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THE PERSISTENCE OF PRESCHOOL EFFECTS FROM EARLY CHILDHOOD THROUGH ADOLESCENCE

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Abstract

Using data from the Early Childhood Longitudinal Study Kindergarten Cohort of 1998 (*n* = 15,070), this study used propensity scores to examine the short- and long-term academic and psychosocial benefits of preschool education for a diverse sample of middle-class children. Compared with children who attended informal care at age 4, preschool attendees consistently performed better on achievement tests from age 5 through early adolescence, but exhibited less optimal psychosocial skills. These negative behavioral effects of preschool were concentrated among children who attended preschool for 20 or more hours per week, but otherwise, there was little evidence of heterogeneity as a function of program type or child- and family-characteristics. The long-term academic advantages of preschool were, however, largely explained by their positive effects on academic skills early in formal schooling and there was evidence for convergence in children's academic test scores, which was partially attributed to the differences in children's social skills during the early elementary school years.

Key Words: preschool; informal care; convergence; persistence; ECLS-K 1998

Educational Impact and Implications Statement

Middle class children across the United States who attended preschool at the age 4 demonstrated stronger academic skills at the start of kindergarten as compared with their classmates who experienced informal care and these academic advantages persisted, albeit at reduced levels, through the end of eighth grade. At the same time, however, children who attended preschool for 20 or more hours per week also demonstrated somewhat greater externalizing behavior problems and less optimal social skills, which in the long run diminished to negligible levels. When taken together, these findings suggest that investments in preschool programs can have long-term academic benefits for children up to a decade later.

The Persistence of Preschool Effects from Early Childhood through Adolescence

Disparities in educational achievement are established early in the life course, and once these gaps are established, children's prospects of upward mobility are diminished (Kalil, 2015). These initial differences in early childhood often accumulate into long-term differences in educational attainment because they shape children's early experiences, including their interactions with teachers and classmates (Entwisle, Alexander, & Olson, 2005), curricular placement (Winsler et al., 2012, 2013), and interactions with their family (Crosnoe, Augustine, & Huston, 2012), such that these systems act on the initial disparities and compound them from year-to-year. These disparities in early learning and development are, thus, the underpinning for later inequality, which is why the early childhood years serve as a critical juncture for intervening in children's long-term educational careers (Heckman, 2008).

There is an extensive literature documenting preschool programs as an effective means of preparing both low-income and middle-class children academically for kindergarten, but there is no consensus on the effects of preschool for children's psychosocial development and even less is known about the extent to which the early academic benefits of preschool persist into adolescence (Phillips et al., 2017). Addressing these questions regarding the *short-term* academic and psychosocial benefits of preschool education—defined as the benefits within the program year or shortly thereafter into kindergarten—and *long-term* benefits of preschool education—defined as the benefits during the elementary and middle school years—has important theoretical and policy implications as it could point to groups of children and to critical periods in the life course that can be targeted for efforts to boost, or at least maintain, preschool effects.

Although the question of whether preschool programs have academic and psychosocial benefits for children has been the subject of decades of research, the current investigation attempts to address some inconsistencies in the literature and tackles this question in new ways and, in doing

so, this study takes some key steps to advance this important literature. For example, this study moves the early childhood field forward by considering both the direct and indirect effects of preschool participation, and therefore, provides a more in depth and nuanced understanding of why contemporary preschool programs may have long-term academic and psychosocial benefits for middle class children. Here, I define indirect effects as those that operate through a mediator variable. This investigation also contributes to the existing literature by directly assessing the extent to which, and the periods during which, there is convergence in the academic and social-behavioral development of children who did and did not attend preschool. Finally, this study considers heterogeneity in these long-term associations as a function of child, family, and program characteristics. I use data from the Early Childhood Longitudinal Study Kindergarten (ECLS-K) 1998 Cohort (Tourangeau et al., 2009) to address these objectives, which although over 10 years old, is one of the only contemporary national samples that has followed children from kindergarten through the end of middle school, which allows for a careful analysis of the study objectives.

Preschool Education: Persistence, Convergence, and Sleeper Effects

The short-term associations between preschool enrollment and children's academic achievement are fairly clear (e.g., Bassok, 2010; Bumgarner & Brooks-Gunn, 2015; Crosnoe, 2007; Gormley et al., 2005; Magnuson & Waldfogel, 2005; Puma et al., 2010; Votruba-Drzal et al., 2004; Weiland & Yoshikawa, 2013). Evidence from both experimental and correlational research have consistently shown that children from both low-income and middle-class families who attend preschool, especially those of high quality, enter kindergarten more ready academically than children who experience informal care. Even though there is a rich literature documenting the short-term academic benefits of preschool, the long-term effects into elementary school and beyond are more ambiguous, with some scholars documenting continued academic benefits of both publicly and privately funded preschool programs for children during middle childhood and

adolescence (Ansari et al., 2017; Magnuson et al., 2007; Vandell, Belsky, Burchinal, Vandergrift, & Steinberg, 2010; Vandell, Burchinal, & Pierce, 2016) and others documenting no consistent benefits shortly beyond the program year (Hill et al., 2015; Lipsey et al., 2015; Puma et al., 2012). And although the evidence-base to date has largely focused on the experiences of children from lower-income families (approximately 90% of rigorous evaluations; Leak et al., 2010), recent studies from across the country do suggest that middle-class children also benefit from preschool enrollment. For example, quasi-experimental research on the short-term academic benefits of preschool programs in both Boston and Tulsa have found that for middle-class children preschool impacts were roughly 70-90% of the impact for lower-income children (Gormley, Gayer, Phillips, & Dawson, 2005; Weiland & Yoshikawa, 2013). Similar conclusions have been drawn from other evaluations of programs in New Jersey (Lamy, Barnett, & Jung, 2005) and Georgia (Peisner,-Feinberg, Schaaf, LaForett, Hildebrandt, & Sideris, 2014) along with correlational studies using nationally representative samples (Loeb, Bridges, Bassok, Fuller & Rumberger, 2007). Thus, the evidence that does exist on the experiences of middle-class children indicates that although these children might benefit slightly less than lower-income children, they do benefit in the short-term from preschool enrollment, and do so quite substantially.

In contrast to the short-term academic benefits of preschool, the short-term implications of preschool for children's psychosocial functioning remains far more ambiguous, with some educational scholars documenting negative effects of preschool enrollment (e.g. Bassok et al., 2015; Magnuson et al., 2007; National Institute of Child Health and Human Development Early Child Care Research Network, 2003) and others documenting positive or null effects (Ansari et al., 2017; Zachrisson, Dearing, Lekhal, & Toppelberg, 2013; Zhai et al., 2015). Some scholars have also argued that preschool programs are more likely to have negative effects for children's socio-emotional development when they come from higher- and not lower-income homes and that

these negative effects manifest because of disruptions in parent-child relationships and/or via exposure to new high stress contexts and peers (Huston, Bobbitt, & Bentley, 2015). While these assertions are rooted in attachment and social-learning theory, there has been inconsistent empirical support for these points. And even among the studies that have found that preschoolers do worse behaviorally as a result of their enrollment, these effects have been found to disappear fairly rapidly (Dearing, Zachrisson, & Naerde, 2015; Pingault, Tremblay, Vitaro, Japel, Boivin, & Cote, 2015).

These discrepancies in the literature discussed above have raised a number of questions about the long-term efficacy of contemporary preschool programs. In response, developmental and educational scholars have proposed a number of conceptual models that lay the groundwork for potentially reconciling disparities in the existing literature and for understanding both *whether* and *why* preschool programs may have long-term academic and psychosocial benefits for children, namely models of persistence, convergence, and sleeper effects (Bailey et al., 2017; Barnett, 2011; Yoshikawa et al., 2013). I outline these three developmental models below and discuss them in light of the existing evidence-base surrounding the longer-term benefits of preschool participation.

Persistence of preschool effects. Classic, long-term evaluations of early childhood programs (Abecedarian: Campbell & Ramey, 1994; Chicago Parent-Child Centers: Reynolds, Temple, White, Ou, & Robertson, 2011; Perry Preschool: Schweinhart, 2005) and theories from the economic and developmental literatures on skill building (Bailey et al., 2017; Cunha et al., 2006) argue that preschool effects are likely to persist over time because these programs can provide children with the foundational skills necessary for later school success. As one example, children's early counting skills have been documented as the basis for math (and reading) achievement in subsequent years such that children with higher math abilities during the transition to kindergarten are more likely to score higher on future assessments of more advanced

mathematics knowledge (Duncan et al., 2007). Likewise, children's earlier social-behavioral functioning lay the groundwork for their future educational engagement (Ansari et al., 2017; Wright, Morgan, Coyne, Beaver, & Barnes, 2014).

Thus, from this perspective, we would hypothesize that successful preschool programs that promote children's early academic achievement and psychosocial functioning may have long-term benefits within these domains because children enter school more ready to learn. That is, preschool participation results in greater kindergarten readiness (broadly defined), and that early school success lays the foundation for accelerated achievement through elementary school, which in turn leads to greater middle school success. In support of this developmental model, the follow-up to the Abecedarian Project revealed that the children who attended the program during early childhood were more likely to graduate from college and had greater annual earnings when compared with children in the control group who stayed at home (Campbell et al., 2012). Other experimental and correlational studies of contemporary preschool programs targeted at both low-income and middle class families have also been linked with improvements in moderate- to longer-term outcomes (Curenton et al., 2015; Magnuson et al., 2007; Phillips, Gormley, & Anderson, 2016) and suggest that these longer-term academic and psychosocial benefits can be accounted for by improvements in earlier skill development (Ansari et al., 2017; Campbell et al., 2002; Reynolds, 1992; Sorensen & Dodge, 2015; Vandell et al., 2010). Thus, these studies suggest that preschool programs not only have short-term academic and psychosocial benefits for children through the transition to kindergarten, but these benefits can persist through middle childhood, adolescence, and in some cases, even into young adulthood. These results also suggest that children's earlier academic achievement and psychosocial functioning can serve as important mediators of the long-term benefits of preschool.

Convergence of preschool effects. Despite the potential long-term benefits of preschool

(versus other informal care arrangements), in recent years its efficacy has often been found to be minimal across different communities and at the national level (Hill et al., 2015; Lipsey et al., 2015; Magnuson et al., 2007; Puma et al., 2012), with the short-term academic impacts persisting at full strength for 1-2 years beyond the program year before dissipating (Leak et al., 2010). Thus, even though preschool programs can have long-term academic benefits for children of all backgrounds, much of the recent findings of contemporary preschool programs have often been described as experiencing convergence. Convergence can occur for one of the following two reasons (see also: Bailey et al., 2017; Barnett, 2011; Magnuson et al., 2007; Yoshikawa et al., 2013):

(1) **Catchup**: Children who enter kindergarten without a preschool background and, therefore, with a less developed skillset (broadly defined), may accelerate in their learning over time and catch-up with their classmates who entered school with preschool experiences and stronger skills and behaviors.

(2) **Fadeout**: Children who enter kindergarten with a preschool background and as a result with stronger skills, may make fewer gains in subsequent school years as compared with their classmates who entered school without a preschool experience and with a less developed skill set.

In line with these arguments, recent experimental evaluations of the federally funded Head Start program documented positive program impacts for low-income children's academic achievement through the end of preschool, but by the time children entered kindergarten and first grade, there were no consistent academic advantages (Puma et al., 2012). Similar patterns of convergence have also been documented across other localized preschool programs that have considered the efficacy of programs targeted at largely low-income children (Hill et al., 2015; Lipsey et al., 2015) as well as with national samples of middle class families (Magnuson et al., 2004, 2007).

With regards to children's psychosocial behaviors, and as briefly discussed above, prior studies that have documented negative effects of preschool in the short-term have also documented fairly rapid convergence (Dearing et al., 2015; Pingault et al., 2015). Some scholars speculate that this convergence in behavioral effects is due to the fact that children who do not experience preschool undergo a transition to new social groups that negatively impacts their social behavioral development during the elementary school years, which is an adaptation process that preschoolers have already experienced (Pingault et al., 2015). Put another way, this adaptation hypothesis posits that there is convergence in the negative effects of preschool for children's psychosocial skills because children who did not receive preschool catch up with those who did.

At the same time, however, it is important to acknowledge that one potential explanation for the differences between classic preschool evaluations that show sustained effects and those of more recent evaluations of scaled-up programs that show convergence is the changing counterfactual (Duncan & Magnuson, 2013; Phillips et al., 2017; Yoshikawa et al., 2013). That is, the early childhood experiences of the control groups were markedly different in the classic studies of preschool education, where children generally stayed at home (Campbell et al., 2012; Ramey & Ramey, 2006; Schweinhart, 2005), than they are in today's evaluations, where children generally experience some other form of preschool education (Puma et al., 2012). Yet, despite the extensive debates regarding the convergence in outcomes between preschool participants and non-participants across different domains of early learning and development, there has been limited empirical evidence about when and why convergence occurs.

Sleeper effects. Finally, the sleeper-effects phenomena states that educational benefits of preschool may emerge later in the life course even in the absence of initial programmatic benefits (Clarke & Clarke, 1981). Although there has not been much empirical evidence for sleeper effects with classic evaluations of early childhood programs (Campbell et al., 2012; Schweinhart, 2006),

which have documented fairly consistent impacts for children throughout the life course that carry forward (i.e., no break in the benefits of preschool), there has been growing recognition of the sleeper effects model in the developmental literature. In line with this model, two studies of preschool programs targeted at middle class families in the United States found that the academic benefits of quality preschool programs increased over time, even when there were no short-term non-linear effects of classroom quality (Vandell et al., 2010) and when compared with other informal care arrangements in a national sample (Magnuson et al., 2007). Similar patterns of sleeper effects have also been documented in other evaluations of intervention programs during the early elementary school years (e.g., Barrera et al., 2002). While it is not entirely clear why these sleeper effects emerge, some scholars speculate that these patterns may be attributed to improvements in socio-emotional development and other complex functional abilities that, in turn, serve as the basis for more advanced academic learning (Heckman & Kautz, 2012; McClleland et al., 2013). Accordingly, these studies suggest that children's early psychosocial functioning can serve as an important mediator of the long-term academic benefits of preschool participation.

Heterogeneity in Preschool Effects

Although the above theoretical models outline why, on average, the benefits of preschool may persist or diminish over time, educational and developmental scholars have also become increasingly interested in optimizing preschool education by understanding heterogeneity in preschool effects (Duncan & Magnuson, 2013). After all, children's education does not occur in a vacuum nor are all preschool experiences the same—children enter school with wide-ranging differences in personal, experiential, and social-cultural experiences that can either be built on by their teachers or can hinder the benefits children derive from these early investments (Entwisle & Alexander, 1988). Moving beyond the overall (or main) effects of preschool participation, this

study also considers whether: (a) children from different backgrounds respond differently to preschool programs; and (b) children respond in different ways to different programs.

Heterogeneity in preschool effects by child and family characteristics. As outlined above, on average, children from various demographic backgrounds benefit from preschool enrollment. However, given the goal of preschool, which is to prepare children for kindergarten, there has been growing interest in understanding whether preschool programs meet this goal for all children or only a subset of children as this has implications for policy and practice. As part of this effort, a great deal of research and policy attention has been paid to variation in preschool effects as a function of children's race/ethnicity, gender, disability status, and socioeconomic status, but who benefits most has remained fairly ambiguous (Phillips et al., 2017; Yoshikawa et al., 2013). For example, evidence from both Tulsa and the Boston suggest that Latino children may benefit more in the short-term from preschool enrollment than non-Latino children (Gormley et al., 2005; Weiland & Yoshikawa, 2013), whereas other correlational and experimental preschool evaluations suggest that Black children may benefit more (Bassok, 2010; Puma et al., 2010). As another example, data from older experimental trials suggest that girls benefit more than boys from early childhood programs (Anderson, 2008), but a recent meta-analysis by Magnuson and colleagues (2016) appears to indicate that the impacts of early childhood investments for measures of achievement and behavior do *not* vary as a function of child gender. Other studies have suggested conflicting support for heterogeneity in preschool effects across the socioeconomic distribution (e.g., Gormley et al., 2005; Loeb et al., 2007; Weiland & Yoshikawa, 2013) and only a handful of studies have considered the benefits of preschool for children with disabilities (Bloom & Weiland, 2015; Phillips & Meloy, 2012; Weiland, 2016).

Despite these discrepancies in who might benefit more from preschool, what most of these studies have in common is that they have been restricted to short-term evaluations of the

academic and social-behavioral benefits of preschool and, thus, have not been able to consider heterogeneity in the persistence of preschool effects. To illustrate the importance of this point consider what we know is generally true: low-income and middle-class children both benefit academically from preschool in the short-term. Does this mean that the degree to which these benefits persist over time will be the same? In reality, this scenario might be unlikely because low-income children are likely to face more external barriers to and constraints on their ability to succeed and, therefore, it is possible—if not probable—that lower-income children experience a greater degree of convergence over time than do middle-class children (Brooks-Gunn, 2003). Accordingly, it is necessary to consider whether the persistence of preschool effects varies across different groups of children and as a function of the experiences children bring to the table.

Heterogeneity in preschool effects by program characteristics. Developmental science also suggests that another potential source of heterogeneity stems from program implementation. Indeed, a number of developmental and educational scholars have illustrated that children's day-to-day experiences in preschool matters greatly (Mashburn et al., 2008; Peisner-Feinberg, Burchinal, Clifford, Culkin, Howes, Kagan, & Yazejian, 2001). And although proximal indicators of preschool quality and experience are not available in the ECLS-K: 1998 Cohort, there are other important dimensions of preschool experience that shape children's academic and psychosocial functioning including the number of hours children are in preschool and program type, which in this study I consider as potential sources of heterogeneity.

Correlational studies from across the country on the extent of children's overall participation in preschool (as measured by hours) have yielded mixed evidence when looking at children's academic achievement as the outcome (Burchinal, Zaslow, & Tarullo, 2016; Loeb et al., 2007; NICHD & Duncan, 2003; Reynolds et al., 2014). Similarly, while several analyses from the NICHD SECCYD have found that children who spend more hours in early child care and

preschool exhibit less optimal social-behavioral development (Belsky et al., 2007; NICHD ECCRN, 2006; Vandell et al., 2010), a number of national and international studies have found no significant differences as a function of dosage and care quantity (for a review see: Dearing & Zachrisson, 2017). And even among the studies that have documented significant behavioral differences, these effects have been found to diminish over time (Dearing et al., 2015; Pingault et al., 2015). In terms of program type, prior studies suggest that public prekindergarten programs generally have more rigorous standards and offer a higher quality learning experience than center-based programs (Bassok, Fitzpatrick, Greenberg & Loeb, 2016), which might mean that this subset of programs has larger effects that persist over time (Ansari et al., 2017; Bassok et al., 2016), but longer-term evaluations of these programs have been few and far between. For these very reasons, there is a need for continued work that considers the long-term implications of the extent of children's preschool participation along with the type of experiences children have.

The Current Study

The current study attempts to address some of these inconsistencies in the existing literature by considering the different ways in which preschool enrollment at age 4 might affect children's short- and long-term school success, both academically and in terms of children's psychosocial functioning. First, in evaluating the models of persistence and sleeper effects, I consider the following research questions: (RQ1) Are there academic and psychosocial benefits of preschool education for children as they transition into middle childhood and adolescence? Next, in evaluating the model of convergence I address the following question: (RQ2) Is there evidence for convergence of academic test scores and children's psychosocial functioning across preschool participants and non-participants and, if so, when and why does it occur? In comparing each of these conceptual models, I also consider: (RQ3) What share of the long-term academic benefits of preschool is a result of earlier academic and psychosocial functioning? Finally, as a means of

moving beyond the average effects of preschool I also consider: (RQ4) The extent to which the academic and psychosocial benefits of preschool through early adolescence differ by demographic groups (i.e., race/ethnicity, gender, disability status, and income) and preschool characteristics (i.e., dosage and program type). In addressing each of these objectives, this study adds to the discussion surrounding the benefits of preschool education by adjudicating among the three conceptual models underlying the long-term benefits of preschool and capturing the different ways in which these programs might shape children's long-term school success. Given the conflicting evidence regarding the long-term academic and psychosocial effects of preschool and who benefits most for these experiences, I leave the study objectives as largely exploratory.

Method

Data for this study were drawn from the ECLS-K 1998 Cohort (Tourangeau et al., 2009), a nationally representative sample of roughly 21,000 kindergarteners who were followed from kindergarten entry through the end of eighth grade. Children were followed across six waves of data collection: (1) the fall of kindergarten; (2) the spring of kindergarten; (3) the spring of first grade; (4) the spring of third grade; (5) the spring of fifth grade; and (6) the spring of eighth grade. Across each time point, information was collected from parents and teachers as well as direct assessments of children. For the purposes of this investigation, I restricted the sample to children who (a) were first time kindergartners (n = 16,752) and (b) had valid kindergarten data and preschool information (n = 16,637). Similar to prior publications with the ECLS-K (see also: Bassok, Gibbs, & Latham, 2015; Curenton et al., 2015; Loeb et al., 2007; Magnuson et al., 2004) and other early childhood evaluations (see also, Lee, Zhai, Brooks-Gunn, Han, & Waldfogel, 2014), Head Start was removed from the preschool category for three reasons: (1) it is widely regarded as different than standard center-based care or state-funded pre-K; (2) prior studies have shown that there are no added benefits of Head Start participation in the ECLS-K as compared

with parental care (Curenton et al., 2015; Magnuson et al., 2007); and (3) it was not possible to achieve optimal balance across the Head Start and preschool conditions when using propensity score matching, even within the low-income sample (see also: Magnuson et al., 2007). The above exclusion criteria resulted in a final analytic sample of 15,070 children and families.

For sample descriptives stratified by children's age 4 preschool arrangement, both before and after matching (propensity score matching is discussed below), see Table 1. It should be noted that because of the inclusion criteria and matching algorithm employed as part of the current investigation, the study sample was diverse, but included predominantly middle class families. At the aggregate level, the sample of children from the matched models were predominantly White (66%), came from households with an average annual income of $60,245 (*SD* = $37,951), and had mothers who averaged a little over 14 years of education (*SD* =2.42). Roughly one out of every ten mothers received government assistance (6% received Temporary Assistance for Needy Families [TANF] and 10% received food stamps) and 92% of children spoke English at home.

Measures

Preschool enrollment. During the beginning of the kindergarten year, parents were asked both whether and how many hours their child attended a "day care center, nursery school, preschool, or prekindergarten program" during the prior school year. Similar to prior studies using the ECLS-K, children who attended any of the above programs (excluding Head Start) were categorized as having attended preschool, but only if they were enrolled for five or more hours per week (Bassok et al., 2015). Due to limited exposure, children who attended preschool for less than five hours per week were classified as having attended informal care along with children who were cared for by a relative, non-relative, family child care provider, or parent (see also: Ansari & Crosnoe, 2015; Iruka, Gardner-Neblett, Matthews, Winn, 2014; Tucker-Drob, 2012). Thus, the focal predictor was a binary marker of preschool enrollment defined as a center- or school-based

program (1 = *enrolled in a preschool program*, *n* = 9,207; 0 = *no preschool enrollment*, *n* = 5,873).

Preschool program characteristics. As a means of looking at program characteristics, I disaggregated the preschool category in two different ways. First, I re-classified preschool attendees into two mutually exclusive groups: those who attended public prekindergarten programs (*n* = 2,576, 17% of full sample and 28% of preschool sample) and those who attended center-based care (*n* = 6,631, 44% of full sample and 72% of preschool sample) at age 4 (see also, Bassok et al., 2015; Magnuson et al., 2007), both of which were compared with informal care. It is important to note that the 17% participation rate in prekindergarten programs closely matches estimates of the proportion of 4-year-olds enrolled in public school prekindergarten programs during that time (Smith, Kleiner, Parsad, Farris, & Green, 2003). I also constructed a measure of dosage based on the number of hours per week children attended preschool. In line with both Bassok and colleagues (2015) and Magnuson and colleagues (2007), I grouped children into those who attended preschool full-time (20+ hours per week; *n* = 4,413, 29% of full sample and 48% of preschool sample) and those who attended preschool for part-time (5-20 hours per week; *n* = 4,794, 32% of full sample and 52% of preschool sample).

Children's outcomes. Three domains of children's academic achievement and psychosocial functioning were assessed over time and selected because prior educational studies have found that these are outcomes that are influenced by preschool education (Ansari et al., 2017; Bumgarner & Brooks-Gunn, 2013; Weiland & Yoshikawa, 2013; Winsler et al., 2007) and shape children's future school success (Ansari et al., 2017; Duncan et al., 2007; McClleland et al., 2013; Vandell et al., 2010). First**,** children's math and reading skills were directly assessed from kindergarten through eighth grade using age standardized assessments developed by the National Center for Educational Statistics (for more information on these measures, see: Rock & Pollack, 2002). Content from the reading assessment covered letter recognition, reading, and phonological

awareness, whereas the math assessment covered children's conceptual knowledge, procedural knowledge, and problem solving skills. Both assessments of math (α's across waves = .92–.94) and reading (α's across waves = .87–.93; Rock & Pollack, 2002) have demonstrated strong reliability. The earlier assessments during kindergarten and first grade emphasized basic reading and math skills, whereas the later assessments placed a stronger emphasis on more advanced academic skills (e.g., reading comprehension and algebra). Due to the high correlation between the math and reading subscales (mean r= .71, range = .66-.73), and because all results were comparable when examining the two scales separately (results are available upon request), an average composite was created at each wave for children's academic achievement (for similar methods see: Coley & Kull, 2016).

Next, using an adapted version of the Social Rating Scale (SRS; Gresham & Elliot, 1990) teachers reported on children's social-emotional and behavioral problems from kindergarten through fifth grade (not available at eighth grade). The SRS was based on a 4-point Likert scale (1 = *never* to 4 = *very often*) and used to create the two final outcomes of interest: (1) children's social skills, which were based on 9 items that captured children's self-control and interpersonal skills; and (2) children's externalizing behavior problems, which were based on six items from the SRS and captured children's aggression and impulsivity (for more information on the measure see: Rock & Pollack, 2002). Both measures of children's social skills (α's across assessment waves = .75-.89) and behavior problems demonstrated acceptable reliability (α's across assessment waves = .77-.78). Even though the correlation between social skills and behavior problems were of similar magnitude to that correlation between math and reading, these measures were kept as separate indicators in the primary analyses because the effects of preschool on these two outcomes (and the associations among the outcomes) were different (discussed in more depth below).

As a means of capturing skill gaps (i.e., convergence) over time, all focal outcomes of

interest were standardized within each wave at the population level after imputation to have a mean of 0 and standard deviation of 1 with the ECLS-K cross-sectional weights using the full sample of children (C1CW0-C7CW0; for similar methods see: Tourangeau et al., 2009; Magnuson et al., 2007). Thus, the average American child between the fall of 1998 (i.e., fall of kindergarten) and spring of 2007 (i.e., eighth grade) had an outcome score of 0 and standard deviation of 1 on assessments of academic achievement, social skills, and externalizing behavior, and therefore, the estimates reported herein are relative to the population as a whole. For unstandardized and standardized outcome descriptives at the population level (which were used for standardization) as compared with descriptives for the unmatched and matched preschool and informal care samples, see Appendix Table 1. And for bivariate correlations among the focal variables of interest, see Appendix Table 2.

Analysis Plan

A primary concern with studies on preschool education is that the preschool enrollment is endogenous, which can undermine causal inference to be made about associations between preschool participation and children's academic and social-behavioral development, as factors that select children into preschool might also influence their success in school (Crosnoe, Purtell, Davis-Kean, Ansari, & Benner, 2016; Duncan & Magnuson, 2013). To address this issue of selection, the current study implements a form of propensity scores where the conditional probability of attending preschool given a set of covariates is used to create matched samples (Rosenbaum & Rubin, 1983). To generate these samples, I included a number of variables that fall under six broader factors that are often considered in theoretical work geared at understanding parents' preschool decisions (see: Coley, Votruba-Drzal, Collins & Miller, 2014; Crosnoe et al., 2016; Meyers & Jordan , 2006). It is important to note that the below variables do *not* include time varying covariates from middle childhood and adolescence because if time varying factors were

to be affected by preschool enrollment then their inclusion in the models would bias the estimates generated. The factors included in the propensity score models were:

1. **Children's characteristics:** child age at kindergarten entry, children's age of first care, children's gender, and children's disability status.
2. **Cultural background:** race and ethnicity (White, Black , Latino, Asian/other) along with home language (English, not English).
3. **Household structure and characteristics:** mothers' marital status, mothers' age, household size, and the number of siblings in the home.
4. **Family socioeconomic status:** mothers' employment status (employed full time, employed part time, unemployed), household income, receipt of TANF, receipt of Food Stamps, and mothers' years of education.
5. **Family home and school involvement:** home learning activities (e.g., reading books and singing songs), parents' school involvement (e.g., attended open house and parent-teacher conference), and educational resources (i.e., number of child books) in the home.
6. **Community characteristics:** urbanicity (large city, suburbs, town) and region (Northeast, Midwest, South West).

The primary omitted variables, which are not available in the 1998 Cohort of the ECLS-K, are children's academic achievement and psychosocial functioning *prior* to preschool entry. If higher functioning children were more likely to experience preschool, then that would inflate the preschool estimates reported in this study. However, two prior studies with the Early Childhood Longitudinal Study Birth (ECLS-B) Cohort, a nationally representative sample of children who were followed from birth to kindergarten during a similar time frame as the ECLS-K, found that net of the above factors used in the propensity scores, higher functioning children were *not* more

likely to experience preschool (Coley et al., 2014; Crosnoe et al., 2016). And although it is not possible to comprehensively assess issues of omitted variable bias with non-experimental data, the inclusion of over 30 covariate indicators coupled with propensity scores approximates randomization as best as possible within the context of the data available (Rosenbaum & Rubin, 1983).

With the above in mind, I used the nearest neighbor method (with four matches) with a caliper of .01, ensuring a sufficient overlap between the various conditions on their propensity scores. The first three research questions were addressed within these matched samples, which were weighted by the number of times "control" cases (i.e., children in informal care at age 4) were matched with "treatment" cases (i.e., children in preschool at age 4). To ensure that the models were unbiased, all models included clustering and stratification variables to adjust for shared variance. Finally, 50 datasets were imputed via chained equations in Stata (Stata Corp, 2009) to address missing data, which ranged from 0-53% per variable (mean of 16%) and were generally due to sample attrition by the eighth grade wave of data collection (see also, Coley & Kull, 2016). After data were imputed in Stata, the 50 datasets were exported to the *Mplus* program where all focal models were estimated (Muthén & Muthén, 2013). As a precaution, all primary preschool versus informal care analyses were also estimated among the subsample of children who participated in data collection through the end of eighth grade and all findings were the same as those reported below (see Appendix Table 3). Similar to Coley and Kull (2016) who also looked at eighth grade outcomes using the ECLS-K, I report models that used multiple imputation.

The focal research objectives were addressed in a series of steps. First, to understand the short- and long-term associations between preschool participation and children's learning and development, I estimated fully saturated path models that corresponded to Figure 1 (although not shown in the figure, all within time variables were covaried). Specifically paths A1-A2, B1-B2,

and C1-C2 of Figure 1 correspond to the short-term effects of preschool for children's externalizing behavior, academic achievement, and social skills, respectively, whereas paths A3-A5, B3-B6, and C3-C5 correspond with the long-term benefits of preschool for the same set of outcomes from first grade through the end of fifth and/or eighth grade. It is also important to note that there would be empirical evidence for sleeper effect if the following conditions were met: (a) paths B2-B6 were statistically significant; (b) path B1 was not statistically significant; and (c) the coefficients for B1 and B2-B6 were significantly different from one another (i.e., B1 ≠ B2-B6).

Next, to assess for convergence (i.e., research question 2), I created difference scores that compared the regression slopes of preschool participation versus informal care from either: (a) baseline to each of the subsequent waves (t_x-t_1) or (b) from one wave to the next (t_x-t_{x-1}). The first set of analyses illustrates *whether* there is empirical evidence for convergence of test scores from kindergarten through eighth grade, whereas the second set of analyses illustrates *when* convergence occurs during the periods between kindergarten and eighth grade. Across both specifications, these difference scores capture *changes* in the benefits of preschool for children's academic and social-behavioral development, which can be interpreted as the degree of convergence between the different study periods (see also: Magnuson et al., 2007). I use this modeling strategy as opposed to a simple growth curve model because this method allows me to address this specific question regarding the periods during which convergence occurs, which is not possible within a growth curve-modeling framework.

To address the third research question (i.e., the extent to which the long-term academic benefits of preschool were attributed to earlier skill development), all models were re-estimated and included autoregressive and cross lag pathways between children's psychosocial functioning and academic achievement (see Figure 2). Similar to a number of other studies using this methodology (e.g., MacKenzie, Nicklas, Brooks-Gunn, & Waldfogel, 2015; Ritchie, Bates, &

Plomin, 2015), I include all potential lagged and cross-lagged pathways to capture all potential unique pathways through which preschool might shape children's subsequent development. The INDIRECT command, which takes the product of the regression coefficients, was used to estimate the total indirect effects of preschool on children's academic learning over time. These indirect effects of preschool for children's academic learning were then decomposed to assess the specific contribution of children's earlier academic skills, behavior problems, and social skills.

The fourth and final research question regarding heterogeneity in preschool effects as a function of child and program characteristics was addressed in two different ways. When considering variation as a function of child characteristics, I used interaction terms within the matched samples discussed above to gauge the extent to which preschool effects varied across different subgroups in the population. To address heterogeneity as a function of program characteristics, I re-estimated the propensity score models to create demographically comparable groups of children in the different types of preschool programs, both as a function of preschool type (i.e., prekindergarten and center-based care) and dosage (i.e., part and full day). After achieving balance, I re-estimated the path models within these matched samples and compared children who attended informal care with: (a) children who attended preschool full-time (20+ hours per week) and those who attended preschool for part-time (5-20 hours per week); and (b) children who attended public prekindergarten programs and those who attended center-based programs.

While the above served as the primary model specification for the propensity scores, I also estimated a number of alternative specifications for the focal preschool versus informal care contrast to ensure that the findings were robust to the analytic decisions. First, it is important to acknowledge that there is controversy over the best approach to addressing survey weights when using propensity scores (Austin et al., 2016; DuGoff et al., 2014). Similar to the recommendations of DuGoff and colleagues (2014), I estimated supplemental models that included a series of cross-

sectional weights from each wave of data collection as covariates in the propensity score matching algorithm (i.e., C1CW0-C7CW0) to address any issues that may stem from the sampling strategy and nonresponse bias over time (children who attrited from the sample and did not have an assigned weight were coded as "-1" to reflect that they no were longer present). Results from these supplemental analyses were the same as those presented below (see Appendix Tables 3). There is also debates surrounding whether survey weights should be used in the models to predict outcomes and whether these propensity scores should be generalizable to the population (Austin et al., 2016; DuGoff et al., 2014; Zanutto et al., 2006). Considering that the propensity scores used in this study were *not* intended to generalize to the population and because the cases were weighted by the number of times children were matched across conditions (i.e., a survey weight could not also be used), I estimated additional models that included the kindergarten weight within an OLS framework that replicated the sample specific analyses at the population level. Results from these nationally representative analyses were largely the same as those presented below (see Appendix Table 3). The final point of consideration is surrounding the inclusion of covariates when predicting outcomes in the matched samples (doubly robust estimation; Funk et al., 2011). Accordingly, I estimated supplemental models that controlled for each of the covariates listed in Table 1 within the matched samples and all results were quantitatively and qualitatively similar to the results from the primary specification (see Appendix Table 3).

Results

Across the 50 imputed datasets, I was able to successfully match roughly 96-97% of children across preschool and informal care. To assess the overall quality of matches, I: (a) checked the standardized mean differences between preschool and informal care for all of the covariates using the 10% benchmark, which is a standard in the propensity score literature indicating negligible differences between groups (see Austin, 2011); (b) regressed each of the covariates,

individually, on the indicator variable that distinguished children in informal care as compared with preschool within the matched samples; and (c) separated the comparison conditions into quartiles on the basis of children's propensity scores and checked the balance of covariates within each quartile. As can be seen in Table 1, before matching, almost all of the covariate contrasts were significantly different; after matching, however, there were no longer any differences. Likewise, all of the standardized mean differences across the two groups were less than 10% of a standard deviation and there were no significant differences among the covariates within the different strata of the propensity scores, which, when taken together, indicate that balance was successfully achieved. Again, however, it is important to emphasize that as part of the matching process, the resulting sample was more economically advantaged.

Persistence of preschool effects versus sleeper effects. Having successfully balanced the preschool and informal care conditions, I estimated a fully saturated path model within the matched samples. Note that because these were fully saturated models, these path models fit the data perfectly (i.e., CFI =1.00, RMSEA = 0.00). As can be seen in column 1 of Table 2, children who attended preschool at age 4 scored significantly higher on kindergarten assessments of academic achievement (E.S. = 0.20 standard deviation units [*SD*]). Similar, albeit slightly smaller, academic benefits were documented through the end of eighth grade, with effect sizes ranging from 0.09-0.16 *SD*s. Despite these academic benefits through early adolescence, preschool attendees were found to demonstrate higher levels of externalizing behavior upon kindergarten entry (E.S. = 0.18 *SD*s), which persisted at reduced levels through the end of fifth grade (E.S. = 0.05-0.16 *SD*s). Likewise, preschool attendees exhibited less optimal social skills upon kindergarten entry (E.S. = 0.07 *SD*s), which persisted through the end of first grade (but not third or fifth grade). When taken together, these results from the ECLS-K: 1998 Cohort reveal that there was no "break" in the benefits (or drawbacks) of preschool and, thus, there was no support for the sleeper effects

hypothesis, at least concerning the outcomes examined. Instead, the associations between preschool participation and children's academic achievement and psychosocial skills persisted, but at reduced levels, through middle childhood and early adolescence.

Convergence of preschool effects. Having illustrated both the short- and long-term associations between preschool participation and children's learning and development, I proceeded to assess whether, and when, convergence of preschool effects occurred. As can be seen in column 2 of Table 2, results from these analyses indicated that, as compared with baseline, the academic benefits of preschool shrunk over time. It is of note, however, that this convergence of test scores occurred almost entirely through the end of kindergarten and first grade. As can be seen in column 3 of Table 2 and in Panel A of Figure 3, the initial academic benefits of preschool participation shrunk by approximately 20% ($p < .05$; calculated by dividing the effect size for each wave by the baseline effect size) from the fall to the spring of kindergarten year. Although not reaching conventional levels of statistical significance, there was also some suggestive evidence of attenuation from the spring of kindergarten to spring of first grade (roughly 20%, $p < .10$). There was no further attenuation in the academic benefits of preschool, from one year to the next, after the spring of first grade. Put another way, roughly 70% of the convergence that was documented by the end of eighth grade had already manifested during the two years after preschool. In terms of children's psychosocial skills, these convergence analyses revealed that the negative associations between preschool enrollment and children's externalizing behavior shrunk by a little over 70% through the end of fifth grade (see columns 2 and 3 of Table 2 and panel B of Figure 3), whereas for children's social skills, convergence largely occurred between first grade and third grade (see column 3 of Table 2 and panel C of Figure 3).

Prior functioning as mediators. The third research objective was to determine the extent to which the associations between preschool programs and children's long-term academic

development were mediated by their earlier academic and psychosocial functioning. To address these objectives, these models included autoregressive and cross-lags and the resulting model fit the data well (CFIs > 0.95, RMSEA < 0.07; for autoregressive and cross-lag estimates see Appendix Table 4). Despite the evidence for convergence in children's academic test scores, results from these mediational models indicated that the long-term associations between preschool enrollment and children's academic functioning were almost entirely due to children's earlier skill development, with indirect effects ranging from 8-16% of a *SD* (see column 3 of Table 3). Put another way, children's earlier learning and development accounted for roughly 90-100% of the total direct association between preschool enrollment and children's academic functioning over time (calculated by dividing the indirect effect by the direct effect). In contrast, the corresponding direct pathways were no longer statistically significant (see column 2 of Table 3).

Having established the indirect effects of preschool enrollment, I next decomposed these estimates into the long-term benefits of preschool that were attributed to children's earlier: (a) academic achievement; (b) externalizing behavior; and (c) social skills (see columns 4-6 of Table 3). Results from this effort revealed two important points. First, the long-term academic benefits of preschool were almost entirely due to children's earlier academic functioning during the early elementary school years. Second, there was evidence to suggest that the convergence of test scores across the preschool and informal care conditions were in part a function of children's social skills. Specifically, the difference in children's social skills throughout middle childhood that was attributed to preschool enrollment accounted for roughly 10-20% of the convergence in their academic test scores from kindergarten through eighth grade. That is, children who attended preschool at age 4 demonstrated lower social skills during kindergarten, which in turn resulted in them making fewer gains in academics during middle childhood and early adolescence. Results from these mediation models also indicated that preschool programs had academic benefits for

children during third and fifth grade via heightened levels of externalizing behavior (i.e., preschool → greater externalizing behavior → greater academic achievement), but this was only true when including children's social skills as a mediator of their academic performance over time. When models were: (a) re-estimated without social skills (see Appendix Table 5) and (b) re-estimated with a composite of social-behavioral functioning (see Appendix Table 5), these estimates were in the expected direction and all other findings were the same, suggesting that the strong correlation between social skills and externalizing behavior (within time r = |.65-.72|) resulted in a model that captured the variance in children's academic achievement that was not explained by their social skills. Given the strong overlap between these two dimensions of social-behavior, these indirect effects via externalizing behavior should be interpreted with caution.

Heterogeneity in preschool effects. The final set of analyses considered heterogeneity in preschool effects as a function of both program and child-characteristics. In terms of child characteristics, results indicated that there was no consistent evidence for moderation as a function of children's gender, race/ethnicity, and/or disability status (see Table 4). Among the 80 interactions tested, only one reached conventional levels of statistical significance and, therefore, was not interpreted. There was, however, some suggestive evidence for heterogeneity as a function of children's socioeconomic status (3 of the 16 interactions reached conventional levels of significance and 2 reached marginal levels of significance). Specifically, although the academic benefits of preschool were comparable across the socioeconomic distribution, the negative effects of preschool for children's social-behavioral development during the elementary school years were somewhat larger among children from less economically advantaged homes. Even in light of these suggestive patterns it is nonetheless important to emphasize that by early adolescence, there was no evidence for variation among the socio-demographic characteristics examined, and when taken as a whole, these results suggest that, at least among this diverse sample of middle class families,

homogeneity in the effects of preschool was far more common than heterogeneity.

In terms of program characteristics, after propensity score matching (see Appendix Tables 6-8 for descriptives before and after matching), I found no evidence of differences across the two mutually exclusive groups of public prekindergarten programs and center-based care (see Table 5 and see Appendix Figures 1-3). However, after balancing the various conditions (see Appendix Tables 9-11 for descriptives before and after matching), results from the dosage models revealed three important points (see Table 6 and Appendix Figures 4-6). First, both children who attended part- and full-day preschool programs outperformed their classmates who attended informal care in areas of academic achievement from kindergarten through eighth grade (8-22% of a *SD*). Second, there was no difference in the academic performance of children who attended full- versus part-day programs. And, finally, the negative associations between preschool enrollment and children's psychosocial functioning were *only* true among children in full-day programs, with effect sizes ranging from 8-33% of a *SD* when compared with children in informal care and 12-22% of a *SD* when compared with children in part-day programs. Ultimately, although both children in part- and full-day preschool programs experienced similar levels of convergence through the end of eighth grade as compared with non-preschool participants, the underlying cause for the convergence in their academic test scores was somewhat different. For children in full-day programs the convergence was largely rooted in fadeout that resulted from their lower levels of social skills, whereas the convergence in test scores for children in part-day programs was attributed to an unmeasured factor.

Discussion

There is a great deal of experimental (Campbell et al., 1994; Schweinhart et al., 2006) and correlational (Crosnoe, 2007; Magnuson et al., 2004, 2007; Weiland & Yoshikawa, 2013; Winsler et al., 2007) evidence to suggest that preschool programs can be leveraged to boost young

children's early learning, and these benefits hold true for children from all income backgrounds (Gormley et al., 2005; Lamy et al., 2005; Peisner-Feinberg et al., 2014; Weiland & Yoshikawa, 2013). Despite the wealth of empirical inquiry into preschool education, whether contemporary preschool programs continue to have academic and psychosocial benefits for children through early adolescence and beyond has remained contested, especially among routinely implemented preschool programs for children from middle-class families (for a consensus statement see: Phillips et al., 2017). Accordingly, this investigation sought to push the early childhood literature forward by addressing these gaps in knowledge with a diverse sample of middle class children and families from the ECLS-K: 1998 Cohort. Below, I discuss four take home messages of this work.

First, results from this investigation revealed that children who attended preschool at age 4 not only outperformed their classmates in areas of academic achievement upon kindergarten entry, but these benefits were carried forward over time, which is both similar to (e.g., Curenton et al., 2015; Magnuson et al., 2007; Vandell et al., 2010, 2016) and different from (e.g., Hill et al., 2015; Lipsey et al., 2015; Puma et al., 2012) the extant literature. One possible explanation for these inconsistencies is the difference in socioeconomic status between samples; the children who participated in the current study were, on average, from middle-class households, which means that this sample of children faced fewer external barriers to and constraints on their ability to succeed. Thus, although children from across the income distribution benefit from preschool enrollment, lower-income children may be more likely to experience a greater degree of convergence over time because preschool programs are not a panacea for the various disadvantages faced by children throughout the life course (Brooks-Gunn, 2003).

It is also of note that the comparison condition used in this study was different from recent preschool evaluations whose control groups often include children enrolled in other types of preschool programs (e.g., Puma et al., 2012; Weiland & Yoshikawa et al., 2013). In this study, the

children in the comparison condition did not experience alternative forms (or extensive hours) of preschool and when I compared children who attended center-based care and prekindergarten, no differences emerged. In that sense, the results reported herein are more comparable to the classic studies where children in the control group generally stayed at home. These differences in the counterfactual are of increasing importance and need to be considered when comparing the results of this study with the existing literature. As one example, Zhai and colleagues (2014) found that while the Head Start program did produce stronger academic skills for low-income children through the end of the program year as compared with the control group (roughly 0.20 *SD*s), the program was most beneficial for those who otherwise would have received informal care (roughly 0.35 *SD*s). These particular findings are of note because they suggest that the effect sizes documented herein would be smaller if the comparison condition were more similar to recent control groups that have included children who experienced other forms of preschool. Nonetheless, when making comparisons between the results of this study and the extant literature, careful attention should be paid to the comparison condition.

Similar to the published literature, however, there was evidence to suggest that the initial academic advantages conferred by preschool programs shrunk over time; the academic benefits of preschool participation reduced in size by approximately half once children were nine years from the end of preschool. Some convergence in preschool effects is perhaps inevitable, but there is an important distinction between preschool effects that diminish over time and effects that disappear. To this very point, the results of this study are in line with recent evaluations of publicly and privately-funded programs in North Carolina (Muschkin et al., 2015), Miami (Ansari et al., 2017), and at the national level (Curenton et al., 2015; Magnuson et al., 2007) and suggest that preschool programs do have academic benefits for children in the long run, regardless of child characteristics, dosage, and program type. These results build on these existing efforts by revealing that the

advantages that persisted through the end of third and fifth grade can be maintained through the end of middle school. Not only were these advantages statistically significant and comparable to earlier studies done with the ECLS through the early elementary school years (0.07-0.12 *SD*s; Curenton et al., 2015; Magnuson et al., 2007), but the documented benefits of preschool education exceeded the benchmarks put forward by Chetty and colleagues (2011; 0.04-0.07 *SD*s) with respect to programs "breaking even" and matched the more conservative estimates developed by Magnuson and Duncan (2014; 0.09-0.15 *SD*s).

Next, while the effects of preschool on children's socio-emotional development remains less clear than its effects on children's academic achievement (e.g., Bassok et al., 2015; Dearing et al., 2015; Magnuson et al., 2007; National Institute of Child Health and Human Development Early Child Care Research Network, 2003), the results from the current investigation revealed that preschool attendees demonstrated less optimal psychosocial functioning over time as compared with children who attended informal care. Overall, however, these associations were concentrated among children who attended preschool for 20 or more hours per week and these negative social-behavioral effects converged to negligible levels over time. One potential explanation for some of the variation in results across studies is that the current investigation could not differentiate between more general preschool programs and programs that emphasized children's socio-emotional development (Yoshikawa et al., 2013). Moreover, some scholars have argued that early childhood programs are more likely to have negative effects for children's socio-emotional development when they come from higher- and not lower-income homes (Huston, Bobbitt, & Bentley, 2015), but the pattern of moderation that did emerge with regard to families socioeconomic status in this study does conflict with these assertions. Although speculative, one potential explanation circles back to the sampling of the ECLS-K coupled with the fact that the matching models resulted in fewer children who were truly economically disadvantaged, which

limits the income distribution available for consideration (e.g., only 10% of families received food stamps in the matched samples, whereas lower-income samples from a similar time frame have rates closer to 45%; Chor, 2016).

Even so, it is worth emphasizing that unlike measures of academic achievement, the quality of measurement for children's socio-emotional development needs to be considered, as does a more explicit focus on *why* programs result in less optimal behavior. While some developmental scholars speculate that these negative effects on children's psychosocial behaviors might result from disruptions in parent-child relationships or via social learning, there has not been conclusive evidence for either hypothesis (Huston et al., 2015). At the same time, however, these results are in line with the social group adaptation hypothesis (Pingault et al., 2015), which posits that convergence in the negative behavioral effects of preschool occur because children who experienced informal care must adapt to social group settings *after* the transition to kindergarten, which preschool attendees have already experienced *before* the transition to formal schooling.

Third, by using six waves of data that spanned across nine years, this study was also able to pinpoint the periods in which partial convergence occurred. This study revealed that convergence of academic test scores across preschool and informal care groups happened almost entirely during the two years after preschool. After first grade, the initial academic advantages conferred by preschool programs were largely maintained. Put another way, during the two years after preschool, the academic benefits of children's participation in these programs shrunk by roughly .035 standard deviation units per year, but between the end of first and eighth grade, these benefits shrunk by less than .005 standard deviation units per year. One potential explanation for these differences in convergence during early elementary school as compared with the later grades is the type of instruction that children are exposed to. Indeed, recent national studies have found that instruction during these early years often covers basic skills (Engel, Claessens, Watts, &

Farkas, 2016), which are skills that preschool children may have already mastered.

If these results regarding the periods of convergence are replicated across different samples, then these findings indicate that to maintain the academic benefits of preschool—which have been central to the discourse on preschool education—policymakers and researchers should focus on the one or two years after the end of preschool as a potential point of intervention. In doing so, we can better understand *how* to maintain the academic gains made by children through the transition to kindergarten. For example, the legacy impact of early experiences may vary as a function of experience in subsequent exogenous environments (Bailey, Duncan, Odgers, & Wu, 2017) and, thus, studying the school environment during kindergarten and first grade can potentially provide answers for maintaining preschool effects (Jenkins et al., 2016; Magnuson et al., 2007; Swain, Springer, & Hofer, 2015). Alternatively, providing booster interventions after preschool can also prove to be effective in maintaining the initial advantages conferred by these programs (see: Tolan, Gorman-Smith, Henry, & Schoeny, 2009) as can initiatives that aim to build stronger connections between preschool programs and elementary schools (e.g., Pre-K-3rd Education; Benner, et al., 2016; Reynolds, Magnuson, & Ou, 2010; Shore, 2009). That is to say that, it is likely that more systematic and comprehensive interventions will have greater academic and psychosocial benefits for children than preschool programs that occur in isolation for only one year.

The fourth and final key point of this investigation centered on the underlying reasons for the long-term academic benefits of preschool education. Resonating with some of the recent empirical literature (e.g., Ansari et al.,, 2017; Sorensen & Dodge, 2015; Vandell et al., 2010) and some of the "landmark" studies in early childhood education (e.g., Campbell et al., 2002; Reynolds, 1992), the results of this study suggest that the long-term advantages of preschool were a function of children's earlier academic achievement and that the convergence in test scores was partially

attributed to the fact that preschoolers, especially those who attended full-day programs, entered school with less developed social skills. Thus, there was some support for models of skill building, which argue that preschool programs may have long-term benefits because human capital investments accumulate over time (Cunha et al., 2006)—after all, it was the early advantages that explained later achievement differences. At the same time, however, there was little support for the sleeper-effects phenomena, which posits that program benefits may emerge later in the life course even in the absence of initial programmatic benefits (Clarke & Clarke, 1981). There was no "break" or hiatus in the benefits (or drawbacks) of preschool, at least among the outcomes examined, nor did the initial advantages that resulted from preschool accumulate over time. Rather, preschool programs provided children with a small academic boost for kindergarten, which persisted through early adolescence.

Despite these contributions to the early childhood literature, there are a number of limitations that need to be acknowledged. Primarily, although this study attempted to capture the different kinds of preschool programs attended by children (e.g., center-based care and public pre-K and as a function of dosage) to tease apart the heterogeneity that exists within this broader umbrella of preschool, there are other sources of heterogeneity that require attention (e.g., process quality; Johnson, Markowitz, Hill, & Phillips, 2016). That is, one of the consequences of using ECLS-K data is that the effects reported combine very different categories of experience and quality, which may lower all types of effects over time. Accordingly, continued work is necessary to understand *which* programs confer greater benefits for children, and why. Relatedly, in keeping with prior research done with the ECLS-K and other preschool evaluations (e.g., Lee et al., 2014; Loeb et al., 2007; Magnuson et al., 2004), Head Start programs were excluded from the current definition of preschool. This is of note because Head Start serves roughly a quarter of the low-income population (Crosnoe et al., 2016), which is why these analyses do not speak to the

experiences of low-income children. Nonetheless, understanding the long-term benefits of preschool for primarily middle-class families is equally important, and outside of work done by the NICHD Network (Belsky et al., 2007; Vandell et al., 2010, 2016) and older experimental trials (Campbell et al., 2002; Reynolds et al., 2011; Schweinhart et al., 2006), this study is one of the few to consider the benefits of contemporary preschool programs through the end of middle school.

Additionally, much of the existing literature, including the current study, has relied on test scores as a means of evaluating the effectiveness of preschool programs. In light of some of the long-term follow-ups of early interventions, which reveal a host of psychosocial and economic benefits (Campbell et al., 2012; Schweinhart, 2005), an important future direction is for researchers to think more broadly about the myriad of outcomes in elementary school and beyond that may result from preschool enrollment. For example, Bailey and colleagues (2017) discuss the importance of considering whether preschool experiences help children seize new opportunities and avoid imminent risks that can potentially shift children's educational trajectories down the line. Within this framework, potential outcomes of interest can include placement in special education (Muschkin et al., 2015), school retention (Winsler et al., 2012), disciplinary infractions (Wright et al., 2014), and course taking patterns (Vandell et al., 2016).

It is also important to acknowledge that this study considered the landscape of preschool education during the 1997-1998 school year, which is prior to the major expansions of publicly funded preschool programs across the country. These data were selected because the ECLS-K: 1998 Cohort is one of the few contemporary national datasets that has tracked children's experiences through early adolescence, which were required to address the study objectives. Even so, recent studies have found that the patterns documented in the 1998 cohort of the ECLS-K closely resemble those of the 2010 cohort through the end of first grade (Bassok et al., 2015), suggesting that the findings documented herein are still relevant today. However, this limitation

speaks to a larger issue in a field where cohort effects are of increasing importance for consideration given the changing landscape of early childhood education and, ultimately, because government initiatives may dramatically change this landscape in the coming decades. To this very point, the landmark studies often discussed in the early childhood literature are Perry Preschool and Abecedarian, but how those programs translate to today's reality is unclear.

Finally, it is important to acknowledge two methodological limitations. First, the structure of the ECLS-K data collection limited the type of analyses that could be estimated. Similar to other studies with these data (e.g., Curenton et al., 2015; Magnuson et al., 2007), all of the variables used in the propensity score models were assessed *after* preschool attendance. Even though some of the variables were time invariant (e.g., race, gender, age), the best implementation of propensity scores is to use pre-treatment covariates. And even though this study used propensity score matching with a rich set of child and family covariates, which rules out many alternative explanations, these results do not imply cause and effect as it is not possible to completely rule out differential selection into preschool that result from unmeasured confounds. It is nonetheless interesting to point out that the propensity score models did little beyond the conditional regression models, which is perhaps not surprising given that this methodology does not change the causal identification (Elze et al., 2017). Considering that the estimated models included roughly 35 covariates regularly implicated in preschool selection (e.g., Coley et al., 2014; Crosnoe et al., 2016), it is likely that the OLS regression models were adequate in addressing issues related to bias. Second, some scholars emphasize the importance of disentangling "within" and "between" person effects and question whether cross-lagged models do so adequately (Berry & Willoughby, 2017). In their work, Berry and Willoughby (2017) outline an alternative methodological approach to addressing this issue (i.e., autoregressive latent trajectory models), which requires further attention. While this alternative strategy is certainly one way of addressing these issues, it is not

the only way. To address these issues, much of the current literature emphasizes the importance of including covariates, which help address between-person differences. And as other scholars have argued (Gershoff, Aber, & Clements, 2009), the autoregressive lag in cross-lagged models becomes a "fixed effect" for time invariant characteristics that addresses within person differences. Thus, while there are alternative approaches to addressing these concerns, the models estimated in this study are in line with much of educational and developmental literatures.

With these limitations and future directions in mind, the current investigation advanced our knowledge about preschool education and the theories surrounding the development of children by illustrating the long-term implications of preschool enrollment for children's academic achievement and psychosocial functioning. Moreover, the results of this study provided key insight into the periods of convergence, the similarities and differences in the long-term benefits of preschool across different subgroups of children and families, and the role of children's psychosocial skills in the dissipating academic benefits of preschool from kindergarten through eighth grade. Ultimately, although preschool programs can be an effective means of preparing children for kindergarten, in the long run, these programs, short of other supports, are not, and should not be expected to be, a remedy for educational inequality throughout the life course.

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Table 1.

Descriptive statistics of the focal variables in the ECLS-K, before and after matching.

Variable	Before matching			After matching		
	Informal care	Preschool	Sig. Diff.	Informal care	Preschool	Sig. Diff.
Children's characteristics						
Child age at kindergarten entry (months)	65.63 (4.19)	65.85 (4.11)	**	65.79 (4.21)	65.85 (4.11)	
Child age of first care (months)	23.41 (20.14)	20.82 (18.97)	***	21.28 (19.68)	20.81 (18.97)	
Child gender (male)	0.50	0.51		0.51	0.51	
Child has a disability	0.12	0.14	***	0.15	0.14	
Cultural background						
Child is White	0.51	0.67	***	0.66	0.66	
Child is Black	0.12	0.12		0.12	0.12	
Child is Latino	0.24	0.12	***	0.12	0.12	
Child is Asian/other	0.13	0.09	***	0.09	0.09	
Home language not English	0.18	0.08	***	0.08	0.08	
Household structure and characteristics						
Mother is married	0.69	0.76	***	0.76	0.76	
Mother is separated	0.16	0.13	***	0.13	0.13	
Mother is single	0.15	0.11	***	0.11	0.11	
Mothers' age	32.39 (6.66)	33.99 (6.07)	***	33.99 (6.53)	33.99 (6.07)	
Household size	4.71 (1.50)	4.31 (1.20)	***	4.34 (1.20)	4.31 (1.19)	
Number of siblings	1.60 (1.25)	1.29 (1.01)	***	1.30 (0.99)	1.29 (1.01)	
Family socioeconomic status						
Mom is employed full time	0.43	0.50	***	0.50	0.50	
Mom is employed part time	0.19	0.24	***	0.24	0.24	
Mom is unemployed	0.38	0.26	***	0.26	0.26	
Household income (/10,000)	4.15 (3.31)	6.06 (3.84)	***	5.99 (3.75)	6.06 (3.84)	
Received TANF	0.13	0.06	***	0.06	0.06	
Received Food Stamps	0.22	0.10	***	0.10	0.10	
Mothers' years of education	12.69 (2.37)	14.15 (2.39)	***	14.14 (2.45)	14.15 (2.39)	
Family home and school involvement						
Home learning activities	2.77 (0.51)	2.80 (0.47)	***	2.80 (0.48)	2.80 (0.47)	

Parents' school involvement	0.54 (0.24)	0.62 (0.22)	***	0.62 (0.22)	0.62 (0.22)	
Educational resources	63.52 (56.91)	86.10 (60.31)	***	87.66 (63.31)	86.10 (60.31)	
Community characteristics						
Large city	0.42	0.41		0.41	0.41	
Suburbs	0.35	0.43	***	0.43	0.43	
Town	0.23	0.16	***	0.16	0.17	
Northeast	0.17	0.20	***	0.20	0.20	
Midwest	0.25	0.26	**	0.27	0.26	
South	0.29	0.33	***	0.33	0.33	
West	0.29	0.21	***	0.20	0.21	
Children's academic achievement						
Fall of kindergarten	-0.15 (0.89)	0.34 (1.05)	***	0.14 (1.01)	0.34 (1.04)	***
Spring of kindergarten	-0.11 (0.92)	0.32 (1.05)	***	0.16 (1.00)	0.32 (1.05)	***
Spring of first grade	-0.09 (0.94)	0.29 (1.00)	***	0.17 (0.98)	0.29 (1.00)	***
Spring of third grade	-0.10 (0.94)	0.30 (0.93)	***	0.18 (0.93)	0.30 (0.93)	***
Spring of fifth grade	-0.06 (0.92)	0.32 (0.88)	***	0.21 (0.89)	0.32 (0.88)	***
Spring of eighth grade	-0.09 (0.91)	0.27 (0.87)	***	0.18 (0.88)	0.27 (0.87)	***
Children's externalizing behavior						
Fall of kindergarten	-0.14 (0.91)	0.01 (0.99)	***	-0.18 (0.87)	0.01 (0.99)	***
Spring of kindergarten	-0.11 (0.93)	0.01 (0.98)	***	-0.14 (0.91)	0.01 (0.98)	***
Spring of first grade	-0.07 (0.95)	0.00 (0.99)	***	-0.11 (0.92)	0.00 (0.99)	***
Spring of third grade	-0.05 (0.95)	-0.04 (0.95)		-0.11 (0.92)	-0.04 (0.95)	***
Spring of fifth grade	-0.09 (0.92)	-0.09 (0.93)		-0.14 (0.90)	-0.09 (0.93)	**
Children's social skills						
Fall of kindergarten	0.05 (0.95)	0.07 (0.98)		0.15 (0.95)	0.07 (0.98)	***
Spring of kindergarten	0.06 (0.97)	0.07 (0.98)		0.14 (0.98)	0.07 (0.98)	***
Spring of first grade	0.04 (0.99)	0.05 (0.99)		0.13 (0.98)	0.05 (0.99)	***
Spring of third grade	0.01 (1.00)	0.07 (0.99)	**	0.09 (0.99)	0.07 (0.99)	
Spring of fifth grade	0.04 (0.96)	0.10 (0.96)	*	0.12 (0.95)	0.10 (0.96)	

Notes. All estimates correspond to means or proportions. Estimates in brackets correspond to standard deviations. Proportions may not sum to 1.00 due to rounding. n = 15,070 before matching. n = 14,521-14,629 after matching. Sample sizes in the matched samples vary across the 50 imputed datasets. *** $p < .001$. ** $p < .01$. * $p < .05$.

Table 2.
The associations between participation in preschool versus informal care at age 4 and children's academic and psychosocial functioning over time, using matched data.

		Convergence from…	
	Effect size	Baseline	Prior wave
Academic achievement			
Fall of kindergarten	0.195 (0.028) ***	---	---
Spring of kindergarten	0.155 (0.027) ***	-0.040 (0.013) **	-0.040 (0.013) **
Spring of first grade	0.126 (0.027) ***	-0.069 (0.019) ***	-0.030 (0.016) †
Spring of third grade	0.115 (0.026) ***	-0.080 (0.022) ***	-0.011 (0.016)
Spring of fifth grade	0.107 (0.024) ***	-0.088 (0.022) ***	-0.008 (0.012)
Spring of eighth grade	0.092 (0.023) ***	-0.103 (0.023) ***	-0.015 (0.012)
Externalizing behavior			
Fall of kindergarten	0.184 (0.022) ***	---	---
Spring of kindergarten	0.158 (0.023) ***	-0.026 (0.016)	-0.026 (0.016)
Spring of first grade	0.117 (0.023) ***	-0.067 (0.024) **	-0.041 (0.023) †
Spring of third grade	0.068 (0.024) **	-0.116 (0.026) ***	-0.049 (0.023) *
Spring of fifth grade	0.050 (0.022) *	-0.133 (0.025) ***	-0.018 (0.023)
Social skills			
Fall of kindergarten	-0.074 (0.024) **	---	---
Spring of kindergarten	-0.076 (0.025) **	-0.002 (0.021)	-0.002 (0.021)
Spring of first grade	-0.088 (0.025) ***	-0.014 (0.028)	-0.012 (0.026)
Spring of third grade	-0.024 (0.026)	0.050 (0.031)	0.064 (0.029) *
Spring of fifth grade	-0.025 (0.024)	0.048 (0.030)	-0.002 (0.029)

Notes. All estimates in brackets correspond to standard errors. All continuous variables were standardized to have a mean of 0 and standard deviation of 1 and, therefore, the coefficients in this table correspond to effect sizes. Because these were fully saturated path models, the above models had a CFI of 1.00, RMSEA of 0.00. Convergence estimates might not sum to the effect sizes differences due to rounding.
*** $p < .001$. ** $p < .01$. * $p < .05$. † $p < .10$

Table 3.

The indirect associations between participation in preschool versus informal care at age 4 and children's achievement over time, using propensity score matched data.

	Total direct effect with no mediators	Total direct effect with mediators	Total indirect effect	Total indirect effect of preschool enrollment via earlier…		
				Academic achievement	Externalizing behavior	Social skills
Fall of kindergarten	0.195 (0.028) ***	---	---	---	---	---
Spring of kindergarten	0.155 (0.027) ***	-0.008 (0.012)	0.164 (0.024) ***	0.167 (0.024) ***	0.000 (0.002)	-0.003 (0.001) *
Spring of first grade	0.126 (0.027) ***	-0.001 (0.016)	0.127 (0.022) ***	0.132 (0.022) ***	0.002 (0.003)	-0.007 (0.002) **
Spring of third grade	0.115 (0.026) ***	0.016 (0.015)	0.099 (0.021) ***	0.105 (0.020) ***	0.010 (0.003) ***	-0.016 (0.004) ***
Spring of fifth grade	0.107 (0.024) ***	0.009 (0.011)	0.098 (0.022) ***	0.103 (0.022) ***	0.011 (0.004) **	-0.017 (0.005) ***
Spring of eight grade	0.092 (0.023) ***	0.009 (0.012)	0.083 (0.020) ***	0.093 (0.019) ***	0.003 (0.003)	-0.014 (0.004) ***

Notes. All estimates in brackets correspond to standard errors. All continuous variables were standardized to have a mean of 0 and standard deviation of 1 and, therefore, the coefficients in this table correspond to effect sizes. All models had good fit: CFIs > 0.95 and RMSEAs < 0.07.

*** $p < .001$. ** $p < .01$. * $p < .05$.

Table 4.

Heterogeneity in the direct associations between participation in preschool versus informal care at age 4 and children's academic and psychosocial functioning over time, using matched data.

	Preschool X household income	Preschool X Black child (vs. White)	Preschool X Hispanic child (vs. White)	Preschool X Asian/Other child (vs. White)	Preschool X child disability status	Preschool X child gender
Academic achievement						
Fall of kindergarten	0.026 (0.028)	-0.018 (0.063)	0.006 (0.062)	0.061 (0.092)	-0.059 (0.068)	0.031 (0.053)
Spring of kindergarten	0.027 (0.027)	0.000 (0.067)	0.025 (0.068)	0.072 (0.094)	-0.013 (0.074)	0.021 (0.050)
Spring of first grade	0.035 (0.025)	0.017 (0.070)	-0.034 (0.071)	0.039 (0.081)	-0.068 (0.079)	0.010 (0.049)
Spring of third grade	0.025 (0.022)	0.014 (0.070)	-0.012 (0.068)	0.041 (0.077)	-0.036 (0.078)	0.025 (0.047)
Spring of fifth grade	0.023 (0.021)	-0.003 (0.070)	-0.018 (0.063)	0.066 (0.072)	-0.019 (0.076)	0.035 (0.048)
Spring of eighth grade	0.021 (0.022)	0.032 (0.073)	-0.006 (0.063)	0.071 (0.074)	-0.053 (0.069)	0.042 (0.047)
Externalizing behavior						
Fall of kindergarten	-0.017 (0.026)	0.193 (0.069) **	-0.017 (0.064)	-0.039 (0.068)	0.024 (0.067)	0.073 (0.040) †
Spring of kindergarten	-0.037 (0.024)	0.091 (0.071)	0.026 (0.058)	-0.044 (0.069)	-0.046 (0.068)	0.039 (0.042)
Spring of first grade	-0.052 (0.025) *	0.100 (0.074)	0.017 (0.063)	-0.073 (0.080)	0.017 (0.064)	0.042 (0.042)
Spring of third grade	-0.065 (0.028) *	0.112 (0.069)	0.016 (0.064)	-0.161 (0.083) †	0.023 (0.073)	0.051 (0.046)
Spring of fifth grade	-0.043 (0.024) †	0.032 (0.072)	0.045 (0.061)	-0.017 (0.067)	-0.034 (0.070)	-0.019 (0.049)
Social skills						
Fall of kindergarten	-0.002 (0.028)	-0.055 (0.071)	0.097 (0.063)	0.106 (0.079)	0.033 (0.070)	0.006 (0.041)
Spring of kindergarten	0.015 (0.027)	-0.043 (0.075)	-0.013 (0.061)	0.031 (0.078)	0.086 (0.074)	0.022 (0.047)
Spring of first grade	0.046 (0.026) †	-0.015 (0.083)	0.030 (0.059)	0.135 (0.073) †	0.014 (0.074)	0.004 (0.045)
Spring of third grade	0.069 (0.028) *	-0.057 (0.078)	0.004 (0.071)	0.081 (0.084)	0.017 (0.073)	-0.013 (0.047)
Spring of fifth grade	0.034 (0.027)	0.014 (0.074)	-0.025 (0.066)	0.012 (0.075)	0.024 (0.068)	0.020 (0.050)

Notes. All estimates in brackets correspond to standard errors. All continuous variables were standardized to have a mean of 0 and standard deviation of 1 and, therefore, the coefficients in this table correspond to effect sizes. *** $p < .001$. ** $p < .01$. * $p < .05$. † $p < .10$.

Table 5.
The associations between participation in public prekindergarten and center-based care versus informal care at age 4 and children's academic and psychosocial functioning over time, using matched data.

		Convergence from…	
	Effect size	Baseline	Prior wave
Prekindergarten vs. informal care			
Academic achievement			
Fall of kindergarten	0.238 (0.039) ***	---	---
Spring of kindergarten	0.200 (0.039) ***	-0.037 (0.018) *	-0.037 (0.018) *
Spring of first grade	0.136 (0.038) ***	-0.101 (0.024) ***	-0.064 (0.022) **
Spring of third grade	0.128 (0.038) ***	-0.109 (0.030) ***	-0.008 (0.023)
Spring of fifth grade	0.119 (0.037) ***	-0.119 (0.029) ***	-0.009 (0.015)
Spring of eighth grade	0.102 (0.039) **	-0.136 (0.033) ***	-0.017 (0.018)
Externalizing behavior			
Fall of kindergarten	0.222 (0.035) ***	---	---
Spring of kindergarten	0.213 (0.034) ***	-0.009 (0.024)	-0.009 (0.024)
Spring of first grade	0.168 (0.035) ***	-0.054 (0.036)	-0.045 (0.033)
Spring of third grade	0.105 (0.036) **	-0.117 (0.035) ***	-0.063 (0.032) *
Spring of fifth grade	0.091 (0.034) **	-0.136 (0.033) ***	-0.014 (0.033)
Social skills			
Fall of kindergarten	-0.083 (0.039) *	---	---
Spring of kindergarten	-0.105 (0.035) **	-0.021 (0.030)	-0.021 (0.030)
Spring of first grade	-0.096 (0.039) *	-0.013 (0.043)	0.008 (0.040)
Spring of third grade	-0.044 (0.042)	0.039 (0.043)	-0.050 (0.036)
Spring of fifth grade	-0.050 (0.036)	0.033 (0.042)	-0.005 (0.041)
Center-based care vs. informal care			
Academic achievement			
Fall of kindergarten	0.171 (0.028) ***	---	---
Spring of kindergarten	0.133 (0.029) ***	-0.038 (0.014) **	-0.038 (0.014) **
Spring of first grade	0.114 (0.029) ***	-0.057 (0.021) **	-0.019 (0.017)
Spring of third grade	0.106 (0.028) ***	-0.065 (0.022) **	-0.008 (0.017)
Spring of fifth grade	0.098 (0.025) ***	-0.073 (0.022) ***	-0.008 (0.013)
Spring of eighth grade	0.086 (0.025) ***	-0.085 (0.025) ***	-0.011 (0.014)
Externalizing behavior			
Fall of kindergarten	0.174 (0.023) ***	---	---
Spring of kindergarten	0.144 (0.025) ***	-0.031 (0.018) †	-0.031 (0.018) †
Spring of first grade	0.101 (0.027) ***	-0.073 (0.027) **	-0.042 (0.026) †
Spring of third grade	0.055 (0.027) *	-0.119 (0.028) ***	-0.046 (0.025) †
Spring of fifth grade	0.038 (0.024)	-0.136 (0.027) ***	-0.017 (0.024)
Social skills			
Fall of kindergarten	-0.075 (0.026) ***	---	---
Spring of kindergarten	-0.068 (0.028) *	0.007 (0.021)	0.007 (0.021)
Spring of first grade	-0.085 (0.028) **	-0.010 (0.030)	-0.017 (0.028)
Spring of third grade	-0.018 (0.029)	0.056 (0.034) †	0.066 (0.031) *
Spring of fifth grade	-0.017 (0.026)	0.058 (0.032) †	0.001 (0.030)
Prekindergarten vs. center-based care			
Academic achievement			
Fall of kindergarten	0.060 (0.037)	---	---
Spring of kindergarten	0.050 (0.037)	-0.010 (0.016)	-0.010 (0.016)
Spring of first grade	0.003 (0.036)	-0.057 (0.025) *	-0.047 (0.022) *
Spring of third grade	-0.005 (0.037)	-0.064 (0.028) *	-0.008 (0.022)
Spring of fifth grade	-0.005 (0.035)	-0.064 (0.030) *	0.000 (0.014)

Spring of eighth grade	-0.013 (0.037)	-0.072 (0.033) *	-0.008 (0.016)
Externalizing behavior			
Fall of kindergarten	-0.002 (0.032)	---	---
Spring of kindergarten	0.037 (0.032)	0.039 (0.020) †	0.039 (0.020) †
Spring of first grade	0.037 (0.038)	0.039 (0.030)	0.000 (0.030)
Spring of third grade	0.034 (0.040)	0.026 (0.033)	-0.003 (0.030)
Spring of fifth grade	0.031 (0.034)	0.032 (0.033)	-0.003 (0.033)
Social skills			
Fall of kindergarten	0.011 (0.038)	---	---
Spring of kindergarten	-0.027 (0.033)	-0.038 (0.026)	-0.038 (0.026)
Spring of first grade	-0.006 (0.037)	-0.016 (0.038)	0.021 (0.036)
Spring of third grade	-0.018 (0.039)	-0.028 (0.037)	-0.012 (0.038)
Spring of fifth grade	-0.031 (0.037)	-0.042 (0.036)	-0.013 (0.036)

Notes. All estimates in brackets correspond to standard errors. All continuous variables were standardized to have a mean of 0 and standard deviation of 1 and, therefore, the coefficients in this table correspond to effect sizes. Because these were fully saturated path models, the above model above had a CFI of 1.00, RMSEA of 0.00. Convergence estimates might not sum to the effect sizes differences due to rounding.
*** $p < .001$. ** $p < .01$. * $p < .05$. † $p < .10$

Table 6.
The associations between participation in part- and full-day preschool versus informal care at age 4 and children's academic and psychosocial functioning over time, using matched data.

		Convergence from…	
	Effect size	Baseline	Prior wave
Part day preschool vs. informal care			
Academic achievement			
Fall of kindergarten	0.166 (0.034) ***	---	---
Spring of kindergarten	0.124 (0.034) ***	-0.042 (0.016) **	-0.042 (0.016) **
Spring of first grade	0.113 (0.035) ***	-0.053 (0.024) *	-0.010 (0.019)
Spring of third grade	0.100 (0.033) **	-0.066 (0.027) *	-0.013 (0.020)
Spring of fifth grade	0.090 (0.028) ***	-0.076 (0.025) **	-0.010 (0.014)
Spring of eighth grade	0.077 (0.028) **	-0.089 (0.028) **	-0.013 (0.014)
Externalizing behavior			
Fall of kindergarten	0.045 (0.025) †	---	---
Spring of kindergarten	0.036 (0.024)	-0.010 (0.018)	-0.010 (0.018)
Spring of first grade	0.000 (0.025)	-0.045 (0.029)	-0.035 (0.027)
Spring of third grade	-0.015 (0.026)	-0.061 (0.030) *	-0.015 (0.027)
Spring of fifth grade	-0.018 (0.027)	-0.063 (0.030) *	-0.003 (0.027)
Social skills			
Fall of kindergarten	0.014 (0.029)	---	---
Spring of kindergarten	0.013 (0.029)	-0.002 (0.023)	-0.002 (0.023)
Spring of first grade	-0.003 (0.027)	-0.018 (0.032)	-0.016 (0.031)
Spring of third grade	0.052 (0.030) †	0.038 (0.038)	0.055 (0.033) †
Spring of fifth grade	0.032 (0.029)	0.017 (0.035)	-0.020 (0.034)
Full day preschool vs. informal care			
Academic achievement			
Fall of kindergarten	0.221 (0.035) ***	---	---
Spring of kindergarten	0.191 (0.034) ***	-0.030 (0.016) †	-0.030 (0.016) †
Spring of first grade	0.144 (0.031) ***	-0.077 (0.023) ***	-0.047 (0.020) *
Spring of third grade	0.142 (0.031) ***	-0.079 (0.027) **	-0.003 (0.020)
Spring of fifth grade	0.136 (0.030) ***	-0.085 (0.027) **	-0.006 (0.016)
Spring of eighth grade	0.125 (0.028) ***	-0.096 (0.029) ***	-0.011 (0.016)
Externalizing behavior			
Fall of kindergarten	0.333 (0.029) ***	---	---
Spring of kindergarten	0.290 (0.032) ***	-0.043 (0.023) †	-0.043 (0.023) †
Spring of first grade	0.238 (0.031) ***	-0.095 (0.031) **	-0.052 (0.031) †
Spring of third grade	0.144 (0.032) ***	-0.189 (0.032) ***	-0.094 (0.029) ***
Spring of fifth grade	0.120 (0.030) ***	-0.213 (0.032) ***	-0.024 (0.029)
Social skills			
Fall of kindergarten	-0.159 (0.032) ***	---	---
Spring of kindergarten	-0.164 (0.033) ***	-0.005 (0.027)	-0.005 (0.027)
Spring of first grade	-0.175 (0.033) ***	-0.016 (0.038)	-0.011 (0.037)
Spring of third grade	-0.098 (0.033) **	0.061 (0.037) †	-0.082 (0.031) **
Spring of fifth grade	-0.082 (0.031) **	0.077 (0.038) *	0.016 (0.034)
Full day preschool vs. part day preschool			
Academic achievement			
Fall of kindergarten	0.051 (0.038)	---	---
Spring of kindergarten	0.063 (0.039)	0.012 (0.017)	0.012 (0.017)
Spring of first grade	0.016 (0.040)	-0.035 (0.023)	-0.047 (0.018) **
Spring of third grade	0.008 (0.041)	-0.043 (0.027)	-0.008 (0.023)
Spring of fifth grade	0.011 (0.039)	-0.040 (0.027)	0.002 (0.015)

Spring of eighth grade	-0.002 (0.038)	-0.053 (0.029) †	-0.013 (0.017)
Externalizing behavior			
Fall of kindergarten	0.222 (0.031) ***	---	---
Spring of kindergarten	0.220 (0.032) ***	-0.002 (0.024)	-0.002 (0.024)
Spring of first grade	0.202 (0.032) ***	-0.020 (0.034)	-0.018 (0.033)
Spring of third grade	0.160 (0.036) ***	-0.061 (0.037) †	-0.042 (0.033)
Spring of fifth grade	0.125 (0.034) ***	-0.097 (0.036) **	-0.035 (0.034)
Social skills			
Fall of kindergarten	-0.159 (0.032) ***	---	---
Spring of kindergarten	-0.180 (0.033) ***	-0.021 (0.026)	-0.021 (0.026)
Spring of first grade	-0.158 (0.032) ***	0.001 (0.040)	0.022 (0.040)
Spring of third grade	-0.156 (0.034) ***	0.003 (0.041)	0.001 (0.037)
Spring of fifth grade	-0.120 (0.037) ***	0.039 (0.043)	0.037 (0.039)

Notes. All estimates in brackets correspond to standard errors. All continuous variables were standardized to have a mean of 0 and standard deviation of 1 and, therefore, the coefficients in this table correspond to effect sizes. Because these were fully saturated path models, the above model above had a CFI of 1.00, RMSEA of 0.00. Convergence estimates might not sum to the effect sizes differences due to rounding.
*** $p < .001$. ** $p < .01$. * $p < .05$. † $p < .10$

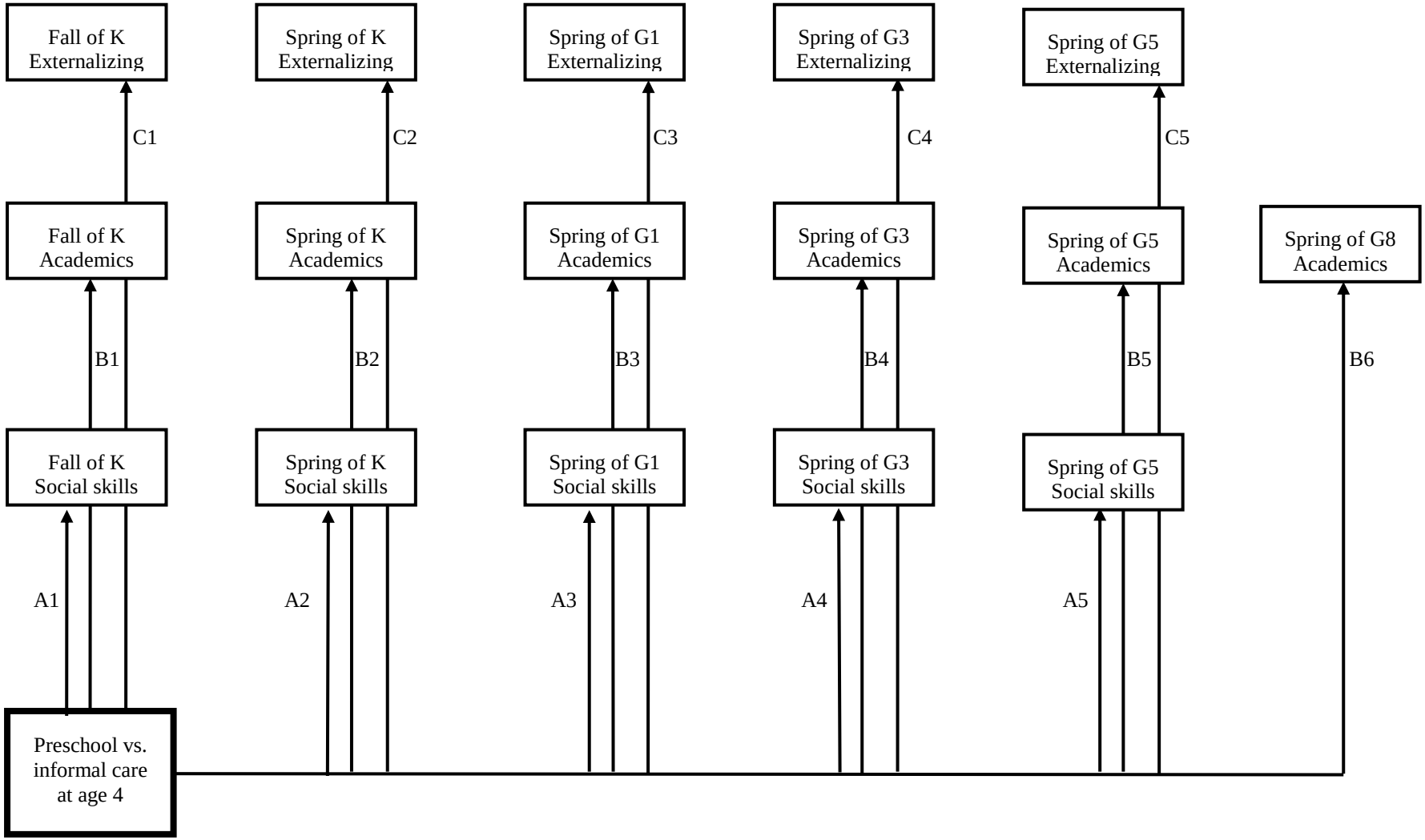

Figure 1. Hypothesized model for the direct effects of preschool enrollment on children's social skills (A paths), academic achievement (B paths), and externalizing behavior (C paths). K = kindergarten. G = grade. All within time measures were covaried.

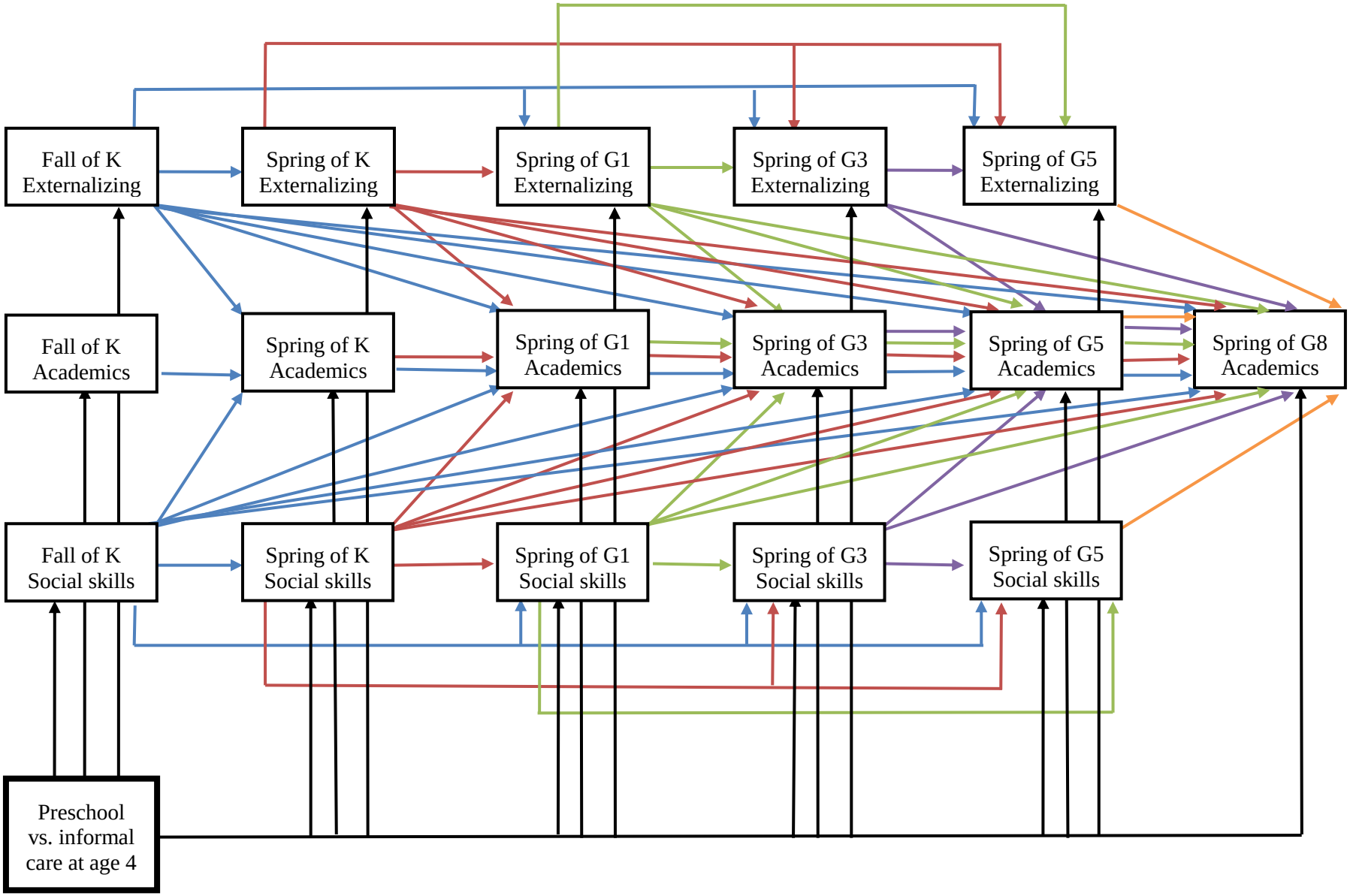

Figure 2. Hypothesized model for the total indirect effects of preschool enrollment. Black lines correspond to preschool effects. Blue lines correspond to fall of kindergarten effects. Red lines correspond to spring of kindergarten effects. Green lines correspond to spring of first grade effects. Purple lines correspond to spring of third grade effects. Orange lines correspond to spring of fifth grade effects. K = kindergarten. G = grade. All within time measures were covaried.

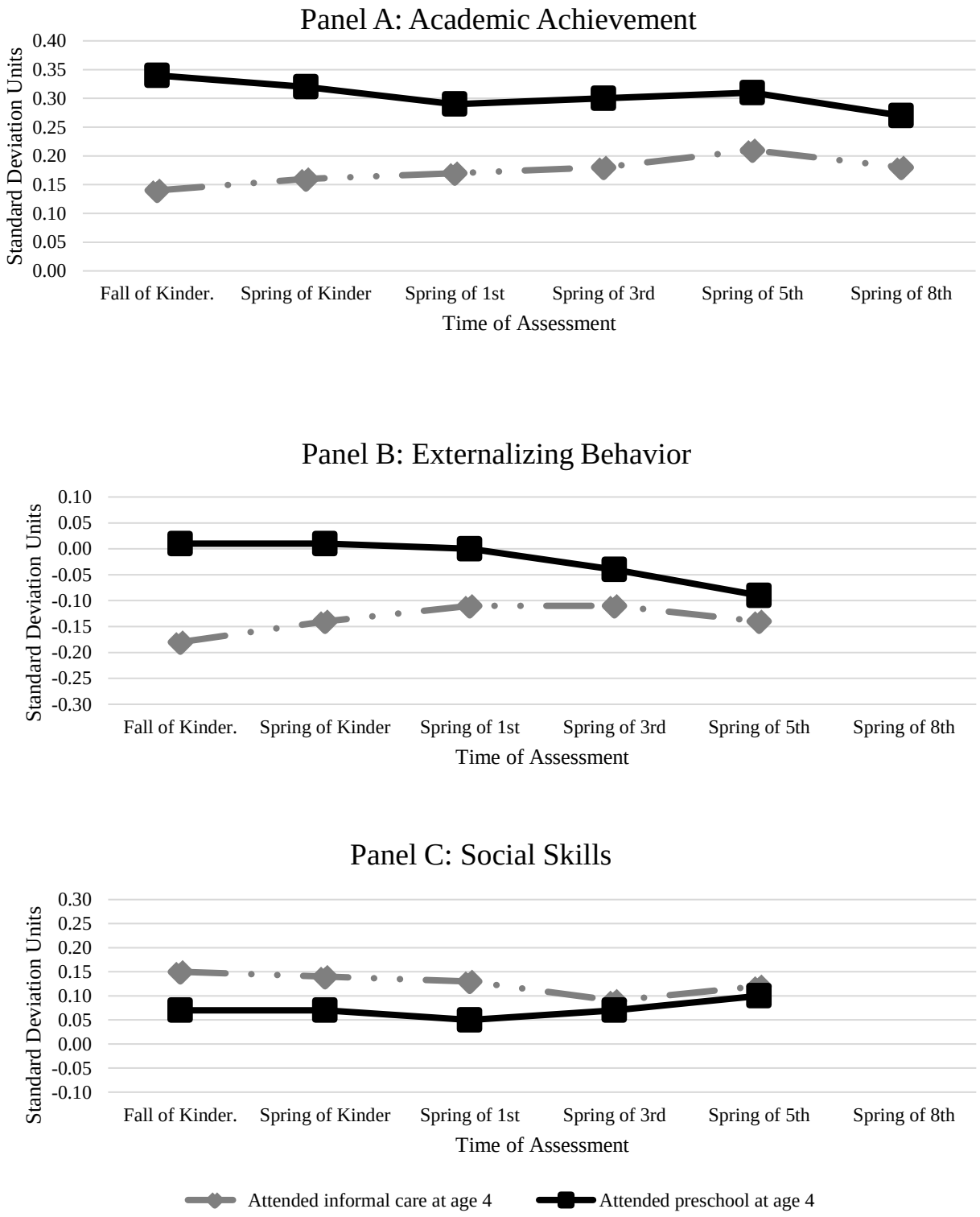

Figure 3. Plots of the children's academic test scores (panel A), externalizing behavior (panel B), and social skills (panel C) from kindergarten entry through the end of eighth grade across the preschool and informal care conditions, using the matched samples. Kinder = kindergarten.