitudinal Study, Birth Cohort [ECLS-B]), who were tracked between 24 and 72 months of age. The analysis extends a quasi-experimental method to rigorously take into account prior factors (confounders) that may influence family selection into pre-k and lift child development as well. The ECLS-B data allow for wide external validity of findings, while being constrained by the range and texture of classroom quality measures.

We do not presume that pre-k teachers currently focus exclusively on academic competencies *or* structured play activities; many blend the two elements of instructional organization. Yet pre-k classrooms in the American context have come to focus more on children's preliteracy and academic competencies, while de-emphasizing social development (Bassok, Latham, & Rorem, 2016). What's not understood is whether this academic orientation inside the classroom results in stronger cognitive growth, or whether effects on social development, be they positive or negative, can be detected. Certain subgroups of children may benefit more from academic-oriented preschool, whether gauged in the cognitive or social domain.

Three literatures inform our research questions. First, we review how *instructional organization* – including but not limited to time spent on oral language, preliteracy and math activities – generally elevates

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children's cognitive growth. Second, we review prior work on how pre-k effects are conditioned by the length of children's attendance (*dosage*). Third, we ask whether certain *groups*, namely Black or Latino children, may benefit from academic-oriented preschool, given home conditions and disproportionate selection into pre-k centers, including Head Start, that may display this academic emphasis.

1. Classroom activities and preschool benefits

Taking high-quality preschool to scale and sustaining developmental gains has been a challenging task. Oklahoma's universal preschool effort has shown encouraging results for poor children in Tulsa, along with gains for the one-third that came from non-poor families (Gormley, Gayer, Philips, & Dawson, 2005). Similar benefits have been observed in Boston and Chicago, where programs largely serve children from low-income families (Reynolds et al., 2011; Weiland & Yoshikawa, 2013).

But early studies drawing on national samples reveal small effect sizes for the average American child attending a typical preschool (Loeb et al., 2007; Magnuson et al., 2007). Few studies are designed to disaggregate pre-k effects for children from poor versus middle-class family backgrounds – even as the nation's middle-income households grow more diverse. The overall effect of pre-k attendance was estimated at 0.13 *SD* by the Loeb team, ranging up to 0.23 *SD* for preliteracy skills of Latino children, compared with peers who did not attend preschool and based on quasi-experimental techniques. Magnuson's team, also drawing on a national sample, estimated similarly tepid mean effects from pre-k, compared with home-based care. Even when cognitive gains do appear, they often fade-out by the fifth grade (NICHD, 2005).

Still, research that takes quality measures into account (most often relying on local samples) does find stronger pre-k effects, even for less-poor or middle-class children, especially when classroom practices emphasize preliteracy skills or carefully structured tasks focusing on math concepts, ranging between 0.13 and 0.37 *SD* depending on child subgroups and outcome measures (Landry, Anthony, Swank, & Monsegue-Bailey, 2009; Mashburn et al., 2008; Pianta & Stuhlman, 2004; Weiland & Yoshikawa, 2013). Cognitive gains can be absent when teachers exhibit steady emotional support, but spend less time on activities that nurture preliteracy skills (Pianta et al., 2005).

Idle time inside classrooms or over-reliance on unguided play appears to reduce the beneficial effects of preschool on cognitive growth (Early et al., 2010). On the other hand, more time spent on tightly organized activities with rich academic content helps contribute to cognitive gains (Chien et al., 2010; Landry et al., 2009). One observational study from 671 pre-k classrooms found that organized time spent on oral language and preliteracy activities, along with supportive interactions, yielded significant effects on 4 year-olds' expressive language, pre-reading skills, and knowledge of math concepts, with effect sizes ranging up to 0.32 *SD* (Burchinal, Vandergrift, Pianta, & Mashburn, 2010). Academic content is variably animated by teachers in the feedback they provide to children, offering cognitive facilitation and motivating encouragement, the construct of instructional support (e.g., Pianta et al., 2014). We focus on the first part of this theorized model: how time spent on academic activities may lift growth, recognizing that classroom tasks are embedded in differing forms of social interaction with adults and peers.

1.1. Academic orientation and social development

Fear of didactic practices or "direct instruction" animates much of the worry over increased time spent on preliteracy and math activities in pre-k classrooms (Gopnik, 2016). Nurturing the child's capacity to explore or to construct their own understandings of language or mathematical concepts is what's developmentally appropriate, many practitioners and psychologists argue (e.g., Copple & Bredekamp, 2009). Earlier work has detailed the prevalence of direct instruction in many preschools, where teachers emphasize memorization of facts or academic knowledge, even in classrooms serving 3 or 4 year-olds (Hamre, 2014; Stipek, Feiler, Daniels, & Milburn, 1995).

At the same time, we know that children's feelings of competence or efficacy, often experienced when engaged in stimulating learning tasks, help to predict steeper cognitive gains (Blankston et al., 2013; Denham et al., 2003; Lemerise & Arcenio, 2000). The child's emotional confidence and eagerness to engage in classroom activities similarly contribute to gains in knowledge of math concepts (Galindo & Fuller, 2010), including when facilitated through "guided play," defined as "a discovery-learning approach intermediate between didactic instruction and free play" (Fisher, Hirsh-Pasek, Newcombe, & Golinkoff, 2013:1872). Similarly, McCartney et al. (2010) found that time spent in cooperative peer activities, including cognitively rich tasks, helped to buoy young children's social development (also, NICHD, 2005).

Indeed, a less dichotomous model of play versus academic content has emerged over the past generation, one that includes cognitive facilitation, emotional support, *and* socialization, at times including guided-play activities. Unstructured play or over reliance on child-selected activities may fail to advance cognitive outcomes, even those linked to creativity or cooperative problem-solving (Lillard et al., 2013). Still, work by Bridget Hamre and colleagues shows that consistent instructional support by teachers – manifest in well-structured tasks, enrichment of oral language, and supportive feedback to children – spills over to advance children's self-regulation and cooperative skills as well (Hamre, Hatfield, Pianta, & Jamil, 2014). We know less about whether academically intensive classrooms – spending more time on oral language, preliteracy, or math activities – shape children's social development, beyond gains in the cognitive domain, and whether such effects are discernible with national samples of children and classrooms.

We contribute to this work on instructional organization by estimating whether teachers' emphasis on oral language, preliteracy, and math activities – their *academic orientation* – may affect growth in children's cognitive *and* social competencies, drawing on nationwide data and moving beyond local samples. The present paper does not speak to the wider debate over learning-through-play or the direct instruction of young children. We do directly test whether greater classroom time spent on academic-oriented activities yield gains in both developmental domains.

The effects from activity structures in classrooms are likely moderated by other dimensions of quality, especially the character of teacher-child interactions (e.g., Downer, Sabol, & Hamre, 2010). But first, we assess whether academic-oriented preschools yield stronger effects than previously observed in national studies, which failed to distinguish variation in classroom activities, or gauge benefits for differing groups of children.

1.2. Dosage and academic orientation

The magnitude of preschool effects, including the possible benefits of academic-oriented programs, may be sensitive to the timing or length of pre-k attendance. Such dosage effects may stem from the age at which a child enters preschool, as well as the hours of exposure each week. Karoly, Kilburn, and Cannon's (2005) review found that more time spent in preschool, entering at age 3 or attending more hours per week, was associated with stronger developmental gains. This earlier literature did not benefit, however, from national samples of children, take into account which children select into differing dosage conditions, or distinguish between cognitive and social outcomes.

A review by Zaslow et al. (2010) finds that more hours attending preschool each day are associated with stronger social development and knowledge of math concepts, at least for poor children. The NICHD (2005) longitudinal study offered the advantage of looking at continuous monthly exposure to home- or center-based care over time, finding stronger cognitive gains for children spending more hours in preschool. But no sustained social-development benefits from additional weekly hours in nonparental care could be discerned (Duncan & NICHD, 2003). The Loeb et al. (2007) team found that full-day programs (at least 30 h per week) yielded higher effects on cognitive growth only for Black preschoolers, relative to half-day attendance.

Turning to a second form of dosage – earlier entry into preschool – the findings are encouraging when it comes to cognitive benefits. Loeb, Fuller, Kagan, and Carrol (2004) found that children who had entered a center by 2½ years of age and remained through age 4 displayed stronger cognitive gains, compared with non-attenders or peers entering after 2½ years of age. A longitudinal study in Britain, tracking over 3,000 young children through 141 preschools and into elementary school, found distinct benefits from higher quality, especially for children who entered at 2 or 3 years of age or attended more hours per week (Sylva, Melhuish, Sammons, Siraq-Blatchford, & Taggart, 2011). Similar results come from the experimental Head Start evaluation (Puma et al., 2012). Children entering Head Start at age 3, rather than 4, displayed greater gains in oral language or, for Spanish speakers, word recognition, through grade 1, compared with the control group.

Dosage effects are likely conditioned by facets of preschool quality. Children from poor families attending two years or more in high-quality Chicago Parent-Child Centers displayed more sustained cognitive and social benefits, compared with peers who attended for just one year (Reynolds et al., 2011). What remains unknown is whether higher doses of academic-oriented preschool prove more effective and lift the early learning of certain groups of children. Nor do we know how child age may interact with pre-k quality to shape early development, even in nonlinear fashion, as youngsters mature.

1.3. Child background and academic orientation

We know that the size of preschool effects differs between poor – more often Black and Latino children – and middle-class White children. Still, much less is understood about how preschool may lift the average child from a middle-income family. This question becomes more pressing as many American families, while middle class, become more diverse in their ethnic or cultural heritage, along with holding differing literacy traditions. This requires scholars to move beyond a sole focus on children from low-income households and the preschools that serve them (Fuller & Garcia Coll, 2010; Bassok, 2010). Subsamples of non-poor children remain small in local studies of pre-k effects, including the studies in Boston and Tulsa (Gormley et al., 2005; Weiland & Yoshikawa, 2013).

Causal pathways that account for pre-k effects may operate differently among social-class groups. One stems from a developmental-risk frame, arguing that children exposed to weaker preliteracy practices, less rich oral language, or differing discourse patterns at home (including only recent exposure to English in the case of second-generation Latinos), may show steeper growth when attending academic-oriented pre-k. That is, a compensatory process may operate and apply to groups of children whose parents have risen into the middle class but lack strong traditions of literacy or reading at home.

The pre-k studies from Boston and Tulsa find stronger pre-k effects for Latino children in the cognitive domain, relative to other ethnic groups (Gormley et al., 2005; Weiland & Yoshikawa, 2013). One review of 25 studies, drawing from national and local samples, found promising benefits for Latino preschoolers, but uncovered little work on how instructional organization or classroom language may shape effect sizes or the persistence of gains through elementary school (Buysse, Peisner-Feinberg, Páez, Hammer, & Knowles, 2014). Bassok (2010) found significant pre-k effects for Black children from non-poor families, but again we don't know whether the magnitude of such benefits are stronger in academic-oriented programs.

Another pathway for how pre-k may affect children's growth differentially among ethnic groups stems from our discovery that Black and Latino children largely sort into publicly subsidized programs that often score high on academic orientation, compared with fee-supported preschools that generally serve middle-class peers. So, we must consider selection patterns into differing types of preschool before estimating ethnic-specific effects as detailed below.

1.4. Unique contribution and research questions

In summary, we don't know whether preschool teachers who spend more time on oral language, preliteracy, and math skills – academic activities that reflect one dimension of classroom quality – yield stronger effects on children's cognitive or social development, relative to prior estimates tied to the average, rather undifferentiated pre-k program. The present study directly informs this question, along with whether the effects of academic-oriented preschools are moderated by dosage, or enjoyed by certain groups of children more than others.

The structure of academic activities likely interacts with the character of social interactions and related facets of instructional support, as reviewed above. Our ability to test more complex interactions in the present study was limited by the nature of the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) data, which relied on a reduced form of the Early Childhood Environmental Rating Scale (ECERS) to gauge quality. Its subscales showed no consistent effects on child outcomes, replicating findings reported by Gordon, Fujimoto, Kaestner, Korenman, and Abner (2013). Thus our hypotheses focus on the potential effects of time spent on academic classroom tasks. We will return to how improved designs might test for interactions among the structure of instructional activities, character of adult-child interactions, and collateral dimensions of classroom quality. We specifically examine this sequence of hypotheses:

H1. Children attending preschool at about 48 months of age show stronger cognitive and social-developmental outcomes overall, compared with peers who do not attend preschool. This initial analysis serves to replicate earlier findings, now with nationwide ECLS-B data, before isolating on the effects of academic-oriented programs.

H2. Children entering preschool between 24 and 36 months of age (*early entrants*) display stronger cognitive and social-developmental outcomes, compared with children entering at about 48 months of age. Children attending preschool at least 20 h per week (*full-time*) will display stronger cognitive and social-developmental outcomes than peers attending fewer hours.

H3. The cognitive and social-developmental benefits of attending an academic-oriented preschool at about 48 months of age display stronger magnitudes than attending the nation's mean preschool program. These effects will be stronger for Black and Latino children, relative to White peers.

H4. The benefits of attending an academic-oriented preschool persist to 60 months of age into the kindergarten year.

Our logic is to first establish overall preschool effects as a baseline, along with examining sensitivities to dosage. Then, we estimate whether academic-oriented programs yield stronger effects than the average pre-k center, and test for whether these benefits are enjoyed by particular ethnic groups and persist into the kindergarten.

2. Methods

We employ a quasi-experimental design that stems from the family of marginal structural models (MSMs), increasingly used in developmental studies to estimate treatment effects from specific interventions, such as home visitation or pre-k, utilizing large-scale population data, while controlling for the prior effects of confounding factors that likely shape both child selection into preschool and downstream outcomes (e.g., Bassok, 2010; Miller, Henry, & Votruba-Drzal, 2016). This allows us to approximate a true experiment when children cannot be randomly assigned to a treatment – in our case estimating the contemporaneous effects of preschool attendance at about 4½ years of age, when ECLS-B field staff actually visited families and directly assessed children, net of the prior effects from confounders. We then test whether the positive benefits of pre-k persist into the subsequent data wave after most children had entered kindergarten.

MSM estimation strategies do not eliminate bias introduced by unobserved confounders. But by controlling for observed selection factors and weighting cases based on the likelihood of entering the treatment, the risk of mis-specification bias is reduced relative to ordinary least-squares. The comparison group consists of children who are not enrolled in preschool at the 48-month data wave. For the persisting-effects analysis, when children were 60–72 months of age, the comparison group consists of children who had not attended pre-k and had not yet entered kindergarten. MSM techniques, including propensity-score matching, build from a first-stage selection model that accounts for observed selection factors. While the National Center for Education Statistics (NCES) termed the data collection panel as “48 months,” almost half the children were assessed at 54 months or older. This allowed for longer exposure to preschool, as reported by parents. But it remains important to test for the sensitivity of pre-k effects to dosage.

Our hypotheses center on three treatment conditions experienced by children. The first is simply whether the child is *attending any preschool* at 52 months of age (the actual mean age of assessment) versus cared for within any home setting (Hypothesis 1). Second, we test whether three forms of *dosage* moderate main effects from preschool exposure (Hypothesis 2): attending a preschool for at least 20 h per week or fewer hours each week; whether the child was enrolled in a center at 2 or 3 years of age *and* at 52 months, who we term *early entrants*; and the *child's age* at assessment interacted with pre-k attendance to gauge the sensitivity of possible effects to the child's age.

Similar to prior work (Hofferth, Brayfield, Deich, & Holcomb, 1991) we defined weekly attendance of 20 h or more per week as *high dosage*, and < 20 h per week as *low dosage*. This split the working sample into two roughly equal counts of children. All instances of preschool were used for each child. For example, if a child was enrolled in two centers, each for 10 h per week, then the child was classified as high-dosage. We conducted a sensitivity analysis to see if using a cutoff dosage of 10 h per week yielded differing estimates. Effects proved stronger when utilizing the 20-h threshold.

We identified those children who first entered a center-based program by the earlier 24-month fielding of home visits, when children were 2 or 3 years of age, those we call *early entrants*. The literature reviewed above suggests that earlier exposure to pre-k centers yields stronger benefits, compared with not entering preschool until 4 years of age.

We interacted each pre-k treatment condition with the child's age in months at assessment, further checking for sensitivity to dosage. We expect that longer exposure in months to each treatment will yield stronger preschool effects. Child age is not perfectly correlated with months of preschool attendance, but it may further gauge dosage.

Third, we turn to our core hypothesis testing, estimating whether children attending a preschool in which teachers report more time spent on oral language, preliteracy, or math-concepts activities – *academic-oriented* – display stronger developmental levels, compared with children in home-based care (Hypothesis 3). We test for moderating dosage effects and whether the benefits of academic orientation prove stronger for Black or Latino children.

Our analytic strategy involves estimating the discrete effect of preschool attendance at both the 48- and 60-month data waves. We focus the analysis on the 48-month data wave, when the mean child was 52 months of age and ECLS-B field staff visited homes and directly assessed children. This holds the advantage of estimating contemporaneous effects during the period most proximal to when most children experience preschool; teacher reports of their classroom activities occur at this period as well.

One constraint in estimating pre-k effects at 48 months with ECLS-B data is that parent interviews did not glean knowledge of how many months the focal child had attended a preschool prior to the 48-month home visit. We do know that the 48-month preschool spell began prior to the home visit, and we know whether the child had earlier attended a center-based program at 2 or 3 years of age. And again, by interacting age at assessment with each pre-k treatment condition, we further determine sensitivity to dosage.

To further verify that child effects are gauged after experiencing the full pre-k treatment, along with the sustainability of benefits, we tested for preschool effects about one year later, at the 60-month data wave (Hypothesis 4), after 77% of the children had entered kindergarten. We estimated these persisting effects separately for children who had entered, or had not yet entered, kindergarten. This distinguishes the independent effects of earlier preschool exposure at the 48-month data wave from the likely benefits of kindergarten attendance.

2.1. Child sample

We utilize data from successive data waves of the ECLS-B, fielded by the National Center for Education Statistics (NCES, 2007). A national probability birth sample was drawn in 2001, based on 114 primary sampling units (mainly counties). NCES first conducted 10,700 home visits when focal children were about 9 months of age. We draw on subsequent maternal interview and child assessment data collected at the 24, 48, and 60-month data waves. Interviews asked about family attributes and current child care or preschool enrollment, along with direct child assessments and videotaping of mother-child interactions. As part of the 48-month field work, the child's preschool teacher was interviewed regarding learning goals, school-readiness beliefs, and classroom activities, including time spent on structured activities designed to advance oral language and preliteracy skills, math concepts, and other activities tied to academic knowledge.

Since our preschool-selection model includes maternal attributes and home practices (along with the child's cognitive proficiencies at 24 months), we excluded children who did not reside with their birth mother during the first 4 years of life, along with those suffering from congenital birth defects. This reduced our working sample from 8,100 to 6,150 weighted children (matched to resident birth mothers) with complete data on all necessary variables (rounding to the nearest 50 under NCES rules).

We use Stata's ‘svy’ algorithms that specify sample weights, primary sampling units, and strata to allow inferences to the U.S. population. For most analyses, a sampling weight, W3R0, and corresponding sampling unit and stratification variables were used. For the analysis that includes variables from the teacher interview, we use the weight W33J0 to adjust for variable response rates as recommended by NCES.

2.2. Measures

2.2.1. Cognitive and social-developmental outcomes

Direct assessments of the focal child's language and preliteracy skills were completed, as well as parent reports of social behavior, using similar measures at the 48- and 60-month data waves. The 48-month preliteracy battery covered receptive language, vocabulary, and prereading skills, drawn from the Peabody Picture Vocabulary Test, along with knowledge of print material, letter-sound relationships, letter recognition, phonological awareness, and understanding of spoken words (NCES, 2007). At the 60-month data wave a two-stage adaptive test was employed to assess word recognition and comprehension, gauging similar constructs but not vertically aligned with the 48-month instruments.

The math-concepts assessment gauged children on six constructs:

number sense, counting, operations, geometry, pattern understanding, and measurement. We utilized the IRT scale scores calculated by NCES. Both the language-preliteracy and the math-concepts instruments showed strong inter-item reliability, with estimates near or above 0.90 for the IRT-based scores at both the 48- and 60-month data waves.

The focal child's social-emotional status at 48 months was measured from 24 items asked of the parent, usually the mother. These Likert scales pertained to negative and positive behaviors, drawn from the Social Skills Rating System (Gresham & Elliott, 1990) and the Preschool and Kindergarten Behavioral Scales (Merrell, 2002). Using principal components analysis, we identified 14 inter-correlated items as 'pro-social' and 9 items as 'active or aggressive,' from which IRT scores were generated using a partial credit model.

2.2.2. Child and family background measures – selection model

Our analytic strategy is based on the assumption that influential confounders are observed and can be included in the first-stage selection model. We found that 23 covariates strongly predicted the likelihood of the child attending preschool at 48 months of age. These covariates fell into five categories: prior attendance in a center-based program (at the 24-month data wave); basic demographic attributes of the mother, including maternal education and ethnic membership; the family's socioeconomic status; the child's health status; and pro-development activities in which the child was engaged (e.g., frequency of mother reading with the child, going to the library).

2.2.3. Defining preschool

The mother reported at each home visit (24, 48, and 60-month fieldings) whether the focal child *currently* received care within a Head Start center, 'preschool,' or 'child care center' (NCES, 2007). We combined these responses into a 'preschool' category, recognizing that not all centers offer an enriched learning program. The reference group for age 52-month estimations was thus defined as children in any form of home-based care, whether care by parent or kin member, paid babysitter, or family child-care home charging fees.

2.2.4. Defining academic-oriented classrooms

We constructed an index of time spent each week on academic activities that focused on building oral language, preliteracy skills, or knowledge of math concepts, as reported by the child's pre-k teacher. This index of *academic orientation* was built by summing four items. They included a common stem related to the amount of time spent each week on, for example, names and sounds of letters, simple writing, phonics, and counting manipulatives, each tied to 6-point Likert scales, ranging from 'never' (0) to 'three or four times a week' (4) and 'every day' (5). The maximum score (20) reflects everyday use of letter names, writing, phonics, and counting manipulatives. Scores of 16 and higher – scoring a 4 or higher per item on average – were considered as indicating an *academic-oriented* preschool. This cut-point holds face validity in terms of regular attention to academic knowledge most days in pre-k classrooms.

The four-item index displayed adequate internal reliability (Cronbach $\alpha = 0.81$), with commensurately high item-to-index associations. For example, the teacher's reported frequency of working on names of letters, simple writing tasks, or counting manipulatives was correlated with the academic intensity index at $r = 0.71$, 0.75, and 0.61, respectively. Testing for convergent validity (Campbell & Fiske, 1959), we examined associations between the academic index and similar constructs measured during the same teacher interview. The index was correlated with other frequently organized activities in the classroom, such as the prevalence of teaching print conventions (0.39), counting out loud in a group (0.32), playing math games (0.44), along with select teacher beliefs regarding the importance of academic skills for "school readiness", further detailed in the Appendix. Adding scales to our index (e.g., teacher-reported priority assigned to academic knowledge or cognitive skills) neither improved inter-item reliability, nor the index's magnitude of predictive validity vis-à-vis child outcomes.

Note that teacher reports of time spent on academic-related activities differ from measures of instructional quality, concept development, or supportive interactions between teacher and children when derived from classroom observations (Burchinal et al., 2010). Much remains to be learned about the complementarities between the organization of academic tasks and other measures of instructional quality.

2.3. Procedure

We conceptualize the impact of rival preschool settings within a potential outcomes framework for causal inference, sometimes termed the *Rubin causal model* (Holland, 1986). The effect of treatment 1 (preschool) compared with treatment 0 (staying at home) for a child at about 48- or 60-months of age is defined as the difference in the potential outcomes Y(1) and Y(0) that the child would achieve if she hypothetically received these treatments. We then estimate average treatment effects with MSM estimation developed by Robins, Hernán, and Brumback (2000).

Average treatment effects are expressed as functions of the regression coefficients of the MSM. We estimate the MSM regression coefficients using inverse-probability-of-treatment-weights (IPTW; Bassok, 2010; Hill, Waldfogel, Brooks-Gunn, & Han, 2005, in the developmental literature). The IPTW technique holds the advantage, compared with propensity-score matching, of accommodating multiple treatment conditions. Weights are derived from the inverses of each child's estimated probability of selecting into the treatment that the child in fact received, derived from fitting the logistic model that predicts selection into preschool, the *selection model* as reported below. The IPTW weights are combined when intersecting conditions are specified, such as for children who experience high dosage of academic-oriented preschool. Our models recognize dependence of potential outcomes on age, and we estimate treatment effects at the actual mean age of assessment, that is 52 months for the 48-month data wave.

The MSM must consider a vector of potential outcomes for each child for each treatment and each month of assessment. We let $Y(a,t)$ denote the potential outcome a child would achieve if, possibly contrary to fact, she received treatment a and was assessed at age t months. For example, Y(0,52) is the counterfactual outcome at 52 months for a child receiving at-home care. We illustrate the MSM for Hypothesis 1. The two treatments are preschool ($a = 1$) and at-home care ($a = 0$, the reference group). Our parameter of interest is the average treatment effect of treatment 1 relative to treatment 0 at 52 months, E[Y(1, 52) - Y(0, 52)]. Our MSM allows for a quadratic relationship between the potential outcome and age, along with an interaction between age and treatment (if found to be statistically significant at the 5% level):

$$E\,[Y\,(a,\,t)] = \beta_0 + \beta_1 a + \beta_2 t_c + \beta_3 t_c^2 + \beta_4 a \times t_c$$

where $t_c = t - 52$, so that β_1 is the parameter of interest. Parallel MSMs were then constructed for each hypothesis. The necessary check for propensity balance, ensuring a sufficient count of cases for treated and untreated contrasts, appears in the Appendix.

3. Results

3.1. Which children enter preschool?

Table 1 reports attributes of sampled children and families, split by the organizational auspice of the preschool in which children were enrolled at the 48-month data wave. This illuminates differing selection paths by parents into various preschool types. We see that among children selecting into a Head Start preschool, 31% were Black, 34%, Latino, and 28% non-Latino White. Yet among Independent nonprofit preschools (non-Head Start, non-school district based), enrollments

Table 1
Selected Child, Family, and Organizational Characteristics by Type of Preschool Selected During 48-month Data Wave (weighted frequencies and means).

N of preschool organization cases	Federal Head Start			School district based			Independent-nonprofit		
	No 900	Yes	*t*-Value	No 550	Yes	*t*-Value	No 1100	Yes	*t*-Value
Child									
Ethnicity									
African American	10.9%	31.3%	8.27***	15.9%	17.7%	0.71	13.7%	15.3%	0.87
Latino	19.8%	34.2%	4.83***	17.7%	28.2%	2.79**	17.8%	21.2%	1.48
White (non-Latino)	62.4%	28.0%	− 14.56***	61.1%	47.7%	− 3.20**	62.7%	57.5%	− 1.76†
Family									
Below the poverty line	18.1%	48.9%	13.14***	20.4%	28.6%	2.61**	17.9%	23.2%	2.32*
Mother's educational level									
High school or less	43.3%	74.7%	13.92***	40.7%	63.0%	6.10***	38.4%	41.3%	1.03
Some college	45.2%	24.3%	− 9.68***	46.7%	33.6%	− 3.51**	47.8%	45.1%	− 1.07
Core elements of academic orientation									
Letter names	4.1	4.5	7.19***	4.3	4.4	2.00*	4.3	4.4	1.71~
Writing	3.5	3.9	5.63***	3.6	3.5	− 0.57	3.6	3.7	2.04*
Phonics	4.0	4.3	6.15***	4.2	4.4	2.86**	4.2	4.3	1.99*
Counting manipulatives	3.5	4.0	6.37***	3.8	3.9	1.24	3.8	3.9	0.61

Note: *N*'s rounded to nearest 50. Field staff observed a purposefully selected sample of preschool centers.
* $p < 0$ 0.05.
** $p < 0$ 0.01.
*** $p < 0$ 0.001.
† $p < 0.1$.

were 15% African American, 21% Latino, and 57% White, mirrored by differences in family poverty and maternal education levels.

Turning to variation in time spent on academic-oriented activities, we see that Head Start teachers reported more frequent deployment of academic tasks, compared with teachers in other preschools. Conversely, teacher emphasis on language, preliteracy, and math skills tended to be weaker in preschools serving more advantaged children. Thus, children are not randomly distributed across preschools when it comes to their teacher's academic orientation. Program boundaries and institutional histories matter.

Table 2 reports estimates for our selection models, estimating attendance in differing kinds of preschool at 52 months of age on average (48-month wave), as well as levels of dosage selected. The first column shows results for selection into any form of preschool, where the reference group includes children not currently enrolled in preschool. Columns 2 and 3 show logistic regression results for selecting high-dosage (at least 20 h per week) by type of preschool. Column 4 shows results for selecting an academic-oriented preschool, conditioned upon attending any preschool.

Black children are *more* likely to select into academic-oriented preschools, along with children residing in the South. Children with better educated mothers are *less* likely to enter academic-intense preschools, although these coefficients fall short of significance. This is consistent with the descriptive findings showing that Head Start teachers, serving children from low-income families, tend to emphasize academic-oriented practices, compared with their non-Head Start peers.

3.2. Differing levels of development by treatment group

Table 3 reports mean levels of child outcomes by treatment group, indicating differences *before* taking into account preschool selection factors. We observe much higher preliteracy and math-concepts skills for children attending academic-oriented preschools, compared with peers attending the mean preschool at 52 months of age (48-month wave), equaling over half a standard deviation. Yet variability in social-behavioral scores by type or amount of preschool attended is not significant, foreshadowing generally null effects from pre-k in this domain.

3.3. Benefits of attending preschool

3.3.1. Overall preschool benefits (Hypothesis 1)

Table 4 reports MSM estimates of average treatment effects for the mean child attending preschool at 52 months of age, now accounting for prior selection effects, and taking into account the age of assessment and the interaction of pre-k attendance with age. This starting model offers a baseline against which we can compare effects from academic-oriented pre-k. We see that preschool exposure has a significant positive effect on children's math and preliteracy scores: coefficients estimated as 2.02 ($p < 0.0001$) and 2.27 ($p < 0.0001$), respectively. Each additional month of age-at-assessment is associated with a 0.20 increment in the effect of preschool for both math and preliteracy scores.

These positive effects hold when the MSM model is fit only for Black children, and the estimated coefficients are higher (2.88 and 2.66 for math concepts and preliteracy, respectively), compared with the corresponding coefficients for all children. (We report effect sizes below.) For all children the interaction with age at assessment is significant for cognitive outcomes, which indicates that preschool effects are larger for older children. Results for Latino children, however, were not appreciably different from the results for White peers (available from the authors).

3.3.2. Additional effects from preschool dosage (Hypothesis 2)?

Table 5 reports similar MSM results, now testing for possible effects from a higher dose of preschool. We see in columns 1–2 that children attending either low- or high-dose preschool show stronger math-concepts scores at 52 months (48-month wave), compared with children remaining in home-based care. The age × high dosage interaction further shows that the effect of high-dosage preschool increases by 0.27 for each additional month of the age at which the mean child was assessed. Columns 3–4 show very similar results for preliteracy scores, but again we see no effects on children's social development.

Significant benefits for African American children are observed in high-dose preschools. Low-dose coefficients are positive but statistically insignificant. Each additional month of age-at-assessment is associated with an estimated 0.04-point greater effect of high-dosage preschool on social development ($p < 0.05$). This finding deserves greater attention in future research. It is the only discernible effect of pre-k attendance on social-behavioral growth that we observed.

Table 2
Estimated odds of family selection into preschool during 48-month data wave

	Preschool	Low dose (< 20 h/week)	High dose (at least 20 h/week)	Academically oriented preschool[a]
Attending preschool at 24 months	2.75***	1.63**	3.91***	1.07
Ethnicity				
Black	1.11	0.59**	1.63**	1.49*
Hispanic	0.69**	0.64**	0.80	1.02
Asian	0.73	0.71	0.80	1.09
Native American	1.29	0.78	2.11**	1.49
Other	0.69	0.60*	0.83	1.86
Gender				
Female	1.12	1.12	1.13	0.92
Father type				
Birth father lives with child	0.76*	1.03	0.61***	0.87
Foreign born; years in US				
< 5 years	1.32	1.22	1.43	1.53
≥ 5 years	1.36	1.24	1.49*	0.75
Primary home language				
English	0.93	0.92	0.92	0.70
Child's health				
Overall health	0.94	0.91	0.96	1.14
Parent-child activities				
Reading together	1.02	1.04	1.02	1.04
Visiting a library	1.14	1.25*	0.98	0.76
Socioeconomic status				
Household income	1.07***	1.12***	1.02	1.05
Geographic region				
Midwest	0.49***	0.66*	0.34***	1.25
South	0.54***	0.42***	0.56**	1.38*
West	0.52***	0.68*	0.35***	1.49
Mother's employment status				
Mother works ≥ 35 h/week	0.98	0.63***	1.57***	0.78
Mother works < 35 h/week	0.97	0.94	1.03	1.08
Size of household				
Ratio of children to adults	0.97	1.15	0.81*	0.95
Mother's education				
Some college	1.7***	1.71***	1.66***	0.79
Graduate school	2.50***	2.26**	2.88***	0.83
N of children	6150	6150	6150	2100
Reference Group	No preschool	No preschool	No preschool	Nonacademic preschool

[a] Conditional on attending preschool at least 20 h per week.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

3.3.3. *Does early entry to preschool matter?*

We tested for the second possible dosage effect: whether entering preschool between ages 2 and 3 years (24-month data wave) *and* being enrolled at 4 years of age (48-month wave) yields stronger effects, compared with children who did not enter until the 48-month point. The estimation model revealed significant effects for early entrants relative to peers who entered one to two years later, as shown in Table 6. This analysis was conducted only for children attending preschool at the 48-month wave, 850 of whom were early entrants (14% of the full sample), given our focus on additional effects of treatment conditions for those entering at about 24 to 30 months of age.

The effect of early preschool entry for those in preschool at the 24-month wave on math concepts is stronger than the effect of later entry for all children (treatment coefficient equals 3.23, compared with 2.02, the latter shown in Table 4). The mean preliteracy score was higher for early entrants as well, but not significant when tested with a linear-combination contrast. Early entrants did not experience a stronger dosage effect when attending academic-oriented preschool (at the 48-

Table 3
Descriptive statistics for child outcome measures during 48 and 60-month data waves, prior to controls for selection factors and possible confounders.

	Math		Preliteracy		Social development	
	Mean	SD	Mean	SD	Mean	SD
48-month data wave assessment (n = 6150 children)						
Full eligible sample of children	29.33	9.36	25.17	9.88	0.97	0.68
No preschool	27.63	8.89	23.26	8.71	0.95	0.68
Low dosage preschool	30.67	9.19	26.56	9.84	0.98	0.64
High dosage academic oriented preschool	30.19	9.89	26.14	11.34	0.97	0.75
60-month data wave assessment (n = 3750)						
Full eligible sample of children	42.96	10.64	42.52	15.40		
Eligible sample attending kindergarten	43.19	10.46	42.93	14.99		
Eligible sample not in kindergarten	38.88	12.85	34.97	20.24		
Attended preschool at 48 months	40.72	12.70	37.12	20.12		
Not attended preschool at 48 months	35.22	12.08	30.61	19.51		

Table 4
Estimated effects (standard errors) of attending preschool of any form during 48-month data wave by child ethnicity, relative to home-based care after taking into account prior selection factors and possible confounders.

	All children			Black children		
	Math	Preliteracy	Social development	Math	Preliteracy	Social development
Age at assessment	0.65*** (0.07)	0.53*** (0.07)	0.01* (0.00)	0.58*** (0.13)	0.59*** (0.16)	− 0.01 (0.01)
Preschool	2.02*** (0.40)	2.27*** (0.47)	0.02 (0.03)	2.88** (0.89)	2.66** (0.95)	0.07 (0.07)
Age × preschool	0.20* (0.09)	0.20* (0.09)	0.00 (0.01)	0.19 (0.17)	0.13 (0.18)	0.03 (0.02)
Intercept	27.97*** (0.34)	23.64*** (0.39)	0.96*** (0.03)	23.99*** (0.68)	20.55*** (0.69)	0.84*** (0.07)
R-squared	0.13	0.09	0.01	0.15	0.13	0.01
N of children	6150			900		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

month wave), relative to non-early entrants.

3.3.4. Stronger effects from academic-oriented preschools (Hypothesis 3)?

Turning to our core question of interest, Table 7 reports on the estimated effects of exposure to high doses of academic-oriented preschool. The treatment conditions are low dose, high-dose nonacademic and high-dose academic-oriented, compared with no preschool (reference group). Columns 1 and 2 show the estimated effects on math concepts and preliteracy at 52 months. Children's exposure to high-dose nonacademic preschool shows significant effects (coefficients estimated at 1.66 and 2.02 for math and preliteracy, respectively). Larger effects are estimated for children attending high doses of academic-oriented pre-k (coefficients of 2.54 and 2.77, respectively, $p < 0.0001$).

The estimated effect on knowledge of math concepts for African American children, stemming from high-dose academic-oriented preschool, is stronger, relative to the benefit observed for the entire child sample. We see estimated coefficients ranging up to 3.43 ($p < 0.001$) for Black youngsters, while the estimate pertaining to preliteracy is 2.73 ($p < 0.02$), similar to the effect for the entire sample.

We also ran the basic model with interaction terms for the child's ethnicity (results available from the authors). Yet this conventional procedure yields imprecise results, since the a priori selection model is no longer specific to that ethnic group. That said, the results were quite similar to results shown in Table 7. The only exception is that we found significantly stronger social development for Latino children attending non-academic oriented preschools, compared with peers in home-based care.

3.3.5. Do preschool benefits persist into kindergarten (Hypothesis 4)?

When estimating the persistence of pre-k benefits out to the 60-month data wave, we must consider whether or not the child had entered kindergarten. This is necessary to identify the discrete effect from preschool attendance experienced at the 48-month wave. So, Table 8 reports MSM results for the effect of attending preschool at the 48-month wave, compared with children who did not attend preschool at 48 months *and* had not yet enrolled in kindergarten at 60–72 months

Table 6
Estimated effects (standard errors) of early preschool entry into academically oriented preschool among children attending preschool at 48-month data wave after taking into account prior selection factors and possible confounders.

	Estimated preschool effects for early entrants	
	Math	Preliteracy
Model 1. Basic preschool attendance at 48 months		
Age at assessment	0.65*** (0.06)	0.48*** (0.06)
Preschool	3.23*** (0.81)	2.50** (0.71)
Age × preschool	0.17 (0.17)	0.31 (0.17)
Intercept	27.09*** (0.31)	22.78*** (0.32)
R-squared	0.12	0.08
Model 2. Attending academically oriented preschool		
Age at assessment	0.65*** (0.06)	0.48*** (0.06)
Low dosage	2.70* (1.26)	2.10 (1.13)
High-dose non-academic	1.45 (1.21)	2.15 (1.39)
High-dose academic	2.57* (1.15)	1.89* (0.86)
Age × low dose	0.13 (0.23)	0.10 (0.25)
Age × High dose non-academic	0.02 (0.29)	0.11 (0.30)
Age × High dose academic	0.35 (0.27)	0.65** (0.20)
Intercept	27.10*** (0.31)	22.79*** (0.32)
R-squared	0.11	0.08
N of children	2700	

Note: Analysis conducted only for children enrolled in preschool at 48 months. Of these 2700 children, 850 were early entrants. Reference group consists of children who did not enter preschool until 48 months.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Estimated effects (standard errors) of preschool dosage on children's cognitive and social development during 48-month data wave after taking into account prior selection factors and possible confounders.

	All children			Black children		
	Math	Preliteracy	Social development	Math	Preliteracy	Social development
Age	0.66*** (0.07)	0.55*** (0.07)	0.01* (0.00)	0.58*** (0.13)	0.59*** (0.16)	− 0.01 (0.01)
Low dosage	1.66** (0.53)	2.02** (0.59)	0.01 (0.03)	1.02 (1.06)	1.96 (1.15)	− 0.06 (0.11)
High dosage	2.29*** (0.48)	2.47*** (0.54)	0.02 (0.04)	3.11** (0.97)	2.58* (1.04)	0.07 (0.07)
Age × low dosage	0.17 (0.12)	0.10 (0.13)	0.01 (0.01)	0.08 (0.21)	0.03 (0.23)	0.02 (0.02)
Age × high dosage	0.27** (0.10)	0.38*** (0.10)	0.01 (0.01)	0.20 (0.18)	0.1 (0.21)	0.04* (0.02)
Intercept	27.96*** (0.35)	23.65*** (0.40)	0.96*** (0.03)	24.03*** (0.69)	20.57*** (0.69)	0.84*** (0.07)
R-squared	0.13	0.09	0.01	0.16	0.14	0.02
N of children	6150			900		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 7
Estimated effects of academically oriented preschool on Children's cognitive and social developmental levels at 48-month data wave after taking into account prior selection factors and possible confounders.

	All Children			African American Children		
	Math	Preliteracy	Social development	Math	Preliteracy	Social development
Age at assessment	0.66*** (0.07)	0.55*** (0.08)	0.01* (0.00)	0.58*** (0.13)	0.59*** (0.16)	− 0.01 (0.01)
Low dose	1.66** (0.53)	2.02** (0.59)	0.01 (0.03)	1.02 (1.06)	1.96 (1.15)	− 0.06 (0.11)
Non-academically oriented	2.01* (0.81)	2.12* (0.87)	0.04 (0.05)	2.05 (1.15)	1.89 (1.22)	0.13 (0.10)
High dose academically oriented	2.54*** (0.54)	2.77*** (0.57)	− 0.01 (0.05)	3.43** (0.98)	2.73* (1.11)	0.06 (0.08)
Age × low dose	0.17 (0.12)	0.10 (0.13)	0.01 (0.01)	0.08 (0.21)	0.03 (0.23)	0.02 (0.02)
Age × High dose non-academic	0.30 (0.17)	0.32 (0.22)	0.00 (0.01)	0.42 (0.29)	0.21 (0.31)	0.03 (0.03)
Age × High dose academic	0.26* (0.11)	0.42** (0.12)	0.02 (0.01)	0.10 (0.17)	0.19 (0.22)	0.03 (0.02)
Intercept	27.96*** (0.35)	23.65*** (0.40)	0.96*** (0.03)	24.03*** (0.69)	20.57*** (0.69)	0.84*** (0.07)
R-squared	0.13	0.10	0.01	0.17	0.14	0.02
N of children	6150			900		

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

Table 8
Estimated effects (standard errors) of academically oriented preschool at 48-month data wave on children's cognitive development at 60 months, split by children attending, or not yet attending, kindergarten.

	Math		Preliteracy	
Age at assessment	0.87***	(0.08)	1.19***	(0.10)
Children not yet in kindergarten				
Low dosage	4.44	(3.00)	3.80	(4.34)
High dose non-academic	4.67	(4.00)	2.74	(6.02)
High dose academic	7.93**	(2.91)	13.58*	(6.56)
Children attending kindergarten				
No preschool	4.83*	(2.13)	7.32	(3.68)
Low dosage	6.67**	(2.17)	10.81**	(3.66)
High dose non-academic	7.11**	(2.12)	11.95**	(3.87)
High dose academic	6.60**	(2.14)	12.03**	(3.67)
Intercept	36.64***	(2.01)	32.06***	(3.58)
R-squared	0.10		0.11	
N of children	3700			

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

(the relevant reference group). We cannot include children in the reference group who did *not* attend preschool at 48 months but *had entered* kindergarten by 60 months, since we must set aside any discrete kindergarten effect (reducing Table 8 results to $n = 3700$ children).

We do observe persisting benefits from academic-oriented preschool for children who had not yet, *and* among those who had, entered kindergarten by the 60-month data wave. Among the subset of children who had entered kindergarten, any form of earlier preschool attendance yielded significant advantages, relative to the reference group. The size of these coefficients, relative to estimated 48-month effects from preschool, should be interpreted carefully: the reference group is modest in size and more disadvantaged than the treatment groups. Still, the consistency with which preschool effects persist through the kindergarten period, after taking into account prior selection and children's earlier (48-month) cognitive scores, remains encouraging.

3.3.6. Comparing effect sizes for preschool conditions

Table 9 summarizes the differing magnitudes with which preschool influenced child outcomes at the 48 and 60-month data waves in terms of estimated Cohen's *d* effect sizes with pooled weighted standard deviations. Simple exposure to preschool for at least 20 h per week shows modest effect sizes, quite similar to early estimates based on other national probability samples: 0.22 *SD* for math concepts and 0.23 *SD* for preliteracy scores. We also estimate slightly higher effect sizes for children attending high doses of academic preschool, moving up to 0.26 *SD* and 0.27 *SD* for math and preliteracy, respectively. More notable, Black children enjoy stronger benefits, especially in math concepts, ranging up to 0.39 *SD*, and they benefit from higher doses of preschool, whether academic-oriented or not.

The fraction of children who enrolled early in preschool, most by 3 years of age, displayed a 0.34 *SD* advantage in math scores, compared with children who remained in home-based care at the 24 and 48-month data waves. And children displayed higher knowledge of math concepts and preliteracy scores for each additional month of age, when gauged by the age-of-assessment interaction term, equaling 0.03 *SD* in math concepts and 0.04 *SD* in preliteracy scores per month of age.

That is, stronger effects on preliteracy and math concepts stem from each additional month of age. We cannot pinpoint how many months children had attended preschool by the time of assessment. But for a child who entered an academically oriented pre-k at about 48 months of age, he would have been assessed after experiencing 4 months of preschool, that is, at the mean age of 52 months. After an additional 4 months, the effect size of pre-k attendance on preliteracy would equal about 0.43 *SD* (the sum of 0.27 at 52 months, plus 0.04 × 4 months, tied to the effect size of interacting age with academic-oriented

Table 9
Summary of effect sizes for statistically significant MSM estimates of preschool treatment effects (when coefficients $p < 0.05$ or less).

48-Months outcomes		All children		Black children		Early entrants at 24 mos. (compared with later entrants)	
		Math	Preliteracy	Math	Preliteracy	Math	Preliteracy
Preschool effect	Attending preschool at 48-month wave	0.22	0.23	0.32	0.29	0.34	0.27
Dosage effects	Low dosage	0.17	0.20	.	.	0.28	.
	High dosage	0.24	0.25	0.35	0.29	0.26	0.22
Academic orientation	High dose non-academic	0.21	0.21	.	.	.	.
	High dose academic	0.26	0.27	0.39	0.30	0.27	0.20
Age	Age	0.07	0.05	0.07	0.07	0.07	0.05
	Age × high dose academic	0.03	0.04	.	.	.	0.07

preschool). This suggests that children entering pre-k after 48 months of age may experience larger benefits, given they would have been assessed with less pre-k exposure on average. Data sets providing month-by-month enrollment could yield more precise estimates of magnitude.

4. Discussion

We observe positive benefits on the average child's cognitive proficiencies after about five to six months of attending a preschool that is academic-oriented, and these effects display stronger magnitudes than prior studies with national samples, where investigators did not focus on academic intensity, as one specific element of classroom quality. Effect sizes are estimated at 0.02 to 0.07 *SD* higher than those earlier reported for children attending a typical preschool. Among those enrolled in academic-oriented preschool for about 8 months (assuming entry at close to 48 months of age), preliteracy scores ranged up to 0.43 *SD* higher than for children remaining in home-based care.

These benefits from academic-oriented preschools range higher for the average Black child attending at least 20 h per week, where effects ranged up to 0.39 *SD* for math concepts. Effects are sensitive to dosage in other ways. Early entrants – children who enrolled in pre-k at 2 or 3 years of age – displayed stronger benefits in math concepts by the 48-month wave, 0.34 *SD*, compared with 0.22 *SD* for the entire child sample.

Overall, these results offer a more complete picture of how the magnitude of preschool benefits is sensitive to the intensity of academic content and varies among subgroups of children. These effects are stronger for Black children, many raised in poor households. At the same time, cognitive benefits are shared by the average American preschooler, albeit at lower levels of magnitude, when attending an academic-oriented program.

We detected few advantages from attending academic preschools when it came to children's social development. This should assuage the fears of early educators who worry that greater academic intensity undercuts social and emotional nurturance. On the other hand, better organized instructional activities would ideally work to advance children's social competence as well. More work is required to better understand how related dimensions of instructional organization, including the character of teacher and child interactions, may interact with academic activities to advance youngsters' social-emotional growth (e.g., Hamre, 2014).

Our findings show that greater time spent on academic content – focused on oral language, preliteracy skills, and math concepts – contributes to the early learning of the average child at magnitudes higher than previously estimated. We tested the effects of teachers spending more time on academic-related activities, as one particular dimension of classroom quality. We found no collateral main effects from elements of the classroom environment as gauged by the ECERS instrument (replicating Gordon et al., 2013 results). But no textured measures of the teacher's instructional support or teacher-child interactions (e.g., tapped by the CLASS instrument, Mashburn et al., 2008) were available in this particular data set. Additional research is needed to theoretically clarify how activity structures that emphasize academic skills may interact with the social dimensions of classroom quality.

Our inability to detect consistent cognitive benefits for Latino children points to another urgent area for additional research. We did find that Latino children attending non-academic preschool displayed stronger social development, compared with peers remaining in home-based care. But this remains in the context of null effects on social growth for the overall national sample.

The ECLS-B data include a heterogeneous range of Latino-origin children. For those from Spanish-speaking homes, it may be that insufficient classroom time is spent on preliteracy activities to reach a required threshold. Or, weak instructional organization may yield tepid returns when language gaps operate between teacher and child, given the shortage of bilingual teachers (Dickinson, Golinkoff, & Hirsh-Pasek, 2010). Little remains known about the variability of instructional activities to which non-English speaking preschoolers are exposed. Nor do we understand how pre-k efforts can lift young children whose parents may be the first generation to speak English in the home and engage unevenly in literacy practices.

Still, for the average American child it's encouraging to learn that academic-oriented preschool yields benefits that persist into the kindergarten year, and at notably higher magnitudes than previously detected. We must learn more about how complementary dimensions of quality, especially the character of teacher-child interactions, might elevate social-developmental gains in academic-oriented preschools. Time spent on academic tasks alone may not boost the sustainable long-term effects of preschool. Collateral dimensions of classroom quality are in play as well. Future research designs must capture these collateral dimensions of instructional quality, placing richer academic content in the complex social dynamics of preschool classrooms.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.appdev.2017.05.001.

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