



Problem behaviors at the classroom-level and teacher-child interaction quality in Head Start programs: Moderation by age composition

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ABSTRACT

This study explored the link between classroom-level problem behaviors and teacher-child interaction quality in 307 Head Start preschool classrooms. The moderating role of the classroom's age composition (e.g., 3- and 4-year-olds versus 4-year-olds only) also was examined. Using a dataset of 852 3-year-old children and 1114 4-year-old children, classroom-level problem behaviors were operationalized using teacher reports of children's problem behaviors. Results indicated that classroom-level problem behaviors, specifically oppositional/aggressive and internalizing behavior, were associated with lower teacher-child interaction quality (i.e., emotional support, classroom organization, and instructional support). In contrast, classroom-level hyperactivity was only negatively related to classroom instructional support. Moderation results indicated that high-levels of classroom-level activity were related to lower-levels of teacher-child interaction quality, but for 4-year-old only classrooms. The results of this study have implications for practice and policy.

At times, preschool behavioral difficulties reduce opportunities for children to engage successfully in classroom activities that are fundamental for their development and learning (Hemmeter et al., 2006). Approximately 30% of low-income preschool children have been reported to exhibit moderate to clinically significant emotional and behavioral needs (Barbarin, 2007; Feil et al., 2005), potentially indicating that within Head Start classrooms, which serve children from low-income backgrounds, as many as four or five children in a classroom of 18 may demonstrate problem behaviors. In addition to directly undermining a child's learning, child problem behaviors may also be negatively associated with overall teacher-child interaction quality.

Teacher-child interaction quality, one of the most critical drivers of children's learning and social-emotional development within preschool classrooms, may be influenced by the level of problem behavior displayed (e.g., Burchinal, 2018; Pianta et al., 2016). High rates of classroom-level problem behaviors are negatively correlated with aspects of teacher-child interaction quality, such as teachers' ability to execute instructional activities as planned due to time and attention being devoted continuously to dealing with behavioral issues (Friedman-Krauss et al., 2014). Researchers and policymakers focus on the roles of teachers (e.g., qualifications, training) in teacher-child interaction quality; however, little work has considered how characteristics of children themselves, including their ability to regulate their behavior, may influence the quality of their schools, despite evidence that children themselves contribute to the classroom environment (Coelho et al., 2019; LoCasale-Crouch et al., 2007; Mashburn et al., 2006).

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Due to the importance of teacher-child interaction quality on children's learning and development, this study aimed to understand how children's behavior at an aggregate level was related to teacher-child interaction quality. As part of this work, we also examined the role of mixed-age classrooms (i.e., those serving children of different ages in the same classroom), which make up roughly 75% of all Head Start classrooms (Ansari & Purtell, 2018). Little research has explored how mixed-age classrooms may be related to teacher-child interaction quality and the relationship between classroom-level problem behaviors and teacher-child interaction quality. Given the developmental trajectory of children's regulatory capacities during the preschool period and the different expectations for classroom behavior for children of varying ages, these processes may unfold differently in classrooms serving younger (e.g., 3- and 4-year-olds) and older (e.g., 4-year-olds) children. This study aimed to elucidate how problem behaviors, averaged across children in a classroom, contributed to teacher-child interaction quality in mixed-age Head Start classrooms and classrooms serving 4-year-olds only. Results from this study can assist Head Start and other preschool programs better understand how children's behaviors may be related to teacher-child interaction quality. Practically, these findings provide ideas for potential professional development and ongoing support for teachers that can help them manage problem behavior and improve the overall teacher-child interaction quality.

1. Teacher-child interaction quality

Teacher-child interaction quality is one of the most important contributors to children's social and academic development during preschool (Burchinal, 2018; Burchinal et al., 2015). High-quality preschools influence children's learning and development in various domains, including children's motivation to learn, socioemotional and behavioral skills, and development of positive peer relationships (La Paro et al., 2004; Schmitt et al., 2018). Teacher-child interaction quality is characterized by teachers' practices and behaviors such as their social interactions with children and instructional practices (Pianta et al., 2008). Three domains of teacher-child interaction quality are recognized as critical contributors to children's learning and development: (a) emotional support, (b) classroom organization, and (c) instructional support (Hamre et al., 2014). *Emotional support* is characterized by warm, sensitive, responsive, and individualized interactions. *Classroom organization* is defined as how well teachers structure and manage classroom activities, routines, and materials to support children's self-regulation, attention, and engagement in learning. Finally, *instructional support* reflects a teacher's use of cognitively stimulating practices with children, such as encouraging problem-solving, higher-order reasoning, and more advanced language (La Paro et al., 2004). To date, a substantial literature has examined predictors of quality at the program- and teacher-level in preschool settings (e.g., Manning et al., 2019; Tout et al., 2006), but rarely has the association with children's behavior and teacher-child interaction quality been examined.

2. Children's problem behaviors

In the literature, the two types of problem behaviors that typically are examined include externalizing behaviors and internalizing behaviors (e.g., Rimm-Kaufman et al., 2005; Williford & Wolcott, 2015). In the present study, we examined three teacher-reported problem behaviors: (a) oppositional/aggressive, (b) hyperactivity, and (c) internalizing behavior. Children's oppositional/aggressive behaviors (often conceptualized as a component of externalizing behavior) are characterized by overt hostility, conduct problems, and oppositional defiance behaviors (Whitcomb, 2013). Extant research shows that children who exhibit oppositional/aggressive behaviors are less likely to engage successfully in classroom activities (Moffett & Morrison, 2020; Rimm-Kaufman et al., 2005). Hyperactive behaviors such as impulsivity and inattention frequently are operationalized as a dimension of externalizing behavior (along with oppositional/aggressive) in preschool (e.g., Montroy et al., 2014; Williford & Wolcott, 2015). However, research suggests that even though oppositional/aggressive and hyperactive behaviors correlate, they are distinct dimensions of problem behavior and have different implications for children's academic and social functioning (Gustafsson et al., 2018). Internalizing behaviors, such as extreme shyness, social withdrawal, and anxiety, are described as directed towards the self (Whitcomb, 2013). Children who exhibit internalizing behaviors are often unable to form strong peer relationships and are more likely to engage in isolating behaviors and social withdrawal (e.g., Oland & Shaw, 2005).

3. Classroom-level problem behaviors and teacher-child interaction quality

Extant research focuses on how teacher-child interaction quality relates to children's skills and behavior. For example, emotionally supportive, well-managed, and higher-quality instructional classrooms reduce individual children's problem behaviors (e.g., Hamre & Pianta, 2005; La Paro et al., 2004). However, the reverse relationship (i.e., the extent to which children's problem behaviors influence the quality of teacher-child interaction quality) is under-researched. To conceptualize the role that problem behaviors at the classroom-level may have on teacher-child interaction quality, we draw upon the literature on transactional models, which posits that development is a consequence of the ongoing dynamic interaction between children and their environment (Sutherland & Oswald, 2005). Although we did not test the bidirectional relationship between problem behaviors and teacher-child interaction quality, this underlying theory is necessary to understand a few pathways through which classroom-level problem behaviors might contribute to teacher-child interaction quality.

Children play a major role in modifying their social experience through evoking specific reactions from those around them (Nurmi & Kiuru, 2015). First, problem behavior displayed by children can negatively affect teacher-child relationships and place an extra burden or stress on teachers. This stress can evoke negative affective, behavioral, and cognitive responses in teachers towards (all) children (Nurmi & Kiuru, 2015), undermining teacher-child interaction quality by introducing a "burnout cascade" response from teachers in which children's behaviors and teachers' responses to their behaviors continue to worsen over time and teacher-child

interaction quality declines (Jennings & Greenberg, 2009). Second, children's problem behaviors also can influence peers to exhibit problem behaviors (i.e., a contagion effect) whereby children's problem behaviors encourage behavior problems among their peers (Bulotsky-Shearer et al., 2012; Rojas et al., 2020).

Teacher-child interaction quality may vary depending on the type of classroom-level problem behavior displayed. As posited by the burnout cascade theory, teachers tend to feel more negative and stressed when they perceive aggression/opposition behavior in the classroom, leading to anger and frustration because these behaviors hamper their teaching ability (Bosman et al., 2019). Moreover, following the contagion theory, children also exhibit more aggression/opposition when in classrooms with higher levels of aggression/opposition (Thomas et al., 2011). Classroom-level aggression/opposition often inhibits teachers' ability to provide consistent emotional support and positive behavior management (Zinsser et al., 2013) and reduces the available instructional time (Long et al., 2018). However, contrary to other prior research, Friedman-Krauss et al. (2014) found that higher levels of child aggression/opposition behavior problems in the fall were related to higher classroom emotional climate in the spring, over and above fall emotional climate and child-, teacher-, and classroom-level covariates. These mixed results suggest that more work is needed to understand the relationship between classroom-level aggression/opposition and teacher-child interaction quality; considering research suggesting that aggression/opposition behaviors are related to more negative behaviors among peers and teachers, we posited an exploratory hypothesis that higher levels of classroom aggression/opposition behavior may be negatively related to the emotional climate and classroom organization.

Like the extant literature on classroom-level aggression/opposition, there are mixed findings regarding the relationship between classroom-level hyperactivity and teacher-child interaction quality. In Partee et al. (2020), classroom-level hyperactivity was negatively related to classroom management ($\beta = -0.15, p = 0.04$) and instructional support ($\beta = -0.19, p = 0.01$) and marginally related to negative emotional support at the end of the year. However, in Bosman et al. (2019), teachers reported using more sensitive practices when responding to individual children's hyperactive behaviors in the classroom. Teachers' increased sensitivity for hyperactive behaviors among children may be due to greater awareness about hyperactivity and symptoms of ADHD and when teachers understand what children are not able to or otherwise struggle to control their behavior in the classroom, this may influence the sensitivity of their teaching in a positive way (Chang & Davis, 2009). Given these mixed results, we hypothesized that higher rates of classroom-level hyperactivity would be negatively related to emotional support and classroom organization.

Less attention has been paid to the association between children's internalizing behaviors and teacher-child interaction quality. Compared to children with more disruptive problem behaviors like externalizing and hyperactivity behaviors, children with internalizing symptoms often receive less attention from teachers because their problems are less apparent and more difficult to detect (Berg-Nielsen et al., 2012). Yet, teachers who do not aid and comfort children struggling with internalizing problems may increase children's anxiety withdrawal symptoms, which can negatively impact teacher-child interaction quality (Jeon et al., 2019). Buyse et al. (2008) found that higher average levels of internalizing behavior in the classroom significantly predicted more relational conflict between teachers and children, suggesting that classroom-level internalizing behavior may negatively affect emotional support. Children's internalizing behavior, which is in part a function of children's ability to manage emotional distress, is expected to be most strongly linked to the quality of emotional support in the classroom.

4. Mixed-age classrooms as a potential moderator

Children's behavior and teacher-child interaction quality may unfold and interact differently in classrooms serving older children versus classrooms serving children across a broader age range. For example, although some Head Start programs serve 3- and 4-year-olds in separate classrooms, most Head Start programs combine 3- and 4-year-olds in mixed-age classrooms (Ansari & Pianta, 2019). However, to our knowledge, only Guo et al. (2014) investigated interrelations among age composition, teacher-child interaction quality, and children's skills and found that mixed-age classrooms were beneficial for preschoolers, but only when coupled with high-quality interactions. In addition, prior studies have not examined, to our knowledge, the extent to which the age grouping of classrooms (same-age or mixed-age) interacts with classroom-level problem behaviors to contribute to teacher-child interaction quality.

We predicted that mixed-age classrooms would moderate the relationship between classroom-level problem behaviors and teacher-child interaction quality based on the theoretical and limited empirical literature. However, the direction of the hypothesis remained exploratory given the limited prior research and theory. It is plausible that the negative association between classroom-level problem behaviors and teacher-child interaction quality may be even more pronounced in mixed-age classrooms than in classrooms serving 4-year-olds where the association may be less pronounced or non-existent. Prior studies suggest that managing a classroom with a wide range of ages and diverse needs can be challenging (Guo et al., 2014) and uniquely stressful to teachers (Friedman-Krauss et al., 2014). A mixed-age classroom with a broader range of behaviors and developmental skills could be negatively related to a teacher's ability to provide high-quality instructional support, emotional support, and classroom organization. For example, Ansari and Pianta (2019) found that teachers who taught in mixed-age classrooms demonstrated less optimal teacher-child interaction quality. Therefore, it is plausible that mixed-age grouping is negatively related to teacher-child interaction quality (Ansari & Pianta, 2019), that classroom-level problem behaviors are negatively related to teacher-child interaction quality (Partee et al., 2020), and that these challenges are magnified when in combination, resulting in lower teacher-child interaction quality.

In contrast, we might find that the associations between classroom-level problem behaviors and teacher-child interaction quality were less pronounced in mixed-age classrooms than in classrooms serving 4-year-olds only. Drawing upon developmental theories, we hypothesized that what was developmentally normative – and teachers' expectations about what was developmentally normative – for a 3-year-old may be different from what was normative for a 4-year-old (Chang & Davis, 2009). Prior studies have demonstrated that teachers are likely to feel frustrated or angry towards children when they feel like the child could have controlled their behavior

(Bosman et al., 2019; Chang & Davis, 2009). It is plausible that teachers may perceive behavioral challenges and react to them differently in mixed-age classrooms versus classrooms serving only 4-year-olds. For instance, in mixed-age classrooms, 3-year-old children may exhibit more internalizing behaviors such as crying when parents leave the classroom, but because the teacher may perceive that behavior as more developmentally appropriate, they may warmly comfort those children, which is associated with higher quality classrooms. Conversely, more classroom-level problem behaviors in 4-year-old only classrooms may be related to lower teacher-child interaction quality because teachers see oppositional/aggressive, hyperactivity, and internalizing behaviors as inappropriate for 4-year-olds. In other words, expectations about children in mixed-age classrooms may have buffered preschool teachers against the difficulties of handling more behavioral challenging classrooms. However, no studies to our knowledge have explored this hypothesis.

5. Present study

The goal of the present study was to advance our understanding of the relation between classroom-level problem behavior and teacher-child interaction quality within a diverse sample of Head Start programs and the potential for mixed-age classrooms, one of the most common models of preschool programs, to increase or decrease the challenges of teaching in classrooms with high-levels of classroom problem behavior. The following research questions were examined:

(1) Are fall baseline classroom-level problem behaviors (oppositional/aggressive, hyperactivity, and internalizing behaviors) associated with spring post teacher-child interaction quality (emotional support, classroom organization, and instructional support)?

(2) To what extent are the relations between fall baseline classroom-level problem behaviors and spring post teacher-child interaction quality moderated by classroom age composition?

Given the mixed findings in the literature, we heavily relied upon our theoretical frameworks and prior studies to propose the following exploratory hypotheses: (a) higher levels of classroom oppositional/aggressive behavior would be negatively related to emotional support and classroom organization, (b) higher levels of classroom hyperactivity would be negatively related to emotional support and classroom organization, and (c) higher levels of classroom internalizing behaviors would be negatively related to emotional support. It is important to note that we have no hypotheses about the effects of mean classroom problem behaviors on instructional support. For Research Question 2, due to limited existing research, we posited an exploratory hypothesis that teacher-child interaction quality would be moderated by classroom age composition such that mixed-age classrooms with higher classroom level problem behaviors would show more negative teacher-child interaction quality relative to 4-year-old only classrooms.

6. Method

6.1. Participants

The present study used a secondary data set that was collected as part of the cluster-randomized control trial (Head Start Classroom-based Approaches and Resources for Emotion and Social skill promotion [CARES]; Morris et al., 2014) that tested three social-emotional programs implemented over a single preschool year from fall to spring. The sample included 17 Head Start grantees within 10 states. Cohort 1 (2009–2010 school year) included four Northeastern grantees and Cohort 2 (2010–2011 school year) was comprised of 13 grantees, including four in the West, three in the South, and six in the Midwest/Plains. Within the 17 Head Start grantees, >100 centers participated. An average of three classrooms per center (range = 1–6) participated. All eligible classrooms (classrooms with mostly 4-year-olds who were not in special education) from each center were included. Two-thirds of classrooms were full-day (>3.5 h per day) and one-third were part-day (3.5 h or less, in the morning or afternoon). There were 155 mixed-age and 152 4-year-old only classrooms.

Centers, within each grantee, were randomly assigned to a control condition or to one of four treatment conditions. These treatment conditions consisted of classrooms where each classroom was implementing one of the following: (a) Incredible Years, (b) Preschool Paths, (c) Tools of the Mind—Play, or (d) business-as-usual. The Incredible Years program (Webster-Stratton, 2015) focuses on supporting children's adaptive social behavior and reducing problem behaviors by strengthening teachers' classroom and behavior management practices. The Preschool PATHS program (Domitrovich et al., 1999) provides structured whole-group lessons and extension activities focused on emotion identification and social problem-solving. The Tools of the Mind—Play is a 1-year adaptation of the more extended Tools of the Mind executive function intervention in which teachers restructure the day to include a 50-min pretend play block designed to enhance children's self-regulation and executive functioning through structured pretend play activities (Bodrova & Leong, 2007).

All (100%) eligible teachers consented to participate in the study. The final analytical sample consisted of 307 teachers spread across 104 centers.¹ Teachers were racially diverse, with 35% identifying as Black, 29% as White, 30% as Hispanic, and the remaining as other (6%). Teachers were predominantly female (96%) and most teachers had at least a bachelor's degree (62%). The mean age of

¹ Between the spring baseline and spring post time points, approximately one-fourth of the teachers left their jobs at the Head Start centers (and thus, were removed from the study) and were replaced by other teachers during the study (who were included in the study). Most teachers left during the summer before implementation began and before the fall baseline data collection time point. Analyses revealed that teachers who left the sample (a) were more likely to have <3 years of experience, (b) were less likely to have 10 or more years of experience, (c) were more likely to report being burned out, and (d) were less likely to report valuing academic readiness as much as socio-emotional readiness (Morris et al., 2014).

teachers was 43 years ($SD = 11.84$). The majority (63%) had taught for 10 years or more.

Approximately 90% of eligible children's parents provided consent to participate in the study. Due to budgetary constraints, an average of 10 (consented) children per classroom were randomly selected to participate. The child sample was comprised of 852 3-year-old children and 2114 4-year-old children; 49% of the children were female. Approximately 44% were Hispanic, 33% African American, and 16% were White. The study sample was like the national Head Start population, which was about one-third African American (Head Start, 2019). Compared to Head Start families nationally whose monthly household income is about \$1900, Head Start CARES families reported a monthly household income of \$1800. Fifty-nine percent of Head Start CARES families reported receiving food stamps and 11% received Temporary Assistance for Needy Families. The attrition rate between fall baseline data collection and the spring post data collection was approximately 11%.

6.2. Procedures

Data for the study were collected at three different time points (spring baseline, fall baseline, and spring post; see Table 1). Spring baseline information on teachers and classrooms was collected in the spring before implementation of the social-emotional programs began (i.e., before the teachers had any exposure to the programs and with a different cohort of children than included in this article). The data collected at the spring baseline time point included baseline teacher-child interaction quality observations (covariate). Fall baseline data on children included teacher reports on children's problem behaviors (predictor) and child and family demographics (covariate). Finally, spring post data included teacher-child interaction quality observations (outcome) and teacher demographics (covariate).

6.3. Measures

6.3.1. Teacher-child interaction quality

Teacher-child interaction quality was assessed by the widely used Classroom Assessment Scoring System - Preschool (CLASS; Pianta et al., 2008). The CLASS provides global, 7-point scores about all adults and children in the classroom across 10 items divided into three domains. The Emotional Support domain includes positive and negative climate, teacher sensitivity, and regard for student perspectives. The Classroom Organization domain consists of behavior management, productivity, and instructional learning formats. Finally, the Instructional Support domain is comprised of concept development, quality of feedback, and language modeling. Observers who were trained on the CLASS were required to attend a 2-day training with a certified trainer and (b) score within one point of "gold-standard" codes (scored by CLASS developers) on 80% of CLASS domains across four videos. Paired observers also checked reliability on 20% of observations throughout data collection. Inter-rater agreement ranged from 93% to 95% across baseline and post-time points. Ratings were averaged across four cycles in a day, with each cycle consisting of 20 min of observation and 10 min of coding. The three composite scores were created based on the developer's recommendation (Pianta et al., 2008) and consisted of Emotional Support ($M_{\text{baseline}} = 5.15$, $SD = 0.94$; $M_{\text{follow-up}} = 5.35$, $SD = 0.85$), Classroom Organization ($M_{\text{baseline}} = 4.68$, $SD = 1.04$; $M_{\text{follow-up}} = 4.90$, $SD = 1.03$), Instructional Support ($M_{\text{baseline}} = 2.52$, $SD = 1.04$; $M_{\text{follow-up}} = 2.40$, $SD = 0.90$). Reliability based on Cronbach alphas of the Emotional Support, Classroom Organization, and Instructional Support subscales were reported to be 0.68, 0.78, and 0.93, respectively (Hamre et al., 2014). Adequate criterion and predictive validity have been demonstrated for the CLASS, including associations with other teacher-child interaction quality measures (Pianta, La Paro and Hamre, 2008), gains on standardized assessments of academic achievement, and improved social adjustment (e.g., Mashburn et al., 2006).

6.3.2. Children's problem behaviors

The Behavior Problems Index (BPI; Zill, 1990) was used to measure the frequency, range, and type of children's problem behaviors. A prior EFA of the teacher data (Morris et al., 2014) revealed three subscales, consistent with prior research, related to children's oppositional/aggressive behavior (e.g., "Cheats or tells lies", "Does not seem to feel sorry after misbehaving"), internalizing behavior (e.g., "Clings to adults", "Cries too much"), and hyperactivity (e.g., "Is restless, overly active, cannot sit still", "Is impulsive or acts without thinking"). The 26-item survey uses a 3-point scale (0 = *often true*, 1 = *sometimes true*, and 2 = *not true*). For each subscale, the score was calculated as the sum of the survey items. In the present study, internal consistency was high for the teacher-reported Oppositional/Aggressive subscale (11 items; Cronbach's $\alpha = 0.93$), Internalizing Behavior subscale (10 items; Cronbach's $\alpha = 0.86$), and Hyperactivity subscale (5 items; Cronbach's $\alpha = 0.85$). The BPI has demonstrated good test-retest reliability in past research (range = 0.77–0.99 across multiple studies; e.g., Parcel & Menaghan, 1993; Zill, 1990). However, despite the wide use of the BPI to measure the presence of behavior problems in children, psychometric data demonstrating evidence of validity is limited.

6.3.3. Child, classroom, and teacher covariates

Covariates included in this study were selected based on what was used in the Head Start CARES impact study, which was informed by theory and information about each covariate's predictive power. Teacher covariates included teachers' race/ethnicity (Black, non-Hispanic; White, non-Hispanic; Other, non-Hispanic; Hispanic), whether the teacher had a bachelor's degree or higher (0 = *no*; 1 = *yes*), and if the teacher had 10 or more years of teaching experience (0 = *no*; 1 = *yes*). Classroom-level child race/ethnicity variables

Table 1
Data collection schedule.

	Spring Baseline (Spring before Implementation Year)	Fall Baseline (Fall of Implementation Year)	Spring Post (Spring of Implementation Year)
Teacher-child interaction quality (same teacher, different cohorts of children)	X		X
Children's problem behaviors		X	X
Children's covariates		X	

Note. Spring baseline classroom observations were completed with the same teacher but with different classes of children compared to the Spring follow-up time point.

were included (percentages of non-Hispanic Black, non-Hispanic White, and Hispanic children). Three dummy variables were used to indicate the intervention status of the classroom (Incredible Years, Preschool PATHS, and Tools of the Mind).² As determined by the Head Start CARES impact study, a classroom was considered mixed-age if children in the classroom were both 3- and 4-years-old at the beginning of the school year (at least 50% of the children needed to be 4-year-olds); approximately 50.4% of classrooms in the sample were mixed-age. A dummy variable about whether a classroom was mixed-age (0 = 4-year-old only classroom, 1 = mixed-age) was included in all models. Finally, baseline CLASS scores (collected in the spring before the intervention implementation) were also used as a covariate.

6.4. Analytic approach

Missing data in this study were relatively low. Ninety-eight percent of classroom observations were completed at the spring baseline time point (covariate) and 100% of classroom observations were completed at the spring post timepoint (outcome). Missing data from teacher reports on individual children's behavioral problems were low (predictor) as approximately 2% were missing at fall baseline and less <1% were missing at spring post. Missing data on teacher, parent, and child demographics ranged from 2% to 13%.

We conducted multiple imputation to address missing data. Following guidelines provided by [Enders and Baraldi \(2018\)](#), multiple imputation with 100 data sets was used to deal with missing data. Multiple imputation has less strict assumptions about the mechanisms for the missing data patterns and tends to yield more accurate estimates compared to traditional missing data handling techniques (e.g., listwise deletion; [Schafer & Graham, 2002](#)). Little's (1988) missing completely at random (MCAR) test was conducted to examine missing data patterns in the sample; if non-significant, differences would be unlikely between excluded cases and the remaining sample. Considering all variables included in the final model, we found that the MCAR test was not significant, $\chi^2 = 338.57$, $df = 321$, $p = 0.55$. Due to the non-significant results, missing data were accounted for using multiple imputation procedures. For our imputation models, we included all variables that were part of the final model in Stata. To combine the results across the 100 imputed data sets, parameter estimates were averaged and standard errors were pooled following Rubin's rule ([Rubin, 1987](#)). To assess the robustness of the imputed results presented in the present study, final models were run with and without imputed data and a varied number of imputations (10 vs. 100 imputed data sets), yielding consistent results across all different methods.

To estimate the classroom-level problem behaviors (oppositional/aggressive, hyperactivity, and internalizing behavior problems) hypothesized in Research Question 1, we operationalized classroom-level problem behaviors as the mean level of teacher-reported oppositional/aggressive, hyperactivity, and internalizing behavior problems across all children in a classroom during the fall data collection period whose parents had consented to their child's participation and for whom teachers completed the BPI. In the case of mixed-age classrooms, we included teacher-reported problem behaviors of both 3- and 4-year-olds. To create a classroom-level problem behavior variable, individual child-level BPI subscale scores were averaged within the classroom resulting in three classroom-level mean scores for oppositional/aggressive, internalizing behavior, and hyperactivity. Mean classroom oppositional/aggressive behavior scores ranged from 0 to 12, with an average of 2.99 ($SD = 2.29$). Mean classroom internalizing behavior scores ranged from 0 to 10, with an average of 1.72 ($SD = 1.65$). Finally, mean classroom hyperactivity behavior scores ranged from 0 to 6, with an average of 1.86 ($SD = 1.27$).

We approached Research Question 1 (i.e., the association between fall classroom-level problem behavior and spring teacher-child interaction quality) with a series of ordinary least squares regression models with standard error correction (Huber-White; [White, 1982](#)) for clustering of classrooms within sites ([Murnane & Willett, 2010](#)). Due to concerns about multicollinearity, separate models were run for each classroom-level problem behavior (i.e., oppositional/aggressive, internalizing behavior, and hyperactivity) associated with the three dimensions of teacher-child interaction quality (i.e., emotional support, instructional support, and classroom organization).

² Three sensitivity analyses were conducted. First, given the possibility that the intervention may affect the patterns of associations between classroom-level problem behavior and teacher-child interaction quality, we examined whether there was an interaction between classroom-level problem behavior and intervention status as a sensitivity analysis. We found two significant and negative interactions between Tools of the Mind and classroom-level internalizing on classroom emotional support and Tools of the Mind and classroom-level hyperactivity on classroom emotional support. Second, we also analyzed the control group only sample; we did not find differences in results from the full sample. Third, we reran models controlling for whether the teacher at spring baseline and spring follow-up (see Footnote 1) was the same person and found no substantive differences relative to the findings reported in the paper's main text.

To address Research Question 2, we investigated whether a mixed-age classroom moderated the relationship between classroom-level problem behaviors and teacher-child interaction quality. Interactions (variables were group-mean-centered before calculation of the interactions) were added to test the moderation effect of mixed-age classroom and classroom-level problem behaviors on teacher-child interaction quality. Three separate interactions were run for each domain of problem behaviors. We conducted simple slope analysis at low (-1 SD), average, and high ($+1$ SD) levels to explore statistically significant interactions. A set of classroom-level covariates (i.e., teachers' years of experience, teacher's educational level teacher race/ethnicity classroom-level child race/ethnicity, baseline spring CLASS scores, and intervention status) were included in all models.

To help assure the robustness of our findings and avoid potential Type I (false positive) errors, we applied the Benjamini–Hochberg procedure to all estimated coefficients. The Benjamini–Hochberg procedure controls the false discovery rate (FDR) using sequential modified Bonferroni correction for multiple hypothesis testing (Benjamini & Hochberg, 1995). This procedure was implemented by first ordering all p -values from smallest to largest and assigning ranks to each value (e.g., the smallest p -value had a rank of 1). We then calculated each individual p -value's Benjamini–Hochberg critical value, using the formula $(i/m)Q$ where i is the p -value rank, m is the total number of tests, and Q is the false discovery rate of 10%. Finally, we only interpreted coefficients as statistically significant if the Benjamini–Hochberg critical value was <0.05 . The p -values presented in the findings and tables thus reflect the findings from models employing these procedures. The following cut-off values were used for the evaluation of the effect sizes (Funder & Ozer, 2019): tiny ≤ 0.05 , very small from 0.05 to ≤ 0.10 , small from 0.10 to ≤ 0.20 , medium from 0.20 to ≤ 0.30 , large from 0.30 to ≤ 0.40 , and very large > 0.40 .

Table 2
Demographic statistics.

	Total sample					4-year-old only classrooms					Mixed-age Classrooms				
	<i>N</i>	<i>M</i> / %	<i>SD</i>	Min	Max	<i>N</i>	<i>M</i> / %	<i>SD</i>	Min	Max	<i>N</i>	<i>M</i> / %	<i>SD</i>	Min	Max
Classroom and Teacher Covariates															
Teacher non-Hispanic Black (S baseline)	217	35%				119	25%				98	47%			
Teacher non-Hispanic White (S baseline)	217	29%				119	39%				98	17%			
Teacher non-Hispanic Other (S baseline)	217	6%				119	4%				98	8%			
Teacher Hispanic (S baseline)	217	30%				119	32%				98	28%			
Teacher had Bachelor's degree or higher (S baseline)	222	60%				119	67%				104	53%			
Teacher had 10 years or more of experience (S baseline)	221	66%				118	60%				103	73%			
Classroom emotional support (S baseline)	307	5.18	0.86	3	7	152	5.00	0.85	2.56	6.94	155	5.35	0.83	2.56	6.69
Classroom organization (S baseline)	307	4.72	0.94	2	7	152	4.55	0.95	2.17	6.58	155	4.88	0.91	1.75	6.92
Classroom instructional support (S baseline)	307	2.51	0.97	1	6	152	2.32	0.98	1	6.00	155	2.70	0.92	1	5.33
Percent of children non-Hispanic Black (F baseline)	307	44%				152	39%				155	50%			
Percent of children non-Hispanic White (F baseline)	307	55%				152	65%				155	46%			
Percent of children Hispanic (F baseline)	307	43%				152	47%				155	40%			
Outcomes															
Classroom emotional support (S post)	307	5.35	0.85	2	7	152	5.26	0.95	2.44	6.90	155	5.43	0.73	3	6.88
Classroom organization (S post)	307	4.90	1.03	1	7	152	4.85	1.15	1.33	6.92	155	4.94	0.89	1.92	6.75
Classroom instructional support (S post)	307	2.40	0.90	1	6	152	2.46	0.94	1	5.25	155	2.33	0.86	1	5.58
Classroom-Level Problem Behaviors															
Classroom-level oppositional/aggressive (F baseline)	307	2.99	2.29	0	12	152	2.89	2.34	0	11.66	155	3.09	2.24	0	11.45
Classroom-level internalizing (F baseline)	307	1.72	1.65	0	10	152	1.64	1.64	0	8.57	155	1.79	1.65	0	10.30
Classroom-level hyperactivity (F baseline)	307	1.86	1.27	0	6	152	1.81	1.33	9	5.75	155	1.90	1.21	0	5.33

Note. S baseline = spring baseline time point; F baseline = fall baseline time point; S post = spring post time point.

Table 3
Correlations.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1 Teacher non-Hispanic Black (S baseline)	1																
2 Teacher non-Hispanic White (S baseline)	−0.47 ***	1															
3 Teacher non-Hispanic Other (S baseline)	−0.19 **	−0.16 *	1														
4 Teacher Hispanic (S baseline)	−0.48 ***	−0.42 ***	−0.17 **	1													
5 Teacher had Bachelor's degree or higher (S baseline)	−0.13	0.22 ***	0.16 *	−0.17 *	1												
6 Teacher had 10 years or more of experience (S baseline)	0.13	−0.22 ***	0.1	0.03	−0.20 ***	1											
7 Classroom emotional support (S baseline)	0.11	−0.06	−0.1	−0.01	−0.1	0.1	1										
8 Classroom organization (S baseline)	0.14 *	−0.05	−0.1	−0.05	−0.02	0.07	0.85 ***	1									
9 Classroom instructional support (S baseline)	0.10	−0.03	−0.07	−0.04	−0.05	0.08	0.66 ***	0.69 ***	1								
10 Percent of children non-Hispanic Black (F baseline)	0.72 ***	−0.18 *	−0.21 *	−0.47 ***	−0.07	0.05	−0.2	0.10 ***	0.67	1							
11 Percent of children non-Hispanic White (F baseline)	−0.70 ***	0.31 ***	0.20 **	0.33 ***	0.12	−0.08	−0.01	−0.10	−0.03	−0.84 ***	1						
12 Percent of children Hispanic (F baseline)	−0.50 ***	−0.31 ***	0.32 ***	0.67 ***	−0.09	0.06	0.01	−0.07	−0.10	−0.73 ***	0.59 ***	1					
13 Classroom emotional support (S post)	−0.1	0.13	−0.09	0.03	0.07	−0.07	0.19 ***	0.20 ***	0.19 ***	−0.18 ***	0.06	0.20 ***	1				
14 Classroom organization (S post)	−0.08	0.07	−0.15	0.09	0.09	−0.07	0.11 *	0.18 ***	0.17 ***	−0.11 *	0.04	0.11	0.79 ***	1			
15 Classroom instructional support (S post)	−0.12	0.34 ***	−0.1	−0.16 **	0.24 ***	−0.14 *	0.09	0.12 *	0.15 *	−0.06	−0.13 *	0.15 **	0.54 ***	0.51 ***	1		
16 Classroom-level oppositional/aggressive (F baseline)	0.13 *	0.08	−0.20 ***	−0.11	−0.06	0.04	−0.07	−0.06	0.04	0.17 **	−0.20 ***	−0.17 **	−0.16 ***	−0.13 *	−0.14	1	
17 Classroom-level internalizing (F baseline)	0.04	0.03	−0.08	−0.02	−0.14	0.1	−0.02	−0.04	0.03	0.04	−0.04	−0.08	−0.14*	−0.13 *	−0.14 *	0.74 ***	1
18 Classroom-level hyperactivity (F baseline)	0.07	0.1	−0.12	−0.11	−0.02	0.1	−0.07	−0.02	0.02	0.06	−0.14 *	−0.10	−0.1	−0.05	−0.1	0.79 ***	0.70 ***

Note. S baseline = spring baseline time point; F baseline = fall baseline time point; S post = spring post time point. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 4

Associations between classroom-level problem behaviors and teacher-child interaction quality.

	Classroom emotional support			Classroom organization			Classroom instructional support		
	Coef	SE	Effect Size	Coef	SE	Effect Size	Coef	SE	Effect Size
<i>Main effects model</i>									
Classroom-level oppositional/aggressive	−0.08	0.03*	0.12	−0.09	0.03*	0.09	−0.09	0.03**	0.23
Mixed-age classroom	−0.07	0.20		−0.05	0.24		−0.21	0.20	
Incredible Years	−0.03	0.16		−0.06	0.20		−0.13	0.16	
Preschool PATHS	0.14	0.16		0.09	0.20		0.09	0.17	
Tools of the Mind	0.15	0.16		0.16	0.20		0.10	0.16	
Baseline CLASS score	0.16	0.06**		0.16	0.07***		0.13	0.06*	
Teacher >10 years of experience	−0.10	0.12		−0.06	0.14		−0.07	0.12	
Teacher non-Hispanic Black	0.50	0.33		0.44	0.39		0.28	0.32	
Teacher non-Hispanic White	0.45	0.32		0.45	0.38		0.47	0.32	
Teacher Hispanic	0.34	0.27		0.64	0.32*		0.23	0.27	
Teacher has Bachelor's degree or higher	0.09	0.12		0.14	0.14		0.27	0.12*	
Percent children in classroom non-Hispanic Black	−0.48	0.32		−0.51	0.38		−0.30	0.32	
Percent children in classroom non-Hispanic White	0.19	0.28		−0.07	0.34		0.31	0.28	
Percent children in classroom Hispanic	−0.19	0.27		−0.39	0.33		−0.63	0.27*	
<i>Interaction model</i>									
Classroom-level oppositional/aggressive x mixed-age classroom	0.08	0.05		0.05	0.06		0.05	0.05	
<i>Main effects model</i>									
Classroom-level internalizing	−0.11	0.05*	0.13	−0.14	0.05*	0.09	−0.11	0.05*	0.24
Mixed-age classroom	−0.02	0.17		−0.03	0.21		−0.13	0.17	
Incredible Years	−0.02	0.16		−0.07	0.21		−0.14	0.17	
Preschool PATHS	0.15	0.16		−0.07	0.21		0.10	0.17	
Tools of the Mind	0.13	0.16		0.14	0.21		0.07	0.16	
Baseline CLASS score	0.16	0.06***		0.16	0.07*		0.13	0.06*	
Teacher >10 years of experience	−0.09	0.12		−0.04	0.14		−0.06	0.12	

(continued on next page)

Table 4 (continued)

	Classroom emotional support			Classroom organization			Classroom instructional support		
	Coef	SE	Effect Size	Coef	SE	Effect Size	Coef	SE	Effect Size
Teacher non-Hispanic Black	0.47			0.40			0.23		
		0.33			0.38			0.32	
Teacher non-Hispanic White	0.42			0.39			0.42		
		0.32			0.38			0.32	
Teacher Hispanic	0.30			0.57			0.17		
		0.27			0.32			0.27	
Teacher has Bachelor's degree or higher	0.07			0.10			0.23		
		0.12			0.14			0.12	
Percent children in classroom non-Hispanic Black	−0.54			−0.57			−0.33		
		0.32			0.38			0.32	
Percent children in classroom non-Hispanic White	0.17			−0.09			0.31		
		0.28			0.34			0.28	
Percent children in classroom Hispanic	−0.17			−0.38			−0.63		
		0.27			0.33			0.27*	
<i>Interaction model</i>									
Classroom-level internalizing x mixed-age classroom	0.10			0.07			0.04		
		0.07			0.09			0.07	
<i>Main effects model</i>									
Classroom-level hyperactivity	−0.14		0.12	−0.15		0.07	−0.16		0.23
		0.8			0.09			0.06**	
Mixed-age classroom	−0.21			−0.30			−0.39		
		0.20			0.25			0.21	
Incredible Years	−0.02			−0.07			−0.12		
		0.16			0.20			0.16	
Preschool PATHS	0.14			−0.08			0.09		
		0.16			0.20			0.16	
Tools of the Mind	0.13			0.15			0.09		
		0.16			0.20			0.16	
Baseline CLASS score	0.16			0.16			0.13		
		0.06***			0.07*			0.06*	
Teacher >10 years of experience	−0.09			−0.05			−0.05		
		0.12			0.14			0.32	
Teacher non-Hispanic Black	0.39			0.31			0.15		
		0.33			0.39			0.32	
Teacher non-Hispanic White	0.38			0.36			0.0		
		0.32			0.38			0.32	
Teacher Hispanic	0.26			0.53			0.13		
		0.27			0.32			0.27	
Teacher has Bachelor's degree or higher	0.09			0.14			0.27		
		0.12			0.14			0.12*	
Percent children in classroom non-Hispanic Black	−0.45			−0.45			−0.27		
		0.32			0.39			0.32	
Percent children in classroom non-Hispanic White	0.19			−0.07			0.31		
		0.27			0.34			0.28	
Percent children in classroom Hispanic	−0.16			−0.34			−0.60		
		0.27			0.33			0.27*	
<i>Interaction model</i>									
Classroom-level hyperactivity x mixed-age classroom	0.20			0.22			0.18		
		0.09*			0.11*			0.09*	

Note. All main effect and interaction models were examined separately. Interaction models control for peer problem behavior, mixed age, intervention status, baseline CLASS scores, teacher years of experience, teacher demographics, child demographics, and teacher education. Effect sizes metric: tiny ≤ 0.05 , very small from 0.05 to ≤ 0.10 , small from 0.10 to ≤ 0.20 , medium from 0.20 to ≤ 0.30 , large from 0.30 to ≤ 0.40 , and very large > 0.40 . * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7. Results

The results of the descriptive analyses are provided in Table 2 and correlations are provided in Table 3. Mean levels of baseline classroom-level oppositional/aggressive behavior were higher than classroom-level internalizing behavior, $t(1.27)$, $p = 0.004$, and hyperactivity behavior, $t(1.13)$, $p = 0.002$. Mean-levels of baseline classroom-level hyperactivity were higher than internalizing behavior, $t(0.15)$, $p = 0.03$. There were no mean-level significant differences between 4-year-old and mixed-age classrooms on classroom-level problem behaviors, Oppositional/aggressive behavior: $t(-0.79)$, $p = 0.43$; internalizing behavior: $t(-1.20)$, $p = 0.23$; hyperactivity: $t(-1.11)$, $p = 0.27$. Similarly, no statistically significant mean-level differences were found between 4-year-old and mixed-age classrooms and teacher-child interaction quality scores at baseline (emotional support: $t(-1.70)$, $p = 0.14$; classroom organization $t(-1.85)$, $p = 0.22$; instructional support: $t(-1.58)$, $p = 0.24$) and spring timepoints (emotional support: $t(-1.83)$, $p = 0.08$; classroom organization $t(-0.78)$, $p = 0.44$; instructional support: $t(1.14)$, $p = 0.25$). No association was found between teacher experience and classroom age composition, $\chi^2(2) \geq 3.92$, $p = 0.06$, or between teacher education and classroom age composition, $\chi^2(2) \geq 4.57$, $p = 0.09$.

8. Are classroom-level child problem behaviors related to teacher-child interaction quality?

Table 4 shows the results from models that examined whether classroom-level problem behaviors in the fall were associated with spring teacher-child interaction quality scores, controlling for a set of covariates, including spring baseline teacher-child interaction quality. The results suggested that fall classroom-level oppositional/aggressive behavior was negatively related to spring classroom emotional support ($d = 0.12$, $p = 0.04$), classroom organization ($d = 0.09$, $p = 0.03$), and instructional support ($d = 0.23$, $p = 0.01$). Fall classroom-level internalizing behavior was negatively related to spring classroom emotional support ($d = 0.13$, $p = 0.04$), classroom organization ($d = 0.09$, $p = 0.01$), and instructional support ($d = 0.24$, $p = 0.01$). Finally, fall classroom-level hyperactivity was negatively related to spring classroom instructional support ($d = 0.23$, $p = 0.008$), but fall classroom-level hyperactivity was not significantly associated with spring classroom-level emotional support ($d = 0.12$, $p = 0.22$) or classroom organization ($d = 0.07$, $p = 0.22$). The effect sizes for classroom-level problem behaviors and teacher-child interaction quality ranged from very small to medium (emotional support: small; classroom organization: very small; instructional support: medium).

9. To what extent are the relations between classroom-level problem behaviors and teacher-child interaction quality moderated by classroom age composition?

We tested whether classroom-level behavior problems differed according to classroom age composition to address Research Question 2. Mixed-age classrooms did not moderate the relationship between fall classroom-level oppositional/aggressive scores and teacher-child interaction quality scores (classroom emotional support: $b = 0.08$, $p = 0.15$; classroom organization: $b = 0.05$, $p = 0.46$; instructional support: $b = 0.05$, $p = 0.35$). Similarly, classroom age composition did not moderate the relationship between fall classroom-level internalizing behavior scores and teacher-child interaction quality scores (classroom emotional support: $b = 0.10$, $p = 0.16$; classroom organization: $b = 0.07$, $p = 0.42$; instructional support: $b = 0.04$, $p = 0.55$). However, classroom age composition

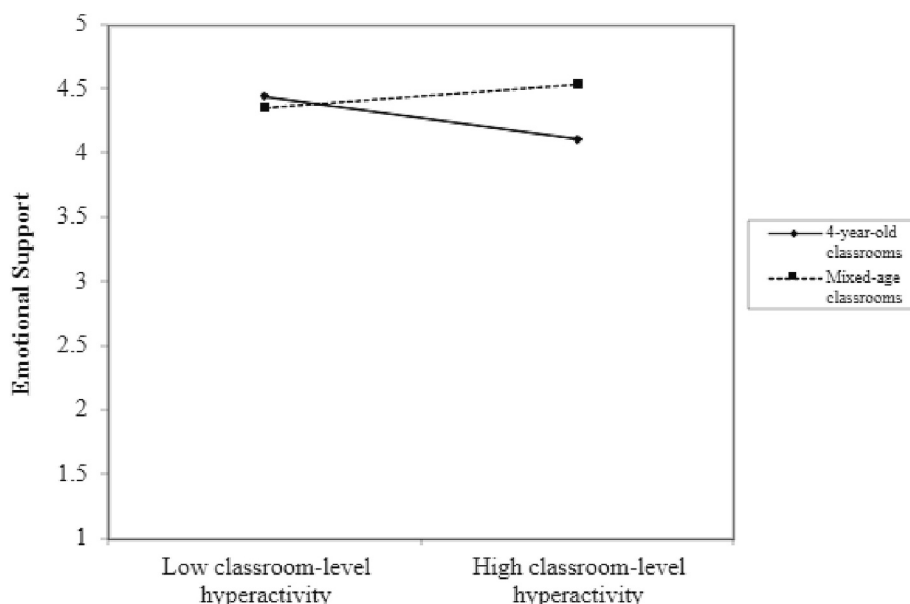


Fig. 1. Two-way interaction between classroom-level hyperactivity and classroom age composition for emotional support.

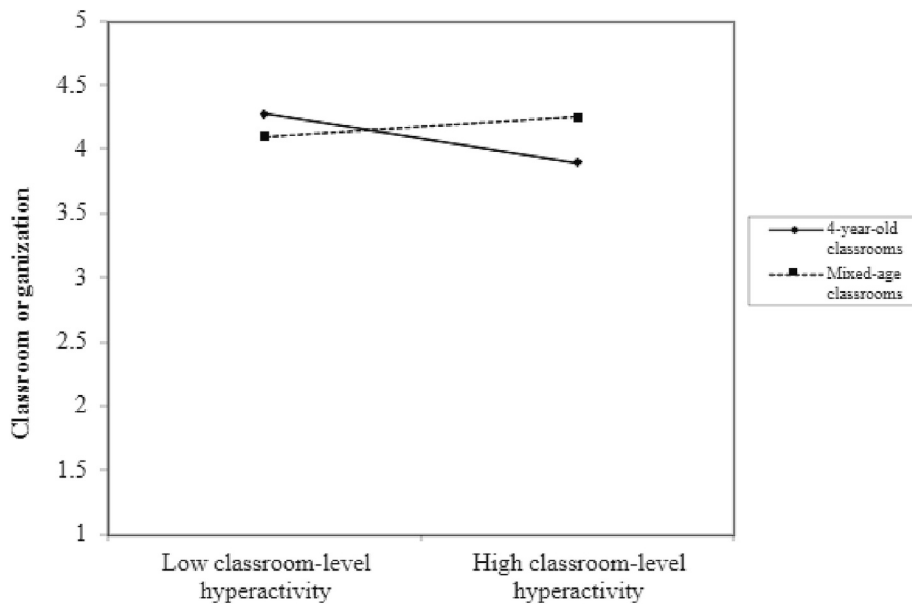


Fig. 2. Two-way interaction between classroom-level hyperactivity and classroom age composition for classroom organization.

moderated the relations between classroom-level hyperactivity and (a) classroom emotional support x mixed age classroom ($b = 0.20$, $p = 0.03$), (b) classroom organization x mixed age classroom ($b = 0.22$, $p = 0.05$), and (c) instructional support x mixed age classroom ($b = 0.18$, $p = 0.05$).

The Preacher plotting tool for multiple linear regression (Preacher et al., 2006) was used to further examine these significant interactions. Analyses of simple slopes and inspections of interaction plots revealed that hyperactivity in 4-year-old classrooms was significantly and negatively related to classroom emotional support ($b = -0.16$, $p < 0.01$; Fig. 1), classroom organization ($b = -0.17$, $p = 0.001$; see Fig. 2), and instructional support ($b = -0.18$, $p < 0.01$; see Fig. 3). In contrast, the simple slopes were not significant for mixed-age classrooms. Non-significant simple slopes suggest that although the relationships between classroom-level hyperactivity problems and teacher-child interaction quality significantly differed due to mixed-age status, the relations only reached statistical significance for 4-year old classrooms.

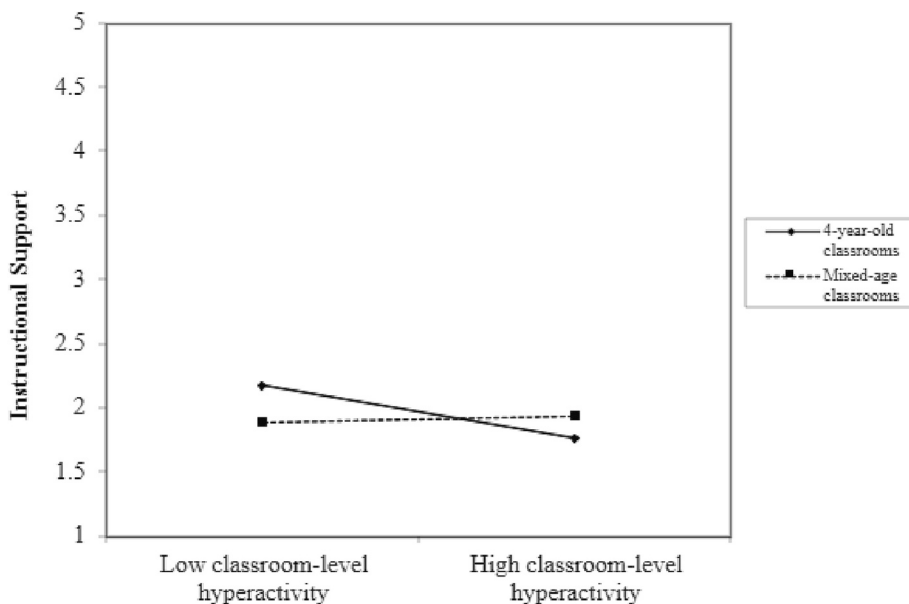


Fig. 3. Two-way interaction between classroom-level hyperactivity and classroom age composition for instructional support.

10. Discussion

There is broad consensus in research, practice, and policy communities that teacher-child interaction quality is an essential ingredient of high-quality preschool (Burchinal, 2018; Pianta et al., 2016). Most prior research examining teacher-child interaction quality and children's problem behavior has focused on how teacher-child interaction quality that is characterized by high rates of positive and supportive teacher-child interactions can reduce children's problem behaviors (Hamre & Pianta, 2005; Wilson et al., 2007). Conversely, the present study explored whether classroom-level problem behaviors were associated with teacher-child interaction quality. This study's primary objective was to examine the role of fall classroom-level problem behavior on spring teacher-child interaction quality and to explore whether classroom age composition moderated the relationship between classroom-level problem behavior and teacher-child interaction quality.

Our results found that classroom-level oppositional/aggressive and internalizing behavior were associated with lower teacher-child interaction quality even after controlling for teacher-child interaction quality in the year prior. That is, classrooms with higher mean oppositional/aggressive and internalizing behaviors were rated as having lower levels of emotional support, classroom organization, and instructional support, although the effect sizes suggested only small associations. Although we did not specify any hypotheses for the association between classroom-level problem behaviors and instructional support, our results suggest a negative, significant relationship. Given the considerably low rates of instructional support in classrooms found in prior studies (e.g., Curby et al., 2009; Hamre et al., 2013; Mashburn et al., 2008; von Suchodoletz et al., 2014), these results suggest that classroom-level problem behavior may be a contributor. This trend of lower instructional support quality is critical because instructional support is the core of teaching practices linked to students' academic learning and engagement (Hamre et al., 2013).

There also were null interaction results, which suggest that classroom-level oppositional/aggressive and internalizing behaviors and the age composition of children in classrooms do not interact in a way that related to teacher-child interaction quality. Potentially, teachers have difficulty dealing with oppositional/aggressive and internalizing behaviors or find them more troubling when displayed by children regardless of classroom age composition. Finally, it is possible that the null findings for interactions with classroom-level internalizing behavior could be due to methodological issues (e.g., teacher reports of internalizing behavior may be less reliable and difficult for teachers to report; McElwain & Volling, 2005).

Importantly, we also examined hyperactivity as a separate dimension of problem behavior rather than as a dimension of externalizing behavior as it is frequently operationalized in other studies (e.g., Montroy et al., 2014; Williford & Wolcott, 2015). We found that when classroom-level hyperactivity was higher, teacher-child interaction quality was lower in 4-year-old only classrooms. In contrast, within mixed-age classrooms, teacher-child interaction quality scores remained stable as classroom-level hyperactivity increased. Although these effects were small in magnitude, they provisionally suggest that teachers within 4-year-old only classrooms may struggle to maintain teacher-child interaction quality when higher rates of classroom-level hyperactivity are present. At the very least, the current findings suggest preliminary patterns that warrant further exploration.

Several possible explanations exist for why lower levels of teacher-child interaction quality may occur when classroom-level hyperactivity is higher within 4-year-old classrooms. First, it could be due to teachers having specific expectations for how 4-year-old children should behave that differ from their expectations for 3-year-old children's behavior (e.g., Brophy & Good, 1970). Teachers' expectations about children's hyperactivity could be related to their beliefs about normative development. Prior studies illustrate that children with hyperactive behaviors tend to have difficulty focusing their attention long enough or well enough to learn (Barkley, 2015). Teachers may expect children in mixed-age classrooms, particularly the 3-year-olds, to exhibit more hyperactive behavior. It is also plausible that the emphasis on kindergarten readiness has led to increased pressure and apprehension among preschool teachers (particularly those in 4-year-old only classrooms; Brown et al., 2019); this heightened focus on academic content and teachers' expectations for how children should behave could be related to higher expectations for behaviors among teachers within 4-year-old only classrooms (Le et al., 2019).

These expectations of children's behaviors may be associated with teachers being less tolerant of hyperactivity with children within 4-year-old only classrooms. High rates of classroom-level hyperactivity, such as children impulsively getting up from circle time or interrupting a book reading with lots of talking, may be particularly frustrating for teachers. Hamre et al. (2008) found that older children were reported to have more conflict with teachers than expected based on their level of teacher-reported problem behavior. This suggests that teachers may be less permissive of hyperactivity among children in 4-year-old only classrooms even if they are displaying similar rates of hyperactivity as 3-year-old children. Teachers may also feel that 4-year-old children could have controlled their problem behaviors had they wanted to or had specific intentions with their behavior, which could amplify teachers' negative reactions. As a result, teachers may feel frustrated or angry, which in turn may negatively influence the sensitivity of their practices.

In this study we controlled for teacher-child interaction quality in the prior year; thus, only the variance in the spring teacher-child interaction quality not explained by teacher-child interaction quality scores in the previous year could be related to classroom-level problem behaviors. This suggests that classrooms' teacher-child interaction quality scores may be partially dependent on classroom-level problem behaviors and teachers' reactions to those problem behaviors. In other words, the composition of children in the classroom, and in this case, the mean levels of problem behaviors, play a unique role in the teacher-child interaction quality. Although teacher-child interaction quality (i.e., CLASS scores) tends to be relatively stable throughout the year, teacher-child interaction quality potentially may fluctuate year to year (and even within the year; Burchinal, 2018). It may be that levels of teacher-child interaction quality shift year-to-year as the composition of children's problem behaviors fluctuate and teachers vary in their ability to adjust their teaching to address the behaviors (Patrick & Mantzicopoulos, 2016).

11. Limitations and future directions

Although much of the extant literature relies on teacher reports of children's problem behavior, we consider this to be a potential limitation of this study. Despite teachers being able to provide valuable perspectives relating to child problem behavior because they observe behaviors outside of the home setting, witness children in situations that provoke strong reactions, and develop norms regarding child development due to their exposure to multiple children (Saudino et al., 2005), teachers' judgments of children are partly associated with teachers' existing perspectives that may be shaped by personal or psychological characteristics (Mashburn et al., 2006). Observations of teacher-child interaction quality may relate to other variables associated with the teacher's relationship with children that are correlated with their perceptions and ratings of children; we cannot disentangle these potential associations. Future research should explore how different developmental expectations of teachers in mixed-age vs. 4-year-old classrooms and increased pressure on teachers for kindergarten readiness may relate to teacher-child interaction quality. Similarly, future research should examine whether teachers' beliefs about developmentally normative child behavior may indeed be influenced by classroom age composition; to do so, surveys of teachers' beliefs of children's behaviors may need to be developed given the lack of existing measures.

A second concern is that classroom-level problem behaviors may have been underestimated because our assessment was based only on those children who consented to participate in the study rather than all children in each classroom. Prior studies suggest that parents of most at-risk children are less likely to provide consent for their child to participate in research (Heinrichs et al., 2005). Although the study randomly sampled, on average, 10 children per classroom, and given the consent rate across centers was approximately 90%, we believe that we have a fair representation of eligible children within each classroom (Morris et al., 2014). Because the data consisted of a sample of children from low-income backgrounds, there may be more children with problem behaviors than one might find in a non-Head-Start preschool classroom. Thus, the results from this study may only be generalizable for a Head Start sample. This study should be replicated in a sample with children from higher-income backgrounds or classrooms that serve mixed-income populations. Similarly, future studies could examine whether different methods of using individual-level data to represent classroom composition is related to teacher-child interaction quality.

An additional limitation concerns our measure of age composition. We used a binary variable indicating whether the classroom was a mixed-age classroom or a 4-year-old only classroom. Future work should be done to understand whether the proportion of 3-year-olds or the range of children's ages is related to teacher-child interaction quality. In this study, we used mean teacher ratings of children's problem behavior levels to represent the classroom composition of problem behavior. Nonetheless, other studies should examine whether different classroom behavioral composition factors (e.g., standard deviations around mean, using the proportion of children in each classroom that scored above the whole sample 75th percentile) besides the classroom mean influence teacher-child interaction quality.

Due to our use of a secondary data set, we were restricted to the measurement timing as determined by the original researchers (Morris et al., 2014). One limitation is that the baseline teacher-child interaction quality observation, used as a covariate in our analysis, was collected in the prior year. This means we controlled teacher-child interaction quality in classrooms with a different cohort of children. Additionally, due to teacher turnover between school years (about 25%), the teachers observed for the teacher-child interaction quality measure are sometimes different at baseline compared to post-assessment. Another limitation due to the timing of the baseline teacher-child interaction quality observation is that we could not test the bidirectional model. Nonetheless, future research should intentionally design data collection to examine potential bidirectional associations between problem behavior and teacher-child interaction quality within and across school years and to control for baseline teacher-child interaction quality collected within the same school year. Finally, given work that has found day-to-day variations in teacher-child interaction quality (e.g., Patrick & Mantzicopoulos, 2016), future studies should consider conducting more than one classroom observation to get a more accurate assessment of quality.

Future work should examine possible mechanisms to explain the relationship between classroom-level problem behaviors and teacher-child interaction quality. For instance, questions remain about whether this relationship is mediated by teacher stress or lack of time on instructional content. Understanding the mechanism of this will provide valuable information for potential interventions.

12. Implications for practice and policy

The results of this study have potential implications for educational practice and policy. From a practice perspective, a critical concern is how to support teachers in providing high-quality interactions when faced with high-level classroom problem behaviors. Given results suggesting that classroom-level problem behaviors are negatively related to teacher-child interaction quality, the study's findings suggest the need to provide universal interventions, such as Preschool Paths, Tools of the Mind, I Can Problem Solve, and The Incredible Years, that do not just target children who face various disadvantages but programs that can be delivered to the whole classroom (Bierman & Motamedi, 2015; Murano et al., 2020). Although many universal interventions focus on supporting teachers to improve the emotional and relational aspects of the classroom, impacts have also been found on the instructional support of the classroom (e.g., Morris et al., 2014). Given the low rates of instructional support in preschool classrooms across the country and the globe, universal interventions that focus on classroom problem behaviors could be a mechanism to improve these scores (e.g., Curby et al., 2009; Hamre et al., 2013; Mashburn et al., 2008; Von Suchodoletz et al., 2014). For example, My Teaching Partner, an intervention where teachers work one-on-one with a coach using videotaped observations, has resulted in higher scores on instructional support (Early et al., 2017). Finally, a school psychologist or behavior consultant may be needed to help teachers understand how to best support different needs within a classroom. For example, the Chicago School Readiness Project (CSRP), which uses a mental health consultant who coaches teachers, offers a promising approach for reducing children's problem behaviors in classroom settings (Raver et al., 2008).

Given that classroom-level problem behaviors influence teacher-child interaction quality, it may be advantageous to develop policies that encourage the mixing of children with varying hyperactivity levels in a classroom. Methods of assigning children to teachers that consider a teacher's threshold for handling hyperactivity behaviors can also be considered to promote a high-quality preschool classroom. Given that many preschool teachers lack the knowledge and skills to work with children who have chronic problem behavior, particularly hyperactivity (Hemmeter et al., 2006), providing support to increase teachers' awareness, knowledge, and effectiveness with problem behaviors could help increase high-quality teacher-child interactional quality within 4-year-old only classrooms. Similarly, creating mixed-age classrooms could be related to higher teacher-child interaction quality. Nonetheless, it could be useful for teachers to increase their awareness of how behavioral problems, like hyperactivity, and characteristics of children contribute to their feelings and perceptions and evaluate how these problems influence their daily practices. It is possible that teachers need additional training in dealing with problem behaviors and the positive or negative emotions that follow certain behaviors, particularly hyperactivity.

From a policy perspective, it is important to understand how classroom-level problem behaviors are related to instruments, like the CLASS, that are routinely used for accountability and evaluation systems across the United States and the world (Vitiello et al., 2018). The results of this study emphasize the need to consider the proportion of children in a classroom who demonstrate problem behaviors when interpreting teachers' CLASS scores and making decisions based on these scores.

13. Conclusion

This study provides much-needed insight into the implications of classroom-level problem behavior on teacher-child interaction quality. In sum, classroom-level problem behavior, specifically oppositional/aggressive and internalizing behavior, was related to lower teacher-child interaction quality. Furthermore, classroom age composition moderated the relationship between classroom-level hyperactivity and teacher-child interaction quality; that is, teacher-child interaction quality in 4-year-old classrooms decreased as mean levels of hyperactivity increased. In contrast, teacher-child interaction quality scores remained stable within mixed-age classrooms as classroom-level hyperactivity increased. Given the vital role of teacher-child interaction quality in children's development and within accountability and licensing systems (e.g., Tout et al., 2006), these findings underscore the need for continued investigation into the influence of classroom-level problem behavior.

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