PEER EFFECTS IN THE PRESCHOOL CLASSROOM: EXAMINING THE ROLE OF CHILD AND PEER CHARACTERISTICS

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ABSTRACT

Tiffany Jamie Foster: Peer Effects in the Preschool Classroom: Examining the Role of Child and Peer Characteristics
(Under the direction of Beth Kurtz-Costes and Margaret Burchinal)

Having highly skilled classmates appears to positively influence preschool children's academic and social development. Despite relatively consistent evidence to indicate that peers can promote positive child development, there are many issues regarding the role of peers in preschool that need to be understood in order to provide guidance to teachers and administrators who wish to capitalize on peer influence in the classroom. The goal of the present dissertation was to conduct three studies to expand current research on peer influence by reaching a more in-depth understanding of the child- and peer-level factors that contribute to the strength of peer influence in preschool. In Study One, I examined the role of child skill at entry to pre-kindergarten, in Study Two I considered child dual language learner status, and in Study Three I explored whether the relation between peer skill and child development depends on peer gender and age cohort. Study One and Two drew from a sample of 455 children who attended a state-funded prekindergarten program in rural areas of North Carolina. Study Three used data from 4,005 children attending a high-quality preschool program at 16 sites across the United States. Hierarchical linear models were used for all analyses to account for the nesting of children in classrooms. Overall, results indicated that child and peer characteristics can moderate the relation between peer skill and child development. However, the pattern of results was found to differ across the examined outcomes. Implications of these findings for the preschool classroom context are discussed.

To my mentors, family, and cohort. Thank you for all of the support.

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AC	Auditory Comprehension
AP	Applied Problems
CLASS	Classroom Assessment Scoring System
DADG	Different age cohort different gender peers
DASG	Different age cohort same gender peers
DECA	Devereux Early Childhood Assessment
DIBELS	Dynamic Indicators of Basic Early Literacy Skills
DLL	Dual language learner
EO	English only
EOW	Expressive One-Word Picture Vocabulary Test
FSF	First Sound Fluency
LBS	Learning Behavior Scale
LW	Letter-Word Identification
PLS	Preschool Language Scale
PPVT	Peabody Picture Vocabulary Test
Pre-k	Prekindergarten
PSF	Phoneme Segmentation Fluency
PV	Picture Vocabulary
SADG	Same age cohort different gender peers
SASG	Same age cohort same gender peers
STRS	Student-Teacher Relationship Scale
TCRS	Teacher-Child Rating Scale

WJ	Woodcock Johnson

CHAPTER 1: INTEGRATIVE INTRODUCTION: PEER EFFECTS IN THE PRESCHOOL CLASSROOM

In the preschool setting, children spend large portions of the day engaging with peers while playing and participating in academic activities (Palmero et al., 2014). Evidence suggests that positive interactions with preschool peers may promote various developmental competencies, such as school success, positive self-perceptions, learning behaviors, social adjustment, language skills, and problem-solving skills (Coolahan et al., 2000; Henry & Rickman, 2007; Johnson et al., 2000; Nelson et al., 2005). As a main goal of preschool programs is to provide children with the support they need to succeed in school, it is important to consider how peers can contribute to a more positive preschool environment. Researchers use the concept of peer effects as one way to explain the link between peers and preschoolers' skill development. According to the peer effects framework, exposure to peers who are more highly skilled can have both direct and indirect influences on a child's development (Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009).

To date, evidence has generally supported the hypothesis that being in a classroom with more highly skilled peers will have a positive influence on preschoolers' development (e.g., Henry & Rickman, 2007; Justice et al., 2011). However, the child- and peer-characteristics that play a role in the strength of peer influence remain understudied. Examination of for whom peer skill matters most and which peers may be most influential for specific groups of children can help inform classroom practices and policies that aim to capitalize on positive peer influences. A main goal of the present dissertation was to expand current research on peer influence by

reaching a more in-depth understanding of the child- and peer-level characteristics that contribute to the strength of peer influence in the preschool environment. Study 1 examined the role of initial skill level upon entry to preschool, Study 2 focused on dual language learner (DLL) status, and Study 3 considered peer age cohort and gender.

Peer Influences on Children's Skill Development

Broadly, peer effects have been defined as "any externality in which peers' backgrounds, current behavior, or outcomes affect an outcome" (Sacerdote, 2011, p. 250). A large portion of peer effects research has considered how peer skill relates to a child's own skill development, which is the focus of the present dissertation. Research examining the influence of peer skill level draws from Vygotsky's (1978) sociocultural theory. According to the theory, learning is a social process, and children learn through interactions with others. A key concept is the zone of proximal development, or the difference between what children can do on their own and what they can do with the support and guidance of a more skilled partner. More highly skilled peers may be able to provide less skilled children with the scaffolding and support they need to advance their learning to a level they could not have reached alone.

According to the peer effects framework, peers can have either direct or indirect effects on child outcomes (e.g., Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009). Direct effects occur during child-to-child interactions, which is consistent with Vygotsky's theory. Through peer interactions, more highly skilled peers may model and teach their skills to other children. For example, preschoolers may promote the learning of others by offering simple corrective feedback to their peers, such as letting a classmate know when he or she has used a word incorrectly (Palmero et al., 2014). Indirect effects occur when the skills of a child's peers have an influence on child development through changes in the environment. For example, when

many children in a classroom have a lower level of skill, the classroom may have access to more supportive learning resources, which may be beneficial for all children. However, teachers may have to spend more time on instruction to support the learning of the less skilled children, which may not greatly benefit the most highly skilled children in the classroom.

Peer Effects in the Preschool Classroom

Preschool appears to be especially effective at improving school-entry skills for children who are DLLs (i.e., learning English along with a second home language) and children from low-income families (Yoshikawa et al., 2013). Children in these groups often enter elementary school academically behind their more advantaged peers, but high-quality preschool can have large benefits for these children upon entry into school and beyond (Yoshikawa et al., 2013). The potential benefits of preschool make it important to understand the environmental factors that contribute to a positive, high-quality preschool experience. To date, much of the research on high-quality preschool has focused on teacher-child relationships (Burchinal, 2018), but in the preschool classroom, children spend much of their time interacting with peers during academic activities and play (Palmero et al., 2014). Preschoolers frequently spend more time interacting with peers than with teachers, potentially making peers an important source of knowledge and support (Sawyer et al., 2018). However, peers have often been omitted from models attempting to explain the link between preschool attendance and positive child development (Henry & Rickman, 2007).

Although research has supported the importance of peer effects in elementary school and beyond, few studies to date have focused on peer effects in the preschool classroom (Atkins-Burnett et al., 2017). This gap in the literature may be due, in part, to a belief that older children are more susceptible to peer effects than preschoolers (Delay et al., 2016; Hartup, 1989).

However, the limited research on preschoolers supports the hypothesis that peer skill can play an important role in supporting the development of individual children. In at least one study, researchers examined effect sizes and concluded that peer effects may, in fact, be equally, if not more important, in preschool than later in a child's schooling (Henry & Rickman, 2007).

To examine peer influence, researchers generally take a sample of about four to eight children per classroom and calculate an average level of skill for this group of children (e.g., Atkins-Burnett et al., 2017; Henry & Rickman, 2007; Justice et al., 2011). It is also important to subtract out the child's own skill level so that the target child is not considered to be a peer of him- or herself. This method creates an estimate of the child's everyday exposure to classmate skill. The present studies will use this method to focus on peer language skill, peer social skill, and peer behavioral skill as predictors of child development.

Peers with higher language skills are better equipped to verbally teach and share their skills with peers. For example, a child with better language skills may have the vocabulary to verbally resolve a conflict, providing a model for their playmates, or explain an academic concept to their friend in multiple ways. In that case, peer language skill might be related to the child's academic, social, and behavioral development. Previous research has consistently supported a link between higher peer language skill and children's language development in the preschool setting (Atkins-Burnett et al. 2017; Justice et al., 2011; Mashburn et al., 2009). However, few studies have examined whether peer language is related to child development in other domains.

In addition, little work has considered the impact of peer social and peer behavioral skill on preschoolers' outcomes. Theory suggests that children can learn from more socially and behaviorally skilled partners who may be better equipped to control their behaviors, creating a

more positive learning environment (Park & Lee, 2015). For example, children with better social skills may contribute to a classroom environment where teachers can spend more time on academic lessons rather than behavior management, benefiting the academic development of all children in the classroom. One study found that a higher level of peer social skill was related to higher spring social skills for preschoolers (Aikens et al., 2010). In samples of early elementary age children, more behavior problems among peers were related to higher levels of behavior problems and poorer cognitive outcomes for individual children (Neidell & Waldfogel, 2010; Thomas et al., 2011). This limited evidence supports the need to reach a better understanding of the role of peer social skill and peer behavioral skill as predictors of child development in the preschool classroom.

Differences in Peer Influence Based on Child Skill, DLL Status, and Peer Gender and Age Cohort

Having highly skilled preschool peers predicts gains in a variety of developmental areas (e.g., Henry & Rickman, 2007; Thomas et al., 2011). However, little work has considered the children for whom peer skill matters most and which peers may have the strongest influence on children with different characteristics. The goal of the present dissertation is to address this gap in the literature by examining child initial skill level, child DLL status, and peer age cohort and gender as factors that may play a role in determining how strongly peer skill relates to children's academic, social, and behavioral development.

Peer skill may be particularly important for children who enter preschool with the lowest level of skill, as these children have the most to gain from the support of their more highly skilled peers (Justice et al., 2011; Webb, 1991). Peer interactions can provide one-on-one opportunities to observe and practice skills with a responsive, more skilled partner. Children with higher skills than many of their peers may not have as much to learn from their classmates but

may benefit from teaching their less skilled classmates (McGregor, 2000), as teaching others provides opportunities to think about and apply skills in new ways. More-skilled children may also be better equipped than less-skilled children to take advantage of the learning opportunities created by peers (see Mashburn et al., 2008).

The limited studies that have simultaneously examined peer skill and child skill have tended to focus on language development. In a study of overall peer language skill, peers had a greater impact on less linguistically skilled classmates than on classmates with more advanced language skills (Justice et al., 2011). In contrast, another study found that children with better language comprehension skills appeared to benefit more from exposure to peers with better oral language skills (Mashburn et al., 2009). Thus, the existing results in this area are mixed and are limited to language development. Additional research is needed to better understand how peer skill and child initial skill interact given the theoretical explanations for why both children with lower skills and children with higher skills could benefit most from their peers.

Researchers have also started to examine whether DLL children benefit similarly from peers with higher skills as compared to English-only (EO) children (e.g., Atkins-Burnett et al., 2017; Gamez et al., 2019). Understanding the factors that positively contribute to the development of DLL children is important as many DLL children come from lower income families with access to few educational resources, and an achievement gap has been documented between DLLs and EO children upon entry to school and beyond (Lee & Burkam, 2002; Mulligan et al., 2012). Interactions with highly skilled peers may create opportunities for DLL children to build and practice the skills that create a foundation for school success (Palmero & Mikulski, 2014). Peer interactions may be particularly important for DLL children's English

language development as DLL children may have few opportunities to practice English outside of the preschool classroom.

A small number of studies have considered the role of peer language skill in relation to DLL children's language development. One study found that peers' vocabulary skills had a greater impact on vocabulary learning among DLL children than among EO children, on average (Atkins-Burnett et al., 2017). Results of another study also showed that DLL children's language skills were positively influenced by the presence of peers with better language skills, but DLL children did not benefit significantly more than EO children (Gamez et al., 2019).

These limited findings suggest that peer skill can have a positive influence on DLL children's language development. However, researchers have not considered whether DLL and EO children benefit similarly from peer language in other domains. Research has consistently demonstrated a link between language and development in domains such as math (Purpura & Ganley, 2014) and reading (Burchinal et al., 2020). Peer language skill may operate similarly to predict child development across domains. Peers with better language skills may be better able to verbally share their skills in a way that their peers will understand. Peer language skill has been linked to preschoolers' social skills, behavior problems, and self-regulation (Aikens et al., 2010; Foster et al., 2020) with other domains remaining unexplored.

Finally, little to no evidence exists regarding whether the impact of peer skills varies depending on peer characteristics such as age cohort and gender. Although not directly considering the role of peer skill, research does suggest that children may spend more time interacting with peers who are similar to themselves in age and gender. Segregation by gender is common in the preschool setting (Martin & Fabes, 2001). Age cohort segregation in classrooms with both younger and older preschoolers has also been documented (Lederberg et al., 1986).

Preschoolers attending mixed-age classrooms become increasingly segregated by both age cohort and gender over the course of the school year (Winsler et al., 2002). Spending more time interacting within these segregated groups may create more opportunities for skills to transfer within rather than across groups. Social identity and social categorization theories also suggest that children will engage in behaviors and activities that reinforce connections to their social groups (Masland & Lease, 2013; Powlishta, 1995; Tajfel, 1978), which may facilitate the transmission of skills within peer groups. Thus, it seems likely that the skills of same-gender and same-age cohort peers would have a stronger influence on preschoolers than would the skills of other classmates.

Overall, understanding how child skill, DLL status, and peer age cohort and gender interact with peer skill to predict child development should help inform classroom practices that attempt to leverage children's natural social interactions to promote learning. Preschool programs are designed to provide children with the supports they need to succeed in school. Accordingly, evidence that skilled peers may particularly benefit children who tend to enter the formal school setting behind their classmates may encourage the development and study of practices that try to harness positive peer influence. To create the most effective peer interaction opportunities, it will be important to understand whether peer characteristics play a role in determining the strength of peer influence. For example, if girls are most positively influenced by other girls, it may be beneficial to create at least some opportunities for preschool-age girls to work together on academic activities to support the potential transfer of skills. To date, little is known about the most effective ways to group children to collaborate on academic activities in the preschool setting despite peer grouping being a widespread learning practice (Park & Lee, 2015).

Preschoolers from Low-Income Families

The present dissertation focused on two samples of preschoolers from low-income families. One sample of children attended the North Carolina Prekindergarten Program (NC Pre-K). NC Pre-K is designed to provide high-quality educational experiences the year prior to kindergarten to prepare children to succeed academically in the formal school setting. The program targets five developmental domains, including approaches to play and learning, emotional and social development, health and physical development, language development and communication, and cognitive development (NCDHHS, 2020). The second sample of children attended Educare, an enhanced Head Start Program, at sites across the United States. Educare supports families and children from birth to age 5 by providing high-quality early education and family support services. The Educare model focuses on data utilization, high quality teaching practices, embedded professional development, and intensive family engagement (Educare Learning Network, 2016).

Children from low-income families often enter the school setting with lower skills than their more economically advantaged peers (Slaby et al., 2005). Entering school with lower skills contributes to an achievement gap between low-income and higher-income children that persists throughout the school years (Reardon, 2013). Research indicates that the achievement gap between low- and high-income students has grown in recent decades, leading to an increased interest in the role schools can play in reducing the gap (Reardon, 2013).

A typical goal of preschool programs that target low-income children is to provide these children with the support they need to succeed in the formal school setting. Research suggests that attending a high-quality preschool program can have larger impacts on lower income children than on higher income children (Yoshikawa et al., 2013). This finding makes it

important to understand the factors that contribute to a positive preschool experience. Peers are a major part of the preschool environment, and researchers have started to question whether peer effects operate in preschool programs that target low-income children. These programs tend to cluster children with low skills together, limiting potential exposure to more advantaged children who tend to have higher academic skills (Justice et al., 2011; Schechter & Bye, 2007). However, even in classrooms serving low-income children, there is still variation in peer skill, and research demonstrates that peers can have a positive influence on children attending such programs. For example, peer language skills have a positive influence on language development among children in programs targeting low-income families (Justice et al., 2011; Mashburn et al., 2009), and peer engagement has a positive influence on motor-cognitive readiness (Rojas et al., 2020). Research specifically on the Educare sample has also shown that peers appear to have an influence on children's language and behavioral development (Foster et al., 2020). Overall, research suggests that peer effects operate in preschool classrooms serving low-income children, but questions remain regarding the role of child and peer characteristics.

The Present Dissertation

To explore the child and peer characteristics that are important for understanding the strength of peer influence, I conducted three studies. The studies drew from two samples of children attending preschool programs designed to support the learning and growth of children who come from low-income families. As in previous research, peer skill was represented by taking an average of the skill of all of a child's peers with available data for a given classroom.

In Study 1, I considered whether the influence of peer skill depends on a child's skill level upon entry to preschool. The main research question was whether children with lower skills benefit more than children with higher skills from peers with higher skills on average. Study 1

expanded on previous research by examining not only peer language skill but also peer social skill, which few studies of preschool peer effects have considered as a predictor. Furthermore, most previous work on child entry skill has focused on children's language skills, whereas the present study considered math, literacy, self-regulation, and social skills in addition to language skills.

In Study 2, I examined whether peer language skill benefits DLL and EO children similarly. As in Study 1, Study 2 built upon previous research by focusing not only on language development but also math, literacy, self-regulation, and social skills. A conceptually scored measure of peer vocabulary skill was used in which DLL children were able to provide correct answers in either Spanish or English. This type of measurement helps to avoid underestimating the skill of bilingual children who may know a word in one language but not the other (Atkins-Burnett et al., 2017). Exploratory analyses also considered measures of peer English skill and peer Spanish skill independently to examine whether the pattern of results differs depending on how peer language is assessed. I also examined a moderated mediation model that has been previously untested in the preschool setting. I considered whether children's language skills are a potential mediator of the relation between peer language skill and children's English language, math, literacy, social, and self-regulation skills, particularly for DLL children. Some evidence supports a link between peer language skill and DLL children's language outcomes (Atkins-Burnett et al., 2017; Gamez et al., 2019). Peer-enhanced language skills might also benefit children in other domains, as many academic activities and classroom interactions rely on a child's ability to use and understand language.

Finally, in Study 3, I tested whether a child's classmates of the same age cohort and gender have a larger impact than other classmates on the acquisition of language and behavioral

skills. This is a question that has previously been unexplored among preschoolers as most prior studies have relied on smaller subsamples of children to estimate peer skill. However, assessing all or most children in a given classroom is likely needed to be able to better estimate the skill level of subgroups of peers. Unlike previous studies of peer influence in the preschool setting, I used a dataset in which data are available for all or most children in a large number of classrooms across the United States. These data allowed me to create more accurate peer skill variables for subgroups of peers.

Overall, the goal of the present dissertation was to fill existing gaps in the preschool peer effects literature by reaching a better understanding of the role of child and peer characteristics in shaping the skill development of young children. This research will inform interventions and classroom practices that could capitalize on the natural peer interactions that occur in the classroom on a day-to-day basis. Research in this area can help identify children who may benefit the most from opportunities to interact with more highly skilled peers and the types of peers that may most benefit particular groups of children. Importantly, the present research aligns with the larger research effort that is aiming to better understand the factors that make preschool effective at providing children, particularly those who enter school behind their peers, with the support they need to succeed in school.

CHAPTER 2: PAPER 1 - PEER EFFECTS AND CHILD INITIAL SKILL

Peers have important influences on preschoolers' developmental outcomes (e.g., Coolahan et al., 2000; Johnson et al., 2000; Nelson et al., 2005). Preschoolers appear to particularly benefit from exposure to more highly skilled classmates who can model and share their skills (e.g., Henry & Rickman, 2007). Higher average peer skill has been linked to preschoolers' skill development in a variety of areas, such as language, pre-reading, and cognitive skills (e.g., Henry & Rickman, 2007; Justice et al., 2011). However, little research on preschool samples has considered whether the influence of peer skill may differ depending on child characteristics.

One potentially important characteristic to consider is a child's own level of skill. Children begin preschool with varying levels of skill in different developmental domains. Some children enter the classroom with very low levels of skill in particular areas and require extra support to catch up to their peers, while others enter preschool with a strong set of skills that help to support success in preschool and beyond. These differences in preschool entry skills may play a role in how strongly children are influenced by their peers. For example, researchers hypothesize that children with the lowest skills may benefit the most from more highly skilled classmates because these children have the most to gain from their peers (e.g., Rojas et al., 2020). Previous research in this area has generally focused on peer language skill and children's language development (e.g., Justice et al., 2011; Mashburn et al., 2009). The present study explores whether peer effects differ depending on a child's initial skill-level at preschool entry in

a sample of children attending a state-funded prekindergarten (pre-k) program in rural areas of North Carolina. Peer language and peer social skill were examined as the predictors of interest and outcomes included language (i.e., vocabulary), literacy (i.e., pre-reading), math, self-regulation, and social skills.

Peer Effects in the Preschool Classroom

About 70% of children in the U.S. attend a preschool program in the year prior to kindergarten entry, with many of these children attending programs that target low-income families (Barnett et al., 2008; NCES, 2020; NIEER, 2019). One goal of these programs is to help ensure that children have the skills and support they need to succeed in the formal school setting, making it important to understand the factors that contribute to a beneficial preschool experience. In the preschool classroom, children spend a large portion of the day interacting with their peers, during both free play and academic activities. Preschoolers often spend more time interacting with their peers than with their teachers (Sawyer et al., 2018), which makes peers a potentially important source of knowledge and support for children's skill development.

A main theoretical basis for peer effects research is Vygotsky's (1978) sociocultural theory. A key concept of this theory is the zone of proximal development, or the range between what a child can do independently and what he or she can do with the help of someone more skilled. More highly-skilled peers may be able to support the learning of their less skilled peers in various ways, such as by modeling more advanced skills during play or providing simple corrective feedback. This peer support may help a less-skilled child advance their own skills in ways that would not have been possible had the child been working independently. However, some researchers argue that if the gap between the most and the least skilled children is too large

without peers whose skills fall in between to bridge this gap, then children with the lowest skills may not experience as much benefit (Atkins-Burnett et al., 2017).

According to the peer effects framework (Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009), peers can have either direct effects or indirect effects on a child's skills. Direct peer effects occur when children transfer skills to one another through interactions, which aligns with Vygotsky's theory. The peer effects framework also argues that peer effects may be indirect. Indirect peer effects occur when peer skill levels contribute to changes in the learning environment. For example, when more children in a classroom have positive behavioral skills, a teacher may be able to spend more time facilitating learning opportunities rather than managing behavior.

Despite the theorized importance of peer influence and the large amount of time spent interacting with peers in preschool classrooms, research on preschool peer effects remains limited. The research that has been conducted generally suggests that peer effects play an important role in the preschool environment. For example, using a composite score of peer skill that included measures of language, math, pre-reading, and other basic skills, researchers found that being in a classroom with peers who were more highly skilled on average positively related children's math, pre-reading, and expressive language development from the fall of preschool to the fall of kindergarten (Henry & Rickman, 2007). Another study focused on noncognitive preschool competency, such as enjoyment of school and the ability to follow classroom rules and adapt to changes. Children in classrooms with a higher average peer level of noncognitive competency developed higher levels of noncognitive competency across the preschool year than children in classrooms where peers had less noncognitive competency (DeLay et al., 2016).

Peer Language and Peer Social Skill as Predictors

The present study focused on peer language skills and peer social skills as the main predictors of interest. Both peer language skills and peer socials skills are important to consider as they may have an impact on the dynamics of a classroom in ways that can influence children's development (Aikens et al., 2010). For example, better peer language skills may lead to a classroom environment where there is more coordinated play and learning activities with better peer-to-peer communication, creating more opportunities for skill transfer. Similarly, better peer social skills may increase the amount of positive social interactions in a classroom and lead to more opportunities for children to learn from one another. However, whereas preschool peer language skills have been the focus of multiple studies (e.g., Atkins-Burnett et al. 2017; Justice et al., 2011; Mashburn et al., 2009), peer social skills remain understudied in the preschool setting.

Several studies have focused on peer language skills mainly as a predictor of children's language development. Results consistently indicate that exposure to peers with higher language skills on average positively relates to individual preschoolers' language development (Atkins-Burnett et al. 2017; Justice et al., 2011; Mashburn et al., 2009). Peer expressive language is related to both receptive and expressive language development (Atkins-Burnett et al., 2017; Mashburn et al., 2009). Justice and colleagues (2011) created a latent score from several language measures to better represent children's overall language ability and also found a positive relation between peer language skill and child language development.

Less research has considered peer social skill as a predictor, but theory suggests that peers with better social skills may be better able to control their behavior, contributing to a more positive learning environment (Park & Lee, 2015). For example, children may prefer to interact

with peers with better social skills, creating more opportunities for children to learn from these peers. Some researchers also argue that children may imitate peers' negative behaviors, particularly if they see that children engaging in these behaviors receive attention from their teacher (Goldstein et al., 2001). At least one study found that higher average peer social skill was associated with better social skill development for individual children across the preschool year (Aikens et al., 2010). Similar results have been found with samples of early elementary-age children when examining behavior problems and cognitive skills (Neidell & Waldfogel, 2010; Thomas et al., 2011).

Peer Effects and Child Skill Level

With the present study I will extend previous research by examining how the influence of peer skill differs depending on a child's own initial skill level at preschool-entry. Few studies have considered this question in the preschool context. However, children enter preschool at different skill levels and may be differentially impacted by their peers depending on whether their skill level is high or low.

Considering children with higher skill levels, researchers have mixed hypotheses about the role of peer skill. Some researchers have raised concerns about possible spillover effects whereby highly skilled children may be negatively influenced by the less-skilled peers in their classrooms (see Fletcher, 2010). However, at least one study of children in Grades 3 through 6 found that after controlling for family and teacher characteristics related to achievement, exposure to skilled peers still positively related to more highly-skilled children's achievement growth across the school year, although less strongly than for children with average or lower skill levels (Hanushek et al., 2003). One hypothesis to explain this finding is that highly skilled children do not have as many opportunities to gain from their peers, as their level of skill may

already exceed that of many of their classmates (Cohen & Lotan, 1995; Justice et al., 2011). Other researchers hypothesize that more highly-skilled children may experience benefits from teaching their less-skilled peers. Teaching others provides children with opportunities to reinforce and think about their skills in new ways. Some research has supported this hypothesis in studies of older children (Dineen et al., 1977; Duran, 2017) as well as preschoolers (McGregor, 2000).

Considering children with lower levels of skill, some evidence suggests that children with the lowest skills may benefit the most from being in classrooms with more highly skilled peers because these children have the most to gain from their peers (Hoxby & Weingarth, 2005; Mashburn et al., 2009; Rojas et al., 2020; Webb, 1991). Interacting with more-skilled partners in one-on-one or small group settings can benefit children by providing opportunities to observe and practice skills as well as receive direct feedback. In the preschool classroom, children typically do not have many opportunities to engage in one-on-one exchanges or practice their skills individually with their teachers (see Bradley & Reinkin, 2011). In contrast, children typically spend large portions of the day engaging with their peers one-on-one and in small groups, providing opportunities for children to build skills with the support of responsive and potentially more-skilled partners.

Much of the theory behind peer effects is based on the hypothesis that children with lower skills will benefit from the presence and support of more highly-skilled peers. For example, children with higher language skills may be better equipped to explain concepts and provide feedback to their less-skilled classmates, and children with better social skills may contribute to a classroom environment where teachers can spend less time managing behavior and more time facilitating children's skill development (Henry & Rickman, 2007).

This hypothesis is in line with the large body of evidence that suggests that children who experience greater disadvantages often experience stronger positive influences from high quality preschool experiences than their more advantaged peers (e.g., Baydar & Brooks-Gunn, 1991; Burchinal et al., 1995; Mashburn, 2008; Peisner-Feinberg & Burchinal, 1997). Children who experience greater disadvantage often enter preschool with lower skills (Justice et al., 2011) and have more to gain from the support and skill-building opportunities that are available in the preschool environment. Exposure to peers with higher skills is one factor that may contribute to a higher quality preschool experience for children who enter the preschool classroom with lower skills (Choi et al., 2018).

However, preschool programs targeting low-income children typically have less variability in child skill (Justice et al., 2011). As many low-income children have lower levels of skills, such preschool programs may limit the opportunities these children have to interact with more highly skilled peers. Although this more limited peer skill variability has led to questions of whether peer effects operate in such environments, evidence collected to date suggests that peer effects still play an important role in the skill development of children attending programs that target low-income children (e.g., Justice et al., 2011; Mashburn et al., 2009).

The studies in the preschool context that have examined whether the relation between peer skill and child development depends on child skill level have primarily focused on the relation between peer and child language skills. One study found that as compared to children with less skill in understanding language, children with more skill in this area appeared to benefit more from being in a classroom with peers who had better oral language skills. The researchers argued that less skilled children may not have the skill or desire to engage with their more highly skilled peers, limiting opportunities for skill transfer (Mashburn et al., 2009). In contrast, in an

examination of overall peer language skill, peers appeared to have a greater impact on less linguistically skilled children than on their more skilled counterparts (Justice et al., 2011). These findings are better aligned with the hypothesis of the peer effects framework, which posits stronger peer effects among less-skilled children than among higher-skilled classmates. One factor that may have contributed to these differing results is sample size. Justice et al. (2011) had data on an average of 7 children per classroom whereas Mashburn et al. (2009) only had data on an average of 4 children per classroom. This difference may have contributed to better estimates of average peer skill by Justice and colleagues.

Two studies of preschoolers were found that looked beyond language development. Rojas et al. (2020) examined motor-cognitive readiness using a measure that assessed motor, language, and content knowledge. They found that children at all levels of preschool-entry engagement gained in motor-cognitive readiness when in a classroom with peers who, on average, had higher engagement levels than peers in other classrooms. However, children who entered preschool with higher engagement levels benefited the most from their peers (Rojas et al., 2020). Similarly, children with higher self-regulation skills were found to benefit more from peers' self-regulation skills than children with lower self-regulation skills (Choi et al., 2018). The researchers argued that children with higher skills may be better equipped to benefit from learning opportunities created by their peers than children with lower levels of skill (Choi et al., 2018; Rojas et al., 2020).

Although child skill level may be important in shaping the influence of preschool peers' impact on learning, the results are mixed, and mechanisms may differ depending on the specific combination of peer skill and child skill variables being examined. Additional work is needed to examine whether children with the lowest skills will benefit the most from their peers across

different developmental domains. To date, research has primarily focused on peer language skill and child language development, so little is known about the way peer language skill may relate to a child's skill in other areas. More linguistically-skilled peers are better equipped to verbally share their skills across domains with their less-skilled classmates. For example, children with better language skills may have the vocabulary to explain an activity in multiple ways to help a peer better understand. However, some skill areas, such as math, may rely on a more specialized set of skills and vocabulary that children with the lowest skills may not have. A child with low skills in certain domains may not want or be able to engage with their more linguistically-skilled peers (Mashburn et al., 2009), limiting opportunities to learn and benefit from peers in these areas.

Research on the interaction between peer skill and child initial skill in the preschool setting has also not yet considered peer social skills. Affiliation with peers with higher social skills may be particularly beneficial for children with the lowest skills in various domains. Peers with higher social skills may contribute to a classroom environment where more time can be spent on learning rather than resolving conflict and behavior management. Such an environment would create more opportunities for children with lower skills to learn from both their peers and their teachers. On the other hand, it is theorized that the gap between higher and lower skilled children widens because children with higher skills are better able to take advantage of high-quality learning experiences (see Mashburn et al., 2009). Thus, children with higher skills may be better equipped to take advantage of the learning opportunities created by more socially skilled peers, leading to more benefit for children with higher skills than for children with lower skills (Rojas et al., 2020).

The Present Study

Using data from a sample of children attending a state-funded pre-k program in rural areas of North Carolina, the present study examined the role a child's initial pre-k skill level may play when considering the relation between peer skills and child outcomes. Research has suggested that peer skill may differentially relate to a child's outcomes depending on whether the child enters preschool with a high level or low level of skill on an outcome of interest (e.g., Justice et al., 2011; Mashburn et al., 2009). However, few studies have considered this question among preschoolers, and the studies that do exist have primarily focused on peer and child language skills.

Expanding on previous work, the present study considers peer social skill along with peer expressive language skill as predictors of residualized gains in child outcomes. We looked beyond children's language gains to also consider how the interaction of peer skill and child initial skill related to literacy, math, self-regulation, and social gains. In the present study, language was defined as a child's vocabulary skills, and literacy skills encompassed the early skills children develop to support later reading, including letter-word identification, first sound fluency, and phoneme segmentation fluency. The main research question we examined was whether peer effects differ depending on a child's absolute initial skill level relative to the sample for the outcome of interest. It was hypothesized that children with low levels of skill for a given outcome in the fall of pre-k would benefit the most from exposure to classmates with higher levels of language and social skills.

Method

Sample

The present study used data from a longitudinal study of children who attended a state-funded pre-k program targeting low-income children in 6 rural counties of North Carolina. A list of all the pre-k classrooms in the counties was used to randomly select a sample of 63 classrooms. The number of classrooms recruited per county was in proportion with the number of pre-k classrooms within that county. In each classroom, parent consent forms were sent home with all children. From the returned consents, an average of six children from each classroom were randomly recruited to participate in the study. An emphasis was placed on recruiting Spanish-English dual language learners (DLLs). A total of 366 children were recruited in the fall.

To ensure children had enough peers with data in their classroom to calculate average peer skill, children were removed from the present sample if they were in a classroom with fewer than four total children with data. Nine children were removed, resulting in a final sample of 357 children. On average, data were available from 7.24 children in each classroom (*SD* = 1.97, Range = 4-15), and each classroom had an average of 16.72 children in total (*SD* = 1.86, Range = 9-18). In the final sample, 51% of the children were male and 49% were female. Considering race and ethnicity, 29% were Black, 24% were non-Hispanic White, and 42% were Hispanic/Latinx. In addition, 36% were DLLs. In the fall of pre-k, children were 4.53 years old on average (*SD* = 0.32). Additional demographic information can be found in Table 1.

To determine how the present sample compared to the classroom populations, we used available demographic information for our sample and teacher reports of demographic information for the whole classroom. We calculated the proportion of DLL children, males, Hispanic children, Black children, and White children for our sample for a given classroom. We

also created proportions based on teacher reports of the total number of children in each of these categories for a given classroom. Proportions for the present sample were correlated with the classroom total proportions for each variable. The variables were all moderately to strongly positively correlated (r = .53 to .90) suggesting that the present sample of children adequately represented the classroom populations on these examined characteristics (see Appendix A).

Table 1

Descriptive Statistics for Study Children

	N	Proportion/Mean	Std. Deviation
Child and Family Characteristics			
Child Age	357	4.53	0.32
Child Gender			
Male	175	0.49	-
Female	182	0.51	-
Race[a]			
White	159	0.55	-
Black	129	0.37	-
Other	16	0.04	-
Hispanic/Latinx	131	0.37	-
Language			
English Only	238	0.67	-
Dual Language Learner	119	0.33	-
Parental Education (in years)	355	12.41	2.40
Pre-K Classroom Quality	357	4.32	0.59
Peer Language Skill	339	100.37	9.35
Peer Social Skill	344	4.23	0.32
Fall Pre-K Assessments			
WJ AP – Math	352	389.17	28.44
WJ LW – Literacy	352	318.31	24.77
FSF – Literacy	351	2.62	6.89
PSF – Literacy	350	1.90	5.82
WJ PV - Language	351	453.20	20.09
EOW – Language	346	98.76	14.40
Social Skills	346	4.08	0.60
Self-Regulation	346	3.89	0.56
Spring Pre-K Assessments			
WJ AP – Math	427	406.61	22.10
WJ LW – Literacy	427	339.00	23.70
FSF – Literacy	428	6.31	10.02
PSF – Literacy	428	4.41	8.68
WJ PV - Language	427	459.40	17.36
EOW – Language	421	100.48	14.61
Social Skills	414	4.23	0.57
Self-Regulation	414	3.93	0.61

Note: DLL = dual language learner, WJ = Woodcock Johnson Tests of Achievement, AP = Applied Problems, LW = Letter-Word Identification, PV = Picture Vocabulary, EOW = Expressive One Word Picture Vocabulary Test;

[a]Parents were allowed to indicate more than one race, but some parents entered Hispanic or a Latin or South American country as the child's race so the tally for race is not 100%.

Procedures

Six measures were used to assess children's academic and language skills: The Woodcock Johnson (WJ) Applied Problems subtest, the WJ Letter-Word Identification subtest, the WJ Picture Vocabulary Subtest, the Expressive One-Word Picture Vocabulary Test, DIBELS First Sound Fluency, and DIBELS Phoneme Segmentation Fluency. These abilities, which were assessed by trained data collectors in the fall and spring of the pre-k year, were used to calculate initial child academic and language skill level (fall measures) and outcomes (residualized gains with spring scores as the outcome and fall skills as a predictor). One measure—the Expressive One-Word Picture Vocabulary Test —was used to assess peers' expressive language ability.

Teachers also completed surveys about each target child's social and self-regulation skills in the fall (i.e., October through December) and spring (i.e., May through June). Measures included the Student-Teacher Relationship Scale (STRS; Pianta, 2001), the Teacher-Child Rating Scale (TCRS; Hightower, 1986), and the Learning Behavior Scale (LBS; McDermott et al., 1999). From these measures, two factors were created to represent children's social skills and self-regulation. These factors were used to calculate children's initial social and self-regulation skill level and outcomes. The measure of social skills was also used to assess peers' social ability.

Children's primary caregivers provided demographic information in a survey sent home with the consent forms. Trained observers also assessed classroom quality through a one-day observation scheduled in the winter.

Measures

Child Skills

Woodcock Johnson III Tests of Achievement (WJIII). Three WJIII (Woodcock et al., 2001) subtests were used to assess children's academic skills. Children respond to items until they make a defined number of consecutive errors. The Applied Problems (WJ AP) subtest assessed children's early numeracy skills by asking children to analyze and solve math problems that rely on various math skills, such as counting and arithmetic. For example, children might view a set of different shapes and be asked to count all of the squares. The Picture Vocabulary (WJ PV) subtest measured vocabulary by requiring children to recognize and provide the correct name for different images (e.g., giraffe, comb, flower). Finally, the Letter-Word Identification (WJ LW) subtest measures early decoding literacy skills by requiring children to identify letters and read words. For example, a child might be shown a set of letters and asked to point to the letter 'a.' The WJIII has been calibrated and normed for use with people ranging from 2- to 90-years-old. The reported test-retest reliabilities range from .69 to .99. The scores used in the present analyses were standardized scores.

Expressive One-Word Picture Vocabulary Test (EOW). EOW (Brownell, 2000) was used as a norm-referenced measure of children's expressive language. Data collectors showed a series of images that children were required to label with a single word. Images could depict actions, objects, or concepts. For example, a child might be shown an image of a person running and be asked to label the action. Children's responses were scored based on a list of acceptable answers, and children continued through the test until they made a defined number of consecutive errors. Based on parent and teacher reports of children's home language, children were administered the English version of the EOW if their home language was English and the

bilingual version if their home language was Spanish. For the present analyses, standardized scores were used. Internal consistency reliability estimates for the EOW range from .94 to .98.

Dynamic Indicators of Basic Early Literacy Skills (DIBELS). DIBELS (Good & Kaminski, 2002) subtests were administered to measure basic literacy skills. First Sound Fluency (FSF) measured children's ability to recognize the sounds of letters by requiring children to provide the initial sounds of different words. For example, a data collector may read the word "shelf," and a correct answer would be providing the /sh/ sound. Phoneme Segmentation Fluency (PSF) assessed phonemic awareness by asking children to segment the sounds of different words out loud. For example, a child might hear the word 'cave' and be required to sound out the /k/, /ai/, and /v/ sounds. Both subtests were scored based on the number of correct responses a child provided over a one-minute period. The reported alternate-form reliability of FSF for a pre-k sample is 0.86 (Cummings et al., 2011) and for PSF is 0.88 (Kaminski & Good, 1996). The present study used raw scores for these subtests because benchmarks were only available for kindergarten and not pre-k at the time of data collection.

Teacher Ratings of Social Skills and Self-Regulation. In the fall and spring of pre-k, teachers completed online surveys about each study child in their classroom. The survey included three measures: the short form of the Student-Teacher Relationship Scale (STRS; Pianta, 2001), the Teacher-Child Rating Scale (TCRS; Hightower, 1986), and the Learning Behavior Scale (LBS; McDermott, et al., 1999). In the present sample, the scale scores from all three measures showed good internal consistency reliability (0.91-0.95).

The STRS measures a teacher's perceptions of their relationship with a target child. The STRS is made up of two subscales, conflict (e.g., *this child easily becomes angry with me*) and

closeness (e.g., *this child values his/her relationship with me*), and includes 15 items. The items are rated on a 5-point scale ranging from "Definitely Does Not Apply" to "Definitely Applies."

The TCRS assesses children's social skills using 38 items across seven subscales: Acting Out (e.g., *disruptive in class*), Shyness/Anxiety (e.g., *shy, timid*), learning problems (e.g., *poor work habits*), assertive social skills (e.g., *defends own views under group pressure*), task orientation (e.g., *functions well even with distraction*), frustration tolerance (e.g., *accepts imposed limits*), and peer social skills (e.g., *makes friends easily*). Each item is rated on a 5-point scale ranging from "Not at All" to "Very Well."

The LBS measures a child's classroom learning behaviors using 29 items across 4 subscales: Competence Motivation (e.g., *easily gives up on tasks*), Attitude Toward Learning (e.g., "*don't care*" *attitude to success or failure*), Attention/Persistence (e.g., *doesn't stick to tasks*), and Strategy/Flexibility (e.g., *invents silly ways to do tasks*). Each item was rated on a 3-point scale ranging from "Doesn't Apply" to "Most Often Applies."

Due to high correlation between many of the subscales across teacher-reported measures, a principal component analysis with varimax rotation was conducted to reduce the subscales to a smaller number of factors. The analysis resulted in two factors labeled social skills and self-regulation with Eigenvalues considerably greater than one. The social skills factor was made up of STRS closeness, TCRS peer social skills, and reverse scores of TCRS shyness/anxiety. The social skills factor accounted for 31-32% of the total variance in the fall and spring ratings (alpha = .79 in the fall and alpha = .74 in the spring). The self-regulation factor was made up of TCRS frustration tolerance, TCRS assertive social skills, LBS competence motivation, LBS strategy/flexibility, and reverse scores of STRS conflict and TCRS acting out. The self-regulation factor accounted for 43-44% of the total variance in the fall and spring ratings (alpha

= .91 in both the fall and spring). The scale scores of the LBS were transformed to be on the same scale as the TCRS and STRS. A mean of the scales loading on each factor was then computed.

Peer Skill

Peers' scores on the conceptually scored EOW and teacher ratings of peers' social skills (i.e., using the social skills factor as calculated in the principal components analysis) were used to create the measures of peer language skill and peer social skills, respectively. For each target child, classroom average scores on both measures were calculated based on all available data without the target child's own scores included. This procedure allowed peer skill to be included in the analyses as a child-level variable, so a child was not considered to be a peer of him- or herself.

Covariates

Children's primary caregivers reported child gender (i.e., male or female), race (a choice between White, Black or African American, American Indian or Alaska Native, Asian American or Pacific Islander, or Other), ethnicity (a yes or no question where parents indicated whether their child is of Hispanic or Latinx origin or descent), and DLL status (parents were first asked whether their child speaks Spanish at home and then were asked whether a language other than English or Spanish is spoken in the home). Due to a high level of overlap between ethnicity and DLL status (87% of Hispanic or Latinx children were also DLLs), only DLL status was included in the models. Caregivers indicated their own level of education on an eight-category scale ranging from eighth grade or less to a doctoral or professional degree.

At the classroom level, we controlled for classroom quality as measured by the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). The CLASS measures the

quality of teacher-child interactions. The CLASS includes ten dimensions that are averaged into three domain scores labeled Classroom Organization, Emotional Support, and Instructional Support. Classrooms were observed for four to six cycles of 20 minutes each. Each dimension was rated on a scale of 1 (low quality) to 7 (high quality). The present analyses controlled for a CLASS total score created by taking the average of the three domain scores for each classroom. All data collectors were required to receive certification from the measure's developer, Teachstone. About 20% of classrooms were visited by two data collectors to monitor reliability. Weighted kappas were found to range from acceptable to good (.48–.76; *M* =.65; Landis & Koch, 1977). Intra-class correlations for each domain ranged from good to excellent (.83–.97; *M* = .90; Koo & Li, 2016).

Analysis Plan

Descriptive Analyses

Table 1 provides descriptive information about the sample, covariates, peer language skill, peer social skill, and child outcomes. Correlational analyses were performed to examine the relations among the main predictors and the outcomes of interest (see Tables 2 and 3).

Inferential Analyses

Hierarchical linear models (HLMs) were used to examine whether the relation between peer skill and child outcomes depends on children's initial pre-k skill-level on the outcomes of interest. Outcomes included spring of pre-k vocabulary, literacy (i.e., letter-word identification, phoneme segmentation fluency, and first sound fluency), math, social, and self-regulation skills controlling for the child's fall skill-level. Models accounted for the nesting of children within classrooms and school districts. Continuous variables were standardized to have a mean of zero and a standard deviation of one to aid in the interpretation of results.

The primary variables of interest were peer skill, child initial skill-level on the given outcome, and the interaction between the two variables. To address the research question of whether child skill plays a role in the relation between peer skill and child outcomes, peer language skill and peer social skill were included in the models both as main effects and in interactions with child pre-k initial skill (i.e., fall scores on the outcome). The main research question was addressed with the interactions between child initial skills and peer skills by testing whether peer skills related to outcomes more strongly for children with lower initial skills.

In the HLMs, the Level 1 equation describes the child outcomes of the *i*th child in the *j*th classroom and includes peer skill and the child's initial skill-level. Additional covariates included child gender, race, and primary language, and primary caregiver level of education. The Level 1 equation also includes the residual for a given child, r_{ij}. The Level 2 equation relates the Level 1 parameters to classroom-level quality as measured by the CLASS and includes the error term for the classrooms, u_{0j}. The equations are as follows:

Level 1 (child): $Y_{ij} = \beta_{0j} + \boldsymbol{\beta_{1j}}\boldsymbol{Peer\ Language\ Skill_{ij}} + \boldsymbol{\beta_{2j}}\boldsymbol{Peer\ Social\ Skill_{ij}} + \beta_{3j}Child\ Initial\ Skill\ Level_{ij} + \boldsymbol{\beta_{4j}}\boldsymbol{Peer\ Language\ Skill\ x\ Child\ Initial\ Skill\ Level_{ij}} + \boldsymbol{\beta_{5j}}\boldsymbol{Peer\ Social\ Skill\ x\ Child\ Initial\ Skill\ Level_{ij}} + \beta_{6j}\ Child\ DLL_{ij} + \beta_{7j}\ Child\ Gender_{ij} + \beta_{8j}Child\ Race_{ij} + \beta_{9j}Parental\ Education_{ij} + r_{ij}$

Level 2 (classroom): $\beta_{0j} = \gamma_{00} + \gamma_{01}Classroom\ Quality_j + u_{0j}$

Significant interactions were probed and plotted. The relation between peer skill and child outcomes was examined by estimating the simple main effects and plotting the lines at low (-1 SD or the 25th percentile score), average (mean), and high (+1 SD) levels of child initial skill. The significance of the simple slopes of each line was examined to determine whether each line was significantly different from zero. For significant interactions, the region of significance was

used to determine the values of child skill where the relation between peer skill and the outcome changes from non-significant to significant. Overall, the goal of these analyses was to understand whether children with lower-than-average skills benefit more from peers with higher skills than children with higher-than-average skills.

Multiple Imputation

Multiple imputation was used to account for missing data. Forty datasets were imputed using the Markov chain Monte Carlo method and Rubin's approach (Rubin, 1987; Schafer, 1997). All available data were used for the imputations. Analyses were performed with each of the 40 imputed datasets and parameter estimates were combined, accounting for variability both within and between datasets.

Results

Descriptive Statistics

Descriptive information about the study children, peer skill variables, and outcomes of interest can be found in Table 1. Correlational analyses were conducted to examine the relations among the main predictors of interest and children's spring outcomes (see Tables 2 and 3). The majority of the examined child outcomes showed a modest to moderate positive correlation with one another. Considering the predictors of interest, peer expressive language skill was moderately positively correlated with children's spring language, literacy, and math outcomes. Peer social skill showed small positive correlations with the FSF, self-regulation, and social skills outcomes. Children's initial skill level for a given outcome showed moderate to strong positive correlations with that outcome.

Table 2

Correlations between Child Outcomes

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
EOW	1.00	0.20***	0.25***	0.30***	0.29***	0.37***	0.18***	0.19***
WJ PV		1.00	0.35***	0.20***	0.18***	0.54***	-0.09	0.09
WJ LW			1.00	0.35***	0.39***	0.56***	0.12*	0.14*
FSF				1.00	0.76***	0.45***	0.23***	0.27***
PSF					1.00	0.42***	0.26***	0.24***
WJ AP						1.00	0.19***	0.28***
Self-Regulation							1.00	0.69***
Social Skill								1.00

Note: * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems

Table 3

Correlations between Peer Skill, Child Initial Skill and Child Outcomes

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Peer Language Skill	0.31***	0.20***	0.18**	0.20***	0.18**	0.22***	0.07	0.04
Peer Social Skill	0.09	-0.02	0.01	0.10*	-0.01	0.03	0.22***	0.25***
Child Initial Skill	0.63***	0.83***	0.66***	0.53***	0.47***	0.74***	0.82***	0.72***

Note: * p<.05; ** p<.01; *** p<.001; Child initial skill is the child's fall score for the given outcome; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems

Inferential Analyses

HLMs were used to examine whether the relation between peer skill and child outcomes depends on children's initial pre-k skill-level on the outcomes of interest. Examined outcomes included children's spring of pre-k vocabulary, literacy (i.e., letter-word identification, first sounds fluency, and phoneme segmentation fluency), math, social, and self-regulation skills. Models account for child gender, race, and DLL status, maternal education, and overall classroom quality.

The primary variables of interest were the interactions between peer expressive language skill and child initial skill and the interactions between peer social skill and child initial skill. As shown in Table 4, the interaction between peer language skill and child initial skill was significant for English vocabulary (B = -.08, SE = .03, p = .02), letter-word identification (B = .11, SE = .04, p = .01) and phoneme segmentation fluency (B = .13, SE = .05, p = .01) skills. The interaction between peer social skill and child initial skill was only found to be significant for first sound fluency skills (B = .21, SE = .06, p = .03).

To understand how the relation between peer skill and child outcomes differed depending on children's skill level upon entry to pre-k the significant interactions were examined at low, average (i.e., mean), and high levels of child initial skill. For WJ PV and WJ LW, a low level of skill was considered to be a score 1 standard deviation below the mean and a high level of skill was considered to be a score 1 standard deviation above the mean. For FSF and PSF, the 25th percentile score was used to represent a low level of skill because a score one standard deviation below the mean was outside of the range of the data. A high level of skill for these variables continued to be represented by a score of 1 standard deviation above the mean. The regions of significance were also examined to determine the values of child initial skill level where the simple slopes for the relation between peer skill and child outcomes were significantly different from zero.

Table 4

HLMs Examining Child Initial Skill as a Moderator of Peer Language and Peer Social Skill

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Intercept	-0.01(0.11)	0.08(0.06)	-0.03(0.09)	0.2+(0.1)	0.11(0.11)	0.1(0.08)	0.07(0.07)	0.01(0.08)
Fall Pre-k Skill	0.6***(0.04)	0.75***(0.04)	0.68***(0.04)	0.63***(0.06)	0.39***(0.07)	0.74***(0.04)	0.77***(0.03)	0.69***(0.04)
Child DLL	0.11(0.11)	-0.25*(0.1)	0.16(0.12)	-0.04(0.13)	-0.14(0.14)	-0.06(0.11)	0.07(0.09)	0.18+(0.11)
Maternal Education	-0.04(0.04)	0(0.03)	0.01(0.05)	0.02(0.05)	-0.02(0.06)	-0.01(0.04)	-0.03(0.04)	0.03(0.04)
Child Gender	0.03(0.07)	0.04(0.06)	-0.1(0.08)	-0.2*(0.09)	-0.11(0.1)	-0.05(0.07)	-0.06(0.06)	-0.09(0.07)
Child Race (Black)	-0.14(0.1)	0.02(0.07)	0(0.1)	-0.09(0.11)	-0.06(0.12)	-0.17+(0.09)	-0.12(0.08)	0(0.09)
CLASS Total	0.03(0.06)	0.04(0.03)	0.12*(0.05)	0.02(0.05)	-0.04(0.05)	0.03(0.04)	0.02(0.04)	0.05(0.04)
Peer EOW	-0.13(0.08)	0.07*(0.03)	0.01(0.05)	0.09+(0.05)	0.08(0.06)	0.06(0.04)	-0.01(0.04)	0(0.04)
Peer Social	0.1+(0.05)	0.02(0.03)	-0.04(0.05)	0.02(0.05)	0.02(0.06)	0.02(0.04)	0.02(0.03)	0.07+(0.04)
Peer EOW*Child Skill	0.07(0.04)	-0.08*(0.03)	0.11**(0.04)	-0.01(0.04)	0.13*(0.05)	0.03(0.04)	-0.04(0.03)	0.02(0.03)
Peer Social*Child Skill	-0.02(0.04)	0.01(0.03)	0.04(0.04)	0.21**(0.06)	-0.02(0.07)	-0.01(0.04)	0.02(0.03)	-0.06(0.04)

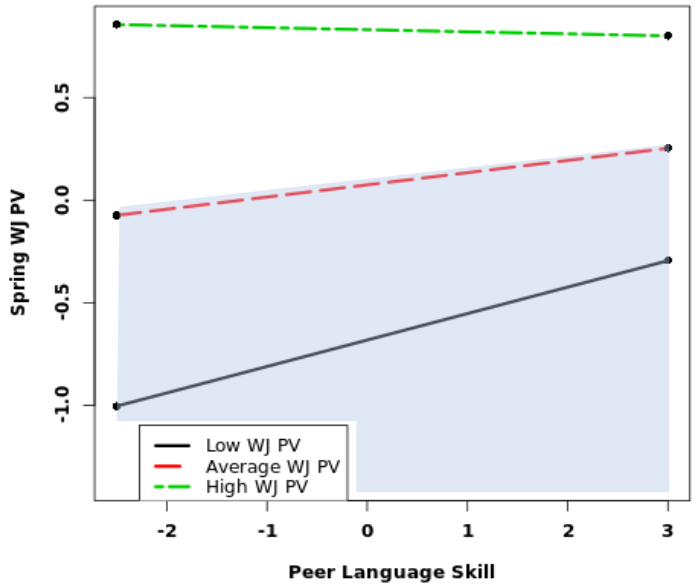
Note: + p< .10; * p<.05; ** p<.01; *** p<.001; Child initial skill is the child's fall score for the given outcome; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems; DLL = dual language learner; CLASS = Classroom Assessment Scoring System

As shown in Figure 1, children with low initial English vocabulary skills on the WJ PV appeared to benefit the most from exposure to peers with higher expressive language skills as compared to children with average and high initial levels of vocabulary skills. However, exposure to peers with higher language skills did not help children who began with low initial vocabulary skills reach the same level as their more skilled peers. In contrast, for children with high initial vocabulary skills, level of peer language skill did not appear to strongly relate to spring WJ PV scores.

An examination of the region of significance (see the shaded area of Figure 1) indicated that the simple slopes for the relation between peer language skill and spring vocabulary scores are significant below a child initial skill level of .07 SDs above the sample mean and above a child initial skill level of 4.70 SDs above the sample mean. The upper bound of the region of significance is outside of the range of the present data, and thus, is not shown in the graph. The region of significance further illustrates that children with approximately below average initial levels of vocabulary skill or lower were benefited by exposure to more highly skilled peers. This relation was stronger at lower levels of child initial skill.

Figure 1

Plotting the Region of Significance for the Interaction Between Peer Language Skill and Child Initial WJ PV Skill



Note: The simple slopes for the interaction between peer language skill and child initial skill on the WJ PV are significant within the shaded region (i.e., when child initial skill level is less than .07); WJ PV = Woodcock Johnson Picture Vocabulary; Low WJ PV indicates 1 SD below the mean, average WJ PV indicates the mean, and high WJ PV indicates 1 SD above the mean.

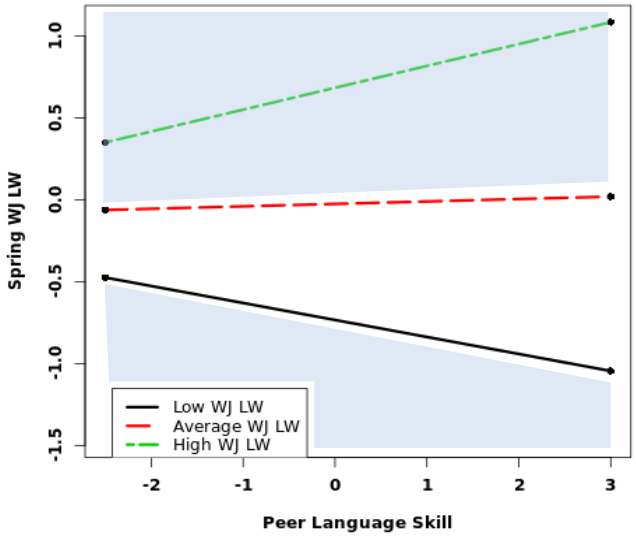
Considering children's literacy outcomes, Figure 2 shows that children with high initial letter-word identification skills on the WJ LW had higher spring letter-word identification scores when in classrooms with peers who had higher expressive language skills on average. In contrast, children who entered with low letter-word identification skills appeared to have lower spring WJ LW scores when their classmates had higher language skills. Peer language skill did not strongly relate to WJ LW scores for children entering with an average level of skill.

The region of significance (see the shaded areas of Figure 2) shows that the simple slopes for the relation between peer expressive language skill and spring letter-word identification scores are significant below a child initial skill level of -1.08 SDs below the sample mean and above a child initial skill level of 0.10 SDs above the mean. Children with initial skills less than

approximately 1 standard deviation below the mean had better WJ LW outcomes when peer skill was lower. The slope for this relation becomes steeper at lower levels of skill. In contrast, children with above average initial skills had better outcomes when peer skill was higher, and the slope for this relation becomes steeper at higher levels of child initial skill.

Figure 2

Plotting the Region of Significance for the Interaction Between Peer Language Skill and Child Initial WJ LW Skill



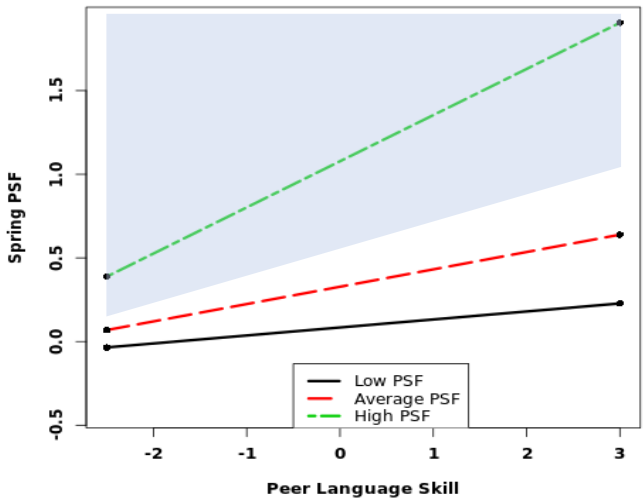
Note: The simple slopes for the interaction between peer language skill and child initial skill on the WJ LW are significant within the shaded region (i.e., when child initial skill level is less than -1.08 and above .10); WJ LW = Woodcock Johnson Letter-Word Identification; Low WJ LW indicates 1 SD below the mean, average WJ LW indicates the mean, and high WJ LW indicates 1 SD above the mean.

Similar to the WJ LW outcome, Figure 3 shows that children with high initial phoneme segmentation fluency scores on the PSF scale appeared to benefit from exposure to peers with higher expressive language skills. For children entering with average and low levels of skill, peer language skill level appeared to have a weaker positive relation with spring PSF scores. Neither of these slopes were found to be significantly different from zero.

The region of significance (see the shaded area of Figure 3) shows that the simple slopes are significant between a child initial skill level of 0.26 SDs and 19.15 SDs above the sample mean. The upper bound is outside of the range of the present data and not shown on the graph. The region of significance indicates that the phoneme segmentation fluency skills of children with approximately higher than average initial levels of skill or greater benefited from exposure to more linguistically skilled peers with the slope for this relation becoming steeper at higher levels of initial skill.

Figure 3

Plotting the Region of Significance for the Interaction Between Peer Language Skill and Child Initial PSF Skill



Note: The simple slopes for the interaction between peer language skill and child initial skill on PSF are significant within the shaded region (i.e., when child initial skill level is between 0.26 and 19.15); PSF = Phoneme Segmentation Fluency; Low PSF indicates the 25th percentile, average PSF indicates the mean, and high PSF indicates 1 SD above the mean.

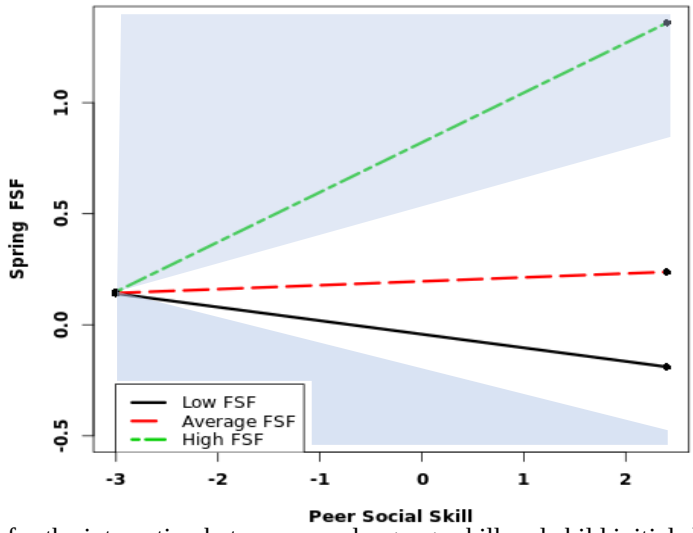
Finally, Figure 4 illustrates that children with high initial first sound fluency scores on the FSF scale appeared to have better spring outcomes when their peers had higher social skills on average. Peer social skill appeared to have little relation with spring FSF scores for children

entering with average levels of FSF skill and a slightly negative relation for children entering with low FSF skills. Neither of these slopes were found to be significantly different from zero.

Examining the region of significance (see the shaded areas of Figure 4) shows that the simple slopes for the relation between peer social skill and spring FSF scores are significant below a child initial skill level of -.69 SDs and above a value of .57 SDs. In other words, children with higher initial levels of first sound fluency skill were more benefited by exposure to more socially skilled peers. In contrast, children with lower initial levels of first sound fluency skill had better outcomes when the average level of peer social skill was lower.

Figure 4

Plotting the Region of Significance for the Interaction Between Peer Language Skill and Child Initial FSF Skill



Note: The simple slopes for the interaction between peer language skill and child initial skill on FSF are significant within the shaded region (i.e., when child initial skill level is below -0.69 and 0.57); FSF = First Segmentation Fluency; Low FSF indicates the 25th percentile, average FSF indicates the mean, and high FSF indicates 1 SD above the mean.

Follow-Up

To better visualize how different levels of peer skill related to the outcomes of children with a range of initial skill levels, we also examined graphs where peer skill was treated as the

moderator. We examined low (i.e., 1 SD below the mean), average (i.e., mean), and high (i.e., 1 SD above the mean) levels of peer skill for the significant outcomes described above.

Figure 1B illustrates how children with lower initial levels of vocabulary skill on the WJ PV appeared to have better outcomes when in classrooms with peers with high expressive language skills as compared to peers with low skills. This difference became most apparent at the lowest levels of child initial skill. The skill level of peers made less difference for children with higher initial vocabulary skills.

Figure 2B illustrates how this pattern differed for the WJ LW outcome. At higher levels of initial letter-word identification skill, children appeared to benefit more from exposure to peers with high levels of language skill. However, when child initial skill was lower, children appeared to have better outcomes when in classrooms with peers with low levels of language skill.

Figure 3B illustrates the relation for the PSF outcome. At lower levels of child initial phoneme segmentation fluency skill, peer language skill level does not appear to have a strong relation with spring PSF scores. However, at higher levels of child initial skill, children appeared to benefit more from exposure to peers with high levels of language skill as compared to peers with low levels of language skill.

Finally, Figure 4B illustrates the interaction between peer social skill and child initial first sound fluency skill. Peer social skill level did not appear to have a strong relation with spring FSF scores at lower levels of child initial skill. However, at higher levels of child initial skill, children appeared to benefit more from being in classrooms with peers with high social skills as compared to peers with low social skills.

Discussion

In the present study, we asked whether child initial skill level upon entry to pre-k plays a role in the relation between peer skill and child outcomes. We hypothesized that children with low initial levels of skill for a given outcome would benefit the most from exposure to classmates with higher skills. Overall, results indicated that child initial skill level mattered for children's language (i.e., vocabulary) and literacy (i.e., prereading) outcomes. For English vocabulary skill as measured by the WJ PV, children with lower initial vocabulary skills appeared to benefit the most from more linguistically skilled peers, supporting our hypothesis. However, as compared to children entering preschool with lower initial literacy skills, children with higher initial literacy skills appeared to benefit more from being in classrooms with peers with higher levels of language skills or social skills depending on the examined outcome.

Peer Effects and Child Vocabulary Skills

Consistent with our hypothesis, children with lower initial vocabulary skills appeared to benefit more than children with higher initial vocabulary skills from exposure to peers with better expressive language skills. These results are consistent with the findings of Justice and colleagues (2011) but contradict the earlier results of Mashburn and colleagues (2009). Justice and colleagues created a latent variable from several measures to better represent children's overall language skills while Mashburn and colleagues examined expressive language and receptive language independently, but none of the measures in either study overlapped with those used in the present study. However, similar to the Justice et al. (2011) study, the present study had data on an average of about 7 children per classroom while the Mashburn et al. (2009) study only had data available on about 4 children per classroom. As discussed previously, this may

have contributed to better estimates of average peer skill in the Justice et al. study as well as the present study.

One possible explanation for this finding is that children entering preschool with lower vocabulary skills may benefit from opportunities to listen to and practice their skills with their more verbally skilled peers. Children benefit from exposure to language that is more complex than their own (Cabell et al., 2015). Children with better expressive language skills may also contribute to changes in the peer dynamics of the classroom (Aikens et al., 2010) that are beneficial for children with lower vocabulary levels. For example, peers with better language skills may verbally communicate with their friends more during play, creating more opportunities for their less skilled classmates to learn and practice language with responsive partners. Research suggests that frequent conversations with peers are an important contributor to the development of young children's language skills (Connor et al., 2006).

Considering possible indirect pathways, in classrooms where more children have higher expressive language skills on average, teachers may use more varied and advanced vocabularies (Atkins-Burnett et al., 2017). Exposure to this more advanced language may be beneficial for less skilled children (Cabell et al., 2015), particularly if they receive appropriate scaffolding from teachers to support their word learning (Pentimonti et al., 2017). Teachers may also be able to spend more time working individually and in small groups with less verbally skilled children in classrooms where most children are already at a higher level of skill.

Importantly, we did not find evidence to indicate that children in the present sample entering with higher vocabulary skills were negatively influenced by exposure to peers with lower levels of skill. This potential negative influence is a concern that has been previously raised by researchers (see Fletcher, 2010). Rather, there appeared to be little evidence of a

relation between peer expressive language skill and vocabulary outcomes for this group of children. Children entering with higher vocabulary skills may have little to gain from other linguistically skilled peers due to already having similar or better vocabulary skills than their classmates (Cohen & Lotan, 1995; Justice et al., 2011).

Child Literacy Skills

The interaction between peer skill and child initial skill was also found to play a role in predicting children's literacy skills, which were defined as early prereading skills in the present study. Considering expressive peer language skill as the predictor of interest, our results suggested that peer language skills play a role for preschoolers' literacy outcomes. This finding aligns with research indicating that conversations during play with peers are positively related to children's early literacy skills, such as letter recognition and print awareness (Bergen & Mauer, 2000; Dickinson & Tabors, 2001; Pellegrini, 1980).

More specifically, our results indicated that children entering preschool with higher letter-word identification and phoneme segmentation fluency skills appeared to benefit more from exposure to more verbally skilled peers than children entering pre-k with lower skills in these areas. Although this finding was not consistent with our hypothesis, it is not completely surprising given existing theory. Some researchers have argued that children with higher skills may, in fact, be better equipped than less skilled children to take advantage of and benefit from high quality learning opportunities, such as interactions with other skilled classmates (Mashburn, 2008; Rojas et al., 2020). Furthermore, some researchers have argued that less skilled children may not have the ability or desire to engage with their more linguistically skilled peers (Mashburn et al., 2009).

These hypotheses may help to explain our present findings in regards to the examined literacy outcomes. Children with lower literacy skills may not engage with their more verbally skilled peers on topics or activities related to literacy, limiting opportunities to benefit from peers. For example, children with lower literacy skills may lack the basic pre-reading skills needed to successfully interact with more verbally skilled peers who are looking at and talking about a picture book together. In contrast, children with higher literacy skills may be better able to take advantage of learning opportunities created by their more verbally skilled peers to build and practice their own developing literacy skills. Children with higher language skills may also seek out peers with similar levels of skill when completing literacy activities.

It is also possible that indirect peer effects could play a role in explaining this relation. Teachers may spend more time on advanced content in classrooms with more verbally skilled children on average. This focus may be an advantage for children already entering the classroom with higher levels of literacy skill but may reduce the opportunities children entering with lower literacy skills have to catch up with their peers. For letter-word identification specifically, we found that less skilled children appeared to have better outcomes when in classrooms with less verbally skilled peers. Children in classrooms with other peers with low levels of skill may be provided access to more supports and resources at the classroom-level to support their literacy growth than would be the case if they were in classrooms with more highly skilled peers on average (Gottfried, 2015). More research is needed to replicate the present findings and determine the mechanisms that may help to explain why children entering preschool with higher literacy skills benefit more from their skilled peers.

Due to a lack of consistent evidence across the other literacy outcomes, a more difficult to explain finding is that children with higher first sound fluency skills at entry to pre-k appeared

to have better first sound fluency skills in the spring when peer social skill was higher on average. It may be the case that as compared to children entering with lower first sound fluency skills, children entering with higher first sound fluency skills are better able to take advantage of the positive learning opportunities created by more socially skilled peers to further advanced their skills (see Mashburn et al., 2009). In contrast, children entering preschool with low first sound fluency skills may need more direct support from teachers in order to build and advance their skills. Simply having more socially skilled peers may not be enough to benefit these children. However, it is important to note that none of the other literacy skills showed a similar pattern of results with peer social skill. More research is needed to determine whether this finding can be replicated or whether it was a spurious finding of the present study.

Explaining the Differing Results for Literacy and Language Outcomes

When trying to understand why our findings for literacy skills differed from our hypothesis that children with the lowest level of skill would benefit the most from their peers, it may be the case that the nature of the interaction between peer skill and child initial literacy skills changes as children's skills develop. When children's literacy skills are first emerging, which is the case for many preschoolers, skill level may not matter because children are lacking skills upon which peers can build. Children may need to reach an intermediate level of literacy skill before exposure to more skilled peers starts to make a difference. Children with the highest literacy skills in the present sample may be at this intermediate level of absolute skill and thus are able to benefit from their skilled peers or the more advanced content that teachers may present when peers are more skilled on average.

Relatedly, differences in the types of skill measured may also help to explain why our findings for children's language skills and literacy skills differed. We defined language skills

using measures of vocabulary. Children begin to develop vocabulary skills from a very early age, and these skills continue to develop throughout preschool (Suggate et al., 2018). In contrast, our measures of literacy skill encompass the early skills children need when they are beginning to learn how to read, a skill set that does not emerge until somewhat later in life and is predicted by early language skills (Dickinson et al., 2010; Suggate et al., 2018). Children who are behind their peers in terms of vocabulary development may benefit from interactions with peers to help them reach a more developmentally appropriate level. In contrast, as discussed above, children's literacy skills may not benefit from exposure to skilled peers until they reach a certain level of skill as represented by children with higher levels of skill in the present sample.

Implications

The results of the present study support the importance of understanding the interplay between peer skill and child initial skill-level in the preschool classroom. We found that children with lower vocabulary skills appeared to benefit from exposure to peers with better vocabulary skills. This finding suggests that young children with low vocabulary skills may benefit from being placed in classrooms where classmates have strong expressive language skills. This finding also supports the importance of creating opportunities for children to interact with peers with different levels of skill in the preschool classroom.

However, the relation we found was relatively small, and children with low initial skills who were in classrooms with more highly skilled peers were still behind their peers in terms of WJ PV scores in the spring of pre-k. Future research could examine whether peer effects are strengthened when teachers intentionally create opportunities for children of varying skill levels to interact and facilitate conversations between more and less linguistically skilled children. Teachers may be able to maximize positive peer influences by strategically managing peer

interactions (DeLay et al., 2016). To accomplish this successfully, teachers may need training and support to understand how to best support peer interactions in the classroom.

Some researchers have also suggested the possibility of experimentally manipulating the average skill level of classrooms through the strategic placement of children (e.g., Atkins-Burnett et al., 2017; Justice et al., 2011). Currently, preschool programs targeting low-income children typically have many children who enter the classroom with low levels of skill, limiting opportunities for these children to interact with highly skilled peers (Justice et al., 2011; Mashburn et al., 2009). If such experiments provide further evidence to indicate that less skilled children's language outcomes benefit from opportunities to interact with more linguistically skilled peers, preschool programs targeting low-income children may consider allocating slots for low-risk children who are more likely to have higher levels of skill (Atkins-Burnett et al., 2017). More research is needed to examine the potential benefits and feasibility of such a practice.

For the examined literacy outcomes, children entering with higher skills appeared to benefit the most from exposure to skilled peers. This finding suggests that although conversations with peers during play have been linked to children's literacy skills (Bergen & Mauer, 2000; Dickinson & Tabors, 2001; Pellegrini, 1980), children entering preschool with low literacy skills may need more direct support from teachers in order to catch up with their peers. Researchers may consider whether there are ways to strengthen positive peer influences for children entering preschool with lower literacy skills or whether children need to reach a certain level of literacy skill before peers can start to play a significant role in supporting future development.

For more skilled children to have a beneficial influence on less skilled children in some developmental areas, such as literacy, teachers may need to create and facilitate peer interaction opportunities based around particular skills. Unlike language skills, which children typically use while playing with one another (Bergen, 2002), children are less likely to explicitly practice literacy skills with one another unprompted. Furthermore, as discussed earlier, less skilled children may not have the skill or desire to interact with more skilled peers who are applying their literacy skills, supporting the need for teacher intervention. For example, teachers may group children of different levels of literacy skill together to look at picture books and use questions to guide the children's interactions. It may also be beneficial for teachers to create peer groups that include children with low, average, and high skills as some researchers suggest that children with average skills can help bridge the interactions between less skilled and more skilled children, possibly increasing the benefits for children with lower skills (Atkins-Burnett et al., 2017).

Limitations

Several limitations must be noted when considering the present results. First, our analyses are observational in nature. Thus, we cannot make causal conclusions about the relations between peer skill and child outcomes. Additional variables that could not be accounted for in the present analyses may have been playing a role in the present results. For example, some teachers may have been creating peer groups based on skill level or interacted with children with lower levels of skill differently from children with higher levels of skill.

In addition, data were not available on all children within a given classroom. We had teacher reports of the total number of children in each classroom by race, gender, and DLL status, and based on these characteristics, we examined correlations between the proportions in

our sample and the whole classroom proportions. On the examined characteristics, the proportions were moderately to highly positively correlated, suggesting adequate representation in our sample. However, we do not know whether children in our sample systematically differed from other peers in the classroom on other unexamined characteristics. Having data for more children per classroom would likely lead to more accurate estimates of the average skill level of peers.

There are also issues with the restricted range of child initial skill level that naturally exists within preschool classrooms. Since peer effects are experienced within classrooms, the child with the highest level of skill in the classroom cannot have peers with higher levels of skill and the child with the lowest level of skill cannot have peers with lower levels of skill. Given the somewhat limited number of children per classroom, it is difficult to know whether the most highly skilled children in the present sample would have benefited more than less skilled children from opportunities to interact with more highly skilled peers. However, even with this issue, we found evidence to suggest that children with high literacy skills did benefit more than less skilled children from opportunities to interact with peers with higher expressive language skills on average.

We also found little evidence of a relation between peer social skill and child outcomes. The present study only had teacher ratings of child social skills available. Additional measures of child social skills from different reporters or direct observations may help to better capture a child's level of social skill.

Finally, we did not have data available on the peers with whom a child spent the most time interacting. Considering the concept of direct peer effects, it is likely that children are more

strongly influenced by the peers with whom they interact the most. Future studies would benefit from observing peer interactions and tracking the peers with whom target children interact.

Conclusion

Overall, the results of the present study contribute to a growing literature that indicates that peers are an important factor to consider when studying the preschool environment. Previous research consistently finds that children tend to benefit from exposure to skilled peers (e.g., Atkins-Burnett et al. 2017; Henry & Rickman, 2007). However, the results of this and other studies (e.g., Justice et al., 2011; Mashburn et al., 2009) suggest that the role of peer skill in the preschool classroom cannot be fully understood without considering a child's own level of skill, particularly for language and literacy outcomes. More work is needed to better understand this relation and to determine how peer effects can be capitalized on to benefit children who are entering preschool classrooms with low levels of skill.

CHAPTER 3: PAPER 2 - PEER SKILL AND CHILD DUAL LANGUAGE LEARNER STATUS

Although it is recognized that preschoolers are influenced by the skill level of their peers (e.g., Henry & Rickman, 2007; Justice et al., 2011), little is known about the way peer skill may relate to the development of children from Spanish-speaking homes. The number of children from Spanish-speaking homes who are learning English along with their home language (i.e., dual language learners or DLLs) is growing in the United States (Child Trends Databank, 2019). It is important to understand the factors that contribute to the school success of these children. Many DLLs face challenges upon school entry, such as little or no support for their home language (Garcia, 2018; Palmero & Mikulski, 2014), and academic achievement gaps have been documented between DLL children and English-only (EO) children upon entry to kindergarten and beyond (Lee & Burkam, 2002; Mulligan et al., 2012). High-quality preschool has been identified as a point of early intervention for DLL children: Attending preschool can have large benefits for their school success (Yoshikawa et al., 2013). Some research has suggested that DLL children make larger gains in preschool than their EO classmates (Minervino, 2014; Puma et al., 2012).

DLL children's classmates are one potential source of information and support that could contribute to DLL's school success. Peers with higher skill levels may be able to provide support and model skills that can help DLL children advance their own development (Gamez et al., 2019). DLL children may particularly benefit from peers in terms of language development, as

DLL children typically enter preschool with lower English skills and have more to gain from their peers as compared to EO children (Hammer et al., 2014).

Accordingly, much of the research to date on the way peers may help promote DLL children's skills has focused on language development. Peers can introduce new vocabulary and model correct grammar, creating learning opportunities for DLL children. Peer interactions can also provide DLL children opportunities to practice their developing English and Spanish skills. For these reasons, researchers argue that being around more linguistically skilled peers can be beneficial for the language development of DLL children (Gamez et al., 2019), and some evidence supports this claim (e.g., Atkins-Burnett et al., 2017). Although unexplored in previous research in the preschool setting, peers with better language skills may benefit DLL children in other domains as well. For example, a peer with strong language skills may be able to more clearly explain how to do a math activity.

Peer language skills may also contribute indirectly to DLL children's development through improved language skills because many academic activities rely on the ability to use and understand language (Snow & Matthews, 2016). This potential pathway is supported by evidence documenting peers' influence on children's language development (e.g., Atkins-Burnett et al., 2017) and the link between individual language skills and development in other domains (e.g., Dickinson et al, 2010; Purpura & Ganley, 2014). The present study used a sample of children attending a state-funded pre-k program in rural areas to examine whether DLL children benefit similarly as compared to EO children from peer expressive language skill in terms of their language (i.e., vocabulary), literacy (i.e., prereading), math, social, and self-regulation development. A second aim was to test whether the target child's level of English language skill

in the spring of pre-k helped to explain the relation between peer language skill and child outcomes, particularly for DLL children.

DLL Children and the Preschool Setting

DLL children often come from lower-income families that have access to fewer educational resources and less familiarity with the U.S. education system than more advantaged families (Calderón et al., 2011; Kieffer, 2008; MPI, 2019). Many of these children are primarily exposed to a language other than English in the home and enter classrooms where English is the only or primary language spoken (Garcia, 2018; Palmero & Mikulski, 2014). Without support for their home language, these children begin school with a limited ability to understand their teacher's instructions and lessons or engage in classroom discussions. The impact of these challenges can be seen in the achievement gap between Spanish-speaking DLL children and their EO peers, particularly in terms of English vocabulary and reading skills (Halle et al., 2012; Mancilla-Martinez & Lesaux, 2011; US DHHS, 2016).

Research has suggested that attending preschool may be particularly beneficial for DLL children and can contribute to reducing the achievement gap between DLL and EO children (Buysse et al., 2013; Gormley, 2008; Phillips et al., 2017). For many DLL children, the preschool classroom is the first formal English learning environment encountered (Palmero & Mikulski, 2014). The preschool classroom also provides exposure to basic academic skills before DLL children formally enter elementary school (Palmero & Mikulski, 2014). Preschool participation has been linked to growth in English and other academic skills for Spanish-speaking children (Hammer et al., 2008). The potential benefits of preschool participation make it important to understand the factors that contribute to a successful preschool experience for DLLs.

Children can learn and practice skills through social interactions (Brostrom, 2017; Vygotsky, 1978). Research suggests that DLL children often spend more time during the preschool day interacting with their peers than with their teachers (Aukrust, 2004; Palmero et al., 2014), making peers a potentially valuable learning resource. Some researchers argue that peers may have a stronger impact on DLL children's English skills than either parents or teachers due to the large amounts of time children spend interacting with one another (Palermo et al., 2014; Rojas et al., 2016). DLL peers may also create opportunities for DLL children to practice and build their Spanish skills, which otherwise may not be possible in classrooms where none of the adults speak Spanish.

DLL Children and Peer Effects

Much of the existing research on peer effects has a theoretical basis in Vygotsky's (1978) zone of proximal development—the range between what a child can do independently and what a child can do with the help of someone more skilled. It is hypothesized that more skilled children may have a positive influence on their less skilled peers by providing support and by modeling their skills (Atkins-Burnett et al., 2017; Gersten et al., 2007). According to the peer effects framework (Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009), peer effects can be direct or indirect. Direct peer effects occur when skills transfer through peer-to-peer interaction. Indirect peer effects occur when peers' skills contribute to changes to the classroom environment. For example, if many children in a classroom have low levels of skill, a teacher may spend more time helping these children reach a level similar to that of the more-skilled children in the classroom rather than teaching more advanced content.

Due to the importance of learning English for DLL children's school success, researchers have focused on the relation between peer language and individual children's language

development (e.g., Atkins-Burnett et al., 2017; Gamez et al., 2019). Although all children may benefit from interacting with more linguistically skilled peers, it has been hypothesized that DLL children may have more to gain from peers in terms of language development than their EO classmates. Learning language requires opportunities to practice and use language with others. In preschool classrooms, teachers often speak to children in group settings with few opportunities for one-on-one interactions in which children are able to apply their language skills (see Bradley & Reinkin, 2011). Thus, many DLL children may rely on peer conversations to practice their English skills and learn new vocabulary more than EO children who often have more opportunities to use English with parents and siblings outside of the classroom. Furthermore, as DLL children often enter preschool with low English skills, they may be better able to benefit from peers than EO children who enter preschool with English skills already similar to that of many of their peers. Interacting with other DLL children may also create opportunities for DLL children to learn and practice their skills in both Spanish and English. For example, DLL children may be able to ask their DLL peers questions in Spanish to reach a better understanding of what their EO peers are saying in English (Strong, 1983).

Some research has focused on DLL children's interactions with both English- and Spanish-speaking peers. DLL children in classrooms with more English-dominant peers showed higher English vocabulary scores in the spring of preschool than DLL children in classrooms with a higher proportion of DLLs (Garcia, 2018). Similarly, exposure to a higher proportion of peer interactions in English was positively related to DLL children's letter-word identification skills and English vocabulary skills (Palmero & Mikulski, 2014; Palmero et al., 2014). Although these studies provide evidence to suggest that peer language use can influence children's

language development, they are limited in that they did not consider the role of peers' level of language skill.

Higher peer language skill is linked to benefits for individual children's language development among preschoolers (e.g., Atkins-Burnett et al. 2017; Justice et al., 2011; Mashburn et al., 2009). Such benefits may differ among DLL as compared to EO children. One study examined conceptually scored expressive vocabulary where DLL children were given credit regardless of whether they knew a word in Spanish or English (Atkins-Burnett et al., 2017). Conceptual scoring was used to better represent DLL children's overall knowledge of language because they may know a word in one language but not the other. Conceptual vocabulary development increased more among DLL children than among their EO classmates from being in classrooms with a higher level of average peer conceptual vocabulary (Atkins-Burnett et al., 2017). In a study of kindergartners, DLL children's English receptive and expressive language development was positively influenced by exposure to peers with better English language skills, but the benefits accrued by DLL children did not differ from those of EO children (Gamez et al., 2019). Overall, the limited existing research suggests that DLL children's language development can be positively influenced by their peers' language skills at least at a level similar to that of their EO classmates.

Language and Cross-Domain Effects

Although some research has shown positive relations between peer language skill and DLL children's language development, the relation between peer language and DLL children's skills in other domains remains understudied. A child's skills in one domain may positively influence development in other domains (Burchinal et al., 2020; Choi et al., 2016; McCabe & Meller, 2004; Nix et al., 2013). Peer effects may operate in a similar manner: Children who

interact with peers who are more highly skilled in one area may experience benefits in other domains as well. For example, peers who are more linguistically skilled may be able to model how to successfully solve a social conflict without aggression by discussing possible solutions. Existing evidence, although limited, supports the idea of cross-domain peer effects. For example, higher variation in peer language skills was positively related to individual children's social skills (Aikens et al., 2010), and average peer language skill was related to children's behavior problems and self-regulation (Foster et al., 2020).

Peer language skill is a promising cross-domain predictor due to the large body of evidence that has linked children's language skills to outcomes in a variety of domains. A strong language foundation is thought to be necessary to support children's learning in various areas (Burchinal et al., 2020; Pace et al. 2019). Children require strong language proficiency to comprehend classroom instruction and directions as well as express their thoughts and questions. Children's language skills have been linked to developmental progress in reading (Burchinal et al., 2020; Dickinson et al., 2010), math (LeFevre et al., 2010; Purpura & Ganley, 2014), social skills (Aro et al., 2012), and self-regulation (Vallotton & Ayoub, 2011).

Peer language skills may operate in a similar manner to predict child outcomes across domains. Peers with better language skills may be better equipped to verbally provide instruction and feedback relevant to a child's skill development in various domains. DLL children, in particular, are in a unique position to benefit both from peers with more advanced English skills and peers with more advanced Spanish skills. For example, a DLL child who does not understand a task in English may benefit from the verbal instruction and feedback of a Spanish-speaking peer. However, skill development in some academic areas, such as math, may rely on an understanding of specialized vocabulary (Monroe & Panchyshyn, 2012). Without a basic

understanding of this vocabulary, DLL children may not greatly benefit in certain skill areas from interactions with more verbally skilled peers. There is also some evidence that DLL children have better social skills than EO children (De Feyter & Winsler, 2009). In this skill area, EO children may experience more benefit from peers as they have more to gain than DLL children. One goal of the present study is to examine how DLL children benefit from the language skills of their peers as compared to EO children when considering academic, social, and self-regulation development.

Child Language Skill as a Mediator

One pathway through which peer language skill may have cross domain effects is through improvements in individual children's language development. Building from the hypothesis that DLL children's language development will benefit more than EO children's language development from exposure to higher peer language skill, it may be that DLL children experience more gains in math, literacy, social, and self-regulation development through greater language gains. Previous research has linked all of these skill areas to children's language skill (Aro et al., 2012; Burchinal et al., 2020; Dickinson et al., 2010; LeFevre et al., 2010; Purpura & Ganley, 2014; Vallotton & Ayoub, 2011). Improved language skills may help children better understand and gain more from academic instruction and also support children's self-regulation and social skills (Aro et al. 2012; Vallotton & Ayoub, 2011). Furthermore, at least one study suggests that exposure to peers with higher language skills has a stronger relation to language acquisition in DLL as compared to EO children, at least when considering conceptually scored language skills (Atkins-Burnett et al., 2017). This pathway has been previously unexplored in the preschool setting but may contribute toward explaining why preschool attendance sometimes

relates to greater gains for DLL children than for EO children (Minervino, 2014; Puma et al., 2012).

The Present Study

In the present study, I considered how peer effects may differentially relate to residualized skill gains for DLL children and EO children who attended a state-funded pre-k program in six rural North Carolina counties. Following recommendations that the vocabulary skills of DLL children should be conceptually scored (Atkins-Burnett et al., 2017; Bedore et al., 2005; deVilliers, 2015), peer expressive vocabulary skills were assessed recognizing both English and Spanish vocabulary. Using conceptually scored vocabulary is important as DLL children may learn some words in their home language and other words in English (Bialystok et al., 2010). Measuring vocabulary in only one of these languages could underestimate the skill of a child's bilingual peers (Atkins-Burnett et al., 2017).

Expanding on previous research that has primarily focused on how peers influence DLL children's language outcomes, the outcomes examined in the present study include language (i.e., English vocabulary and conceptually scored vocabulary) as well as literacy (i.e., prereading), math, self-regulation, and social skills. The main research question considered was whether DLL and EO children benefit similarly from their peers' expressive language skills or whether one group of children appears to benefit more. We also examined whether the relation between pre-k peer expressive language skills and child outcomes in the fall of kindergarten could be partially explained by children's spring of pre-k English language skills and whether findings differed for DLL and EO children. It was hypothesized that peer language skill would contribute to greater residualized gains in English vocabulary skills for DLL children, which, in turn, would relate to greater residualized gains in the examined fall of kindergarten outcomes.

Language, math, literacy, social, and self-regulation skills were chosen as the outcomes of interest. Language, math, and literacy skills were considered due to the documented academic achievement gaps between DLL and EO children and the importance of understanding factors that may help to reduce this gap (Lee & Burkam, 2002; Mulligan et al., 2012; US DHHS, 2016). The present study defined language as children's vocabulary skills and literacy as early skills that create a foundation for later reading, including letter-word identification, first sound fluency, and phoneme segmentation fluency. Social and self-regulation skills were examined because these skills are important for successfully navigating the classroom environment (McClelland & Morrison, 2003; Vallotton & Ayoub, 2011). For example, children with better social and self-regulation skills may be more likely than other children to appropriately express their desires or feelings rather than acting out in frustration (Vallotton & Ayoub, 2011).

Two key covariates included the proportion of DLL children in the classrooms and classroom quality. The proportion of DLL children was chosen as a control because more DLL peers in a classroom may decrease the number of peer interactions a DLL child has in English. Classroom quality was controlled because of the link between high quality preschool and DLL children's skill gains (e.g., Yoshikawa et al., 2013). Child skill in the fall of pre-k was also controlled to allow for an examination of residualized gains as the outcomes of interest. Other covariates included child gender and race, and parental education because of their relations to preschoolers' academic and social competence (e.g., Bassok et al., 2010; Harding et al., 2015; Matthews et al., 2009).

Method

Sample

The present study used a sample of children who attended a state-funded, pre-k program in 6 rural counties of North Carolina during the 2016-2017 schoolyear. Children attended the program for the full day (a minimum a 6.5 hours) for 10 months during the schoolyear (NC DHHS, 2020). A sample of 63 classrooms was randomly selected from a list of every classroom in the six counties. Parent consent forms were sent home with all of the children in each chosen classroom. On average, six children were randomly recruited in the fall with a special emphasis on recruiting Spanish-English DLL children. The total fall sample included 366 children (32% Spanish-English DLLs). In the spring, 89 additional children were recruited to replace children lost due to attrition and increase the number of DLL children in the sample. The final pre-k sample included 455 children.

Due to our focus on peer effects, nine children were removed from the analyses because data were available for fewer than four children in their classrooms. In addition, as the goal of the study was to examine Spanish-speaking DLLs in comparison to their EO peers, six DLLs were removed from the sample because they spoke a language other than Spanish. This left a final total pre-k sample of 440 children. Data were available on an average of 7.73 children in each classroom (*SD* = 2.36, Range = 4-15). On average, classrooms had a total of 16.71 children (*SD* = 1.88, Range = 9-18). Overall, 50.5% of the children were male and 49.5% were female. With regard to race and ethnicity, 33.7% were Black, 45.4% were White, and 44.2% were Hispanic/Latinx. In addition, 38.6% were Spanish-English DLLs. On average, children were 4.5 years old (*SD* = 0.31) in the fall of the pre-k year. Additional demographic information appears in Table 5.

We examined how our classroom samples compared to the classroom populations from which they were drawn. Teachers reported the total number of DLL children, males, Hispanic children, Black children, and White children in the study classrooms. Based on parent reported demographic information, we calculated the proportion of children falling into each of these categories for our sample for a given classroom. Correlations were then used to compare our sample proportions and the proportions for the whole classrooms. As shown in Appendix C, all of the variables were moderately to strongly positively correlated (r = .52 to .90) suggesting that our subsample was comparable to the classroom populations on the examined characteristics.

The children were followed into 186 kindergarten classrooms in 63 schools. In total, 373 of the 440 children had outcome data available in the fall of the kindergarten year. The majority of the children who were not assessed were absent, could not be located, or moved out of the study's target counties.

Table 5

Descriptive Statistics for English-Only and Spanish-English DLL Children

	English Only N = 270			Spanish-English DLLs N = 170		
	N	Proportion/ Mean	Std. Deviation	*N*	Proportion/ Mean	Std. Deviation
Child and Family Characteristics						
Child Age	270	4.53	0.31	170	4.49	0.32
Child Gender						
Male	133	0.49	-	89	0.52	-
Female	137	0.51	-	81	0.48	-
Race[a]						
White	140	0.52	-	55	0.34	-
Black	143	0.53	-	2	0.01	-
Other	11	0.04	-	5	0.03	-
Hispanic/Latinx	24	0.09	-	170	1.00	-
Parental Education (in years)	270	13.31	2.05	168	10.57	2.10
Pre-K Classroom Characteristics						
Proportion DLL	264	0.21	0.21	170	0.49	0.21
Classroom Quality	270	4.28	0.57	170	4.42	0.61
Peer Language Skill	257	99.53	10.20	164	102.15	5.31

Peer Social Skill	255	4.20	0.29	159	4.28	0.34
Fall Pre-K Assessments						
WJ AP – Math	238	398.45	22.67	114	369.80	29.58
WJ LW – Literacy	238	324.83	24.01	114	304.69	20.51
FSF – Literacy	238	3.41	7.70	113	0.97	4.36
PSF – Literacy	237	2.52	6.62	113	0.60	3.26
WJ PV - Language	238	463.98	11.21	113	430.50	22.19
EOW – Language	234	96.88	14.64	112	102.69	13.10
Social Skills	232	4.12	0.60	114	4.01	0.59
Self-Regulation	232	3.81	0.59	114	4.06	0.45
Spring Pre-K Assessments						
WJ AP – Math	260	412.73	18.16	167	397.09	24.26
WJ LW – Literacy	260	343.47	22.64	167	332.06	23.70
FSF – Literacy	260	6.91	10.44	168	5.39	9.30
PSF – Literacy	260	5.19	9.87	168	3.21	6.28
WJ PV - Language	260	468.90	8.94	167	444.61	16.96
EOW – Language	257	97.56	15.30	164	105.05	12.16
Social Skills	255	4.22	0.57	159	4.26	0.57
Self-Regulation	255	3.81	0.65	159	4.11	0.48

Note: DLL = dual language learner, WJ = Woodcock Johnson Tests of Achievement, AP = Applied Problems, LW = Letter-Word Identification, FSF = First Sound Fluency; PSF = Phoneme Segmentation Fluency; PV = Picture Vocabulary, EOW = Expressive One Word Picture Vocabulary Test.

[a]Parents were allowed to indicate more than one race, but some parents entered Hispanic or a Latin or South American country as the child's race so the tally for race is not 100%

Procedures

Children's language and academic skills were assessed using six measures: The Expressive One-Word Picture Vocabulary Test (EOW), the Woodcock Johnson (WJ) Picture Vocabulary Subtest, the WJ Letter-Word Identification subtest, the WJ Applied Problems Subtest, DIBELS First Sound Fluency, and DIBELS Phoneme Segmentation Fluency. Trained data collectors assessed children on these measures in the fall and spring of pre-k and the fall of kindergarten. Bilingual data collectors assessed children's Spanish skills. Spanish skills and English skills were assessed on different days. The EOW was used to represent EO peers' English language ability and DLL peers' bilingual language ability. Two additional measures, the WJ Picture Vocabulary subtest and the Woodcock-Muñoz Picture Vocabulary subtest, were used to represent peers' English language skills and Spanish language skills, respectively.

At each time point, teachers also completed surveys in which they rated the social and self-regulation skills of each study child in their classroom. Measures included the Student-Teacher Relationship Scale (STRS; Pianta, 2001), the Teacher-Child Rating Scale (TCRS; Hightower, 1986), and the Learning Behavior Scale (LBS; McDermott et al., 1999). Using the measures' subscale scores, two factors were created that represented social skills and self-regulation.

Demographic information was collected from the children's primary caregiver using a survey sent home with the consent forms. Teachers completed a fall survey, providing information about their classrooms. Trained data collectors also observed classroom quality in the winter of the pre-k year.

Measures

Child Skills

Expressive One-Word Picture Vocabulary Test. The Expressive One-Word Picture Vocabulary Test (EOW; Brownell, 2000) was used to assess children's expressive language during the pre-k year only. Based on teacher and parent report, children were administered the English EOW if English was their home language and a Spanish-English bilingual version of the EOW if Spanish was their home language. Children viewed images and were asked to label the object, action, or concept shown in each image with a single word. For example, a child might be shown an image of a girl eating and be asked 'what is she doing?' Children continued responding until they made a defined number of consecutive errors. Responses were scored based on a list of accepted words provided in the measure's assessment booklet. For the bilingual version, children could provide their response in either Spanish or English. EOW is a norm-referenced assessment designed to measure language in people ranging from 2- to 70-years-old. Internal consistency

reliability estimates range from .94 to .98. Standardized scores were used for the present analyses.

Woodcock Johnson III Tests of Achievement (WJ). Children's English language, literacy, and math skills were assessed in pre-k and kindergarten using the Woodcock Johnson III Tests of Achievement (Woodcock et al., 2001). To measure language skill, children were administered the Picture Vocabulary (WJ PV) subtest. WJ PV requires children to provide the correct names for a series of images (e.g., giraffe, ruler). Literacy skills were measured using the Letter-Word Identification (WJ LW) subtest. Children demonstrated their decoding skills by identifying letters and reading words out loud. For example, a child might be asked to point to the letter 'A' in a group of letters. Finally, children's early numeracy skills were assessed using the Applied Problems (WJ AP) subtest, which features math problems that require the application of various skills such as counting and addition. For example, a child might be asked to count the circles in a group of shapes. Children responded to items on each subtest until they made a defined number of consecutive errors. WJIII has been calibrated and normed for use across the lifespan with reported test-retest reliability estimates ranging from .69 to .99. The present analyses used standardized scores.

Batería III Woodcock-Muñoz (WM). The Spanish vocabulary skills of the Spanish-speaking DLL children were assessed using the Batería III Woodcock-Muñoz Picture Vocabulary (WM PV) subtest (Muñoz-Sandoval et al. , 2005). The WM PV tests vocabulary skill in the same manner as the WJ PV, but instruction and responses occur in Spanish. Research suggests that the WM PV and the WJ PV assess the same language competencies (Woodcock & Muñoz, 1993).

Dynamic Indicators of Basic Early Literacy Skills (DIBELS). The DIBELS (Good & Kaminski, 2002) Phoneme Segmentation Fluency (PSF) and First Sound Fluency (FSF) subtests were administered in pre-k and kindergarten as measures of children's literacy skills. PSF measures phonemic awareness by requiring children to segment out loud the sounds that makeup words. For example, a child might be read the word 'game' and be asked to provide the sounds /g/, /ai/, and /m/. Scores are based on the number of sounds correctly identified in one minute. The reported alternate-form reliability for pre-k children is 0.88 (Kaminski & Good, 1996). FSF measures letter-sound knowledge by requiring child to verbally identify the initial sounds of words. For example, a child might hear the word "rang" and be asked to provide the /r/ sound. Scores are again based on the number of initial sounds correctly identified in one minute. The reported alternate-form reliability for pre-k children is 0.86 (Cummings et al., 2011). Raw scores on these scales were used in the present analyses because the assessments were benchmarked for kindergarten. At the time the tests were administered, pre-k versions were not available.

Teacher Ratings of Social Skills and Self-Regulation. At each timepoint, teachers completed an online survey about each study child in their classroom. The survey included the Teacher-Child Rating Scale (TCRS, Hightower, 1986), the Learning Behavior Scale (LBS, McDermott et al., 1999), and the short form of the Student-Teacher Relationship Scale (STRS; Pianta, 2001). In the present sample, the scale scores from all three measures showed good internal consistency reliability (0.91-0.95).

The TCRS is composed of seven subscales and 38 items that assess children's social skills. Teachers rate each item on a 5-point scale from "Not at All" to "Very Well" to indicate how well each item describes the target child. The subscales include acting out (e.g., *disruptive in class*), shyness/anxiety (e.g., *shy, timid*), learning problems (e.g., *poor work habits*), assertive

social skills (e.g., *defends own views under group pressure*), task orientation (e.g., *functions well even with distraction*), frustration tolerance (e.g., *accepts imposed limits*), and peer social skills (e.g., *makes friends easily*).

The LBS measures children's classroom learning behaviors using 29 items. For each item, teachers use a 3-point scale from "Doesn't Apply" to "Most Often Applies" to indicate how well the items represent the target child. Four subscales assess Competence Motivation (e.g., *easily gives up on tasks*), Attitude Toward Learning (e.g., "*don't care*" *attitude to success or failure*), Attention/Persistence (e.g., *doesn't stick to tasks*), and Strategy/Flexibility (e.g., *invents silly ways to do tasks*).

The STRS assesses a teacher's perceptions of their relationship with a given child. The measure is made up of 15 items divided across a conflict subscale (e.g., *this child easily becomes angry with me*) and a closeness subscale (e.g., *this child values his/her relationship with me*). Teachers rate each item (1 = *Definitely Does Not Apply*; 5 = *Definitely Applies*) to characterize his or her relationship with the given child.

Because many of the subscales were highly correlated with one another, a principal component analysis with varimax rotation was performed with the goal of reducing the subscales to more precise measures of teacher-rated skills. The analysis resulted in two factors with eigenvalues substantially greater than one; the factors were labeled social skills and self-regulation. Social skills accounted for 31-32% of the total variance in the fall and spring ratings (alpha = .79 in the fall and alpha = .74 in the spring) and included STRS closeness, TCRS peer social skills, and reverse scores of TCRS shyness/anxiety. Self-regulation accounted for 43-44% of the total variance in the fall and spring ratings (alpha = .91 for both the fall and spring) and included TCRS frustration tolerance, TCRS assertive social skills, LBS competence motivation,

LBS strategy/flexibility, and reverse scores of STRS conflict and TCRS acting out. The LBS scores were transformed to be on the same scale as the STRS and TCRS. A mean of the scales loading on each factor was calculated.

Peer Skill

Peer language skill was operationalized using EOW scores. The EOW scores that each child's classmates received were averaged together with that child's score excluded from the calculation. This procedure allowed peer expressive language skill to be included in the analyses as a child-level variable, so a child was not considered to be a peer of him- or herself.

For the exploratory analyses, two additional peer language skill variables were created. First, a measure of average peer English vocabulary skill was created using scores from the WJ PV. For the DLL children, a measure of average peer Spanish vocabulary skill was created using the Batería III Woodcock-Muñoz Picture Vocabulary (WM PV) subtest (Muñoz-Sandoval et al., 2005).

Covariates

The children's primary caregivers provided information about the target children's gender (i.e., male or female), race (a choice between White, Black or African American, American Indian or Alaska Native, Asian American or Pacific Islander, or Other), ethnicity (parents selected *yes* or *no*, indicating whether their child was of Hispanic or Latinx origin or descent), and Spanish-English DLL status (parents selected *yes* or *no*, indicating whether the child spoke Spanish at home). Due to a high level of overlap between ethnicity and DLL status (88% of Hispanic or Latinx children were also DLLs), the present analyses only accounted for DLL status. Primary caregivers also provided their own level of education by responding to an item with eight categories ranging from eighth grade or less to a doctoral or professional degree.

At the classroom-level, teachers provided the total number of children in their classroom as well as the total number of DLL children. This information was used to create a variable representing the proportion of DLL children in the classroom.

Pre-k classroom quality was assessed using the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). The CLASS measures the quality of teacher-child interactions across 10 dimensions. The 10 dimensions are then averaged into three domain scores: Emotional Support, Instructional Support, and Classroom Organization. Each classroom was observed for four to six 20-minute cycles. Items are rated following each cycle on a scale from 1 (low quality) to 7 (high quality). For the present analyses, a CLASS total score was created by averaging together a given classroom's scores on each of the three domains. All data collectors were certified by Teachstone. In addition, 20% of classrooms were visited by two data collectors for reliability purposes. Weighted kappas ranged from acceptable to good (.48 to .76; *M* =.65; Landis & Koch, 1977), and on each domain, intra-class correlations ranged from good to excellent (.83 to .97; *M* = .90; Koo & Li, 2016).

Analysis Plan

Descriptive Analyses

Descriptive statistics for covariates, peer language skill, and child outcomes separated by DLL status appear in Table 5. Correlational analyses were also performed as a preliminary examination of the relations among the predictors and outcomes of interest.

Inferential Analyses

Main Research Question. Hierarchical linear models (HLMs) were used to examine whether the influence of peer language skill depended on child DLL status. Models accounted for the nesting of children in classrooms and districts. The main predictors of interest included

peer expressive language skill, child DLL status (0 = EO, 1 = DLL), and the interaction between the two variables. The examined outcomes included child language (i.e., vocabulary), math, literacy (i.e., prereading), self-regulation, and social skills in the spring of pre-k. All outcomes were assessed in English except for the bilingual version of the EOW for the DLL children. The models also controlled for child gender, race, and skill level on the outcome of interest in the fall of pre-k, primary caregiver education, the proportion of DLL children in a given classroom, and pre-k classroom quality. To aid in the interpretation of the coefficients, continuous variables were standardized to have a mean of zero and a standard deviation of one.

For the HLMs, the Level 1 equation describes the outcomes of the *i*th child in the *j*th classroom and includes the child-level variables and each child's residual value, r_{ij}. The Level 2 equation relates the Level 1 parameters to the classroom-level variables and includes a given classroom's error term, u_{0j}. The equations are as shown:

Level 1 (child): $Y_{ij} = \beta_{0j} + \mathbf{\beta_{1j}}\boldsymbol{Peer\ Language\ Skill_{ij}} + \beta_{2j}\,Child\ DLL_{ij} + \mathbf{\beta_{3j}}\boldsymbol{Peer\ Language\ Skill\ x\ Child\ DLL_{ij}} + \beta_{4j}Child\ Gender_{ij} + \beta_{5j}Child\ Race_{ij} + \beta_{6j}Child\ Entry\ Skill\ Level_{ij} + \beta_{7j}Parental\ Education_{ij} + r_{ij}$

Level 2 (classroom): $\beta_{0j} = \gamma_{00} + \gamma_{01}Classroom\ Quality_{j} + \gamma_{02}Proportion\ DLL\ in\ Class_{j} + u_{0j}$

Significant peer language skill by DLL status interactions were probed and plotted to examine how the relation differed for DLL children and EO children. Simple main effects were estimated and the lines for EO children and DLL children were plotted on the same graph. The simple slopes of each line were examined to determine whether they were significantly different from zero.

Exploratory Analyses. Exploratory analyses were performed to examine whether the results related to the main research question differed depending on the type of peer language skill variable used. The primary analysis was conducted using the EOW, a conceptually scored measure of expressive language in which bilingual children were given credit whether they knew a word in English or Spanish. However, such an approach could obscure a child's skill level in each individual language. For the follow-up analyses, peer language skill variables were created using the WJ PV, a measure of English vocabulary skill, and the WM PV, a measure of Spanish vocabulary skill. Analyses using the WM PV as a measure of peer Spanish language skill were conducted in a subsample of 145 DLL children who were in a pre-k classroom with at least one other DLL peer with available data.

Analyses were also conducted to examine whether child English language skill as measured by the WJ PV in the spring of pre-k mediates the relation between the peer language skill by DLL status interaction and child outcomes in the fall of kindergarten. If the path from the interaction to child language skill and the path from child language skill to child outcomes were both significant for a given outcome, the Sobel test was used to test mediation.

Multiple Imputation. Missing data were addressed using multiple imputation. Using all available data, forty complete datasets were imputed using the Markov chain Monte Carlo Method and Rubin's approach (Rubin, 1987; Schafer, 1997). Analyses were then performed with the 40 complete datasets. Final results were obtained by taking the average of the resulting 40 sets of parameter estimates and computing standard errors that accounted for variability both within and between the datasets.

Results

Descriptive Analyses

Descriptive information about the study children, predictors of interest, covariates, and child outcomes by DLL status can be found in Table 5. Tables 6 and 7 present correlations between each of the spring of pre-k child outcomes and between the spring of pre-k child outcomes and peer language skill, respectively. In general, the spring of pre-k outcomes showed a modest to moderate positive correlation with one another for both EO and DLL children. Peer language skill was modestly to moderately positively correlated with all outcomes for EO children. For DLL children, peer language skill was modestly positively correlated with English vocabulary scores and modestly to moderately negatively correlated with letter-word identification, first sound fluency, and social skills.

Table 6

Correlations between Spring of Pre-K Child Outcomes for EO and DLL Children

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
EOW	1.00	0.61***	0.39***	0.39***	0.36***	0.59***	0.18**	0.23***
WJ PV	0.36***	1.00	0.33***	0.20**	0.18**	0.52***	0.21***	0.23***
WJ LW	0.08	0.30***	1.00	0.32***	0.38***	0.48***	0.24***	0.23***
FSF	0.20**	0.23**	0.30***	1.00	0.76***	0.45***	0.26***	0.29***
PSF	0.13	0.15	0.25**	0.78***	1.00	0.42***	0.29***	0.29***
WJ AP	0.29***	0.44***	0.50***	0.39***	0.31***	1.00	0.30***	0.31***
Self-Regulation	0.07	0.07	0.14	0.25**	0.24**	0.36***	1.00	0.75***
Social Skill	0.14	0.18*	0.08	0.19*	0.09	0.42***	0.67***	1.00

Note: * p<.05; ** p<.01; *** p<.001; Correlations for EO children are shown above the diagonal and correlations for DLL children are shown below the diagonal; EO = English only; DLL = dual language learner; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems

Table 7

Relations between Peer Skill and Child Spring of Pre-K Outcomes by DLL Status

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Peer Language Skill								
EO Children	0.43***	0.13*	0.17**	0.28***	0.22***	0.22***	0.14*	0.14*
DLL Children	0.01	0.16*	-0.14*	-0.11	0.02	-0.01	-0.11	-0.23**

Note: * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems

Inferential Analyses

HLMs were used to examine the main research question of whether child DLL status moderates the relation between peer expressive language skill and child outcomes. Examined outcomes included children's language (i.e., vocabulary), literacy (i.e., prereading), math, self-regulation, and social skills in the spring of pre-k. Models accounted for child gender and race, maternal education, classroom quality, and the proportion of DLL children in the classroom.

To address our research question, we considered the interaction between peer language skill and child DLL status. Table 8 shows that the interaction was significant for children's spring of pre-k EOW (B = -.21, SE = .10, p = .04), WJ PV (B = .17, SE = .07, p = .02), and FSF (B = -.27, SE = .11, p = .01) skills. The significant interactions were probed and plotted to examine how the relation between peer language skill and the given outcome differed for DLL children and EO children.

Table 8

HLMs Examining Child DLL Status as a Moderator of Peer Language Skill

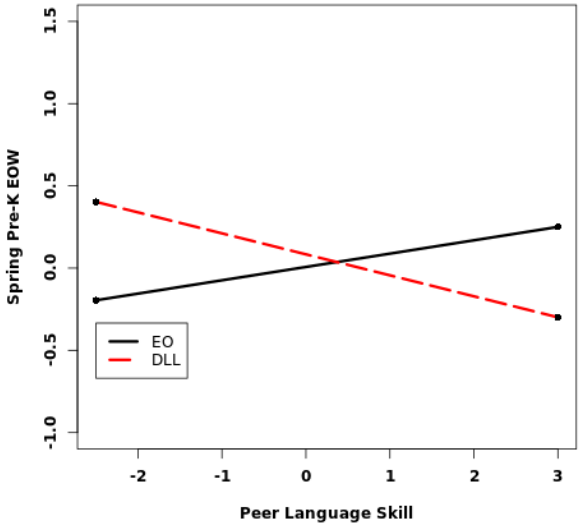
	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Intercept	0.01(0.11)	0.11+(0.06)	0.02(0.09)	0.18+(0.1)	0.14(0.1)	0.1(0.08)	0.02(0.07)	-0.06(0.08)
Fall Pre-K Skill	0.58***(0.04)	0.79***(0.04)	0.65***(0.04)	0.5***(0.05)	0.41***(0.05)	0.74***(0.04)	0.79***(0.03)	0.71***(0.04)
Child DLL	0.08(0.12)	-0.23*(0.1)	0.09(0.11)	-0.02(0.13)	-0.11(0.14)	-0.04(0.11)	0.08(0.09)	0.19+(0.1)
Maternal Education	-0.05(0.04)	0.01(0.03)	0.04(0.05)	0.03(0.05)	0(0.05)	0.01(0.04)	-0.04(0.04)	0.04(0.04)
Child Gender	0.02(0.07)	0.02(0.05)	-0.14+(0.07)	-0.21*(0.08)	-0.13(0.09)	-0.05(0.07)	-0.01(0.06)	-0.07(0.07)
Child Race (Black)	-0.18+(0.09)	0.01(0.07)	0.05(0.1)	-0.18(0.11)	-0.11(0.12)	-0.18*(0.09)	-0.07(0.08)	0.07(0.09)
Proportion DLL	0.07(0.12)	0.08*(0.04)	0.07(0.06)	0.01(0.07)	0(0.06)	0.01(0.05)	0(0.04)	0.07(0.05)
CLASS Total	0(0.05)	0.02(0.03)	0.09*(0.05)	-0.02(0.05)	-0.04(0.05)	0.01(0.04)	0.02(0.03)	0.06(0.04)
Peer EOW	0.08(0.26)	0.02(0.03)	0.05(0.05)	0.14*(0.06)	0.14*(0.06)	0.07(0.04)	-0.01(0.04)	0.07+(0.04)
Peer EOW*DLL Status	-0.21*(0.1)	0.17*(0.07)	-0.18+(0.1)	-0.27*(0.11)	-0.19+(0.11)	-0.11(0.09)	0.01(0.08)	-0.11(0.09)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems; DLL = dual language learner, CLASS = Classroom Assessment Scoring System

First, we considered vocabulary skills as measured using the EOW (see Figure 5). On this measure, DLL children could provide a correct response in either Spanish or English. EO children appeared to show some benefit from exposure to peers with higher language skills. In contrast, DLL children had somewhat lower residualized gains in vocabulary scores when peer language skill was higher. The pattern was different for the WJ PV, which measured the English vocabulary skills of both EO and DLL children (see Figure 6). Probing the interaction indicated that DLL children had greater residualized gains in English vocabulary scores when in classrooms with more skilled peers. On the other hand, peer language skill was not found to be related to residualized gains in English vocabulary skills for the EO children.

Figure 5

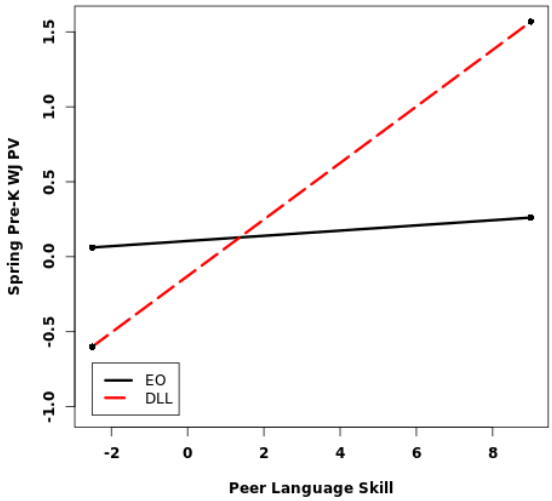
Plotting the Interaction Between Peer Language Skill and Child DLL Status Predicting Residualized Gains in Pre-K EOW Scores



Note: EOW = Expressive One Word Picture Vocabulary, EO = English only, DLL = dual language learner

Figure 6

Plotting the Interaction Between Peer Language Skill and Child DLL Status Predicting Residualized Gains in Pre-K WJ PV Scores

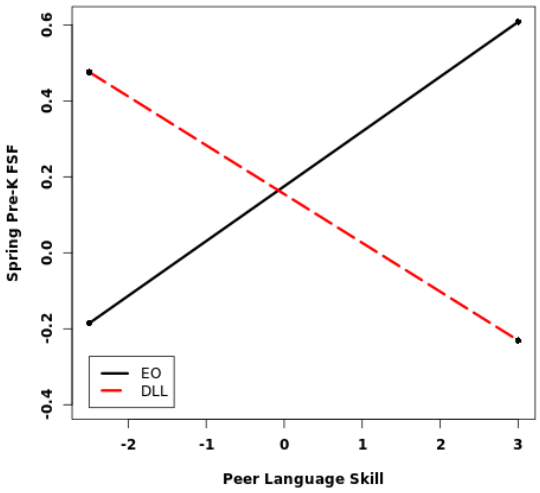


Note: WJ PV = Woodcock Johnson Picture Vocabulary, EO = English only, DLL = dual language learner

Looking at the literacy outcomes, EO children appeared to have greater gains in first sound fluency scores when peer language skill was higher on average (see Figure 7). In comparison, DLL children appeared to have greater residualized gains in first sound fluency scores when peer language skill was lower. Although only marginally significant, the interaction for letter word identification (B = -.18, SE = .10, p = .06) and phoneme segmentation fluency (B = -.19 SE = .11, p = .09), the two other examined literacy outcomes, trended toward a similar pattern; EO children had better outcomes when peer language skill was higher while DLL children had better outcomes when peer language skill was lower.

Figure 7

Plotting the Interaction Between Peer Language Skill and Child DLL Status Predicting Residualized Gains in Pre-K FSF Scores



Note: FSF = First Sound Fluency, EO = English only; DLL = dual language learner

Exploratory Analyses

Peer Skill Measured Using the WJ PV and WM PV

Our first set of exploratory analyses involved examining peer English language skill using the WJ PV and peer Spanish language skill using the WM PV as the predictors of interest in separate models. These analyses were conducted because the EOW may not fully represent the skill level of DLL peers in each individual language. Peer WJ PV skill was interacted with DLL status to predict outcomes for all children in the sample. Peer WM PV was only used to predict the outcomes of the subset of 145 DLL children who were in classrooms where at least 2 DLL children had available data.

Considering peer English language skill as measured by the WJ PV (see Table 1D), the interaction between peer skill and DLL status was significant for spring of pre-k EOW (B = -.17, SE = .09, p = .048) and WJ LW scores (B = -.18, SE = .09, p = .03). These two significant interactions were probed and plotted, and the results were found to be similar as compared to

when peer EOW was used as the predictor of interest. Figure 1D shows that for the EOW outcome, EO children had greater residualized gains in vocabulary during the pre-k year when exposed to peers with higher English language skills. In contrast, DLL children had smaller residualized gains in vocabulary when peer English language skill was higher. The relation for WJ LW is shown in Figure 2D. DLL children had smaller residualized gains in letter word identification when peer English language skill was higher. Peer English language skill was not found to relate to residualized gains in letter word identification skills for the EO children.

Peer Spanish language skill as measured by the WM PV was then examined as the predictor of interest for the subsample of DLL children (see Table 1E). Peer Spanish language skill was not found to be a significant predictor of any of the examined outcomes.

Child Language Skill as a Mediator

The second set of exploratory analyses involved examining child English language skill in the spring of pre-k as a mediator of the relation between peer expressive language skill and child outcomes in the fall of kindergarten for DLL and EO children. Child English language skill was measured using the WJ PV. The path from peer language skill to child language skill was estimated separately for the DLL and EO children (see Table 9). Mediation analyses were not conducted with the EOW as the outcome because this measure was not collected in kindergarten. Self-regulation and social skills also were not examined because there was no evidence of mediation in the initial path analyses.

For DLL children, peer language skills positively predicted spring of pre-k English vocabulary scores (B = 0.19, SE = .07, p = .01). In addition, spring English vocabulary skills predicted better scores in the fall of kindergarten for all children on the WJ PV (B = .50, SE = .06, p < .001), WJ LW (B = .17, SE = .06, p = .005), FSF (B = .23, SE = .07, p < .001), PSF (B =

.29, *SE* = .07, *p* < .001), and WJ AP (*B* = .22, *SE* = .07, *p* = .001). A test of mediation indicated that DLL children's English language skills in the spring of pre-k helped to explain the relation between peer language skill and several outcomes in the fall of kindergarten: English vocabulary (*B* = 2.65, *SE* = 0.04, *p* = .01), letter word identification (*B* = 1.99, *SE* = .02, *p* = .047), first sound fluency (*B* = 2.13, *SE* = .02, *p* = .03), phoneme segmentation fluency (*B* = 2.31, *SE* = .02, *p* = .02), and applied problems (*B* = 2.09, *SE* = .02, *p* = .04). For DLL children, having more verbally skilled peers predicted better English vocabulary skills in the spring of pre-k, which, in turn, predicted better language, literacy, and math outcomes upon entry to kindergarten.

For EO children, the relation between peer language and spring of pre-k English vocabulary skills was non-significant (*B* = 0.02, *SE* = .03, *p* = .57). A test of mediation indicated that the indirect path from peer language skill to child kindergarten outcomes through English vocabulary skill in the spring of pre-k was weaker and non-significant (*p* > .05) for EO children as compared to the results for the DLL children. In other words, no evidence was found to suggest that English language skill in the spring of pre-k helped to explain a relation between peer expressive language skill and child outcomes in the fall of kindergarten for the EO children.

Table 9

Examining Spring of Pre-K English Language Skill as a Mediator of the Relation Between Peer Language Skill and Child Outcomes in the Fall of Kindergarten for EO and DLL Children

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
	Not Administered	*Indirect Path B (SE)*	*Indirect Path B (SE)*	*Indirect Path B (SE)*	*Indirect Path B (SE)*	*Indirect Path B (SE)*	*Indirect Path B (SE)*	*Indirect Path B (SE)*
Indirect Path: Peer Language Skill ➔ Spring Pre-K EOW ➔ Fall K Outcomes								
EO	-	0.56(0.01)	0.55(0.01)	0.55(0.01)	0.56(0.01)	0.55(0.01)	-	-
DLL	-	2.65**(0.04)	1.99*(0.02)	2.13*(0.02)	2.31*(0.02)	2.09*(0.02)	-	-

Note: * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems, DLL = dual language learner, EO = English-only; EOW was not measured in the fall of kindergarten and thus was excluded from the mediation analyses

Discussion

In the present study, we explored whether child DLL status plays a role in the relation between peer expressive language skill and child outcomes. Our goal was to determine whether DLL and EO children benefit similarly from their peers or whether one group of children appears to benefit more. Overall, results regarding the group of children who benefited more from their peers were mixed. Perhaps most importantly when considering English language skill as measured by the WJ PV, DLL children appeared to benefit more than EO children from exposure to more verbally skilled peers. Follow-up mediation analyses indicated that child English language skill in the spring of pre-k helped to explain the relation between peer language skill and DLL children's language (i.e., vocabulary), literacy (i.e., prereading), and math outcomes in the fall of kindergarten.

Peer Language Skill Predicting Outcomes for DLL and EO Children

For the WJ PV, a measure of English vocabulary, DLL children appeared to benefit when peer expressive language skill was higher. In contrast, peer language skill did not have a strong relation with EO children's English vocabulary scores. These results are similar to the study conducted by Atkins-Burnett and colleagues (2017) who found that DLL children showed greater vocabulary gains than EO children when peer language skill was higher on average (Atkins-Burnett et al., 2017).

One possible explanation for the present findings is that DLL children may have had more to gain from their peers in terms of English vocabulary than their EO peers (Hammer et al., 2014). Peer interactions create opportunities for children to learn and practice their developing English skills with responsive partners (Gamez et al., 2019). DLL children in particular may rely more on peer interactions to learn basic English vocabulary than EO children due to having

fewer opportunities to interact in English outside of the context of peer interactions. In contrast, EO children typically have more opportunities to learn English outside of the classroom through interactions with family members. Consistent with this hypothesis, EO children in the present sample had significantly higher English vocabulary scores on average in the fall of pre-k than their DLL peers (see Table 5).

The WJ PV measure also focuses on children's ability to label nouns. DLL children's ability to learn from their peers and add English nouns to their vocabularies may have been supported by visual cues in the classroom, such as toys and picture books. For example, a peer may provide the English words for different animals while playing with farm animal toys, allowing a DLL child to connect the label with a visual reference. Research suggests that the word learning of DLL children can be supported through the use of nonverbal information, such as pictures or gestures (Rowe et al., 2013).

The measure of peer language skill also captured both the Spanish and English skill of DLL children's bilingual peers. Thus, it is also possible that having peers more skilled in Spanish is beneficial for DLL children as DLL peers with stronger Spanish language skills may be able to use Spanish to explain the meaning of an English word to DLL peers with lower English skills (Strong, 1983). We did not find evidence to support this explanation in our follow-up analyses using peer Spanish language skill as a predictor. However, we had a small DLL peer sample in the present study, which may have limited the accuracy of the average estimates of peer Spanish language skill.

Considering possible indirect effects, teachers may have been able to spend more time supporting the English development of DLL children in classrooms where the other children already had stronger language skills on average. Teachers may also have conversed more and

used more varied and advanced language in classrooms where children had stronger language skills, creating opportunities for DLL children to be exposed to a wider English vocabulary. Research suggests that DLL children may benefit from exposure to more sophisticated vocabulary and discussions that are extended and intellectually challenging, particularly when they receive appropriate scaffolding from their teachers (Castro et al., 2011; Dickinson et al., 2009).

For the EOW measure, which allowed DLL children to respond in either Spanish or English, the results differed such that EO children's vocabulary appeared to benefit from more verbally skilled peers while DLL children had better vocabulary outcomes when in classrooms with less verbally skilled peers. These results contradict a previous study conducted by Atkins-Burnett and colleagues (Atkins-Burnett et al., 2017) and are inconsistent with results of this study that showed greater WJ PV gains among DLL children than among EO children. In the present sample, children's EOW and WJ PV scores were not strongly correlated, so it is not completely surprising that the pattern of results differed across the two measures. In follow-up analyses using peer English language skill as the predictor, the same pattern of results was found for DLL and EO children on the EOW, suggesting that peer English language skill specifically is likely playing a role in this relation.

One possible explanation for these differing results is that EO children may have had more to gain from their peers' English skills on the types of vocabulary assessed by the EOW as compared to the WJ PV. While the WJ PV focuses exclusively on nouns for individual objects, the EOW also includes questions about verbs and superordinate nouns (i.e., nouns referring to a class or category of things). For example, a child might be shown a picture of a girl swimming and be asked "what is she doing?" or different articles of clothing and be asked "what one word

names all of these?" Research suggests that verbs are more difficult for children to learn than nouns (see McDonough et al., 2012). In addition, when learning new words, children are more likely to understand a noun as referring to individual objects rather than groups of objects and rely on cues to understand when a word is referring to a category of things (Bloom & Kelemen, 1995; Bloom & Markson, 1998; Waxman & Gelman, 1986). Understanding and using superordinate nouns is also considered more cognitively complex than learning basic nouns for individual objects (Gershkoff-Stowe et al., 1997). While EO children may not have as much to gain from peers as DLL children on the vocabulary skills measured by the WJ PV, at least some EO children may still be able to learn from peers who are at a more advanced level on some of the more complex skills captured by the EOW. In contrast, for DLL children who are still building their basic English vocabulary, peers may not provide enough scaffolding to support DLL children's learning of these more complex words.

Considering possible indirect effects, DLL children may have received more of the support they need to learn some of the more complex vocabulary covered by the EOW when in classrooms with less verbally skilled peers. Researchers have suggested that children in classrooms with lower average levels of peer skill may receive access to more resources and support at the classroom-level than would be the case in classrooms with a higher average level of peer skill (Gottfried, 2015). Including classroom quality in the models may have accounted for some of this effect, but the CLASS does not necessarily capture a child's individual experiences with teachers or the classroom resources and services a child may be able to access.

The differing ways DLL children were able to respond across the two measures may also help to explain the results. On the WJ PV, DLL children could show improvements either by learning the English word for a word they already know in Spanish or by learning the English

word for a word they did not know in either language. Interactions with more verbally skilled peers could help support both forms of word learning, contributing to better outcomes on the WJ PV when DLL children were in classrooms with more verbally skilled peers. In contrast, on the EOW, DLL children could respond in either English or Spanish, meaning DLL children may only show growth by learning entirely new words through direct or indirect peer effects. As some of the words on the EOW may be more difficult to learn as described above, DLL children with less English skill may not have the level of skill needed to gain as much from their peers as their EO classmates on the skills covered by the EOW. DLL children may also have had few opportunities to gain these skills in Spanish from their Spanish-speaking peers if they were in classrooms where it is expected or encouraged for children to speak primarily in English. Many preschool programs lack supports for DLL children's home language (Raikes et al., 2019).

Considering children's literacy skills, for the first sound fluency outcome, DLL children appeared to have better outcomes when in classrooms with less verbally skilled peers while EO children had better outcomes when in classrooms with more skilled peers. In the main analyses, the other measures of literacy, phoneme segmentation fluency and letter word identification, trended toward a similar pattern. In follow-up analyses where peer English language skill was examined as a predictor, DLL children also appeared to have better letter word identification outcomes when in classrooms with less verbally skilled peers as compared to more verbally skilled peers.

As DLL children often enter preschool with lower English skills than their EO peers (Hammer et al., 2014), it is possible that DLL children lacked the language skills necessary to engage with their more verbally skilled peers in literacy-related activities. Some researchers have argued that children with lower skills in certain areas may not have the ability or desire to engage

with peers with higher language skills (Mashburn et al., 2009), which would limit opportunities for children to benefit from direct peer effects. The frequency in which children engaged in literacy-related activities with their peers may have also been too low for DLL children to directly benefit from their peers.

Furthermore, in the present sample, EO children entered the preschool classrooms with higher literacy skills on average as compared to DLL children. EO children may be at a point in their literacy development where exposure to skilled peers has greater benefits. DLL children may rely more on teacher and parent support than on peer support to reach a similar level of literacy skill. It is possible that exposure to skilled peers may be beneficial for DLL children when they reach a higher level of literacy development.

Indirect peer effects may help to explain why DLL children had better outcomes when in classrooms with less verbally skilled peers. As discussed, classrooms with a greater number of students with a lower level of skill may receive access to more resources and services than classrooms with more skilled children on average (Gottfried, 2015; Hanushek et al., 2002). DLL children with low English skills who are unable to directly benefit from their more skilled peers may need this extra classroom-level support to advance their literacy skills. Having more supports available may, in turn, contribute to teachers having more time to interact with DLL students (Gottfried, 2015) and support their literacy skill development. More work is needed to replicate the present findings for literacy outcomes and to examine possible mechanisms to help explain the role of peers for DLL and EO children.

Child Language Skill as a Mediator

Child language skill in the spring of pre-k helped to explain the link between pre-k peer language skill and children's language, literacy, and math skills at entry to kindergarten. For

DLL children, being around more verbally skilled peers was related to better English vocabulary scores in the spring of pre-k. Better English scores were, in turn, linked to higher kindergarten entry scores. Although in a positive direction, this indirect path to kindergarten outcomes was weaker and non-significant for EO children because peer skill did not play a strong role in predicting EO children's English vocabulary scores on the WJ PV.

Consistent with these findings, previous research has linked children's language skills to later math, literacy, and language skills (e.g., Burchinal et al., 2020; Purpura & Ganley, 2014). Building language skills through exposure to more advanced peers may help DLL children gain more from their experiences in school more broadly as much of academic instruction relies on the ability to use and understand language (Snow & Matthew, 2016). Learning English is particularly important for supporting DLL children's developmental outcomes as many DLL children attend schools where English is the primary language spoken and receive little or no support for their home language (Garcia, 2018; Palmero & Mikulski, 2014). Future work should be conducted to determine whether evidence of this mediational pathway can be found in other samples of DLL children.

Implications

We found evidence to suggest that exposure to more linguistically skilled peers is beneficial for DLL children's English vocabulary development. This finding supports the importance of creating opportunities for DLL children to verbally interact with their peers in the preschool classroom. Some researchers have suggested that DLL children with low English skills could benefit from being paired with peers with more developed English skills for play and academic activities (Atkins-Burnett et al., 2017; Gersten et al., 2007). Such peers could act as models to further support DLL children's English acquisition. Teachers may also play a role in

supporting positive peer interactions by encouraging or guiding conversations. Research suggests that teachers can help maximize positive peer influences by strategically managing peer interactions (DeLay et al., 2016). Training may be necessary to help teachers learn the strategies needed to best facilitate interactions between DLL children with low English skills and their peers with higher English skills in order to maximize possible benefits.

As our measures focused on children's understanding of vocabulary, and nouns primarily, more work is also needed to examine whether peers can benefit other areas of DLL children's English language development. It may be the case that DLL children require more direct support from teachers or opportunities to engage in specific types of activities with peers in order to advance their English language development in other areas.

The importance of encouraging peer language interactions is further supported by our findings that positive peer influences on children's language development may go on to benefit DLL children's academic skills in kindergarten. This finding suggests that the peers a child interacts with early in life may have at least somewhat lasting influences on children's skill development through their language skills. Whether peers can play a meaningful role in reducing achievement gaps between DLL and EO children is an area for continued research (Halle et al., 2012; Mancilla-Martinez & Lesaux, 2011). More work is needed to continue to examine how the interplay between peer influence and child language skills relates to DLL children's academic development in preschool and early elementary school.

For the examined literacy outcomes, we found that DLL children appeared to have better outcomes in classrooms where peer language skill was lower. We also did not find evidence of a relation between peer language skill and either DLL or EO children's math, self-regulation, or social skills in the present sample. Future research could consider whether peer-focused

interventions may promote a link between more verbally skilled peers and child development in these areas. For example, teachers might spend more time facilitating math and literacy activities where children with different levels of language skill are required to work together to complete a task. As discussed earlier, pairing DLL children with low English skills with a peer with stronger English skills may be beneficial for DLL children's English language development (Atkins-Burnett et al., 2017; Gersten et al., 2007), but benefits may extend into other domains as well with additional teacher supports and opportunities to engage in certain activities with peers. Future research could examine whether DLL and EO children benefit from such intervention efforts where a more deliberate effort is made to capitalize on positive peer influences.

Limitations

One limitation of the present study is that our analyses are observational. Thus, we cannot make causal conclusions about the relations between peer skill and outcomes for DLL and EO children. Although our models included multiple controls, other variables that could not be accounted for may be contributing to the present effects. For example, teachers may interact differently with EO and DLL children and create different learning experiences for these two groups of children.

We also did not have data for all peers in a given classroom, which may have contributed to a less accurate understanding of the average level of peer language skill a child is exposed to in the classroom. The children we recruited may have also differed from the peers we did not recruit in systematic ways. Teachers reported on the total number of children falling into different gender, racial, and DLL status categories, so we were able to examine correlations between overall classroom proportions and proportions in our sample based on these characteristics. All of the variables were moderately to highly positively correlated, suggesting

that we had good representation on these characteristics. However, peers in our sample may have differed from other children in the classroom based on unexamined characteristics. Future research may benefit from increasing the number of children recruited per classroom to create a more accurate understanding of average peer skill level.

Relatedly, our ability to test the relation between peer Spanish skill and DLL children's outcomes was also limited due to a small sample size. We had data on an average of about four DLL children per classroom, which may have also limited our ability to estimate the average Spanish ability level of DLL peers. These factors may have contributed to the lack of significant findings when peer WM PV skill was examined as the predictor of interest. Spanish-speaking peers may also contribute more to DLL children's Spanish outcomes, which were not examined in the present study, in comparison to their English outcomes. Future research may aim to collect data on more DLL children per classroom in schools with large numbers of DLL students to better understand the role of DLL and EO peer skill in predicting DLL children's English and Spanish outcomes.

Finally, we did not have data available on the peers with whom a target child was spending the most time interacting or the languages in which those interactions occurred. Children are likely more strongly influenced by the peers with whom they spend the most time in the classroom. The present study design may have captured more indirect peer effects rather than direct peer effects; any specific child in the study may have spent the majority of his or her time interacting with children who were not in the study. Future studies could use observations of child interactions in combination with measures of peer skill to better understand how the development of DLL and EO children is influenced by the peers with whom they interact.

Conclusion

Overall, the results of the present study suggest that peers are an important part of the preschool environment for both DLL and EO children. With the growing number of DLL children attending preschool in the United States (Child Trends Databank, 2019), it will be important to continue to examine how peers can contribute to a positive preschool experience for these children. The present results suggest that peers play a role in DLL children's English language development, which, in turn, contributes to positive skill development in other domains. More research is needed to continue to advance the present understanding of how to capitalize on positive peer influences in the classroom to benefit the skill development of both DLL and EO children.

CHAPTER 4: PAPER 3 - PEER SKILL, AGE COHORT, AND GENDER

Interaction with more highly skilled peers has been linked to preschool children's academic, language, and behavioral development (e.g., Aikens et al., 2010; Justice et al., 2011; Mashburn et al., 2009). Although the potentially important role of peer influence in the preschool classroom is recognized, the factors that contribute to the strength of peer influence at this age are not yet well understood. The role of peer and child characteristics, such as age cohort and gender, is one area in need of further exploration.

Children may be more strongly influenced by peers of the same age cohort and gender. For example, boys may learn more from interactions with the other boys in their classrooms than they do from interactions with girls. This hypothesis needs to be explored as evidence suggests that preschoolers often segregate by both age cohort and gender when playing in the classroom (e.g., Winsler et al., 2002). Interactions within these segregated groups may create more opportunities for skills to transfer, leading peers of the same age cohort and gender to have larger influences on a child's development than the child's other classmates. Understanding whether the strength of peer influence depends on peer characteristics could be informative for intervention efforts and classroom practices that involve creating groups of children to collaborate on activities. To address this issue in the present study, we used a large sample of children attending a preschool program at multiple sites across the United States to examine whether the strength of peer influence on children's language and behavioral development depends on the age cohort and gender of a given child's peers.

Peer Effects in the Preschool Setting

Children spend large portions of the preschool day interacting with peers while playing and completing learning activities (Sawyer et al., 2018). According to the peer effects framework (Henry & Rickman, 2007; Justice et al., 2014; Mashburn et al., 2009), these peer interactions can create direct opportunities for skills to transfer among the children in a classroom. One of the framework's main hypotheses is that children with lower skills benefit from more highly skilled peers. The idea of direct peer effects is consistent with Vyogtsky's (1978) concept of the zone of proximal development or the range between what a child can accomplish independently and what a child can accomplish with the support of a more skilled partner. Early research suggested that children can successfully share information and skills with one another through both modelling and direct instruction (French, 1987).

The peer effects framework also argues that peers may have indirect effects on a child (Henry & Rickman, 2007). Indirect effects may occur when peer skills contribute to changes in the classroom environment. For example, if there are many children in a classroom with low levels of skill, the classroom as a whole may receive access to more resources to support the skill development of these children than would be the case if only a small number of children in the classroom had low skill levels.

Although interest in preschool peer effects has grown in recent years, research on the topic remains limited. The evidence that has been collected generally supports the hypothesis that exposure to more skilled peers positively influences preschoolers' skill development in different domains. Multiple studies have linked exposure to peers with higher language skills to better language development for children (Atkins-Burnett et al., 2017; Justice et al., 2011; Mashburn et al., 2009). Using a composite of peer skill that included language skills as well as a

variety of other basic skills, Henry and Rickman (2007) found that being in a classroom with a higher peer composite score was related to better language, math, and pre-reading skills for children. At least one study has shown that higher average peer social skill was related to better social skills for preschoolers (Aikens et al., 2010). Similarly, in samples of early elementary-age children, exposure to peers with fewer behavior problems was related to fewer behavior problems as well as better cognitive skills (Neidell & Waldfogel, 2010; Thomas et al., 2011).

Both theory and research evidence have supported the importance of peer influence in the preschool classroom. However, questions remain regarding factors that contribute to the strength of peer influence for preschool children. Such research can help inform classroom practices and policies that aim to use peer interactions as a way to positively influence child development.

The Potential Role of Peer Age Cohort and Gender in Understanding Preschool Peer Effects

Because one of the main hypothesized pathways through which peer effects operate is direct child-to-child interactions, it seems likely that the characteristics of a child's peers would play a role in determining the strength of peer effects. Many preschool classrooms have multiple age cohorts. Perhaps most commonly, children who are 3 years old and those who are 4 years old at the beginning of the school year are combined into a single class, with many of them staying in the class for two years. Research suggests that young children in such mixed age classrooms select playmates partially based on their age cohort and gender, and often spend much of their time in the classroom interacting with same-age cohort, same-gender peers (Maccoby, 2002; Winsler et al., 2002). As more interactions create more opportunities for skills to transfer, it is likely that children are most influenced by the peers with whom they spend the most time.

The idea that same-age cohort, same-gender peers may have a stronger influence on a child than other classmates is further supported by social identity and social categorization

theories. From a young age, children categorize people based on characteristics such as age cohort and gender (Patterson & Bigler, 2006). For example, an older child starting their second year in a mixed age classroom may categorize the other older children with whom they are already familiar separately from the younger children who are entering the classroom for the first time. Children will also associate attributes such as traits or roles with the resulting groups (Patterson & Bigler, 2006). According to social identity theory (Tajfel, 1978; Tajfel & Turner, 1979), group membership creates a sense of social belonging. People often engage in behaviors and activities that reinforce group norms (Masland & Lease, 2013) and that are viewed positively by the group (Powlishta, 1995). For example, if a girl sees other girls in her classroom choosing to play with dolls instead of trucks, she may be more likely to play with dolls too, strengthening her connection with the other girls in the classroom. Similar processes may also support the transfer of skills among members of same-age cohort, same-gender peer groups. Children may be more willing to learn from peers they view as belonging to their group in order to become more like their peers and reinforce their own sense of belongingness to the group. Children are also more likely to rely on members of their group rather than other peers when learning new information (see Liberman et al., 2017).

Most prior studies of preschool peer effects have been limited in their ability to examine the role of peer characteristics by small sample sizes of about four to eight children per classroom (e.g., Atkins-Burnett et al., 2017; Henry & Rickman, 2007; Justice et al., 2011; Mashburn et al., 2009). Measures of peer skill are typically created by averaging the skill level of all peers in a classroom for whom data are available. This average is taken as an estimate of the overall skill level of the children in a given classroom even if data are not available for all children. Attempting to estimate the average skill level of subgroups of children when sample

sizes are already small can greatly limit the accuracy of the average estimates for these subgroups. Assessing most or all children within a classroom is likely necessary to be able to successfully examine whether peer influence depends on peer characteristics.

Although researchers have not simultaneously examined the role of peer skill and peer characteristics in the preschool context, some have considered the role of peer characteristics more broadly in relation to child development. For example, some research on young children has demonstrated that a higher proportion of girls in the classroom can be beneficial for children's academic and social-emotional development (Pahlke et al., 2013) with evidence to suggest that boys particularly benefit in terms of cognitive development (Moller et al., 2008).

Preschool-age children typically show a clear preference for same-gender playmates. Children begin to favor same gender playmates as early as 30 to 36 months, and this preference strengthens across childhood (Martin et al., 1999; Martin et al., 2005; Ruble & Martin, 1998; Serbin et al., 1994). During free-play, when children are typically able to choose from all or most possible playmates in the classroom, preschool children tend to spend more time interacting with same-gender rather than other-gender peers (Brazza et al., 1997; Maccoby, 2002). In one study, researchers determined that gender accounted for 70% to 80% of the variance in preschoolers' playmate choices (Martin & Fabes, 2001). Even when preschoolers do interact with other-gender peers, it is more commonly in the context of interactions involving mixed-gender groups rather than interactions involving only other-gender peers (Martin & Fabes, 2001). Although not directly examining the influence of peers on skill acquisition, researchers have also found that children become increasingly more like their same-gender peers in terms of interests and activities (Martin et al., 2013), which is consistent with social categorization and social identity theories.

Within the context of mixed-age classrooms, preschool children segregate by both age cohort and gender (Goldman & Chaillé, 1984; McGrew, 1974; Roopnarine, 1984). In some early work, researchers found that segregation by gender, while still frequent, was sometimes less common in mixed age groups as compared to same age groups (Field, 1982). However, peer gender still plays a strong role in the selection of peers in mixed age classrooms (Goldman, 1981), and same-gender interactions are more common than other-gender interactions (Lederberg et al., 1986). In contrast to this preschool preference for same-gender interactions, findings regarding age cohort preferences were mixed in early studies (Goldman, 1981; Lederberg et al., 1986; Roopnarine et al., 1992).

Although evidence from early research is somewhat mixed, in a more recent study of peer interactions in mixed age preschool classrooms with both three- and four-year-old children, Winsler and colleagues (2002) found that children became increasingly segregated by both age cohort and gender over the course of the school year. These results may help to explain some of the inconsistent results of previous studies. By the end of the year, children were spending less than half of the observed interactions engaged with peers whose age cohort or gender differed from their own (Winsler et al. 2002). This finding is consistent with the argument that children are more likely to form lasting relationships with peers with whom they can exchange information and establish common activities, which is more likely to be successful among children of the same age cohort (Gottman, 1983; French, 1987) and gender (Maccoby, 2002; Martin et al., 2013). Same-age and same-gender interactions have also been found to be more responsive and positive than cross-age and cross-gender interactions (Lederberg et al., 1986).

Children in the same age cohort will also typically advance through preschool together. In mixed age classrooms, older children may already have established relationships with one

another from the previous year. As the year goes on and the novelty of the new, younger cohort fades, older children may spend more time interacting with peers in their own age cohort, who are more likely to be on a similar developmental level (Lederberg et al., 1986; Maccoby, 2002). This segregation, in turn, may create more opportunities for children in the younger cohort to interact and form connections with one another. Furthermore, at least some younger children in mixed age classrooms appear to systematically avoid interactions with their older peers (Maccoby, 2002). Taken together, these peer interaction patterns may limit opportunities for peer skills to directly transfer across age cohorts.

Overall, theory and existing evidence is consistent with the hypothesis that peer age cohort and gender could contribute to a better understanding of peer effects. Evidence suggests that children often spend more time interacting with peers of the same age cohort and gender than with other peers (Winsler et al., 2002). Furthermore, as argued by social categorization and social identity theories, children may be more likely to adopt the activities and behaviors of similar peers (Masland & Lease, 2013), which could also support the transfer of skills among these peers.

Children's Language and Behavioral Development

The present study will consider how peer skill predicts children's language and behavioral development. Both language and behavioral skills are predictors of later school success. Children's language skills are foundational for classroom learning; many activities rely on the ability to use and understand language. Better language skills have been linked to better math (Purpura & Ganley, 2014), reading (National Early Literacy Panel, 2008), social (Aro et al., 2012), and self-regulation skills (Aro et al., 2014; Vallotton & Ayoub, 2011). Children's behavioral skills are important for meeting the demands of the classroom environment, such as

quietly paying attention while the teacher is giving a lesson to the whole group. Research has supported a link between children's behavioral skills and both academic and social success (Bulotsky-Shearer & Fantuzzo, 2011; Denham et al., 2011; Keane & Calkins, 2004).

Peers may positively influence children's language development by modeling more advanced language skills and by providing opportunities to practice developing language skills in back-and-forth conversations. Peers with better behavior contribute to a classroom environment where more time can be spent engaged in conversations during play or in academic activities rather than on behavior management or resolving peer conflicts. Similarly, peers may have a positive influence on children's behavioral development by modeling appropriate behavioral skills in the classroom or using their language skills to demonstrate how to solve social conflicts without relying on negative behaviors, such as yelling or hitting.

The Present Study

Aims of the present study were to expand the existing literature on preschool peer effects by conducting an exploratory analysis to examine whether the peer characteristics of age cohort and gender play a role in determining the strength of peer influence. To accomplish this goal, we used data from the Educare Implementation Study. The present study expands on previous research using the Educare sample, which demonstrated that peer skill is related to children's language and behavioral development during the preschool year (Foster et al., 2020).

The Educare sample is unusual in that a goal of the Educare Implementation Study is to collect data from all children attending Educare schools. Unlike previous studies that relied on small subsamples of about four to eight children per classroom, the present study draws from a large sample of classrooms across the United States with data available from all or most of the children in each classroom. This availability of data allows for the creation of more accurate peer

skill variables based on peer age cohort and gender than could be accomplished in previous studies with smaller samples of children per classroom. Peer age cohort and gender were examined separately to determine whether each is uniquely related to child outcomes. We also examined interactions involving both peer age cohort and gender, and hypothesized that the skills of peers who are both the same age cohort and gender as a given child will be most strongly related to that child's language (i.e., auditory comprehension and vocabulary) and behavioral (i.e., behavior problems and self-control) development.

Method

Sample

The present study used data collected for the Educare Implementation Study, an enhanced Head Start program that provides high quality care and support to children and their families from birth to age 5 (Educare Learning Network, 2016). For the present study, a subsample of children attending mixed-age classrooms at 16 Educare sites across the United States was used. A mixed-age classroom was defined as a classroom where the age difference between the youngest and oldest children was 18 months or greater. Eighteen months was chosen as the cut point based on Educare enrollment practices and the distribution of age within all Educare classrooms (see Foster et al., 2020 for more details).

Data were used from 4,005 3- and 4-year-olds attending 101 classrooms. About 52% of the children were boys and 48% were girls, and 38% of the children were Black, 37% were Hispanic, and 12% were non-Hispanic White (see Table 10 for additional details). On average, data were available on 16.0 children per classroom (*SD* = 2.02; Range = 9 to 20), and classrooms had an average of 16.8 children (*SD* = 1.17; Range = 9 to 20). Each classroom had an average of

3.9 younger age cohort females (*SD* = 1.49), 4.1 younger age cohort males (*SD* = 1.69), 3.0 older age cohort females (*SD* = 2.0), and 3.3 older age cohort males (*SD* = 1.46).

In order to consider peer skill for same-age cohort and different-age cohort peers, all children were categorized as being in the older age cohort or younger age cohort based on their age in the late spring when assessments were completed about 6 months into the academic year. Children were categorized as older if they were 4.5 years or older and as younger if they were less than 4.5 years old. This age cut-off was chosen in order to separate children entering the classroom as 3-year-olds with two years left in the program before kindergarten and children entering as 4-year-olds who may have attended the program the previous year and only have one year left in the program left before kindergarten.

Table 10

Descriptive Statistics for Younger and Older Children by Gender

Variable	Younger Girls (*N* = 1239)		Younger Boys (*N* = 1301)		Older Girls (*N* =685)		Older Boys (*N* = 780)	
	N	Prop	*N*	Prop	*N*	Prop	*N*	Prop
Race/Ethnicity								
Black	482	.39	524	.40	243	.35	274	.35
Hispanic/ Latinx	450	.36	459	.35	269	.39	296	.38
White	151	.13	173	.13	74	.11	94	.12
Other	156	.12	145	.11	99	.14	116	.15
Primary Language								
English	890	.72	949	.73	463	.68	526	.67
Spanish	304	.25	304	.23	181	.26	206	.26
Other	45	.04	48	.04	41	.06	48	.06
Has an IEP	104	.08	229	.18	43	.06	126	.16
	N	*M*(*SD*)	*N*	*M*(*SD*)	*N*	*M*(*SD*)	*N*	*M*(*SD*)
Age	1239	3.96(0.33)	1301	3.95(0.32)	685	4.96(0.33)	780	4.99(0.33)
CLASS								
Instructional	1157	3.55(1.10)	1209	3.53(1.09)	588	3.58(1.25)	664	3.57(1.14)
Organization	1157	5.75(0.82)	1209	5.77(0.82)	588	5.66(0.95)	664	5.71(0.85)
Emotional	1157	6.26(0.57)	1209	6.27(0.58)	588	6.25(0.65)	664	6.27(0.58)

Peer Language	1239	111.78(8.60)	1301	111.62(8.63)	685	112.82(8.63)	780	112.72(8.25)
Peer Behavior	1239	11.12(3.51)	1301	11.28(3.57)	685	10.87(3.74)	780	10.87(3.62)
Child Outcomes								
PLS: AC	725	98.86(12.76)	742	94.61(13.00)	353	96.36(12.89)	423	91.22(13.73)
PPVT	1227	93.50(14.79)	1288	92.15(15.27)	679	93.20(15.28)	764	90.74(15.69)
Behavior	1204	49.16(9.24)	1262	53.87(9.72)	655	46.56(10.28)	747	50.70(10.88)
Self-Control	1210	51.49(9.35)	1269	47.51(9.46)	655	54.56(9.95)	747	50.57(10.24)

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

Procedures

Children's language skills were assessed by trained and certified data collectors, and teachers rated children's behavioral skills. Two assessments of language skills and one measure of teacher-rated behavioral skills were collected in the spring of every schoolyear and served as the outcome variables in the present analyses. Children's baseline language assessments differed depending on when they entered the program. For children who entered the program as infants or toddlers, children were first assessed on the PPVT when they turned three and on the PLS in the spring before they moved to a preschool classroom. Children who entered the program at three-years-old were assessed in the fall that they entered the program. For four-year-old children, the baseline assessment used was typically the spring score they received the previous year. However, if children entered the program as 4-year-olds, they were assessed in the fall upon program entry, and this fall score was used as a baseline measure. Teachers rated children's behavioral skills each fall, allowing for fall scores to be used as the measure of baseline skill for all children.

Measures

Child Outcomes

PLS. The Preschool Language Scale Auditory Comprehension Scale (PLS AC; Zimmerman et al., 2002; Zimmerman et al., 2011) was used as a measure of the child's language comprehension. The PLS AC assesses children's understanding of basic vocabulary, concepts, and grammar through interactive tasks. Children are asked to respond to increasingly complex verbal questions using non-verbal responses such as pointing. In the present sample, some children were assessed using the fourth version of the PLS. Later in the Educare Implementation study, the fifth version of the PLS was used. This change was statistically controlled in the present analyses.

Although the items generally remained the same across the two versions of the PLS, different norming samples were used, with each sample comprised of over 1,400 English-speaking children. Internal consistency coefficients ranged from .66 to .96 for the PLS-4 and from .91 to .98 for the PLS-5 (Zimmerman et al., 2011). Test-retest reliability coefficients ranged from .90 to .97 for the PLS-4 and from .86 to .95 for the PLS-5. Age standardized scores were used as the outcome variable.

PPVT-4. English receptive vocabulary was measured using the Peabody Picture Vocabulary Test Fourth Edition (PPVT-4; Dunn & Dunn, 2007). The PPVT-4 requires children to point to a picture out of a group of four that best matches the word spoken by a data collector. For example, a child might be shown four colored circles and be asked to point to 'red.' The test begins by establishing a baseline level of skill and continues until the child reaches a ceiling defined by the measure. The PPVT-4 has been normed to examine vocabulary development in the preschool years. For children ranging from age 2 to 6, internal consistency of the measure has

been found to range from .95 to .97 (Dunn & Dunn, 2007). Test-retest reliability ranges from .91 to .94. Age standardized scores were used as the outcome variable.

DECA. Behavioral skills were assessed using the Devereux Early Childhood Assessment (DECA; LeBuffe & Naglieri, 1999), a teacher-completed questionnaire. The DECA assesses children's behavior with the goal of understanding social and emotional strengths and risks. The present study considered children's *t*-scores on two DECA subscales: the self-control subscale (8 items; e.g., "how often did the child handle frustration well;" alpha = .90) and the behavior problems subscale (10 items; e.g., "how often did the child fight with other children;" alpha = .85). Higher self-control scores indicated better self-control while higher behavior problems scores indicated more behavior problems. Teachers were asked to consider children's behavior during the past 4 weeks and rate the frequency of each behavior on a 5-point scale (1 = *never*; 5 = *very frequently*). The two subscales were treated as separate outcomes for the present analyses.

Peer Skills

Peers' score on the PPVT and on the behavior problems subscale of the DECA were used to create a peer language skill variable and a peer behavioral skill variable, respectively. In order to represent skill level rather than relative position within each measure's age norming population, these variables were created using growth scores for the PPVT, which are used to track changes in vocabulary over time, and raw scores for the DECA.

For each child, classmates with available data were sorted into one of four categories: peers the same age cohort (i.e., older or younger) and same gender (i.e., boy or girl) as the target child, peers the same age cohort and a different gender as the target child, peers a different age cohort and the same gender as the target child, and peers a different age cohort and different gender than the target child. The average peer skill for these four groups was then calculated.

Thus, each child had four associated peer skill variables in the dataset. The child's own score was not included in any of these calculations so that the child was not considered to be a peer of him- or herself.

Covariates

Child and family covariates were collected using parent surveys completed upon enrollment into Educare. Child-level covariates included gender (0 = female, 1 = male), race and ethnicity (dummy coded with the categories Black, Hispanic, and other), primary language (0 = other, 1 = English), and disability status (0 = no documented disability, 1 = documented disability). Primary caregivers provided information about their years of education, marital status (0 = partnered, 1 = single), and depression (0 = not depressed, 1 = depressed). Primary caregivers also indicated whether the family experienced food insecurity (0 = no food insecurity, 1 = food insecurity). Additional covariates at the child-level included the child's baseline score on the outcome of interest. When PLS scores were the outcome, PLS version was controlled due to the transition from the PLS-4 to the PLS-5.

At the classroom-level, we controlled for classroom quality as assessed using the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). Trained and certified data collectors observed classrooms and completed the CLASS in the winter of the schoolyear. The CLASS examines the quality of teacher-child interactions across 10 dimensions that are averaged into three domain scores: Emotional Support, Classroom Organization, and Instructional Support. Each item is rated on a scale from 1 to 7 with a higher score indicating higher quality. For the present analyses, a measure of overall quality was created by averaging each classroom's scores on the three domains.

Analysis Plan

Descriptive Analyses

Descriptive information about the sample, the peer skill variables, and the outcomes of interest can be found in Table 10. Correlations were examined to gain a preliminary understanding of the relations between the main predictors and outcomes of interest.

Inferential Analyses

Hierarchical linear modeling (HLM) was used to address the question of whether children are more strongly influenced by the skill level of same-age cohort and same-gender peers. Models accounted for the nesting of children in classrooms and Educare site, and continuous predictor variables were standardized to have a mean of zero and standard deviation of one for the purpose of interpretation.

Analyses began by considering overall peer language skill and peer behavior problems without accounting for peer age cohort or gender. Peer language skill was calculated by taking the average of all of a target child's classmates scores on the PPVT with that child's score excluded from the calculation. The same process was repeated for peer behavior skill using scores from the behavior problems subscale of the DECA.

The Level 1 equation included the peer skill variables as well as child age cohort, gender, primary language, race, ethnicity, disability status, and baseline skill level on the outcome of interest; parental education and depression; and family food insecurity. The Level 1 equation also includes the residual value for a given child, r_{ij}.

The Level 2 equation relates the Level 1 parameters to classroom-level quality. The Level 2 equation also includes the classroom error term, u_{0j}.

The Level 1 and Level 2 equations are as follows:

Level 1 (child): $Y_{ij} = \beta_{0j} + \mathbf{\beta_{1j}}\mathbf{\textit{Peer Language Skill}_{ij}} + \mathbf{\beta_{2j}}\mathbf{\textit{Peer Behavior Problems}_{ij}} +$

$\mathbf{\beta_{3j}}\textit{Child Age Cohort}_{ij} + B_{4j}\,\textit{Child Gender}_{ij} + \beta_{5j}\,\textit{Child Primary Language}_{ij} +$

$\beta_{6j}\textit{Child Race}_{ij} + \beta_{7j}\textit{Disability}_{ij} + \beta_{8j}\textit{Baseline Skill Level}_{ij} + \beta_{9j}\textit{Marital}_{ij} +$

$\beta_{10j}\textit{Parental Education}_{ij} + \beta_{11j}\textit{Food Insecurity}_{ij} + r_{ij}$

Level 2 (classroom): $\beta_{0j} = \gamma_{00} + \gamma_{01}\textit{Classroom Quality}_{j} + u_{0j}$

The main research questions for the present study were addressed through models that accounted for peer age cohort and gender when calculating peer language and peer behavior skill. The Level 1 equation describes the outcomes of the *i*th child in the *j*th classroom. The four peer skill variables described earlier were included to represent the skill of peers the same age cohort and gender as the target child (SASG), peers the same age cohort and a different gender as the target child (SADG), peers a different age cohort and the same gender as the target child (DASG), and peers a different age cohort and gender as the target child (DADG). Each of these variables was included in a two-way interaction with child age cohort and a two-way interaction with child gender. In addition, all four peer group variables were included in a three-way interaction that involved child age cohort and child gender simultaneously. Other covariates at the child level included child primary language, race, ethnicity, disability status, and baseline skill level on the outcome of interest; parental education and depression; and family food insecurity. The Level 1 equation also includes the residual value for a given child, r_{ij}.

The Level 2 equation relates the Level 1 parameters to the classroom-level quality. The Level 2 equation also includes the classroom error term, u_{0j}.

The Level 1 and Level 2 equations are as follows:

Level 1 (child): $Y_{ij} = \beta_{0j} + \mathbf{\beta_{1j}}\mathbf{\textit{Peer Skill SASG}_{ij}} + \mathbf{\beta_{2j}}\mathbf{\textit{Peer Skill SADG}_{ij}} + \mathbf{\beta_{3j}}\mathbf{\textit{Peer Skill}}$

$\mathbf{\textit{DASG}_{ij}} + \mathbf{\beta_{4j}}\mathbf{\textit{Peer Skill DADG}_{ij}} + \beta_{5j}\,\textit{Child Age Cohort}_{ij} + \mathbf{\beta_{6j}}\mathbf{\textit{Peer Skill SASG x}}$

$$\boldsymbol{Age_{ij}} + \boldsymbol{\beta_{7j}}\,\boldsymbol{Peer\ Skill\ SADG\ x\ Age\ Cohort_{ij}} + \boldsymbol{\beta_{8j}}\,\boldsymbol{Peer\ Skill\ DASG\ x\ Age\ Cohort_{ij}} + \boldsymbol{\beta_{9j}}\,\boldsymbol{Peer\ Skill\ DADG\ x\ Age\ Cohort_{ij}} + B_{10j}\,Child\ Gender_{ij} + \boldsymbol{\beta_{11j}}\boldsymbol{Peer\ Skill\ SASG\ x\ Gender_{ij}} + \boldsymbol{\beta_{12j}}\,\boldsymbol{Peer\ Skill\ SADG\ x\ Gender_{ij}} + \boldsymbol{\beta_{13j}}\,\boldsymbol{Peer\ Skill\ DASG\ x\ Gender_{ij}} + \boldsymbol{\beta_{14j}}\,\boldsymbol{Peer\ Skill\ DADG\ x\ Gender_{ij}} + \beta_{15j}\,Child\ Age\ Cohort\ x\ Child\ Gender_{ij} + \boldsymbol{\beta_{16j}}\boldsymbol{Peer\ Skill\ SASG\ x\ Gender\ x\ Age\ Cohort_{ij}} + \boldsymbol{\beta_{17j}}\,\boldsymbol{Peer\ Skill\ SADG\ x\ Gender\ x\ Age\ Cohort_{ij}} + \boldsymbol{\beta_{18j}}\,\boldsymbol{Peer\ Skill\ DASG\ x\ Gender\ x\ Age\ Cohort_{ij}} + \boldsymbol{\beta_{19j}}\,\boldsymbol{Peer\ Skill\ DADG\ x\ Gender\ x\ Age\ Cohort_{ij}} + \beta_{20j}\,Child\ Primary\ Language_{ij} + \beta_{21j}Child\ Race_{ij} + \beta_{22j}Disability_{ij} + \beta_{22j}Baseline\ Skill\ Level_{ij} + \beta_{23j}Marital_{ij} + \beta_{23j}Parental\ Education_{ij} + \beta_{23j}Food\ Insecurity_{ij} + r_{ij}$$

Level 2 (classroom): $\beta_{0j} = \gamma_{00} + \gamma_{01}Classroom\ Quality_j + u_{0j}$

Exploratory analyses involved contrast coding to probe the interactions and address the question of whether the strength of the relation between peer skill and child outcomes depends on the age cohort and gender of a given child's peers (see Appendix F for equations). The child's own gender and age cohort were also taken into account. The interactions allowed the role of age cohort and gender for both peers and individual children to be examined individually and simultaneously. Main effects, two-, three-, four-, and five-way interactions were considered. The five-way interactions involved peer skill, peer age cohort and gender, and child age cohort and gender. For each outcome, the highest order significant interaction for a given peer skill (i.e., language or behavior problems) was further examined to understand the nature of the relation. The peer skill slope was computed for each group as defined by the other terms in the interaction (e.g., for an interaction among peer language skill, peer age cohort, and child age cohort, the slopes for peer language were computed for older age cohort children with same-age cohort peers, older age cohort children with different-age cohort peers, younger age cohort children

with same-age cohort peers, and younger age cohort children with different-age cohort peers). The pattern of differences within one of the terms of the interaction (e.g., peer age cohort) was examined to identify why the interaction was statistically significant. Special attention was paid to differences involving statistically significant slopes. Plots were also used as necessary to visually understand the nature of the interactions.

Multiple Imputation

Multiple imputation was used to address the issue of missing data. With all available data, 40 datasets were imputed using the Markov chain Monte Carlo method and Rubin's approach (Rubin, 1987; Schafer, 1997). Analyses were then conducted with the 40 complete datasets, and the final parameter estimates were obtained by averaging the results of the 40 analyses. The computation of the standard errors accounted for variability both within and between datasets.

Results

Descriptive Analyses

Table 10 includes descriptive information about the sample including demographic information, peer skill, and child outcomes. As shown in Table 11, the two language outcomes were strongly positively correlated with one another. Child behavior problems and self-control were strongly negatively correlated. Table 12 shows the correlations between the peer skill variables and each examined outcome. Generally, peer language skill and peer behavior problems were modestly to moderately correlated with the outcomes of interest.

Table 11

Correlations between Language and Behavioral Outcomes

	PLS AC	PPVT	DECA Behavior	DECA Self-Control
PLS Auditory Comprehension	1	0.67***	-0.13***	0.15***
PPVT		1	-0.05**	0.02
DECA Behavior Problems			1	-0.75***
DECA Self-Control				1

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

Table 12

Correlations among the Main Peer Skill Predictors and Children's Language and Behavioral Outcomes in the Spring

	PLS AC	PPVT	DECA Behavior Problems	DECA Self-Control
Peer Language Skill	0.19***	0.35***	0.05**	-0.07***
SASG Peer Language Skill	0.06**	0.21***	-0.04*	0.06***
SADG Peer Language Skill	0.05*	0.20***	0.01	0.01
DASG Peer Language Skill	0.18***	0.23***	0.11***	-0.11***
DADG Peer Language Skill	0.15***	0.21***	0.16***	-0.15***
Peer Behavior Skill	0.08***	0.10***	0.47***	-0.30***
SASG Peer Behavior Skill	0.04*	0.08***	0.34***	-0.26***
SADG Peer Behavior Skill	0.18***	0.14***	0.19***	-0.11***
DASG Peer Behavior Skill	0.00	0.05*	0.25***	-0.16***
DADG Peer Behavior Skill	0.11***	0.09***	0.09***	-0.03

Note: * p<.05; ** p<.01; *** p<.001; PLS AC = Preschool Language Scale Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Inferential Analyses

Overall Peer Skill Predicting Child Outcomes

The first step for the inferential analyses was to use HLMs to examine the relation between overall peer skill and children's auditory comprehension, vocabulary, behavioral, and self-control outcomes. In the initial analyses, peer skill did not account for peer age cohort or gender, and no interactions were examined. All models accounted for the nesting of children in classrooms and site. Control variables included children's initial scores on the outcome of interest, disability status, gender, age cohort, race, ethnicity, and primary language, caregiver depression, education, and marital status; whether the family experienced food insecurity; and classroom quality.

The results of this first model are shown in Table 13. Higher peer language skills were significantly positively related to larger residualized gains in auditory comprehension (B = 0.05, SE = 0.02, p = .01) and vocabulary (B = 0.08, SE = 0.01, p < .001) skills. Higher peer language skills were also significantly negatively related to smaller residualized gains in self-control (B = -0.04, SE = .02, p = .04). Considering peer behavior problems, higher levels of peer behavior problems were positively related to larger gains in behavior problems (B = 0.28, SE = 0.01, p < .001) and smaller gains in self-control (B = -0.19, SE = 0.02, p < .001).

Table 13

Peer Language Skill and Peer Behavior Problems Predicting Language and Behavioral Outcomes

	School Readiness Outcomes			
	PLS AC	PPVT	DECA Behavior	DECA Self-Control
	B(SE)	*B(SE)*	*B(SE)*	*B(SE)*
Intercept	0.08(0.05)	0.01(0.04)	-0.19***(0.05)	0.11+(0.05)
PLS Version	0.1+(0.05)	-	-	-
Pre-Test Score	0.7***(0.02)	0.72***(0.01)	0.51***(0.01)	0.54***(0.01)
Child Disability	-0.22***(0.05)	-0.16***(0.03)	0.19***(0.04)	-0.24***(0.04)
Gender	-0.13***(0.03)	-0.02(0.02)	0.2***(0.03)	-0.16***(0.03)
Age Cohort	-0.04(0.03)	0.07**(0.02)	-0.12***(0.03)	0.15***(0.03)
Black	-0.07(0.04)	-0.07*(0.03)	0.09*(0.04)	-0.04(0.04)
Hispanic	-0.01(0.05)	-0.07*(0.03)	0.04(0.04)	0.02(0.05)
Primary Language	0.08+(0.05)	0.09**(0.03)	0.03(0.04)	-0.04(0.04)
Caregiver Depression	0.01(0.04)	0.01(0.03)	0.02(0.03)	-0.01(0.04)
Caregiver Education	0.07***(0.02)	0.06***(0.01)	-0.01(0.01)	0.01(0.01)
Food Insecurity	0(0.03)	-0.03(0.02)	-0.01(0.03)	-0.02(0.03)
Marital Status	-0.01(0.03)	-0.02(0.02)	0.05+(0.03)	-0.03(0.03)
CLASS Total	0.03+(0.02)	0(0.01)	0.01(0.01)	0.02(0.02)
Peer Language Skill	0.05**(0.02)	0.08***(0.01)	0.01(0.02)	-0.04*(0.02)
Peer Behavior Skill	-0.03+(0.02)	0(0.01)	0.28***(0.01)	-0.19***(0.02)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PLS AC = Preschool Language Scale Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test, DECA = Devereux Early Childhood Assessment; CLASS = Classroom Assessment Scoring System; The sample size for the model was 4,005 children and covariates included child primary language, race, ethnicity, disability status, and baseline skill level on the outcome of interest; parental education and depression; and family food insecurity.

Peer Skill Accounting for Peer Age Cohort and Gender

The next set of models included four peer skill variables that accounted for peer age cohort and gender. The variables represented the skill of peers the same age cohort and gender as

the target child (SASG), peers the same age cohort and a different gender as the target child (SADG), peers a different age cohort and the same gender as the target child (DASG), and peers a different age cohort and gender as the target child (DADG). Each peer skill variable was included in an interaction with child age cohort, an interaction with child gender, and an interaction that involved child age cohort and child gender simultaneously (see Table 1G).

The goal of these analyses was to determine whether peer age cohort and gender play a role in the relation between peer skill and child outcomes and whether results differ depending on a child's own age cohort and gender. To accomplish this goal, contrasts (see Appendix F) were used to explore the relations for different peer and child groups. The highest order significant interaction for peer language skill and for peer behavior problems for a given outcome were probed. Table 14 shows the results of analyzing the contrasts that were used to better understand the nature of the interactions between peer skill, peer age cohort and gender, and child age cohort and gender.

Table 14

Examining the Interactions Between Peer Skill, Peer Age Cohort and Gender, and Child Age Cohort and Gender

	PLS: AC	PPVT	DECA Behavior	DECA Self-Control
	B(SE)	*B(SE)*	*B(SE)*	*B(SE)*
Child Characteristics				
C Gender	-0.41***(0.1)	-0.06(0.07)	0.23*(0.09)	-0.1(0.09)
C Age Cohort	-0.29+(0.15)	0.16(0.1)	-0.09(0.13)	0.13(0.14)
C Gender * C Age Cohort	0.24(0.21)	-0.23(0.14)	0.08(0.19)	-0.05(0.19)
Peer Language Skill				
P Language Skill	0.03**(0.01)	0.02*(0.01)	0.01(0.01)	-0.02+(0.01)
P Language * C Gender	-0.01(0.02)	-0.01(0.01)	-0.02(0.01)	0.02(0.01)
P Language * C Age Cohort	-0.04*(0.02)	-0.01(0.01)	-0.02(0.02)	0.03+(0.02)
P Language * P Gender	-0.01(0.06)	0.07(0.04)	0.01(0.06)	0.1(0.06)
P Language * P Age Cohort	0.22***(0.05)	-0.01(0.04)	0.02(0.05)	0.04(0.05)
P Language * P Gender * C Gender	0.02(0.08)	-0.05(0.07)	-0.05(0.08)	-0.12(0.09)
P Language * P Gender * C Age Cohort	-0.06(0.09)	-0.03(0.06)	0.05(0.08)	-0.1(0.08)
P Language * P Age Cohort * C Gender	-0.24***(0.07)	0(0.05)	0(0.07)	0(0.07)
P Language * P Age Cohort * C Age Cohort	-0.19*(0.08)	-0.01(0.06)	-0.01(0.07)	-0.04(0.09)
P Language * C Gender * C Age Cohort	0.01(0.03)	0.01(0.02)	0.04+(0.02)	-0.05*(0.02)
P Language * P Gender * P Age Cohort	0.04(0.15)	-0.05(0.1)	-0.16(0.13)	0.21(0.14)
P Language * P Gender * C Gender * C Age Cohort	-0.09(0.12)	-0.07(0.09)	0.01(0.11)	0.04(0.11)
P Language * P Age Cohort * C Gender * C Age Cohort	0.26*(0.11)	0.1(0.08)	-0.12(0.1)	0.02(0.1)
P Language * P Gender * P Age Cohort * C Gender	0.03(0.21)	0.04(0.15)	0.1(0.19)	-0.37+(0.21)
P Language * P Gender * P Age Cohort * C Age Cohort	-0.05(0.23)	-0.41*(0.16)	-0.18(0.2)	-0.27(0.22)
P Language * P Gender * P Age Cohort * C Gender * C Age Cohort	-0.06(0.31)	0.4(0.25)	0.18(0.3)	0.69+(0.36)
Peer Behavior Problems				
P Behavior	0(0.01)	0(0.01)	0.03**(0.01)	-0.02(0.01)
P Behavior * C Gender	0.02(0.01)	0.01(0.01)	0.03*(0.01)	-0.02+(0.01)
P Behavior * C Age Cohort	0.01(0.02)	0.01(0.01)	0.04*(0.02)	-0.02(0.02)
P Behavior * P Gender	0.07(0.06)	0.06(0.04)	-0.04(0.05)	0.01(0.05)

P Behavior * P Age Cohort	0.06(0.04)	-0.01(0.03)	0.02(0.04)	0.12**(0.04)
P Behavior * P Gender * C Gender	-0.03(0.08)	-0.05(0.06)	0.04(0.08)	-0.01(0.08)
P Behavior * P Gender * C Age Cohort	-0.04(0.09)	-0.04(0.06)	0.03(0.08)	0.01(0.08)
P Behavior * P Age Cohort * C Gender	-0.06(0.05)	0.1*(0.04)	0.04(0.05)	-0.10+(0.05)
P Behavior * P Age Cohort * C Age Cohort	-0.07(0.07)	0(0.06)	-0.08(0.07)	-0.2**(0.08)
P Behavior * C Gender * C Age Cohort	-0.03(0.02)	-0.02(0.02)	-0.03(0.02)	0.04+(0.02)
P Behavior * P Gender * P Age Cohort	-0.03(0.12)	0.07(0.09)	-0.13(0.11)	0.26*(0.12)
P Behavior * P Gender * C Gender * C Age Cohort	-0.09(0.11)	0.02(0.08)	0.01(0.11)	-0.07(0.11)
P Behavior * P Age Cohort * C Gender * C Age Cohort	0.03(0.09)	-0.1(0.07)	-0.02(0.09)	0.13(0.09)
P Behavior * P Gender * P Age Cohort * C Gender	0.04(0.16)	-0.2(0.13)	0.04(0.16)	-0.43*(0.18)
P Behavior * P Gender * P Age Cohort * C Age Cohort	-0.22(0.2)	-0.16(0.14)	-0.02(0.18)	-0.35+(0.19)
P Behavior * P Gender * P Age Cohort * C Gender * C Age Cohort	0.56*(0.27)	0.28(0.21)	0.09(0.26)	0.71*(0.3)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; C = Child, P = Peer, PLS AC = Preschool Language Scale Auditory Comprehension, PPVT = Peabody Picture Vocabulary Test; DECA = Devereux Early Childhood Assessment; The sample size for the model was 4,005 children and covariates included child primary language, race, ethnicity, disability status, and baseline skill level on the outcome of interest; parental education and depression; and family food insecurity.

Child Language Outcomes.

PLS AC. Analyses indicated that children's residualized gains in auditory comprehension were related to both peer language skill and peer behavior problems. The association between peer language and auditory comprehension varied depending on peer and child age cohort and child gender. The association between peer behavior problems and auditory comprehension varied depending on the gender and age cohort of both the target child and peers.

The main effect of peer language skill predicting residualized gains in auditory comprehension skill was significant (B = .03, SE = .01, p = .01). The two-way interactions between peer language and peer age cohort (B = .22, SE = .05, p < .001) and between peer language and child age cohort were also significant (B = -.04, SE = .02, p = .048). In addition, there was a three-way interaction between peer language, peer age cohort, and child gender (B = -.24, SE = .07, p < .001) as well as a three-way interaction between peer language, peer age cohort, and child age cohort (B = -.19, SE = .08, p = .02). Finally, there was a significant interaction between peer language skill, peer age cohort, child gender, and child age cohort (B = .26, SE = .11, p = .02).

The highest order interaction involving peer language skill, peer age cohort, child gender, and child age cohort was further examined to better understand the nature of the relation (see Table 15 and Figure 8). As shown in Table 15, the association between peer language and PLS AC scores was not different than zero for male children overall and for older age cohort female children. For girls in the younger age cohort, residualized gains in auditory comprehension skills were positively related to the peer language of younger age cohort peers (B = .15, SE = .03, p < .001) and negatively related to the peer language of older age cohort peers (B = -.08, SE = .03, p = .003).

Table 15

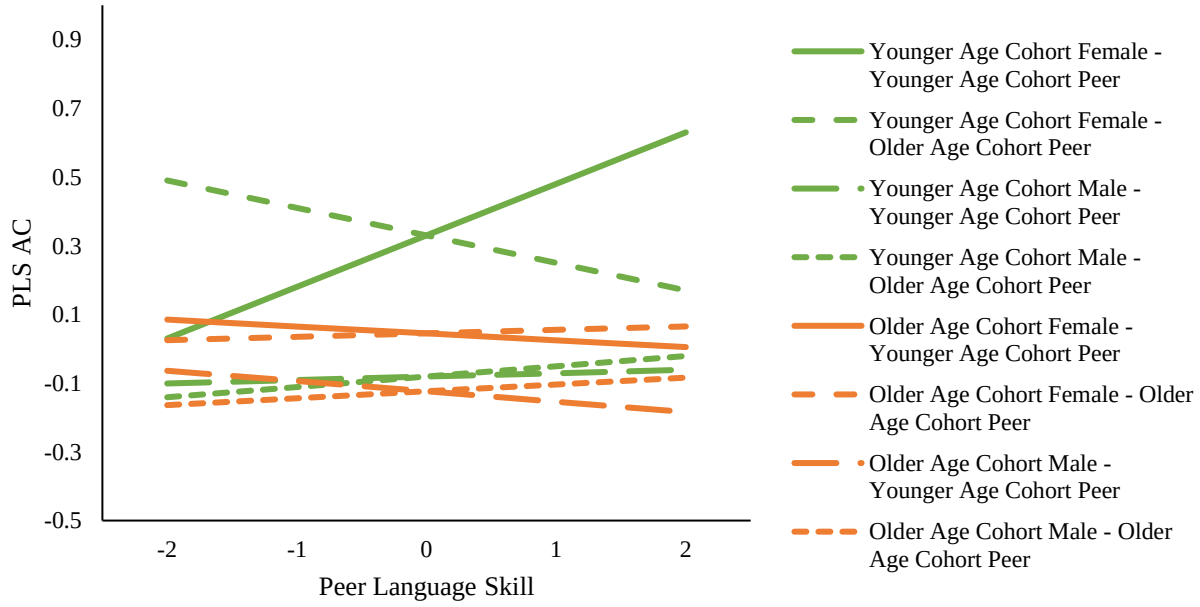
Simple Slopes for the Interaction Between Peer Language Skill, Peer Age Cohort, and Child Age Cohort and Gender Predicting PLS AC Scores

	PLS AC
Peer Language * Peer Age Cohort * Child Gender * Child Age Cohort	*B(SE)*
Younger Age Cohort Female Children with:	
Younger Age Cohort Peer Language	0.15***(0.03)
Older Age Cohort Peer Language	-0.08**(0.03)
Younger Age Cohort Male Children with:	
Younger Age Cohort Peer Language	0.01(0.03)
Older Age Cohort Peer Language	0.03(0.03)
Older Age Cohort Female Children with:	
Young Age Cohort Peer Language	-0.02(0.04)
Older Age Cohort Peer Language	0.01(0.03)
Older Age Cohort Male Children with:	
Younger Age Cohort Peer Language	-0.03(0.04)
Older Age Cohort Peer Language	0.02(0.04)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PLS AC = Preschool Language Scale Auditory Comprehension

Figure 8

Plotting the Simple Slopes for the Interaction Between Peer Language Skill, Peer Age Cohort, and Child Age Cohort and Gender Predicting PLS AC Scores



Note: PLS AC = Preschool Language Scale Auditory Comprehension

Considering peer behavior problems as a predictor of auditory comprehension, there was a significant interaction between peer behavior, peer gender, peer age cohort, child gender, and child age cohort (*B* = .56, *SE* = .27, *p* = .04). Upon further examining this interaction to better understand the relation among these variables (see Table 16), it was found that for girls in the younger age cohort, the behavior problems of older age cohort boys predicted smaller residualized gains in auditory comprehension (*B* = -.08, *SE* = .04, *p* = .04). There was little evidence that the behavior problems of peers in the other examined peer groups reliably predicted the auditory comprehension skills of younger age cohort girls. For boys in the older cohort, the behavior problems of boys in the younger cohort related to smaller residualized gains in auditory comprehension (*B* = -.13, *SE* = .06, *p* = .02) while the behavior problems of girls in the younger cohort related to larger residualized gains (*B* = .14, *SE* = .07, *p* = .03). The behavior of older age cohort peers was not found to reliably relate to the auditory comprehension skills of older age cohort boys. Furthermore, for girls in the older age cohort and boys in the younger age cohort, the association between peer behavior problems and residualized gains in auditory comprehension was not found to be different from zero. Figures 9 and 10 visually represent these relations for younger age cohort children and older age cohort children, respectively.

Table 16

Simple Slopes for the Interaction Between Peer Behavior Problems, Peer Age Cohort and Gender, and Child Age Cohort and Gender Predicting PLS AC Scores

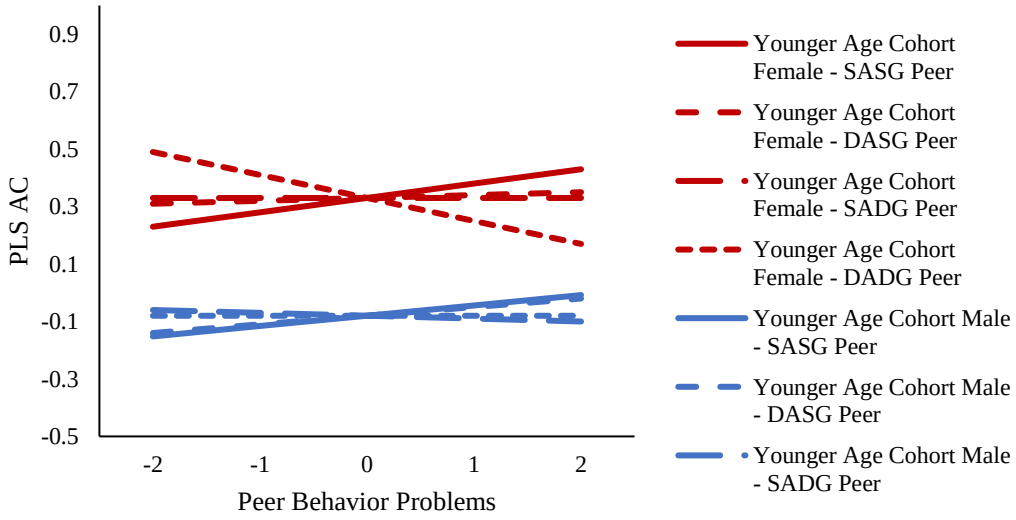
	PLS AC
Peer Behavior * Peer Gender * Peer Age Cohort * Child Gender * Child Age Cohort	*B(SE)*
Younger Age Cohort Female Children with:	
SASG Peer Behavior	0.05(0.06)
DASG Peer Behavior	0.01(0.04)
SADG Peer Behavior	0(0.04)
DADG Peer Behavior	-0.08*(0.04)
Younger Age Cohort Male Children with:	
SASG Peer Behavior	0.03(0.04)

DASG Peer Behavior	0.03(0.04)
SADG Peer Behavior	-0.01(0.06)
DADG Peer Behavior	0(0.04)
Older Age Cohort Female Children with:	
SASG Peer Behavior	-0.05(0.05)
DASG Peer Behavior	0.08(0.08)
SADG Peer Behavior	0.05(0.05)
DADG Peer Behavior	-0.07(0.06)
Older Age Cohort Male Children with:	
SASG Peer Behavior	0.01(0.04)
DASG Peer Behavior	-0.13*(0.06)
SADG Peer Behavior	-0.07(0.05)
DADG Peer Behavior	0.14*(0.07)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PLS AC = Preschool Language Scale Auditory Comprehension; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Figure 9

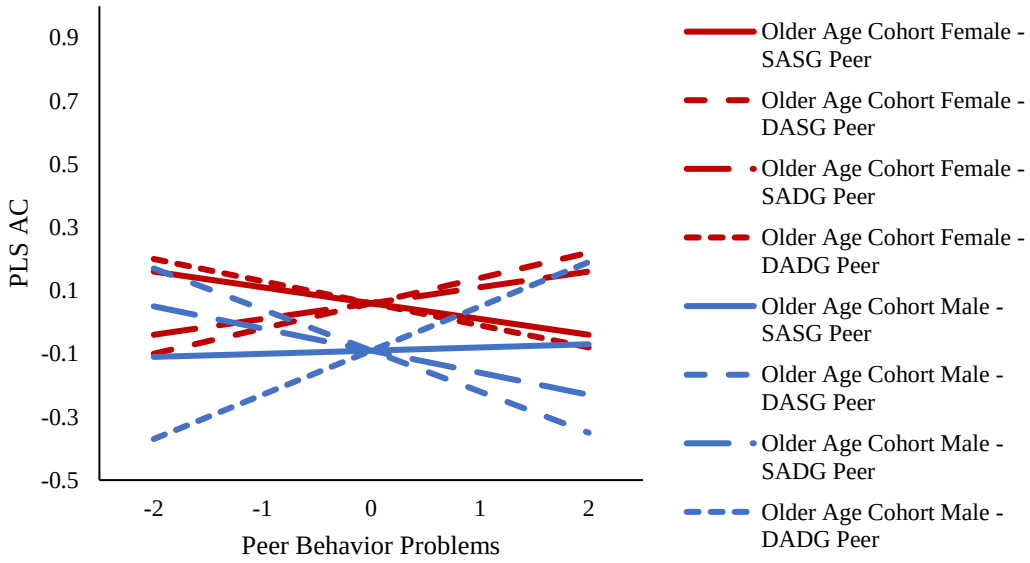
Plotting the Simple Slopes for the Interaction Between Peer Behavior Problems and Peer Gender and Age Cohort for Younger Age Cohort Children Predicting PLS AC Scores



Note: PLS AC = Preschool Language Scale Auditory Comprehension; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Figure 10

Plotting the Simple Slopes for the Interaction Between Peer Behavior Problems and Peer Gender and Age Cohort for Older Age Cohort Children Predicting PLS AC Scores



Note: PLS AC = Preschool Language Scale Auditory Comprehension; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

PPVT. For the PPVT, residualized gains in vocabulary were related to the language skills but not the behavior problems of peers. The association between peer language and child vocabulary varied depending on peer and child age cohort and child gender.

There was a significant main effect of peer language skill (*B* = .02, *SE* = .01, *p* = .01). There was also a significant interaction between peer language skill, peer gender, peer age cohort, and child age cohort (*B* = -.41, *SE* = .16, *p* = .01). The nature of this interaction was further explored (see Table 17 and Figure 11). Residualized gains in vocabulary scores for children in the older age cohort were positively related to the peer language skills of older age cohort peers of the opposite gender (*B* = .09, *SE* = .03, *p* = .003). There was not strong evidence that the language skill of peers in the other three peer groups (i.e., SASG, DASG, and DADG) reliably predicted vocabulary gains for children in the older age cohort. Furthermore, it was not

found that the language skills of peers in any of the examined peer groups reliably predicted the vocabulary skills of children in the younger age cohort.

Table 17

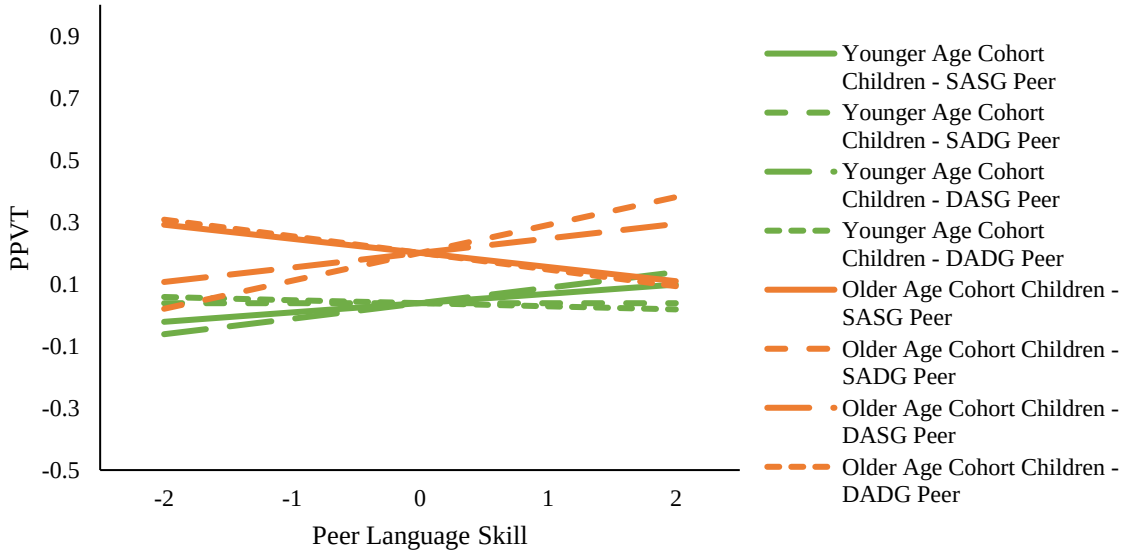
Simple Slopes for the Interaction Between Peer Language Skill, Peer Age Cohort and Gender, and Child Age Cohort Predicting PPVT Scores

	PPVT
Peer Language * Peer Age Cohort * Peer Gender * Child Age Cohort	*B(SE)*
Younger Age Cohort Children with:	
SASG Peer Language	0.03(0.03)
SADG Peer Language	0(0.03)
DASG Peer Language	0.05+(0.03)
DADG Peer Language	-0.01(0.03)
Older Age Cohort Children with:	
SASG Peer Language	-0.05(0.03)
SADG Peer Language	0.09**(0.03)
DASG Peer Language	0.05(0.03)
DADG Peer Language	-0.05+(0.03)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PPVT = Peabody Picture Vocabulary Test; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Figure 11

Plotting the Simple Slopes for the Interaction Between Peer Language Skill, Peer Age Cohort and Gender, and Child Age Cohort Predicting PPVT Scores



Note: PPVT = Peabody Picture Vocabulary Test; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Considering the relation between peer behavior problems and PPVT scores, there was a significant interaction between peer behavior, peer age cohort, and child gender (*B* = .10, *SE* = .04, *p* = .02). However, upon further examining the interaction, none of the simple slopes were significant. The significance of the interaction appeared to be driven by the lines crossing over one another, suggesting that further attention to this interaction may not be warranted (see Table 18 and Figure 12).

Table 18

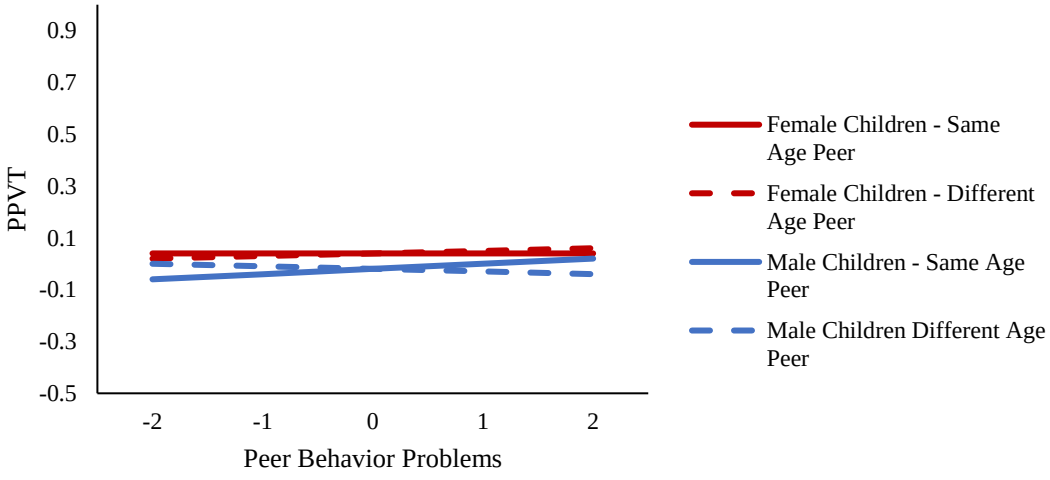
Simple Slopes for the Interaction Between Peer Behavior Problems, Peer Age Cohort, and Child Gender Predicting PPVT Scores

	PPVT
Peer Behavior * Peer Age Cohort * Child Gender	*B(SE)*
Female Children with:	
Same Age Peer Behavior	0.00(0.01)
Different Age Peer Behavior	0.01(0.02)
Male Children with:	
Same Age Peer Behavior	0.02(0.01)
Different Age Peer Behavior	-0.01(0.01)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PPVT = Peabody Picture Vocabulary Test

Figure 12

Plotting the Simple Slopes for the Interaction Between Peer Behavior Problems, Peer Age Cohort, and Child Gender Predicting PPVT Scores



Note: PPVT = Peabody Picture Vocabulary Test

Child Behavioral and Self-Control Outcomes.

***Behavior Problems*.** Peer behavior problems but not peer language skills related to residualized gains in behavior problems. The association varied depending on child age cohort and child gender.

There was a significant main effect of peer behavior problems (B = .03, SE = .01, p = .002) and a significant two-way interaction between peer behavior and child gender (B = .03, SE = .01, p = .02). Regardless of peer age cohort and peer gender, having peers with more behavior problems predicted larger residualized gains in behavior problems for children in both the younger and older age cohort. The relation was somewhat stronger for children in the older cohort (B = .07, SE = .01, p < .001) as compared to children in the younger cohort (B = .04, SE = .01, p < .001). There was also a significant two-way interaction between peer behavior and child age cohort (B = .04, SE = .02, p = .01). Again, regardless of peer age cohort and peer gender, exposure to peers with more behavior problems related to larger residualized gains in behavior problems for both girls and boys. The relation was somewhat stronger for boys (B = .08, SE = .02, p < .001) than for girls (B = .05, SE = .01, p < .001).

***Self-Control*.** Considering the self-control outcome on the DECA, peer behavior problems, but not peer language skills, predicted residualized gains in self-control. The association between peer behavior problems and self-control varied depending on the gender and age cohort of both the target child and peers.

There was a significant interaction between peer language skill, peer gender, child gender, and child age cohort (B = -.05, SE = .02, p = .02). Upon further examination of this interaction, none of the simple slopes were found to be significantly different from zero, so further examination of this interaction is likely unwarranted (see Table 19 and Figure 13).

Table 19

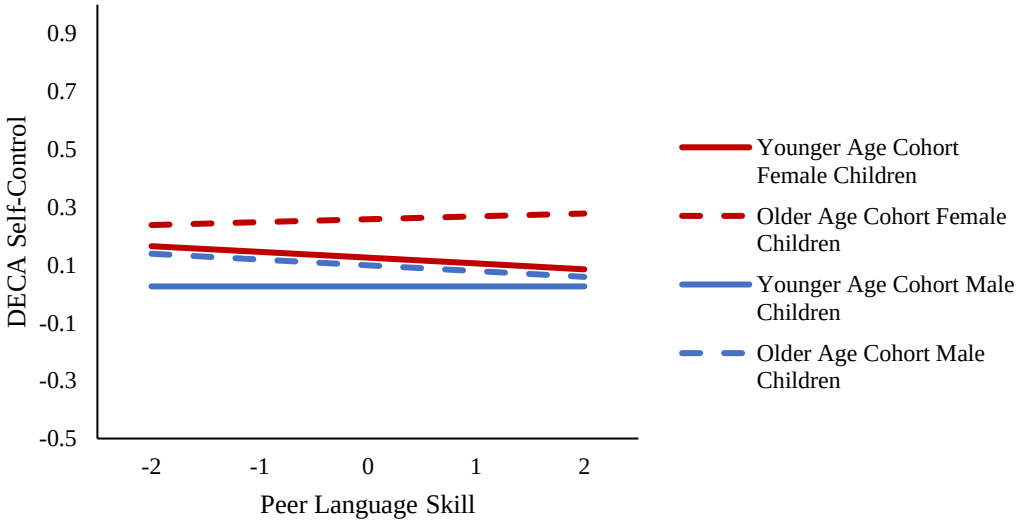
Simple Slopes for the Interaction Between Peer Language Skill, Child Age Cohort. and Child Gender Predicting DECA Self-Control Scores

	Self-Control
Peer Language * Child Age Cohort * Child Gender	*B(SE)*
Peer Language Skill with:	
Younger Age Cohort Female Children	-0.02+(0.01)
Older Age Cohort Female Children	0.01(0.02)
Younger Age Cohort Male Children	0(0.01)
Older Age Cohort Male Children	-0.02(0.01)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; DECA = Devereux Early Childhood Assessment

Figure 13

Plotting the Simple Slopes for the Interaction Between Peer Language Skill, Child Age Cohort, and Child Gender Predicting DECA Self-Control Scores



Note: DECA = Devereux Early Childhood Assessment

Finally, looking at peer behavior problems as the predictor of interest, there was a significant interaction between peer behavior and peer age cohort (*B* = .12, *SE* = .04, *p* = .01). There were two significant three-way interactions, including the interaction between peer behavior, peer gender, and peer age cohort (*B* = .26, *SE* = .12, *p* = .03) and the interaction between peer behavior, peer age cohort, and child age cohort (*B* = -.20, *SE* = .08, *p* = .01). There

was also a significant interaction between peer behavior, peer gender, peer age cohort, and child gender (*B* = -.43, *SE* = .18, *p* = .02). Finally, there was a significant interaction between peer behavior, peer gender, peer age cohort, child gender, and child age cohort (*B* = .71, *SE* = .30, *p* = .02).

This highest order interaction was further examined (see Table 20), revealing that for girls in the younger age cohort, the behavior problems of other girls in the younger age cohort predicted greater residualized gains in self-control (*B* = .11, *SE* = .05, *p* = .04) while the behavior problems of girls in the older age cohort predicted smaller gains in self-control (*B* = -.14, *SE* = .05, *p* = .01). It was not found that the behavior problems of younger or older age cohort boys reliably predicted the self-control of girls in the younger age cohort. Furthermore, there was no strong evidence that peer behavior problems reliably related to the self-control of boys in the younger age cohort or boys or girls in the older age cohort. The nature of these relations for children in the younger age cohort and children in the older age cohort can be seen in Figures 14 and 15, respectively.

Table 20

Simple Slopes for the Interaction Between Peer Behavior Problems, Peer Gender and Age Cohort, and Child Gender and Age Cohort Predicting DECA Self-Control Scores

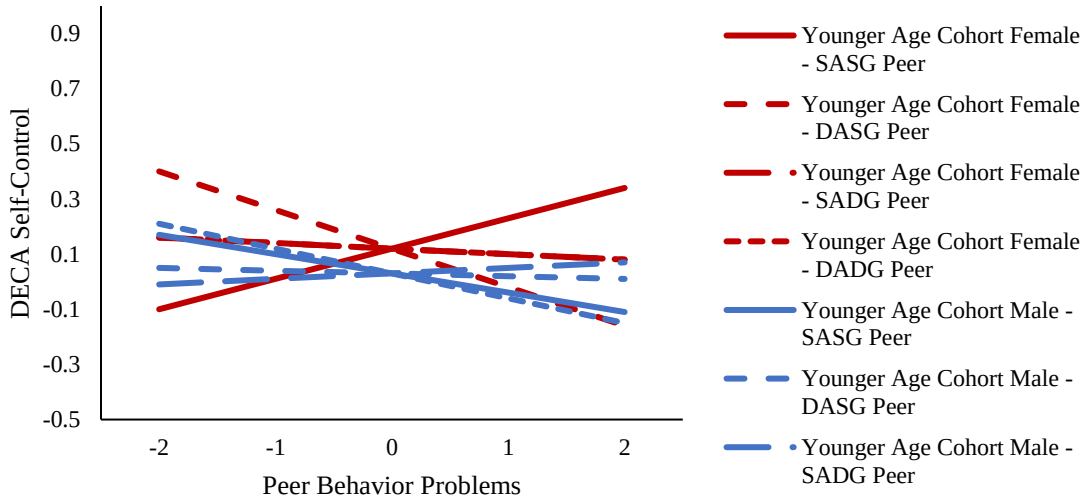
	Self-Control
Peer Behavior * Peer Gender * Peer Age Cohort * Child Gender * Child Age Cohort	*B(SE)*
Younger Age Cohort Female Children with:	
SASG Peer Behavior	0.11*(0.05)
DASG Peer Behavior	-0.14**(0.05)
SADG Peer Behavior	-0.02(0.04)
DADG Peer Behavior	-0.02(0.04)
Younger Age Cohort Male Children with:	
SASG Peer Behavior	-0.07(0.04)
DASG Peer Behavior	-0.01(0.04)
SADG Peer Behavior	0.02(0.06)
DADG Peer Behavior	-0.09+(0.05)

Older Age Cohort Female Children with:	
SASG Peer Behavior	-0.09+(0.05)
DASG Peer Behavior	0.03(0.07)
SADG Peer Behavior	-0.07(0.04)
DADG Peer Behavior	-0.03(0.06)
Older Age Cohort Male Children with:	
SASG Peer Behavior	-0.02(0.04)
DASG Peer Behavior	-0.07(0.06)
SADG Peer Behavior	-0.06(0.05)
DADG Peer Behavior	0.08(0.06)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; DECA = Devereux Early Childhood Assessment; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Figure 14

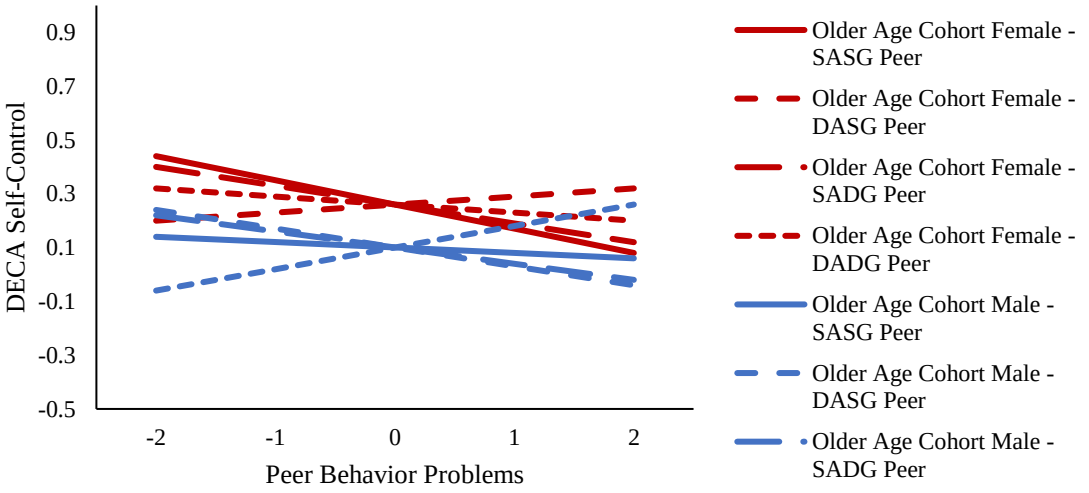
Plotting the Simple Slopes for the Interaction Between Peer Behavior Problems and Peer Gender and Age Cohort for Younger Age Cohort Children Predicting DECA Self-Control Scores



Note: DECA = Devereux Early Childhood Assessment; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Figure 15

Plotting the Simple Slopes for the Interaction Between Peer Behavior Problems and Peer Gender and Age Cohort for Older Age Cohort Children Predicting DECA Self-Control Scores



Note: DECA = Devereux Early Childhood Assessment; SASG = same age same gender, SADG = same age different gender, DASG = different age same gender, DADG = different age different gender.

Discussion

Research has supported a link between peer skill and child development in the preschool setting (e.g., Atkins-Burnett et al., 2017; Henry & Rickman, 2007), but few studies to date have considered whether peer skill interacts with peer and child characteristics. The goal of the present study was to conduct exploratory analyses to examine whether peer and child age cohort and gender play a role in the relation between peer skill and children's language (i.e., auditory comprehension and vocabulary), behavioral, and self-control outcomes. Overall, we found little evidence to support our hypothesis that children would be most strongly influenced by peers of the same age cohort and gender. However, we did find evidence to suggest that peer age cohort and gender are important to consider when studying peer skill and that the role of these peer characteristics may depend on a child's own age cohort, gender, or both. As these interactions

were not hypothesized, replication is warranted before it can be assumed that these relations generalize beyond the present sample.

Peer Skill and Child Development

Our initial analyses looking at the overall average skill level of all peers in a given classroom indicated that both peer language skill and peer behavior problems played a role in predicting child outcomes. Peer language skill related to greater gains in auditory comprehension and vocabulary scores as well as smaller gains in self-control. Higher levels of peer behavior problems also related to greater gains in behavior problems and smaller gains in self-control. These findings are consistent with previous research that also used data from the Educare Implementation Study (Foster et al., 2020) as well as other studies of peer effects (e.g., Atkins-Burnett et al. 2017; Justice et al., 2011; Thomas et al., 2011).

In our primary analyses, we considered whether these relations between peer skill and child outcomes may depend on peer and child age cohort and gender. We examined the skill level of four different peer groups: SASG peers, SADG peers, DASG peers, and DADG peers. Our findings suggest that taking into account peer and child age cohort and gender may be important when trying to understand the relation between peer skill and child development. However, the relations appear to differ depending on the type of peer skill and area of child development being examined.

Examining the Patterns of Results Across All Outcomes

For our main model, we begin by first considering overall patterns of results. We hypothesized that the skill of SASG peers would have the strongest relation with child outcomes. This hypothesis was based on evidence that children segregate by age cohort and gender in preschool classrooms (e.g., Winsler et al., 2002) and the concept of direct peer effects, which

suggests that children are likely to be most strongly influenced by the peers with whom they spend the most time interacting. In the present sample, we found little evidence to support this hypothesis beyond a marginal relation between SASG peer behavior problems and the self-control of older age cohort girls. Looking at peer age cohort and gender independently, there was some additional, although still limited, evidence that same age cohort or same gender peers may play an important role for some children. The auditory comprehension skills of younger age cohort girls were most strongly related to the language skills of SA peers. Furthermore, the vocabulary skills of children in the older age cohort were most strongly related to the language skills of SADG peers. Considering peer gender, younger age cohort girls' self-control was most strongly related to the behavior problems of DASG peers.

One potential explanation for the lack of support for the present hypothesis may be that examining peer age cohort and gender did not fully account for children's complex interaction patterns. For example, even if a child spends a lot of their free time interacting within peer groups mostly comprised of SASG peers, he or she may spend the most time interacting one-on-one with a peer who falls outside of this peer group. Research suggests that even in classrooms where children spend a lot of their time interacting with SASG peers, most children will interact with peers from other peer groups as well (Martin & Fabes, 2001; Winsler et al., 2002). Thus, future research would likely benefit from including indicators of the peers with whom a target child spends the most time interacting in order to determine whether these close peers have the strongest influence on child development.

Although not hypothesized, there was also some evidence of other patterns of results. The skills of different age cohort peers appeared to relate somewhat consistently with child outcomes with the nature of the relation depending on peer gender, child gender, child age cohort, or some

combination of these variables. For example, the language skill of DA peers was negatively related to the auditory comprehension scores of girls in the younger age cohort while the behavior problems of DADG peers positively related to the auditory comprehension skills of older age cohort boys. It may be the case that cross-age cohort interactions are more challenging for children to navigate than same-age cohort interactions due to gaps in skill and interests between older age cohort and younger age cohort children (Lederberg et al., 1986; Maccoby, 2002). Whether navigating these challenges is beneficial or harmful for child development may depend on a variety of factors, including child characteristics and the outcome under consideration. More detailed potential explanations for the significant interactions are presented in the following subsections.

These findings related to different age cohort peers may help to explain some of the mixed results in the literature regarding the relation between attending a mixed age classroom and differences in outcomes for younger and older children. For example, while some studies have found benefits of attending mixed age classrooms for older (Derscheid, 1997) and younger children (Bailey et al., 1993; Winsler et al., 2002), there is also evidence that older children may have poorer outcomes in mixed age classrooms as compared to same age classrooms (Bailey et al., 1993; Winsler et al., 2002). Some more recent larger scale studies did not find evidence of a relation between mixed age classroom attendance and children's academic (Bell et al., 2013**)**, social, emotional, or behavior skills (Ansari et al., 2016; Bell et al., 2013). The present study suggests that when child and peer characteristics as well as peer skill are taken into account, the pattern of results may differ across different groups of children depending on the examined outcome. The conflicting results of previous mixed age classroom research may be due to a failure to take all of these variables into account.

Some evidence in the present study also indicated that peer skill may be particularly important for girls in the younger age cohort. For example, the language skill of SA peers positively predicted auditory comprehension while the behavior problems of DASG peers negatively predicted self-control. Perhaps younger age cohort girls enter the preschool classroom with a greater susceptibility to peer influences than younger age cohort boys. This greater susceptibility to peer influences may be because girls have a stronger inclination to cooperate and fit in with their peers than boys (see Fabes et al., 2003). Once girls transition to the older age cohort, susceptibility to peer influence may decrease due to being at a higher level of skill development and already having an established peer group to which they belong.

Child Language Development: Peer Influences on Auditory Comprehension Development

Considering children's residualized gains in auditory comprehension, younger age cohort girls were positively influenced by the language skills of younger-cohort peers and negatively influenced by the language skills of older-cohort peers. In contrast, there was no reliable evidence that the language skill of either younger or older age cohort peers predicted the auditory comprehension of younger age cohort boys, older age cohort boys, or older age cohort girls.

Younger age cohort girls may have had opportunities to increase auditory comprehension through conversations with other younger cohort children in the classroom. The preschool classroom is many children's first opportunity to interact with large groups of peers (Darwish et al., 2001), so younger cohort girls entering the preschool classroom for the first time may need to learn how to understand and communicate with their peers, strengthening their auditory comprehension skills. Research suggests that girls engage in more cooperative play than boys, which relies on the ability to effectively communicate with and understand one's peers (Martin

& Fabes, 2001). From a young age, girls have stronger language skills and rely more on verbal interactions when engaging with peers than boys (Edwards et al., 2001; Merrell & Gimpel, 2014). Learning how to navigate a positive play scenario and engaging in conversation with other younger age cohort peers in the classroom may have contributed to younger age cohort girls' developing auditory comprehension skills. Younger age cohort boys may not have benefited from their peers in the same way due different play preferences and interaction patterns. For example, young boys prefer rough and tumble play, which focuses on physical activity and may rely on less complex communication skills than more cooperative play (Merrell & Gimpel, 2014; Smith & Inder, 1993; St George & Fletcher, 2020).

Exposure to older age cohort peers with higher language skills may have been related to smaller residualized gains in auditory comprehension skills for younger age cohort girls due to a lack of scaffolding. Older age cohort peers were likely using more advanced language than younger age cohort children. However, older age cohort children with higher skills may not have provided the supports younger cohort girls need to develop their auditory comprehension. In contrast, older cohort peers with lower levels of skill may still have somewhat higher skills than their younger cohort peers. This slightly more advanced input may be within the zone of proximal development (Vygotsky, 1978) and beneficial for the auditory comprehension development of younger cohort girls even without explicit scaffolding from peers.

The lack of evidence for an association between peer language skill and auditory comprehension for children in the older age cohort may be because these children had less to gain from their peers due to being at a skill level that already exceeds that of many of their peers in a mixed age environment (Cohen & Lotan, 1995; Justice et al., 2011). The PLS AC assesses children's understanding of vocabulary and grammar, and children in the older age cohort likely

have an understanding of language that surpasses their younger age cohort peers in these areas. Furthermore, many children in the older age cohort attended Educare classrooms in the year prior to collection of outcome data. Due to having similar educational experiences and potential exposure to verbally skilled peers in their prior year, older age cohort children may have had less to gain in terms of auditory comprehension from other older age cohort peers with high levels of language skill. Older age cohort children may be at a stage where meaningfully advancing their auditory comprehension skills requires more advanced language input and support from their teachers or other adults. It may also be the case that the other aspects of peer language skill not captured by the measure of vocabulary used in the present study would make more of a difference for the auditory comprehension development of older age cohort children.

A relation was also found between peer behavior problems and children's auditory comprehension. For younger age cohort girls, the behavior problems of boys in the older age cohort were the strongest peer predictor with higher levels of peer behavior problems linked to smaller residualized gains in auditory comprehension. For boys in the older age cohort, the behavior problems of younger age cohort boys were a predictor of smaller residualized gains in auditory comprehension while the behavior problems of younger age cohort girls were a predictor of larger residualized gains in auditory comprehension.

Exposure to older age cohort boys with more behavior problems may have been a particularly negative experience for younger age cohort girls' developing auditory comprehension skills through disruptions in peer interactions. As discussed, younger age cohort girls' auditory comprehension skills appear to benefit from exposure to younger age cohort peers with higher language skills. Thus, girls' auditory comprehension skills likely benefit from opportunities to engage with peers in conversation. However, boys with behavior problems often

display more externalizing behaviors than girls, which may be particularly disruptive to positive peer interactions, reducing opportunities for younger age cohort girls to advance their auditory comprehension skills (see Miner & Clarke-Stewart, 2008). Boys with more behavior problems may also require more teacher attention, reducing opportunities for younger age cohort girls to build their auditory comprehension skills through conversations with their teachers. However, based on these explanations, it is unclear why the behavior problems of younger age cohort boys would not have a similar relation with the auditory comprehension of younger age cohort girls.

Furthermore, for older age cohort boys, the pattern of results differed such that the behavior problems of younger age cohort boys, but not other older age cohort boys, predicted smaller residualized gains in auditory comprehension. Younger age cohort boys with more behavior problems may have a stronger preference to engage in rough and tumble play that involves less complex conversation (Smith & Inder, 1993; St George & Fletcher, 2020). Older age cohort boys who engage with these peers may then have fewer opportunities to make gains in their auditory comprehension skills through peer conversation. Again, it is unclear why higher levels of behavior problems among older age cohort boys would not lead to a similar pattern of results, warranting replication of these unexpected findings. A greater understanding of peer interaction patterns and the content of those interactions may also help to clarify some of these somewhat conflicting results.

For older age cohort boys, there was also a relation between the behavior problems of younger age cohort girls and larger residualized gains in auditory comprehension skills. When faced with peer problems, girls tend to respond more competently than boys and may be more likely to rely on verbal strategies to talk through their problems (Walker et al., 2002). Exposure to this use of verbal problem-solving strategies may be beneficial for the auditory comprehension

skills of older age cohort boys. Furthermore, when boys and girls play together, they often play in closer proximity to adults than boys would alone, contributing to greater levels of adult supervision (Fabes et al., 2003). When girls display behavior problems around nearby adults, the adults may encourage and scaffold the use of verbal strategies to work through these problems, again potentially benefiting the auditory comprehension skills of older age cohort boys who are in close proximity. A similar pattern may not be found with older age cohort girls due to segregation by gender becoming stronger with age, limiting opportunities for direct peer effects on older age cohort males (Martin et al., 2005; Winsler et al., 2002).

There was no evidence of a reliable relation between peer behavior problems and auditory comprehension for boys in the younger age cohort or girls in the older age cohort. For girls in the older age cohort, it may be the case that their auditory comprehension skills are at a level that is less susceptible to peer influences. Looking at raw scores, older age cohort girls had the highest average auditory comprehension scores out of all four groups of children. During play, boys in the younger age cohort may be relying on less complex communication with peers in general (Merrell & Gimpel, 2014), creating fewer opportunities for peers to influence the development of their auditory comprehension skills. Thus, exposure to peers with more or fewer behavior problems may not make a meaningful difference for the development of the auditory comprehension skills of younger age cohort boys.

Child Language Development: Peer Influences on Vocabulary Development

There was little evidence of a reliable relation between peer language skill and the vocabulary skills of children in the younger age cohort as measured by the PPVT. This finding was unexpected due to research and theory suggesting that exposure to verbally-skilled peers supports children's vocabulary growth (e.g., Henry & Rickman, 2007; Justice et al., 2011).

Perhaps children in the younger age cohort relied more on teacher input and scaffolding than on peer input to advance their vocabulary skills. Younger age cohort children may not have frequently engaged in the types of peer interactions needed to contribute to advances in vocabulary. Due to having less developed language skills than their older cohort peers, younger cohort children who played with one another may have relied less than older cohort children on verbal negotiations and sustained conversations during play. Research suggests that language use during play increases in complexity as children grow older (Levy et al., 1986; Weisberg et al., 2013). Younger age cohort children may have also been spending time establishing their peer groups. Until these groups were established, children in the younger cohort may have engaged in less complex interactions with their peers due to a lack of established games and conversation topics that are associated with stronger peer relationships (Newcomb & Bagwell, 1995).

The lack of an association with the language skills of older age cohort peers may be because younger age cohort children did not have enough sustained interactions with more verbally skilled older cohort peers to make meaningful gains in vocabulary. Research suggests that segregation by age cohort sometimes occurs during play in mixed age classrooms (Winsler et al., 2002), which may have limited opportunities to benefit from older cohort peers.

For children in the older age cohort, the language skills of SADG peers related most strongly to residualized gains in vocabulary. Cross-gender interactions may be more difficult to navigate than same-gender interactions due to differences in preferences, play styles, and points-of-view (Smith & Inder, 1993). Thus, agreeing on an activity and maintaining an interaction may require more verbal negotiation than is the case in same-gender interactions. Girls have been found to be better at social problem-solving than boys and are more likely than boys to attempt to mitigate conflict rather than retaliate or use aggression (Miller et al., 1986; Walker et al.,

2001). The strategies employed by girls often rely more strongly on verbal skills, such as offering compromises, persuasion, or clarifying the other person's feelings (see Holmes-Lonergan, 2003). Applying verbal skills to navigate cross-gender peer interactions may provide girls with opportunities to strengthen their vocabulary skills. Responding to and listening to girls' negotiations may also be beneficial for boys' developing vocabulary skills.

Peer Influences on the Development of Child Behavior Problems

Contrary to study hypotheses, peer influences on behavior problems did not differ by peer age cohort and gender. However, exposure to higher levels of peer behavior problems overall predicted larger residualized gains in behavior problems for both older and younger age cohort children as well as both boys and girls.

These findings are in line with research that has found preschool attendance to be associated with increased behavior problems; researchers have hypothesized that this relation is at least partially attributable to peer processes in the classroom (Belsky et al., 2007). Many behavior problems, such as aggression, are highly visible and disruptive in the classroom, and children who display behavior problems often receive attention from the teacher (Goldstein et al., 2001; Thomas et al., 2011). Children who observe behavior problems among their peers sometimes imitate those behaviors, particularly if they desire their teacher's attention (Goldstein et al., 2001). In classrooms with higher levels of behavior problems, children may also be more accepting of peers with behavior problems or even encourage the display of behavior problems (Thomas et al., 2011).

Considering indirect effects, teachers may also have to spend more time focusing on children with behavior problems. In classrooms with high levels of behavior problems, teachers likely have less time to engage in positive interactions with children or present interesting

lessons and activities. Children in these classrooms may begin to display more behavior problems due to boredom or a lack of supervision. Thus, high levels of peer behavior problems overall regardless of peer age cohort and gender may have a negative influence on children's behavior.

Peer Influences on the Development of Self-Control

Considering the relation between peer behavior problems and self-control, our results suggested that effects differed by peer and child gender and age cohort. For girls in the younger age cohort, exposure to other younger age cohort girls with high levels of behavior problems was related to larger residualized gains in self-control. In contrast, exposure to girls in the older age cohort with more behavior problems was related to smaller residualized gains in self-control. There was not strong evidence that peer behavior problems reliably predicted self-control for older age cohort girls or boys overall.

As discussed, younger children are still learning how to navigate peer interactions (Bagwell & Schmidt, 2011). Girls tend to learn strategies to mitigate peer conflict and seek compromise and cooperation among their peers (Miller et al., 1986; Walker et al., 2001). Exposure to SASG peers with more behavior problems may help younger cohort girls learn how to employ social problem-solving strategies that foster cooperation among peers, such as talking through a problem. Learning how to employ such strategies that meet these goals rather than more impulsive strategies, such as retaliation or aggression, may foster increases in self-control.

In contrast, children are often found to use their older peers as models (French, 1987; Katz et al, 1990; Moller et al., 2008), so girls in the younger age cohort may be using older age cohort girls as models for their behavior. If older cohort girls are displaying high levels of behavior problems, younger cohort girls may be imitating these problem behaviors and

displaying lower levels of self-control. This conclusion is in line with the finding that behavior problems and self-control were strongly negatively correlated in the present sample. Younger cohort girls may also benefit from having older age cohort girls to act as models to learn peer interaction strategies that rely on self-control. However, if older cohort girls are displaying high levels of behavior problems, younger cohort girls may miss out on these learning opportunities and experience more frustrating peer interactions that contribute to lower levels of self-control.

Somewhat surprisingly, the behavior problems of boys did not play a role in the relation between peer behavior problems and self-control. Boys often display more externalizing behavior problems than girls, such as aggression, that are likely noticeable to children and have an influence on the functioning of the classroom (see Miner & Clarke-Stewart, 2008). Perhaps children were more likely to avoid boys with high levels of behavior problems or teachers more often separated these boys from their peers, reducing the possibility of strong direct peer effects on the development of self-control.

Similarly, it is less clear why peer behavior problems were unrelated to residualized gains in self-control for the other examined groups of children. Girls in the older age cohort may have experienced peer influence when they were in the younger age cohort and be at a point in the development of their self-control where peers no longer play a strong role. Boys' self-control development may be more strongly predicted by other factors, such as parenting or other aspects of the classroom environment, such as their relationship with their teacher. Future research is needed to replicate the present findings for self-control and examine the mechanisms through which peer behavior problems influence the development of self-control in preschoolers.

Summary of the Present Findings

Overall, our findings suggest that peer skill plays a role in predicting the language, behavioral, and self-control outcomes of preschoolers. However, these relations appear to differ depending on peer and child age cohort and gender as well as the examined area of development. We did not find strong evidence to support our hypothesis that the skill of SASG peers would be the strongest predictor of child outcomes. Rather, the pattern of results differed across outcomes and for particular groups. Our hypothesis was based on evidence that children segregate by age cohort and gender in preschool classrooms (Winsler et al. 2002) and that children would be most strongly influenced by the peers with whom they spend the most time. However, we lacked data on the peers with whom individual children spent the most time interacting. To better understand the present results, more work is needed to examine children's peer interaction patterns and the role played by both direct and indirect peer effects on children's developing language and behavioral skills. Due to the exploratory nature of our analyses and lack of support for our hypothesis, the present results must be interpreted with caution until they are replicated.

Implications

The complex and exploratory nature of the present analyses makes considering practical implications of this work somewhat difficult. However, the results do suggest that for some groups of children, exposure to the skills of peers outside of their SASG peer groups may be beneficial for particular outcomes. As there is evidence that children in mixed age classrooms increasingly segregate by age cohort and gender over the course of the schoolyear (Winsler et al., 2002), teachers may aim to create opportunities for preschoolers to interact with more diverse groups of peers in terms of age cohort, gender, and skill level in order to maximize potential benefits. Positive peer effects may also be strengthened if teachers help children learn basic

scaffolding strategies, such as how to appropriately correct a peer, to support the transfer of peer skills.

Along with potential benefits, our results also suggest that exposure to the skills of particular peer groups may lead to more negative outcomes for some groups of children. Therefore, when creating opportunities to interact with diverse groups of peers in the classroom, it may be important for adults to monitor the interactions in order to promote positive development and minimize the potential for negative effects. Research suggests that the strategic management of peer interactions can help to promote more positive development (DeLay et al., 2016). Teachers may need training in order to understand how to create optimal interaction opportunities with diverse groups of peers. Through future studies that aim to replicate and expand on the present study, it will be possible to more thoroughly explore the implications of the interplay between peer skill and child and peer characteristics.

Limitations

One limitation of the present study is that our analyses were observational in nature. Thus, we cannot draw causal conclusions based on the present analyses. Although our models included multiple control variables, other factors may be contributing to the observed results, such as differences in the ways teachers interact with children depending on their age cohort and gender or the ways teachers promote peer interactions in the classroom.

Although our sample size was relatively large, the number of SASG children in each classroom was small, thereby limiting children's choices for play partners, and possibly limiting our power to detect effects. Moreover, we were examining complex interactions. The complexity of our models may have limited our power to detect smaller effects, potentially impacting the conclusions that can be drawn from the present study. However, it is questionable whether any

undetected smaller effects would be meaningful when considering children's development on the examined outcomes.

Due to the complicated nature of the analyses and limitations of the sample, we also did not examine other peer characteristics that may be relevant to the relation between peer skill and child development. In particular, it would be beneficial to consider the role of race. Research suggests that as early as preschool, children will show preferences for play partners based on race (Fishbein et al., 2009), so race may play a role in the strength of peer effects. For example, in a classroom with two Hispanic children, those two may spend more time with each other than with other children regardless of their gender or age cohort. Similarly, children who know each other from non-school contexts such as church, neighborhood, or family, may choose to spend large amounts of time together regardless of their gender or age cohort.

The present study is also limited in that no data were available on the peers with whom the target child was interacted, the content of those interactions, and the amount of peer interaction. As discussed, children may be more strongly influenced by the peers with whom they most interact, and certain types of interactions likely create more opportunities for skills to transfer. Some teachers may also create more opportunities for peer interaction than others, increasing the likelihood of direct peer effects. Considering peer characteristics in combination with children's interaction patterns may lead to a deeper understanding of the way peer effects operate in the preschool classroom.

Another limitation of the present study is that the outcomes examined were limited to children's language, behavioral and self-control skills. Our results suggest that the relation between peer skill and child development may differ depending on the examined outcomes.

Future work may look beyond the present outcomes to consider child development in areas such as literacy and social skills.

Conclusion

Overall, the results of the present study contribute to the growing literature supporting the importance of peer effects in the preschool classroom. We considered the role of both peer and child characteristics, and our results indicate that the interplay between peer skill and peer and child age cohort and gender is complicated and may differ depending on the examined outcome. As the present study was exploratory in nature and the results generally differed from our hypothesis, all results must be viewed with caution until further evidence is collected. More research is needed to better understand how peer effects operate in preschool and to explore potential explanations for the present results.

CHAPTER 5: INTEGRATIVE DISCUSSION

Research has consistently demonstrated that the skill level of a preschooler's peers can play a role in supporting positive development (e.g., Henry & Rickman, 2007; Justice et al., 2011; Mashburn et al., 2009). In the present dissertation, my goal was to expand this existing research base through three studies that explored the role of child and peer characteristics in the relation between peer skill and child development in the preschool setting. To date, this topic has been understudied but holds important implications for informing classroom policies and interventions that involve a child's peers.

Overall, the results of the present studies support the importance of examining the role of child and peer characteristics when studying peer effects. In particular, we found evidence to suggest that children's skill level upon entry to preschool, DLL status, age cohort, and gender moderate the role of peer effects in the preschool classroom. However, many questions still remain regarding how peer effects operate and support positive child development. It is important to note that some of the present results contradicted our hypotheses and suggested that peer effects may not operate in the same way across different outcomes for different groups of children. Thus, additional research is needed to replicate our findings and to better understand the mechanisms that drive peer effects. These studies did not examine the independent contributions of direct and indirect peer effects nor how they might differ across types of outcomes or child characteristics such as age. A better understanding of how peer effects operate in the classroom will help to inform future policies and practices that are based in the peer effects literature.

Understanding the Mechanisms Behind Peer Effects

Both direct and indirect peer effects likely operate in the preschool classrooms. While direct peer effects involve peer-to-peer interactions, indirect peer effects generally focus on the way peer skill level may contribute to changes in the classroom environment (Henry & Rickman, 2007). For instance, as discussed previously, a classroom with less skilled children on average may have access to more supports and resources that are beneficial for all children (Gottfried, 2015). Teachers may also change the way they interact with a class depending on child skill level, such as by spending more time interacting with less skilled children in classrooms where children are more skilled on average. Exploring the role of such indirect mechanisms may contribute to a better understanding of peer effects in the preschool classroom and clarify some of the present findings that are more difficult to explain through direct peer effects alone.

In addition, considering our differing patterns of results across outcomes in all three studies, it is also likely the case that the mechanisms through which peer effects operate differ depending on the examined area of development. For example, there may be a strong direct relation between children's language development and opportunities to practice their language skills with peers with higher levels of skill. In contrast, children are less likely to spontaneously engage in literacy activities with one another without teacher guidance, so children's literacy skills may benefit more from indirect changes to the classroom learning environment that are linked to peer skill level. Similarly, peer influences on self-control and behavioral problems may be driven primarily by indirect mechanisms such as teachers' reactions to peers' disruptive behavior in the classroom.

The Role of Child and Peer Characteristics

As the present studies point to the importance of considering peer and child characteristics when studying peer effects, future research may also consider the role of other characteristics not examined in the present studies. For example, the present research did not consider the role of race. Research suggests that preschoolers show preferences for playmates based on race (Fishbein et al., 2009). Based on these preferences, children may be more strongly influenced by peers in certain racial groups. Learning more about the interplay between peer influence and race may help teachers better understand how to effectively promote and support diverse peer interactions in the preschool classroom. Another possible characteristic to consider is child temperament. For example, children who are more outgoing may have more opportunities to directly benefit from peer interactions while children who are shyer may have more limited peer interactions, reducing opportunities to benefit from peers.

Observational Studies of Peer Effects

Future research would also benefit from the use of classroom observations to better understand whether the strength of peer effects depends on the peers with whom a child spends the most time interacting, the types of interactions in which children engage, and the extent to which children have opportunities to engage with their peers. As discussed in Study 3, the concept of direct peer effects suggests that children are likely to be more strongly influenced by the peers with whom they spend more time interacting. However, Study 3 was limited in that no data were available on the specific peers with whom children interacted or the content of those interactions, such as the use of language or mutual engagement in academic activities. Understanding the contributions of peers with whom a child interacts could help clarify the

unique contributions of direct and indirect peer effects to child development in different domains.

Observational techniques may also help researchers understand whether children are simply influenced by the peers with whom they spend more time or whether children are influenced more strongly by some peers based on their characteristics. For example, a three-year-old Black girl may spend most of her time interacting with a four-year-old White girl, a three-year-old Black girl, and a four-year-old Black girl in her class. Although the girl spends a similar amount of time interacting with each peer, she may be more likely to use one peer as a model depending on peer race and age, and in turn, be more strongly influenced by this peer than the other two.

The content of peer interactions is also likely important in determining the strength of peer effects. Children may play or engage in academic activities together, but the level and quality of interaction that occurs can vary widely. For example, if a child with low language skills is interacting with a more highly skilled peer on the playground but little conversation is occurring, it is unlikely that the higher language skills of the peer are having any direct benefits for the less skilled child.

Depending on the structure of the preschool day provided by the teacher, some children may be in classrooms where there are more opportunities to engage with peers than others. For example, one teacher might focus more time on whole group instruction where children must pay attention to the teacher while another teacher provides children more opportunities for free play and centers where children can engage with their peers. Classrooms where children have more opportunities to engage with their peers may have stronger direct peer effects.

The Implications of Peer Effects Research for Preschool Classrooms

As peer effects in the preschool classroom are better understood, researchers may also consider the potential benefits of classroom practices and interventions that aim to capitalize on the positive influences interacting with skilled peers may have on child development. Although it is common to split children into groups to collaborate on academic activities, most research on this topic has been done with older children and little is known about effective preschool peer grouping practices (Park & Lee, 2015).

Understanding the role of child and peer characteristics can help identify the children who may benefit the most from opportunities to interact with more highly skilled peers and the types of peers that most benefit particular groups of children. For example, the results of Study 2 suggest that DLL children may benefit more than EO children in terms of English vocabulary development from opportunities to interact with peers with better vocabularies. This finding is in line with research that has suggested that DLL children may benefit from being paired up with peers with strong English skills when completing classroom activities (Atkins-Burnett et al., 2017; Gersten et al., 2007). The results of Study 3 were more complex, suggesting that the influence of different groups of peers may differ depending on a child's age cohort and gender and the examined area of development. Continued research is needed to inform how teachers can best organize learning activities or play groups and facilitate positive peer interactions to provide children with opportunities to benefit from their more highly skilled peers. The current results suggest that encouraging diverse peer interactions in the preschool setting with teacher supervision to help minimize the possibility of negative influences may be an important first step.

As interventions based in the peer effects framework are researched and developed to benefit the children who enter preschool behind their peers, the potential positive and negative impacts for highly skilled children will also need to be considered. Some research suggests that children can benefit from explaining concepts to their peers (Duran, 2017), and in Study 1, we found some evidence to suggest that in certain circumstances, it may be that more highly skilled children benefit the most from exposure to other highly skilled peers. Whether these findings hold in the context of specific interventions or classroom policy changes needs to be explored.

Findings from the present dissertation and related future research may also influence policies related to the organization of preschool classrooms. As children are thought to benefit from exposure to more highly skilled peers, some researchers have argued that preschool programs that target low-income children should consider creating slots for children who are from more advantaged backgrounds and more likely to have higher levels of skills (Atkins-Burnett et al., 2017). Although the results of Study 1, which examined the role of child skill, were mixed, we did find evidence to suggest that children with lower language skills benefit from exposure to more verbally skilled peers. To better understand whether creating slots for more highly skilled children could be beneficial, studies using experimental designs to manipulate the average skill level of peers in classrooms could provide stronger causal evidence to link increases in average peer skill to better child development. As explored in Study 3, the age cohort and gender of peers may be additional factors to consider when attempting to create balanced classrooms that provide as many children as possible with opportunities to benefit from their peers. However, if such policies are considered in the future, it will also be necessary to determine how to create classrooms that take these factors into account without reducing the number of preschool slots for the children who need them most.

Conclusion

Overall, the present dissertation contributes to the growing literature focused on understanding the role of peers in the preschool classroom. Peer effects are clearly complex, and our results suggest that the relation between peer skill and child development cannot be fully understood without considering the role of child and peer characteristics. More research is needed to continue to explore for whom peer skill matters most and which peers may have the strongest influence on children with different characteristics. Furthermore, an important next step will be to consider why positive relations between peer skill and child development are found for some groups of children but not others and why patterns of results differ across areas of development. With continued work, a better understanding of how to effectively harness the benefits of peer effects in the preschool classroom can be reached.

APPENDIX A: CORRELATIONS FOR SAMPLE AND CLASSROOM PROPORTIONS – STUDY 1

Table 1A

Correlations Between Sample Proportions and Classroom Proportions of Child Characteristics

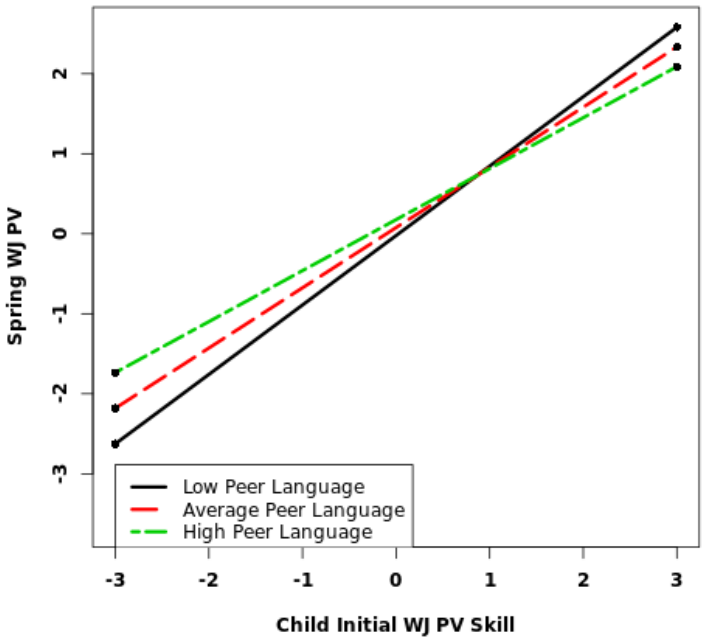
	Sample DLL	Sample Male	Sample Hispanic	Sample Black	Sample White
Classroom DLL	0.90***				
Classroom Male		0.53***			
Classroom Hispanic			0.89***		
Classroom Black				0.83***	
Classroom White					0.67***

Note: * p<.05; ** p<.01; *** p<.001; DLL = dual language learner

APPENDIX B: INTERACTIONS WITH PEER SKILL AS THE MODERATOR – STUDY 1

Figure 1B

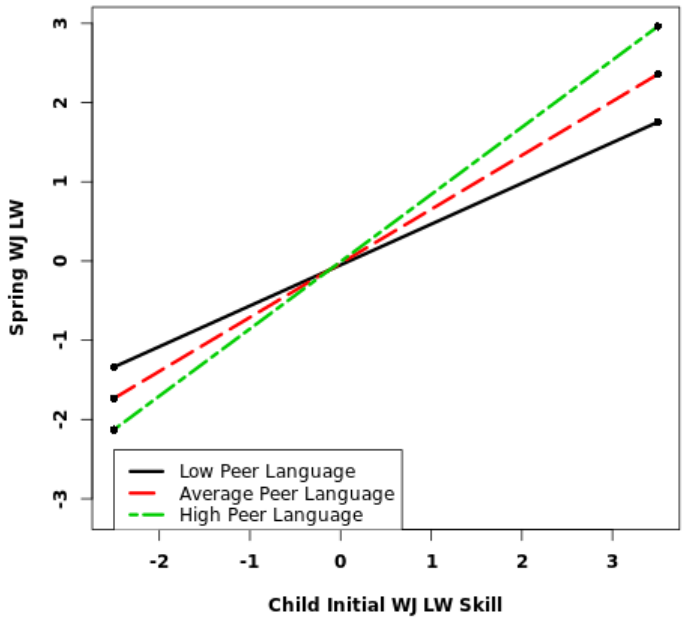
Plotting the Interaction for Child Initial WJ PV Skill with Peer Language Skill as the Moderator



Note: Low peer language indicates 1 SD below the mean, average peer language indicates the mean, and high peer language indicates 1 SD above the mean; WJ PV = Woodcock Johnson Picture Vocabulary.

Figure 2B

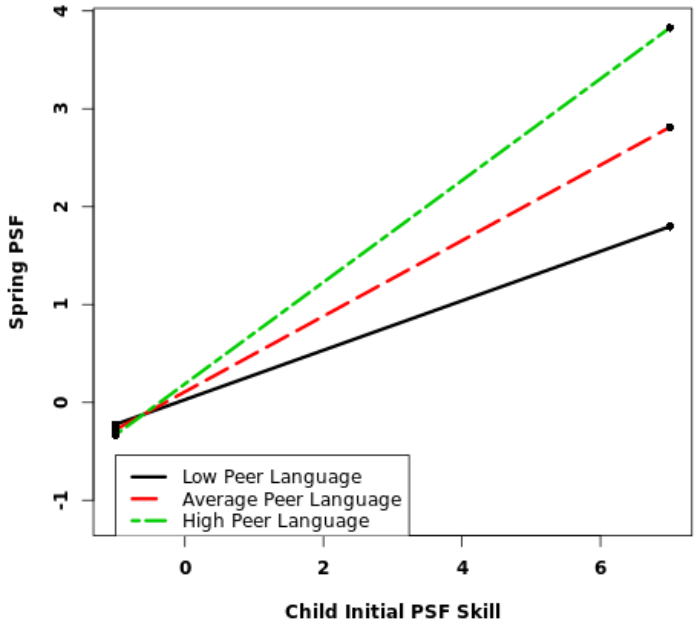
Plotting the Interaction for Child Initial WJ LW Skill with Peer Language Skill as the Moderator



Note: Low peer language indicates 1 SD below the mean, average peer language indicates the mean, and high peer language indicates 1 SD above the mean; WJ LW = Woodcock Johnson Letter-Word Identification.

Figure 3B

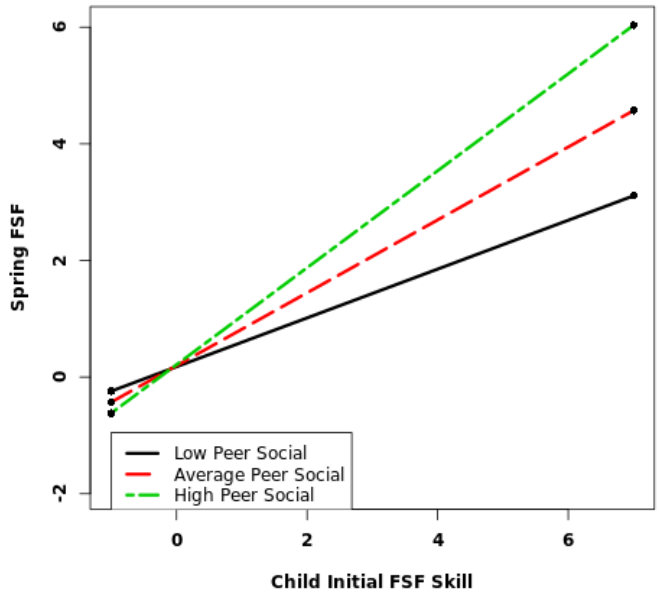
Plotting the Interaction for Child Initial PSF Skill with Peer Language Skill as the Moderator



Note: Low peer language indicates 1 SD below the mean, average peer language indicates the mean, and high peer language indicates 1 SD above the mean; PSF = Phoneme Segmentation Fluency

Figure 4B

Plotting the Interaction for Child Initial FSF Skill with Peer Language Skill as the Moderator



Note: Low peer language indicates 1 SD below the mean, average peer language indicates the mean, and high peer language indicates 1 SD above the mean; FSF = First Sound Fluency

APPENDIX C: CORRELATIONS FOR SAMPLE AND CLASSROOM PROPORTIONS – STUDY 2

Table 1C

Correlations Between Sample Proportions and Classroom Proportions of Child Characteristics

	Sample DLL	Sample Male	Sample Hispanic	Sample Black	Sample White
Classroom DLL	0.90***				
Classroom Male		0.52***			
Classroom Hispanic			0.91***		
Classroom Black				0.84***	
Classroom White					0.73***

Note: * p<.05; ** p<.01; *** p<.001; DLL = dual language learner

APPENDIX D: PEER WJ PV SKILL AS A PREDICTOR OF CHILD OUTCOMES – STUDY 2

Table 1D

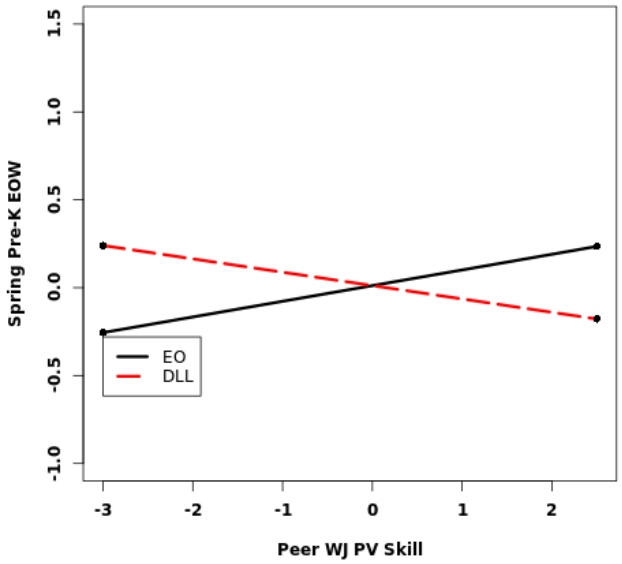
HLMs Examining Child DLL Status as a Moderator of Peer English Language Skill

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Intercept	0.01(0.1)	0.1(0.06)	0.01(0.09)	0.19+(0.1)	0.14(0.11)	0.09(0.09)	0.03(0.07)	-0.06(0.08)
Fall PK Skill	0.6***(0.04)	0.79***(0.04)	0.67***(0.04)	0.5***(0.05)	0.42***(0.05)	0.74***(0.04)	0.80***(0.03)	0.71***(0.04)
Child DLL	0.00(0.11)	-0.24*(0.10)	0.09(0.12)	-0.06(0.13)	-0.16(0.14)	-0.03(0.11)	0.07(0.09)	0.19+(0.11)
Maternal Education	-0.04(0.04)	0(0.03)	0.04(0.05)	0.04(0.05)	0.01(0.05)	0.02(0.04)	-0.04(0.04)	0.06(0.04)
Child Gender	0.03(0.07)	0(0.05)	-0.15*(0.07)	-0.21*(0.08)	-0.12(0.09)	-0.05(0.07)	-0.04(0.06)	-0.06(0.07)
Child Race (Black)	-0.19*(0.10)	-0.01(0.07)	0.04(0.1)	-0.0242	-0.13(0.11)	-0.19*(0.09)	-0.09(0.08)	0.03(0.09)
Proportion DLL	0.11(0.09)	0.05(0.04)	0.03(0.08)	0.04(0.08)	0.06(0.08)	0.01(0.07)	0.06(0.06)	0.12+(0.07)
CLASS Total	-0.02(0.05)	0.01(0.03)	0.08+(0.05)	-0.03(0.05)	-0.06(0.05)	0.01(0.04)	0.03(0.03)	0.05(0.04)
Peer WJ PV	0.09(0.08)	0.01(0.04)	-0.02(0.08)	0.09(0.08)	0.14+(0.08)	0.03(0.07)	0.06(0.05)	0.07(0.06)
Peer WJ PV*DLL Status	-0.17*(0.09)	0.01(0.06)	-0.18*(0.09)	-0.12(0.10)	-0.15(0.1)	-0.08(0.08)	0.01(0.07)	-0.06(0.08)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems; DLL = dual language learner; CLASS = Classroom Assessment Scoring System

Figure 1D

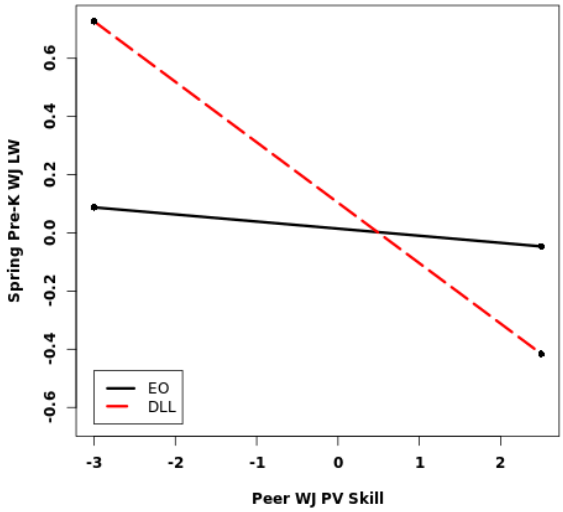
Plotting the Interaction Between Peer English Language Skill and Child DLL Status Predicting Spring EOW Scores



Note: EOW = Expressive One Word Picture Vocabulary, WJ PV = Woodcock Johnson Picture Vocabulary; EO = English only; DLL = dual language learner

Figure 2D

Plotting the Interaction Between Peer English Language Skill and Child DLL Status Predicting Spring WJ LW Scores



Note: WJ LW = Woodcock Johnson Letter-Word Identification, WJ PV = Woodcock Johnson Picture Vocabulary; EO = English only; DLL = dual language learner

APPENDIX E: PEER WM PV SKILL AS A PREDICTOR OF CHILD OUTCOMES – STUDY 2

Table 1E

HLMs Examining Child DLL Status as a Moderator of Peer Spanish Language Skill

	EOW	WJ PV	WJ LW	FSF	PSF	WJ AP	Self-Regulation	Social Skills
Intercept	-0.05(0.14)	0.04(0.12)	-0.02(0.15)	0.16(0.15)	0.13(0.14)	0.05(0.12)	0.10(0.14)	0.02(0.13)
Fall PK Skill	0.38***(0.10)	0.81***(0.08)	0.36***(0.11)	0.35**(0.11)	-0.11(0.11)	0.52***(0.09)	0.64***(0.08)	0.59***(0.08)
Maternal Education	-0.11(0.09)	-0.05(0.07)	0.07(0.09)	0.02(0.09)	0.06(0.1)	0.02(0.08)	-0.07(0.07)	0.07(0.08)
Child Gender	0.18(0.18)	0.04(0.14)	0.06(0.17)	-0.22(0.17)	-0.16(0.19)	-0.08(0.15)	-0.06(0.15)	0.03(0.16)
Proportion DLL	-0.04(0.11)	-0.04(0.10)	0.24*(0.12)	0.01(0.12)	-0.05(0.11)	0(0.09)	-0.01(0.11)	0.04(0.11)
CLASS Total	-0.07(0.1)	0.03(0.09)	-0.02(0.11)	-0.09(0.11)	-0.17(0.10)	0.09(0.09)	0.02(0.09)	0.07(0.09)
Peer WM PV	0.00(0.11)	0.00(0.09)	-0.16(0.12)	-0.23+(0.12)	-0.20+(0.12)	-0.01(0.10)	0.10(0.10)	0.08(0.10)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; EOW = Expressive One Word Picture Vocabulary Test, WJ = Woodcock Johnson, PV = Picture Vocabulary, LW = Letter-Word Identification, FSF = First Sound Fluency, PSF = Phoneme Segmentation Fluency, AP = Applied Problems; DLL = dual language learner; CLASS = Classroom Assessment Scoring System; WM = Woodcock Muñoz

APPENDIX F: CONTRAST CODING – STUDY 3

Level 1 (child): $Y_{ij} = \beta_{0j} + \mathbf{\beta_{1j}}\mathbf{\textit{Peer Skill SASG}_{ij}} + \mathbf{\beta_{2j}}\mathbf{\textit{ Peer Skill SADG}_{ij}} + \mathbf{\beta_{3j}}\mathbf{\textit{ Peer Skill DASG}_{ij}} + \mathbf{\beta_{4j}}\mathbf{\textit{ Peer Skill DADG}_{ij}} + \beta_{5j}\textit{ Child Age Cohort}_{ij} + \mathbf{\beta_{6j}}\mathbf{\textit{Peer Skill SASG x Age}_{ij}} + \mathbf{\beta_{7j}}\mathbf{\textit{ Peer Skill SADG x Age Cohort}_{ij}} + \mathbf{\beta_{8j}}\mathbf{\textit{ Peer Skill DASG x Age Cohort}_{ij}} + \mathbf{\beta_{9j}}\mathbf{\textit{ Peer Skill DADG x Age Cohort}_{ij}} + B_{10j}\textit{ Child Gender}_{ij} + \mathbf{\beta_{11j}}\mathbf{\textit{Peer Skill SASG x Gender}_{ij}} + \mathbf{\beta_{12j}}\mathbf{\textit{ Peer Skill SADG x Gender}_{ij}} + \mathbf{\beta_{13j}}\mathbf{\textit{ Peer Skill DASG x Gender}_{ij}} + \mathbf{\beta_{14j}}\mathbf{\textit{ Peer Skill DADG x Gender}_{ij}} + \beta_{15j}\textit{ Child Age Cohort x Child Gender}_{ij} + \mathbf{\beta_{16j}}\mathbf{\textit{Peer Skill SASG x Gender x Age Cohort}_{ij}} + \mathbf{\beta_{17j}}\mathbf{\textit{ Peer Skill SADG x Gender x Age Cohort}_{ij}} + \mathbf{\beta_{18j}}\mathbf{\textit{ Peer Skill DASG x Gender x Age Cohort}_{ij}} + \mathbf{\beta_{19j}}\mathbf{\textit{ Peer Skill DADG x Gender x Age Cohort}_{ij}} + \beta_{20j}\textit{ Child Primary Language}_{ij} + \beta_{21j}\textit{Child Race}_{ij} + \beta_{22j}\textit{Disability}_{ij} + \beta_{22j}\textit{Baseline Skill Level}_{ij} + \beta_{23j}\textit{Marital}_{ij} + \beta_{23j}\textit{Parental Education}_{ij} + \beta_{23j}\textit{Food Insecurity}_{ij} + r_{ij}$

Level 2 (classroom): $\beta_{0j} = \gamma_{00} + \gamma_{01}\textit{Classroom Quality}_{j} + \gamma_{02}\textit{Proportion DLL in Class}_{j} + \gamma_{03}\textit{Site}_{j} + u_{0j}$

Note: Peer groups are as follows: SASG =peers who are the same age cohort and the same gender as the target child; SADG = peers who are the same age cohort and a different gender as the target child; DASG = peers who are a different age cohort and the same gender as the target child; DADG = peers who are a different age cohort and a different gender as target child. Although not shown in the model to reduce length, both peer language skill and peer behavioral skill will be examined.

Contrasts among the coefficients will address the major questions of the study as described below.

Contrasts

Contrast to test for main effect of peer skill

(.25 * β_{1j}*Peer Skill SASG* +.25 * β_{2j}*Peer Skill SADG* + .25 * β_{3j}*Peer Skill DASG* +.25 * β_{4j}*Peer Skills DADG*)

Contrast to test for peer skill x peer gender – do peer skills relate to outcomes differently depending on whether the peer is the same or a different gender?

(.5 * β_{1j}*Peer Skill SASG* + .5 * β_{2j}*Peer Skill DASG)* – (.5 * β_{3j}*Peer Skill SADG* +.5 * β_{4j}*Peer Skills DADG)*

Contrast to test for peer skill x peer age cohort – do peer skills relate to outcomes differently depending on whether peer is the same or a different age cohort?

(.5 β_{1j}*Peer Skill SASG* + .5* β_{2j}*Peer Skill SADG)* – *(.5 * β_{3j}Peer Skill DASG* +.5 * β_{4j}*Peer Skills DADG*)

Contrast to test for peer skill x peer gender x peer age cohort – do peer skills relate to outcomes differently depending on both peer gender and age?

(1* β_{1j}*Peer Skill SASG* – 1* β_{2j}*Peer Skill SADG*) – (1 * β_{3j}*Peer Skill DASG* – 1 * β_{4j}*Peer Skills DADG*)

Contrast to test for peer skill x child gender

(.25 * β_{1j}*Peer Skill SASG x Gender* +.25 * β_{2j}*Peer Skill SADG x Gender* + .25 * β_{3j}*Peer Skill DASG x Gender* +.25 * β_{4j}*Peer Skills DADG x Gender*)

Contrast to test for peer skill x peer gender x child gender – do peer skills interact with child gender differently for peers that are the same or a different gender?

(.5 * β_{1j}*Peer Skill SASG x Gender* + *.5 * β_{2j}Peer Skill DASG x Gender)* – (.5* β_{3j}*Peer Skill SADG x Gender* + .5 * β_{4j}*Peer Skills DADG x Gender*)

Contrast to test for peer skill x peer age cohort x child gender – do peer skills interact with child gender differently for peers of the same or a different age cohort?

*(.5 * β_{1j}Peer Skill SASG x Gender* + .5 * β_{2j}*Peer Skill SADG x Gender)* – (.5 * β_{3j}*Peer Skill DASG x Gender* + *.5* * β_{4j}*Peer Skills DADG x Gender*)

Contrast to test for peer skill x peer gender x peer age cohort x child gender – do peer skills interact with child group differently for peers of the same or different age cohort and gender?

(1 * β_{1j}*Peer Skill SASG x Gender* – 1 * β_{2j}*Peer Skill SADG x Gender)* – (1 * β_{3j}*Peer Skill DASG x Gender* – 1 * β_{4j}*Peer Skills DADG x Gender*)

Contrast to test for peer skill x child age cohort

(.25 * β_{1j}*Peer Skill SASG x Age Cohort* +.25 * β_{2j}*Peer Skill SADG x Age Cohort* + .25 * β_{3j}*Peer Skill DASG x Age Cohort* +.25 * β_{4j}*Peer Skills DADG x Age Cohort*)

Contrast to test for peer skill x peer gender x child age cohort – do peer skills interact with child age cohort differently for peers that are the same or a different gender?

(.5 * β_{1j}*Peer Skill SASG x Age Cohort* + .5 * β_{2j}*Peer Skill DASG x Age Cohort)* – (.5* β_{3j}*Peer Skill SADG x Age Cohort* + .5 * β_{4j}*Peer Skills DADG x Age Cohort*)

Contrast to test for peer skill x peer age cohort x child age cohort – do peer skills interact with child age cohort differently for peers of the same or a different age cohort?

*(.5 * β_{1j}Peer Skill SASG x Age Cohort* + .5 * β_{2j}*Peer Skill SADG x Age Cohort)* – (.5 * β_{3j}*Peer Skill DASG x Age Cohort* + .5 * β_{4j}*Peer Skills DADG x Age Cohort*)

Contrast to test for peer skill x peer gender x peer age cohort x child age cohort – do peer skills interact with child age cohort differently for peers of the same or different age cohort and gender?

*(*1 * β_{1j}*Peer Skill SASG x Age Cohort* – 1 * β_{2j}*Peer Skill SADG x Age Cohort)* – (1 * β_{3j}*Peer Skill DASG x Age Cohort* – 1 * β_{4j}*Peer Skills DADG x Age Cohort*)

Contrast to test for peer skill x child age cohort x child gender

(.25 * β_{1j}*Peer Skill SASG x Gender x Age Cohort* +.25 * β_{2j}*Peer Skill SADG x Gender x Age Cohort* + .25 * β_{3j}*Peer Skill DASG x Gender x Age Cohort* +.25 * β_{4j}*Peer Skills DADG x Gender x Age Cohort*)

Contrast to test for peer skill x peer gender x child age cohort x child gender – do peer skills interact with child gender and child age cohort differently for peers that are the same or a different gender?

(.5 * β_{1j}*Peer Skill SASG x Gender x Age Cohort + .5 * β_{2j}Peer Skill DASG x Gender x Age Cohort)* – (.5* β_{3j}*Peer Skill SADG x Gender x Age Cohort* + .5 * β_{4j}*Peer Skills DADG x Gender x Age Cohort*)

Contrast to test for peer skill x peer age cohort x child age cohort x child gender – do peer skills interact with child gender and child age cohort differently for peers of the same or a different age cohorts?

*(.5 * β_{1j}Peer Skill SASG x Gender x Age Cohort* + .5 * β_{2j}*Peer Skill SADG x Gender x Age Cohort)* – (.5 * β_{3j}*Peer Skill DASG x Gender x Age Cohort + .5 * β_{4j}Peer Skills DADG x Gender x Age Cohort*)

Contrast to test for peer skill x peer gender x peer age cohort x child age cohort x child gender – do peer skills interact with child gender and child age cohort differently for peers of the same or a different age cohort and gender?

*(*1 * β_{1j}*Peer Skill SASG x Gender x Age Cohort* – 1 * β_{2j}*Peer Skill SADG x Gender x Age Cohort)* – (1 * β_{3j}*Peer Skill DASG x Gender x Age Cohort* – 1 * β_{4j}*Peer Skills DADG x Gender x Age Cohort*)

APPENDIX G: PEER SKILL GROUPS PREDICTING CHILD OUTCOMES – STUDY 3

Table 1G

Peer Skill Accounting for Peer Age Cohort and Gender Predicting Children's Language and Behavioral Outcomes

	School Readiness Outcomes			
	PLS AC	PPVT	DECA Behavior	DECA Self-Control
	B(SE)	*B(SE)*	*B(SE)*	*B(SE)*
Intercept	0.33***(0.09)	0.04(0.07)	-0.22*(0.09)	0.12(0.09)
PLS Version	0.1*(0.05)	-	-	-
Pre-Test Score	0.7***(0.02)	0.73***(0.01)	0.56***(0.01)	0.56***(0.01)
Child Disability	-0.22***(0.05)	-0.15***(0.03)	0.19***(0.04)	-0.24***(0.04)
Gender	-0.41***(0.1)	-0.06(0.07)	0.23*(0.09)	-0.1(0.09)
Age Cohort	-0.29+(0.15)	0.16(0.1)	-0.09(0.13)	0.13(0.14)
Black	-0.06(0.04)	-0.08*(0.03)	0.06(0.04)	-0.04(0.04)
Hispanic	-0.01(0.05)	-0.09*(0.04)	0.02(0.05)	0.02(0.05)
Primary Language	0.06(0.04)	0.09**(0.03)	0.06(0.04)	-0.06(0.04)
Caregiver Depression	0(0.04)	0.01(0.03)	0.02(0.04)	-0.01(0.04)
Caregiver Education	0.07***(0.02)	0.06***(0.01)	-0.02(0.01)	0.01(0.01)
Food Insecurity	0(0.03)	-0.03(0.02)	-0.01(0.03)	-0.02(0.03)
Marital Status	-0.01(0.03)	-0.02(0.02)	0.05+(0.03)	-0.02(0.03)
CLASS Total	0.03+(0.02)	-0.01(0.01)	-0.01(0.02)	0.02(0.02)
SASG Peer Language	0.15*(0.06)	0.04(0.04)	-0.02(0.05)	0.1+(0.05)
DASG Peer Language	-0.09(0.06)	0.07+(0.04)	0.04(0.05)	-0.05(0.06)
SADG Peer Language	0.14*(0.06)	0(0.04)	0.05(0.05)	-0.1+(0.06)
DADG Peer Language	-0.06(0.05)	-0.02(0.04)	-0.05(0.05)	-0.04(0.05)
SASG Peer Behavior	0.05(0.06)	0.04(0.04)	-0.01(0.05)	0.11*(0.05)
DASG Peer Behavior	0.01(0.04)	0.02(0.04)	0.03(0.05)	-0.14**(0.05)
SADG Peer Behavior	0(0.04)	-0.06+(0.03)	0.09*(0.04)	-0.02(0.04)
DADG Peer Behavior	-0.08*(0.04)	0(0.03)	0.01(0.03)	-0.02(0.04)
Child Gender * Age Cohort	0.24(0.21)	-0.23(0.14)	0.08(0.19)	-0.05(0.19)
SASG Peer Language * Gender	-0.12(0.08)	-0.03(0.06)	-0.02(0.07)	-0.13+(0.08)
DASG Peer Language * Gender	0.11(0.07)	-0.05(0.06)	-0.07(0.07)	0.05(0.08)
SADG Peer Language * Gender	-0.15*(0.08)	0(0.06)	-0.02(0.07)	0.18*(0.08)
DADG Peer Language * Gender	0.11(0.08)	0.02(0.06)	0.04(0.07)	-0.01(0.08)
SASG Peer Behavior * Gender	-0.02(0.07)	-0.02(0.05)	0.08(0.07)	-0.18**(0.07)
DASG Peer Behavior * Gender	0.02(0.06)	-0.02(0.05)	0.02(0.06)	0.13*(0.07)
SADG Peer Behavior * Gender	-0.01(0.07)	0.13*(0.05)	0.02(0.07)	0.04(0.07)
DADG Peer Behavior * Gender	0.07(0.05)	-0.06(0.05)	0(0.06)	-0.07(0.06)
SASG Peer Language * Age Cohort	-0.18*(0.09)	-0.13*(0.06)	-0.05(0.07)	-0.11(0.08)
DASG Peer Language * Age Cohort	0.04(0.08)	0.09(0.06)	0.06(0.07)	0.07(0.08)
SADG Peer Language * Age Cohort	-0.09(0.09)	0.1(0.06)	-0.01(0.07)	0.13(0.08)
DADG Peer Language * Age Cohort	0.07(0.09)	-0.09(0.06)	-0.08(0.08)	0.04(0.09)

SASG Peer Behavior * Age Cohort	-0.11(0.08)	-0.06(0.06)	0.01(0.07)	-0.21**(0.08)
DASG Peer Behavior * Age Cohort	0.07(0.08)	0.03(0.06)	0.1(0.08)	0.17*(0.09)
SADG Peer Behavior * Age Cohort	0.05(0.07)	0.06(0.05)	-0.01(0.06)	-0.04(0.06)
DADG Peer Behavior * Age Cohort	0.01(0.07)	-0.01(0.05)	0.06(0.07)	-0.02(0.07)
SASG Peer Language * Gender * Age Cohort	0.08(0.12)	0.12(0.08)	0.03(0.1)	0.15(0.11)
DASG Peer Language * Gender * Age Cohort	-0.15(0.11)	-0.18*(0.09)	0.06(0.11)	-0.22+(0.12)
SADG Peer Language * Gender * Age Cohort	0.21+(0.12)	-0.01(0.09)	-0.07(0.11)	-0.24*(0.12)
DADG Peer Language * Gender * Age Cohort	-0.09(0.12)	0.09(0.09)	0.14(0.11)	0.08(0.13)
SASG Peer Behavior * Gender Age Cohort	0.08(0.1)	0.01(0.07)	-0.01(0.09)	0.25*(0.1)
DASG Peer Behavior * Gender * Age Cohort	-0.23*(0.11)	-0.02(0.08)	-0.03(0.1)	-0.24*(0.11)
SADG Peer Behavior * Gender * Age Cohort	-0.11(0.1)	-0.15*(0.08)	-0.07(0.09)	-0.03(0.1)
DADG Peer Behavior * Gender * Age Cohort	0.14(0.1)	0.09(0.08)	0(0.1)	0.19+(0.11)

Note: + p<.10; * p<.05; ** p<.01; *** p<.001; PLS AC = Preschool Language Scale Auditory Comprehension; PPVT = Peabody Picture Vocabulary Test, DECA = Devereux Early Childhood Assessment; CLASS = Classroom Assessment Scoring System; SASG = same age same gender; DASG = different age same gender; SADG = same age different gender; DADG = different age different gender

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