Cross-sectional and longitudinal associations between quality of parent-child interaction and language ability in pre-school-aged children with developmental language disorder

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We have no conflicts of interest to disclose.

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Abstract

Purpose: This study explores whether the quality of parent-child interaction is associated with language abilities cross-sectionally and longitudinally up to preschool-age among children with developmental language disorder (DLD).

Method: Participants were 97 monolingual children with DLD and their parents from the Helsinki Longitudinal SLI study, HelSLI (baseline, age in years; months, mean (M) = 4;3, standard deviation (SD) = 0;10), of which 71 pairs were followed longitudinally (age in years; months M = 6;6, SD = 0;5). Video recordings from three play sessions were scored for child, parent, and dyadic behavior using Erickson's sensitivity scale protocol and mutually responsive orientation at baseline. Children's expressive and receptive language and language reasoning ability were assessed at baseline, and expressive and receptive language were assessed at follow-up.

Results: At baseline, engaged child behavior, parent's supportive guidance, and fluent and attuned dyadic behavior were associated with better receptive language ability, and engaged child behavior and dyadic synchrony were positively associated with language reasoning ability in 3-6-year-olds. The child's positive engagement, and fluent and attuned dyadic behavior at baseline, were associated with better expressive and receptive language abilities at follow-up,-in 6-7-year-olds, respectively.

Conclusions: Fluent and attuned dyadic behavior is associated with better receptive language ability in preschool-aged children. Parent behavior alone was not associated with language ability. A connected and mutually attuned parent-child relationship could be a protective factor for language development for children with DLD.

Keywords: parent-child interaction, engagement, supportive guidance, dyadic behavior, developmental language disorder, specific language impairment, pre-school age

A wealth of research on typically-developing children illustrates that interactions between caregiver and child shape language development in a fundamental manner (Blinkoff et al., 2016). Much of the available research on parent-child interaction and language development has focused on parent-child language use (Rowe & Snow, 2020), and less on the emotional quality of interaction. Moreover, little research exists on the role of the emotional quality of caregiver-child interaction on language development in populations with developmental challenges in language acquisition. Considering the importance of parent-child interaction to language development, research with these children could open new avenues of intervention, and provide further support for existing ones (e.g., parent-child interaction therapy, Falkus et al., 2016). The current study will focus on the association between parent-child interaction and language development in children with developmental language disorder (DLD).

Parent-child interaction and language development

Language development is influenced by a complex combination of biological and environmental factors (Dale et al., 2015; Hayiou-Thomas, 2008; Spinath et al., 2004). Central among the environmental factors on language development is parent-child interaction (Rowe & Weisleder, 2020). An important feature of caregiver input for a child's language development, in addition to linguistic and conceptual input, is interactive input. (Rowe & Snow, 2020). Interactive input refers to the back-and-forth nature of parent-child interaction and is founded on features such as parent responsiveness and sensitivity (Rowe & Snow, 2020). Parents build on early episodes of caregiver-infant joint attention, by offering sensitive, timely and contingent responses (Blinkoff et al., 2016). As the child grows parent and child eventually cocreate connected, fluent interactional exchanges (Rowe & Snow, 2020). Sensitive, fluent, and connected parent-child interaction has been associated with several positive language outcomes, like larger vocabulary in toddlerhood larger vocabulary in toddlerhood (Brooks &

Meltzoff, 2008; Farrant & Zubrick, 2012; Todd, 1983), and greater communicative competence (Rocissano & Yatchmink, 1983; Tomasello & Farrar, 1986).

Research on parent-child interaction and language development particularly with children aged 3-5 years old has focused mostly on language use (Rowe & Snow, 2020), and less on the role of emotional expressiveness and matching (Harrist & Waugh, 2002). Some studies have extended the above findings to examine how the quality of parent-child interaction can encourage or impede language development. The quality of parent-child interaction is quantified through rating scales designed to measure different features of interaction, which are thought to contribute to the emotional quality of parent-child interaction. For the purposes of this study, parent-child interaction is operationalized using Erickson's sensitivity scales (Egeland et al., 1990; Erickson et al., 1985), an observational schedule which includes measures of child (e.g., enthusiasm, persistence), parent (e.g., supportiveness, sensitivity and timing and clarity of instruction) and dyadic behaviors (e.g., quality of the relationship, diffusion of boundaries).

Parent sensitivity is a key feature of parent-child interaction often examined in the context parent-child interaction. Sensitivity refers to the extent to which a parent is attentive to their child's needs, affect, arousal, and capability. A considerable amount of evidence suggests that parenting sensitivity is associated with better expressive and receptive language ability in toddlers (Barnett et al., 2012; Loi et al., 2017; Pungello et al., 2009; Stanton-Chapman et al., 2002), even when controlling for earlier language ability (Loi et al., 2017).

Another feature of parent-child interaction that has been examined in relation to language development is dyadic synchrony, which is defined as a pattern of interaction that is regulated by both parent and child in cooperation, that is reciprocal in orientation and responsiveness, and where communication is harmonious and smooth-flowing (Harrist & Waugh, 2002). Dyadic synchrony has also been associated with greater communicative

competence in toddlers (Rocissano & Yatchmink, 1983; Tomasello & Farrar, 1986). Specifically, shared affect during parent-child interaction has been associated with the earlier achievement of expressive language milestones, such as vocabulary size and the use of combinatorial speech, in toddler-aged children (Nicely et al., 1999) and greater expressive language skills at 3 years (Lindsey et al., 2009). Nicely et al. (1999) hypothesize, that shared affect may serve to make parent utterances more salient to toddlers or serve to motivate longer episodes of joint attention.

Parent-child interaction and children with DLD

Interaction in dyads with children who have language impairment is characterized by several features, which may pose additional challenges to creating the kind of smooth-flowing and connected episodes of interaction that are associated with greater language competence. Children with language impairment may be less compliant and persistent during interaction with parents than typically-developing (TD) children (Skibbe et al., 2010). Moreover, Skibbe et al. (2010) found that children with language impairment participate more actively in storybook reading, when their mothers showed a high level of sensitivity. Thus, children with language impairment may be more dependent on the emotional support provided by their caregiver (Skibbe et al., 2010). Research suggests that linguistic and pragmatic difficulties of children with developmental language disorder (DLD) may result in more frequent breakdowns of communication (Bishop et al., 2000; Rescorla et al., 2001; Rescorla & Fechnay, 1996). Furthermore, children with DLD may give less input for parents to respond or attune their communication to than typically-developing children, thus resulting in an impoverished conversational context, which could negatively impact language development (Bishop et al., 2000; Paul & Shiffer, 1991; Rescorla et al., 2001; Rescorla & Fechnay, 1996; van Balkom et al., 2010).

Findings on the behavior of parent with children who have language impairment are somewhat contradictory. Research has shown on one hand, that parents of children with DLD may be less responsive (Hoffer & Bliss, 1990; Schodorf & Edwards, 1983), and use shorter utterances and provide less input (Schodorf & Edwards, 1983). On the other hand, parents of children with language impairment may also appear more controlling and directive (Blackwell et al., 2015; Conti-Ramsden et al., 1995; Hammer et al., 2001; Hoffer Corbett & Bliss, 1990; Kloth et al., 1998). Parents of language-impaired children may also be less emotionally supportive during interactions than parents of typically-developing children (Skibbe et al., 2010). There is agreement among researchers examining parent-child interaction from a linguistic perspective, that parents are likely attuning their language use and level of responsiveness to the child's language ability and output (Blackwell et al., 2015; Conti-Ramsden et al., 1995; Majorano & Lavelli, 2014; Paul & Elwood, 1991). Given that DLD has a clear genetic component (Bishop, 2006) parents of children with DLD may have language difficulties themselves (Hammer et al., 2001), which may limit their ability to manage the child's non-compliance and lack of persistence during interactions.

Only one study was identified examining parent-child dyadic synchrony with children who have impaired language development. In a study with late-talkers, Rescorla and Fechnay (1996) found that dyads with late-talkers did not differ in dyadic synchrony from dyads with TD children. However, results also indicated that controlling mothers had lower levels of synchrony. Taken together, parents of children with DLD who have more directive and controlling parenting styles might have lower levels of dyadic synchrony and in turn, less of the kind of smooth-flowing and connected interaction, which has been shown to play a significant role in language development. Notably, the participants for this study were identified as late-talkers, and thus generalizations to children with DLD should be viewed with caution. Thus, no research was identified examining dyadic synchrony in children with

DLD. Moreover, a paucity of information exists on how dyadic synchrony might be associated with language development in children with developmental challenges in language ability, and thus more research is needed to clarify the associations between dyadic synchrony and language impairment.

In summary, existing research has examined how children with DLD and their parents may differ individually and in terms of their dyadic functioning from children with typically-developing language. However, no research was identified examining the associations between different facets of parent-child interaction (child, parent, and dyadic behaviors) and language development in children with DLD. This is a significant gap in the existing literature. Moreover, few studies have examined receptive language comprehensively with relation to parent-child interaction, as the majority of the research has focused on expressive language impairment (Blackwell et al., 2015; Conti-Ramsden & Friel-Patti, 1984; Rescorla & Fechnay, 1996). Considering that children with receptive language impairment are at greater risk for negative outcomes than children with expressive language impairment, and that less is known about treating receptive language impairment, more information on potential protective and risk factors for receptive language development is needed (Boyle et al., 2010).

Current study

The evidence on the emotional features of parent-child interaction with children who have DLD is scarce. Furthermore, no studies were found examining how the quality of parent-child interaction is longitudinally associated with language development in children with DLD. Moreover, few studies have examined the association between receptive and parent-child interaction in children with language impairment (Blackwell et al., 2015; Conti-Ramsden & Friel-Patti, 1984; Rescorla & Fechnay, 1996). This study will focus on children with DLD, which is the current label used to categorize children who have lasting language difficulties, which are not caused by any known biomedical issue or intellectual disability

(Bishop, 2017). This study aims to address the gaps within the existing literature by exploring first how the quality of parent-child interaction might be associated with language ability in 3-6-year-old children with DLD. This study will examine child, parent, and dyadic behaviors to gain a multidimensional understanding of the emotional quality of parent-child interaction in children with DLD. Measures of expressive and receptive language and language reasoning ability will be included to enable a comprehensive examination of the associations between the quality of parent-child interaction and different facets of language ability. This study will then use a longitudinal approach to examine whether these features of parent-child interaction in 3–6-year-old children are longitudinally associated to the language development of pre-school-aged children with DLD.

Method

Participants

Participants were Finnish monolingual children from the Helsinki Longitudinal SLI study (HelSLI, see Laasonen et al., 2018, for a protocol and comprehensive description of participants). Participants were recruited from the initial clinical assessment at the children's audiophoniatric ward at the Helsinki University Hospital (HUH) during 2013-2015. Inclusion criteria for the HelSLI study were a referral to the audiophoniatric ward for an enduring concern in language development, without any known biomedical etiology. Children had been assessed by speech-language therapists and had received speech-language therapy prior to referral to the audiophoniatric ward. All children in the sample had been diagnosed with a language disorder as per the criteria set out in the Finnish ICD-10 (WHO, 2010). Out of the monolingual children with language impairment participating in the HelSLI study (n = 136), written informed consent was obtained from parents, and video recording and cognitive testing were conducted, for 120 children. Exclusion criteria were hearing defects, intellectual disability, autism spectrum disorders, diagnosed neurological defects or disorders (e.g.,

epilepsy, XYY syndrome), oral anomalies, and performance intelligence quotient below 70 (n = 98). Further, one child was excluded because they participated in the video recording with a grandparent. The final sample at baseline after exclusions consisted of 97 parent-child pairs (children's age in years; months, mean (M) = 4;3, standard deviation (SD) = 0;10), range = 2;10 – 6;10), and 71 pairs at follow-up (children's age in years; months M = 6;6, SD = 0;5, range = 5;6 – 7;5) (Table 1). Parents participating included both mothers and fathers, and the ratio of mothers to fathers was approximately 3:1 at both baseline and follow-up. The median maternal level of education was primary or secondary-level education. The sample in this study consisted of monolingual, mother-tongue Finnish speakers. The follow-up was conducted during the academic year when the children were due to begin pre-school or had begun preschool (from August to June the following year). The study was approved by the HUH Ethics committee (§ 248/2012).

Measures

Child, parent, and dyadic behaviors

Video recording of interactional sequences was conducted in an examination room on the ward. Parent-child interaction was examined in three different situations - drawing, free-play, and assembling a puzzle, with a target timing of 5-minutes per task. Both the drawing and puzzle tasks were goal-oriented, while the free play task was less structured. The videos were scored using the Erickson scales (Egeland et al., 1990; Erickson et al., 1985) and the scale for mutually responsive orientation (Aksan et al., 2006). The Erickson scales are a commonly used measure for sensitivity (Mesman & Emmen, 2013), and are grounded in attachment theory (Mesman & Emmen, 2013). The scales are used to code interactions during teaching tasks with toddlers and preschoolers and include measures for child, parent, and dyadic behavior (Mesman & Emmen, 2013). The sensitivity construct measured by the

Erickson scales is sensitive to changes in maternal sensitivity following intervention (Stams et al., 2001). The Erickson scales were selected as they allowed for the examination of interactional sequences from child, parent, and dyadic perspectives, and were suitable for use with children up to preschool age (Mesman & Emmen, 2013). The scale for mutually responsive orientation (MRO) is also founded in attachment theory and is based on four theoretical components (coordinated routines, mutual cooperation, harmonious communication, emotional ambiance) (Aksan et al., 2006). Aksan et al. (2006) have explored the psychometric properties of MRO and conclude that their findings suggest that the MRO is sensitive to changes in the dyadic relationship, has good discriminant validity when compared to individual measures, and shows structural stability over time and across mother-child and father-child relationships (please see Aksan et al., 2006, for a detailed description of the psychometric properties of this scale). MRO was included as it allows for the assessment different aspects of the dyad specifically, and not individual features of parent and child.

Two research assistants with training in the use of the Erickson scales coded the videotaped interactional sequences for child, parent, and dyadic behavior (Egeland et al., 1990; Erickson et al., 1985) drawing and puzzle completion tasks on seven-point scales. Children were evaluated on enthusiasm, persistence, negativity, compliance, experience of the session, avoidance, and affection towards the parent. Parents were evaluated on supportive presence, hostility, intrusiveness, clarity of instruction, sensitivity, timing of instruction, and confidence. Dyads were assessed on the quality of the relationship and dissolution of physical/psychological parent-child boundaries. During drawing, puzzle-making, and free play dyads were also assessed on mutually responsive orientation (MRO) (Aksan, Kochanska, & Ortmann, 2006), on five dimensions: harmonious communication,

coordinated routines, mutual cooperation, and emotional ambiance. (Please see Supplemental tables 2 and 3 for short descriptions of the variables described above).

Inter-rater reliability was evaluated using a two-way mixed model, consistency, average-measures intra-class correlation (ICC) for child, parent, and dyadic factors in the drawing and puzzle-completion tasks. ICCs indicated good (0.74 – 0.90) to excellent (above 0.90) reliability for all factors (Koo & Li, 2016).

Language ability (baseline and follow-up)

Cognitive and language performance was assessed at visits to the audiophoniatric ward by neuropsychologists and speech and language therapists. Measures used to assess cognitive and language performance were limited to those available in Finnish. The following subtests were used from Wechsler Preschool and Primary Scale of Intelligence - Third Edition (WPPSI-III) (Wechsler, 2009): Picture Naming, Receptive Vocabulary, Information, Vocabulary, Word Reasoning. From Nepsy-II (Korkman et al., 2008), Comprehension of Instructions was used. The Expressive and Comprehension scales from Reynell Developmental Language Scales III (Edwards et al., 1997) were also used, as well as the Expressive (EOWPVT) and Receptive (ROWPVT) One-Word Picture Vocabulary Tests (Martin & Brownell, 2010, 2011) and the Boston Naming Test (BNT) (Kaplan et al., 1983). At baseline, all 11 measures of language were used. At follow-up, only measures used by clinical speech and language therapists were evaluated, and thus measures from WPPSI-III and Nepsy-II were not available at follow-up. (Table 1)

Confounding variables

Child's age, as well as mother's age and education, were selected as covariates (Table 1). Age influences the child's language skills, with higher skill-level associated with more advanced development. Mother's age (years) was controlled for to account for biological risk factors to child development associated with giving birth at a later age on the one hand

(Frederiksen et al., 2018), and the protective effect of advanced maternal age on development, including language development, on the other (Sutcliffe et al., 2012). Maternal educational attainment ((1) secondary-level education or less, (2) bachelor's degree or above) was also controlled for, as maternal educational attainment is associated with (1) children's language development (Pungello et al., 2009; Zambrana et al., 2012) and is also (2) indicative of maternal socioeconomic status, which also has strong associations to children's language development (Jalovaara & Andersson, 2018; Pungello et al., 2009). (Table 1).

Analysis

Data was analyzed using IBM SPSS Statistics v27. Missing values were identified in maternal education, maternal age at childbirth, and language outcome variables (Table 1). Of the confounding variables, 19.7% of cases were missing either maternal age at childbirth or maternal education level. At baseline 17.5% and at follow-up 29.6% of cases had missing values in at least one language outcome variable. The missing values were analyzed using Little's test and determined as missing completely at random at baseline ($\chi^2 = 63.40$, df = 60, p = .358) and follow-up ($\chi^2 = 19.31$, df = 17, p = .278) as the probability values for both exceeded 0.05 (Little, 1988). The missing data were then imputed using the expectation-maximization algorithm (Dempster et al., 1977).

Factor analysis was conducted to identify underlying factors among the behavioral variables to reduce the number of subsequent analyses, in order to avoid increased likelihood of type I error associated with conducting a large number of statistical tests. Although larger sample sizes are generally preferred for factor analysis, a smaller sample as in this study (n=97) can be considered sufficient (Bryant & Yarnold, 1995; Hair et al., 1998; Osborne, 2014). Examination of distributions behavioral variables showed four variables with highly skewed distributions (child's avoidance, child's negativity, parent's hostility, and parent's intrusiveness); these variables were removed as containing little information, and as

problematic in terms of the assumptions of exploratory factor analysis. The child's affection towards their parent was also removed, as the content of the variable was more dyadic in nature (see the description of Erickson scales in Supplemental table 1), and thus had low factor loadings on the child behavior factor. Following this, an exploratory factor analysis with the remaining interactional variables in one model was conducted. Parallel analysis, (O'Connor, 2000), where eigenvalues from the real data set were compared with eigenvalues from a randomly generated dataset with the same number of cases and variables (Tabachnik et al., 2007), was used to determine the number of factors to be retained and suggested a three-factor solution (Supplemental table 3 and Supplemental Figure 2). The three factors identified encapsulated child, parent, and dyadic behaviors (Supplemental table 3). The factor structure was parallel to the structure of the Erickson scales and theoretically justified (Erickson et al., 1985). Mutually responsive orientation also fit in well with this factor solution (Aksan et al., 2006). Confirmatory factor analyses were conducted, inputting child, parent, and dyadic variables in to separate factor analyses, to confirm the factor solution (Supplemental table 4). The series of factor analyses described above was conducted for interaction variables in both drawing and puzzle completion tasks. As the results were similar, results are presented for the drawing task only

The child factor encapsulated the child's enthusiasm, persistence, experience of the session, and compliance, and can be described as ***the child's positive engagement***. The parent factor comprised the parent's sensitivity, supportiveness, clarity, and confidence, and can be described as ***the parent's supportive guidance***. The dyadic factor comprised the quality of the relationship, mutually responsive orientation, and diffusion of psychological/physical boundaries and refers to the level of ***fluent and attuned dyadic behavior***. This three-factor solution was used to calculate composite scores of child, parent, and dyadic behavior using sample-standardized z-scores from the ratings derived from the video-recorded play sessions.

For language variables, sample standardized z-scores were calculated from raw scores of the 11 language measures used. Expressive, receptive, and complex language reasoning composites were formed as averages of these z-scores, as per the hierarchical three-factor model outlined in a previous publication (Lahti-Nuuttila et al., 2021) (Supplemental figure 1). A complex language reasoning composite was only formed for children above 4 years old (n=54) as two of the subtests required for calculating the complex language reasoning composite (WPPSI-III Vocabulary, Word Reasoning), were not available for younger children. At follow-up, expressive and receptive language composites were formed from the five available measures (RDLS Expressive and Comprehension scales, EOWPVT, ROWVPT, BNT) (see Table 1).

Hierarchical linear regression models were used to test (1) the cross-sectional associations between child, parent, and dyadic behavioral factors and child's expressive and receptive language, and language reasoning ability in 3-6-year-olds, at the baseline, and (2) the longitudinal associations between child, parent, and dyadic behavioral factors measured in 3-6-year-olds at the baseline, and the child's expressive and receptive language ability measured in 6-7-year-olds at follow-up, after controlling for corresponding language ability composites measured at baseline. The child's age, maternal education level, and maternal age at childbirth were controlled for in all models.

Results

Correlations between main research variables and covariates showed that child's age was positively and significantly associated with language composite scores at baseline and follow-up. Maternal education level and age at childbirth were significantly and positively associated with parent and dyad behaviors in both tasks. Child, parent, and dyad behaviors in the two different tasks were strongly intercorrelated. (Table 2)

Parent-child interaction and language ability at baseline

In the drawing task, the child's positive engagement was positively associated with better receptive language and complex language reasoning at baseline. The parent's supportive guidance was also positively associated with better receptive language ability. Fluent and attuned dyadic behavior was positively associated with receptive language and complex language reasoning ability. In the puzzle-completion task, fluent and attuned dyadic behavior was positively associated with receptive language and complex language reasoning ability. In the free play task, mutually responsive orientation was positively associated with receptive language ability. (Table 3).

Parent-child interaction at baseline and language ability at pre-school follow-up

The child's positive engagement in the puzzle task at baseline was positively associated with better expressive language ability at pre-school follow-up. Fluent and attuned dyadic behavior in the puzzle task was positively associated with better receptive language ability at pre-school follow-up. Notably significant associations were not found between behavioral variables measured during the drawing task and language ability in pre-school aged children with DLD. (Table 4).

Discussion

This study examined (1) how the quality of parent-child interaction, i.e., the child's positive engagement, the parent's supportive guidance, and fluent and attuned dyadic behavior, is associated with expressive and receptive language, and complex language reasoning ability for 3–6-year-old children with DLD, and (2) whether the quality of parent-child interaction in 3–6-year-old children with DLD is associated with the child's expressive and receptive language ability at pre-school follow-up. In 3–6-year-old children, parent-child interaction characterized by the child's positive engagement, supportive parental guidance, and attuned dyadic behavior were cross-sectionally associated with better receptive language ability. The

child's positive engagement, as well as fluent and attuned dyadic behavior, were also associated with better complex language reasoning ability. The child's positive engagement during play sessions with their parent in 3–6-year-old children, was longitudinally associated with better expressive language ability at pre-school age. Moreover, fluent, and attuned dyadic behavior during parent-child play sessions in 3–6-year-old children, was longitudinally associated with better receptive language ability at pre-school age.

The findings of the current study suggest that parent-child interaction is associated with language ability in children who have DLD, as several significant associations were identified at the cross-sectional phase of the study. Moreover, they suggest that the quality of parent-child interaction is longitudinally associated with language outcomes in pre-school-aged children. These findings are in accordance with the wealth of research highlighting the importance of smooth-flowing, connected, and engaged parent-child interaction to language development (McGillion et al., 2013; Romeo et al., 2018; Rowe & Snow, 2020; Tamis-Lemonda et al., 1998, 2001). Earlier research has illustrated the importance of parent responsiveness, and connectedness between parent and infant, to early features of linguistic ability, such as first words, and vocabulary growth in typically-developing children (Donnellan et al., 2020; Hirsh-Pasek et al., 2015). The findings of the current study extend those results, showing that the quality of the parent-child relationship is important to language development beyond infancy and toddlerhood (Rocissano & Yatchmink, 1983; Rowe & Snow, 2020) for children with DLD. These findings support earlier research highlighting the role of engaged, connected episodes of interaction, as opposed to a focus on parent or child behaviors separately (Ford et al., 2020; Rowe & Snow, 2020). Furthermore, they highlight the potential importance that the emotional quality of parent-child interaction might have for language development. These findings echo earlier findings and suggest that over and above individual parent behaviors like sensitivity and responsiveness, which are often the focus of research, it may be the general patterns of

interaction and the emotional atmosphere that forms between parent and child that could be salient for language development (Lindsey et al., 2009; Nicely et al., 1999).

The reason for the significance of dyadic synchrony may be that it supports the kind of atmosphere that is conducive to long bouts of engaged interaction between parent and child, which in turn are beneficial for language development (Romeo et al., 2018). A high level of dyadic synchrony also means fewer breakdowns and faster repair of breakdowns when they do occur. This could simply free up cognitive resources to language development, which in the context of a more precarious and less predictable parent-child relationship might be dedicated to attempts at re-establishing connection, acceptance, and affection after a breakdown. The findings of the current study could suggest that an emotional atmosphere characterized by shared positive affect, connectedness, mutual attunement, and fluent, harmonic interaction where parent and child boundaries are maintained, facilitates a higher level of shared attention and prolonged episodes of shared attention, which in turn might facilitate orientation toward salient objects in the environment (Lindsey et al., 2009; Rocissano & Yatchmink, 1983; Romeo et al., 2018; Tomasello & Farrar, 1986) allowing for more efficient accumulation of receptive language ability.

Notably, the only significant association for expressive language ability was that between the child's positive engagement and expressive language in 6-7-year-old children. As there is less research on the association between parent-child interaction and receptive language ability, as measures for expressive language development are included more often than receptive measures (Blackwell et al., 2015), there is little to compare this result to in the literature on parent-child interaction and language development. The association between positive child engagement and better expressive language ability in 6-7-year-olds is, however, in line with findings from research on language development and temperament, which show that more outgoing children have better expressive language ability (Paul &

Kellogg, 1997; Pérez-Pereira et al., 2016; Prior et al., 2008). This association between higher surgency and expressive language ability has been found in TD children and children with language impairment. This study adds to the existing knowledge base providing support for the notion, that children who are more engaged in interaction actively and in a positive manner, may develop better expressive language ability.

Limitations

The lack of a typically-developing control group is a limitation of the current study and prevents conclusions from being drawn concerning the role of parent-child interaction in language development overall. The lack of balancing in the order of interactional tasks provides uniformity in the administration of these tasks but could also bias results. It should also be noted that the sample size of the current study was, though sufficient, on the modest side for the use of factor analysis as a statistical technique. Moreover, though the Erickson scales are widely used to assess parenting sensitivity (Mesman & Emmen, 2013), there is no comprehensive resource widely available addressing the psychometric properties of this instrument, and therefore results and generalizations are preliminary.

Conclusions

The results of this study add to the current literature on language development in children with DLD by illustrating that the emotional quality of the parent-child interaction is significantly associated to language development for preschool-aged children with DLD. These findings point towards important protective factors for language development for children with DLD. Particularly, a parent-child relationship characterized by connectedness, belonging, and shared positive affect, despite significant language impairment can serve to encourage receptive language development. Moreover, parent behavior alone was not longitudinally associated with a child's language development, but rather the quality of the

interactive relationship, to which their child's temperament and cognitive abilities also have bearing.

The findings of this study provide potential directions for treatment. In addition to speech and language therapy and interventions focused on parent behaviors like responsiveness, treatment could also consider the level of connectedness between parent and child during interaction. Treatment for children with DLD could perhaps include the option of interventions to foster more attuned, cohesive and positive interactions between parents and children.

Acknowledgments

The project was funded by the Hospital District of Helsinki and Uusimaa, Academy of Finland (grant number 288435) and Social Insurance Institution of Finland (KELA, grant number 407).

References

Aksan, N., Kochanska, G., & Ortmann, M. R. (2006). Mutually responsive orientation between parents and their young children: Toward methodological advances in the science of relationships. *Developmental Psychology*, *42*(5). https://doi.org/10.1037/0012-1649.42.5.833

Barnett, M. A., Gustafsson, H., Deng, M., Mills-Koonce, W. R., & Cox, M. (2012). Bidirectional associations among sensitive parenting, language development, and social competence. *Infant and Child Development*, *21*(4), 374–393. https://doi.org/10.1002/icd.1750

Bishop, D. V. M. (2006). What Causes Specific Language Impairment in Children? *Current Directions in Psychological Science*, *15*(5). https://doi.org/10.1111/j.1467-8721.2006.00439.x

Bishop, D. V. M. (2017). Why is it so hard to reach agreement on terminology? The case of developmental language disorder (DLD). *International Journal of Language & Communication Disorders*, *52*(6). https://doi.org/10.1111/1460-6984.12335

Bishop, D. V. M., Chan, J., Adams, C., Hartley, J., & Weir, F. (2000). Conversational responsiveness in specific language impairment: Evidence of disproportionate pragmatic difficulties in a subset of children. In *Development and Psychopathology* (Vol. 12).

Blackwell, A. K. M., Harding, S., Babayiɨit, S., & Roulstone, S. (2015). Characteristics of parent-child interactions: A systematic review of studies comparing children with primary language impairment and their typically developing peers. In *Communication Disorders Quarterly* (Vol. 36, Issue 2, pp. 67–78). SAGE Publications Inc. https://doi.org/10.1177/1525740114540202

Blinkoff, E., Levine, D., Avelar, D., Golinkoff, R. M., & Hirsh-Pasek, K. (2016). Language development: Overview. In *The Curated Reference Collection in Neuroscience and Biobehavioral Psychology*. Elsevier Science Ltd. https://doi.org/10.1016/B978-0-12-809324-5.23578-5

Boyle, J., Mccartney, E., O'Hare, A., & Law, J. (2010). Intervention for mixed receptive-expressive language impairment: a review. *Developmental Medicine & Child Neurology*, *52*(11). https://doi.org/10.1111/j.1469-8749.2010.03750.x

Brooks, R., & Meltzoff, A. N. (2008). Infant gaze following and pointing predict accelerated vocabulary growth through two years of age: A longitudinal, growth curve modeling study. *Journal of Child Language*, *35*(1), 207–220. https://doi.org/10.1017/S030500090700829X

Bryant, F. B., & Yarnold, P. R. (1995). Principal-components analysis and exploratory and confirmatory factor analysis. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and understanding multivariate statistics* (pp. 99–136). American Psychological Association.

Conti-Ramsden, G., & Friel-Patti, S. (1984). MOTHER-CHILD DIALOGUES: A COMPARISON OF NORMAL AND LANGUAGE IMPAIRED CHILDREN. *Journal of Communication Disorders*, *17*(1), 19–35.

Conti-Ramsden, G., Hutcheson, G. D., & Grove, J. (1995). Contingency and breakdown: Children with SLI and their conversations with mothers and fathers. *Journal of Speech and Hearing Research*, *38*(6), 1290–1302. https://doi.org/10.1044/jshr.3806.1290

Dale, P. S., Tosto, M. G., Hayiou-Thomas, M. E., & Plomin, R. (2015). Why does parental language input style predict child language development? A twin study of

514 gene-environment correlation. *Journal of Communication Disorders*, *57*, 106–117.
515 https://doi.org/10.1016/j.jcomdis.2015.07.004
516 Dempster, A. P., Laird, N. M., & Rubin, D. B. (1977). Maximum likelihood from
517 incomplete data via the EM algorithm. *Journal of the Royal Statistical Society:*
518 *Series B (Methodological)*, *39*(1), 1–22.
519 Donnellan, E., Bannard, C., McGillion, M. L., Slocombe, K. E., & Matthews, D. (2020).
520 Infants' intentionally communicative vocalizations elicit responses from caregivers
521 and are the best predictors of the transition to language: A longitudinal
522 investigation of infants' vocalizations, gestures and word production.
523 *Developmental Science*, *23*(1). https://doi.org/10.1111/desc.12843
524 Edwards, S., Fletcher, P., Garman, M., Hughes, A., Letts, C., & Sinka, I. (1997). *Reynell*
525 *Developmental Language Scales III*. NFER Nelson.
526 Egeland, B., Erickson, M. F., Clemenhagen-Moon, J., Hiester, M. K., & Korfmacher, J.
527 (1990). 24 month tools coding manual: Project STEEP— Revised 1990 from
528 mother–child project scales. In *npublished manu- script, Department of*
529 *Psychology, University of Minnesota, Twin Cities Campus, Minneapolis.*
530 Erickson, M. F., Sroufe, L. A., & Egeland, B. (1985). The relationship between quality
531 of attach- ment and behavior problems in preschool in a high-risk sample. *Growing*
532 *Points of Attachment: Theory and Research. Monographs of the Society for*
533 *Research in Child Development*, *50*, 147–166.
534 Farrant, B. M., & Zubrick, S. R. (2012). Early vocabulary development: The importance
535 of joint attention and parent-child book reading. *First Language*, *32*(3), 343–364.
536 https://doi.org/10.1177/0142723711422626
537 Ford, A. L. B., Elmquist, M., Merbler, A. M., Kriese, A., Will, K. K., & McConnell, S.
538 R. (2020). Toward an ecobehavioral model of early language development. *Early*

Childhood Research Quarterly, *50*, 246–258. https://doi.org/10.1016/j.ecresq.2018.11.004

Frederiksen, L. E., Ernst, A., Brix, N., Braskhøj Lauridsen, L. L., Roos, L., Ramlau-Hansen, C. H., & Ekelund, C. K. (2018). Risk of Adverse Pregnancy Outcomes at Advanced Maternal Age. *Obstetrics & Gynecology*, *131*(3). https://doi.org/10.1097/AOG.0000000000002504

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis fourth edition. .* Prentice Hall.

Hammer, C. S., Tomblin, J. B., Zhang, X., & Weiss, A. L. (2001). Relationship between parenting behaviours and speci c language impairment in children. *Int. j. Lang. Comm. Dis*, *36*(2), 185–205. https://doi.org/10.1080/1368282001001991

Harrist, A. W., & Waugh, R. M. (2002). Dyadic synchrony: Its structure and function in childrenÕs development q. *Developmental Review*, *22*, 555–592. www.academicpress.com

Hayiou-Thomas, M. E. (2008). Genetic and environmental influences on early speech, language and literacy development. *Journal of Communication Disorders*, *41*(5), 397–408. https://doi.org/10.1016/j.jcomdis.2008.03.002

Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., Pace, A., Yust, P. K. S., & Suma, K. (2015). The Contribution of Early Communication Quality to Low-Income Children's Language Success. *Psychological Science*, *26*(7), 1071–1083. https://doi.org/10.1177/0956797615581493

Hoffer Corbett, P., & Bliss, L. S. (1990). Maternal Verbal Responsiveness With Language-Impaired, Stage-Matched, and Age-Matched Normal Children. *JOURNAL OF APPLIED DNELOPMENTAL PSYCHOLOGY*, *11*, 305–319.

563 Jalovaara, M., & Andersson, G. (2018). Disparities in Children's Family Experiences by
564 Mother's Socioeconomic Status: The Case of Finland. *Population Research and*
565 *Policy Review*, *37*(5), 751–768. https://doi.org/10.1007/s11113-018-9485-1
566 Kaplan, E., Goodglass, H., Weintraub, S., & Segal, O. (1983). *Boston Naming Test.* Lea
567 & Febiger.
568 Kloth, S., Janssen, P., Kraaimaat, F., & Brutten, G. J. (1998). *Communicative styles of*
569 *mothers interacting with their preschoolage children: a factor analytic study* (Vol.
570 25). http://journals.cambridge.org/JCL
571 Korkman, M., Kirk, U., & Kemp, S. L. (2008). *NEPSY-II: Lasten Neuropsykologinen*
572 *Tutkimus.* Psykologien Kustannus.
573 Laasonen, M., Smolander, S., Lahti-Nuuttila, P., Leminen, M., Lajunen, H. R.,
574 Heinonen, K., Pesonen, A. K., Bailey, T. M., Pothos, E. M., Kujala, T., Leppänen,
575 P. H. T., Bartlett, C. W., Geneid, A., Lauronen, L., Service, E., Kunnari, S., &
576 Arkkila, E. (2018). Understanding developmental language disorder -The Helsinki
577 longitudinal SLI study (HelSLI): A study protocol. *BMC Psychology*, *6*(1).
578 https://doi.org/10.1186/s40359-018-0222-7
579 Lahti-Nuuttila, P., Service, E., Smolander, S., Kunnari, S., Arkkila, E., & Laasonen, M.
580 (2021). Short-Term Memory for Serial Order Moderates Aspects of Language
581 Acquisition in Children With Developmental Language Disorder: Findings From
582 the HelSLI Study. *Frontiers in Psychology*, *12*.
583 https://doi.org/10.3389/fpsyg.2021.608069
584 Lindsey, E. W., Cremeens, P. R., Colwell, M. J., & Caldera, Y. M. (2009). The structure
585 of parent-child dyadic synchrony in toddlerhood and children's communication
586 competence and self-control. *Social Development*, *18*(2), 375–396.
587 https://doi.org/10.1111/j.1467-9507.2008.00489.x

588 Little, R. J. A. (1988). A Test of Missing Completely at Random for Multivariate Data
589 with Missing Values. *Journal of the American Statistical Association*, *83*(404).
590 https://doi.org/10.1080/01621459.1988.10478722
591 Loi, E. C., Vaca, K. E. C., Ashland, M. D., Marchman, V. A., Fernald, A., & Feldman,
592 H. M. (2017). Quality of caregiver-child play interactions with toddlers born
593 preterm and full term: Antecedents and language outcome. *Early Human*
594 *Development*, *115*, 110–117. https://doi.org/10.1016/j.earlhumdev.2017.10.001
595 Majorano, M., & Lavelli, M. (2014). Maternal input to children with specific language
596 impairment during shared book reading: Is mothers' language in tune with their
597 children's production? *International Journal of Language and Communication*
598 *Disorders*, *49*(2), 204–214. https://doi.org/10.1111/1460-6984.12062
599 Martin, N. A., & Brownell, R. (2010). *Receptive One-Word Picture Vocabulary Test-4*
600 *(ROWPVT-4)*. Academic Therapy Publications.
601 Martin, N. A., & Brownell, R. (2011). *Expressive One-Word Picture Vocabulary Test-4*
602 *(EOWPVT-4)*. Academic Therapy Publications.
603 McGillion, M. L., Herbert, J. S., Pine, J. M., Keren-Portnoy, T., Vihman, M. M., &
604 Matthews, D. E. (2013). Supporting early vocabulary development: What sort of
605 responsiveness matters. *IEEE Transactions on Autonomous Mental Development*,
606 *5*(3), 240–248. https://doi.org/10.1109/TAMD.2013.2275949
607 Mesman, J., & Emmen, R. A. G. (2013). Mary Ainsworth's legacy: A systematic review
608 of observational instruments measuring parental sensitivity. *Attachment and*
609 *Human Development*, *15*(5–6), 485–506.
610 https://doi.org/10.1080/14616734.2013.820900
611 Nicely, P., Tamis-Lemonda, C. S., & Bornstein, M. H. (1999). MOTHERS' ATTUNED
612 RESPONSES TO INFANT AFFECT EXPRESSIVITY PROMOTE EARLIER

ACHIEVEMENT OF LANGUAGE MILESTONES. *INFANT BEHAVIOR & DEVELOPMENT*, *22*(4), 557–568.

Osborne, J. W. (2014). *Best practices in exploratory factor analysis*. Scotts Valley, CA: CreateSpace Independent Publishing Platform.

Paul, R., & Elwood, T. J. (1991). Maternal linguistic input to toddlers with slow expressive language development. *Journal of Speech and Hearing Research*, *34*(5), 982–988. https://doi.org/10.1044/jshr.3405.982

Paul, R., & Kellogg, L. (1997). Temperament in Late Talkers. In *J. Chitd Psychol. Psychiat* (Vol. 38, Issue 7). Cambridge University Press.

Paul, R., & Shiffer, M. E. (1991). Communicative initiations in normal and late-talking toddlers. In *Applied Psycholinguistics* (Vol. 12).

Pérez-Pereira, M., Fernández, P., Resches, M., & Gómez-Taibo, M. L. (2016). Does temperament influence language development? Evidence from preterm and full-term children. *Infant Behavior and Development*, *42*, 11–21. https://doi.org/10.1016/j.infbeh.2015.10.003

Prior, M., Bavin, E. L., Cini, E., Reilly, S., Bretherton, L., Wake, M., & Eadie, P. (2008). Influences on communicative development at 24 months of age: Child temperament, behaviour problems, and maternal factors. *Infant Behavior and Development*, *31*(2), 270–279. https://doi.org/10.1016/j.infbeh.2007.11.001

Pungello, E. P., Iruka, I. U., Dotterer, A. M., Mills-Koonce, R., & Reznick, J. S. (2009). The Effects of Socioeconomic Status, Race, and Parenting on Language Development in Early Childhood. *Developmental Psychology*, *45*(2), 544–557. https://doi.org/10.1037/a0013917

Rescorla, L., Bascome, A., Lampard, J., & Feeny, N. (2001). Conversational patterns in late talkers at age 3. *Applied Psycholinguistics, 22*(2), 235–251. https://doi.org/10.1017/S0142716401002053

Rescorla, L., & Fechnay, T. (1996). Mother-child synchrony and communicative reciprocity in late-talking toddlers. *Journal of Speech, Language, and Hearing Research, 39*(1), 200–208. https://doi.org/10.1044/jshr.3901.200

Rocissano, L., & Yatchmink, Y. (1983). Language Skill and Interactive Patterns in Prematurely Born Toddlers. *Child Development*, *54*(5), 1229–1241.

Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Allyson, P. M., Rowe, M. L., & Gabrieli, J. D. E. (2018). Beyond the 30-Million-Word Gap: Children's Conversational Exposure Is Associated With Language-Related Brain Function. *Psychological Science*, *29*(5), 700–710. https://doi.org/10.7910/DVN/DIDBMQ

Rowe, M. L., & Snow, C. E. (2020). Analyzing input quality along three dimensions: Interactive, linguistic, and conceptual. *Journal of Child Language*, *47*(1), 5–21. https://doi.org/10.1017/S0305000919000655

Rowe, M. L., & Weisleder, A. (2020). *Language Development in Context*. https://doi.org/10.1146/annurev-devpsych-042220

Schodorf, J. K., & Edwards, H. T. (1983). COMPARATIVE ANALYSIS OF PARENT-CHILD INTERACTIONS WITH LANGUAGE-DISORDERED AND LINGUISTICALLY NORMAL CHILDREN*. In *JOURNAL OF COMh4UNICATION DISORDERS* (Vol. 16).

Skibbe, L. E., Moody, A. J., Justice, L. M., & McGinty, A. S. (2010). Socio-emotional climate of storybook reading interactions for mothers and preschoolers with language impairment. *Reading and Writing*, *23*(1), 53–71. https://doi.org/10.1007/s11145-008-9149-3

671 Spinath, F. M., Price, T. S., Dale, P. S., & Plomin, R. (2004). The Genetic and
672 Environmental Origins of Language Disability and Ability. *Child Development*,
673 *75*(2), 445–454.
674 Stams, G. J. J. M., Juffer, F., van Ijzendoorn, M. H., & Hoksbergen, R. C. (2001).
675 Attachment-based intervention in adoptive families in infancy and children's
676 development at age 7: Two follow-up studies. *British Journal of Developmental*
677 *Psychology*, *19*(2), 159–180. https://doi.org/10.1348/026151001166010
678 Stanton-Chapman, T. L., Chapman, D. A., Bainbridge, N. L., & Scott, K. G. (2002).
679 Identification of early risk factors for language impairment. *Research in*
680 *Developmental Disabilities*, *23*, 390–405.
681 Statistics Finland (2013). *Etnisyystiedon merkitys kasvaa maahanmuuton lisääntyessä*.
682 Statistics Finland. https://www.stat.fi/artikkelit/2013/art_2013-09-
683 23_003.html?s=0#5
684 Sutcliffe, A. G., Barnes, J., Belsky, J., Gardiner, J., & Melhuish, E. (2012). The health
685 and development of children born to older mothers in the United Kingdom:
686 observational study using longitudinal cohort data. *BMJ*, *345*(aug21 1).
687 https://doi.org/10.1136/bmj.e5116
688 Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics.*
689 Boston, MA: Pearson.
690 Tamis-Lemonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal
691 Responsiveness and Children's Achievement of Language Milestones. *Child*
692 *Development*, *72*(3), 748–767.
693 Tamis-Lemonda, C. S., Bornstein, M. H., Kahana-Kalman, R., Baumwell, L., &
694 Cyphers, L. (1998). Predicting variation in the timing of language milestones in the

second year : an events history approach*. *Journal of Child Language*, *25*, 675–700.

Todd, J. (1983). Joint attention and lexical acquisition style. *First Language*, *4*(12), 197–211. https://doi.org/10.1177/014272378300401202

Tomasello, M., & Farrar, M. J. (1986). Joint Attention and Early Language. In *Source: Child Development* (Vol. 57, Issue 6).

van Balkom, H., Verhoeven, L., & van Weerdenburg, M. (2010). Conversational behaviour of children with Developmental Language Delay and their caretakers. *International Journal of Language and Communication Disorders*, *45*(3), 295–319. https://doi.org/10.3109/13682820902994226

Wechsler, D. (2009). *WPPSI-III - Wechsler Preschool and Primary Scale of Intelligence - Third edition.* Psykologien Kustannus.

WHO. (2010). *ICD-10: International statistical classification of diseases and related health problems: 10th revision. [Finnish version: Terveyden ja hyvinvoinnin laitos (THL), (2011) Tautiluokitus ICD-10.]* (3rd ed.). Terveyden ja hyvinvoinnin laitos. .

Zambrana, I. M., Ystrom, E., & Pons, F. (2012). Impact of Gender, Maternal Education, and Birth Order on the Development of Language Comprehension. *Journal of Developmental & Behavioral Pediatrics*, *33*(2). https://doi.org/10.1097/DBP.0b013e31823d4f83

716 **Tables**

717 **Table 1**

718 *Descriptive statistics for unimputed gender, age, maternal education level, maternal age at*

719 *childbirth, and language variables at baseline and follow-up*

Table 1. Descriptive statistics for unimputed gender, age, maternal education level, maternal age at childbirth,and language variables at baseline and follow-up

	Baseline		Follow-up	
	n=97	% missing	n=71	% missing
Male n (%)	73 (75.3)	-	57 (80.3)	-
Female n (%)	24 (24.7)	-	14 (19.7)	-
Childs age, M in years; months (SD in months)	4;3 (10)	-	6;6 (5)	-
Maternal education level		8.2		12.7
Primary or secondary level n (%)	55 (56.7)		36 (50.7)	
Bachelor's degree or above n (%)	42 (43.3)		35 (49.3)	
Maternal age at childbirth, years M(SD)	30.1 (5.6)	13.4	30.7 (5.5)	7
Expressive language variables M(SD)				
Boston Naming Test M(SD)	10.3 (8.7)	5.2	27.2 (7.2)	4.2
Reynell Expressive M(SD)	13.8 (12.8)	14.4	31.4 (10.3)	23.9
EOWPVT M(SD)	30.7 (23.7)	0	71.1 (13.9)	1.4
WPPSI-III Picture Naming M(SD)	9.9 (7.0)	0	-	-
Receptive language variables M(SD)				
WPPSI-III Receptive Vocabulary M(SD)	22.7 (5.6)	0	-	-
Reynell Comprehension M(SD)	42.8 (9.5)	1	53.8 (4.9)	21.2
ROWPVT M(SD)	53.4 (18.5)	0	97.9 (34.5)	2.8
Complex language reasoning variables[a]				
WPPSI-III Information M(SD)	13.6 (6.0)	0	-	-
Nepsy-II Comprehension of Instructions M(SD)	11.5 (4.1)	1	-	-
WPPSI-III Word Reasoning M(SD)	6.1 (6.3)	0	-	-
WPPSI-III Vocabulary M(SD)	8.1 (5.9)	0	-	-

Note: a n for complex language variables was 54.M = mean, SD = standard deviation, EOWPVT = Expressive One-Word Picture Vocabulary Tests, ROWPVT = Receptive (ROWPVT) One-Word Picture Vocabulary Tests, WPPSI-III = Wechsler Preschool and Primary Scale of Intelligence - Third Edition.

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723 **Table 2**

724 *Correlations (Pearson's r, two-tailed) between child's age, maternal education, maternal*

725 *age, child, parent and dyad behaviors and language composites*

Table 2. Correlations (Pearson's r, two-tailed) between child's age, maternal education, maternal age, child, parent and dyad behav
language composites

	1	2	3	4	5	6	7	8	9	10	11	12
1 Child's age (mo)	--											
2 Maternal education level	-.09	--										
3 Maternal age at childbirth	-.14	.33**	--									
4 Child behavior (drawing task)	.07	.19	.16	--								
5 Parent behavior (drawing task)	-.03	.34**	.35**	.62**	--							
6 Dyad behavior (drawing task)	-.07	.28**	.32**	.70**	.79**	--						
7 Child behavior (puzzle task)	.07	.05	.26*	.38**	.26**	.35**	--					
8 Parent behavior (puzzle task)	-.20	.33**	.24*	.44**	.71**	.63**	.43**	--				
9 Dyad behavior (puzzle task)	-.13	.16	.26*	.49**	.65**	.73**	.46**	.76**	--			
10 Expressive language composite baseline	.65**	.00	-.07	.13	-.07	-.01	.14	-.18	-.09	--		
11 Receptive language composite baseline	.64**	-.10	-.05	.23*	.13	.18	.16	-.06	.09	.51**	--	
12 Complex language reasoning composite baseline	.66**	.08	.00	.36**	.15	.24*	.19	-.01	.12	.75**	.78**	--
13 Expressive language composite follow-up	.28*	.33**	.18	.27*	.13	.23	.27*	.11	.15	.22	.21	.32**
14 Receptive language composite follow-up	.31**	.06	-.15	.15	.07	.19	-.04	.12	.20	-.14	.22	.23

Note: Degrees of freedom = 95, except for expressive and receptive language composites at follow-up where degrees of freedom =
*the p statistic *p ≤ .05, ** p ≤ 01*

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729 **Table 3**

730 *Results from hierarchical regression analyses testing the relationship between parent-child*

731 *interaction during drawing and puzzle-completion and language ability at baseline*

Table 3. Results from hierarchical regression analyses testing the relationship between parent-child interaction during drawing an

	Drawing task					Puzzle-completion task			
	B	**SE B**	**β**	**t**	**p**	**B**	**SE B**	**β**	**t**
Expressive language ability									
Child's age (months)	.057	.007	.650**	8.148	<.001	.056	.007	.647**	8.137
Maternal education level	.097	.159	.052	.612	.542	.125	.156	.066	.798
Maternal age at childbirth	-.001	.014	-.009	-.102	.919	-.005	.015	-.027	-.312
Child behaviors	.054	.061	.071	.874	.385	.086	.074	.095	1.164
R^2	.433					.437			
F for change in R^2	.763					1.355			
Child's age (months)	.057	.007	.660**	8.332	<.001	.056	.007	.644**	8.019
Maternal education level	.159	.162	.085	.985	.327	.162	.162	.086	.999
Maternal age at childbirth	.004	.015	.024	.278	.782	.002	.014	.011	.136
Parent behaviors	-.073	.071	-.088	-1.018	.311	-.085	.083	-.087	-1.029
R^2	.435					.435			
F for change in R^2	1.036					1.059			
Child's age (months)	.057	.007	.658**	8.259	<.001	.057	.007	.656**	8.205
Maternal education level	.111	.160	.059	.694	.489	.120	.158	.064	.759
Maternal age at childbirth	-.001	.015	-.005	-.057	.955	.000	.015	.002	.029
Dyad behaviors[a]	.019	.086	.019	.225	.822	-.014	.100	-.011	-.140
R^2	.429					.429			
F for change in R^2	.051					.019			
Receptive language ability									
Child's age (months)	.050	.006	.620**	7.884	<.001	.050	.006	.629**	7.811
Maternal education level	-.166	.144	-.096	-1.153	.252	-.104	.146	-.060	-.715
Maternal age at childbirth	.005	.013	.034	.414	.680	.004	.014	.028	.318
Child behaviors	.140	.056	.200*	2.511	.014	.090	.069	.108	1.314
R^2	.450					.423			
F for change in R^2	6.307*					1.726			
Child's age (months)	.051	.006	.635**	8.025	<.001	.052	.007	.655**	8.045
Maternal education level	-.187	.149	-.108	-1.258	.211	-.154	.151	-.089	-1.016
Maternal age at childbirth	.002	.013	.011	.122	.903	.007	.013	.047	.546
Parent behaviors	.133	.065	.176*	2.037	.045	.082	.077	.092	1.068
R^2	.438					.419			
F for change in R^2	4.149*					1.141			
ge (months)	.052	.006	.645**	8.421	<.001	.053	.006	.657**	8.301

Maternal education level	-.197	.142	-.114	-1.389	.168	-.137	.144	-.079	-.950
Maternal age at childbirth	-.001	.013	-.009	-.103	.918	.003	.013	.020	.240
Dyad behaviors[a]	.244	.076	.262*	3.214	.002	.198	.091	.178*	2.185
R^2	.472					.441			
F for change in R^2	10.332*					4.772*			
Complex language reasoning ability									
Child's age (months)	.056	.010	.563**	5.339	<.001	.061	.011	.609**	5.644
Maternal education level	.196	.201	.108	.977	.333	.285	.207	.158	1.381
Maternal age at childbirth	.005	.020	.028	.254	.801	-.005	.022	-.025	-.212
Child behaviors	.210	.074	.300*	2.839	.007	.186	.094	.221	1.988
R^2	.477					.436			
F for change in R^2	8.061					3.952			
Child's age (months)	.062	.011	.622**	5.612	<.001	.064	.011	.641**	5.578
Maternal education level	.210	.218	.116	.963	.340	.226	.218	.125	1.034
Maternal age at childbirth	.002	.022	.012	.099	.921	.007	.022	.035	.301
Parent behaviors	.103	.089	.135	1.156	.253	.099	.109	.107	.912
R^2	.407					.401			
F for change in R^2	1.336					.831			
Child's age (months)	.063	.010	.630**	6.069	<.001	.065	.011	.656**	6.034
Maternal education level	.184	.201	.102	.919	.363	.279	.205	.154	1.361
Maternal age at childbirth	-.003	.021	-.016	-.147	.884	-.003	.021	-.018	-.156
Dyad behaviors[a]	.277	.096	.309*	2.894	.006	.248	.113	.242*	2.189
R^2	.479					.445			
F for change in R^2	8.376					4.792			

Note: *p ≤ .05, ** p ≤.001. [a] Of the dyadic variables, only mutually responsive orientation (Aksan, Kochanska & Ortman, 2006)

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736 **Table 4**

737 *Results from hierarchical regression analyses testing the relationship between parent-child*

738 *interaction during drawing and puzzle-completion at baseline, and language ability at*

739 *preschool follow-up*

Table 4. Results from hierarchical regression analyses testing the relationship between parent-child interaction during drawing an language ability at preschool follow-up

	Drawing task					Puzzle-completion task				
	B	**SE B**	**β**	**t**	**p**	**B**	**SE B**	**β**	**t**	**p**
Expressive language ability										
Child's age (months)	.036	.017	.243*	2.140	.036	.041	.017	.274*	2.469	.01
Maternal education level	.332	.202	.199	1.646	.105	.384	.195	.230	1.967	.05
Maternal age at childbirth	.008	.018	.051	.442	.660	-.001	.018	-.006	-.054	.95
Expressive language ability at baseline	.183	.109	.190	1.679	.098	.178	.106	.185	1.673	.09
Child behaviors	.109	.079	.158	1.381	.172	.210	.096	.247*	2.180	.03
R^2	.228					.260				
F for change in R^2	1.908					4.754*				
Child's age (months)	.039	.017	.260*	2.260	.027	.039	.017	.258*	2.244	.02
Maternal education level	.419	.219	.251	1.913	.060	.353	.213	.211	1.660	.10
Maternal age at childbirth	.013	.019	.085	.697	.488	.009	.018	.061	.518	.60
Expressive language ability at baseline	.204	.109	.212	1.869	.066	.215	.111	.224	1.932	.05
Parent behaviors	-.053	.104	-.067	-.512	.610	.039	.113	.042	.347	.73
R^2	.209					.207				
F for change in R^2	.262					.120				
Child's age (months)	.037	.017	.249*	2.177	.033	.038	.017	.256*	2.241	.02
Maternal education level	.332	.212	.198	1.566	.122	.357	.203	.214	1.756	.08
Maternal age at childbirth	.007	.019	.045	.368	.714	.007	.019	.046	.379	.70
Expressive language ability at baseline	.208	.109	.216	1.907	.061	.214	.109	.222	1.959	.05
Dyad behaviors[a]	.084	.123	.086	.681	.498	.102	.141	.084	.724	.47
R^2	.211					.212				
F for change in R^2	.464					.524				
Receptive language ability										
Child's age (months)	.042	.018	.276*	2.335	.023	.042	.018	.280*	2.331	.02
Maternal education level	.049	.212	.029	.232	.817	.088	.210	.052	.418	.67
Maternal age at childbirth	-.029	.019	-.184	-1.508	.136	-.027	.020	-.175	-1.370	.17
Receptive language ability at baseline	.132	.123	.128	1.070	.288	.159	.122	.154	1.304	.19
Child behaviors	.083	.085	0.119*	.979	.331	.019	.104	.022	.180	.85
R^2	.159					.147				

F for change in R^2	.959					.032				
Child's age (months)	.041	.018	.274*	2.296	.025	.043	.018	.282*	2.398	.01
Maternal education level	.046	.227	.027	.204	.839	.009	.215	.005	.041	.96
Maternal age at childbirth	-.029	.020	-.185	-1.459	.149	-.029	.019	-.190	-1.565	.12
Receptive language ability at baseline	.152	.122	.148	1.250	.216	.167	.119	.161	1.399	.16
Parent behaviors	.052	.110	.065	.470	.640	.149	.114	.159	1.308	.19
R^2	.150					.169				
F for change in R^2	.221					1.711				
Child's age (months)	.041	.018	.270*	2.319	.024	.043	.017	.284*	2.452	.01
Maternal education level	-.031	.216	-.018	-.142	.888	.039	.205	.023	.188	.85
Maternal age at childbirth	-.036	.019	-.233	-1.865	.067	-.036	.019	-.232	-1.895	.06
Receptive language ability at baseline	.118	.121	.114	.978	.332	.125	.118	.121	1.059	.29
Dyad behaviors[a]	.224	.129	.227	1.735	.087	.292	.146	0.238*	2.004	.04
R^2	.185					.197				
F for change in R^2	3.010					4.015*				

Note: *p ≤ .05, ** p ≤.001. [a] Of the dyadic variables, only mutually responsive orientation (Aksan, Kochanska & Ortman, 2006) task.

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742 **Supplemental Material**

743 **Supplemental table 1**

744 *Descriptions of Erickson's sensitivity scales (Egeland et al., 1990; Erickson et al., 1985)*

745 *and mutually responsive orientation (Aksan, Kochanska, & Ortmann, 2006).*

Supplemental Table 1. Descriptions of Erickson's sensitivity scales (Egeland et al., 1990; Erickson et al., 1985).

Child	
Persistence	This scale describes the child's task-orientedness; at the low end the child does not make an effort to do the task, refuses to participate, runs away or spends time on activities other than the task itself, participates only when their parent forces their attention to the task at hand or when answering their parents' questions about the task.
Enthusiasm	This scale describes the extent to which the child approaches the task with energy, confidence and willingness. At the high end the child approaches the task with energy and also with a degree of persistence.
Compliance	This scale describes the extent to which the child displays a willingness to listen to their parents' suggestions and abide by their requests. At the high end, the child adjusts their behavior to their parents' instructions in a detailed manner (e.g. if the parent suggests the child uses a particular block to continue their design, the child uses that particular block).
Experience of the session	The extent to which the session produces an experience of success and competence in the tasks at hand, and trust in a good relationship with the parent. At the high end the child has a very positive experience of succeeding in the tasks, as well as enjoying verypositive interactions with their parent.
Parent	
Supportiveness	This scale describes the extent to which the parent expresses positive attention and emotional support for their child. This might include acknowledgement of the child's achievements, and encouragement through the use of positive emotional attention. The child knows that they have their parents' trust and support for managing the situation.

Clarity of instruction	This scale describes the extent to which the parent is able to give their child instructions at the child's level. This is reflected in the parents' ability to structure the situation in a way the enables the child to know what the task and aims are, giving the child instructions and feedback to facilitate the child's problem-solving.
Sensitivity and timing of instruction	This scale describes the extent to which the parents clues and hints are timed so as to fit with the child's attempts and actions to do the task. At the high end of this scale, the parents instructions are consistently well-timed and appropriate to what the child is doing. The parent attunes their hints and tips to the child's behavior and their signals.
Self-confidence	This scale describes the extent to which the parent appears to trust their ability to work succesfully in cooperation with their child, and that their child will behave as they have directed.
Dyad	
Quality of the parent-child relationship	This scale is a dyadic, global scale, that focus on the affect and mutuality of the parent-child relationship. At the high end, there is a high degree of cohesion and mutual commitnemtn between parent and child, as both pay attention to and react to each other.
Diffusion of boundaries	This scale describes the extent to which parent and child maintain appropriate roles in relation to each other. When observing parent and child, it should be clear who is the parent and who is the child, so that the parent is in charge and has more power than the child.

Note: For the Erickson scales, descriptions have been included only for those scales used in the current study. These condensed descriptions of child, parent and dyadic variables in the Erickson scales (Egeland et al., 1990) are intended to provide clarity for readers regarding the kinds of behaviors assessed during scoring of the videotaped interactional sequences. Readers should refer to the original work by Egeland et al. (1990), and for more in-depth information regarding scoring.

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750 **Supplemental table 2**

751 *Descriptions of the aspects assessed when scoring mutually responsive orientation (MRO)*

752 *(Aksan, Kochanska & Ortmann, 2006).*

Supplemental Table 2. Descriptions of the aspects assessed when scoring mutually responsive orientation (MRO) (Aksan, Kochanska & Ortmann, 2006)

Mutually responsive orientation	
Coordinated routines	The extent to which the pair displays coordinated activities and settles in to routines scripted over time. Coordination is easy and comfortable.
Harmonious communication	The extent to which communication flows smoothly and effortlessly.
Mutual cooperation	The extent to which the pair is mutually attuned, as a result of which conflict is resolved effectively.
Emotional ambiance	The extent to which the atmosphere between parent and child is emotionally positive, with both showing pleasure in being together.

Note: These condensed descriptions of the aspects of parent-child interaction assessed when scoring for mutually responsive orientation (Aksan, Kochanska & Ortmann, 2006) are intended to provide clarity for readers regarding the kinds of behaviors assessed during scoring of the videotaped interactional sequences. Raters were advised to use the above as "anchor points", but give each dyad an overall rating for MRO. Readers should refer to Aksan, Kochanska & Ortmann (2006) for more in-depth information regarding scoring.

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Supplemental table 3

Factor loadings from an exploratory factor analysis of parent, child, and dyadic variables measured during the drawing task.

Supplemental Table 3. Factor loadings from an exploratory factor analysis of parent, child, and dyadic variables measured during the drawing task**.**

	Factor loadings		
	Child's positive engagement	**Parent's supportive guidance**	**Fluent and attuned dyadic behavior**
Child			
Persistence	**-.863**	.032	-.101
Enthusiasm	**-.893**	.077	-.093
Compliance	**-.411**	.107	**.440**
Experience of the session	**-.803**	-.068	.182
Parent			
Supportive presence	-.264	**.632**	.050
Clarity of instruction	-.046	**.908**	-.174
Sensitivity and timing of instruction	-.090	**.827**	-.138
Self-confidence	.060	**.631**	.310
Dyad			
Quality of the relationship	-.431	.286	**.394**
Diffusion of boundaries (reversed)	**.093**	**.642**	**.150**
Mutually responsive orientation	-.373	.383	**.391**
Rotation sums of squared loadings	4.856	5.078	2.221

Note: Extraction method: Principal axis factoring, oblimin rotation with Kaiser Normalization.

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762 **Supplemental table 4**

763 *Factor loadings from three separate one-factor factor analyses of child, parent, and dyadic*

764 *behavioral variables measured during the drawing task.*

Supplemental Table 4. Factor loadings from three separate one-factor factor analyses of child, parent, and dyadic behavioral variables measured during the drawing task.

	Factor loadings		
	Child's positive engagement	**Parent's supportive guidance**	**Fluent and attuned dyadic behavior**
Child			
Persistence	.861		
Enthusiasm	.898		
Experience of the session	.805		
Compliance	.642		
Parent			
Clarity of instruction		.859	
Sensitivity and timing of instruction		.851	
Supportiveness		.800	
Self-confidence		.680	
Dyad			
Mutually responsive orientation			.937
Quality of the parent-child relationship			.897
Diffusion of boundaries			.522

Note: Extraction method: Principal axis factoring, oblimin rotation with Kaiser Normalization.

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768 **Supplemental Figure 1**

769 *Hierarchical three-factor model of language, originally published in Lahti-Nuuttila et al.,*

770 *(2021), reproduced with the author's permission.*

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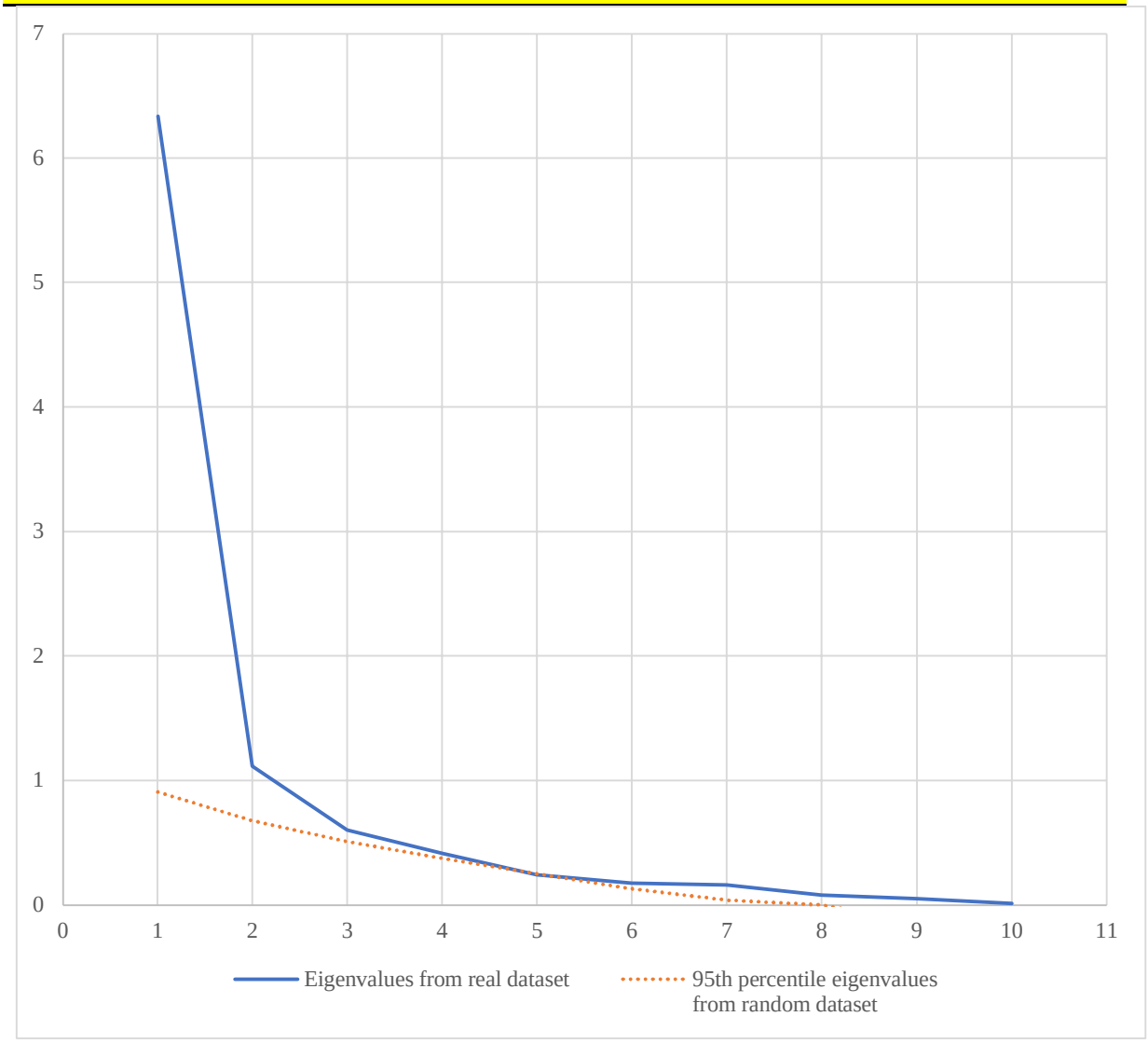
772 **Supplemental Figure 2**

773 *Parallel analysis for the exploratory factor analysis of parent, child and dyadic variables*

774 *measured during the drawing task (see Supplemental table 3 for loadings).*

Supplemental Figure 2. Parallel analysis for the exploratory factor analysis of parent, child and dyadic variables measured during the drawing task (see Supplemental table 3 for loadings).



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