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Building connections through play: Influences on children's connected talk with peers

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Abstract
Effective reciprocal communication is a vital component in forming and maintaining social relationships. Peer social play may provide a particularly important context for communicative skill development, as sophisticated negotiation and exchange are required to coordinate play. We focus on connectedness, a property of conversation referring to the topical relation between speakers’ turns, to understand how partners coordinate ideas to build a shared play experience. The present study uses a longitudinal secondary analysis approach to drive forward our understanding of the individual and shared influences that contribute to connectedness during peer social play. Using data from a three-wave, longitudinal study of children's play and social relationships during the first 3 years of school in the United Kingdom (https://osf.io/3p4q8/), we coded connectedness from transcripts of video observations of 148 children playing in pairs at wave three (mean age 6.79 years) and model individual differences in language ability, theory of mind, and emotion comprehension from all three waves as potential predictors of connectedness. Our results show substantial dyadic effects on connectedness, but individual differences in socio-cognitive measures were not significant predictors of connectedness. These findings indicate the importance of dyadic and partner effects in children's social interactions and implicate the dyad as an essential focus for future research.

KEYWORDS
communication, connectedness, dyadic analysis, emotion comprehension, language ability, play, theory of mind
BACKGROUND

Communication is key to forming and maintaining social relationships from early in life. Children first practice reciprocal communication skills with their caregivers through non-verbal means (Carpenter et al., 1998), and typically they later develop friendships and peer relationships that require communication through verbal language and more advanced behavioural cues (Stafford, 2004). We present a study that analyses children's verbal communication with friends and peers in their third year of school (mean age 6.79 years), investigates the socio-cognitive determinants of this communication in the first 3 years of school (mean ages 5.24, 6.05, and 6.79 years), and explores play as a context for developing communication skills. Such skills may help develop intersubjectivity, or a shared understanding, with a communication partner during play (Göncü, 1993). Strong communication skills also predict peer acceptance in early childhood (Kemple et al., 1992), and children's friendships protect against cycles of negative outcomes, including social isolation, depressive symptoms, and loneliness (Laursen et al., 2007; Pedersen et al., 2007). Communication skills continue to be important in adult relationships when conversation partners must recognize the other's perspective and respond appropriately. This study draws on such theories of communication as the basis for intersubjectivity in play with implications for children's social relationships in early childhood and beyond.

Piaget (1926) observed that in early verbal communication, children often fail to account for what the communication partner has said. However, many studies have concluded that children's conversations may be topically coherent more often than Piaget (1926) believed (e.g., Eckerman et al., 1989; Garvey & Hogan, 1973; Mueller, 1972). We focus on this topical coherence, often called connectedness (or ‘connected talk’), to understand how partners coordinate ideas. When communication partners make utterances that are topically related, they have high connectedness. Connectedness considers the content of the talk and whether it is socially coordinated between conversational partners, requiring coordination on both sides (Leach et al., 2019). However, despite the importance of coordination by both partners, research into connectedness has generally failed to appropriately account for this mutual influence on the connected conversation.

Observational research on topic management in children’s conversations has been ongoing for years using various terminology (e.g., Baines & Howe, 2010; Dorval et al., 1984), and various overlapping concepts exist. For example, some research refers to ‘transactive dialogues’ to describe conversations in
which partner’s utterances use the other’s reasoning (Azmitia & Montgomery, 1993). Connectedness is a term most often used in developmental psychology and related fields that considers all topically related talk to be connected without requiring building or elaborating on the partner’s utterances. Like related constructs, connectedness is considered a key contributor to developing intersubjectivity in an interaction (Leach et al., 2019).

Despite this varied research on topical coherence and related constructs, studies into the relationship with socio-cognitive development have been sporadic. Various individual differences in socio-cognitive skills could increase engagement in connected communication. For example, children who engage in more connected talk with peers have a better theory of mind and social understanding (Dunn & Brophy, 2005; Slomkowski & Dunn, 1996), and language ability (LA) is associated with verbal behaviours in children’s interactions (Gibson et al., 2019). These suggest an important role for individual differences in children’s communication.

To engage in successful communication with a partner, a child may require some understanding of their partner’s emotions, ideas, and intentions. Advanced social understanding, including theory of mind (ToM) and emotion comprehension (EC), may therefore result in more effective communication. ToM is linked to social relationships and communication throughout childhood (Bartsch & London, 2000; Hughes & Leekam, 2004). For example, ToM in the early years of school predicts later peer acceptance (Caputi et al., 2012). Children’s use of perspective-taking strategies in communication tasks increases with age (Bartsch & London, 2000; Clark & Delia, 1976; Kline & Clinton, 1998), and from age eight children have been shown to consistently use information about a conversation partner's beliefs to inform their social interactions (Bartsch & London, 2000). Perspective-taking ability may also support children to form connected responses to the partner or to form initiations pitched appropriately for the partner’s knowledge and elicit connected responses. In younger children, Ensor and Hughes (2008) found that mother–child connectedness at age two was related to children’s social understanding (a combination of EC and false belief) at age four, and Slomkowski and Dunn (1996) found that children who performed better on affective perspective taking and false-belief tasks at age three engaged in significantly more connected talk with their friends a few months later. These findings suggest that developing social understanding may contribute to higher levels of connectedness in early childhood, warranting further longitudinal exploration in older children.

In addition to social understanding, LA has been linked to verbal play behaviours, indicating its importance for children’s communication and interactions (Gibson et al., 2019). Receptive LA may help a child to understand the conversation partner, and expressive LA may permit the child to contribute to the conversation in a way that elicits connected responses. Dunn and Cutting (1999) found LA, among other individual differences including ToM and EC, predicted children’s cooperative behaviours during play at age four. Gibson et al. (2019) found at the first timepoint in the Children’s Relationships with Peers through Play (ChiRPP) study (see details below) that verbal play behaviours, such as assigning roles to oneself or the partner, were particularly associated with LA. As connectedness is largely verbal, it is likely that it too will be associated with LA. However, based on Milligan et al.’s (2007) meta-analysis, which found strong effects linking early LA with later false-belief understanding and suggested that engaging in effective communication could be foundational for developing ToM, it is not clear whether LA may have a unique effect on connectedness beyond any associations between connectedness and social understanding.

The extent to which these individual differences directly result in engagement in connected communication is unclear, especially as many studies have not considered relationships longitudinally. In one longitudinal study of connectedness in friends and siblings, Leach et al. (2019) did not find a change in connectedness over time in friendship pairs – there was no change in the frequency of connected talk with friends from age four to age 7 years – but they did find increases in connected talk across timepoints.

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1At Stage One, we mistakenly referenced Ensor and Hughes (2008), who look at connectedness in mother–child dyads. We have removed this reference at Stage Two.
in sibling pairs, providing unclear evidence that connecting talk may be something that children learn over time, possibly influenced by other developmental areas. However, they did not measure individual differences to determine why any changes in sibling pairs’ connectedness might be occurring (Leach et al., 2019). Further longitudinal studies are needed to accurately determine the existence and direction of such associations.

**Play as a special context for communication**

Play has widely been theorized as a special context for child development, but research into how and why this may be the case is lacking (Lillard et al., 2013). The present study focuses on social play as a context for children to put their developing communication and socio-cognitive skills to use. Social play was the focus of theories by Parten (1932) and Vygotsky (1978), who looked at the requirement for effective communication to develop goals for the play, which may result in intersubjectivity. Göncü (1993) examined this idea in a small sample and recognized key features of connectedness, such as building on and extending the partner’s ideas, as allowing intersubjectivity to develop and suggests that this is a necessary element for successful social play.

Children’s interactions with their peers provide opportunities for developing social and communication skills in early and middle childhood, and these skills are often practiced during social play. During play, connected communication may reflect the degree to which partners are in tune with each other (Dunn & Brophy, 2005; Ensor & Hughes, 2008). Pretend play, in particular, requires complex communication between partners to decide together on the play plot, props, and characters and achieve intersubjectivity (Göncü & Kessel, 1984). To form a consensus on pretend elements, children must be able to understand and comment on each other’s ideas. Furthermore, to move the plot forwards, they must be able to build on and communicate their ideas effectively. When children successfully build on each other’s ideas at age five, as they do through connected conversations, they have been found to engage in more pretence (Howe et al., 2005).

Studies into communication during play, and social pretend play in particular, have identified many different characteristics of communication (e.g., Garvey & Berndt, 1975; Giffin, 1984; Göncü & Kessel, 1984; Trawick-Smith, 1998). Studies have primarily examined the content of talk: for example, several have classified different types of play negotiation, observing their frequencies and linking them to different developmental outcomes (e.g., Jenkins & Astington, 2000). In some cases, studies have focused on the influence of individual differences on play behaviours and connectedness, but the partner’s role in these associations has rarely been addressed. Some recent research has found significant dyadic influences on connectedness (Leach et al., 2019) and on play behaviours more generally (Gibson et al., 2019). A dyad’s characteristics may dictate its behaviours and interactions (Dunn & Cutting, 1999; Fabes et al., 2003). For example, there are differences in the way children interact with and talk to others depending on the partner’s characteristics (Brown et al., 1996; Dunn & Cutting, 1999). Leach et al. (2019) found differences in children’s connectedness when they played with a friend and a sibling, demonstrating the partner’s influence on the qualities of the interaction and suggesting that differences in connectedness can be explained by mutual influences (henceforth called dyad-level influences). Dunn and Cutting (1999) found that much of the variance in children’s behaviours could be explained by the partner’s individual differences and behaviours. A study looking at the first timepoint in ChiRPP (see details below) found that variability in social pretend play behaviours were explained by both contributions at the dyad level and by the individual (Gibson et al., 2019). In particular, dyad-level effects explained more of the children’s social pretend play behaviours than did individual differences such as LA and sex (Gibson et al., 2019). Failing to consider these dyadic influences may result in an over-statement of the associations at the individual level, and there is currently little understanding of the dyadic influences on connectedness. We focus on these dyadic influences as an under-researched area in children’s communication.
The present study

Study aims

The present study aims to further understanding of the individual and shared influences that contribute to effective, coordinated conversational exchanges during peer play by (1) analysing the extent to which variations in connectedness occur based on dyad effects by determining the extent to which variation in connectedness is explained by differences between dyads and (2) determining whether there are concurrent and longitudinal relationships between children’s engagement in connected talk and their individual differences in ToM, EC, and LA.

Research question 1

First, we address the following question: How much of the variation in connected talk during play can be explained by variation between dyads? We hypothesize that variability in connectedness will be explained in part by variation between dyads and in part by variation within dyads. We hypothesize that the variation in connectedness explained by the dyad (between dyad variation) will be greater than that explained within dyads. This hypothesis is based on previously discussed literature finding importance in partner and dyadic effects on children's play behaviours (Dunn & Cutting, 1999; Gibson et al., 2019).

Research question 2

Next, we ask: To what extent do children’s individual differences in ToM, EC, and LA, concurrently and at two earlier timepoints, predict their engagement in connected talk with a partner during play? We hypothesize that individual differences in ToM, EC, and LA will positively predict variance in connectedness during play (i.e., children with higher scores on these measures will engage in more connected talk). This hypothesis is informed by previously discussed literature suggesting play could be a crucial context where children put socio-cognitive and linguistic skills to work (Gibson et al., 2019; Slomkowski & Dunn, 1996). We expect to observe these effects longitudinally and concurrently.

METHODS

To test our hypotheses, we used secondary data analyses of longitudinal observational data on children's play and social development. We analysed existing measures of individual differences (ToM, EC, and LA) with a new measure of connectedness, coded from video transcripts of dyads engaged in play with a Playmobil toyset.

Dyadic datasets are often analysed as though each member of the dyad's behaviour is independent, but this assumption has been shown to be unlikely for other play behaviours and is not possible for connectedness by definition. Our rigorous analytical strategy enabled us to tease out individual and shared influences on connected talk. Therefore, we innovate in this field by considering the role of each child's individual differences, in tandem with those of the partner, for connected talk during play. Our methods were based on Kenny et al. (2006)'s recommendations for dyadic analyses.

Quality assurance

We have taken several steps to ensure this study’s quality and rigour. Firstly, the connectedness measure was based on observations and transcripts that had not previously been coded or analysed in any way,
and this measure was not coded until the planned analyses were registered. Furthermore, a 20% sample of transcripts was independently coded for the connectedness measure by an external researcher who had no prior involvement with the dataset to ensure inter-rater reliability in coding. Finally, we offer transparency regarding the roles of the research team: the first author was not involved in the data collection nor in any previous analysis but was involved in transcribing the observations that were used to code outcome measures for this study; the second and fourth authors were involved in the initial design, conception, and implementation of the study from which the present dataset was derived; the third author had no prior involvement with the dataset. Further information about this dataset is given in the following section.

Secondary dataset

This study used secondary data from the ChiRPP study, a three-wave, longitudinal study of children’s play and social relationships during the first 3 years of school in the United Kingdom (https://osf.io/3p4q8/). For the ChiRPP study, 244 children in reception classes at eight schools were recruited to take part in the first wave (T1), where a large sample was required for validation of certain measures not relevant to this paper, and children at five of these schools (N = 172) were designated for follow-up on two further occasions (T2 and T3). This sub-sample of the ChiRPP study, those who were followed up, was the sample of interest for the present research.

Sample characteristics

The follow-up sample included 172 children, 73 female (42.4%) and 99 male (57.6%), at five schools. At T1, these children were aged between 4.48 and 6.49 years (M = 5.24, SD = 0.33). At T2, the sample included 161 children, 67 female (41.6%) and 94 male (58.4%), aged 5.34–7.50 years (M = 6.05, SD = 0.38). At T3, the sample included 152 children, 63 female (41.4%) and 89 male (58.6%), aged 6.12–8.26 years (M = 6.79, SD = 0.38). The small decreases in sample size between waves indicate children who no longer attended the participating schools.

Procedures

The procedures described here are those completed by the ChiRPP research team, which were ethically approved by the University of Cambridge Psychology Research Ethics Committee, prior to the present analyses. Data collection for the measures relevant to this study took place in children’s schools.  

Recruitment

Schools in the Cambridge area were approached by the research team, and eight agreed to participate in the study (including five in the follow-up sample). Classroom teachers from these schools were then recruited, study information was sent to parents, and informed consent was obtained. The consent rate for the follow-up sample was 64.2%.

Measures of individual differences

At each wave, children completed tasks to assess social and cognitive individual differences. Tasks relevant to this research were tests of ToM, EC, and LA.

Theory of mind Children completed 3 second-order false-belief items to assess ToM. Second-order false belief was chosen based on its appropriateness for ages at all three of the ChiRPP timepoints without...
floor or ceiling effects, in addition to its wide use in the field and reliability (Hughes et al., 2000; Perner & Wimmer, 1985; Sullivan et al., 1994).

Each of the three items began with an unexpected transfer false-belief question. Children who answered this question correctly were asked a corresponding second-order false-belief question. Those who answered the first incorrectly were not asked the corresponding second-order question. Children were then asked to justify their second-order answers. Justifications were later coded as appropriate or inappropriate based on previously used classifications (Perner & Wimmer, 1985; Sullivan et al., 1994).

Each story was scored where children would be given a point if all three questions for a story (unexpected transfer, second-order false belief, and justification) were answered correctly. The maximum score possible was three points, one for each story. These scores were then converted to $z$-scores.

**Emotion comprehension** Children's EC was measured based on the procedure described by Fink et al. (2015), which was abridged at T3 as indicated. This procedure focuses on an understanding of the mental aspects of emotion and was selected based on the children's ages at the ChiRPP timepoints and the areas of interest for this study (Pons et al., 2004).

At T1 and T2, children were tested on emotion-based false belief (two items) and three EC components: desire (four items), belief (six items), and hiding (four items). At T3, children were tested on emotion-based false belief (two items) and two EC components: belief (four items) and hiding (four items).

The EC responses were summed for total scores of 0 to 16 at T1 and T2 and of 0 to 10 at T3. Scores were converted to a proportion of correct answers between 0 and 1 by dividing by the total possible score. If children provided an incorrect answer to a control question, their answers on corresponding target questions were dropped from their score by reducing the total possible score. These proportions were then converted to $z$-scores.

**Language ability** Children's expressive and receptive LA were measured using subscales of the Clinical Evaluation of Language Fundamentals 2 – Preschool ( CELF; Wiig et al., 2004) and the Assessment of Comprehension and Expression 6–11 ( ACE; Adams et al., 2001), which were chosen based on their wide-use and well-established validity with the relevant ages. At T1 and T2, children's receptive LA was measured using the CELF's 22-item Sentence Structure subscale, and children's expressive LA was measured using its 13-item Recalling Sentences subscale. At T3, children's expressive LA was measured using the ACE's 25-item Naming subscale, and children's receptive LA was measured using its 31-item Sentence Comprehension subscale. Receptive and expressive LA raw scores at each timepoint were summed for overall LA scores, which were then converted to $z$-scores.

**Observations**

At T3, children were observed engaging in dyadic freeplay with a partner for approximately 8 minutes. Each dyad was left alone to play with a Playmobil treehouse toyset, consisting of a large treehouse toy and various small pieces such as animals, people, and furniture. This toyset was selected to elicit play and provide opportunities to observe the interaction between members of the dyad. Children were assigned to dyads for observation based on their answers to Sanderson and Siegal (1995)'s interview of friendships. Each child was asked to name their 'very best friend' plus two additional best friends. Partners were selected based on their responses, where most children were paired with a reciprocated friend (i.e., dyads where both children nominated each other; $N = 107$; note: odd $N$s are possible here as some children participated in freeplay separately with two different partners). Fewer children were paired with nominated but unreciprocated partners (i.e., dyads where only one child nominated the other; $N = 22$) and non-nominated partners (i.e., dyads where neither child nominated the other; $N = 23$).
Transcription
Observations were transcribed using the manual in Appendix S1 by two transcribers. Fifty-one observations were transcribed by the first transcriber, who had no prior involvement with the dataset, and 29 were transcribed by the second transcriber (the first author). One observation was excluded from transcription due to the children being off-camera and inaudible for much of the observation. A 20% of the first transcriber’s transcriptions (N = 11) were checked for quality control by the second transcriber to verify the accuracy of the transcription and associated timestamps.

Analysis plan
The procedures described in this section were conducted following in-principle acceptance of the present study at Stage One unless otherwise specified. All deviations from our registered plans are described in our Results section. Stage One of this Registered Report is available at https://osf.io/u74zy/.

Connectedness coding
We coded the transcripts using the manual in Appendix S2. Each utterance was scored on two codes: whether it was a successful initiation and whether it was a connected turn. Successful initiations were utterances that were topically connected to any utterance made by the partner beginning up to 5 s after the target utterance’s end. Connected turns were utterances that were topically connected to any utterance made by the partner ending up to 5 s prior to the target utterance beginning. Coding began when the researcher exited the room; we paused coding if the researcher re-entered the room for any length of time (these periods were not transcribed). Coding was conducted by the first author, who planned to achieve inter-rater reliability on 20% of observations with a Kappa of at least 0.8 with an external coder who had no previous involvement in this study nor with the dataset.

Criteria for data inclusion and exclusion
We excluded all participants who did not participate at T3 as we used transcripts of observations from T3 to code our outcome measures. This means that 20 children who participated at earlier timepoints but not at T3 were excluded, and their data were not replaced. We checked for any systematic differences between these children and those who remained in the study and report these with our results.

We excluded participants whose observations could not be transcribed. Reasons for not transcribing observations included video or audio issues and the children being off-camera for significant periods. All observations that were excluded from transcription were agreed by both transcribers. We did not anticipate any such barriers to coding transcripts that would result in the exclusion of transcripts from coding.

We did not plan to exclude outliers unless they appeared to be mistakes in our dataset (e.g., because they were above or below the possible range); however, we did not anticipate high frequencies of mistakes as all data entry for the original dataset was spot-checked to ensure accuracy.

In the dataset, most children were organized into one dyad each. However, some children were assigned to two dyads. These children completed the freeplay observation twice: once with each partner. For these children, we excluded their individual connectedness data from their second freeplay observation and treated it as missing. The partners’ data from both freeplay observations were included, and we imputed the missing connectedness data in these cases.

We conducted a missing data analysis to determine whether data were missing systematically or at random. If we found any systematically missing data, we planned to investigate further to determine the cause, drop these cases, and report the systematic reason for the missing data. For data that were missing at random, we used maximum likelihood estimation to account for these missing values.
Variables

Our variables were structured with lower levels of data nested within the higher levels. Our data structure included three levels, with measurement timepoint at level 1, child at level 2, and dyad at level 3. Within each dyad, there were two children. Within each child, there were three measurement timepoints.

Covariates

We planned to include sex and age as covariates, with sex as a level 2 variable as all children played in same-sex dyads and age as a level 1 variable.

Predictors

Our predictors of interest were ToM, EC, and LA, which were level 1 variables.

Outcomes

Our outcome variables were successful initiations and connected turns. As our outcome variables were coded from observations conducted at the third timepoint, there were no outcome variables for T1 or T2. These variables were calculated as a proportion of utterances out of the total number of utterances, and we checked for floor and ceiling effects before proceeding with our analysis. We also checked for normality and planned to perform any necessary transformations before considering alternative analysis methods if these transformations were unsuccessful.

Model description

As our data had multiple levels, we expected that we would need to use multilevel models to answer our research questions, grouping children within dyads and timepoints within children. To confirm this, we calculated the intra-class correlation coefficient (ICC) for step one of our model below before proceeding with the following steps.

We constructed a random intercept model with fixed slopes (Kenny et al., 2006). We built our model in four steps, first running an empty model, then including only our covariates, and then adding our predictors of interest across two steps. We added our predictors of interest over two steps to consider the contribution of LA before and after ToM and EC were included in the model based on the previously discussed finding that LA is foundational for ToM (Milligan et al., 2007). We used maximum likelihood estimation for this model.

At our first step, for child \( j \) in dyad \( k \) at timepoint \( i \), we defined the model as:

\[
y_{ijk} = \beta_0 + u_{0jk} + v_{0k} + e_{ijk}
\]

where \( \beta_0 \) represents the \( y \)-intercept, \( u_{0jk} \) represents the child-level residuals, \( v_{0k} \) represents the dyad-level residuals, and \( e_{ijk} \) represents the individual residuals of child \( j \) in dyad \( k \) at timepoint \( i \).

At our second step, we defined the model as:

\[
y_{ijk} = \beta_0 + u_{0jk} + v_{0k} + \beta_1(r_{jk}) + \beta_2(t_{ijk}) + e_{ijk}
\]

where \( \beta_1 \) represents how much \( y \) increases for a 1-unit increase in \( r_{jk} \) (and so on for \( \beta_2 \)). We planned to run this model twice in the following forms:

\[
\text{(Successful Initiations}_{ijk}) = \beta_0 + u_{0jk} + v_{0k} + \beta_1(\text{Sex}_{jk}) + \beta_2(\text{Age}_{ijk}) + e_{ijk}
\]

\[
\text{(Connected Turns}_{ijk}) = \beta_0 + u_{0jk} + v_{0k} + \beta_1(\text{Sex}_{jk}) + \beta_2(\text{Age}_{ijk}) + e_{ijk}
\]
At our third step, we defined the model as:

\[ y_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(r_{ijk}) + \beta_2(t_{ijk}) + \beta_3(w_{ijk}) + e_{ijk} \]

where \( \beta_1 \) represents how much \( y \) increases for a 1-unit increase in \( r_{ijk} \) (and so on for \( \beta_2 \) and \( \beta_3 \)). We planned to run this model twice in the following forms:

(Successful Initiations) \[ S_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(S_{xijk}) + \beta_2(A_{yijk}) + \beta_3(L_{Aijk}) + e_{ijk} \]

(Connected Turns) \[ T_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(S_{xijk}) + \beta_2(A_{yijk}) + \beta_3(L_{Aijk}) + e_{ijk} \]

At our fourth step, we defined the model as:

\[ y_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(r_{ijk}) + \beta_2(t_{ijk}) + \beta_3(w_{ijk}) + \beta_4(x_{ijk}) + \beta_5(z_{ijk}) + e_{ijk} \]

where \( \beta_1 \) represents how much \( y \) increases for a 1-unit increase in \( r_{ijk} \) (and so on for \( \beta_2, \beta_3, \beta_4, \) and \( \beta_5 \)). We planned to run this model twice in the following forms:

(Successful Initiations) \[ S_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(S_{xijk}) + \beta_2(A_{yijk}) + \beta_3(L_{Aijk}) + \beta_4(T_{omijk}) + \beta_5(E_{cijk}) + e_{ijk} \]

(Connected Turns) \[ T_{ijk} = \beta_0 + u_{0ijk} + v_{ijk} + \beta_1(S_{xijk}) + \beta_2(A_{yijk}) + \beta_3(L_{Aijk}) + \beta_4(T_{omijk}) + \beta_5(E_{cijk}) + e_{ijk} \]

Assessing model fit

We assessed the fit of our models using Akaike’s Information Criterion (AIC) and chi-squared tests. We planned to test each step in the model described against the previous and tested different covariance structures to compare the fit. We initially used a first-order autoregressive structure as we expected higher correlations among our variables at consecutive timepoints but tested this against other covariance structures. We used this information to make a holistic judgement of our model.

Reporting and interpretation

We planned to report Pearson’s correlations among our variables and the fit indices of our models at each step.

To address research question 1, we planned to report the ICC, which measures how much variance can be explained by differences between groups. The ICC indicates the proportion of the variation that can be explained between and within groups.

We planned to address research question 2 by reporting the \( \beta \)s and relevant standard errors. We also planned to report the partial ICCs as measures of effect size. Previous work addressing the effects of individual differences on children’s talk during play found partial ICCs in the range of 0.08–0.41 (Gibson et al., 2019), and we planned to use these findings as benchmarks for our interpretation. We planned to look at changes in ICCs at each step to determine whether introducing new explanatory variables explained any further variation in the model. As this research covers new ground and is observational by design, we planned to base our interpretation primarily on the effect sizes found. In addition to reporting and interpreting effect sizes, we also planned to report 95% confidence intervals and \( p \)-values for each \( \beta \).
As our study has a pre-determined sample size, we performed a sensitivity analysis prior to conducting our analyses to determine the minimum detectable effect for each construct of interest with 90% power. We report this analysis, which informs the interpretation of our results, in Table 1. Our full scripts and further details of this analysis are included in Appendix S3.

Friendship status

Given the possible influence of friendship status on children's connected communication, we planned to explore and report whether any differences in connectedness occur among our dyads based on friendship status. We report the results of these exploratory analyses alongside our main analysis to inform the interpretation of results.

Timeline

We anticipated completing this research within 8 months following in-principle acceptance. This allowed 3 months for coding, 3 months to analyse, and 2 months to write the Stage Two manuscript.

RESULTS

The findings described in this section follow the methods we registered at Stage One (https://osf.io/u74zy/). We outline and explain any changes from our plans in the ‘Deviations from protocol’ sub-section.

Data inclusion and exclusion

In addition to the 20 children who were lost to follow-up, a further four children were not included due to missing or unintelligible observations at T3. Our final sample size is therefore 148 children. Table 2 presents summary statistics for T1 and T2 data for the non-included 24 children.

Missing data

There were no missing data for age, sex, nor LA. EC data were collected at four of the five participating schools, resulting in missing EC data for 1 school (N = 21). Additionally, 11 participants had missing EC data at T1, four had missing EC data at T2, and one had missing ToM data at T3. Table 3 reports valid Ns for each measure. Upon investigation, we concluded that these data are missing at random as we would not expect their missingness to depend on the missing values (Little & Rubin, 2002; Appendix S4).

Table 1: Sensitivity analysis for minimum detectable effects with power of 90%.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum detectable effecta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept ($\beta_0$)</td>
<td>0.330</td>
</tr>
<tr>
<td>Sex ($\beta_1$)</td>
<td>0.038</td>
</tr>
<tr>
<td>Age ($\beta_2$)</td>
<td>0.026</td>
</tr>
<tr>
<td>LA ($\beta_3$)</td>
<td>0.038</td>
</tr>
<tr>
<td>ToM ($\beta_4$)</td>
<td>0.028</td>
</tr>
<tr>
<td>EC ($\beta_5$)</td>
<td>0.025</td>
</tr>
</tbody>
</table>

| aAssuming estimated random effects variance of 0.5 at level 3, 0.2 at level 2, and 0.01 residual variance.
Observed connectedness

Connectedness coding

Sufficient inter-rater reliability on 20% of transcripts was achieved between two coders for connected turns ($\kappa = 0.719$) and successful initiations ($\kappa = 0.732$). Disagreements in practice coding were settled through discussions between the two coders alongside viewing example observations, and uncertainties during reliability coding were resolved through viewing the relevant observations. Following reliability coding, the remaining 80% of transcripts were coded by the first author using ELAN linguistic annotation software (ELAN, n.d.).

Though our Kappas are similar to those reported for other observational measures of children’s conversations (e.g., Howe et al., 2005), it is nonetheless important to highlight that these are below the benchmark of 0.8 that we set at Stage One. Given rates of connectedness and rates of successful initiations for each child were the final variables used in our models, and Hallgren’s (2012) assertion that reliability calculations are most informative when performed on variables in their final form, an unplanned inter-rater reliability analysis was recalculated on rate scores. These ICCs indicated high agreement (ICCs = 0.863 for connected turns and 0.856 for successful initiations) despite the lower benchmark Kappas for the raw scores.

Pre-analysis checks

Both connected turns and successful initiations were normally distributed without floor or ceiling effects (Figure 1), so no transformations were necessary.

Summary statistics

The dataset contained 7615 utterances in total. Individual children engaged in four to 85 utterances ($M = 46.433, SD = 14.131$) during the freeplay observations. Tables 3 and 4 present summary statistics.
for our categorical and continuous variables, respectively. Table 5 reports Pearson’s correlations between all continuous study variables.

**RQ1: The role of the dyad in connected talk**

To determine the variability in connectedness owing to the dyad, we constructed empty models and calculated the ICCs (Table 6). For **connected turns**, the ICCs indicated 56.3% of the variance was explained between dyads before the inclusion of child-level predictors, and 23.6% of the variance in **connected turns** was explained within dyads. For **successful initiations**, 52.7% of the variance in connectedness was explained between dyads, and 41.9% was explained within dyads. In addition to supporting our hypothesis that
TABLE 4  Summary statistics for continuous study measures.

<table>
<thead>
<tr>
<th></th>
<th>Age a</th>
<th>LA b</th>
<th>ToM b</th>
<th>EC b</th>
<th>Connected turns c</th>
<th>Successful initiations c</th>
</tr>
</thead>
<tbody>
<tr>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>62.900 (3.766)</td>
<td>40.507 (10.052)</td>
<td>0.919 (0.973)</td>
<td>0.563 (0.178)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T2</td>
<td>72.549 (4.292)</td>
<td>43.858 (8.849)</td>
<td>1.486 (1.134)</td>
<td>0.703 (0.146)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T3</td>
<td>81.372 (4.444)</td>
<td>36.095 (6.364)</td>
<td>1.803 (1.083)</td>
<td>0.758 (0.196)</td>
<td>0.471 (0.121)</td>
<td>0.463 (0.118)</td>
</tr>
<tr>
<td>Min, max</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>53.717, 71.294</td>
<td>11, 56</td>
<td>0, 3</td>
<td>0.083, 0.938</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T2</td>
<td>64.099, 84.041</td>
<td>14, 58</td>
<td>0, 3</td>
<td>0.286, 1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T3</td>
<td>72.608, 93.207</td>
<td>18, 48</td>
<td>0, 3</td>
<td>0.200, 1</td>
<td>0.167, 0.772</td>
<td>0.182, 0.759</td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>148</td>
<td>148</td>
<td>148</td>
<td>116</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T2</td>
<td>148</td>
<td>148</td>
<td>148</td>
<td>123</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T3</td>
<td>148</td>
<td>148</td>
<td>147</td>
<td>127</td>
<td>148</td>
<td>148</td>
</tr>
</tbody>
</table>

aMonths.
bRaw scores prior to z-score transformation.
cProportion of total utterances.

TABLE 5  Pearson's correlations between continuous study variables.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. T1 Age</td>
<td>–</td>
<td>.830**</td>
<td>.813**</td>
<td>.247**</td>
<td>.171*</td>
<td>.073</td>
<td>.164*</td>
</tr>
<tr>
<td>2. T2 Age</td>
<td>–</td>
<td>–</td>
<td>.992**</td>
<td>.243**</td>
<td>.230**</td>
<td>.141</td>
<td>.193*</td>
</tr>
<tr>
<td>3. T3 Age</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.237**</td>
<td>.237**</td>
<td>.148</td>
<td>.184*</td>
</tr>
<tr>
<td>4. T1 LA</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.739**</td>
<td>.720**</td>
<td>.609**</td>
</tr>
<tr>
<td>5. T2 LA</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.727**</td>
<td>.520**</td>
</tr>
<tr>
<td>6. T3 LA</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.506**</td>
</tr>
<tr>
<td>7. T1 ToM</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>8. T2 ToM</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>9. T3 ToM</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>10. T1 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11. T2 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>12. T3 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>13. Connected turns</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>14. Successful initiations</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<table>
<thead>
<tr>
<th></th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. T1 Age</td>
<td>.168*</td>
<td>.019</td>
<td>.308**</td>
<td>.167</td>
<td>.161</td>
<td>.031</td>
<td>.044</td>
</tr>
<tr>
<td>2. T2 Age</td>
<td>.155</td>
<td>.006</td>
<td>.317**</td>
<td>.133</td>
<td>.211*</td>
<td>.017</td>
<td>.069</td>
</tr>
<tr>
<td>3. T3 Age</td>
<td>.155</td>
<td>–.001</td>
<td>.315**</td>
<td>.138</td>
<td>.230**</td>
<td>.001</td>
<td>.079</td>
</tr>
<tr>
<td>4. T1 LA</td>
<td>.591**</td>
<td>.505**</td>
<td>.438**</td>
<td>.595**</td>
<td>.615**</td>
<td>.033</td>
<td>.030</td>
</tr>
<tr>
<td>5. T2 LA</td>
<td>.583**</td>
<td>.450**</td>
<td>.380**</td>
<td>.550**</td>
<td>.607**</td>
<td>.102</td>
<td>.031</td>
</tr>
<tr>
<td>6. T3 LA</td>
<td>.452**</td>
<td>.512**</td>
<td>.290**</td>
<td>.412**</td>
<td>.564**</td>
<td>.131</td>
<td>.049</td>
</tr>
<tr>
<td>7. T1 ToM</td>
<td>.578**</td>
<td>.524**</td>
<td>.342**</td>
<td>.386**</td>
<td>.427**</td>
<td>.191*</td>
<td>.107</td>
</tr>
<tr>
<td>8. T2 ToM</td>
<td>–</td>
<td>.521**</td>
<td>.402**</td>
<td>.555**</td>
<td>.519**</td>
<td>.016</td>
<td>.033</td>
</tr>
<tr>
<td>9. T3 ToM</td>
<td>–</td>
<td>–</td>
<td>.261**</td>
<td>.438**</td>
<td>.538**</td>
<td>.149</td>
<td>.114</td>
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</table>
### Table 5 (Continued)

<table>
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<tr>
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<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. T1 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.368**</td>
<td>.348**</td>
<td>−.044</td>
<td>−.005</td>
</tr>
<tr>
<td>11. T2 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.504**</td>
<td>−.046</td>
<td>−.031</td>
</tr>
<tr>
<td>12. T3 EC</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.082</td>
<td>.133</td>
</tr>
<tr>
<td>13. Connected turns</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>.624**</td>
</tr>
<tr>
<td>14. Successful initiations</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

*p < .05.

**p < .01.

### Table 6

Results of main analysis.

<table>
<thead>
<tr>
<th>Step</th>
<th>Parameter</th>
<th>Connected turns</th>
<th>Successful initiations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Random effects&lt;br&gt;Dyad level</td>
<td>0.563</td>
<td>0.527</td>
</tr>
<tr>
<td></td>
<td>Child level</td>
<td>0.236</td>
<td>0.419</td>
</tr>
<tr>
<td></td>
<td>Fixed effects&lt;br&gt;Intercept</td>
<td>0.470 [0.448, 0.492] (0.011)**</td>
<td>0.459 [0.437, 0.481] (0.011)**</td>
</tr>
<tr>
<td>2</td>
<td>Random effects&lt;br&gt;Dyad level</td>
<td>0.641</td>
<td>0.528</td>
</tr>
<tr>
<td></td>
<td>Child level</td>
<td>0.219</td>
<td>0.442</td>
</tr>
<tr>
<td></td>
<td>Fixed effects&lt;br&gt;Intercept</td>
<td>0.477 [0.442, 0.511] (0.018)**</td>
<td>0.456 [0.422, 0.490] (0.017)**</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>−0.021 [−0.070, 0.028] (0.025)</td>
<td>−0.007 [−0.053, 0.040] (0.024)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
</tr>
<tr>
<td>3</td>
<td>Random effects&lt;br&gt;Dyad level</td>
<td>0.641</td>
<td>0.528</td>
</tr>
<tr>
<td></td>
<td>Child level</td>
<td>0.224</td>
<td>0.443</td>
</tr>
<tr>
<td></td>
<td>Fixed effects&lt;br&gt;Intercept</td>
<td>0.476 [0.441, 0.511] (0.018)**</td>
<td>0.456 [0.422, 0.490] (0.017)**</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>−0.021 [−0.070, 0.028] (0.025)</td>
<td>−0.007 [−0.053, 0.040] (0.024)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>0.001 [−0.002, 0.004] (0.001)</td>
<td>0.000 [−0.003, 0.004] (0.002)</td>
</tr>
<tr>
<td>4</td>
<td>Random effects&lt;br&gt;Dyad level</td>
<td>0.611</td>
<td>0.494</td>
</tr>
<tr>
<td></td>
<td>Child level</td>
<td>0.344</td>
<td>0.488</td>
</tr>
<tr>
<td></td>
<td>Fixed effects&lt;br&gt;Intercept</td>
<td>0.492 [0.453, 0.530] (0.020)**</td>
<td>0.471 [0.436, 0.507] (0.018)**</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>−0.026 [−0.077, 0.025] (0.026)</td>
<td>−0.008 [−0.057, 0.040] (0.025)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
<td>0.000 [−0.000, 0.000] (0.000)</td>
</tr>
<tr>
<td></td>
<td>LA</td>
<td>0.001 [−0.002, 0.005] (0.002)</td>
<td>−0.001 [−0.005, 0.003] (0.002)</td>
</tr>
<tr>
<td></td>
<td>ToM</td>
<td>−0.000 [−0.003, 0.003] (0.001)</td>
<td>0.001 [−0.002, 0.004] (0.002)</td>
</tr>
<tr>
<td></td>
<td>EC</td>
<td>0.001 [−0.002, 0.003] (0.001)</td>
<td>−0.000 [−0.003, 0.003] (0.001)</td>
</tr>
</tbody>
</table>

**p < .01.

a ICC.

b β [95% CI] (SE).
more variance in connectedness would be explained by the dyad than within the dyad, these ICCs confirm that our observations of connectedness are not independent and that multilevel models are appropriate for analysing our data.

**RQ2: Socio-cognitive skills as predictors of connected talk**

Next, we included predictors to assess whether individual differences in LA, ToM, and EC predicted children's connected talk. All predictor $\beta$s were negligible in magnitude and below the minimum detectable effects calculated at Stage One. No child variables were significant predictors of either connectedness outcome, and changes in ICCs were small. Table 6 reports the $\beta$s, 95% confidence intervals, and standard errors for the four model steps.

**Model fit**

We tested two covariance structures: a first-order auto-regressive structure and a variance components structure. The first-order auto-regressive structure provided the better fit when compared to the variance components structure at the final step of both models, though a chi-squared likelihood ratio test showed this difference was only significant for connected turns (for connected turns, AICs = −1382.901 and −1380.479 respectively, likelihood ratio = 4.422, $p = .036$; for successful initiations, AICs = −1319.267 and −1317.883 respectively, likelihood ratio = 3.384, $p = .066$).

We report AICs at each step of our models as registered, but we caution against the interpretation of these due to the missing data resulting in uneven sample size across steps (for connected turns, AICs = −1781.665 at Step 1, −1776.695 at Step 2, −1775.003 at Step 3, and −1382.901 at Step 4; for successful initiations, AICs = −1663.369 at Step 1, −1664.138 at Step 2, −1664.167 at Step 3, and −1319.267 at Step 4).

**Exploratory analysis: reciprocated friendship and connectedness**

**Research question**

We conducted an exploratory analysis looking at reciprocated friendship and connectedness, aiming to answer the following question: Does the status of a child's play partner as a reciprocal friend predict engagement in connected talk during play?

**Data structure**

For this analysis, our data had two levels: children at level 1 grouped within dyads at level 2. As all relevant data were measured cross-sectionally at T3, we did not include timepoints nested within children.

**Variables**

We investigated partner status at level 2, where 0 represents a dyad who were not reciprocal friends, and 1 represents a dyad who were reciprocal friends. We included age at level 1 and sex at level 2 as covariates. Our outcome variables were connected turns and successful initiations, calculated as in our main analysis.
Data exclusion

As dyad assignment for observation was based on children’s friendship nominations (Sanderson & Siegal, 1995), many of the children whose partners were not reciprocal friends did not have a reciprocal friend who could have been their partner. We exclude these children without a reciprocal friend (N = 25) from this analysis, resulting in a sample of 123 children who had at least one reciprocal friend. One hundred and six of these were observed playing with a reciprocal friend and 17 were observed with a partner who was not a reciprocal friend.

Model description

We constructed a random intercept model with fixed slopes, starting with an empty model, adding covariates at the second step, and then adding partner status at the third step. We used maximum likelihood estimation and a variance components structure. We did not find a significant effect of partner status on children’s connectedness for connected turns nor successful initiations, but we note that the $\beta$s for partner status are larger than all other predictors of connectedness investigated in this research. The full results of this analysis are reported in Table 7.

Model fit

For connected turns, there were no improvements in fit across the three steps of the model (AICs = −194.459 at Step 1, −190.803 at Step 2, and −190.784 at Step 3). For successful initiations, the inclusion of age and sex at Step 2 resulted in an insignificant improvement in model fit (AICs = −183.588 at Step 1 and

<table>
<thead>
<tr>
<th>Step</th>
<th>Parameter</th>
<th>Connected turns</th>
<th>Successful initiations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Random effects</td>
<td>0.639</td>
<td>0.537</td>
</tr>
<tr>
<td></td>
<td>Dyad level</td>
<td>0.639</td>
<td>0.537</td>
</tr>
<tr>
<td></td>
<td>Fixed effects</td>
<td>0.472 [0.445, 0.498] (0.013)**</td>
<td>0.461 [0.435, 0.487] (0.013)**</td>
</tr>
<tr>
<td>2</td>
<td>Random effects</td>
<td>0.643</td>
<td>0.568</td>
</tr>
<tr>
<td></td>
<td>Dyad level</td>
<td>0.643</td>
<td>0.568</td>
</tr>
<tr>
<td></td>
<td>Fixed effects</td>
<td>0.430 [0.406, 0.484] (0.195)*</td>
<td>0.893 [0.497, 10.288] (0.201)**</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>−0.014 [−0.067, 0.040] (0.027)</td>
<td>−0.009 [−0.061, 0.043] (0.027)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>0.001 [−0.004, 0.005] [0.002]</td>
<td>−0.005 [−0.010, −0.000] (0.002)*</td>
</tr>
<tr>
<td>3</td>
<td>Random effects</td>
<td>0.634</td>
<td>0.554</td>
</tr>
<tr>
<td></td>
<td>Dyad level</td>
<td>0.634</td>
<td>0.554</td>
</tr>
<tr>
<td></td>
<td>Fixed effects</td>
<td>0.393 [0.007, 0.778] (0.196)*</td>
<td>0.837 [0.442, 10.232] (0.201)**</td>
</tr>
<tr>
<td></td>
<td>Sex</td>
<td>−0.011 [−0.064, 0.042] (0.027)</td>
<td>−0.006 [−0.057, 0.046] (0.026)</td>
</tr>
<tr>
<td></td>
<td>Age</td>
<td>0.001 [−0.004, 0.005] (0.002)</td>
<td>−0.005 [−0.010, −0.000] (0.002)*</td>
</tr>
<tr>
<td></td>
<td>Partner status</td>
<td>0.050 [−0.020, 0.119] [0.036]</td>
<td>0.062 [−0.007, 0.130] (0.035)</td>
</tr>
</tbody>
</table>

*p < .05.
**p < .01.
*a ICC.
*b [95% CI] (SE).
Goodacre et al. (18−184.134 at Step 2, likelihood ratio = 4.546, \( p = .103 \)), and the inclusion of partner status at Step 3 also lead to an insignificant improvement in fit (AIC = −185.288 at Step 3, likelihood ratio = 3.154, \( p = .076 \)).

### Deviations from protocol

Here we indicate and explain deviations from our Stage One plans.

#### Covariate labelling

At Stage One, we included child gender as a covariate for RQ2. After referring to the original data collection materials, we realized that our survey included the following response options: female and male. We therefore relabelled the gender covariate as sex to more accurately represent these response options.

#### Reliability

We set a benchmark for reliability at \( \kappa = 0.8 \) at Stage One. However, our reliability fell below this benchmark at \( \kappa = 0.719 \) for connected turns and \( \kappa = 0.732 \) for successful initiations. One possible reason for this deviation is the need for ‘virtual’ reliability training due to COVID-19 restrictions, which may have made it more difficult for coders to reach a consensus on codes. However, our unplanned analysis of inter-rater reliability on connectedness rates revealed sufficient overall agreement (ICCs = 0.863 for connected turns and 0.856 for successful initiations) despite lower agreement on individual utterances.

### DISCUSSION

This study focuses on both dyadic influences and individual differences as under-researched areas in children’s communication. We present two main research questions aiming to investigate the coordination of children’s dyadic communication in a play context, in addition to an exploratory analysis intended to support the interpretation of our results.

First, we investigate how much variation in connected talk is explained by variation between dyads. This question is addressed by the ICCs at Step 1 of our model, which indicates that over half of the variation in connectedness is explained at the dyad level. For both measures of connectedness, ICCs support our hypothesis that between-dyad variation would be greater than within-dyad variation and align with previous findings regarding dyadic effects on children’s play behaviours (Dunn & Cutting, 1999; Etel & Slaughter, 2019; Gibson et al., 2019). This demonstrates that for both connectedness measures, children behaved more similarly to their play partners than they did to children in other dyads. That is, children’s own communication depended on their partner’s communication.

The effect sizes for our first research question are higher than those reported in similar studies. For comparison, Gibson et al. (2019) report 21.9% of the variation in joint proposals and 35.3% of the variation in role assignment, both verbal play behaviours, were explained at the dyad level. Our findings highlight the substantial dyadic influence on connectedness and indicate that future research on connectedness and other verbal play behaviours should account for the dyad’s role. Theoretically, this means that as presented at Stage One, connectedness requires considerable coordination by both partners, resulting in mutual influence on the connected conversation.

Our findings build on previous research into the dyad’s role in verbal communication. Much of the research in this area has compared focal children’s interactions across partners. Brown et al. (1996), for example, found significant partner effects on children’s use of mental state terms during unstructured observations at age 3 years: children made more frequent mental state references with friends and siblings.
than with their mothers. Similarly, Leach et al. (2019)'s study on friend and sibling connectedness identified differences in children's interactions across partners. Our findings expand on this extant research, indicating that communication between partners is strongly associated in a peer play context. That is, not only do children vary their communication and connectedness across partners as shown in previous research but they also engage in similar levels of connectedness to their current play partner.

Our second research question investigates the extent to which children's socio-cognitive skills predict their engagement in connected talk during play. This question is addressed by the final step in our models. We expected children's expressive and receptive language, their understanding of others' perspectives and beliefs, and their comprehension of the situational determinants of emotions to facilitate engagement in connected conversations. Counter to our hypothesis, we did not find a significant association between connected talk and LA, ToM, nor EC. This finding indicates that, once accounting for dyadic effects, children's own socio-cognitive skills do not appear to have a strong influence on their connected talk with peers in middle childhood. Our findings suggest that children's use of perspective-taking strategies to inform their social interactions, as evidenced by Bartsch and London (2000), may not play a significant role in connected communication during freeplay.

Studies reporting similar findings are sparse, possibly owing to publication bias and failure to correct for group clustering (resulting in underestimated standard errors and $p$-values, leading to a higher rate of false significant results; Steele, 2008) among other factors. One exception is Dunn and Cutting (1999), who investigated individual differences in 4-year-old friends' play interactions. They found that neither focal child nor partner characteristics (which included socio-cognitive measures such as ToM, affective-perspective taking, and emotion understanding) were significantly correlated with connected communication other than partner age (Dunn & Cutting, 1999). This is despite finding significant correlations between several of these characteristics and cooperative pretend play, which itself was correlated with connected communication (Dunn & Cutting, 1999). This supports our finding that individual differences in children's socio-cognitive skills may not be directly related to their engagement in connected talk in a play setting.

Conversely, Slomkowski and Dunn (1996) did find links between social understanding and children's connectedness with their friends. However, these findings are reported in 3-year-olds, a sample much younger than that of the current study and that reported in Dunn and Cutting (1999). It is therefore possible that children's communication in early childhood is contingent on these socio-cognitive skills, but that this reliance weakens by middle childhood when children no longer depend on such abilities to maintain connected conversations in a freeplay context. Instead, children of this age may only employ such skills for communication in more challenging situations (e.g., problem-solving tasks). The relevance of task difficulty at different ages is suggested by Azmitia and Perlmutter (1989), who propose that school-age children may not find freeplay particularly challenging for collaboration. They suggest that as children's communicative skills improve during middle childhood, social interaction during familiar and open-ended tasks such as freeplay may become more routine, allowing the child to devote less effort to the activity's social requirements (Azmitia, 1996; Azmitia & Perlmutter, 1989). Instead, they suggest that unfamiliar activities as well as those requiring explanation and discussion may be more demanding for older children (Azmitia & Perlmutter, 1989).

In an even younger sample of mothers and their 2-year-olds, Ensor and Hughes (2008) did not find a significant relationship between social understanding and children's own engagement in connected communication. However, in this mother–child play context, they did find that mothers' connected communication predicted child social understanding concurrently and at two subsequent timepoints (ages three and four), possibly owing to mothers scaffolding the interaction to the child's socio-cognitive abilities (Ensor & Hughes, 2008). In all, these mixed findings lead us to suggest that exposure to connected talk at age two may promote the development of socio-cognitive skills (Ensor & Hughes, 2008), which are then employed to aid children's own engagement in a connected talk at age three (Slomkowski & Dunn, 1996). By age four, this may become less challenging and no longer require advanced social cognition (Dunn & Cutting, 1999), resulting in no significant link between the two for freeplay in middle childhood. It is
evident that further longitudinal study, assessing both connectedness and socio-cognitive development at multiple timepoints in early and middle childhood, in addition to exploring more challenging communication contexts, is needed to further examine this proposal.

Together, the findings from our two research questions provide evidence for Gibson et al. (2019)'s proposition that the characteristics of social play are not based on fixed individual differences and that more attention should instead be paid to the dyadic nature of peer play. Further evidence for this proposal comes from Etel and Slaughter (2019), who similarly found that communication in joint play was overwhelmingly explained by the dyad without finding a significant effect of the individual's ToM. Additionally, Azmitia and Perlmutter (1989) propose that well-known partners, such as friends, may not need to draw on their social skills as heavily during interactions because they can rely on their past experiences with the partner for the social demands of the interaction, suggesting that there may be a dyadic effect on the extent to which socio-cognitive skills are applied. However, while we have identified a strong dyadic effect on communication in peer play with little effect of individual differences, importantly such findings may not hold across diverse groups of children. Although we do not exclude children based on developmental nor demographic factors, children with communication difficulties, for example, may present smaller dyadic effects and a greater reliance on socio-cognitive skills for communication.

Finally, our exploratory analysis investigates dyadic reciprocal friendship and connected talk to inform the interpretation of our main results. We do not find a significant association between dyadic reciprocal friendship and child engagement in connected talk. However, the larger $\beta$s for partner status suggests it will be a rich area for future study. As this analysis is exploratory in nature and is not the primary purpose of our study, any further interpretation of its results should be made cautiously. Among several obstacles to interpreting these results more generally, the children in the present study were not randomly assigned to partners as would be preferable for drawing robust conclusions.

Strengths and limitations

Our study has many strengths, particularly those associated with being a registered report, such as pre-study peer review of methods and our ability to publish null results. Here we discuss additional strengths and limitations.

Our observational coding scheme for connectedness has several strengths: both measures showed sufficient frequency and variation in our sample, without floor or ceiling effects, indicating that measuring connectedness in this way is appropriate for future research with this age group. However, we planned to reach a higher level of inter-rater reliability on our raw coding of connectedness as a lower level of reliability indicates increased measurement error and may prevent the detection of an effect (Hallgren, 2012). While the reliability levels achieved are widely considered to be sufficient for observation of children’s conversations (e.g., Howe et al., 2005), our Kappas were lower than those reported in other studies of connectedness (e.g., Leach et al., 2019). Notably, however, our unplanned reliability analysis using the rate of connected turns and successful initiations – that is the variable of interest in our models – showed high agreement, suggesting that the lower than benchmark reliability on the raw coding likely did not substantially influence our findings.

Additionally, we note that there are both strengths and limitations to our secondary dataset. The use of friendship nominations to pair children for observation allows us to draw conclusions about children’s friendship interactions, an area important for development in middle childhood and beyond (Fink, 2021). However, as play pairs were not randomly allocated, we are unable to draw conclusions regarding whether dyadic effects are down to children adjusting their own communication to match the partner’s or whether these dyadic effects are down to children selecting friends who communicate similarly.

Finally, while we are fortunate to be able to publish our null results and counter biases towards positive results in the current literature (Scheel et al., 2021), we are limited in our ability to interpret such results. Based on a hypothesis testing statistical framework, null results indicate that we do not have
enough evidence to reject the null hypothesis, but they do not provide support for the null hypothesis. Null results could occur due to insufficient power to detect an effect, for example. While our pre-study sensitivity analysis aims to counter this, it cannot be ruled out. Furthermore, several of our $\beta$s fall below the calculated minimum detectable effects, and our lower-than-anticipated reliability may have limited our ability to detect an effect (Hallgren, 2012). We therefore discuss our findings with caution, unable to draw concrete conclusions at the population level within our framework.

**Recommendations for future research: focus on the dyad**

This study aims to provide a theoretical and empirical foundation for future research into play as a context for developing communication skills. Using individual measures, we confirm that connectedness in particular is a dyadic construct. In doing so, we provide substantial evidence for the partner's role in dyadic play communication. We therefore recommend that future observational play research addresses this by collecting and analysing data from both members of the dyad, accounting for dyadic effects in analysis, and measuring behaviours at the dyad level where appropriate. More specifically, measurement of connectedness at the dyad level may be fruitful, which to the best of our knowledge has not yet been done.

In line with these recommendations, we suggest that the status of the dyad beyond our exploratory analysis (e.g., friend–friend, classmate–classmate, sibling–sibling, parent–child, and teacher–child) will be a rich area for future research into connectedness and beyond. Some of this work has already begun, including Leach et al. (2019)'s analysis of connectedness in friend and sibling dyads, looking at within-child between-dyad effects on children’s connectedness. We suggest that future research into this area should consider dyadic designs in data collection while also accounting for the dyad in the analysis.

Finally, we advise that this focus will have relevance throughout developmental psychology research, from developing new measures of individual differences to communication research beyond connectedness. Future research should contemplate whether the individual measurement of socio-cognitive skills provides a complete picture of children’s abilities as it may not capture how these skills are put to use in unfolding social interactions. Instead, researchers should consider how measuring these abilities through social means may offer an informative and complementary understanding of children’s applied social cognition. Additionally, several of the overlapping research areas looking at topic management in conversations mentioned in our Introduction (such as transactive dialogues) would benefit from grouping in analysis, and we hope these methods will be adopted in such dyadic research in developmental psychology more widely.

**AUTHOR CONTRIBUTIONS**

Paul Ramchandani: Conceptualization; supervision; writing – review and editing. Jenny L. Gibson: Conceptualization; methodology; resources; supervision; writing – review and editing.

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**CONFLICT OF INTEREST STATEMENT**

All authors declare no conflict of interest.
OPEN RESEARCH BADGES

This article has earned Open Data, Open Materials and Preregistered Research Design badges. Data, materials and the preregistered design and analysis plan are available at https://osf.io/gt7ws/.

DATA AVAILABILITY STATEMENT

The data used in this study are openly available on the Open Science Framework (https://osf.io/gt7ws/). We are unable to share raw video observations.

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**SUPPORTING INFORMATION**

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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