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The Relation Between Classroom Age Composition and Children's Language and Behavioral Outcomes: Examining Peer Effects

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Grouping children of different ages in the same preschool classroom (i.e., mixed age) is widespread, but the evidence supporting this practice is mixed. A factor that may play a role in the relation between classroom age composition and child outcomes is peer skill. This study used a sample of 6,338 preschoolers (ages 3–5) to examine the influence of both classroom age composition and peer skill on children's behavioral and language outcomes. Results supported the growing literature indicating preschoolers' skills are higher when peer skill is higher, but differences related to classroom age composition were not found. These findings further support the view that peer skill plays an important role in preschool children's outcomes.

Combining 3- to 5-year-old children in a single class is becoming more common in center-based preschools. Such mixed age classrooms are now widely used in preschool centers, especially Head Start (Moiduddin, Aikens, Tarullo, West, & Xue, 2012), in part because it is believed they are more developmentally appropriate for preschoolers than same age classrooms (Katz, Evangelou, & Hartman, 1990). However, the evidence is mixed regarding whether same age or mixed age classrooms are related to better outcomes for preschoolers (Moller, Forbes-Jones, & Hightower, 2008). Although not accounted for in previous work, peer skills should be considered when studying classroom age composition due to greater variation in peer skills, on average, in mixed age classrooms than in same age classrooms. Fairly consistent evidence indicates that peer skills influence preschoolers' acquisition of academic and behavioral skills (Henry & Rickman, 2007; Justice, Petscher, Schatschneider, & Mashburn, 2011; Thomas, Bierman, Power, & The Conduct Problems Prevention Research Group, 2011). Thus, the purpose of this study was to simultaneously examine whether classroom age composition and peer skills relate to the acquisition of language and behavioral skills for 3- to 5-year-old children attending Educare, an enhanced quality Head Start program.

Mixed age classrooms are thought to help preschool children acquire school readiness skills and successfully transition to school by promoting socialization and cognitive development through peer interaction (Katz et al., 1990). This idea is based on the belief that young children benefit from a more family-like experience in which preschoolers can help the classroom's younger children and be helped by the older children (Katz et al., 1990). Others argue that the larger age range in mixed age classrooms could make it more difficult for teachers to provide developmentally appropriate activities for all children due to greater variation in child skills and needs (Bailey, Burchinal, & McWilliam, 1993).

Despite potential concerns and conflicting evidence, mixed age classrooms are currently in widespread use. In 2009, it was determined that mixed age classrooms made up about 75% of Head Start classrooms (Moiduddin et al., 2012). Professional organizations, such as the National Association for the Education of Young Children, also support the use of mixed age classrooms with the belief that such an environment best promotes development during preschool (Katz et al., 1990). The widespread support of mixed age classrooms makes it important to better understand the potential impacts this type of classroom environment may have on a child's development. This question is

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particularly important to address within the context of federally or state-funded programs, such as Head Start, which commonly use mixed age classrooms. Such programs are designed to promote the development of young children. To best accomplish this goal, these programs need to be evidence-based.

Recent studies have conceptualized classroom age composition in different ways, such as the proportion of younger children or the standard deviation of children's ages in a given classroom (Ansari, Purtell, & Gershoff, 2016; Bell, Greenfield, & Bulotsky-Shearer, 2013). Although such research is important for gaining a more nuanced understanding of the effects of classroom age composition on child outcomes, it is not directly related to the policy question of whether to use mixed age or same age preschool classrooms. Within the policy and practice realm, classroom age composition is viewed as a binary variable with classrooms labeled either mixed age or same age. To better reflect policy and practice questions about classroom age composition, this study used a binary indicator of classroom age composition to compare same age classrooms to mixed age classrooms.

Research on Mixed Age Classrooms

Research examining the school readiness outcomes of children in mixed age classrooms has provided inconsistent evidence. Most early studies involved only a few classrooms, resulting in small sample sizes, and were conducted in a wide variety of settings, including Head Start centers, private and community sponsored preschools, and university-based centers. In addition, these early studies looked at classroom age composition as a binary variable. Almost all studies reported better outcomes in mixed age than in same age classrooms for younger children (Bailey et al., 1993; Mounts & Roopnarine, 1987; Urberg & Kaplan, 1986; Winsler et al., 2002). In contrast, findings have been inconsistent for older children. Studies reported that older children had: better outcomes in same age than in mixed age classrooms (Bailey et al., 1993; Winsler et al., 2002); similar outcomes in both same age and mixed age classrooms (Mounts & Roopnarine, 1987; Urberg & Kaplan, 1986), and more positive social and play outcomes in mixed age classrooms (Derscheid, 1997; Goldman, 1981). Interestingly, the type of setting and family characteristics of the participants did not seem to explain the differences in findings across studies.

The small samples of these earlier studies limited confidence in findings, so larger, more rigorous studies were conducted. These studies also yielded mixed results (Ansari et al., 2016; Bell et al., 2013; Moller et al., 2008), but a major difference in these later studies was the way classroom age composition was operationalized. Rather than using a binary variable, these studies looked at classroom age composition in terms of the proportion of younger children (Ansari et al., 2016), the age range between the oldest and youngest child (Moller et al., 2008), or the standard deviation of child age (Bell et al., 2013; Moller et al., 2008) in a given classroom. Furthermore, each study included a large sample of about 800 participants or more, the majority of whom were low income and attended either a publicly funded program, a prekindergarten program, or a Head Start center. All studies accounted for children's initial skill level on the outcomes of interest and had at least some notable nonsignificant results.

Some studies reported no significant differences related to classroom age composition in academic (Bell et al., 2013), social, emotional, or behavior skills (Ansari et al., 2016; Bell et al., 2013). Other studies found that mixed age classrooms seemed to have negative effects on older children, but did not find differences between mixed age and same age classrooms for younger children's acquisition of academic skills (Ansari et al., 2016) and overall development (Moller et al., 2008). In particular, compared to older children in same age classrooms, older children in mixed age classrooms showed lower levels of total, social, motor, and cognitive (Moller et al., 2008) as well as math, language, and literacy (Ansari et al., 2016) skills.

To date, research on classroom age composition suggests that younger children may show larger gains in mixed age classrooms, whereas older children may show larger gains in same age classrooms. Many researchers who have examined the influences of classroom age composition appear to agree that mixed age classrooms should be used with caution, particularly due to negative results concerning older children (Ansari et al., 2016; Bell et al., 2013; Moller et al., 2008). However, the conflicting evidence suggests examining other classroom factors may be necessary to better understand whether and how age composition impacts preschool children's development.

Research on Peer Skill

The skill level of peers is a factor that likely contributes to differences between mixed age and same age classrooms. Previous research on classroom age composition has considered the chronological age

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of peers without explicitly taking into account the role of peer skill. During the school day, children interact with their peers through both play and educational activities and can be influenced by their peers' skills in various ways. According to the peer-effects framework (Henry & Rickman, 2007; Justice, Logan, Lin, & Kaderavek, 2014; Mashburn, Justice, Downer, & Pianta, 2009), children may be influenced by their peers through a direct-effects pathway. For example, a child may directly learn from a peer who is more skilled in a given area. Children may also be influenced by their peers' abilities through an indirect-effects pathway due to changes in the classroom environment that occur to accommodate children's varying skill levels. For example, a child may benefit from more behaviorally skilled peers who are less likely to disrupt the class during learning activities (Henry & Rickman, 2007).

Prior research has shown that the ability level of peers in young children's classrooms relates to individual child outcomes. These studies have generally measured skill in a subsample of about four to eight of a child's classmates. Several studies have related child outcomes to the behavior of classroom peers, reporting more behavior problems and poorer cognitive outcomes among children in classrooms with peers who have higher levels of behavior problems (Neidell & Waldfogel, 2010; Thomas et al., 2011). Other studies related children's language skills to those of their classroom peers, finding higher language skills among children whose peers also had higher language skills (Atkins-Burnett, Xue, & Aikens, 2017; Justice et al., 2011; Mashburn et al., 2009). A few studies have used other measures of peer skills. Henry and Rickman (2007) created a composite score of peer ability level that reflected the cognitive skills, prereading skills, language skills, and other basic skills of classroom peers. They found children's cognitive skills, expressive language skills, and prereading skills were higher when they were in classrooms with higher peer composite skill levels. Using a measure of noncognitive preschool competency, Delay and colleagues found that individual child noncognitive competency was higher when they interacted with preschool peers who had higher levels of noncognitive competency (DeLay, Hanish, Martin, & Fabes, 2016).

In summary, it appears that peer skills should be considered when examining classroom age composition. Both peer language skill and peer behavior problems in particular have been found to relate to individual child outcomes. Although peer skill has not been a focus in research on mixed age classrooms to date, it should account, at least in part, for why being in a mixed age or same age classroom relates to child outcomes. Compared to same age classrooms, mixed age classrooms have greater variability in the age of classmates. Although peer skill is not determined by age alone, older children will tend to be more skilled than their younger peers. As mixed age classrooms include both younger and older children by definition, peer skill is likely to vary more widely in mixed age classrooms than in same age classrooms.

Due to this age-related range of peer skill, the average level of peer skill in a mixed age classroom is likely to be somewhat higher than what a younger child would experience in a same age classroom and lower than what an older child would experience in a same age classroom. For younger children, this higher level of peer skill experienced in mixed age classrooms is likely to have both positive direct and indirect effects on child outcomes as proposed by the peer effects framework (Henry & Rickman, 2007). Thus, peer skill may help to explain why it appears that that mixed age classrooms may be beneficial for younger children, but potentially harmful for older children. To begin exploring this possibility, this study considered the question of whether classroom average peer skill accounts for the anticipated interaction between classroom age composition and child age group. Although the effects of peers are likely more complex with the possibility that a child's closest peers play a particularly important role in the child's development, the present analyses are a first step toward better understanding the role of classroom age composition and peer skills when the two variables are jointly considered.

Children's Language and Behavioral Development and Later School Success

At the individual child level, early language and behavioral development has important implications for a child's later success in the school setting. Being able to comprehend and use language is foundational to a child's ability to navigate both the academic and social context of the classroom. Children's language skills have been linked to children's academic outcomes, including reading (National Early Literacy Panel, 2008) and math skills (Purpura & Ganley, 2014). Children's language skills have also been found to relate to self-regulation development, which can contribute to a child's ability to function effectively in the classroom environment (Aro, Laakso, Maatta, Tolvanen, & Poikkeus, 2014; Vallotton & Ayoub, 2011).

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Being able to behave appropriately in the classroom also positively relates to school outcomes. Children with better behavioral skills are more equipped to meet the demands of the classroom environment, such as interacting successfully with peers and listening quietly while the teacher is talking to the class. Accordingly, preschool behavioral skills have been found to relate to children's adjustment to kindergarten, academic outcomes (Bulotsky-Shearer & Fantuzzo, 2011; Denham et al., 2011), and peer success (Keane & Calkins, 2004).

As discussed, previous research has indicated that children's language and behavioral skills can be influenced by both peer skill and classroom age composition (e.g., Ansari et al., 2016; Justice et al., 2011; Moller et al., 2008; Thomas et al., 2011). Due to the importance of children's early language and behavioral skills for later school success, it is important to examine whether peer skill can help to explain why being in a mixed age classroom is sometimes linked to poorer outcomes for older children and better outcomes for younger children.

The Present Study

Currently, evidence is mixed regarding whether using mixed age or same age classrooms promote school readiness outcomes. In addition, to date, the level of peer skills within the classroom has not been examined as a potential mediator despite logical arguments that peer skills for older preschoolers will be higher in same age classrooms than in mixed age classrooms and for younger preschoolers will be higher in mixed age classrooms than in same age classrooms. This study aims to address this issue by considering peers' language and behavioral skills when examining whether mixed age or same age classrooms promote skills for older or younger preschoolers.

To accomplish these goals, this study used data from the Educare Implementation Study. Children receive early childhood education through Head Start in Educare programs at 23 schools across the United States (for a summary of sites see Educare Learning Network, 2016). Since all Educare sites participate in the Educare Implementation Study and children are evaluated annually, there are data available on a large sample of children from multiple classrooms. These data were used to explore this study's three hypotheses: (a) Child age will moderate how classroom age composition relates to child outcomes, with younger children showing higher levels of skills in mixed age than in same age classrooms and older children showing higher levels of skills in same age than in mixed age classrooms. (b) Higher peer language and lower peer behavior problems will relate to better school readiness outcomes for children. (c) Peer skill will partially account for the expected interaction between classroom age composition and child age.

Method

Sample

This study analyzed data collected from preschool classrooms by the Educare Learning Network. Educare is an enhanced Head Start program designed to support children from birth to age 5 and their families by providing high-quality early childhood education and family support services. The four main components of the Educare model are data utilization, high quality teaching practices, embedded professional development, and intensive family engagement (Educare Learning Network, 2016).

The data set for this study included 6,338 preschool-age children in 206 classrooms across the 17 Educare sites in which child outcomes had been collected for at least 2 years by 2017. Children were included in these analyses if they had a prior assessment on at least one outcome, so the assessment could be used to account for pre-existing differences at the start of the school year. We included only the last assessment per child (i.e., the 4-year assessment among children who met this criterion at both their 3- and 4-year assessments) to reduce differences among the many children who entered the program as 3-year-olds and the relatively fewer children who entered earlier. Classroom age composition (coded as 0 for same age and 1 for mixed age) was defined by the age range in the classrooms. Children in Educare enroll in Early Head Start as infants and toddlers and in Head Start as preschoolers. Children who enroll first in Early Head Start are expected to graduate to Head Start when they turn 3-years-old. Children who enroll first in Head Start are expected to enroll in the fall after they turn 3-years-old. This means that some children graduate from Early Head Start into preschool Head Start classrooms as soon as they turn three and stay in Head Start for up to 3 years, whereas others enter as 3-year-olds and only stay 2 years before entering kindergarten. Thus, there is some variability in age even in same-age classrooms. The distribution of age within classrooms was examined, and a natural break in the distribution was found at 18 months. Based on the gap between the oldest and youngest child in the classroom, children were categorized as being in a

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mixed age classroom if the age difference was 18 months or greater and in a same age classroom if the age difference was less than 18 months.

As shown in Table 1, a total of 2,333 children were in 80 same age classrooms from 17 Educare sites. The average age difference between the oldest and youngest children in the spring was 1.06 years (SD = .22). There were also 4,005 children in 126 mixed age classrooms from 16 Educare sites. The average age difference between the oldest and youngest children in the spring was 1.95 years (SD = .28).

In order to ask whether classroom age composition effects differed for older and younger children, children were also categorized by age (coded as 0 for younger and 1 for older). Children were categorized as younger if they were younger than 4.5-years-old in late spring when assessments occurred and as older if they were 4.5 years or older in late spring. Age 4.5 was chosen as the cut point as children can enter the program as 3- or 4-year-olds in the fall and immediately age up. Thus, the oldest 3-year-olds were about 4.5-years-olds at the time of spring assessments.

As shown in Table 2, in all groups, about half of the children were male and about half were female. In addition, most of the children in all groups were either Black, Hispanic, or Latinx. Although English was the primary language for the majority of the children, a substantial number of children in all groups spoke Spanish as their primary language.

Measures

Assessments and ratings of children in the spring served as outcomes in this study, and a prior assessment of the same outcome served as a control variable to account, in part, for pre-existing differences among children. Children's behavioral skills were assessed every fall and spring using teacher ratings, so fall scores served as baseline scores. In contrast, language was assessed every spring, but the timing of the baseline language measure varied depending on the child's age and when they entered Educare. For 4-year-olds, the prior language assessment was typically collected during the spring of the prior year unless the children entered the program as 4-year-olds and baseline language data were collected in the fall. For 3-year-olds, the baseline language assessment occurred in the spring of the previous year if the child enrolled in Educare as an infant or toddler and in the fall for children who entered the program as 3-year-olds. All data collectors were trained and certified.

Table 1
Overview of Same Age and Mixed Age Classroom Variables

Variable	Statistic	Same age	Mixed age
Number of sites	*N*	17	16
Number of classrooms	*N*	80	126
Number of children	*N*	2,333	4,005
Children per classroom	*M* (*SD*)	17.04 (1.66)	16.77 (1.17)
Age of youngest children	*M* (*SD*)	3.82 (0.47)	3.47 (0.28)
Age of oldest children	*M* (*SD*)	4.87 (0.44)	5.42 (0.21)

Child Outcomes

PLS. The Preschool Language Scale (PLS; Zimmerman, Steiner, & Pond, 2002; Zimmerman, Steiner, & Pond, 2011) was used to assess auditory comprehension. Auditory comprehension focuses on how much language a child understands with items assessing a child's comprehension of basic vocabulary, concepts, and grammar. In the sample, some children were assessed using the fourth version of the PLS. Later in the Educare Implementation Study, the switch was made to the fifth version of the PLS. Although the items remained largely unchanged between the two versions, a different norming population was used, which was taken into account in this study's analyses.

Age standardized scores were used as the outcome variable, so the outcome was in a common metric across the different ages. The PLS–4 was standardized on a sample of 1,564 English-speaking children and the PLS–5 was standardized on a sample of 1,400 English-speaking children. The test–retest reliability coefficients ranged from .90 to .97 for the PLS–4 and from .86 to .95 for the PLS–5. The internal consistency reliability coefficients ranged from .66 to .96 for the PLS–4 and from .91 to .98 for the PLS–5.

PPVT–4. The Peabody Picture Vocabulary Test, 4th ed. (PPVT–4; Dunn & Dunn, 2007) was used to assess English receptive vocabulary skills. The PPVT–4 has been normed to examine vocabulary development from age two-and-a-half to adulthood. During the test, children point to one of four pictures that best matches the meaning of a word stated by a researcher. A baseline of skill is established, and the children are tested until they reach a defined ceiling. Again, age standardized scores were used as the outcome variable of interest. For children between 2- and 6-years-old, internal consistency ranges from .95 to .97. Test–retest reliability has been found to range from .91 to .94.

DECA. The Devereux Early Childhood Assessment (DECA; LeBuffe & Naglieri, 1999) is a questionnaire that was completed by the children's

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Table 2
Variables for Younger and Older Children in Same Age and Mixed Age Classrooms

	Same age Younger (N = 1,543)		Same age Older (N = 790)		Mixed age Younger (N = 2,540)		Mixed age Older (N = 1,465)	
Variable	*N*	Prop	*N*	Prop	*N*	Prop	*N*	Prop
Gender	1,543		790		2,540		1,465	
Female	746	.48	369	.47	1,239	.48	685	.47
Male	797	.52	421	.53	1,301	.52	780	.53
Race/ethnicity	1,541		788		2,540		1,465	
Black	1,073	.70	476	.60	1,006	.40	517	.35
Hispanic/Latinx	278	.18	218	.28	909	.36	565	.39
White	61	.04	40	.05	324	.13	168	.11
Other	129	.08	54	.07	301	.12	215	.15
Primary language	1,543		790		2,540		1,465	
English	1,320	.86	609	.77	1,839	.72	989	.68
Spanish	214	.14	171	.22	608	.24	387	.26
Other	9	.01	10	.01	93	.04	89	.06
	N	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)	*N*	*M* (*SD*)
Child age	1,543	4.01 (0.29)	790	4.93 (0.34)	2,540	3.96 (0.33)	1,465	4.96 (0.34)
CLASS								
Instructional	1,470	3.26 (0.96)	757	3.13 (1.02)	2,366	3.54 (1.09)	1,252	3.58 (1.19)
Organization	1,470	5.59 (0.84)	757	5.28 (0.84)	2,366	5.76 (0.82)	1,252	5.69 (0.90)
Emotional	1,470	6.18 (0.58)	757	6.02 (0.62)	2,366	6.27 (0.57)	1,252	6.26 (0.61)
Peer language	1,543	106.87 (7.67)	790	116.58 (9.13)	2,540	111.70 (8.61)	1,465	112.77 (8.42)
Peer behavior	1,543	11.94 (3.17)	790	11.62 (3.49)	2,540	11.20 (3.54)	1,465	10.87 (3.67)
Child outcomes								
PLS: AC	1,040	95.99 (12.60)	464	91.95 (12.48)	1,467	96.71 (13.05)	776	93.56 (13.59)
PPVT	1,483	91.88 (13.94)	776	91.22 (14.98)	2,515	92.81 (15.05)	1,443	91.90 (15.54)
Behavior	1,504	51.92 (9.84)	760	50.07 (10.76)	2,466	51.57 (9.78)	1,402	48.77 (10.80)
Self-control	1,503	49.03 (9.93)	760	52.07 (10.13)	2,479	49.45 (9.61)	1,402	52.44 (10.29)

Note. Peer language scores are growth scores, peer behavior scores are raw scores, and child outcomes are standard scores. CLASS = Classroom Assessment Scoring System; PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test.

teachers. The DECA assesses behavioral development risks by examining within-child behavioral factors related to resiliency. Teachers rated children's behaviors during the past 4 weeks on a 5-point scale from *never* to *very frequently*. Children's *t*-scores on two subscales were of interest: the self-control subscale (e.g., "how often did the child handle frustration well;" $\alpha = .90$) and the behavior problems subscale (e.g., "how often did the child fight with other children;" $\alpha = .85$).

Peer Skills

To examine peer language skills and peer behavior problems, peers' scores on the PPVT and the behavior problems subscale of the DECA were used. Growth scores for the PPVT and raw scores for the behavior problems subscale were used, so scores reflect skill level rather than relative position within each measure's age norming groups. This means that more skilled children will have higher scores regardless of their age. Classroom average scores on each of these measures were calculated for each target child using all available data from the classroom excluding the child's own scores. This allowed for an examination of how the average skill level of peers within the classroom related to individual child outcomes.

Covariates

For each preschool assessment, the prior assessment on that measure was identified to reflect baseline skills at the beginning of the school year and

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used as a control variable. For the DECA, this was the fall score for the year the outcome was assessed. For the PLS and PPVT, the baseline assessment was the fall assessment for all students who entered Educare that year and was the score from the spring of the prior year for children who attended Educare in the prior year. PLS version was also included as a covariate when PLS scores were the outcome of interest due to the switch from PLS–4 to PLS–5.

In addition, child, family, and classroom covariates were collected. Covariates at the child-level included sex (0 = female, 1 = male), primary language (0 = other, 1 = English), disability status (0 = no disability, 1 = documented disability), and race and ethnicity. The race and ethnicity variable was dummy coded with the categories of Black, Hispanic or Latinx, and other (the reference category). Information on the primary caregiver's depression (0 = not depressed, 1 = depressed), level of education (in years), and marital status (0 = partner, 1 = single) as well as whether the family experienced food insecurity (0 = no food insecurity, 1 = food insecurity) was collected from parents upon their child's enrollment into Educare.

At the classroom level, classroom quality was assessed in the winter using the Classroom Assessment Scoring System (Pianta, LaParo, & Hamre, 2008). Trained observers went to classrooms and assessed quality in the domains of Emotional Support, Classroom Organization, and Instructional Support. Items for each domain were rated on a 7-point scale where higher scores indicate higher quality classrooms. This study controlled for average scores on each domain due to the importance of classroom quality for child outcomes (Burchinal, 2018). Finally, analyses controlled for Educare site.

Data Analysis

As shown in Tables 1 and 2, descriptive statistics were calculated to examine differences based on classroom age composition and child age. Correlational analyses were also performed to examine the associations among the main predictors and the outcome variables (see Tables 3 and 4). A set of hierarchical linear models (HLMs) was developed to address each hypothesis. Model variables were standardized to have a mean of zero to aid in interpretation. The first model tested the effect of classroom age composition crossed with child age. The second model examined peer effects. If the interaction in the first model was significant, then the third model tested peer language skills and behavior problems as potential mediators of the classroom age composition by child age interaction. Multiple imputation was used to account for missing data.

Model 1

The first model addressed the hypothesis that child age moderates how classroom age composition relates to child outcomes. The primary independent variables were classroom age composition, child age (younger vs. older), and the interaction between the two. The Level 1 equation describes the school readiness outcomes of the *i*th child in the *j*th classroom, includes child age group and individual-level covariates, and the residual for that child, r_{ij}. The Level 2 equation relates the Level 1 parameters to classroom age composition and the classroom-level covariates and includes the error term for the classrooms, u_{0j}.

$$\begin{aligned}\text{Level 1: } Y_{ij} &= \beta_{0j} + \boldsymbol{\beta_{1j} AgeGroup_{ij}} + \beta_{2j} Gender_{ij} + \beta_{3j} Race_{ij} \\ &\quad + \beta_{4j} Language_{ij} + \beta_{5j} Disability_{ij} + \beta_{6j} BaselineScore_{ij} \\ &\quad + \beta_{7j} Depress_{ij} + \beta_{8j} Education_{ij} + \beta_{9j} Marital_{ij} \\ &\quad + \beta_{10j} FoodInsecurity_{ij} + r_{ij},\end{aligned}$$

$$\begin{aligned}\text{Level 2: } \beta_{0j} &= \gamma_{00} + \boldsymbol{\gamma_{01} MixedAge_j} + \gamma_{02} Site_j \\ &\quad + \gamma_{03} Instructional_j + \gamma_{04} Organizational_j \\ &\quad + \gamma_{05} Emotional_j + u_{0j} \\ \beta_{1j} &= \gamma_{10} + \boldsymbol{\gamma_{11} MixedAge_j} \\ &\vdots \\ \beta_{11j} &= \gamma_{110}.\end{aligned}$$

Model 2

The second model addressed the hypothesis that greater peer language and fewer peer behavior

Table 3
Correlations Between Language and Behavioral Outcomes

	PLS AC	PPVT	DECA behavior	DECA self-control
PLS AC	1.00	.66***	−.15***	.15***
PPVT		1.00	−.08***	.04**
DECA behavior problems			1.00	−.74***
DECA self-control				1.00

Note. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment.
*$p < .05$. **$p < .01$. ***$p < .001$.

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Table 4
Correlations Among Main Predictors and Language and Behavioral Outcomes in the Spring

	Mixed age	Age group	Average peer language	Average peer behavior
PLS auditory comprehension	.03	−.11***	.14***	.08***
PPVT	.03**	−.02	.32***	.07***
DECA behavior problems	−.03**	−.11***	.01	.44***
DECA self-control	.02	.14***	−.03**	−.26***

Note. Values represent *t*-test results for correlations between binary and continuous variables. PLS = Preschool Language Scale; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment.
*$p < .05$. **$p < .01$. ***$p < .001$.

problems will relate to better school readiness outcomes for children overall. The first model was extended by entering classroom average peer behavior and peer language skills as Level 1 predictors. Average peer skill was considered a Level 1 predictor as each child had a unique average peer skill level without their own score included in the average. The Level 2 equation remained the same as Model 1.

$$\begin{aligned}\text{Level 1}: Y_{ij} &= \beta_{0j} + \beta_{1j} AgeGroup_{ij} + \boldsymbol{\beta_{2j} PeerLanguage_{ij}} \\ &+ \boldsymbol{\beta_{3j} PeerBehavior_{ij}} + \beta_{4j} Gender_{ij} + \beta_{5j} Race_{ij} \\ &+ \beta_{6j} Language_{ij} + \beta_{7j} Disability_{ij} + \beta_{8j} BaselineScore_{ij} \\ &+ \beta_{9j} Depress_{ij} + \beta_{10j} Education_{ij} + \beta_{11j} Marital_{ij} \\ &+ \beta_{12j} FoodInsecurity_{ij} + r_{ij}.\end{aligned}$$

Model 3

A formal test of mediated moderation was performed if the analyses from Models 1 and 2 indicated both classroom age composition differences and associations between peer skills and child outcomes. Methods described by Preacher and Hayes (2004) were to be used to examine the indirect effects of the two peer skill mediators (see Figure 1).

Multiple Imputation

To account for missing data, forty data sets were imputed using the Markov chain Monte Carlo method and Rubin's approach (Rubin, 1987; Schafer, 1997). Rubin's approach is an iterative process where each variable with missing data is regressed on all others, missing values are imputed, and variance parameters are estimated. The process is continued until the convergence criteria are met. The imputations included all of the predictors of interest, the control variables, and the outcome variables. No data were missing for the predictors of interest. Missingness for covariates ranged from 0% to about 38% and missingness for the outcome variables ranged from about 2% to 41% (see Table 2). With the 40 complete data sets, the analyses to address the research questions of interest were performed resulting in 40 sets of parameter estimates and standard errors for each model that was run. A single set of final results for each model was obtained by averaging the 40 sets of parameter estimates. Standard errors were computed that account for variability both within and between data sets.

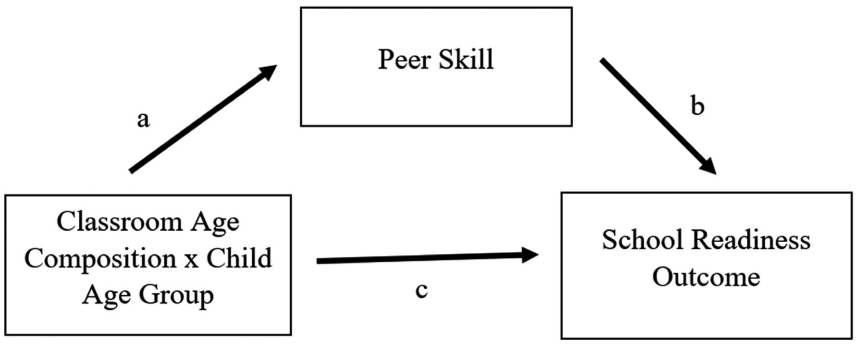

Figure 1. Mediated moderation model with the relation between the classroom age composition by child age group interaction and the language and behavioral outcomes mediated by peer language skill and peer behavior problems.

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Sensitivity Analysis

Three sets of sensitivity analyses were conducted. First, the lack of evidence supporting the anticipated interaction was considered further by examining the simple main effects of classroom age composition within child age groups. The power to test interactions is always less than the power to detect simple main effects, so follow-up analyses contrasted same age and mixed age classrooms within age groups. These analyses addressed concerns that differences in either age group may have been missed in the focus on testing the interactions. Second, whether primary language moderated associations between either classroom age composition or peer skills and child outcomes was examined. Interactions involving primary language were added to Models 1 and 2. Second, although the main analyses conceptualized classroom age composition as a binary variable to reflect policy issues, sensitivity analyses were performed using other definitions of classroom age composition. One analysis was performed where classroom age composition was defined as the proportion of younger children in the classroom, and another analysis was performed where classroom age composition was defined as the standard deviation of children's ages in a classroom.

Results

Descriptive Statistics

Descriptive statistics for the outcome variables of interest are shown in Table 2. Correlational analyses were also performed to examine the relations among the predictors of interest and the spring outcomes (see Tables 3 and 4). Being in a mixed age classroom showed very small associations with better child outcomes. Being an older child showed small associations with lower language outcomes and better behavior and self-control outcomes. Higher average peer language skill showed small to moderate positive associations with language outcomes. On the other hand, higher average peer language skill showed very small associations with more behavior problems and lower self-control. Finally, higher average peer behavior problems showed small positive associations with child language outcomes and a moderate association with more individual child behavior problems and lower self-control.

Model Results

Following the descriptive analyses, the HLMs were analyzed controlling for the relevant pretest score and PLS version when applicable, child sex, primary language, disability status, and race and ethnicity, the primary caregiver's depression, level of education, and marital status, whether the family experienced food insecurity, classroom quality, and data collection site.

Model 1: Does the Effect of Classroom Age Composition Depend on Child Age?

In the first model, the primary variable of interest was the interaction between classroom age composition and child age. As shown in Table 5, classroom age composition was not found to significantly predict any of the examined child outcomes ($p > .05$). On the other hand, child age significantly related to both of the language outcomes. Older children scored significantly lower on age standardized measures of auditory comprehension ($B = -0.92$, $SE = 0.43$, $d = -.07$, $p = .04$), but significantly higher on receptive vocabulary ($B = 1.39$, $SE = 0.26$, $d = .09$, $p < .001$) as compared to the younger children. Looking at the behavioral outcomes, older children had significantly lower scores on standardized measures of behavior problems ($B = -0.94$, $SE = 0.23$, $d = -.06$, $p < .001$) and higher on self-control ($B = 1.47$, $SE = 0.23$, $d = .15$, $p < .001$) as compared to younger children.

No evidence emerged supporting the hypothesized interaction between classroom age composition and child age. Looking at language, the interaction was not statistically significant for auditory comprehension ($B = 0.24$, $SE = 0.73$, $p = .74$) or receptive vocabulary ($B = -0.28$, $SE = 0.54$, $p = .61$). The effect of age composition was very small among both younger and older children for auditory comprehension (younger: $d = .06$; older: $d = .04$) and receptive vocabulary (younger: $d = .05$; older: $d = .03$). Similarly, the interaction was not found to be significant for either the behavior problems ($B = -0.42$, $SE = 0.48$, $p = .39$) or self-control outcomes ($B = -0.12$, $SE = 0.48$, $p = .81$). For both younger and older children, the effect of age composition was very small for behavior problems (younger: $d = .02$; older: $d = -.02$) and self-control (younger: $d = -.00$; older: $d = -.02$).

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Table 5
HLM Outcomes for Model 1

	School readiness outcomes			
	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)
Intercept	93.15 (0.21)***	92.17 (0.14)***	50.92 (0.20)***	50.33 (0.19)***
Mixed age	0.85 (0.51)$^{+}$	0.69 (0.40)$^{+}$	0.22 (0.36)	−0.05 (0.35)
Age group	−0.92 (0.43)*	1.39 (0.26)***	−0.94 (0.23)***	1.47 (0.23***)
Mixed Age × Age Group	0.24 (0.73)	−0.28 (0.54)	−0.42 (0.48)	−0.12 (0.48)
PLS version	7.67 (4.59)	—	—	—
Pretest score	0.70 (0.05)***	0.68 (0.01)***	0.57 (0.01)***	0.54 (0.01)***
Child disability	−3.32 (0.78)***	−2.26 (0.40)***	1.59 (0.33)***	−2.09 (0.33)***
Gender	−1.94 (0.37)***	−0.58 (0.24)*	1.79 (0.21)***	−1.53 (0.21)***
Black	0.45 (0.65)	−1.79 (0.44)***	0.25 (0.37)	0.05 (0.37)
Hispanic	1.94 (0.99)$^{+}$	−1.88 (0.49)***	−0.36 (0.42)	0.62 (0.42)
Primary language	−0.33 (0.85)***	1.63 (0.42)***	0.83 (0.35)*	−0.84 (0.34)*
Caregiver depression	10.05 (1.92)***	−0.60 (0.22)**	0.26 (0.18)	−0.17 (0.18)
Caregiver education	2.30 (0.56)***	0.25 (0.06)***	−0.10 (0.04)*	0.06 (0.04)
Food insecurity	−2.04 (0.62)**	−0.14 (0.26)	0.08 (0.22)	−0.21 (0.22)
Marital status	0.34 (0.37)	−0.11 (0.26)	0.55 (0.22)*	−0.33 (0.22)
CLASS: IS	0.08 (0.25)	0.06 (0.16)	−0.28 (0.15)$^{+}$	0.35 (0.15)*
CLASS: OS	0.03 (0.34)	0.44 (0.25)$^{+}$	0.04 (0.22)	0.05 (0.21)
CLASS: ES	0.90 (0.50)$^{+}$	−0.54 (0.35)	−0.58 (0.31)$^{+}$	0.15 (0.31)

Note. The model also included site as a covariate, which is not shown in the table. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment; CLASS = Classroom Assessment Scoring System; IS = Instructional Support; OS = Organizational Support; ES = Emotional Support; HLM = hierarchical linear model.
$^{+}p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Model 2: Does Peer Skill Predict Child Outcomes?

The second set of models extended Model 1 by adding peer language skill and peer behavior problems as predictors (see Table 6). As expected, higher levels of peer language skill were significantly related to higher auditory comprehension ($B = 0.05$, $SE = 0.03$, $d = .03$, $p = .04$) and receptive vocabulary ($B = 0.16$, $SE = 0.02$, $d = .10$, $p < .001$) skills. Higher levels of peer behavior problems were significantly related to higher levels of behavior problems ($B = 0.85$, $SE = 0.03$, $d = .29$, $p < .001$) and lower levels of self-control ($B = -0.47$, $SE = 0.04$, $d = -.16$, $p < .001$). Surprisingly, higher levels of peer language skill were significantly related to higher levels of behavior problems ($B = 0.04$, $SE = 0.02$, $d = .03$, $p = .01$) and lower levels of self-control ($B = -0.05$, $SE = 0.02$, $d = -.04$, $p = .005$). Peer behavior problems were not significantly related to children's language skills.

Model 3: Does Peer Skill Partially Mediate the Interaction Between Classroom Age Composition and Child Age?

The final model was intended to examine whether peer language and peer behavior skills appear to mediate the anticipated interaction between classroom age composition and child age. These analyses were not conducted because the Model 1 analyses did not yield strong evidence for the interaction when both p-values and effect sizes were examined.

Sensitivity Analyses

The first set of sensitivity analyses considered the effects of classroom age composition and peer skill in separate models for older and younger children. Overall, findings were generally consistent with the primary analyses (see Table A1 in Appendix. The only difference between same age and mixed age classrooms within age groups that emerged in these analyses contradicted our hypothesis, finding that that older children in mixed age classrooms appeared to have better auditory comprehension than older children in same age classrooms ($B = 3.46$, $SE = 1.29$, $d = .26$, $p = .01$). Mediation analyses were then conducted to consider the role of peer language skills and peer behavior problems. However, no evidence emerged to support peer skill as a partial mediator of this effect ($p > .05$).

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Table 6
HLM Outcomes for Model 2

	School readiness outcomes			
	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)
Intercept	93.15 (0.21)***	92.15 (0.12)***	50.85 (0.11)***	50.34 (0.17)***
Mixed age	0.85 (0.51)	0.72 (0.39)$^{+}$	−0.05 (0.32)	0.13 (0.35)
Age group	−1.16 (0.45)*	0.70 (0.27)*	−1.11 (0.22)***	1.62 (0.24)***
Mixed Age × Age Group	0.71 (0.77)	1.06 (0.55)$^{+}$	−0.06 (0.45)	−0.46 (0.49)
Peer language	0.05 (0.03)*	0.16 (0.02)***	0.04 (0.02)*	−0.05 (0.02)**
Peer behavior	0.04 (0.06)	−0.01 (0.04)	0.85 (0.03)***	−0.47 (0.04)***
PLS version	7.67 (4.60)	—	—	—
Pretest score	0.69 (0.05)***	0.67 (0.01)***	0.51 (0.01)***	0.53 (0.01)***
Child disability	−3.34 (0.79)***	−2.28 (0.39)***	1.73 (0.31)***	−2.12 (0.32)***
Gender	−1.94 (0.37)***	−0.55 (0.24)*	1.98 (0.20)***	−1.59 (0.20)***
Black	0.46 (0.65)	−1.79 (0.44)***	0.28 (0.35)	0.03 (0.37)
Hispanic	1.95 (1.00)$^{+}$	−1.90 (0.49)***	−0.53 (0.40)	0.69 (0.41)$^{+}$
Primary language	−0.38 (0.96)	1.54 (0.42)***	0.68 (0.33)*	−0.74 (0.34)*
Caregiver depression	10.07 (1.92)***	−0.58 (0.22)**	0.34 (0.18)$^{+}$	−0.21 (0.18)
Caregiver education	2.30 (0.56)***	0.24 (0.06)***	−0.11 (0.04)**	0.07 (0.04)
Food insecurity	−2.04 (0.62)**	−0.12 (0.26)	0.09 (0.21)	−0.21 (0.22)
Marital status	0.33 (0.37)	−0.12 (0.26)	0.54 (0.21)*	−0.31 (0.22)
CLASS: IS	0.06 (0.25)	0.00 (0.16)	−0.22 (0.14)	0.29 (0.15)*
CLASS: OS	−0.01 (0.33)	0.26 (0.24)	0.03 (0.20)	0.03 (0.21)
CLASS: ES	1.00 (0.50)	−0.25 (0.34)	−0.15 (0.28)	−0.08 (0.30)

Note.. The model also included site as a covariate, which is not shown in the table. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment; CLASS = Classroom Assessment Scoring System; IS = Instructional Support; OS = Organizational Support; ES = Emotional Support; HLM = hierarchical linear model.
$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

The second set of sensitivity analyses included the children's primary language interacted with the predictors of interest in Models 1 and 2. Relatively few findings related to primary language emerged (see Table A2 in Appendix). In Model 1, the interaction between primary language and child age group was significant for receptive vocabulary ($B = -1.39$, $SE = 0.59$, $p = .02$). It appeared that for children who spoke English as their primary language, age did not matter for scores on the age standardized measure of receptive vocabulary. On the other hand, for children who spoke another primary language, being older was related to better receptive vocabulary. Furthermore, in Model 1 the three-way interaction between classroom age composition, child age group, and primary language was significant for behavioral problems ($B = -2.84$, $SE = 1.09$, $p = .01$). In mixed age classrooms, younger children who spoke English as their primary language appeared to have more behavioral problems than younger children who spoke another primary language, but there was not as much of a language-based difference for older children. In contrast, in same age classrooms older children who spoke a primary language other than English had fewer behavior problems than older English speakers, but this was not as true for younger children. In Model 2, both peer language ($B = 0.17$, $SE = 0.07$, $p = .01$) and peer behavior ($B = -0.37$, $SE = 0.15$, $p = .01$) significantly interacted with primary language to predict auditory comprehension. Children who spoke English as their primary language were expected to benefit more from peers with higher language skills and to be more negatively impacted by peers with more behavior problems than children who spoke a primary language other than English.

The final set of sensitivity analyses replaced the binary classroom age composition variable with the proportion of younger children or the standard deviation of child age in Models 1 and 2 (see Table A3 in Appendix). The main results were largely the same. For the proportion of younger children variable, child age group was no longer a significant predictor of any outcome except for self-control. For self-control, the interaction between

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classroom age composition and child age group was significant in Model 1 ($B = -2.87$, $SE = 1.32$, $p = .03$) with younger children appearing to benefit more in terms of self-control when there was a greater proportion of young children in the classroom as compared to older children. However, no evidence emerged to support the application of mediation analyses.

For the standard deviation of child age analyses, standard deviation of child age was found to significantly predict receptive vocabulary ($B = 0.48$, $SE = 0.15$, $p = .001$) in Model 1. This finding suggests that children in classrooms with a higher standard deviation of child age score higher on receptive vocabulary. In Model 2, peer language no longer significantly predicted auditory comprehension.

Discussion

To examine whether the wide-scale use of mixed-age grouping in preschool is related to the acquisition of school readiness skills, this study asked three questions related to classroom age composition, the child's age, and the language skills and behavior problems of the children's classroom peers. Findings suggested that peer skills, but not classroom age composition, were related to children's language and behavioral outcomes.

These findings extend the mixed literature on classroom age composition. Some studies suggested that younger children benefited from being a mixed-age classroom, but older children benefited from being in a same-age classroom (Bailey et al., 1993; Winsler et al., 2002). As in some of the more recent and rigorous research that found no significant relations between classroom age composition and academic, behavioral, and social outcomes (Ansari et al., 2016; Bell et al., 2013), this study suggested overall that classroom age composition neither had a main effect nor interacted with child age in analyses of preschoolers' language and behavioral skills. Furthermore, sensitivity analyses looking at the proportion of younger children and the standard deviation of child age in a given classroom as indicators of classroom age composition demonstrate that this lack of significant findings is not simply a result of differences in the way classroom age composition has been defined across studies.

This study also extended beyond previous research on classroom age composition by considering peer effects. As hypothesized, analyses indicated that peer skills were related to children's acquisition of both language and behavioral skills. Consistent with the peer effects framework, which suggests that children's peers can have direct and indirect effects on their outcomes (Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009), these results further contribute to debate in the literature over the best preschool environment for young children. These findings extend previous work by using peer skills scores that reflected level of skills rather than age standardized measures of those skills. This is important because younger children typically have lower levels of skills even when they are meeting or exceeding age-related norms.

Classroom Age Composition

This study examined whether the effects of classroom age composition differed for older and younger children. Overall, neither older nor younger children were found to benefit more from a mixed age classroom environment as compared to a same age classroom environment. The results of a sensitivity analysis considering older and younger children separately were generally consistent with this finding. While some prior studies that typically involved small samples found that younger children tend to benefit more from a mixed age environment than older children (Bailey et al., 1993; Urberg & Kaplan, 1986; Winsler et al., 2002), the findings from this study are consistent with a recent study that used a large sample of Head Start children and also found that mixed age classrooms did not have any beneficial or harmful influences on either age group (Bell et al., 2013). This study and the study by Bell et al. (2013) suggest that classroom age composition is not a major factor in preschoolers' language and behavioral development, at least in programs with moderately high-quality teacher-child interactions. Perhaps, the teachers in both same age and mixed age classrooms were able to provide all children with responsive and stimulating care despite the greater variability in skills in mixed-age classrooms.

Some consider the finding that classroom age composition does not relate to child outcomes surprising due to research that shows that peers are very influential on children's classroom experiences (Bell et al., 2013; Bulotsky-Shearer, Domínguez, & Bell, 2012; Hamre & Pianta, 2001). However, classroom age composition only accounts for the age of peers. Other peer characteristics are likely to influence child outcomes, including peer skills (Henry & Rickman, 2007). Although it is generally expected that peer skills will be more variable in mixed age

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classrooms, peer skills are not determined by age alone. For example, a younger child in a preschool classroom may be more skilled than their older peer if they have a richer home learning environment and more opportunities to build their skills under the guidance of a supportive adult. Thus, looking at classroom age composition without considering other peer factors is likely not sufficient to understand the role peers play in impacting individual child outcomes.

The Role of Peer Skill

This study looked beyond classroom age composition alone by considering the effect of peer skills on child outcomes. It was found that both peer language and peer behavior problems significantly predicted children's language and behavioral outcomes. Consistent with the this study's findings, previous research has linked greater peer language skills to better language outcomes for individual children in the preschool setting (Atkins-Burnett et al., 2017; Justice et al., 2011; Mashburn et al., 2009). In preschool, children's language development is thought to be influenced by what they hear through their interactions with others. Much of a preschooler's day is spent interacting with peers, which provides numerous opportunities for children to learn from their peers' language skills (Mashburn et al., 2009), and research suggests that frequent peer-to-peer interactions are an important contributor to children's language development (Connor, Morrison, & Slominski, 2006). Exposure to more complex language is considered particularly beneficial for children's language outcomes (Cabell, Justice, McGinty, DeCoster, & Forston, 2015), so peers who use more advanced language may directly benefit the language development of other children in their classroom environment.

A more difficult to explain finding is the relation between peer language skill and both greater child behavior problems and lower self-control. One possibility is that children who are around peers with more advanced language skills may display behavior problems and lower self-control if they lack the language skills to engage and verbally problem solve with their more linguistically advanced peers. However, more research is necessary to replicate and better understand this finding and its implications.

Compared to language, less work has examined the link between the average behavior of classroom peers and the outcomes of young children. Consistent with this study's findings, the work that has been done suggests that average peer behavior can influence individual children's behavioral outcomes (Thomas et al., 2011). Exposure to the problem behaviors of classroom peers may lead to individual children learning and imitating these behaviors (Mrug, Hoza, & Bukowski, 2004; Schunk, 1987). This, in turn, may be reflected in more negative behavioral outcomes. However, peers with more problem behaviors may still use advanced language when they interact with others in the classroom, which could help explain why a link was not found between peer behavior problems and individual child language outcomes.

Implications

This study did not find classroom age composition to be a major factor in children's language and behavioral outcomes. Although no great benefit of mixed age classrooms was found in this study, there was also no evidence to support the claim that mixed age classrooms should not be used. These findings are consistent with some previous research (Ansari et al., 2016; Bell et al., 2013) and do not discount the current practices of early childhood education programs, such as Head Start, that commonly serve low-income children and often place children of varying ages together in a single classroom (Moiduddin et al., 2012).

While the age composition of classroom peers may not have been found to relate to the examined outcomes, the results still suggest it is important to reach a better understanding of the influences preschool peers have on individual child development. Peer skills were found to relate to both language and behavioral outcomes. If a child is placed in either a mixed or same age classroom with many peers who are at a lower skill level, the child's own skill development may be negatively influenced. Due to the influence peer skills appear to have on child outcomes, research is needed to examine the potential benefits of building the skills of preschool children with lower skill levels while still providing the more skilled children with challenging experiences that will support the further development of their own skills. Although classroom age composition did not play a role in this study, providing these experiences is still likely to be particularly challenging in mixed age classrooms where the developmental needs of children can range broadly (Moller et al., 2008). Due to this and other challenges, it would likely be necessary to provide training and resources to teachers, so they will have the tools needed to better support the successful

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development of children who come to preschool with a wide range of skills.

It is important to note that this study did not capture which peers a child was interacting with in the classroom. Being in a classroom with more skilled peers on average may have less of a benefit for a child if they primarily interact with children who are at a lower skill level. In contrast, being in a classroom with less skilled peers may not have a large negative impact on a child who tends to interact with peers who are at a higher skill level. Additional work is needed to consider whether the skills of a child's primary peers have a stronger effect on their outcomes than the average skill level of all peers within a classroom. Such research could help better inform classroom practices related to peer-to-peer interactions.

Another factor not captured by this study is how peers were having an effect on child outcomes. As noted by the peer effects framework, peers can have both direct and indirect effects on individual children (Henry & Rickman, 2007). Based on the results of this study, it would be beneficial to further research the potential benefits of ensuring that children who are at a lower skill level have opportunities to directly interact with children who are more skilled on average. These more skilled peers may be able to pass on some of their skills to the less skilled children in the classroom through modeling or even direct teaching. At times, this may be accomplished through mixed age groupings as, at least on average, the older children in the present sample were more skilled than their younger counterparts. At the same time, always playing the role of teacher or model may not be most beneficial for the development of the more skilled children, suggesting the possible need to create specific opportunities for the more highly skilled children to interact with one another as well.

To ensure such positive peer interactions occur would require facilitation by a teacher or another adult in the classroom. Young children often need support for successful peer interactions as the preschool classroom is many children's first opportunity to learn how to navigate the peer group environment (Hay, Payne, & Chadwick, 2004). Researchers suggest that preschool teachers may be able to maximize positive and minimize negative peer influence through the strategic management of peer interactions (DeLay et al., 2016). This again indicates that work is needed to develop training for teachers, so they can better understand how to best support the peer interactions of children who are at varying skill levels.

Limitations

This study has a number of strengths. The questions of interest were addressed using data from a diverse, multisite study. The policy relevant definition of classroom age composition was used in the analyses, and sensitivity analyses looking at other conceptualizations of classroom age composition produced similar results. The average peer skill variables were also representative of the children in a given classroom rather than only a small subsample due to the Educare Implementation Study's focus on assessing all children in a classroom when possible.

However, this study also has a number of limitations that should be addressed. One limitation is that our data did not reveal how the programs classified classrooms as same age or mixed age. Therefore, we used the data to infer the classroom age composition label as accurately as possible.

Furthermore, the relation between classroom age composition and children's outcome trajectories was not examined as many children only had data available at two time points. Some past work on mixed age classrooms has examined children's outcome trajectories (Bailey et al., 1993; Bell et al., 2013), but more work is needed in this area to explore whether mixed age classrooms have lasting influences on child outcomes.

Another limitation is that there were many school readiness variables that could not be examined as they were not collected. Past research has revealed many important school readiness skills, such as math, literacy, and fine motor skills (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010; Pace, Alper, Burchinal, Golinkoff, & Hirsh-Pasek, 2018), that may relate to classroom age composition in ways that differ from this study. For example, being in a mixed age classroom has been found to negatively influence the math and literacy outcomes of older preschool children in a recent study, which were outcomes that were not examined in this study (Ansari et al., 2016).

Furthermore, classrooms in this study were generally of a higher quality due to the nature of Educare schools and included only children who qualified for Head Start, typically due to low family incomes. Classroom quality may play a role in the relation between classroom age composition and child outcomes. Lower quality classrooms may not be equipped to properly handle the needs of two developmentally different age groups leading to poorer child outcomes. Exclusion of middle- and higher-income children limits generalization as well.

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Future research could examine classroom quality and family income as moderators in the relation between classroom age composition and child outcomes.

There was also evidence of selection biases related to race and primary language in the groups of interest to this study as shown in Table 2. Covariates were included to account for these group differences, but it is likely that these biases have not been fully removed. Thus, the results from this study must be viewed with caution.

Finally, in the present sample, no evidence was found to indicate that the relation between the classroom age composition by child age interaction and the examined outcomes was mediated by peer skill. However, as some of the other larger scale studies found significant effects of classroom age composition on at least some child outcomes, it may be beneficial to look at this issue again within the context of other preschool programs, such as a more typical Head Start program.

As a broader limitation that exists within the literature, there is currently no consensus on how to define classroom age composition. This study relied on the distribution of classroom age ranges and knowledge about the Educare program to define mixed age and same age classrooms. Other recent studies have defined classroom age composition using the proportion of 3-year-olds (Ansari et al., 2016), the age range of a classroom's children (Moller et al., 2008), or the standard deviation of the children's ages (Bell et al., 2013; Moller et al., 2008). The present lack of a widely accepted definition of classroom age composition makes it more difficult to compare results across studies. This study used sensitivity analyses to consider whether operationalizing classroom age composition differently played a role in the results. Findings were largely the same across the different definitions of classroom age composition, but more work is needed to address this issue.

Conclusion

Overall, this study did not find evidence to indicate that classroom age composition related to the examined language and behavioral outcomes for either younger or older children in a large sample from Educare schools. However, peers did appear to have an effect on child outcomes through their average level of skill, providing further evidence for the importance of peers in the preschool setting. This finding suggests that it is important to further examine the potential importance of promoting peer-to-peer contact in the preschool setting and specifically providing children opportunities to interact with more skilled peers. Additional work is needed to advance the current understanding of the role of peer skill in the preschool classroom and how teachers can best support peer interactions, so children at both lower and higher skill levels will benefit.

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Appendix

Table A1
Models 1 and 2 Analyzing the Simple Main Effects of Classroom Age Composition Within Child Age Groups

	Younger children				Older children			
	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)
Model 1								
Intercept	92.79 (0.36)***	91.62 (0.18)***	51.20 (0.20)***	49.57 (0.26)***	89.34 (0.92)***	92.89 (0.25)***	50.33 (0.28)***	51.44 (0.31)***
Mixed age	1.14 (0.85)	0.78 (0.50)	0.19 (0.41)	0.09 (0.45)	3.45 (1.29)**	0.95 (0.72)	0.08 (0.68)	−0.81 (0.70)
Model 2								
Intercept	92.74 (0.38)***	91.86 (0.17)***	51.23 (0.52)***	49.49 (0.27)***	91.55 (0.54)***	92.42 (0.25)***	50.15 (0.22)***	51.46 (0.30)***
Mixed age	1.10 (0.86)	0.57 (0.49)	−0.09 (0.38)	0.35 (0.45)	3.42 (1.29)**	1.28 (0.71)$^{+}$	−0.05 (0.63)	−0.74 (0.70)
Peer language	0.03 (0.05)	0.16 (0.03)***	0.03 (0.02)$^{+}$	−0.06 (0.02)*	0.01 (0.06)	0.17 (0.03)***	0.04 (0.03)	0.00 (0.03)
Peer behavior	0.16 (0.09)$^{+}$	0.02 (0.05)	0.85 (0.04)***	−0.47 (0.05)***	0.08 (0.12)	−0.04 (0.06)	0.85 (0.03)***	−0.28 (0.06)***

Note. Both models also included the following covariates not shown in the table: child sex, disability status, and race and ethnicity, caregiver's depression, level of education, and marital status, whether the family experienced food insecurity, classroom emotional support, organization, and instructional support, site, and PLS version when applicable. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment.
$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

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Table A2
Models 1 and 2 Including the Main Predictors Interacted With the Child's Primary Language

	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)
Model 1				
Intercept	92.30 (0.28)***	92.15 (0.14)***	50.96 (0.20)***	50.34 (0.24)***
Mixed age	1.70 (0.72)*	0.77 (0.41)$^{+}$	0.10 (0.36)	−0.29 (0.38)
Age group	−1.33 (0.59)*	1.40 (0.26)***	−0.97 (0.23)***	2.10 (0.25)***
Primary language	2.82 (0.86)**	1.73 (0.44)***	0.62 (0.36)$^{+}$	−0.90 (0.38)*
Mixed Age × Age Group	1.61 (0.94)$^{+}$	−0.39 (0.55)	−0.30 (0.49)	−0.38 (0.52)
Mixed Age × Primary Language	−1.40 (1.30)	−0.23 (0.73)	0.72 (0.61)	0.09 (0.65)
Age Group × Primary Language	1.59 (1.07)	−1.39 (0.59)*	0.81 (0.51)	−0.77 (0.54)
Mixed Age × Age Group × Primary Language	−4.21 (2.21)$^{+}$	1.10 (1.27)	−2.84 (1.09)**	1.34 (1.16)
Model 2				
Intercept	92.15 (0.30)***	92.13 (0.13)***	50.89 (0.12)***	50.41 (0.24)***
Mixed age	1.80 (0.72)*	0.75 (0.40)$^{+}$	−0.12 (0.33)	−0.15 (0.38)
Age group	−1.25 (0.65)$^{+}$	0.69 (0.27)*	−1.13 (0.22)***	2.24 (0.25)***
Primary language	3.17 (0.88)***	1.62 (0.45)***	0.51 (0.36)	−1.02 (0.39)**
Mixed Age × Age Group	−0.30 (1.89)	1.00 (0.56)$^{+}$	0.02 (0.46)	−0.66 (0.53)
Mixed Age × Primary Language	−2.25 (1.31)$^{+}$	0.02 (0.73)	0.30 (0.59)	0.29 (0.65)
Age Group × Primary Language	0.67 (1.11)	−1.18 (0.61)$^{+}$	0.51 (0.50)	−0.57 (0.55)
Mixed Age × Age Group × Primary Language	−2.50 (2.29)	0.69 (1.29)	−2.39 (1.06)*	1.01 (1.18)
Peer language	−0.01 (0.04)	0.16 (0.02)***	0.04 (0.02)*	−0.04 (0.02)*
Peer behavior	0.14 (0.08)$^{+}$	−0.00 (0.04)	0.85 (0.03)***	−0.41 (0.04)***
Peer Language × Primary Language	0.17 (0.07)**	−0.02 (0.04)	−0.01 (0.03)	−0.03 (0.03)
Peer Behavior × Primary Language	−0.37 (0.15)*	0.13 (0.08)	−0.00 (0.07)	−0.11 (0.08)

Note. Both models also included the following covariates not shown in the table: child sex, disability status, and race and ethnicity, caregiver's depression, level of education, and marital status, whether the family experienced food insecurity, classroom emotional support, organization, and instructional support, site, and PLS version when applicable. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment.
$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

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Table A3
Models 1 and 2 Using the Proportion of Younger Children and the Standard Deviation of Child Age to Represent Classroom Age Composition

	Proportion of younger children				Standard deviation of child age			
	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)	PLS: AC *B* (*SE*)	PPVT *B* (*SE*)	DECA behavior *B* (*SE*)	DECA self-control *B* (*SE*)
Model 1								
Intercept	92.15 (0.77)***	92.83 (0.58)***	51.23 (0.74)***	49.10 (0.70)***	92.86 (0.20)***	92.17 (0.12)***	50.93 (0.20)***	50.32 (0.19)***
Age composition	1.05 (1.06)	−1.03 (0.80)	−0.52 (1.07)	1.68 (1.02)$^{+}$	−0.01 (0.20)	0.48 (0.15)**	0.02 (0.22)	0.02 (0.21)
Age group	−0.57 (1.32)	1.12 (0.95)	−0.72 (0.87)	3.32 (0.87)***	−1.03 (0.40)*	1.37 (0.26)***	−0.90 (0.23)***	1.36 (0.24)***
Age Composition × Age Group	−0.49 (1.87)	0.25 (1.44)	−0.45 (1.32)	−2.87 (1.32)*	−0.13(0.21)	−0.20 (0.19)	−0.23 (0.18)	0.32 (0.18)$^{+}$
Model 2								
Intercept	91.73 (0.78)***	91.39 (0.60)***	50.55 (0.52)***	49.60 (0.67)***	92.85 (0.20)***	92.16 (0.12)***	50.85 (0.11)***	50.33 (0.17)***
Age composition	1.73 (1.08)	1.26 (0.85)	0.40 (0.74)	0.93 (0.98)	−0.04 (0.20)	0.33 (0.15)*	−0.04 (0.14)	0.04 (0.19)
Age group	−0.80 (1.34)	0.40 (0.95)	−0.48 (0.78)	3.25 (0.86)***	−1.17 (0.42)**	0.71 (0.27)**	−1.11 (0.22)***	1.51 (0.24)***
Age Composition × Age Group	−0.30 (1.89)	0.84 (1.44)	−0.96 (1.18)	−2.63 (1.29)*	−0.08 (0.21)	0.07 (0.19)	0.02 (0.16)	0.21 (0.17)
Peer language	0.05 (0.02)*	0.16 (0.02)***	0.04 (0.02)*	−0.04 (0.02)*	0.03 (0.02)	0.15 (0.02)***	0.04 (0.02)**	−0.04 (0.02)*
Peer behavior	0.00 (0.05)	−0.01 (0.04)	0.86 (0.03)***	−0.53 (0.01)***	−0.00 (0.05)	−0.01 (0.04)	0.85 (0.03)***	−0.47 (0.04)***

Note. Both models also included the following covariates not shown in the table: child sex, disability status, and race and ethnicity, caregiver's depression, level of education, and marital status, whether the family experienced food insecurity, classroom emotional support, organization, and instructional support, site, and PLS version when applicable. PLS = Preschool Language Scale; AC = Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment.
$^{+}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

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