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Classroom age composition and the early learning of preschoolers

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ABSTRACT

Data from 1,407 preschoolers were used to examine the implications of classroom age composition for the early learning and development of 4-year-olds in classrooms with 3- and 5-year-olds also in attendance. Results suggest that a greater number of younger classmates did not detract from 4-year-olds' language development, literacy performance, or inhibitory control, nor did having older peers consistently facilitate learning in these domains. However, 4-year-olds who entered school with low inhibitory control and print knowledge demonstrated greater gains in both domains when attending classrooms with more same-age or older classmates than when in classrooms with more younger peers. When taken together, these results suggest that classroom age composition, in prekindergarten programs serving mostly 4-year-olds, for the most part has little consequence except for those 4-year-olds entering school with lower skill levels in key domains, in which case having older peers is of benefit.

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The growing recognition of early childhood as a critical developmental period that has lasting influences has laid the groundwork for the expansion of preschool education for both 3- and 4-year-olds across the country (Duncan & Magnuson, 2013; Yoshikawa et al., 2013). Indeed, recent national estimates suggest that roughly 42% and 68% of 3- and 4-year-olds, respectively, attend preschool during the year before kindergarten, which is greater than enrollment rates from 1990 (33% and 56%, respectively; U.S. Department of Education, 2015). This expansion of preschool stems from the fact that these programs not only facilitate children's school preparedness, but have also been found to narrow developmental disparities throughout the life course (Sorensen & Dodge, 2015; Vandell, Burchinal, & Pierce, 2016). With the promise of preschool coupled with its continued expansion, there has been growing interest in understanding the drivers of how these programs impact children (Duncan & Magnuson, 2013). One such aspect of the classroom ecology that has received a surge of interest among both researchers and policymakers is age composition, in large part because programs often regulate access by age. Notwithstanding these regulations, as preschool expands and Head Start and state prekindergarten (preK) funds are more often used to serve children in common classrooms (i.e., the blending/braiding of local, state, and federal funds), an increasing number of 3-years-olds are being served in classrooms with 4-year-olds, making classrooms that enroll different age children a more prevalent experience for preschoolers across the country (Ansari, Purtell & Gershoff, 2016; National Survey of Early Care and Education, 2012).

Despite the increasing number of programs serving different age children, the implications of classroom age composition has received limited and conflicting empirical support (Mason & Burns, 1996; Veenman, 1995). These equivocal findings, coupled with the widespread prevalence of these types of classrooms in many publicly funded prekindergarten programs in the United States (Ansari et al., 2016; Bell et al., 2013; Moller, Forbes-Jones, & Hightower, 2008), suggest an imperative to document the possible consequences for student learning of this policy for preschool eligibility and enrollment which some research suggests could be potentially undermining its overall effectiveness (Ansari et al., 2016; Moller et al., 2008). Toward that end, as part of the present investigation we addresses the potential benefits and drawbacks of having different age peers in preK classrooms across eight states that serve different age children in the same classrooms (roughly 12% of 3-year-olds in these states are served by public programs; Barnett, Epstein, Sansanelli, & Hustedt, 2009; Barnett et al., 2010). More specifically, we consider both the implications of having younger and older peers in the classroom for the language, literacy, and executive function skills of 4-year-olds and examine heterogeneity in these associations as a function of their skills at entry to preK.

Theoretical framework

In line with the bioecological model of Bronfenbrenner and Morris (2006), we consider how specific proximal processes within prekindergarten classrooms shape the development of young children. Nested within this bioecological framework,

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theories of social learning (Bandura, 1986) and cognitive development (Vygotsky, 1978) also guide our investigation, as they both contend that interactions between children and their peers (i.e., peer effects) can be one of the primary mechanisms through which classroom experience affects students' development. For example, these theories suggest that, in a classroom ecology, higher-skilled (or older) children can *directly* promote the early learning and development of their lower-skilled (or younger) peers and, in so doing, may also bolster their own skills and knowledge (i.e., child-by-child transmission). In support of these theoretical arguments laid out by Bandura (1986) and Vygotsky (1978), a number of studies have found that children's classmates do shape their individual development (Henry & Rickman, 2007; Justice, Logan, Lin, & Kaderavek, 2014; Mashburn, Justice, Downer, & Pianta, 2009; Yudron, Jones, & Raver, 2014). At the same time, however, other developmental and educational scholars suggest that there is considerable more nuance to the peer ecology and that careful attention should be paid to the individual characteristics of children and their families (e.g., Ribeiro, Zachrisson, & Dearing, 2017) and the ways in which the peer ecology intersects with various other aspects of the classroom environment (e.g., Guo, Tompkins, Justice, & Petscher, 2014; Purtell & Ansari, 2018).

Although less often discussed, it is also plausible that the age composition of the classroom affects children through indirect means, such as effects on teacher-child interactions (i.e., child-to-teacher-to-child transmission; Ansari & Pianta, 2018; Snell, Hindman, & Belsky, 2015). Indeed, teachers in classrooms with greater age heterogeneity (e.g., 3-, 4-, and 5-year-olds) are faced with challenges that include adjusting instruction to a wider range of skill levels relative to classrooms that have a more uniform age level (e.g., only 4-year-olds); and at the upper and lower ends of the age distribution this could impact children if teachers cannot address this demand. Accordingly, theories of the peer ecology of classrooms suggest that age composition could have varying effects on children's early school performance and may shape one of the primary pathways through which preschool programs impact children (see also, Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009; Yudron et al., 2014). Regardless of whether these pathways are direct or indirect, it is important to note that, in the present investigation, we focus on the intersection of child age and skill, whereas much of the peer effects literature has focused on skill alone, which is confounded with age.

Review of the background literature

In light of the expansion of preschool education across the United States, particularly in the form of state-funded prekindergarten programs and braided/blended funding for early childhood education, there is a great deal of heterogeneity in the ages of children served within programs and classrooms (Duncan & Magnuson, 2013; Yoshikawa et al., 2013). Some programs serve only 3- or only 4-year-olds, whereas many early childhood classrooms serve children whose ages may span several years (e.g., 3-, 4-, and 5-year-olds; Ansari et al., 2016; National Survey of Early Care and Education, 2012). As we suggested previously, with regard to associations between the age composition of early childhood classrooms with children's school performance, the empirical evidence is mixed, with some scholars documenting positive impacts of classrooms that enroll different age children (Blasco, Bailey, & Burchinal, 1993; Goldman, 1981; Guo et al., 2014; Justice, Logan, Purtell, Bleses, & Højen, 2018) and others documenting largely null or negative associations (Ansari et al., 2016; Bell et al., 2013; Moller et al., 2008; Urberg & Kaplan, 1986; Winsler et al., 2002).

Despite these conflicting claims, three recent large-scale studies of classroom age composition are of note, all of which were done in publicly funded programs. First, Moller et al. (2008), who sampled 4-year-old children from urban preschool programs in the northeastern United States, found that greater heterogeneity in classroom age composition was associated with less optimal school achievement. The negative associations between age heterogeneity and child development were strongest for the oldest children in the classroom. Second, a recent nationally representative study of classrooms in Head Start revealed that 4-year-olds displayed fewer gains in areas of early mathematics and language and literacy when they attended classrooms with a greater number of 3-year-olds (Ansari et al., 2016), with effect sizes in some classrooms corresponding to approximately 4–5 months of development. Both studies also documented no consistent benefits of having older classmates for the school performance of the youngest children in the classroom (Ansari et al., 2016; Moller et al., 2008), suggesting that careful attention must be paid to the older children in these environments. Finally, in contrast to the aforementioned studies, Bell et al. (2013) found that, regardless of children's age, classroom age composition in federally funded preschool programs in the southeastern United States did not have any implications for children's academic or socio-emotional development. Thus, when taken together, these three studies—which represent some of the most rigorous assessments of the age composition of general preK classrooms—provide inconclusive evidence regarding the implications of having different age classmates.

It should also be noted that much of this existing literature on classroom age composition has examined the experiences of children in classrooms with a limited age range. For example, the work done by both Ansari et al. (2016) and Bell et al. (2013) provided a limited contrast of different age children, spanning roughly 12 months. That is, in classrooms with a limited age range of children, the study participants are generally either the youngest or oldest children in the classroom in any given year. In light of the literature and theoretical arguments underpinning peer effects and child development more generally (e.g., Bandura, 1986; Vygotsky, 1978), a more complete assessment of the implications of age composition for children's early learning is likely necessary. In fact, some educational scholars argue that having different age peers in the classroom is likely to be most effective when there are at least three-year age groupings (Lillard, 2016), thereby allowing children to be

exposed to both younger and older classmates as they progress throughout the school year. Accordingly, a more comprehensive assessment of classroom age composition would involve a wider range of different-age classmates, such that children have both younger and older peers available to them.

Given the conflicting claims related to classroom age composition effects, a number of studies have also emphasized the role of children's incoming skill levels, both as a potential moderator of classroom effects and as a means of disentangling the different ways in which classroom compositional factors shape children's early learning (for a related discussion, see Justice, Petscher, Schatschneider, & Mashburn, 2011; Mashburn et al., 2009). Children's own skills at school entry are particularly important when trying to understand the implications of classroom age composition because children's skills and behaviors shape the ways in which children interact with their peers and teachers, and in turn, have implications for the ways in which classrooms impact children. In the context of mixed-aged classrooms, of particular importance are (a) children's language/literacy skills, which enable them to communicate with their peers and teachers, and (b) their executive functioning, which allows children to manage their behavior and emotions (Duncan et al., 2007; Mashburn et al., 2009; Masten et al., 2012; McClelland et al., 2013). And in support of these very points, a number of studies have found that although lower-skilled children do learn more from their interactions with their older and more skilled peers, higher-skilled children are neither harmed by nor consistently benefit from their interactions with their classmates (Guo et al., 2014; Justice et al., 2011).

Present study

In light of the existing literature and current landscape of preschool education in the United States, this study sought to address a key question that is being considered by both researchers and policymakers alike: whether it is more effective to offer preschool programs that constrain the age range of children in classrooms (e.g., when only a 12-month span determines access) or allow for greater heterogeneity (such as programs for 4-year-olds that open eligibility to 3-year-olds). More specifically, we address the following two research questions for low-income children served in state-supported prekindergarten programs:

Research Question 1: Does the age composition of the classroom influence the inhibitory control and language and literacy development of 4-year-old children?

Research Question 2: Do the effects of classroom age composition for the aforementioned dimensions of children's early learning vary as a function of their school entry skills?

As part of the present investigation we explore the role of the peer ecology for 4-year-olds who have both 3- and 5-year-old classmates, which has been largely absent from recent evaluations of classroom age composition (Ansari et al., 2016; Bell et al., 2013) and we consider children's language, literacy, and executive function skills as outcomes, all of which are important precursors for long-term educational success (Duncan et al., 2007; Masten et al., 2012; McClelland et al., 2013). However, given the equivocal nature of the existing literature discussed above, and lack of empirical work in this area looking at executive functioning in particular, we leave our study hypotheses as largely exploratory. Despite these efforts, it is important to acknowledge that our data prohibit us from examining the outcomes of 3-year-olds; nonetheless, understanding whether one group of children benefits from or is harmed by mixed-age environments remains an important endeavor as the goal of early childhood education is to ensure that all children reap the maximum benefit from these programs.

Method

Data for the present study were derived from the National Center for Research on Early Childhood Education (NCRECE) Professional Development Study (see also Hamre et al., 2012; Pianta et al., 2017). The NCRECE investigation is a large multisite, randomized controlled trial of two different types of professional development (coaching and coursework) that were aimed at improving the quality of teachers' interactions with their students in the areas of instructional and emotional support, and classroom organization. The two professional development interventions were delivered in two phases followed by a third phase of data collection. Children only participated in the last two phases, with any given child participating for only one year. For the purposes of this study, we used data from teacher and child participants in the second phase.

As brief background to the NCRECE sampling, teachers were eligible for the larger study if they met the following conditions: (a) they taught in a publicly-funded preschool program; (b) the majority of their students did not have an Individualized Education Program at the start of the school year; and (c) classroom instruction was primarily delivered in English (for more information on sampling see, Hamre et al., 2012). After teachers were recruited and randomly assigned to the treatment and control conditions, families in each classroom were given recruitment packets. Of the children whose parents consented, four were randomly selected (two boys and two girls) per classroom for direct assessments if they had no Individualized Education Program and spoke English (87%) or Spanish (13%). As part of the sampling procedures, priority was given to the 4-year-olds in these classrooms; that is, 3- and 5-year-old children were not recruited and/or assessed as part of the study.

This recruitment strategy resulted in 1,407 children in 325 different classrooms across the country (New York City, NY; Hartford, CT; Chicago, IL; Stockton, CA; Dayton, OH; Columbus, OH, Memphis, TN, Charlotte, NC; Providence, RI). Participating children were ethnically diverse (47% Black, 34% Latino, 11% White, 8% Asian/other) and, on average, their families had an annual income of $23,736 ($SD = \$21,264$) and mothers averaged a little less than 13 ($SD = 2.04$) years of education. These children were largely

enrolled in Head Start (58%) and school-based preK (37%; not mutually exclusive). Their teachers were approximately 42 years of age ($SD = 10.79$), averaged almost 16 years of education ($SD = 1.61$ years), and were largely African American (47%) or White (33%), with a smaller number identifying as Latino (14%) or Asian/other (7%). For more child-level descriptive information on the study sample, see Table 1.

Table 1. Descriptive statistics of the study sample.

Percent of…	
2- or 3-year-olds	20.60 (23.12)
4-year-olds	55.72 (22.71)
5-year-olds	23.68 (21.34)
Beginning-of-year child outcomes	
Receptive vocabulary	86.03 (16.85)
Expressive vocabulary	96.07 (16.80)
Phonological awareness	89.94 (13.98)
Print knowledge	96.02 (14.61)
Inhibitory control	0.46 (0.33)
End-of-year child outcomes	
Receptive vocabulary	89.98 (16.05)
Expressive vocabulary	96.86 (13.54)
Phonological awareness	92.98 (15.03)
Print knowledge	101.93 (14.59)
Inhibitory control	0.64 (0.33)
Child and family characteristics	
Child age	4.17 (0.47)
Child gender	0.49
Child race/ethnicity	
Black	0.47
Latino	0.34
White	0.11
Asian/other	0.08
Household size	4.28 (1.45)
Number of children under 18 years old	2.33 (1.19)
Household income/1,000	23.74 (21.26)
Mothers' education	12.73 (2.04)
Fathers' lives at home	0.47
Child language is English	0.87
Child attends Head Start	0.58
Child attends public school preK	0.37
Teacher characteristics	
Year 1 intervention	
Course	0.39
Control	0.41
Replacement	0.19
Year 2 intervention	
Coaching	0.52
Control	0.48
Teachers' years of education	15.86 (1.61)
Teachers' gender (woman)	0.96
Teachers' age	42.46 (10.79)
Teachers' years of experience	14.53 (9.28)
Teachers' race/ethnicity	
Black	0.47
White	0.33
Latino	0.14
Asian/other	0.07
Classroom characteristics	
Class size	17.81 (3.03)
Percent of…	
Girls in classroom	48.37 (11.75)
Children with disability	7.13 (9.20)
Children with limited English	14.73 (20.50)
White children	11.84 (21.02)
Black children	48.69 (34.88)
Latino children	30.88 (30.26)
Asian/other children	8.59 (13.46)
Average class income	1.07 (0.69)

Notes. All estimates are at the child level and correspond to means or proportions. Estimates in brackets are standard deviations. Proportions might not sum to 1.00 due to rounding.

Measures

Classroom age composition

At the start of the school year, teachers reported on the number of children in their classroom and how many were 2, 3, 4, or 5 years of age. Based on these reports from teachers, we generated our focal independent variables, which were an estimate of the percent of 2-year-olds ($M = 0.09$, $SD = 0.88$), 3-year-olds ($M = 20.51$, $SD = 22.98$), 4-year-olds ($M = 55.72$, $SD = 22.71$), and 5-year-olds ($M = 23.68$, $SD = 21.34$) in each classroom. Note that while teachers reported on the ages of all children in the classroom, not just the study children, the exact ages of children's peers were not available. We combined the percent of children who were 2 and 3 years old into one category given the small number of 2-year-olds.

Child outcomes

Children's preschool performance was directly assessed in the fall and spring of the school year using five different validated measures. First, children's receptive vocabulary was assessed with the Peabody Picture Vocabulary Test (Dunn & Dunn, 1997), which required that assessors ask children to point to one of four pictures that best illustrated the meaning of a word. Second, children's expressive vocabulary was assessed with the Picture Vocabulary test from the Woodcock-Johnson Psycho-Educational Battery (Woodcock, McGrew, & Mather, 2001), which required that children name objects depicted in a series of pictures. Third, two subtests of the Test of Preschool Early Literacy (Lonigan, Wagner, Torgesen, & Rashotte, 2007) were used to measure children's phonological awareness (i.e., word elision and blending) and print knowledge (i.e., conventions of the written language). Each of the above assessments were age standardized. The fifth and final outcome of interest was children's inhibitory control, which was assessed with an adapted version of the pencil-tapping task, which required that children tap twice when the assessor tapped once and vice versa (Diamond & Taylor, 1996). All children were assessed in English (84%) unless they failed the PreLAS language screener (Duncan & De Avila, 1998) or were identified by their parents as a Spanish speaker; if this was the case, then children were assessed in Spanish with parallel measures when available.

Covariates

To reduce the possibility of spurious associations we controlled for a large number of child-, family-, teacher-, and classroom-level characteristics. At the child- and family-level, we controlled for children's age, children's race/ethnicity, children's gender, household size, number of children in the household, household income, mothers' years of education, whether the child's father lived in the same household, and children's primary language in the home. At the teacher- and classroom-level, we adjusted for: teachers' gender, teachers' age, teachers' years of education, teachers'

Table 2. Results from regression models predicting children's school performance.

	Comparison of the age distribution of classrooms		
	Younger peers (same-age peer)	Older peers (same-age peer)	Older peers (younger peers)
Receptive language (LDV =0.68–0.69)			
Main effect of age composition	−0.03 (0.03)	−0.02 (0.02)	0.01 (0.03)
Age Composition × Initial Skill	0.02 (0.03)	0.03 (0.02)	0.01 (0.02)
Expressive language (LDV =0.71–0.72)			
Main effect of age composition	−0.02 (0.02)	0.00 (0.02)	0.02 (0.02)
Age Composition × Initial Skill	0.02 (0.04)	0.00 (0.03)	−0.02 (0.03)
Phonological awareness (LDV= 0.48–0.49)			
Main effect of age composition	0.03 (0.03)	−0.02 (0.03)	−0.04 (0.04)
Age Composition × Initial Skill	0.04 (0.04)	−0.01 (0.03)	−0.05 (0.03)
Print knowledge (LDV =0.61)			
Main effect of age composition	−0.00 (0.04)	−0.02 (0.03)	−0.02 (0.03)
Age Composition × Initial Skill	0.10 (0.03)**	0.01 (0.03)	−0.09 (0.04)*
Inhibitory control (LDV =0.38–0.40)			
Main effect of age composition	−0.03 (0.04)	0.06 (0.03)	0.10 (0.03)**
Age Composition × Initial Skill	0.08 (0.03)**	−0.00 (0.03)	−0.08 (0.03)*

Note. All lagged dependent variables (LDVs) were statistically significant at $p < .001$. All focal parameters have been standardized to have a mean of 0 and standard deviation of 1 and, therefore, all estimates correspond to effect sizes. Estimates in brackets correspond to standard errors.
*$p < .05$. **$p < .01$.

years of experience, class size, teachers' race/ethnicity, the percent of girls in the classroom, the percent of children in the classroom with special needs, the percent of children in the classroom with limited English language skills, the racial/ethnic composition of the classroom, the average class income, program type (Head Start and public school), and site fixed effects. Given the experimental nature of the NCRECE study, we also controlled for the intervention conditions that teachers experienced during years one and two of the study to account for any potential treatment effects, and an interaction between the two conditions to capture teachers who experienced both interventions. Finally, all models adjusted for children's preschool entry skills (i.e., lagged dependent variable modelling), which is one of the strongest methods of addressing concerns of omitted variable bias (Duncan & National Institute of Child Health and Human Development Early Child Care Research Network, 2003). Thus, our models consider the extent to which the age composition of classrooms is associated with changes in children's language, literacy, and executive function skills.

Analytic strategy

All analyses were estimated within a regression framework in the *Mplus* program (version 8; Muthén & Muthén, 1998–2013). To address issues of missing data, we employed full information maximum likelihood estimation and we accounted for dependence in children's school performance by clustering models at the school level. Following the guidelines of Aiken and West (1991), we tested for moderation by interacting our focal predictors (i.e., age composition) with our moderators (i.e., children's school entry skills) and, then, if there was evidence for moderation, we calculated the predicted outcome scores for different combinations of our variables of interest (e.g., ±1 *SD* of the mean). Finally, it is important to note that all continuous variables were standardized to have a mean of zero and standard deviation of one and, thus, all coefficients can be interpreted as effect sizes (e.g., Cohen's *d*).

Results

Overall, results from our main effects analyses revealed that the age composition of the classroom had little meaning for the early learning and development of 4-year-olds over the course of the preschool year (see Table 2). More specifically, having younger peers did not detract from 4-year-old's development of receptive or expressive vocabulary, phonological awareness, print knowledge, or inhibitory control, with effect sizes ranging from 0–3% of a standard deviation. Similarly, having older peers did not facilitate greater growth in children's school performance (effect sizes of 0–6% of a standard deviation). The only instance in which there was a significant association between the age composition of the classroom and 4-year-old's progress in school was when comparing classrooms with a greater share of older children (i.e., 5-year-olds) as compared with younger children (i.e., 3-year-olds), and only for one of the outcomes of interest. In this one instance, results from the main effects models suggested that having a larger number of older classmates as opposed to younger classmates resulted in improvements in children's inhibitory control (effect size of 10% of a standard deviation).

We next considered the implications of age composition for the early learning of 4-year-olds as a function of their school entry skills; that is, do 4-year-olds who enter school most at risk benefit from having older peers, or are more highly skilled 4-year-olds harmed by having younger peers (i.e., classmates who are 3 years of age)? These age composition by initial skill interactions indicated that there were only a few cases in which the effects of age composition were conditioned on children's school entry skills. Specifically, 4-year-olds who entered school with low print knowledge and inhibitory control performed better in classrooms with a greater share of older or same-age peers, whereas those who were more skilled in these domains generally demonstrated somewhat greater gains when they attended classrooms with greater share of younger peers. Practically speaking, these interactions between age composition and children's school entry skills indicate that in

classrooms that had no 3-year-olds (i.e., 1 *SD* below the mean), the least skilled 4-year-olds were doing approximately 15–30% of a standard deviation better in areas of inhibitory control and print knowledge. In contrast, the most skilled 4-year-olds performed roughly 15–25% of a standard deviation better in these domains in classrooms with a greater number of younger classmates. The only exception to this pattern of moderation had to do with the contrast between classrooms with a greater share of older children (i.e., 5-year-olds) as compared with younger children (i.e., 3-year-olds), in which case study participants with strong inhibitory control at preschool entry performed equally well.

Exploratory analyses

Although not a part of our focal study objectives, we also considered the ways in which teachers structured their classrooms as potential moderators of age composition effects. Put another way, we considered whether mixed-age environments exert more positive (or negative) influences under different conditions that stem from teachers' practices. Of particular interest were (a) the quality of teacher-child interactions (as measured by the Classroom Assessment Scoring System; Pianta et al., 2008), (b) the dosage of academic instruction (a composite of minutes per month spent in math, reading, science, and social studies), and (c) the time children spent in various activity settings (teacher-directed activities, child selected activities, routines/meals). All of these measures were reported on by teachers or observed by trained assessors during the spring term of the prekindergarten year. Of the 60 interactions tested that examined the intersection of different age peers and classroom practices, only four reached conventional levels of significance (available from authors upon request). Because we would expect as much by chance, these interactions were not interpreted. It is of note, however, that even net of these classroom factors, the main effects and interactions reported in our focal models remained the same, lending confidence to our general conclusions and suggesting that our findings were not an artifact of these other classroom processes.

Discussion

In light of the increasing number of 3- and 4-year-olds enrolled in preschool (U.S. Department of Education, 2015) coupled with the large number of classrooms serving different age children across the country (Ansari et al., 2016; National Survey of Early Care and Education, 2012), there has been growing research and policy interest in understanding the consequences of classroom age composition for the school preparedness of young children. Using data from the NCRECE Professional Development Study (Hamre et al., 2012; Pianta et al., 2017)—one of the few early childhood datasets that provides information on the ages of all children in the classroom—we sought to advance the knowledge base by describing the implications of the age composition of publicly funded preschool programs for the inhibitory control and language and literacy development of low-income preschoolers. When taken together, the results of our work have two take home messages that contribute to a literature that to date has provided mixed evidence regarding the implications of classroom age composition for children's early learning and development.

Main effects of classroom age composition

Beginning with the first point, the results from the present investigation revealed that, on average, there were no consistent benefits or drawbacks of the age composition of preschool classrooms for the development of children's language and literacy skills. That is, 4-year-olds who attended publicly funded preschool classrooms with a larger number of older classmates performed equally as well as those who attended classrooms with a greater share of younger classmates. However, for children's executive functioning, we did find that 4-year-old children who were enrolled in classrooms with a greater number of older peers exhibited greater gains. These null findings for children's language and literacy achievement is somewhat surprising considering prior work and theory which suggests that children's classmates are influential in shaping both their early school experiences and their early academic learning (e.g., Ansari et al., 2016; Henry & Rickman, 2007; Justice et al., 2011, 2014; Mashburn et al., 2009; Moller et al., 2008). At the same time, however, our findings do point to the potential benefits of having older peers for children's executive function skills, which has been largely absent from much of the peer effects literature and existing work on classroom age composition. These findings regarding executive functioning are noteworthy, as these skills have been found to shape children's short- and long-term school success (Masten et al., 2012; McClelland et al., 2013).

The findings reported herein are also both similar to (Bell et al., 2013) and different from (Ansari et al., 2016; Moller et al., 2008) some of the recent literature on classroom age composition from publicly funded early childhood programs in the United States. One potential explanation for some of the discrepancies between the results reported herein and that of Moller et al. (2008) is that in the present study, we had access to direct assessments of children's school performance, whereas Moller et al. (2008) relied on teacher reports of children's early learning and development. This is a significant distinction because teacher reports are likely problematic and may be biased in that they reflect teachers' perceptions of children's abilities relative to those of their classmates, which is particularly concerning when trying to tease apart the school performance of different age children.

Concerning the discrepancy between our results and that of Ansari et al. (2016), a potential explanation is the actual age composition of the classrooms (see also Lillard, 2016). Specifically, the classrooms evaluated by Ansari and colleagues (2016) were almost entirely composed of 3-year-olds (41%) and 4-year-olds (59%). In the present sample, the study children who were 4 years old had a similar number

of younger (21% were 3 years old) and older peers (24% were 5 years old). Thus, the 4-year-olds who were most harmed by classrooms serving different age children in prior evaluations were often the eldest children in those classrooms, whereas the 4-year-olds in the present sample had both younger and older classmates. Practically speaking, the structure of the classrooms observed in this study meant that the 4-year-olds could observe older and more skilled children and, at the same time, they could scaffold their younger and less skilled classmates, which some argue is the most effective implementation of preschool (three-year age groupings; Lillard, 2016). Unfortunately, we could not verify the extent to which study children engaged with their younger and older peers.

Separate from the age structure of these classrooms, it is also important to acknowledge that the teachers who participated in the present investigation had roughly two years of more teaching experience and one more year of education than the teachers who participated in the study done by Ansari et al. (2016). This is of note because in an analysis of the same data used by Ansari et al. (2016), Purtell and Ansari (2018) found that the effects of classroom age composition were considerably larger among teachers without a professional degree, which over 95% of the present study teachers had received. Accordingly, it is also possible that teachers' qualifications play an important role in understanding the unique influences of classroom age composition for children's early learning and development.

When taken together, the first take home message of our study is that classroom age composition had little meaning for the early language and literacy performance of 4-year-olds, but it did have implications for their executive function skills. And, although speculative, it is plausible that (a) having older and younger age peers and (b) having more educated and qualified teachers might potentially minimize the harmful effects of these mixed-age groupings. Unfortunately, given the small number of classrooms that strictly served 3- and 4-year-olds, and the fact that the vast majority of teachers had advanced degrees, we could not rigorously test specific hypotheses, such as the extent to which classrooms with three-year age groupings are more (or less) effective than those with two-year age groupings, which requires continued attention. Moreover, an equally important question that we could not address as part of our investigation is concerning the meaning of these types of classrooms for the youngest (i.e., 3-year-olds) and eldest children served (i.e., 5-year-olds) because the sampling of the NCRECE Professional Development Study focused only on assessing the 4-year-olds.

Heterogeneity in the effects of classroom age composition

The results from the present investigation also suggest a more nuanced conclusion: that children's school entry skills played an important role in disentangling the different ways in which classroom compositional factors shape children's school performance (for similar patterns see: Justice et al., 2014; Mashburn et al., 2009). Specifically, the associations between classroom age composition and children's early learning varied as function of their school entry skills for their inhibitory control and print knowledge such that the least skilled children were doing better in classrooms with older children, whereas the most skilled children generally performed better in classrooms with a greater number of younger classmates. If replicated across different studies and samples, then the heterogeneity in the associations between classroom age composition and children's early learning have both practical and theoretical implications.

In terms of theory, these findings partially support theoretical assertions regarding scaffolding (Vygotsky, 1978), such that less skilled children do seem to benefit from these environments, perhaps as a result of their interactions with older and more skilled peers, at least with regard to the development of their inhibitory control and print knowledge. We know, however, that such opportunities are less readily available in classrooms with greater age homogeneity (Lillard, 2016). Concerning the practical implications of our work, our results appear to indicate that classrooms that provide children with more opportunities to interact with peers that are more skilled can positively influence their early learning and development. Although we estimated exploratory models that considered the ways in which teachers might structure these environments and found little support for variation as a function of academic rigor, quality, or instructional activities, our measures do not provide the nuance needed to understand how individual children actually experience these classrooms. As just one example, in the presence of wide age range, teachers may use small group activities to more effectively target their students' needs by exposing children to classmates of the same age and skill level, or by grouping children of varying ages and skill levels. To what extent this occurs and whether this actually works in these settings is an open question and beyond the scope of our data.

Notwithstanding some of the heterogeneity documented in this study, it is somewhat surprising that similar associations did not emerge for children's expressive or receptive vocabulary development, which has been at the center of much of the peer effects literature (e.g., Guo et al., 2014; Justice et al., 2011; Mashburn et al., 2009; Ribeiro et al., 2017). Thus, in view of some of our mixed findings, coupled with the inconclusive evidence in the existing literature discussed above (e.g., Ansari et al., 2016; Bell et al., 2013; Moller et al., 2008), continued attention is necessary to tease apart the potential benefits and draw backs of classrooms that enroll different age children for different domains of children's school performance.

Limitations, future directions, and conclusions

Despite these contributions to the literature, the results of this investigation need to be interpreted in light of a few limitations. Primarily, unlike the work of Ansari et al. (2016), our data were not nationally representative and, therefore, caution is warranted when interpreting our

findings. A caveat to this limitation is that one of the key strengths of this investigation is our study sample, which included both a diverse set of publicly funded programs across eight states, some of which included three-year age groupings, which have been largely absent from the existing literature on classroom age composition. And although teachers reported on the ages of all children in their classroom (and not just the study children), we were nonetheless limited by the fact that we did not have the exact ages of children, which limits the degree of heterogeneity that exists in our measures of classroom age composition. That is, 2-, 3-, 4-, and 5-year-olds, vary 12 months with themselves and, consequently, to the extent that age is an educationally relevant parameter, our measure masks some degree of heterogeneity.

Relatedly, we did not have outcome data available for children across the age-spans reflected in these classrooms (i.e., for 3- and 5-year-olds), thereby constraining our ability to test a number of possible hypotheses. For example, our data do not allow us to understand the experiences of younger children in the classroom, whom developmental theory suggest might benefit from these environments (Bandura, 1986; Vygotsky, 1978). Despite this limitation, it is important to reiterate two points. First, two of the three prior large-scale studies found that older children performed worse in these types of settings (Ansari et al., 2016; Moller et al., 2008), which means that understanding the experiences of older children in these classrooms is of particular importance. Second, much of the peer effects literature has also only sampled 4–5 children per classroom (Justice et al., 2014; Mashburn et al., 2009).

Additionally, even though we took a number of precautions to limit concerns of omitted variable bias by controlling for a large number of potential confounds and children's school entry skills (i.e., lagged dependent variables), our findings are not causal. To understand the causal impacts of whether it is more effective to offer preschool programs that constrain the age range of children in classrooms or allow for greater heterogeneity, a randomized control trial is necessary. In addition, although our results illustrate the associations between classroom age composition and the early inhibitory control and language and literacy development of young children, we did not have any direct assessments of children's mathematics achievement, which also requires attention. Finally, the present investigation—similar to its predecessors (e.g., Ansari et al., 2016; Bell et al., 2013; Moller et al., 2008)—could not determine the pedagogical underpinnings of mixed-age classrooms implemented in the larger study; that is, whether mixed-age groupings were intentional or not is beyond the scope of the data available. For these reasons, an important future direction is for researchers, educators, and policymakers to pay closer attention to the implementation of mixed-age classrooms.

With these associated limitations and future directions in mind, the results of the present investigation provide new insight into the potential benefits and draw backs of publicly funded prekindergarten classrooms across eight states that enroll different age children. At the end of the day, these findings suggest that at the aggregate level, classrooms that encompass a wider range of age levels do not appear detract from the inhibitory control and language and literacy development of 4-year-olds. In fact, in a few cases, classrooms that included both younger and older peers did appear to facilitate the language development and executive function of some preschoolers, particularly those with relatively weak skills in those domains. Ultimately, a deeper understanding of the implications of classroom age composition for children's academic and socio-emotional development is necessary and, as such, we need to recognize the replicability and generalizability of previously documented findings and think more carefully about the conditions under which age composition exerts positive (or negative) effects. When coupled with some of the recent literature (e.g., Ansari et al., 2016, Bell et al., 2013; Moller et al., 2008), the findings reported as part of this study point to the need for continued empirical inquiry into the impacts of children's classmates for their early learning and development.

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