**The Role of Full- and Half-Day Preschool Attendance
in the Formation of Children's Social Networks**

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Abstract

In the United States, the duration of children's preschool attendance differs, with some children attending full-day preschool and some children attending half-day preschool. This difference provides uneven daily exposure to peers that may have implications for childhood social outcomes, including the formation of social networks over time. In this study, we examined the role of full- and half-day preschool attendance in children's social network formation. Specifically, using stochastic actor-oriented modeling (i.e., a type of longitudinal social network analysis appropriate for measuring relationship formation over time), we analyzed longitudinal social network data from an intensive observational study of 25 3-year-old and 28 4-year-old students' social play relationships in two preschool classrooms over the course of an entire school year. Our results provide no evidence that attending full-day preschool has a positive effect on the formation of social play relationships in early childhood. Instead, 3-year-old children who attended full-day preschool were significantly less likely than their half-day peers to form social play relationships over time. We discuss potential developmental and contextual factors that might explain this finding as well as future directions for research and practice.

Keywords: preschool attendance, longitudinal, social network, stochastic actor oriented model

Highlights

- This study examines the role of preschool attendance in social network formation.
- Longitudinal network data were collected in a 3-year-old and 4-year-old classroom.
- 3-year-olds in full-day preschool were less likely to form social play relationships over time.
- There was no effect of preschool attendance on network formation for 4-year-olds.

The Role of Full- and Half-Day Preschool Attendance in the Formation of Children's Social Networks

Participation in preschool provides children with novel opportunities to engage with peers, build socioemotional skills, create a shared peer culture, and form complex social networks (Corsaro, 1988; DeLay et al., 2016; Martin et al., 2005; Schaefer et al., 2010). However, the duration of children's preschool attendance differs, with some children attending full-day preschool and some children attending half-day preschool. Although researchers have examined whether full- or half-day preschool attendance is differentially related to the development of socioemotional skills and academic outcomes (e.g., Atteberry et al., 2019; Leow & Wen, 2017; Valenti & Tracey, 2009), less is known about how preschool attendance might be associated with the formation of children's networks of social play relationships. Understanding this association is important because social play relationships with peers typically first emerge during preschool (Schaefer, 2010) and provide opportunities for children to build key socioemotional skills including perspective-taking, cooperation, and social problem solving (Ashiabi, 2007; Coplan et al., 2005; Coplan & Arbeau, 2009; Göncü et al., 2002; Rubin et al., 2006). However, there is variation in the extent to which preschool children engage in social play (see Coplan et al., 2005) which might be driven, in part, by environmental factors like preschool attendance.

In this study, we examine the role of full- and half-day preschool attendance in children's social network formation. First, we review the literature on preschool as a setting for social

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development and the formation of social networks. We also present prior research on associations between preschool attendance and social outcomes. Next, using stochastic actor-oriented modeling, we analyze longitudinal data from an intensive observational study of 25 3-year-old and 28 4-year-old students in two preschool classrooms over the course of an entire school year. For each classroom, we present results comparing the effects of full- and half-day preschool attendance on the formation of children's networks of social play relationships. Finally, to conclude, we discuss the contributions of these results to existing research related to preschool attendance and children's social outcomes as well as practical implications for parents and teachers.

Preschool as a Setting for Social Development

Preschool attendance is common in early childhood. In the United States, around 40% of 3-year-old children and over 60% of 4-year-old children were enrolled in preschool each year between 2000 and 2018 (Hussar et al., 2020). Preschool activities are often centered around play and preschools provide ample time for children to engage in unstructured play with their peers (Hanish et al., 2007; Martin et al., 2005). Therefore, for many children, preschool provides one of the first opportunities for sustained engagement and play with many same-age peers (Corsaro, 1988; Hanish et al., 2021; Martin et al., 2005).

Coupled with increased cognitive capacity to engage in peer interactions, the increased opportunities that preschools provide for play with peers can foster social development (Hartup, 1992; Rubin et al., 2006). Specifically, during preschool, children begin to engage in more complex forms of social play that include taking the perspective of others such as pretend play (Coplan & Arbeau, 2009; Göncü et al., 2002; Rubin et al., 2006). Social interactions during preschool tend to be longer, more coordinated, and involve prosocial behaviors (Coplan &

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Arbeau, 2009). Preschool children also develop reciprocated friendships (Vaughn et al., 2001) and engage in play with larger groups of peers (Hanish et al., 2007; Strayer & Santos, 1996).

Preschool Social Network Formation

As preschool children engage in more complex and higher quality peer interactions in their classrooms, they form relationships with peers and social networks that fluctuate but also become increasingly more stable over time (Barbu, 2003; Martin & Fabes, 2001). These preschool social networks exhibit several structural tendencies that are common in most affiliative social networks. Specifically, affiliative social relationships in preschool networks tend to be reciprocated over time and to exhibit triadic closure (i.e., if child *i* plays with both child *j* and *k*, child *j* and *k* will tend to also play together; Daniel et al., 2013; Daniel et al., 2016; Schaefer et al., 2010). Additionally, throughout the course of a school year, preschool children's networks tend to demonstrate increasing trends toward triadic closure and preferences for the formation of relationships with popular children (i.e., children with more social play relationships; Schaefer et al., 2010).

Preschool children also show strong evidence of gender homophily, or the tendency to form relationships with same-gender peers (Martin et al., 2005; McPherson, Smith-Lovin, & Cook, 2001). For example, a study of U.S. preschool children found that 80% showed preferences for same-gender play partners and 50-60% of children's peer interactions were with same gender peers (Martin & Fabes, 2001). Similarly, studies of preschool social networks in the U.S. and European countries consistently demonstrate that social relationships are more likely to exist between same-gender rather than opposite-gender peers (Barbu, 2003; Chen et al., 2019; Chen et al., 2020; Daniel et al., 2013; Daniel et al., 2016; DeLay et al., 2016; Martin et al., 2013; Neal et al., 2017). Preschool age children both directly select same-gender peers as playmates

and indirectly select same-gender peers based on similar preferences in gender-typed activities (Martin et al., 2013).

Preschool Attendance and Social Outcomes

Although prior research shows evidence of general structural tendencies and gender homophily in preschool social network formation (e.g., Daniel et al., 2013; Martin et al., 2013; Schaefer et al., 2010), less is known about the role of preschool attendance in children's social network formation over time. In the United States, 40% of 3-year-olds and 68% of 4-year-olds were enrolled in preschool in 2018. Of those 3- and 4-year-olds enrolled, 55% were enrolled in full-day preschool programs whereas the remaining were enrolled for only part or half-day (Hussar et al., 2020). These differing levels of preschool attendance provide uneven daily exposure to peers that may have implications for childhood social outcomes. Specifically, past studies of children's social outcomes have focused on comparisons of full- and half-day childcare, preschool, and kindergarten (e.g., Atteberry et al., 2019; Leow & Wen, 2017; Reynolds et al., 2014), as well as comparisons of duration of time spent in preschool or childcare (e.g., Bradley & Vandell, 2007; Schindler et al., 1987). These studies have also largely focused on understanding differences in social competence, socioemotional skills, and behavioral problems.

Because full-day preschool provides children with increased opportunities to interact with and practice engagement with peers, it may offer benefits for social development. Studies using both randomized and non-randomized matched group designs have found that full-day preschool students exhibit higher teacher-reported socioemotional skills than their peers (Atteberry et al., 2019; Reynolds et al., 2014). In these studies, socioemotional skills in young students have often been measured with the Teacher Strategies GOLD Assessment System. This observational

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teacher rating system is sensitive to developmental changes in students over time and has been validated in a large, diverse sample of students (Lambert et al., 2014). Additional research using observations in both the United States and Italy found that day care attendance or time spent in day care was positively related to social play and negatively related to solitary play, onlooker behavior, and unoccupied behavior (Aureli & Colecchia, 1996; Aureli & Procacci, 1992; Schindler et al., 1987).

However, other findings suggest that preschool attendance or time spent in childcare has no effect or perhaps even a deleterious effect on social skills and behavior. Several studies have found no difference in outcomes such as prosocial behavior, behavior problems, or social competence for children attending full- and half-day preschool or childcare (Herry et al., 2007; Howes, 1988; Howes et al., 1994; Leow & Wen, 2017). Additionally, longitudinal work suggests that the amount of time spent in day care in the first few years of life has no long-term effects on externalizing behavior or conflict with teachers by 6th grade (Belsky et al., 2007). On the negative side, at least some work has found that more preschool or childcare attendance is associated with problematic behaviors and poorer social outcomes. For example, a large-scale study in the U.S. found that more hours in childcare was associated with lower levels of teacher-rated social skills, more mother-child conflict, and higher rates of teacher-rated externalizing problems (NICHD, 2005).

Finally, even within certain studies, findings have been mixed. For instance, one study demonstrated that more *hours* per week in childcare are associated with less social competence, while more *days* per week are associated with more social competence (Campbell et al., 2000). This work suggests that children's social outcomes might be maximized if they spend more but shorter days in childcare. Reviews and meta-analyses also present mixed findings. For example,

one review found that increased time in non-parental care predicts short-term poor behavioral outcomes and peer interactions that last until the third grade, but also predicts increases in social competence (Bradley & Vandell, 2007). Additionally, one meta-analysis found that full-day kindergarten was positively associated with self-confidence and the ability to work and play with others but was also associated with less positive attitudes toward school and the tendency to exhibit more behavioral problems (Cooper et al., 2010).

The Current Study

Findings from the current literature are inconclusive regarding the effects of full- and half-day childcare or preschool on childhood social development. Additionally, most studies focus on teacher or parent ratings of social competence, skills, or behavior. Only a handful of studies examine the association between preschool attendance and actual peer interactions (e.g., Aureli & Colecchia, 1996; Aureli & Procacci, 1992; Schindler et al., 1987), and none of these studies specifically examine associations between preschool attendance and social network formation. In particular, the formation of social play relationships with classmates is an important aspect of preschoolers' social development for two reasons. First, social play relationships can help build socioemotional skills like perspective-taking, cooperation, and social problem solving (Ashiabi, 2007; Coplan et al., 2005; Coplan & Arbeau, 2009; Göncü et al., 2002; Rubin et al., 2006). Second, preschool offers one of the first opportunities for children to form networks of social play relationships (Schaefer, 2010) but there is individual variation in the extent to which children engage in social play (Coplan et al., 2005). Preschool attendance represents one important environmental factor that may be associated with children's formation of social play networks.

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The present study leverages longitudinal social network analysis from one 3-year-old and one 4-year-old preschool classroom over the course of a school year to answer the following research question: *How are full- and half-day preschool attendance related to preschool children's formation of classroom social play relationships over time?* Because the literature on social network formation is limited and past literature on the association between preschool attendance and other social outcomes is mixed, we do not attempt to offer specific confirmatory hypotheses, but instead approach this question descriptively.

Method

Setting and Sample

We collected data from children enrolled in one 3-year-old classroom and one 4-year-old classroom at a university preschool in the Midwestern region of the United States. The preschool serves children and families from the community, provides training for student teachers, and offers research opportunities for university faculty. Children in the 3- and 4-year-old classrooms that we studied followed a play-based curriculum that included structured whole and small group instruction with a lead teacher as well as unstructured periods of free play. During the unstructured periods of free play, children were allowed to choose their own activities and to initiate play with classmates of their choice.

The sample for this study includes 25 students enrolled in the 3-year-old classroom (96.2% participation rate) and 28 students enrolled in the 4-year-old classroom (100% participation rate). One child in the 3-year-old classroom was excluded from the study due to very low attendance that limited our ability to observe them in social play during the study. In the 3-year-old classroom, 10 students were enrolled in a full-day program and attended class all day. Additionally, 15 students were enrolled in a half-day program and attended class only in the

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morning ($N = 7$) or the afternoon ($N = 8$). In the 4-year-old classroom, 10 students were enrolled in a full-day program and attended class all day. Additionally, 18 students were enrolled in a half-day program and attended class only in the morning ($N = 10$) or the afternoon ($N = 8$). Table 1 includes additional student demographics including gender, race/ethnicity, and age for students in the 3- and 4-year-old classrooms.

Procedure

This study uses longitudinal, observational data of children's social play collected from both classrooms over the course of a school year between October 2012 and May 2013. Observations occurred Mondays through Thursdays for an average of 4.62 hours per day, occurred both indoors and outdoors, and were scheduled to include periods in both the morning and afternoon. This observation schedule was designed to provide maximal opportunities to capture observations of children in the half-day program who only attended preschool in either the morning or afternoon. The observation schedule also avoided potential biases due to temporal patterns in children's social play behavior. All observations were scheduled to occur during unstructured periods of free play to ensure that the research team was able to observe children's free choice of playmates.

To observe children's social play, 14 observers used scan observation procedures similar to those used in previous studies of preschool children's social interactions and social networks (e.g., DeLay et al., 2016; Hanish et al., 2005; Schaefer et al., 2010). These 14 observers received intensive training, including meetings to review observational procedures and joint practice coding sessions with one of the lead investigators. For each observational period, observers were provided with a randomly ordered list of children as well as pictures and names of each of the children in the classroom. Starting at the top of the list, they observed each child for a 10 second

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period and coded their predominant behavior from the following choices: social play, parallel play, rough and tumble play, onlooking behavior, solitary play, unoccupied behavior, and teacher-oriented behavior. For all behaviors that involved social interactions (e.g., social play, parallel play, rough and tumble play, onlooking behavior), observers also coded the identities of all peers involved.

The 14 observers collected a total of 15,387 scan observations of children's behavior between October 2012 and May 2013. We grouped these observations into four separate waves, each with at least 2,500 total scan observations. Specifically, Wave 1 data included 2,918 scan observations (643 social play observations) collected between October 1, 2012 and October 31, 2012. Wave 2 data included 3,722 scan observations (978 social play observations) collected between November 1, 2012 and December 31, 2012. Wave 3 data included 4,789 scan observations (1,034 social play observations) collected between January 1, 2013 and February 28, 2013. Finally, Wave 4 data included 3,958 scan observations (870 social play observations) collected between March 1, 2013 and May 1, 2013. On average, children were observed 59.55 times ($SD = 22.16$) in Wave 1, 75.96 times ($SD = 32.11$) in Wave 2, 92.10 times ($SD = 42.41$) in Wave 3, and 79.16 times ($SD = 35.14$) in Wave 4. For a subset of the scan observations (14.1%), two observers coded the data and inter-rater reliabilities were calculated. Observers demonstrated 71.88% agreement on behavior codes. Additionally, for observations that were coded as a social play, observers demonstrated 92.05% agreement on the number of playmates and 82.6% agreement on the identity of playmates.

The authors' institutional review board (Protocol 11-1198) approved all procedures used in the current study. Because this study only involved unobtrusive observations that were minimal risk to participants, did not violate participant rights, and could not have been conducted

without observing all participants in the classroom, the institutional review board and participating preschool approved a waiver of active parental consent and student assent for study procedures. This waiver is consistent with the U.S. Federal Common Rule and is common in social network studies (Klov Dahl, 2005; Neal, 2008).

Measures

Preschool attendance and child demographics. Children's enrollment status in either the full-day or half-day preschool program and demographic data (including gender) were provided to our research team by preschool staff.

Social networks. We used data from the scan observations to construct a social network of social play relationships between classmates. Specifically, for each classroom and each wave, we first constructed a non-directed network adjacency matrix of the frequency of observed social play interactions between each possible dyad of classmates. Because some children only attended class in the morning and some children only attended class in the afternoon, structural zeros were entered for all dyads where social interaction was not possible. Structural zeros were also entered to account for enrollment changes during the school year (e.g., children who enrolled in the class in later waves or left the class before the end of the study; Ripley et al., 2021). Next, we dichotomized each network adjacency matrix to reflect the presence or absence of social play relationships between each possible dyad of classmates for two reasons. First, the stochastic actor oriented models we employed to analyze the data require binary social network data (Ripley et al., 2021). Second, due to differences in level of attendance, there were imbalances in the number of observations across children in each classroom. To dichotomize each adjacency matrix, we used the following regression equation within each wave to calculate

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the predicted frequency of social play for each possible dyad (child i and child j) in the classroom:

$$y_{\text{freq. of social play for } i \& j} = a + b_1 X_{\text{total obs. of } i} + b_2 X_{\text{total obs. of } j} + b_3 X_{\text{social play obs of } i} + b_4 X_{\text{social play obs. of } j} + e \quad (1)$$

These predicted frequencies account for potential imbalances in observations including the total number of times each child in the dyad was observed as well as the total number of times each child in the dyad was observed in social play. For each dyad within each wave, we compared the predicted frequency of social play with the observed frequency of social play. In the dichotomized adjacency matrices, we counted a social play relationship in the network as present between two children if (1) the children were observed in social play at least one time in the wave and (2) their observed frequency of social play exceeded their predicted frequency of social play in the wave. In contrast, we counted a social play relationship in the network as absent between two children if (1) the children were not observed in social play at least one time in the wave or (2) their observed frequency of social play did not exceed their predicted frequency of social play in the wave.

Analysis Plan

To examine the effects of full- and half-day preschool attendance on the formation of children's social networks, we used longitudinal stochastic actor-oriented models (SAOMs) performed in RSiena. SAOMs allow researchers to model social network changes over time periods between consecutive waves while controlling for common structural effects (e.g., density, network closure, popularity; Ripley et al., 2021; Snijders et al., 2010). These models are commonly used in developmental science to model social network formation among children

(Veenstra et al., 2013). An initial multi-group analysis and a formal time test conducted in RSiena indicated that our data did not meet the assumption that model parameters were the same across our two study classrooms (Ripley et al., 2021). Therefore, we opted to conduct separate SAOMs for the 3-year-old and 4-year-old classrooms. This modeling choice allowed us to account for potential differences in model parameters between the 3-year-old and 4-year-old classrooms in the study. The data and code necessary to reproduce the results presented in this paper are provided at <https://osf.io/2q6s9/>.

Specification of model dynamics. Because the network relationships in this study were non-directed, we specified the dynamics in each of our SAOMs using the One-Sided Initiative with Reciprocal Confirmation Model (M1) for non-directed networks, which assumes that the creation or dissolution of each relationship in the network is initiated by one child in the dyad (Ripley et al., 2021; Snijders & Pickup, 2016). When the creation of a relationship is initiated by one child in the dyad, the other child in the dyad must confirm the relationship (e.g., if James asks Tara to play with him in the sandbox, Tara must join him to confirm the social play relationship). However, when the dissolution of a relationship is initiated by one child in the dyad, the other child does not need to confirm the dissolution (e.g., if James decides to stop playing with Tara and leaves the sandbox, the relationship is dissolved regardless of Tara's confirmation). This model specification is consistent with patterns of preschoolers' social play, which often involve initiation by one child and confirmation by the other (e.g., Ladd & Hart, 1992; Rizzo & Corsaro, 1995).

Network controls. In each of the SAOMs, we controlled for rate effects, structural network effects, and gender effects. Rate effects were used to estimate rates of change in social play relationships across study periods. Following the guidance of Ripley et al. (2021), we

specified three structural effects. First, we controlled for children's overall tendency to form social play relationships by specifying the density effect. Second, we controlled for tendencies toward network closure (i.e., playmates of playmates tend to become playmates over time) by specifying the geometrically-weighted edgewise shared partnerships effect (i.e., gwesp effect). Third, we controlled for a "rich get richer effect" where children who many playmates tend to acquire more playmates over time by specifying the degree activity plus popularity effect (i.e., degPlus effect). We also controlled two gender effects: the effect of being a girl (i.e., gender effect) and the effect of being the same gender (i.e., same gender effect) on the formation of social play relationships.

Effects of preschool attendance. In each of our SAOMs, to examine our main research question, we include effects for full- or half-day preschool attendance status and the effects of having the same preschool attendance status on the formation of social play relationships.

Time heterogeneity. SAOMs assume that estimated model parameters are consistent across each study period (Lospinoso et al., 2011; Ripley et al., 2021). Therefore, for each model, we used the `sienaTimeTest` function in `RSiena` to examine whether there was time heterogeneity in the model parameters. For the SAOM conducted in the 3-year-old classroom, the joint significance test of time heterogeneity was not significant indicating that the model met the time homogeneity assumption ($\chi^2(14) = 13.05, p = 0.52$). However, for the SAOM conducted in the 4-year-old classroom, the joint significance test of time heterogeneity was significant, indicating that the initial model violated the time homogeneity assumption ($\chi^2(14) = 29.10, p = 0.01$). Further inspection suggested that time heterogeneity could be reduced by removing the first wave of data from analyses and by adding a time dummy variable for the gender effect in the 4-year-old SAOM. This new 4-year-old model, reported in the results below, no longer violated

assumptions of time heterogeneity ($\chi^2(6) = 8.44, p = 0.21$). Therefore, the reported SAOM for the 3-year-old classroom modeled changes in the social play network over three periods (i.e., Wave 1 - Wave 2, Wave 2 - Wave 3, Wave 3 - Wave 4) whereas the reported SAOM for the 4-year-old classroom modeled changes in the social play network over only two periods (i.e., Wave 2 - Wave 3, Wave 3 - Wave 4).¹

Model convergence. For both SAOMs reported in this study, we conducted checks to determine whether the model algorithm converged. Consistent with recommended values for excellent model convergence (Ripley et al., 2021), t-ratios for convergence for the individual parameters in the models were below an absolute value of 0.10. In addition, consistent with recommendations the overall maximum convergence ratio for both classroom SAOMs were less than 0.25 (e.g., overall maximum convergence ratio for 3-year-olds = 0.10; overall maximum convergence ratio for 4-year-olds = 0.08).

Goodness of fit tests. We conducted goodness of fit tests to determine whether both SAOMs fit the observed data with respect to degree distribution, triad census, and geodesic distance distribution (Lospinoso & Snijders, 2019). SAOMs for both the 3-year-old classroom and the 4-year-old classroom exhibited good fit with respect to each of these network characteristics (see violin plots in Supplementary Materials).

Results

Descriptive Statistics

¹It is important to note that the model parameters and significance levels in the 4-year-old SAOM including all waves and no time dummies were similar to those in the final SAOM that was adjusted to ensure time homogeneity. Therefore, although these adjustments provide more confidence in the model results, they did not change the main findings of the study.

Tables 2 and 3 provide descriptive statistics for the social networks in the 3-year-old and 4-year-old classrooms respectively. In both classrooms, social network densities ranged between 0.21 and .26 and children, on average, played with around 6 other classmates at each wave. Jaccard indices showed that 23.6% - 47.1% of social play relationships were stable across waves in the 3-year-old classroom and 34.1% - 35.8% of social play relationships were stable across waves in the 4-year-old classroom. This suggests that there was enough stability in social play relationships between waves to model longitudinal changes in the networks using SAOMs (Ripley et al., 2021).

Network Dynamics for the 3-year-old Classroom.

Structural effects. The first two columns of numbers in Table 4 present results of the SAOM conducted in the 3-year-old classroom. There was a significant negative effect for density indicating that social play relationships in the 3-year-old classroom tended to be sparse ($est. = -1.54, p < .01$). Additionally, the gwesp effect was significant and positive, indicating a tendency toward network closure in the 3-year-old classroom ($est. = 1.49, p < .01$). That is, 3-year-old children were more likely to form social play relationships with the playmates of playmates. The degPlus effect was significant and negative ($est. = -0.04, p < .05$). Three-year-old children with more existing social play relationships were less likely to form new social relationships over time. This may indicate limits to the amount of effort and time that children can devote to forming social play relationships.

Gender effects. In the 3-year-old classroom, there were no significant differences between girls and boys in the formation of social play relationships over time. However, there was a significant tendency for 3-year-old children to form social play relationships with classmates of the same gender ($est. = 0.48, p < .01$). Specifically, the probability that a child in

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the 3-year-old classroom would select a playmate of the same gender was 1.62 times as high as the probability that they would select a playmate of the opposite gender (i.e., $\exp[0.48]$).

Is full-day preschool attendance related to network formation? Results of the SAOM for the 3-year-old classroom revealed a significant negative effect of full-day preschool attendance on the formation of children's social play relationships (*est.* = -0.24, $p < .01$). In particular, the probability that a child in the 3-year-old classroom would engage in social play with a playmate who attended full-day preschool was 0.79 times as likely as the probability of engaging in social play with a playmate who attended half-day preschool (i.e., $\exp[-0.24]$). Three-year old children were not significantly more or less likely to select playmates who held the same preschool attendance status.

Network Dynamics for the 4-year-old Classroom.

Structural effects. The last two columns of numbers in Table 4 present results of the SAOM conducted in the 4-year-old classroom. Like the 3-year-old classroom, there was a significant negative effect for density indicating that social play relationships in the 4-year-old classroom also tended to be sparse (*est.* = -1.36, $p < .01$). However, effects for network closure (i.e., *gwesp*) and popularity (i.e., *degPlus*) were not significant.

Gender effects. Like the 3-year-old classroom, there were no significant differences between 4-year-old girls and boys in the formation of social play relationships over time. However, the tendency for 4-year-old children to form social play relationships with classmates of the same gender only approached significance.

Is full-day preschool attendance related to network formation? In the 4-year-old classroom, there was not a significant effect of full-day preschool attendance on the formation of

children's social play relationships. Additionally, 4-year-old children were not significantly more or less likely to select playmates who held the same preschool attendance status.

Discussion

Preschool affords increased opportunities for children to interact with same-age peers (Martin et al., 2005) and to form more complex social networks (e.g., Daniel et al., 2013; Daniel et al., 2016; Schaefer et al., 2010). However, in the U.S., children differ in their levels of preschool attendance (i.e., full- vs. half-day; Hussar et al., 2020) and these differences may have implications for childhood social outcomes. Past research has yielded mixed results on the association between preschool attendance and a range of social outcomes (e.g., Bradley & Vandell, 2007; Campbell et al., 2000; Cooper et al., 2010). However, to date, there is limited evidence regarding the role of preschool attendance in children's social network formation. Understanding the role of preschool attendance in children's social network formation is important because social play relationships with classmates have implications for social development and can encourage core socioemotional skills like perspective taking, cooperation, and problem-solving skills (Ashiabi, 2007). The current study adds to a growing body of research on associations between preschool attendance and social outcomes by examining how full- and half-day preschool attendance are related to preschool children's formation of classroom social play relationships over time.

Summary of Key Findings.

Over the course of a school year, we found no evidence that full-day preschool attendance has a positive effect on the formation of social play relationships in early childhood. Attending preschool full-day provides more opportunities for peer interactions but these increased opportunities do not necessarily translate into the formation of social play relationships

over time. Indeed, our findings suggest that attending preschool full-day actually decreases the probability that 3-year-old children engage in social play relationships with peers. The preschool environment places increased behavioral and social demands on children that may be intensified for children enrolled full-day (Martin et al., 2005; Neal et al., 2017). If these intensified behavioral and social demands interfere with children's ability to engage with peers, it could help explain why 3-year-olds attending preschool full-day were less likely to form social play relationships over time.

Possible Developmental and Contextual Factors.

Because there was a negative effect of full-day attendance on network formation for 3-year old but not 4-year-old children in our study, our results suggest that the role of full-day preschool in preschool network formation is nuanced and may depend on developmental or contextual factors. Developmental factors may explain differences between the 3-year-old and 4-year-old classrooms. Because younger children are more likely to be earlier in the process of transitioning to preschool, they may have more difficulty than older children in coping with increased environmental demands and regulating their negative emotions over a full day. Past research suggests that preschool children who display higher levels of negative emotionality are less likely to form social play relationships over time (Neal et al., 2017). To test this potential developmental mechanism, future research could examine the interplay between age, preschool attendance, temperament, and the formation of social play relationships over time. Ideally, it would be useful to test a mediational process that examines whether full-day preschool leads to higher negative emotionality among younger preschool children, which in turn leads to a lower probability of engaging in social play with peers over time. However, at present, SAOMs do not allow for mediational analyses. Existing network models that can test mediational processes are

still in development and have focused on network features as the mediator rather than the outcome (e.g., Liu et al., 2021; Sweet, 2019).

Contextual factors may also explain differences between the 3-year-old and 4-year-old classrooms. Past research suggests that importance of quality of care and provider-child interactions for positive social outcomes in early childhood (Howes, 1988; Lamb, 1996; NICHD, 1998). Preschool teachers, in particular, may play an important role in shaping children's social network formation. For example, teachers often engage in practices that reinforce and guide children's classroom peer relationships (Ashiabi, 2007; Farmer et al., 2011). It is plausible that differences in these teaching practices may moderate associations between preschool attendance and social network formation in preschool. To test this potential contextual moderator, future research could collect data on both teaching practices and the social play networks of children attending full- and half-day preschool.

Limitations.

This study fills a gap in the existing literature by exploring associations between preschool attendance and social network formation and is strengthened by the use of longitudinal observational data on children's peer interactions collected over a whole school year. However, results should be interpreted in light of some limitations. First, given the resource intensive nature of the observations, we were only able to collect longitudinal data from two classrooms in a university preschool. This makes it difficult to disentangle whether differences between classrooms are due to developmental or contextual factors and may limit the generalizability of the results. More research is needed with a larger number of classrooms to unpack these developmental and contextual factors and to test associations between preschool attendance and social network formation in samples that vary geographically and demographically. Additionally,

because university preschools often differ from other types of preschools on several features (i.e., their mission, number of adults in the room, structure), future research is needed to compare findings across different types of preschool settings to examine the potential moderating role of contextual factors like preschool quality, classroom structure, and continuity of classroom cohorts across multiple years.

Second, for practical and ethical reasons, we were unable to randomly assign children to attend full- or half-day preschool. Therefore, we cannot definitively rule out potential confounding variables. For example, prior research suggests that family characteristics including income, maternal employment, single-parent status, and parental stress play a role in the selection of preschool childcare arrangements (e.g., Coley et al., 2014; Peyton et al., 2001). It is possible that these family characteristics may also predict both selection into full-day preschool and social network formation. Future work with a larger sample could consider methods like propensity score matching to help minimize potential biases introduced by selection into full- versus half-day preschool attendance (see Leow & Wen, 2017).

Third, because this study was a field study that involved partnering with existing classrooms, we were unable to control the composition of children attending preschool full-day and half-day in the classrooms we observed. In our study, a mix of full- and half-day children were enrolled in each classroom. This design has some methodological strengths (e.g., teachers and classroom contexts are held constant) but also some weaknesses (e.g., there may be qualitative differences in the social play relationships that form between children attending preschool full-day and those attending preschool half-day). Therefore, future studies should consider alternative designs where all children assigned to a classroom have the same enrollment status.

Fourth, although we relied on established scan observation procedures used in previous studies (e.g., DeLay et al., 2016; Hanish et al., 2005; Schaefer et al., 2010), these procedures do not provide directed information about who initiated, accepted, or rejected social play invitations in the classroom. Collecting directional data that includes information about the initiation, acceptance, and rejection of social play invitations could help disentangle the mechanisms behind the finding that 3-year-olds in full-day preschool were less likely to form social play relationships over time. For example, such data would tell us whether 3-year-olds in full-day preschool are less likely to be selected by peers as playmates or whether they are more likely to reject social play invitations from peers.

Contributions to the Existing Literature.

The findings from this study make important contributions to two existing sets of research literature in early childhood. First, this study contributes to the existing literature on preschool social network formation. Past studies on this topic have often focused on documenting and characterizing structural network effects like reciprocity and triadic closure (e.g., Daniel et al., 2013; Daniel et al., 2016; Schaefer et al., 2010) or highlighting the role of ascribed characteristics like gender in preschool social network formation (e.g., Martin et al., 2005). This study extends this growing literature by examining how, in addition to structural and ascribed characteristics, an environmental factor (i.e., preschool attendance) is associated with young children's relationship formation. To our knowledge, our study is among the first to longitudinally explore the role of preschool attendance in social network formation.

Second, this study contributes to the existing literature on preschool or childcare attendance and social outcomes. Past studies on this topic have often focused on teacher or parent ratings of social competence, skills, or behavior (e.g., Atteberry et al., 2019; Belsky et al.,

2007; Reynolds et al., 2014) and have yielded mixed results (e.g., Bradley & Vandell, 2007; Campbell et al., 2000; Cooper et al., 2010). Our study contributes to this mixed literature by demonstrating how preschool attendance is related to another important social outcome that has not previously been explored - children's social network formation. In our study, full-day preschool attendance did not afford positive benefits for social relationship formation. These findings are consistent with previous studies that have failed to find a positive link between the duration of preschool or childcare attendance and children's social outcomes (e.g., Herry et al., 2007; Howes, 1988; Howes et al., 1994; Leow & Wen, 2017).

Implications for Practice.

Given the limitations of the current study, it is important to replicate the findings in future research. However, if the findings replicate, they offer practical implications for both parents and teachers. First, the findings have practical implications for parents making decisions about whether to send their children to full-day or half-day preschool. Our findings suggest that attending full-day preschool does not lead to formation of more social relationships than attending half-day preschool. These results are also partially consistent with some prior research that suggest that shorter days in childcare may be beneficial for social competence (Campbell et al., 2000). In sum, based on our findings, parents could feel more comfortable that a decision to send their child to half-day rather than full-day preschool would not jeopardize their children's social relationships.

Second, our findings also have practical implications for preschool teachers. Specifically, we found that attending full-day preschool may be negatively related to social relationship formation for younger children. It may be useful for preschool teachers of younger children to be cognizant of children's integration into the classroom peer network and engage in practices that

support and foster social relationships among children attending full-day preschool (Farmer et al., 2011). For example, preschool teachers could promote the formation of social relationships to children attending full-day preschool through the active reinforcement of interactions with these students or through intentional grouping arrangements (Bierman, 2011).

Conclusion

This study represents an initial attempt to examine the role of full-day and half-day preschool attendance in the formation of children's social play networks. Results suggest that, for some children, attending preschool full-day is associated with a lower chance of forming social play relationships with peers over time. However, results were not consistent across 3- and 4-year-old classrooms and more work is needed to determine the developmental and contextual factors that might account for this inconsistency. Future research with a wider range of preschool classrooms and that accounts for additional variables (e.g., child temperament, teacher practices) can help illuminate precisely how, and under what conditions, preschool attendance is associated with preschool social network formation.

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Table 1

Participant Demographics

Characteristic	3-year-olds (N = 25)	4-year-olds (N = 28)
<i>Gender</i>		
Boy	13 (52%)	16 (57.14%)
Girl	12 (48%)	12 (42.86%)
<i>Preschool Attendance</i>		
Full-Day	10 (40%)	10 (35.71%)
Half-Day	15 (60%)	18 (64.29%)
<i>Race/Ethnicity</i>		
Asian	6 (24%)	1 (3.57%)
Black/African American	3 (12%)	0 (0%)
White	12 (48%)	17 (60.71%)
Multi-racial or Multi-ethnic	1 (4%)	4 (14.29%)
Missing	3 (12%)	6 (21.43%)
<i>Age (in months), M (SD)</i>	41.40 (4.38)	52.93 (3.55)

Table 2

Descriptive Statistics for 3-year-old Classroom Social Networks

	Wave 1	Wave 2	Wave 3	Wave 4
Density	0.263	0.247	0.260	0.263
Average Degree	6.32	5.92	6.24	6.32
Number of Ties	79	74	78	79
	Period 1 (Wave 1 – Wave 2)	Period 2 (Wave 2 – Wave 3)	Period 3 (Wave 3 – Wave 4)	
Absent Tie (0 → 0)	196	177	180	
Creation of Tie (0 → 1)	25	49	42	
Dissolving of Tie (1 → 0)	30	45	41	
Stable Tie (1 → 1)	49	29	37	
# of Joiners	0	0	2	
# of Leavers	0	0	0	
Jaccard Index	0.471	0.236	0.308	

Table 3

Descriptive Statistics for 4-year-old Classroom Social Networks

	Wave 2	Wave 3	Wave 4
Density	0.233	0.214	0.228
Average Degree	6.286	5.786	6.143
Number of Ties	88	81	86
	Period 1 (Wave 2 – Wave 3)	Period 2 (Wave 3 – Wave 4)	
Absent Tie (0 → 0)	252	255	
Creation of Tie (0 → 1)	38	42	
Dissolving of Tie (1 → 0)	45	37	
Stable Tie (1 → 1)	43	44	
# of Joiners	0	2	
# of Leavers	1	1	
Jaccard Index	0.341	0.358	

Table 4

Stochastic Actor-Oriented Model Results for the Effects of Preschool Attendance on Social Play Relationships in the 3-year-old and 4-year-old Classroom

	<u>3-year-olds</u>		<u>4-year-olds</u>	
	Est.	SE	Est.	SE
<i>Structural Effects</i>				
Degree (density)	-1.54**	0.23	-1.36**	0.38
Network Closure (gwesp)	1.49**	0.22	0.50	0.31
Popularity (degPlus)	-0.04*	0.02	0.01	0.03
<i>Gender Effects</i>				
Gender (1= Girl)	0.05	0.06	-0.10	0.12
Same Gender	0.48**	0.10	0.33	0.17
<i>Preschool Attendance Effects</i>				
Preschool Attendance (1= Full-Day)	-0.24**	0.09	-0.15	0.15
Same Preschool Attendance	-0.08	0.12	0.19	0.15
<i>Time Dummy Effects</i>				
Time Dummy for Gender	--	--	-0.51**	0.19

* $p < .05$ **, $p < .01$