Early conversational skills in the younger siblings of children with autism

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Neurotypical children have increasingly complex conversations in their first three years, beginning to respond in ways that maintain topics and add new information. These skills emerge in the context of dyadic exchanges – caregivers create opportunities for conversation, and conversations build on children's language and pragmatic abilities, which are key areas of challenge for children with autism spectrum disorder (ASD). Compared to children with no family history of autism (typical likelihood, TL), the younger siblings of children with ASD are at elevated likelihood (EL) for both ASD and non-ASD language delays. The present study used natural language sampling (i.e., transcribing and classifying parent and child speech) during parent-child toy play in the home to examine child spoken language, conversational skills, and parent contributions to conversations with three-year-old TL (n=16) and EL children with ASD (EL-ASD, n=10), non-ASD language delays (EL-LD, n=21), and typical development (EL-ND, n=37). Consistent with hypotheses, EL-ASD children produced fewer intelligible utterances and both the EL-LD and EL-ASD groups produced shorter utterances than neurotypical peers. When utterances were intelligible, all groups were highly likely to be contingent to the topic of conversation, contrary to expectations. However, EL-ASD children were less likely than all other groups to add new information to the conversation, and the extent to which children added new information was positively associated with utterance length and vocabulary diversity across groups. Parents of EL-ASD children had fewer opportunities to respond contingently to their child's topic. However, all parents were highly contingent when child speech was intelligible, and complexity of parent speech varied with child spoken language ability and conversational skills. Parents produced similar proportions of questions, and regardless of outcome group, *wh*-questions (i.e., who, what, when, where, why, how questions) elicited child utterances that were longer and more likely to add new information to the conversation than other questions. Finally, coordinated joint engagement and expressive language in toddlerhood were independent predictors of conversational skills. Findings highlight children's strengths in utilizing speech when interacting with caregivers and suggest that *wh*-questions from parents may be a promising target in interventions for children with ASD and non-ASD language delays.

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Preface

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1.0 INTRODUCTION

In the first three years of life, neurotypically developing children say their first words, combine these words into phrases and sentences, and go from asking and answering simple questions to having increasingly complex conversations. Around 18 to 24 months of age, toddlers begin to understand the back-and-forth nature of conversations and the norms of responding (Chapman, 1981), and 2- to 3-year-olds typically begin to ask questions and convey new information in these exchanges (e.g., Snow et al., 1996; Tager-Flusberg et al., 2005). Conversational skills, such as responding in a way that maintains the topic of a conversational partner, are an early building block of pragmatic language. Definitions of pragmatics vary widely (e.g., Ariel, 2010), but pragmatic language generally refers to the appropriate use of language to communicate in social interactions (Bates, 1976). This encompasses a range of abilities, from early conversational skills to a nuanced understanding of "when to say what to whom, and how much to say" (Hymes, 1971; Ninio & Snow, 1996).

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by challenges with social communication and restricted or repetitive behaviors (American Psychiatric Association, 2013). While structural language skills (i.e., lexical and syntactic abilities in expressive and receptive language) vary widely in individuals with ASD, difficulties with social communication, including both nonverbal skills (e.g., eye gaze, gesture) and pragmatic language are a core diagnostic feature (American Psychiatric Association, 2013; Tager-Flusberg et al., 2011). Pragmatic language skills are a challenge throughout the lifespan for individuals with ASD (e.g., see Eigsti et al., 2011, for a review). For example, Tager-Flusberg and Anderson (1991) found that 3- to 7-year-old children with ASD contingently responded (i.e., responded in a way that maintained the topic) to a conversational partner less often than their peers without ASD. Further, in contrast to neurotypically developing children and children with Down syndrome, children with ASD did not show growth in contingent speech or in adding new information to a conversation even with increases in structural language ability (Tager-Flusberg & Anderson, 1991). Conversational back-and-forth, providing the appropriate level of information, and narrative skills are all aspects of pragmatic language that continue to be a challenge into later childhood, adolescence, and adulthood for individuals with ASD (e.g., Colle et al., 2008; Diehl et al., 2006; Losh & Capps, 2003; Nadig et al., 2010).

Current estimates suggest that 1 in 44 children in the general population are diagnosed with ASD (Maenner et al., 2021). However, the younger siblings of children with ASD have an elevated likelihood (EL)[1] of developing ASD, with about 1 in 5 receiving an ASD diagnosis (Ozonoff et al., 2011). There is also substantial variability in the developmental outcomes of EL children who are *not* on the autism spectrum, with another 20-30% experiencing challenges in cognitive, motor, language, and/or social domains (e.g., Charman et al., 2017; Ozonoff et al., 2014). Notably, recent meta-analyses show that EL toddlers with non-ASD outcomes are three to four times more likely to have a clinically significant language delay than their peers with no family history of autism (i.e., typical likelihood peers; TL; Marrus et al., 2018), and that these differences in language skills continue to be present at school age (Roemer, 2021). Language impairments are associated with

[1] The field has traditionally referred to EL infants as "high risk" (HR), but this terminology conveys a view that having an autism spectrum diagnosis is inherently negative. While many individuals with autism need substantial support, many also view their autism as a positive aspect of their identity (Kenny et al., 2016; Robison, 2019). We use the terms "elevated likelihood" (EL) and "typical likelihood" (TL) of autism here in place of the stigmatizing language predominant in the medical model of autism.

social and academic challenges into adolescence (e.g., Lindsay & Dockrell, 2012; St. Clair et al., 2011), so a better understanding of communicative development across the EL population would inform identification and intervention efforts for those with persistent concerns.

Although there is growing evidence of non-ASD language delays in EL siblings, the profiles of structural and pragmatic language differences in EL siblings are not well understood. Pragmatic language (which encompasses early conversational skills and later developing skills in the use of language to communicate in social interactions; Ninio & Snow, 1996; Tager-Flusberg et al., 2005) is a well-documented challenge for individuals with ASD, but research on pragmatic language in EL siblings is sparse (e.g., see Drumm & Brian, 2013; Roemer, 2021 for review). In particular, there is very limited research on the *early* development of pragmatic language in EL siblings, perhaps in part due to the lack of suitable measures of early pragmatic skills (Miller et al., 2015). However, a recent study suggests that measurement of conversational skills in the context of natural, moment-to-moment interactions is more sensitive to subtle differences in school-age EL siblings *without* ASD than standardized assessments and caregiver report measures (Gangi et al., 2021). The goals of the present study are to use natural language sampling to enhance our understanding of early conversational skills in preschool-aged (i.e., 3-year-old) EL siblings with and without ASD and non-ASD language delays, characterize the communicative environments in which early conversations occur, and examine early predictors of individual differences in conversational skills. Following an overview of our current understanding of profiles of structural and pragmatic language in non-ASD populations, literature relevant to each of these aims is reviewed below.

1.1 The BAP and Overlapping Dimensions of Structural and Pragmatic Language

Autism-related characteristics aggregate in families (Gillberg et al., 1992; Sucksmith et al., 2011), and the term "broader autism phenotype" (BAP) has long been used to refer to subclinical autism-related traits in family members of individuals on the autism spectrum (e.g., Bolton et al., 1994). ASD is highly heritable (e.g., Iakoucheva et al., 2019; Ronald & Hoekstra, 2011), and many researchers have examined the BAP in family members with the goal of understanding endophenotypes and susceptibility to autism and related developmental challenges. While a full review of the BAP and its recent use as a "catch-all" term is beyond the scope of this paper (see Sucksmith et al., 2011, for a review), it is important to note that EL siblings without ASD are often differentiated by whether they meet criteria for the BAP, with these criteria varying widely from study to study. For example, the BAP category has been utilized for toddlers meeting criteria ranging from low scores on any subscale (e.g., visual reception, motor, or language) of the Mullen Scales of Early Learning (Greenslade et al., 2019) to cognitive/language delays as early as 14 months (Gamliel et al., 2007).

Additionally, there is some debate in the field about the extent to which clinically significant impairments in structural language (previously known as Specific Language Impairment and currently referred to as Developmental Language Disorder) overlap with the challenges with pragmatic (and at times, structural) language seen in individuals with ASD (Tager-Flusberg, 2016; Tomblin, 2011). Tomblin (2011) reviewed the literature and concluded that structural and pragmatic language exist as overlapping dimensions, with some individuals with ASD also experiencing challenges with structural language, and some individuals with Developmental Language Disorder also experiencing clinically significant challenges with pragmatic language. There is also debate about the extent to which the BAP overlaps with pragmatic communication disorders, which cannot be diagnosed until 4 years of age (see Flax et al., 2019; Norbury, 2014, for review). Thus, the intersection between expressive and receptive language delays and pragmatic language abilities in the siblings of children with ASD is not clear-cut and warrants further research.

Existing research on pragmatics in 'late talkers' (i.e., children under 4 years of age who have slow expressive language development) may be informative for understanding pragmatic language in EL preschoolers with a history of non-ASD language delays. A study examining caregiver report of conversational skills found lower parent ratings of initiating and responding to conversations in 2-year-old late talkers compared to same-aged typically developing peers, but similar ratings compared to younger vocabulary-matched peers (Bonifacio et al., 2007). In another study of conversational patterns in 3-year-olds identified as late talkers, Rescorla et al. (2001) transcribed a 10-minute parent-child toy play session and found that while late talkers had significantly lower mean lengths of utterance (MLU) and were less likely to elaborate on their own topics, they did not differ from same-aged typically developing peers in total number of utterances produced or maintaining the topic of focus. Mothers of late talkers in this study produced more utterances and asked more questions than mothers of comparison children, highlighting the need for considering the dyadic nature of conversations (Rescorla et al., 2001).

Thus, across populations, researchers have considered structural and pragmatic language to exist as overlapping dimensions (Tomblin, 2011), and in populations with Developmental Language Disorders and with ASD, they are strongly correlated (Matthews et al., 2018; Reindal et al., 2021). Indeed, a recent study using a novel pragmatic language test with approximately 400 neurotypically developing school-age children found that structural and pragmatic language skills are highly correlated (r = .79; Wilson & Bishop, 2022). A factor analysis also demonstrated structural language skills fell together as a single cohesive domain, distinct from pragmatic skills, and the authors suggest that structural language skills support development in pragmatic language, and vice versa (Wilson & Bishop, 2022).

1.2 Pragmatic Language in Siblings of Children with ASD

The literature reviewed above suggests that structural and pragmatic language abilities are associated for at least some children with various communicative challenges. The younger siblings of children with ASD are at elevated likelihood (EL) for both ASD and non-ASD language delays (Marrus et al., 2018; Roemer, 2021), but little is known about the early development of pragmatic language in EL siblings. Several studies have examined pragmatic language in school-age siblings of children with ASD in comparison to TL children, with mixed findings (Ben-Yizhak et al., 2011; D. Bishop et al., 2006; Gangi et al., 2021; Gillespie-Lynch et al., 2015; Greenslade et al., 2019). Bishop et al. (2006) used a parent-report communication checklist and found that rather than a specific deficit in pragmatic skills, siblings of children with ASD demonstrated difficulties across a wide range of subscales, with differences emerging on a composite score that combines structural language and communicative use of language. In several studies using observational measures, differences in pragmatic language were found when differentiating a subset of EL siblings with the BAP (Ben-Yizhak et al., 2011; Gangi et al., 2021; Greenslade et al., 2019). These studies involved interaction with an experimenter and used a range of rating scales to measure discourse management, nonverbal communication, conversational competence, and interpersonal communication skills. Notably, all found the BAP group (18-39% of samples of 35-112 school-aged EL children, with varying definitions of the BAP) scored significantly worse on measures of pragmatic language than their typically developing peers (Ben-Yizhak et al., 2011; Gangi et al., 2021; Greenslade et al., 2019).

Thus, at least a subset of EL siblings without ASD appear to experience challenges with pragmatic language in the school-age years. Nonverbal communication and vocabulary development have been the topic of extensive investigation in this population in the first three years of life, and EL siblings with non-ASD language delays tend to fall between their typically developing peers and their peers with ASD in these domains (Iverson et al., 2018; Landa & Garrett-Mayer, 2006; LeBarton & Iverson, 2016; Parladé & Iverson, 2015; West et al., 2019, 2020). However, only two studies to date have sought to examine pragmatic language skills in EL siblings prior to mid-childhood (Bruyneel et al., 2019; Miller et al., 2015). Miller et al. (2015) used a parent report measure of language use (O'Neill, 2007) to examine pragmatic language skills in 3-year-old EL siblings. Consistent with studies in the school-age years, EL preschoolers without ASD scored significantly lower in pragmatic abilities than their TL peers. They also found that EL preschoolers with a pragmatic language impairment (i.e., < 10^{th} percentile on this parent-report measure) were more likely to have low scores on standardized measures of expressive or receptive language than their TL peers (Miller et al., 2015).

Bruyneel et al. (2019) measured language abilities in 3-year-old EL siblings using a multi-method approach, aggregating across items from two standardized assessments and an analysis of spontaneous language from parent-child interaction to capture differences in phonology, grammar, semantics, and pragmatics. More than 60% of EL preschoolers showed delays in at least one area of language, though those with an ASD diagnosis were not separated from those without ASD. While there were no significant differences between groups on a pragmatic language composite, the validity of the composite as a measure of pragmatic language was unclear. Communicative functions of child speech (e.g., requesting, commenting) were coded to capture pragmatics but excluded from analyses, and remaining items in the composite consisted of "language content" on an expressive language scale and two items from a second standardized measure assessing inflection and gestures with non-word vocalizations.

Pragmatic language skill is inherently embedded in the context of a dyadic exchange within the social norms of a culture, and measuring pragmatic language therefore comes with a range of methodological challenges (see Norbury, 2014, for review). One reason for the lack of research on pragmatic language in EL siblings may simply be the lack of available measures (Drumm & Brian, 2013). With standardized tasks (primarily developed for older children), it is not always possible to disentangle pragmatic skill from the demands these measures place on structural language abilities (Matthews et al., 2018; Wilson & Bishop, 2022). One of the more widely used measures of early pragmatic language in the literature on neurotypical development is a parent-report questionnaire designed for 18- to 47-month-old children (Language Use Inventory for Young Children; O'Neill, 2007). The authors note that a primary challenge in measuring pragmatic language is ecological validity, and that parent report enables the measurement of language use in a wide variety of settings and contexts (O'Neill, 2007).

Another challenge to measuring *early* pragmatic language is that while neurotypical children master the basics of conversational skills by 2 years of age (Ninio & Snow, 1996), more advanced aspects of pragmatic language such as tailoring speech to different social roles and the knowledge of the conversational partner, narrative development, and understanding of humor, metaphor, and irony do not develop until the school-age years (Adams, 2002). Further, the relative lack of suitable measures makes it challenging to monitor and assess whether children are experiencing clinically significant challenges in pragmatic language (e.g., see Norbury, 2014, for review).

Consistent with the idea that pragmatic language is difficult to measure outside the context of a dyadic exchange, a recent study shows that compared to standardized assessments and parent report measures, naturalistic conversations are better suited to capturing subtle differences in pragmatic language in school-age EL siblings *without* ASD (Gangi et al., 2021). As the authors note, this has important clinical implications – if children are struggling in moment-to-moment interactions similar to those encountered in everyday life, but these challenges are missed by standardized assessments or screeners, research with measures of naturalistic conversation may inform development of more sensitive assessment measures and specific targets for intervention. Further, natural language sampling (i.e., recording and transcribing speech in natural contexts) is one of the most flexible and robust forms of measuring both structural and pragmatic language across a wide range of ages – from toddlerhood to adulthood – and across a range of language abilities (see Barokova & Tager-Flusberg, 2020, for a review). Kover et al. (2014) compared natural language samples across multiple contexts and found that 15-minute parent-child free play with a standard set of toys (i.e., a farm set) elicited more utterances, more words, more requests and comments, and more conversational turn-taking by 3- to 4-year-old children with ASD when compared to a 15-minute observation of a structured interaction with an experimenter. Thus, observations of caregiver-child interactions in the home are likely especially well-suited to capturing potentially subtle differences in early conversational skills in EL preschoolers with varied developmental outcomes.

Conversational skills, and specifically the ability to respond to caregiver speech, maintain the topic of focus, and add new relevant information are early markers of competence in pragmatic language that are present in neurotypically developing children by the age of 2 or 3 years of age (Ninio & Snow, 1996; Tager-Flusberg et al., 2005). These conversational skills have been examined in children with ASD (Capps et al., 1998; Hale & Tager-Flusberg, 2005; Tager-Flusberg & Anderson, 1991) and in neurotypical populations, late talkers, and children with Developmental Language Disorders (e.g., Rescorla et al., 2001; Wong et al., 2021), and even subtle difficulties in these areas may decrease opportunities for learning about conversational norms and persist into challenges in social interactions with peers (e.g., see Turkstra et al., 2017 for review). However, early conversational skills have yet to be examined in EL siblings. Thus, the first goal of the present study is to characterize spoken language and conversational skills in the context of parent-child toy play interactions at home in EL preschoolers (i.e., 3-year-olds) with ASD (EL-ASD), non-ASD language delays (EL-LD), or no delays or diagnoses (EL-ND), and preschoolers with no family history of ASD (typical likelihood; TL).

1.3 Parent Speech, Language, and Conversational Skills

Early conversational skills do not develop in isolation. They emerge in the context of dyadic exchanges with caregivers and other social partners, and children shape their communicative environments and opportunities for learning (e.g., Adamson et al., 2020; Edmunds et al., 2019; Iverson, 2021; Sameroff, 2009; Thelen, 2005). Children are constantly interacting with caregivers, and just as preschoolers may respond contingently to their caregiver in a conversation, caregivers adapt their speech to their child’s abilities (see Tamis-LeMonda et al., 2018, for review). Thus, caregivers and children create opportunities for one another in conversation, and understanding differences in child conversational skills requires an understanding of the reciprocal influences between the child's language ability and the opportunities that parents provide in conversation (Choi et al., 2020; Snow, 1977).

For example, Hirsh-Pasek et al. (2015) rated several aspects of play interactions between low-income 2-year-olds and their caregivers. They found that fluency and turn-taking, or the "conversational duet" between children and their parents predicted language the following year even after controlling for the child's number of words in the exchange. In line with these findings, studies ranging across infancy to early childhood find the rate of conversational turns across the course of a day to predict child language abilities over and above quantity of caregiver input alone (e.g., Donnelly & Kidd, 2021; Ramírez et al., 2020; Romeo et al., 2018; Zimmerman et al., 2009). These studies used broad automated measures that have notable limitations, such as including overheard adult speech in conversational turns (e.g., see Cristia et al., 2021, for discussion of these issues).

Natural language sampling and transcription allow for more fine-grained measures of the back-and-forth nature of conversational turns. For example, Alper et al. (2021) transcribed interactions between neurotypical 19-month-olds and their caregivers, differentiating conversational turns as "child-adult" (i.e., caregiver speaks within 5 seconds after a child utterance) and vice versa ("adult-child"). Thus, caregiver responses in conversational turns (i.e., caregiver utterances that occur immediately after a child utterance) are likely to provide important context for the bidirectional relationship between caregiver speech and children's developing language and conversational skills. Further, caregiver responses that continue the child's topic of conversation support children's developing conversational skills in neurotypically developing populations (e.g., Chapman, 1981) and in children with developmental delays (e.g., Yoder et al., 1994).

Beyond the rate of caregiver responses in conversational turns, one area in which caregivers provide specific opportunities for their children to respond contingently is in their use of questions. In neurotypical development, caregiver speech changes across developmental time – parents increase the number of questions they ask across the second year of life, suggesting an attunement to their child's increased vocabularies and ability to answer questions (e.g., Bornstein et al., 2008). Further, particularly in the early stages of language development, children are more likely to continue a topic following questions from parents than comments (Bloom et al., 1976). Specifically, the use of *wh*-questions (i.e., questions framed with who, what, when, where, why, and how) is beneficial for toddlers' vocabulary development and elicits opportunities for conversation (Cristofaro & Tamis-LeMonda, 2012; Rowe et al., 2017). For example, Rowe et al. (2017) examined fathers' use of *wh*-questions in reading and play activities in the home and found these questions elicited more on-topic and more complex responses from their 2-year-old children than other types of questions.

Work with children with developmental delays has also examined whether *wh*-questions support conversation. Yoder et al. (1994) conducted an experimental manipulation of the use of *wh*-questions, using a within-subjects design to compare two 20-minute play sessions in which a trained experimenter either used more *wh*-questions or more comments that followed into the child's topic of conversation. In this study, 4-year-old children with non-ASD developmental delays with a range of abilities in structural language (i.e., varying mean lengths of utterance) maintained the topic of conversation more in the *wh*-questions condition (i.e., a larger proportion of their utterances continued the topic of conversation) compared to the comments condition. Thus, as with neurotypical children, *wh*-questions appear to support child conversational skills for children with developmental delays.

However, prior work also highlights the bi-directional nature of conversations and potential impact of the child's abilities on the use of caregiver questions. For example, Rescorla et al. (2001) found that mothers of 3-year-olds with a history of language delay (i.e., late talkers) talked more and a larger proportion of their utterances were questions than mothers of same-aged peers, suggesting that mothers of children with delays in language might have to "work harder at keeping the conversation moving along" (p. 248). In contrast, Venuti et al. (2012) found that mothers of 4-year-old children with ASD used fewer questions (but more direct statements) in a 10-minute play interaction than mothers of 2-year-old neurotypical children matched on developmental level. While these results may suggest different patterns of question use for parents of children with ASD and children with a history of language delays, it is also possible methodological differences in age or matching procedures contributed to findings. Notably, both studies suggested differences in input styles may be a result of the challenges of engaging their child with delays in a back-and-forth conversation (Rescorla et al., 2001; Venuti et al., 2012).

While no studies to date have examined caregiver speech in relation to conversational skills in EL siblings, there is some evidence that parents adapt their input to the language abilities of their EL children (e.g., Choi et al., 2020). There is a growing body of literature on caregiver input to EL infants and toddlers (for reviews, see Bottema-Beutel & Kim, 2021; Edmunds et al., 2019; Swanson, 2020; Woolard et al., 2021). Parents of TL and EL infants do not tend to differ in their overall linguistic input, and responsive input from caregivers has generally found to be predictive of better language skills for children with ASD (Bottema-Beutel & Kim, 2021; Swanson, 2020). However, EL infants and children with ASD also shape their own opportunities for learning (Choi et al., 2020; Fusaroli et al., 2019; Hani et al., 2013). For example, one study showed that while caregivers of EL and TL toddlers used similar rates of types (i.e., number of different words) and tokens (i.e., total number of words), caregivers of EL toddlers used less complex speech (i.e., shorter mean length of utterance) than caregivers of TL toddlers (Choi et al., 2020). Further, Choi et al. (2020) found that for EL toddlers, higher child language scores at 18 months were predictive of more complex caregiver speech six months later.

Child language and parent speech must be considered in tandem, and early conversational skills develop in the context of a changing communicative environment. The intersection between structural and pragmatic language in EL siblings is not clear-cut, and although many aspects of caregiver speech and quality of input have been linked to structural language development in neurotypical development and EL siblings (Swanson, 2020), no research to date has examined caregiver input in relation to pragmatic language (i.e., the appropriate use of language in context) in EL siblings. Thus, a second goal of this study is to examine the communicative context in which emerging conversational skills occur for TL and EL children. As a first step in understanding caregiver speech in relation to conversational skills for EL children with varying developmental outcomes, the present study will examine the rate of parent topic-contingent responses in conversation, parent use of *wh*-questions, and parent mean length of utterance (MLU) and explore whether and how these aspects of parent speech relate to TL and EL preschoolers' spoken language and conversational abilities.

1.4 Early Predictors of Conversational Skills for Siblings of Children with ASD

While existing research on early predictors of conversational skills in EL siblings is sparse, early nonverbal communicative skills (e.g., joint attention, gesture) are often described as developmental precursors to pragmatic language (e.g., Loveland & Landry, 1986; see Turkstra et al., 2017, for a review). For example, joint attention is considered fundamental to developing language, social communication, and the ability to take the perspective of another person in conversations (Charman et al., 2000; Tomasello, 1995). Initiating joint attention (i.e., looking back and forth between a person and object to indicate interest, sometimes with gesture) and responding to bids for joint attention (i.e., following the gaze and/or point of another person to an object) predict language skills for neurotypically developing children and children with ASD (see Bottema-Beutel, 2016, for review).

Two studies to date have examined early predictors of pragmatic language in EL siblings. Both examined joint attention in toddlerhood as a predictor of pragmatic language in the school-age years (Gillespie-Lynch et al., 2015; Greenslade et al., 2019). Gillespie-Lynch et al. (2015) examined structural and pragmatic language in 5- to 10-year-old EL siblings using a parent-report questionnaire. While scores for initiating joint attention at 18 months predicted structural language approximately 6 years later for children with and without ASD, no measures of early joint attention predicted pragmatic language. In contrast, Greenslade et al. (2019) examined pragmatic language using an observational rating scale in 8- to 12-year-old EL siblings and found that initiating joint attention at 14 months predicted school-age pragmatic language. Expressive language scores at 24 months also predicted pragmatic language, and notably, a combination of 14-month joint attention, 24-month expressive language, and 24-month social communication scores explained 66% of variance in school-age pragmatic communication (Greenslade et al., 2019). The authors suggest a potential mediating effect of expressive language in the relation between early joint attention and later pragmatic language, but they did not directly test this possibility.

In addition to measures of joint attention, a growing body of research has examined joint engagement in children with ASD (e.g., Adamson et al., 2009, 2019; Bottema-Beutel et al., 2018) and EL siblings (Roemer et al., 2022). As opposed to the discrete behaviors of initiating and responding to joint attention measured in structured tasks, joint engagement captures a child's experiences in a dyadic interaction and describes the distribution of time parent-child dyads spent actively playing together with the same object (Adamson et al., 2019). Two types of joint engagement have been differentiated – *supported joint engagement* reflects both partners playing together with the same object but *without* the child making eye contact, while *coordinated joint engagement* involves the dyad actively playing together while the child glances back and forth between caregiver and the object of shared interest (Adamson et al., 2004, 2009; Bakeman & Adamson, 1984).

Recent studies have also demonstrated relations between joint engagement and language for children with ASD and EL siblings (Adamson et al., 2019; Bottema-Beutel et al., 2021; Roemer et al., 2022; Shih et al., 2021). Bottema-Beutel et al. (2021) found supported joint engagement to be predictive of expressive and receptive vocabulary eight months later for 2- to 4-year-olds with ASD. Adamson et al. (2019) directly compared measures of joint attention and joint engagement in 2-year-olds; for children with ASD and children with non-ASD developmental delays, joint engagement predicted expressive vocabulary approximately six months later over and above structured measures of joint attention.

Thus, there is strong evidence for a relation between joint engagement and expressive language skills. The only study to date to examine this relation in EL siblings (with a subset of the sample in the present study) also found a positive association between coordinated joint engagement and concurrent expressive language at 18 months of age (Roemer et al., 2022). However, no studies have examined joint engagement as a predictor of pragmatic language abilities in EL siblings. Thus, the final aim of this study is to examine coordinated joint engagement at 18 months of age as an early predictor of conversational skills at 36 months. Additionally, in line with the pathway suggested by Greenslade et al. (2019), we will test whether expressive language at 24 months mediates this association. Notably, recent interventions have successfully increased time in joint engagement for young children with ASD (e.g., Kasari et al., 2015), so a better understanding of these developmental pathways for EL siblings may inform interventions for EL children *without* ASD who are experiencing persistent challenges in language and early conversational skills.

1.5 The Present Study

In sum, while siblings of children with ASD have an elevated likelihood of both an ASD diagnosis themselves and of non-ASD language delays (Marrus et al., 2018; Ozonoff et al., 2011), the relations between structural and pragmatic language in this population are not well understood. While there has been some work suggesting differences in pragmatic language for a subset of EL siblings at school-age (Ben-Yizhak et al., 2011; Gangi et al., 2021; Greenslade et al., 2019), only two studies to date have investigated pragmatics prior to middle childhood in EL siblings (Bruyneel et al., 2019; Miller et al., 2015). Further, no studies to date have examined conversational skills in the context of the everyday communicative environments in which they occur for EL siblings, nor have any studies examined early predictors of conversational skills for EL preschoolers. The present study addressed these gaps in the literature by using a natural language sampling approach to examine parent-child interactions in the home at 3 years of age for TL children and EL children with ASD (EL-ASD), non-ASD language delays (EL-LD), and no diagnosis or delays (EL-ND). The study had three primary aims, described below.

The first aim was to examine profiles of spoken expressive language (including measures of utterance length, vocabulary diversity, and percent of intelligible utterances) and conversational skills (specifically, contingent, topic-related responses and responses that add information) and test whether these profiles differ across preschoolers with a range of developmental outcomes. Based on previous research, we hypothesized the following:

1. We expected the EL-ASD group and EL-LD group to have shorter and fewer intelligible utterances and smaller vocabularies compared to their neurotypically developing peers.
2. We expected the EL-ASD group would perform lowest on measures of conversational skills and the EL-LD group would perform better than their EL-ASD peers but lower than typically developing (EL-ND and TL) peers.
3. We expected measures of spoken language to be positively associated with conversational skills in EL siblings and their TL peers.

The second aim of this study was to characterize parent speech in order to consider child conversational skills in the context of the communicative environments in which they develop, and to take a first step in understanding whether and how aspects of caregiver speech (i.e., contingent responses in conversational turns, *wh-* questions, and MLU) relate to child language and conversational skills. Given the lack of prior research on conversational skills in EL preschoolers, examining the relation between conversational skills and parent speech was somewhat exploratory in nature. However, based on prior work with neurotypically developing children and children with developmental delays, we hypothesized the following:

1. We expected that more topic-contingent parent responses and more complex parent speech (i.e., longer MLU) would be positively associated with concurrent child spoken language skills (i.e., child MLU).
2. We also expected that parent *wh*-questions may be particularly supportive of child topic-maintaining responses that add new information to the exchange.

The final aim of this study was to provide an initial foray into examining early predictors of conversational skills in EL siblings and to test a mediation model of coordinated joint engagement, expressive language, and conversational skills. Prior evidence shows a relation between joint engagement and expressive language for children with ASD and for TL and EL toddlers (Bottema-Beutel et al., 2021; Roemer et al., 2022; Shih et al., 2021). Based on work suggesting a relation between joint attention, expressive language, and school-age pragmatic language (Greenslade et al., 2019), we expected that:

1. Coordinated joint engagement at 18 months of age would predict contingent (i.e., topic-related) child responses and contingent responses that add new information to the conversation at 3 years of age.
2. Expressive language at 24 months of age would mediate this relationship between coordinated joint engagement and conversational skills across TL and EL children with a range of developmental outcomes.

2.0 METHODS

2.1 Participants

The present study draws from two longitudinal studies of motor and communicative development that included 80 EL and 24 TL children enrolled as infants and followed to three years of age. EL children had a full biological older sibling with an ASD diagnosis confirmed by a trained clinician using the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). The EL group was recruited through a university autism research program, parent support organizations, and local agencies and schools serving children with ASD. TL children had at least one older neurotypically-developing sibling, no first- or second-degree relatives with ASD, and were recruited through a university research registry and word of mouth.

Participants in both groups were from full-term, uncomplicated pregnancies and came from monolingual English-speaking households. Most preschoolers meeting inclusion criteria for the present study (described below) in both groups were identified by their caregivers as Caucasian and non-Hispanic (87%; 14/16 TL, 59/68 EL). Two TL children were identified as Multiracial. Two EL children were identified as Asian (n=1) or African American (n=1). Seven EL children were identified as Hispanic. Consistent with prior studies of EL infants (e.g., Croen et al., 2007), mothers and fathers of EL preschoolers were older than mothers ($p = 0.057$) and fathers ($p = 0.006$) of TL preschoolers. Parents of TL preschoolers had a higher level of education than parents of EL preschoolers ($p = 0.012$); though the large majority of parents in both groups completed some college or higher (100% of mothers and fathers of TL children; 89.6% of mothers and fathers of

EL children). There were no likelihood status differences in child sex. Demographic information for each outcome group (described below) is presented in Table 1.

Table 1. Demographics Information for Typical Likelihood (TL) and Elevated Likelihood (EL) Children by Outcome Group

	TL (n=16)	EL-ND (n=37)	EL-LD (n=21)	EL-ASD (n=10)
Sex (# Female, Male)	5, 11	17, 20	8, 13	3, 7
Mean mother age (SD)	31.69 (4.24)	34.00 (3.38)	34.65 (4.48)	31.50 (4.01)
Mean father age (SD)	32.75 (4.28)	37.41 (5.99)	37.45 (4.84)	34.30 (4.88)
Mean parent education[a] (SD)	1.53 (0.43)	1.23 (0.40)	1.25 (0.57)	1.00 (0.58)

Note: TL = Typical Likelihood, EL = Elevated Likelihood; ND = No Diagnosis; LD = non-ASD Language delay; parent age is reported at study entry

[a] Parent education based on averaging education scores for mothers and fathers; 0 = High school, 1 = Some college or college degree, 2 = Graduate or professional school.

2.2 Procedure

Children and their parents were visited regularly in their homes across the first three years of life and videotaped as they engaged in a variety of structured and unstructured procedures and assessments. EL and TL children were followed in two studies with varying observation schedules; both groups had follow-up visits at 18, 24, and 36 months. The 36-month visit included two segments in which the parent and child were given a standard set of age-appropriate toys and asked to play on the floor together as they normally would. A research assistant video-recorded the parent and child with a hand-held camera and the child wore a cloth vest holding a microphone to enhance audio recordings. The first segment included 3 minutes of play following a brief warm-up period; this toy set consisted of a teddy bear, brush, washcloth, cup, spoon, and bowl. The second involved

10 minutes of play with a plastic barn set with various rooms and an assortment of people and farm animals (e.g., farmers, horse, pig, cow).

Inclusion criteria for the present study required that TL and EL children had a parent-child toy play observation lasting at least 10 minutes at their 36-month visit. Of the 80 EL and 24 TL children initially enrolled, 11 (3 TL, 8 EL) withdrew, moved away, or were lost to follow-up prior to their 36-month visit, five (1 TL, 4 EL) did not have a 10- to 13-minute parent-child toy play observation at their 36-month visit, and one (TL) had a video file that was not considered codable due to poor audio quality. An additional 3 TL children who met criteria for a history of language delay (described below) were excluded, leaving a sample of 68 EL (28 girls) and 16 TL (5 girls).

Joint engagement was coded (see below) from a 3- to 6-minute parent-child toy play observation with the same teddy toy set (bear, brush, washcloth, cup, spoon, and bowl) at the 18-month visit for a subset of children as part of a previous study (Roemer et al., 2022). Data from this subset of the present sample (11 TL, 38 EL) contributed to analyses for study aim 3.

2.3 Parent Report and Standardized Measures

At 18, 24, and 36 months, a primary caregiver completed the MacArthur-Bates Communicative Development Inventory (CDI), a parent-report measure of communication including a vocabulary checklist of words the child says. The CDI is used widely in studies of neurotypical development and studies of populations with a range of neurodevelopmental disabilities (e.g., Fenson et al., 1993; Mitchell et al., 2006). It has high levels of internal consistency, test-retest reliability, and validity with experimenter-administered measures (Fenson et al., 1994). CDI scores contributed to classification of language delay, described below.

The Mullen Scales of Early Learning (MSEL; Mullen, 1995) was also completed at 18, 24, and 36 months. The MSEL is a standardized experimenter-administered assessment of cognitive functioning used widely in EL sibling studies (e.g., Jones et al., 2014) that has good convergent validity with other measures (Bishop et al., 2011). Receptive Language, Expressive Language, and Visual Reception (a measure of non-verbal cognitive ability) scales were administered. Expressive Language scores from the 24-month visit were utilized in analyses for study aim 3.

2.4 Outcome Classification

In addition to the language measures described above, EL children were evaluated with the ADOS at 36 months of age by a research-reliable clinician naïve to previous study data and study hypotheses. They were then classified into one of three mutually exclusive outcome groups as follows:

EL children received an ASD diagnosis (EL-ASD) if they met or exceeded cutoff scores based on the ADOS algorithm for ASD and had this confirmed using DSM-IV-TR criteria (data for EL children were collected prior to the release of DSM-5). Using these criteria, 11 EL children were diagnosed with ASD; 10 (3 girls) met inclusion criteria described above for the present study.

EL children were classified as demonstrating language delay (EL-LD) if they *were not* diagnosed with ASD and met one or both of the following criteria:

1. standardized CDI scores at or below the 10^{th} percentile at more than one administration between 18 and 36 months of age;

2. standardized CDI scores at or below the 10th percentile *and* standardized scores on the Receptive and/or Expressive scale of the MSEL at 1.5 *SD*s or more below the mean at 36 months of age

These criteria were developed for the purpose of identifying children with a pattern of delayed language development, not to provide a clinical diagnosis. Similar criteria have been used previously to identify language delay in community and EL samples (e.g., Weismer & Evans, 2002; Gershkoff-Stowe et al., 1997; Heilmann et al., 2005; Ozonoff et al., 2010; Parladé & Iverson, 2015). By definition, all EL-LD children exhibited delays in expressive language (as measured on the CDI alone or a combination of CDI and MSEL data). Using these criteria, 22 children were classified as EL-LD; 21 (8 girls) met inclusion criteria for the present study.

The remaining 39 children who completed the study were classified as having no delay or diagnosis (EL-ND); 37 (17 girls) met inclusion criteria for the present study.

As part of the larger study, the TL group did not receive a formal diagnostic evaluation. However, a primary caregiver completed the M-CHAT-R/F (Modified Checklist for Autism in Toddlers; Robins et al., 2001) at 18 and 24 months; all children scored negative for ASD. As noted above, 3 TL toddlers with a history of language delay (using the above EL-LD criteria) were excluded. Thus, 16 TL children met inclusion criteria for the present study.

To characterize each group's language and cognitive differences on standardized measures, descriptive statistics and group comparisons for CDI and MSEL data at 18, 24, and 36 months are reported in Table 2.

Table 2. Descriptive Statistics Characterizing each Outcome Group at 18, 24, and 36 months

		Typical Likelihood			EL – No Diagnosis			EL – Language Delay			EL – ASD			One-way ANOVA	
Measure	Month	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	F	p
CDI: Words Produced	18	15	35.00	22.99	37	35.54	22.63	21	8.33	11.66	10	7.50	10.07	12.96	<0.001
	24	15	47.00	22.42	34	43.38	20.14	21	14.52	16.35	9	2.78	5.07	21.05	<0.001
	36	15	27.33	24.70	34	26.32	25.74	21	4.05	4.07	10	0.00	0.00	9.03	<0.001
MSEL: Receptive Language	18	14	41.00	11.56	36	42.72	16.92	21	35.62	12.62	10	28.80	15.87	2.74	0.049
	24	15	53.67	11.48	35	55.74	6.98	20	43.50	15.19	8	25.75	8.78	20.06	<0.001
	36	16	55.44	6.44	37	52.62	8.78	21	44.05	8.94	9	29.56	10.33	22.71	<0.001
MSEL: Expressive Language	18	14	52.86	8.29	36	48.78	9.00	21	39.29	6.38	10	35.70	13.86	11.93	<0.001
	24	16	53.31	10.29	35	53.00	6.61	20	44.10	7.96	9	30.56	11.16	20.96	<0.001
	36	16	58.81	9.60	37	56.65	7.52	21	48.38	10.52	10	31.10	11.31	24.32	<0.001
MSEL: Visual Reception	18	15	49.07	8.67	36	49.03	9.55	21	43.81	9.77	10	35.30	12.67	5.88	0.001
	24	16	51.94	13.16	36	49.75	12.87	20	46.45	8.53	9	39.22	8.76	2.71	0.051
	36	16	64.56	11.39	37	59.65	13.54	21	51.67	15.46	9	31.56	13.28	13.26	<0.001

Note: CDI = MacArthur-Bates Communicative Development Inventory, CDI percentile scores are reported; MSEL = Mullen Scales of Early Learning, MSEL standardized T-scores are reported. EL = Elevated Likelihood of ASD.

2.5 Transcription and Coding

Transcription of parent and child speech and coding of child conversational skills, parent responses in conversation, and parent *wh*-questions were completed by the author, who was naïve to outcome classification, and five undergraduate coders who were naïve to likelihood status, outcome classification, and study hypotheses. Transcription and coding were completed in version 1.3.7 of Datavyu (http://datavyu.org; Datavyu Team, 2014). Prior to transcribing and coding study data, all coders were trained until they achieved at or above an agreement threshold (defined below for each transcription or coding pass) on at least three consecutive videos. Following training, coders independently transcribed and coded videos and checked or double-coded for reliability. Discrepancies were discussed and resolved through group consensus, with final consensus codes used in analyses.

2.5.1 Transcription

Parent and child speech transcription occurred in two passes prior to coding all other variables, described below.

2.5.1.1 Pass 1: Utterance identification and parent speech transcription

In the first transcription pass, a trained undergraduate coder played 1- to 2-minute segments of the video at half-speed (or quarter-speed when necessary) to identify all parent and child utterances, including child vocalizations. They then played small sections of each segment in real time and transcribed parent utterances, repeating this process until all child vocalizations/utterances were identified and parent utterances transcribed for the full 10 to 13 minutes of parent-child toy play. This process and transcription conventions were adapted from those developed by the PLAY (Play & Learning Across a Year) project and Datavyu Team (https://www.play-project.org/overview.html; described in Appendix A) which involves transcribing in Datavyu using CHAT conventions of the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). Utterances were segmented based on grammatical closure, prolonged pauses, and intonation. Parent utterances directed to someone other than the child (e.g., researcher, sibling interrupting the session) were not coded.

Coders were trained to a threshold of at least 90% agreement on identification of utterances and 80% on percent words matched on parent transcription. Once trained, undergraduate coders completed Pass 1 for each video. To verify accuracy, all parent transcription was checked by the author and all disagreements were noted and resolved through consensus discussions. To assess for coder drift, the average percent agreement on words matched between the initial transcription and checked transcription was calculated for each file; this ranged from 84 to 100% agreement ($M = 95.6$, $SD = 3.48$) for Pass 1.

2.5.1.2 Pass 2: Child speech transcription

In the second pass, another undergraduate coder transcribed each child utterance identified in the first pass. Transcription followed the same conventions as those described above for parent transcription, though with additional categories and guidelines to aid in determining which child utterances included words that could be transcribed. Coughing, sneezing, laughing, crying, and vegetative sounds (e.g., grunts, exhales) were not coded and were removed if identified on the first pass. Non-speech vocalizations, including babbling (e.g., bababa, babama), single consonants or vowels, and single sound repetitions were coded as a vocalization ("v") but not transcribed. Utterances that contained words or word-like sounds that did not meet full criteria for a word (below) were transcribed, with utterances or parts of utterances that were unintelligible (e.g., pronounced in such a way that two or more equally plausible alternatives exist) denoted as "xxx". Consistent use of the same sound pattern to refer to a specific referent was transcribed as the adult form of the word if it either: a) contained two or more syllables with at least one syllable matching the adult pronunciation of the word; or b) was a sound pattern with any number of syllables that shares at least half its phonemes with the adult pronunciation of the word (e.g., child says "tay" for train). Additional details are provided in Appendix B.

Using these rules, child (but not parent) speech had been transcribed for a subset of the included EL participants as part of a previous project (McQuiston, 2017). Eleven of these previously transcribed files were utilized for training in child speech transcription for the present study. Following training, a consensus file was created for these 11 training files to ensure consistency in transcription conventions with the current study.

Once undergraduate coders were trained to a threshold of at least 80% agreement with the author on percent words matched for child transcription, they completed Pass 2 for the remaining 73 videos (16 TL, 57 EL). To verify accuracy, all child transcription was checked by the author and disagreements were noted and resolved through consensus. To assess for coder drift, an average percent agreement on words matched between the initial transcription and checked transcription was calculated for each file; this ranged from 79 to 97% agreement (M = 91.80, SD = 3.66) for Pass 2.

2.5.2 Coding

Once parent and child speech were transcribed, the author and two undergraduate coders classified child conversational skills, parent responses in conversation, and parent questions. These were each completed in separate passes and involved watching the play observation video alongside the parent and child transcription in Datavyu and classifying utterances as described below. For each of the three coding passes, secondary coders were trained to a Cohen's kappa of at least 0.70 on all levels of the coding scheme for three consecutive videos. Following training, a primary coder (the author for child conversational skills; an undergraduate coder for parent responses and parent questions) coded each video in full, and a secondary coder independently coded 20% of each video to assess inter-rater reliability. To this end, a Datavyu script was created to randomly select a 36-second window of the 3-minute teddy bear segment and a 2-minute window of the 10-minute barn set segment for double coding. Reliability statistics are reported for each coding pass below.

2.5.2.1 Child conversational skills

Coding for child conversational skills was completed with a hierarchical coding scheme with three levels adapted from (Bloom et al., 1976; Tager-Flusberg & Anderson, 1991).

The first level of the coding scheme focused on the relative timing of the child utterance in relation to the previous parent utterance. A Datavyu script flagged a window of 5 seconds following each parent utterance, which aided coders in classifying each child utterance. If a child utterance occurred within the 5-second window, regardless of whether it was a vocalization, unintelligible, or fully transcribed, the child utterance was classified as *adjacent* (follows a parent utterance addressed to the child) or *simultaneous* (child's utterance begins before the prior parent utterance has ended). If more than one child utterance occurred within the 5-second window, the second utterance was classified as *near-adjacent.* For example, if a child produced a vocalization (v), filler (uh, um, etc.), or any utterance followed by a second utterance within the 5-second window, both the *adjacent/simultaneous* and the *near-adjacent* utterance were coded at the second level (described below). All other child utterances were coded as *non-adjacent* (i.e., occurred following two or more of the child's own utterances or following an adult utterance with intervening pause of 5 seconds or more).

At the second level, only *adjacent, simultaneous*, and *near-adjacent* child utterances were coded further to determine topic contingency. Since the topic of child vocalizations and fully unintelligible utterances (denoted as "v" and "xxx" in transcriptions) cannot be determined, these were simply classified as *non-word vocalization* and *fully unintelligible* at this level. An additional *uncodable* category was utilized in cases where the child utterance was partially unintelligible, and the topic could therefore not be determined. Finally, a *filler* category was used in cases where the utterance only contained one or more fillers (e.g., um, uh) and no other words. The remaining (intelligible) utterances were coded in relation to the topic of the previous adult utterance, as *contingent* (maintains topic of prior utterance; see Table 3 for examples) or *non-contingent* (does not relate to topic; for example, parent says, "the farmer is brushing his horse" and child says "I go over here").

At the third level, *contingent* utterances were further classified to distinguish the ways in which they related to the topic of the prior adult utterance and either *do not add new information* (including *imitations*) or *add-new-information* (see Table 3). An additional *contingent-uncodable* category was used for partially unintelligible utterances that were determined to be contingent but could not be classified at this level.

Table 3. Conversational Skills Coding: Classification and Examples of Contingent Utterances

Variable	**Code**	**Rules/Within-code categories**	**Examples (adapted from Tager-Flusberg & Anderson, 1991)**
Contingent + Does not add new information	Imitations (i)	Exact or partial repetition of prior adult utterance	
	Other no-new-info (n)	Yes/no Routines Recode: Repetitions of adult w/ alternation in form Self-recode: Repetitions of prior child utterance after adult acknowledgement Simple responses to adult *wh*-questions that do not add new information	"yeah", "yes", "no" "thank you"; "good night" Parent: "I think that's his tail" Child: "yeah, a tail". Child: "have the cow" Parent: "no" Child: "I want the cow" Parent: "what color is it?" Child: "it's green"
Contingent + Adds new information	Adds-new-info (a)	Expansion: Adds info to the topic and content of prior adult utterance Self-expansion: Expands own prior utterance after adult acknowledgement Alternation: Adds information by opposing some aspect of adult prior utterance Expatiation: Adds info to topic of prior adult utterance and introduces new related topic	Parent: "let's put teddy to bed" Child: "he needs his blanket" Parent: "and here's our farmer" Child: "no he's a doctor" Parent: "Oh I'm glad horse came and played with bunny" Child: "no, pig and horse go outside"
Contingent-uncodable	Uncodable (u)	Partially unintelligible contingent utterances that cannot be classified at this level	Parent: "let's give teddy a bath" Child: "xxx teddy"

Percent agreement and Cohen's kappa were calculated separately at each of the three levels described above across all files, and inter-rater reliability was high for level 1 (*adjacency*, 97% agreement, kappa = 0.96), level 2 (*contingency*, 93% agreement, kappa = 0.85), and level 3 (*adds-new-info*, 90% agreement, kappa = 0.79).

2.5.2.2 Parent responses in conversation

To examine the emerging conversational skills of young children in the context of parent contributions to the conversation, the first two levels of the coding scheme described above were adapted to classify parent utterances as 1) *adjacent, simultaneous,* or *near-adjacent* to child utterances (i.e., occurring within a 5-second window of a child utterance as described above), or *non-adjacent*, and 2) *filler, contingent* or *not contingent* to the topic of the child utterance. Additionally, an *uncodable* category was utilized for parent utterances that followed child vocalizations or fully/partially unintelligible utterances. Thus, *uncodable* at this level reflects parent responses for which the child did not produce sufficient verbal content for their topic to be determined, so the topic contingency of the parent response also could not be determined.

Two coders were trained in classification of parent responses. Percent agreement and Cohen's kappa were calculated at each of the two levels across all files, and inter-rater reliability was high for level 1 (*adjacency*, 97% agreement, kappa = 0.96) and level 2 (*contingency*, 95% agreement, kappa = 0.88).

2.5.2.3 Parent questions

All parent utterances were coded to examine the use of questions. *Wh-* questions were defined as utterances marked as questions in the transcripts using *who, what, when, where, why,* and *how* (e.g., "What do you have?", "Where is your toy?"). All questions were identified and flagged using a Datavyu script that searches and marks utterances with "?" in the transcript. An additional script flagged whether questions included the words *who, what, when, where, why,* and/or *how.* A trained coder watched each video with the transcript and these flagged utterances to confirm and classify each utterance as a *wh-question, other question* (e.g., "Do you want the horsie or the cow?", "Is that the bear's cereal?"), *not a question*, or *uncodable* (i.e., the parent utterance was transcribed as fully or partially unintelligible and could therefore not be classified). Percent agreement and Cohen's kappa were calculated on classification of the above categories across all files, and inter-rater reliability was high (99% agreement, kappa = 0.98).

2.5.2.4 Child responses to parent questions

To examine characteristics of child responses to parent questions (MLU, conversational skills), parent question and conversational coding files were merged and Datavyu scripts were created to identify child utterances that occurred as a response to either a parent *wh-question* or a response to a parent *other question* (i.e., the child utterance occurred within a 5-second window of the parent question). In some cases, a parent *wh-question* was immediately followed by an *other question* (or vice versa) and a child response occurred within 5 seconds of both questions (for example, Parent: "Where did the pig go?" "Do you want to feed him?", Child: "He went in here"). To correctly attribute the child response to the correct type of question, an additional Datavyu script flagged all child responses which occurred within a 5-second window following both question types. For each of these responses, a coder trained in child transcription read through the parent and child transcripts and classified each flagged utterance as a response to a *wh-question* or a response to an *other question*, but not both. Thus, in the above example, "He went in here" would be considered a response to "Where did the pig go?", and "Do you want to feed him?" would not be marked as receiving a response. In cases where the response was ambiguous, the child utterance was classified only as a response to the parent question immediately preceding the child utterance. A secondary coder independently classified the flagged utterances for 20% of each observation, and inter-rater reliability with the primary coder was high (94.7% agreement).

2.5.3 Early predictor variables

As noted above, a subset of children in the sample were included in a prior study investigating joint engagement and language development at 12 and 18 months (Roemer et al., 2022). Children with complete joint engagement data at 18 months and MSEL Expressive Language data at 24 months (11 TL, 13 EL-ND, 16 EL-LD, 9 EL-ASD) contributed to analyses for the third study aim in the present study. Supported and coordinated joint engagement were previously coded continuously as mutually exclusive engagement states with a coding manual adapted from Adamson et al. (2004). For both types of joint engagement, parent and child are actively involved with the same object. In supported joint engagement, the child does not visually acknowledge the parent (for example, parent and child take turns feeding the teddy bear, child does not look up at parent's face). In coordinated joint engagement, the child coordinates their attention, looking back and forth between an object and the parent's face. Additional details on coding, training, and reliability for these measures are described in Roemer et al. (2022).

2.6 Data Reduction and Analytic Approach

This study was designed to examine conversational skills in TL and EL preschoolers, characterize concurrent parent speech, and examine early predictors of conversational skills. Parent and child utterances from 10- to 13-minute toy play observations at 36 months of age were identified, transcribed, and classified, yielding a rich dataset to enhance our understanding of child spoken language and conversational skills and the communicative environments in which they emerge for TL and EL children. Prior to reporting results, preliminary analyses regarding observation duration, procedures for data reduction, and the analytic approach are described below.

2.6.1 Observation Duration

Although most dyads (n = 63 of 84) had exactly 13 minutes of parent-child interaction included, observations for some dyads were either 1) cut short due to fussiness or priority of other study protocols at the visit, 2) had periods of cut-off audio that could not be transcribed, or 3) had prolonged periods of eating, drinking, or singing together, which were excluded from the total observation time during the transcription process. Twenty-one participants had observations lasting 10-13 minutes (7 TL, 6 EL-ND, 5 EL-LD, and 3 EL-ASD). Although TL participants had slightly shorter observations compared to the EL groups (TL: M=12.45 minutes, SD = 1.13; EL-ND: M=12.91 minutes, SD = 0.24; EL-LD: M=12.78 minutes, SD = 0.56; EL-ASD: M= 12.69 minutes, SD = 0.59), a one-way analysis of variance (ANOVA) did not reveal significant differences between groups ($F(3,80) = 2.165$, $p = 0.10$). However, to account for variation in observation time, all frequency variables are calculated as rates (i.e., number of utterances per minute).

2.6.2 Child Language ANalysis (CLAN)

As noted above, parent and child speech was transcribed in Datavyu using the CHAT conventions of the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). Once each transcription was finalized, it was exported from Datavyu into CLAN (MacWhinney, 2000). The RETRACE function was run prior to analyses to automatically insert CHAT symbols to exclude repetitions within utterances. The KIDEVAL function was utilized to calculate the Mean Length of Utterance in Words (MLU) and Number of Different Words (per 100) for child transcriptions and the MLU for parent transcriptions.

To obtain an additional measure of complexity of child responses to parent questions, child transcriptions for 1) responses to *wh*-questions and 2) responses to *other* questions (identified in Datavyu as described above) were exported as two separate datasets into CLAN. The RETRACE and KIDEVAL functions were utilized as described above, yielding the MLU in words for child responses to *wh*-questions and for child responses to *other* questions.

2.6.3 Data Reduction

Child spoken language variables were derived from transcriptions of child speech as described above, with descriptions of data reduction and variable calculations presented in Table 4. Preliminary analyses for child conversational skills were conducted to determine whether there were outcome group differences in *simultaneous* (i.e., overlapping the previous adult utterance) or *near-adjacent* child utterances (i.e., a second child utterance within 5 seconds of the preceding adult utterance). No differences emerged between groups (ps > .10); thus, *simultaneous* and *near-adjacent* utterances were collapsed with *adjacent* utterances to create a single category representing all child utterances occurring within a 5-second window of a parent utterance. The same procedure was conducted for parent responses in conversation; no differences emerged between groups in *simultaneous* or *near-adjacent* parent utterances (ps > .30), and these were collapsed with *adjacent* into a single category representing parent utterances occurring within a 5-second window of a child utterance. Hereafter, these collapsed categories are referred to as *adjacent* child or parent utterances. Further data reduction procedures for child conversational skill variables and parent speech variables are also described in Table 4.

Table 4. Data Reduction Procedures for Child and Parent Speech Variables

Variable	Description/Calculation
<u>Child Spoken Language (Aims 1 and 2)</u>	
Rate of child utterances	(# child vocalizations, unintelligible utterances, and fully or partially intelligible utterances) / observation in minutes
Rate of child utterances with words	((# fully or partially intelligible utterances) – (# utterances containing only filler words or sound effects)) / observation in minutes
Rate of child utterances contributing to MLU	Above, further excluding partially intelligible utterances
Child MLU	Mean Length of Child Utterances in Words
Child NDW	Number of Different Words per 100 words
<u>Child Conversational Skills (Aims 1, 2, and 3)</u>	
Rate of adjacent child utterances	# adjacent utterances (i.e., within 5 seconds of a parent utterance) / observation in minutes
Rate of adjacent child utterances with words	((# adjacent utterances) – (# adjacent utterances classified as vocalizations, unintelligible utterances, or filler words)) / observation in minutes
Rate of contingent child utterances	(# adjacent utterances contingent to the topic of conversation) / observation in minutes
Proportion of adjacent child utterances that are contingent	(# contingent utterances) / (# adjacent utterances with words)
Proportion of contingent child utterances that add new information	(# contingent utterances that add new information) / (# total contingent utterances – # uncodable contingent utterances)
<u>Parent Speech (Aim 2)</u>	
Rate of parent utterances	(# parent utterances) / observation in minutes
Rate of parent utterances contributing to MLU calculations	((# utterances) – (# utterances considered unintelligible or uncodable, fillers, or sound effects)) / observation in minutes
Parent MLU	Mean Length of Parent Utterances in Words
Rate of adjacent parent utterances	# adjacent utterances (i.e., within 5 seconds of a child utterance) / observation in minutes
Rate of contingent parent utterances	(# adjacent utterances contingent to the topic of conversation) / observation in minutes
Proportion of adjacent parent utterances that are contingent	(# contingent utterances) / (# adjacent utterances - # adjacent utterances considered uncodable due to following a child vocalization or unintelligible utterance for which the topic could not be determined)
Proportion of Utterances that are Wh-Questions	(# wh-questions) / (# utterances)
Proportion of Utterances that are Other Questions	(# other questions) / (# utterances)

2.6.4 Analytic Approach

All analyses were conducted in R 4.0.3 (R Core Team, 2020) with the exception of mediation analyses conducted using PROCESS in SPSS 28.0 (Hayes, 2013). Given the well-documented relations between caregiver education and child language (e.g., Cabrera et al., 2007; Rowe et al., 2005) and differences between TL and EL groups in parental education in this sample (see Table 1), mean parent education was initially included as a covariate for all analyses (i.e., included as a covariate in ANCOVAs examining differences between groups and in regressions examining the relationship between variables). Parent education information was missing for one EL-LD participant, and inclusion as a covariate did not change the pattern of results in any analyses. Therefore, analyses are reported without parent education in models to retain maximal power. Notably, the sample was homogeneous with limited variability in parent education, as the large majority (89-100%) of parents of TL and EL children had completed at least some college. Additionally, child sex was included as a covariate and where child sex was a significant predictor, these effects are reported in the results. Data were examined prior to analyses for outliers and to verify analytic assumptions (e.g., normality of residuals, homoscedasticity). In the case of violations, winsorizing of outliers and robust methods with bootstrapping were carried out as described in the results.

For the first aim, child spoken language and conversational skills variables listed in Table 4 were entered as dependent variables in a series of one-way ANCOVAs with outcome group (TL, EL-ND, EL-LD, EL-ASD) as the independent variable and child sex as a covariate. Where significant main effects emerged, post-hoc comparisons between groups were examined with

Bonferroni corrections applied for multiple comparisons. To examine relations between child spoken language and conversational skills and determine whether associations differed by outcome group, linear regression analyses were conducted with child sex as a covariate and outcome group status as a moderator; TL children were the reference group, and a dummy variable was created for each EL outcome group.

For the second aim, a series of one-way ANCOVAs were conducted as described above, with parent speech variables in Table 4 as dependent variables. Next, parent contingent responses, MLU, and wh-questions were examined in relation to child spoken language and conversational skills in a series of partial correlations with child sex included as a covariate. To examine differences in child responses to parent *wh*- vs *other* questions, we conducted a series of 2 x 4 repeated-measures ANOVAs with question type as a within-subjects variable and outcome group as a between-subjects variable. Dependent variables in these analyses were child contingent responses that add new information to the conversation in response to parent questions, and the MLU of responses to parent questions.

Finally, the proportions of observation time spent in coordinated joint engagement at 18 months (previously reported in Roemer et al., 2022) and the Mullen Scales of Early Learning Expressive Language T-scores at 24 months were examined as predictors of child conversational skills. For these analyses, we examined both child contingent responses and the proportion of contingent responses that add new information as dependent variables reflecting different aspects of conversational skills. We first examined Pearson's correlations between variables, then examined a mediation model to estimate direct and indirect effects (Hayes, 2013).

3.0 RESULTS

This study had three primary aims. The first was to examine profiles of child spoken language (intelligible utterances, MLU, NDW) and conversational skills (topic-contingent utterances, adding new information to the conversation). We tested whether these skills differed across TL and EL preschoolers with a range of developmental outcomes and examined the relation between spoken language ability and conversational skills across groups. The second aim was to characterize caregiver speech in order to consider child language and conversational skills in the context of the communicative environments in which they develop. To this end, we examined group differences in aspects of parent speech, characterized the relation between parent speech and child spoken language and conversational skills, and examined whether parent *wh*-questions were more likely to elicit more complex child responses than other types of questions across outcome groups. Finally, as an initial foray into examining early predictors of conversational skills in EL siblings, we tested a mediation model of 18-month coordinated joint engagement and 24-month expressive language from a standardized measure as predictors of 36-month conversational skills. Descriptive statistics and analyses for each of these aims are presented in turn below.

3.1 Profiles of child language and conversational skills (Aim 1)

The first aim of this study was to examine profiles of child spoken language and conversational skills across outcome groups, and to examine the relation between the two. Given the previously documented differences in standardized measures of expressive language in this sample, we expected the EL-ASD and EL-LD groups to have shorter and fewer intelligible utterances than their TL and EL-ND peers at 36 months. With regard to conversational skills, we expected the EL-ASD group to produce fewer topic-contingent responses and to be less likely to add new information to the conversation compared to their neurotypical peers, given the well-documented challenges with pragmatic language in this group (e.g., Tager-Flusberg et al., 2011). Although prior literature examining pragmatic language in EL-LD siblings is sparse, we expected this group to fall between their EL-ASD and neurotypically developing peers in conversational skills.

3.1.1 Child spoken language

Descriptive statistics and one-way ANCOVAs examining differences between groups in child spoken language variables (described in Table 4 above) are presented in Table 5 and Figure 1. The assumption of homoscedasticity was violated for the rate of child utterances, thus a robust test statistic with bootstrapping was conducted for this variable. The pattern of results was unchanged, so the parametric ANCOVA is reported. Additionally, one outlier in NDW in the EL-ND group was winsorized prior to analyses.

Table 5. Child Spoken Language across Outcome Groups

	Typical Likelihood (n=16)		EL – No Diagnosis (n=37)		EL – Language Delay (n=21)		EL – ASD (n=10)		One-way ANCOVA	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	*p*
Rate of utterances per minute	14.75	5.01	13.3	3.18	12.49	5.19	10.37	5.9	2.28	0.086
Rate of utterances with words	11.07	4.17	10.45	3.14	9.2	4.21	5.26	4.75	5.89	0.001
Rate of utterances contributing to MLU	9.6	4.18	9.29	2.84	7.64	3.76	4.32	4.01	6.36	<0.001
Overall MLU	2.62	0.57	2.56	0.46	2.06	0.39	1.54	0.61	15.39	<0.001
NDW per 100 words[a]	47.38	7.1	47.78	7.99	47	5.83	(---)	(---)	0.088	0.916

Note: MLU = Mean Length of Utterance in Words; NDW = Number of Different Words; All comparisons were conducted with ANCOVA, covarying child sex; [a]NDW could only be calculated for children who produced more than 50 fully intelligible utterances, therefore, the EL-ASD group was excluded from analyses on this variable.

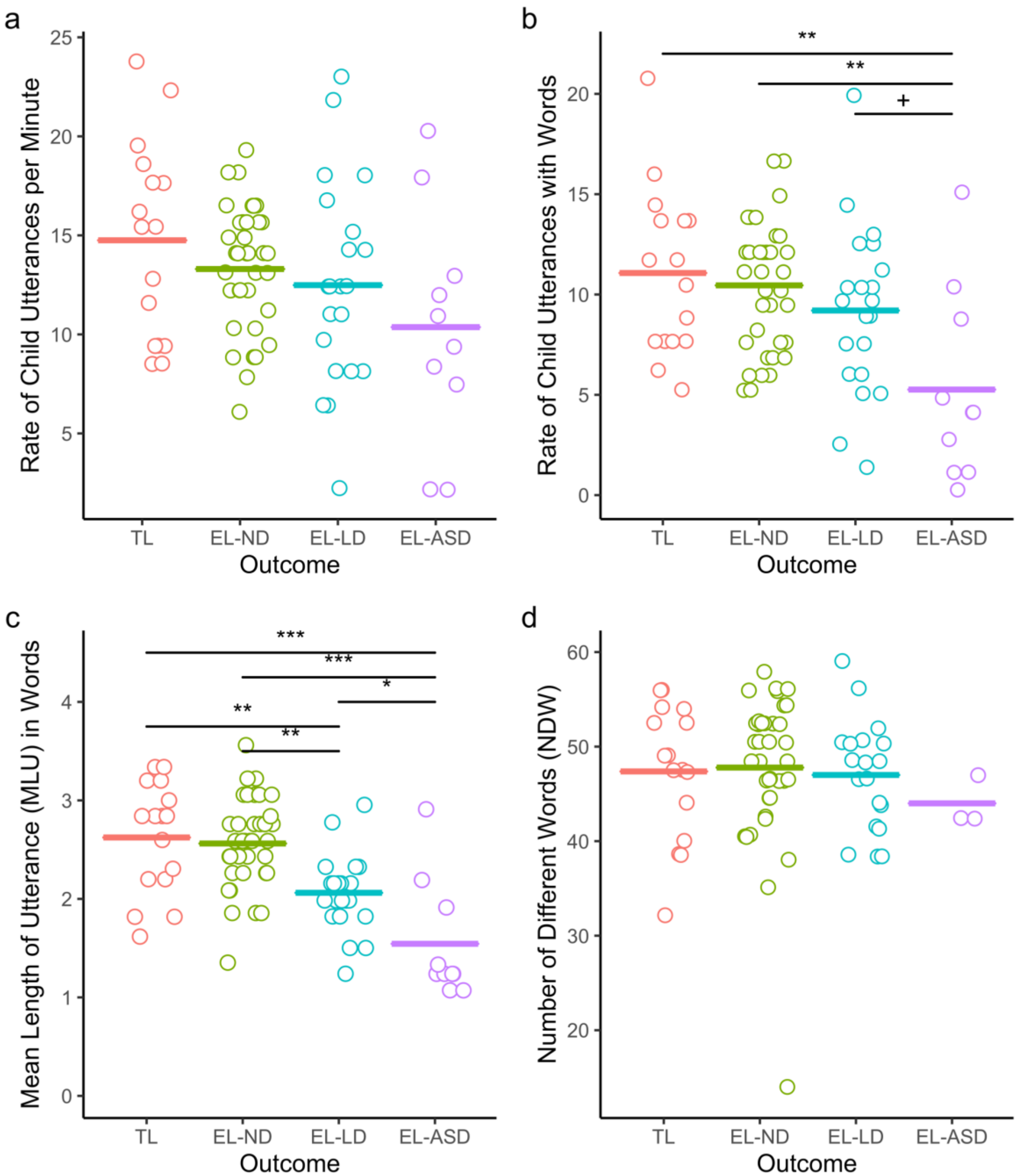

Figure 1. Child Spoken Language across Outcome Groups
Note: Each circle represents a child; colored bars represent group means. The EL-ASD group is excluded from analyses related to NDW (panel d) but the three EL-ASD children with more than 50 fully intelligible utterances are depicted for descriptive purposes.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$

As shown in Figure 1a, the TL group produced on average 14.8 utterances per minute. While the EL-ND, EL-LD, and EL-ASD groups produced slightly lower rates of utterances per minute (13.3, 12.5, and 10.4, respectively), there was not a significant difference between groups ($p = 0.086$). While groups did not differ in their production of utterances per minute, we expected the EL-ASD and EL-LD groups to produce fewer intelligible utterances. Rates of utterances with intelligible words (i.e., partially intelligible utterances) and utterances contributing to MLU (i.e., fully intelligible utterances) are presented in Table 4 and Figure 1b.

On both measures, TL and EL-ND children produced approximately 9 to 11 intelligible utterances per minute. Consistent with hypotheses, EL-ASD children produced fewer than half the intelligible utterances per minute compared to their TL peers, and the EL-LD group showed an intermediate pattern in their production of intelligible utterances. One-way ANCOVAs confirmed between-group differences for partially and fully intelligible utterances ($F(3,79) = 5.89$, $p = 0.001$; $F(3,79) = 6.36$, $p < 0.001$, respectively), with post-hoc pairwise comparisons showing the EL-ASD group produced fewer intelligible utterances on both measures than their TL and EL-ND peers (*p*s < .01), but did not significantly differ from the EL-LD group (*p*s = 0.054; 0.094). The EL-LD group did not differ significantly from their TL and EL-ND peers (*p*s > .50).

Examining only the fully intelligible utterances produced, we expected the EL-ASD and EL-LD groups to produce shorter utterances than their peers (MLU in words[2]; presented in Figure 1c). While TL and EL-ND children produced an average of 2.6 words per utterance, EL-LD

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[2] Prior to analyses, the MLU in words (MLUw) was compared to the MLU in morphemes (MLUm) and to the MLU50 (i.e., MLU in words of the first 50 utterances for those with at least 50 fully intelligible utterances). These measures were highly correlated (*r*s > 0.93, *p*s < 0.001). Examining MLU50 excluding the ASD group (for whom this measure could only be calculated for 3 of 10 participants), a one-way ANOVA showed significant differences (p=.002), with the EL-LD group producing shorter utterances than their TL and EL-ND peers (*p*s = 0.005). To retain the full sample and for ease of interpretation, MLUw (including all fully intelligible utterances, even for those producing fewer than 50 intelligible utterances) was utilized throughout as our measure of grammatical complexity and described simply as "MLU".

children produced utterances containing approximately 2 words on average, and EL-ASD children produced 1- to 2- word utterances on average. A one-way ANCOVA confirmed these group differences ($F(3,79) = 15.39$, $p < 0.001$). Consistent with hypotheses, post-hoc comparisons revealed significantly shorter utterances for EL-ASD children compared to all other groups ($ps < 0.05$). EL-LD children showed an intermediate pattern, producing longer utterances than the EL-ASD group, but shorter utterances than their TL and EL-ND peers ($ps < 0.01$).

As a measure of vocabulary diversity, we examined the Number of Different Words in the first 100 words (NDW). This measure could only be calculated for children whose transcripts contained at least 50 fully intelligible utterances, and notably, most of the EL-ASD group (7 out of 10) and two EL-LD children (of 21) did not meet this criterion. While the individual data and mean NDW for the three EL-ASD children who had sufficient intelligible utterances are presented in Figure 1d for descriptive purposes, the EL-ASD group was excluded from statistical analyses for this variable. As shown in Table 5 and Figure 1d, the TL, EL-ND, and EL-LD groups each produced an average of 47-48 different words per 100 words. A one-way ANCOVA revealed no significant differences between groups ($F(2, 68) = 0.088$, $p = 0.916$). Thus, while EL-LD children produced shorter utterances, they used similarly diverse vocabularies as their TL and EL-ND peers.

3.1.2 Conversational skills

Descriptive statistics and one-way ANCOVAs examining differences between groups in child conversational skills variables (described in Table 4) are presented in Table 6 and Figure 2. Assumptions of normality of residuals and/or homoscedasticity were violated for the rate of adjacent utterances with words, rate of contingent utterances, and proportion of adjacent utterances that were contingent; thus, robust tests with bootstrapping were conducted for these variables. The pattern of significant results was unchanged; thus, parametric ANCOVAs are reported for ease of interpretation. Additionally, one outlier in the proportion of contingent utterances that add new information was winsorized prior to analyses.

Table 6. Child Conversational Skills across Outcome Groups

	Typical Likelihood (n=16)		EL – No Diagnosis (n=37)		EL –Language Delay (n=21)		EL – ASD (n=10)		One-way ANCOVA	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	*p*
Rate of Adjacent Utterances	11.19	4.22	10.31	3.09	9.86	3.9	8.47	4.72	1.29	0.282
Rate of Adjacent Utterances w/ Words	8.7	3.71	8.45	2.93	7.56	3.41	4.35	4.07	4.81	0.004
Rate of Contingent Utterances	8.2	3.67	8.03	2.74	7.21	3.25	3.98	3.71	5.17	0.003
Proportion of Adjacent Utterances with Words that are Contingent	0.93	0.05	0.95	0.03	0.95	0.05	0.92	0.07	2.02	0.117
Proportion of Contingent Utterances that Add New Information	0.27	0.1	0.29	0.09	0.25	0.12	0.14	0.09	6.36	<.001

Note: All comparisons were conducted with ANCOVA, covarying child sex.

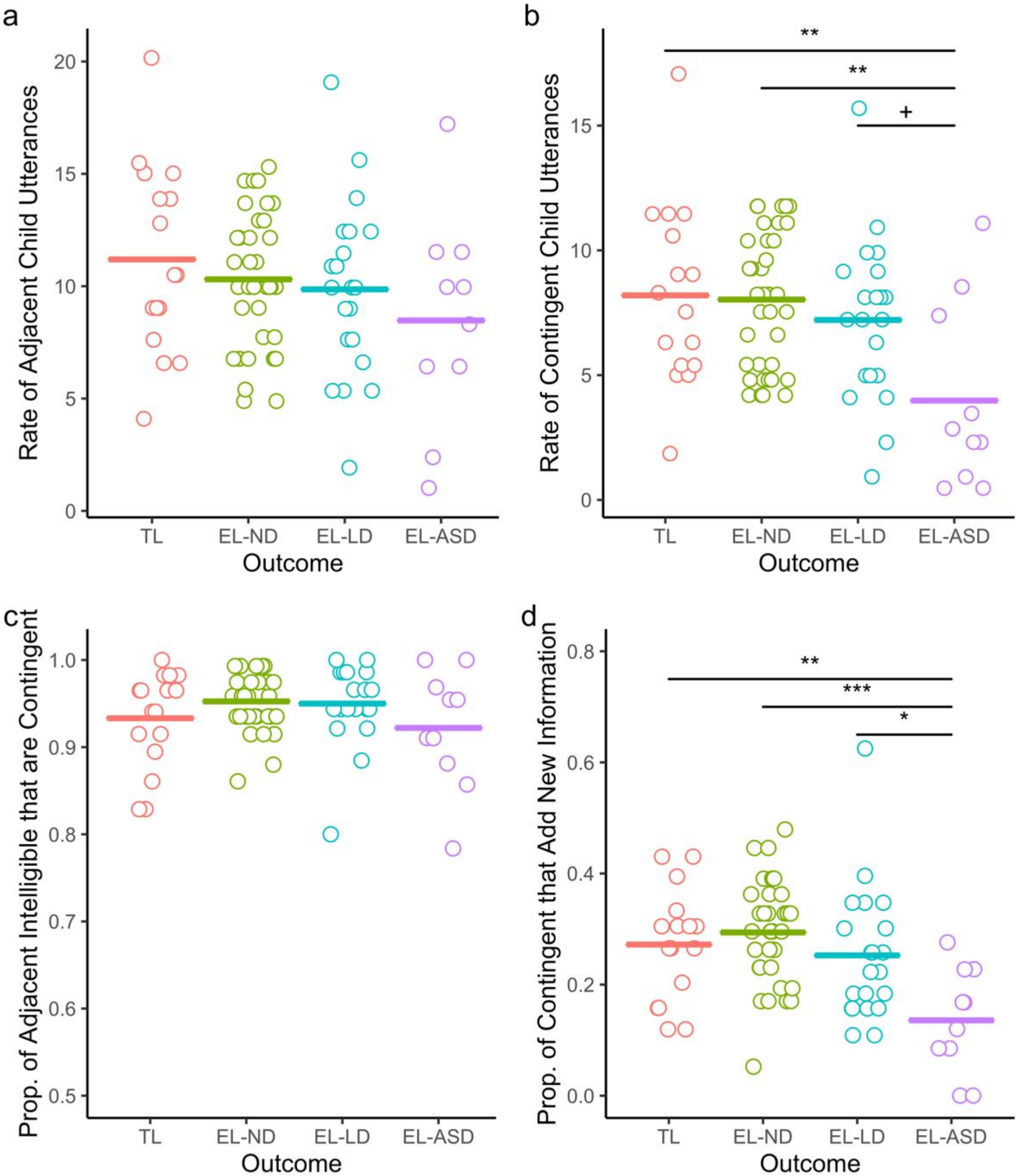

Figure 2. Child Conversational Skills across Outcome Groups

Note. Prop. = Proportion; Each circle represents one child; colored bars represent outcome group means; *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$

As shown in Figure 2a, children produced on average 8 to 11 adjacent utterances per minute (i.e., responding within 5 seconds to a parent utterance). There were no significant differences by outcome group ($F(3,79) = 1.29$, $p = 0.282$), though there was a significant effect of child sex ($F_{sex} = 4.65$, $p = 0.034$), with males ($M = 10.84$, $SD = 3.39$) producing more adjacent utterances than females ($M = 9.08$, $SD = 4.07$). Consistent with overall group differences in intelligible utterances described above, when considering only adjacent utterances with intelligible words, the TL group produced double the rate of adjacent intelligible utterances than their EL-ASD peers (8.7 vs. 4.4 per minute). A one-way ANCOVA confirmed a significant difference between groups ($F(3.79) = 4.81$, $p = 0.004$). Post-hoc comparisons with Bonferroni corrections showed that the EL-ASD group produced fewer adjacent utterances that were intelligible than their TL and EL-ND peers (ps < 0.05) but did not differ significantly from their EL-LD peers ($p = 0.089$).[3]

Similarly, when considering the rate per minute of utterances that were contingent to the topic of conversation (see Figure 2b), TL children produced more than double the rate of contingent utterances than their EL-ASD peers (8.2 vs. 4.0 per minute). A one-way ANCOVA confirmed this difference ($F(3,79) = 5.17$, $p = 0.003$). Post-hoc comparisons showed the EL-ASD group produced fewer contingent utterances than their TL and EL-ND peers (ps < 0.01) but did not differ significantly from their EL-LD peers ($p = 0.059$). However, it is important to note that only utterances with at least one intelligible word could be classified for whether they were contingent to the topic. Therefore, we also examined the proportion of adjacent intelligible utterances that were contingent (see Figure 2c). All groups were highly likely to produce utterances

[3] To examine group differences in the rate of adjacent child utterances and the rate of adjacent child intelligible utterances when controlling for the rate of parent utterances, additional ANCOVAs were conducted with the rate of parent utterances and child sex as covariates. The pattern of results was unchanged, with a significant effect of child sex ($p = 0.022$) and no effect of outcome group ($p > 0.05$) for the rate of adjacent child utterances, and a significant effect of outcome group ($p < 0.001$) for adjacent child intelligible utterances.

contingent to their parents' topic of conversation (92 to 95% of adjacent utterances with intelligible words), and a one-way ANCOVA did not reveal differences between groups ($F(3,79) = 2.02$, $p = 0.117$). Thus, while children with ASD produced fewer utterances that were contingent to the topic of conversation, when they *did* produce intelligible utterances following a parent utterance, they were highly contingent to the topic.

Next, we examined the proportion of contingent child utterances that added new information to the conversation. As shown in Figure 2d, approximately 25 to 27% of contingent utterances added new information for the TL, EL-ND, and EL-LD groups, compared to 14% for the EL-ASD group. A one-way ANCOVA confirmed a significant difference between groups ($F(3,79) = 6.36$, $p < 0.001$), with post-hoc comparisons revealing that EL-ASD children's contingent utterances were significantly less likely to add new information to the conversation than all other groups (ps < 0.05). Sex was also a significant predictor of the proportion of contingent utterances that add new information ($F_{sex} = 6.98$, $p = 0.01$); females ($M = 0.295$, $SD = 0.103$) were more likely to add new information to the conversation than males ($M = 0.238$, $SD = 0.109$).

3.1.3 Relation between child spoken language and conversational skills

To examine the relation between child spoken language and conversational skills, we conducted linear regressions examining MLU and NDW in relation to our two measures of conversational skills that control for group differences in intelligibility (i.e., the proportion of adjacent intelligible utterances that were contingent, and the proportion of contingent utterances that add new information to the conversation). As noted above, outliers in the NDW and the proportion of contingent utterances that add new information were winsorized prior to analyses. Analyses involving NDW were limited to the TL, EL-ND, and EL-LD groups due to most participants in the EL-ASD group having insufficient intelligible utterances to calculate this variable. While the EL-ASD group was excluded from analyses involving NDW, the relation between both complexity (MLU) and vocabulary diversity (NDW) with conversational skills for the EL-LD group was of particular interest given the lack of prior research examining both structural and pragmatic language for EL-LD preschoolers.

Linear regressions with outcome group included as a moderator are presented in Table 7 and displayed in Figure 3. As shown in Figure 3a, the proportion of contingent utterances was not associated with MLU – regardless of utterance length, all groups were highly likely to be contingent to the topic of conversation when they produced intelligible utterances. However, as shown in Figure 3b, there was a negative relation between NDW and the proportion of contingent utterances for TL children ($B = -0.003$, $p < 0.01$). This was moderated by outcome group such that the EL-LD group did not show this negative relationship between contingent utterances and NDW, with EL-ND children falling in between. As can be seen in Figure 3b, this appears to be driven by a cluster of three TL children and one EL-ND child with large vocabularies (> 50 different words per 100 word tokens) who were somewhat less likely to produce contingent utterances than their peers. Yet, most adjacent intelligible utterances were still contingent to the topic of conversation for these children (all over 80%).

Table 7. Child Spoken Language in Relation to Child Conversational Skills

	Proportion of Adjacent Intelligible Utterances that are Contingent		Proportion of Contingent Utterances that Add New Information	
	Estimate	SE	Estimate	SE
Intercept	0.940***	0.056	0.020	0.099
Female	-0.017	0.010	0.034+	0.019
MLU (TL ref group)	-0.001	0.021	0.092*	0.037
EL-ND	0.056	0.070	-0.109	0.125
EL-LD	0.038	0.078	-0.045	0.139
EL-ASD	-0.002	0.069	-0.010	0.123
MLU * EL-ND	-0.013	0.026	0.051	0.047
MLU * EL-LD	-0.010	0.033	0.036	0.059
MLU * EL-ASD	-0.006	0.032	-0.017	0.058
	Estimate	SE	Estimate	SE
Intercept	1.099***	0.062	-0.042	0.146
Female	-0.010	0.009	0.036+	0.021
NDW(TL ref group) [a]	-0.003**	0.001	0.006*	0.003
EL-ND	-0.078	0.075	0.073	0.177
EL-LD	-0.173+	0.092	0.024	0.219
NDW * EL-ND	0.002	0.002	-0.001	0.004
NDW * EL-LD	0.004*	0.002	-0.001	0.005

+ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[a]NDW could only be calculated for children who produced more than 50 fully intelligible utterances; thus, NDW could not be calculated for 2 EL-LD and 7 EL-ASD children. To examine moderations by group, the EL-ASD group was excluded from analyses on this variable.

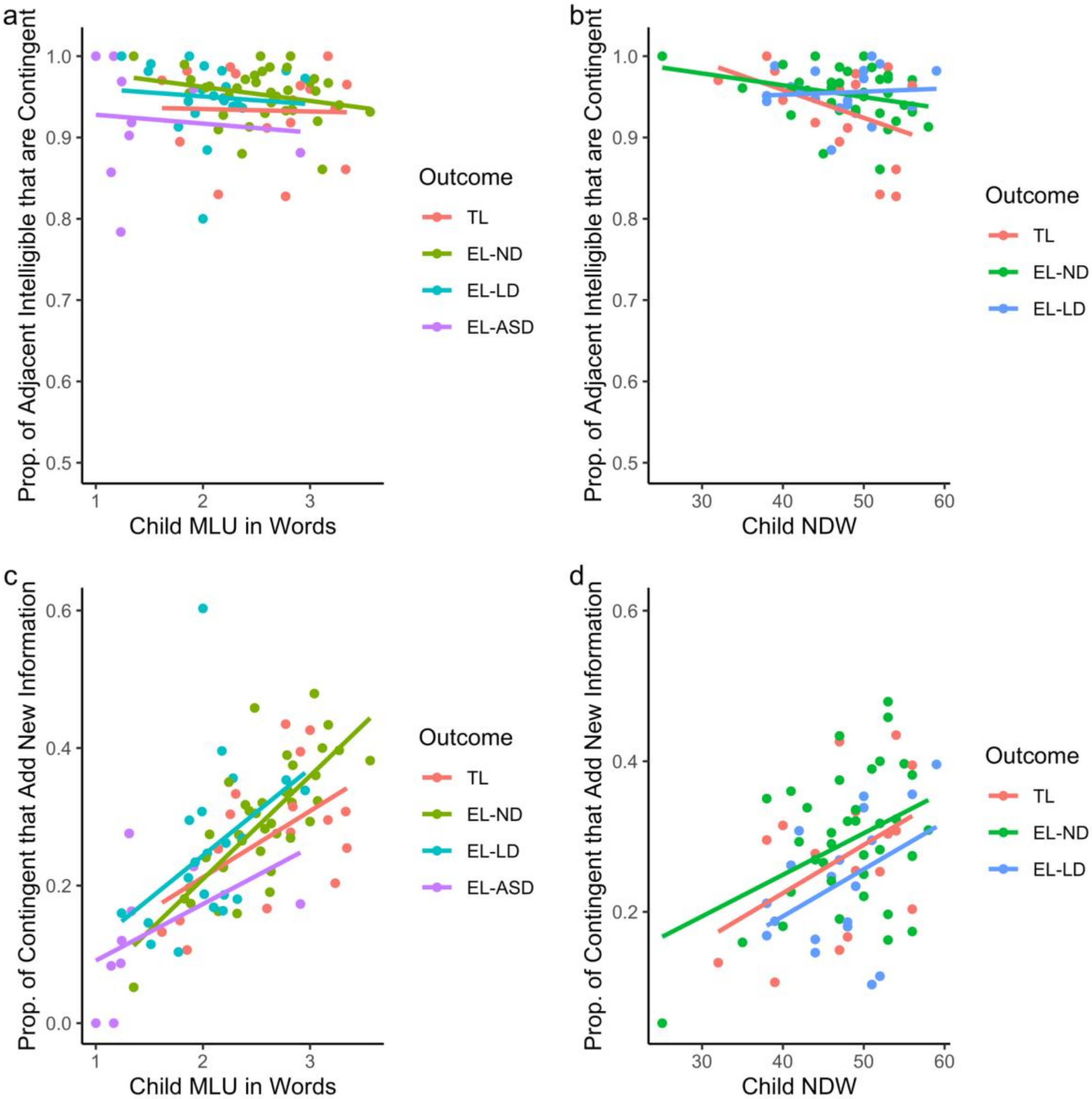

Figure 3. Relation between Child Spoken Language and Conversational Skills by Outcome Group
Note: Prop. = Proportion; NDW could only be calculated for children who produced more than 50 fully intelligible utterances; thus, NDW could not be calculated for 2 EL-LD and 7 EL-ASD children. To examine moderations by group, the EL-ASD group was excluded from analyses on this variable.

While topic contingency was not positively related to MLU and NDW, MLU and NDW were correlated with the proportion of contingent utterances that add new information to the conversation (Figures 3c and 3d). As shown in Figure 3c and Table 7, a one-word increase in MLU was associated with a 9.2% increase in the proportion of contingent utterances that add new information for TL children ($B = 0.092$, $p < 0.05$). This association was not moderated by outcome group, with a similar positive relation between MLU and adding new information to the conversation for all groups. As shown in Figure 3d, NDW (excluding the EL-ASD group due to insufficient intelligible utterances), was also positively associated with adding new information to the conversation. Every one-word increase in vocabulary (per 100 words) was associated with a 0.6% increase in adding new information to the topic of conversation ($B = 0.006$, $p < 0.05$) for the TL group. This was not moderated by outcome group, such that similar positive associations were apparent for the EL-ND and EL-LD groups.

3.1.4 Summary of results (Aim 1)

In sum, while all groups produced similar rates of utterances, EL-ASD children produced less than half the rate of intelligible utterances as their TL and EL-ND peers. Further, considering only fully intelligible utterances, EL-ASD and EL-LD children both produced shorter utterances than their neurotypically developing peers, on average using one- or two-word utterances as opposed to two- to three-word utterances. While most EL-ASD children did not produce sufficient intelligible utterances to calculate vocabulary diversity (i.e., 7 out of 10 had fewer than 50 intelligible utterances), EL-LD children who produced more than 50 intelligible utterances (all but two in this group) had similar vocabulary diversities to their TL and EL-ND peers (47-48 different words per 100 words).

All groups produced similar rates of utterances that were adjacent to (i.e., within 5 seconds of) a parent utterance. Since the EL-ASD group produced substantially fewer *intelligible* utterances and only intelligible utterances could be classified for topic contingency, it is not surprising that the EL-ASD group tended to produce fewer contingent (i.e., on-topic) utterances per minute than their EL-LD peers and produced less than half the rate of contingent utterances compared to TL and EL-ND peers. When only intelligible adjacent utterances were examined, all groups were highly contingent to the topic of conversation. Thus, in contrast to our predictions, even EL-ASD children were very likely to produce topic-contingent speech *when their utterances were intelligible* - on average over 90% of intelligible adjacent utterances were contingent to the topic for each group. In fact, over 75% were contingent to the topic for *every* child in our sample. However, the EL-ASD group was less likely to add new information to the conversation when they produced contingent utterances. The EL-LD group, on the other hand, was just as likely to add new information to the conversation as their TL and EL-ND peers.

The proportion of intelligible utterances that were contingent was not positively related to MLU or NDW – regardless of utterance length or vocabulary, when utterances were intelligible, they were very likely to be contingent to the topic (and if anything, slightly less contingent for a few TL children with larger vocabularies). However, children across outcome groups who produced longer utterances (MLU) and had larger vocabularies (NDW) were more likely to add new information to the conversation.

3.2 Parent speech in relation to child language and conversational skills (Aim 2)

The second aim of this study was to characterize parent speech in conversational exchanges and to examine whether and how aspects of parent speech (i.e., parent MLU, contingent responses, and use of *wh*-questions) relate to child spoken language and conversational skills. Given the scarcity of prior research on conversational skills in EL preschoolers, this aim was somewhat exploratory in nature. However, based on prior work with neurotypically developing children and children with developmental delays, we expected contingent parent responses and more complex parent speech (i.e., longer MLU, more *wh*-questions) to be positively associated with concurrent child MLU. We also expected that parent *wh*- questions would be supportive of longer child utterances and contingent responses that add new information to the exchange (Rowe et al., 2017; Yoder et al., 1994).

3.2.1 Characterizing parent speech

Descriptive statistics and one-way ANCOVAs examining differences between groups in parent speech variables (described in Table 4) are presented in Table 8. Child sex was included as a covariate. Assumptions of normal distributions were violated for the proportion of adjacent utterances that were contingent, the proportion of utterances that were *wh*-questions, and the proportion of utterances that were other questions; thus, robust tests with bootstrapping were conducted for these variables. The pattern of results was unchanged, so the parametric ANCOVAs are reported for ease of interpretation. One outlier in the proportion of adjacent utterances that were contingent was winsorized prior to analyses.

Table 8. Parent Speech across Outcome Groups

Parent speech variable	Typical Likelihood (n=16)		EL – No Diagnosis (n=37)		EL –Language Delay (n=21)		EL – ASD (n=10)		One-way ANOVA	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Test statistic	p
Rate of parent utterances	16.50	4.44	18.75	5.22	19.65	5.43	19.17	5.33	1.22	0.310
Rate of parent utterances contributing to MLU	15.71	4.23	17.68	4.92	18.47	5.25	18.10	4.90	1.04	0.381
Parent MLU	4.11	0.57	3.87	0.46	3.65	0.46	3.21	0.46	8.19	< .001
Rate of parent utterances adjacent to child utterance	11.92	3.99	11.89	3.50	11.52	3.81	10.00	4.74	0.90	0.448
Rate of contingent parent utterances	9.08	3.50	9.25	3.12	8.54	3.51	4.96	3.96	4.77	0.004
Proportion of parent adjacent utterances[a] that are contingent	0.933	0.046	0.914	0.073	0.928	0.057	0.938	0.056	0.47	0.702
Proportion of parent utterances that are *wh*-questions	0.119	0.059	0.141	0.053	0.143	0.051	0.113	0.067	1.03	0.383
Proportion of parent utterances that are other questions	0.255	0.102	0.201	0.066	0.213	0.072	0.204	0.100	2.00	0.121

Note: EL = Elevated Likelihood of ASD; All comparisons were conducted with ANCOVA, covarying child sex.

[a] Since topic contingency of parent utterances could only be determined when the preceding child utterance was intelligible, this proportion excludes adjacent utterances following child vocalizations and unintelligible utterances.

Parent speech was largely similar across outcome groups (see Table 8). Parents produced on average 16 to 20 utterances per minute, and about 16 to 18 of those utterances per minute contributed to MLU calculations (i.e., were not non-word sound effects, fillers, etc.). Parents also did not differ significantly across groups in the proportion of their utterances that were *wh*-questions (11 to 14%) or other questions (20 to 26%; *p*s > 0.12). However, there were notable differences in parent MLU. Parents of TL and EL-ND children on average produced 4.1-word and 3.9-word utterances, while parents of EL-LD and EL-ASD children respectively produced on average 3.7- and 3.2-word utterances. A one-way ANCOVA confirmed this difference ($F(3,79) = 8.19$, $p < 0.001$). Pairwise comparisons revealed that parents of EL-ASD children produced significantly shorter utterances than parents of TL and EL-ND children (*p*s < 0.01), and parents of EL-LD children also produced shorter utterances than parents of TL children ($p = 0.03$). There was also a significant effect of child sex on parent MLU ($F_{sex} = 5.91$, $p = 0.017$), such that parents of girls ($M = 3.94$, $SD = 0.56$) produced longer utterances than parents of boys ($M = 3.68$, $SD = 0.51$).

Examining parent responses in conversation, parents produced on average 10-12 utterances per minute that were adjacent to (i.e., within 5 seconds of) a child utterance, and this did not differ significantly between groups.[4] While parents did not differ across outcome groups in the rate of adjacent utterances (which could occur as responses to child vocalizations and unintelligible utterances), they did differ in their rate of utterances contingent to the conversational topic of the preceding child utterance. Notably, topic contingency could only be classified when the preceding child utterance contained at least one intelligible word – thus, when child utterances were mostly

[4] To examine potential group differences in the rate of adjacent parent utterances controlling for the rate of child utterances, an additional ANCOVA was conducted with the rate of child utterances and child sex as covariates. The pattern of results was unchanged, with no effect of outcome group ($p > 0.05$) for the rate of adjacent parent utterances.

unintelligible, parents had fewer opportunities to respond contingently to their child's topic. A one-way ANCOVA confirmed a between-group difference ($F(3,79) = 4.77$, $p = 0.004$), with post-hoc comparisons showing parents of EL-ASD children used fewer contingent utterances than all other groups (*p*s < 0.05). However, when examining the proportion of adjacent utterances excluding those following a child vocalization or unintelligible utterance, parents in all groups were highly contingent to their child's topic of conversation (91-93%), with no significant difference between groups ($p = 0.702$). Thus, when children produced intelligible speech, parent responses were highly likely to be contingent to their child's topic across outcome groups.

3.2.2 Relations between parent and child speech

Next, we examined relations between aspects of parent speech (rate of utterances, proportion of adjacent responses that were contingent, MLU, and proportion of utterances that were *wh*-questions) and child spoken language (rate of utterances, intelligible utterances, and MLU) and conversational skills (proportion of adjacent intelligible responses that were contingent to the topic, proportion of contingent responses that add new information). Partial correlations between parent and child variables, controlling for child sex, are presented in Table 9. Consistent with hypotheses that complexity of parent speech would be related to child spoken language and conversational skills, parent MLU was significantly associated with the rate of child fully intelligible utterances, child MLU, and the proportion of child contingent utterances that add new information (*p*s < 0.05). Thus, when children produced more intelligible and longer utterances and added new information to the conversation more often, their parents were more likely to use longer utterances during the observation.

Table 9. Partial correlations between child spoken language and conversational skills and parent speech

Parent Speech Variable:	Rate of Child Utterances	Rate of Child Fully Intelligible Utterances	Child MLU	Proportion of Adjacent Intelligible Utterances that are Contingent	Proportion of Contingent Utterances that Add New Information
Rate of Parent Utterances	-0.107	-0.005	-0.143	0.057	-0.013
Proportion of Adjacent Parent Utterances that are Contingent	0.021	0.066	0.014	0.014	0.107
Parent MLU	0.07	**0.236***	**0.453*****	-0.025	**0.248***
Proportion of Parent Utterances that are *wh*-questions	0.063	.189+	0.102	-0.02	-0.003

Note: + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

3.2.3 Do parent *wh*-questions elicit more complex responses than other questions?

To examine whether parent *wh*- questions were more supportive of longer child utterances and contingent responses that add new information in comparison to other questions, we conducted a series of 2 (question type) x 4 (outcome) repeated measures mixed ANOVAs. Dependent variables in these analyses were sequential in nature – as noted in the methods, child responses to parent questions (i.e., adjacent responses occurring after a parent *wh*-question or other question) were classified to examine the proportion of parent *wh*- and other questions receiving a child response. We examined responses that added new information to the conversation and imported subsets of child utterances into CLAN to yield the MLU of responses to each question type. Two children (one EL-LD and one EL-ASD) did not produce an intelligible response to any *wh*-questions, so MLU in response to *wh*-questions could not be calculated for these children. Thus, these two participants were list-wise deleted from analyses.

As shown in Table 10 and Figure 4a, the EL-ASD group was less likely to respond by adding new information in comparison to other groups for both *wh*- and other questions. However, across all groups, children were more likely to respond by adding new information following parent *wh*-questions than other questions. For example, the EL-ASD group responded to 6% of parent *wh*-questions by adding new information to the conversation, as opposed to 3% of other questions, and the TL group responded to 20% of *wh*-questions by adding new information, as opposed to 14% of other questions. A repeated-measures mixed ANOVA revealed a main effect of question type ($F(1,80) = 22.25$, $p < 0.001$) and a main effect of outcome group ($F(3,80) = 6.98$, $p < 0.001$), but no significant interactions between the two ($F(3, 80) = 2.03$, $p = 0.116$). Post-hoc comparisons showed that the EL-ASD group was less likely to add new information in response to parent questions than any other group (*p*s < 0.01).

As shown in Figure 4b, a similar pattern emerged when examining the length of child responses to *wh*-questions and other questions. The EL-ASD group produced on average 1.79-word utterances in response to *wh*-questions as opposed to 1.37-word utterances in response to other questions, and the TL group produced 2.6-word utterances in response to *wh*-questions as opposed to 2.13-word utterances in response to other questions. A repeated measures mixed ANOVA revealed a main effect of question type, such that *wh*-questions received longer responses than other questions ($F(1.78) = 26.79$, $p < 0.001$). The ANOVA also revealed a main effect of outcome ($F(3,78) = 8.22$, $p < 0.001$), but no interaction ($F(3.78) = 0.214$, $p = .887$). Similar to MLU across the full observation as reported in Aim 1, post-hoc comparisons showed the EL-ASD group and the EL-LD group had a shorter MLU (i.e., produced shorter utterances) in response to parent questions overall than the TL and EL-ND groups ($p < 0.05$). Thus, while the EL-ASD and EL-LD groups produced shorter utterances and the EL-ASD group was less likely to add new information to the conversation, parent *wh-* questions appear to provide a boost in both the length and conversational skill of child utterances in comparison to other questions across outcome groups.

Table 10. Child Responses to Parent Wh- vs. Other Questions

Variable	Q Type	TL		EL-ND		EL-LD		EL-ASD		Mixed ANOVAs		
		M	SD	M	SD	M	SD	M	SD	Q Type	Outcome	Q Type x Outcome
Proportion Q's that Child Adds New Information	Wh-	0.20	0.16	0.24	0.12	0.16	0.13	0.06	0.07	F=22.25	F=6.98	F=2.03
	Other	0.14	0.08	0.14	0.07	0.12	0.09	0.03	0.04	p<0.001	p<0.001	p=0.116
MLU of Child Responses to Parent Q's	Wh-	2.60	0.89	2.58	0.59	2.14	0.58	1.79	0.58	F=26.79	F=8.22	F=0.214
	Other	2.13	0.56	2.22	0.48	1.82	0.42	1.37	0.55	p<0.001	p<0.001	p=0.887

Note: Q = Question

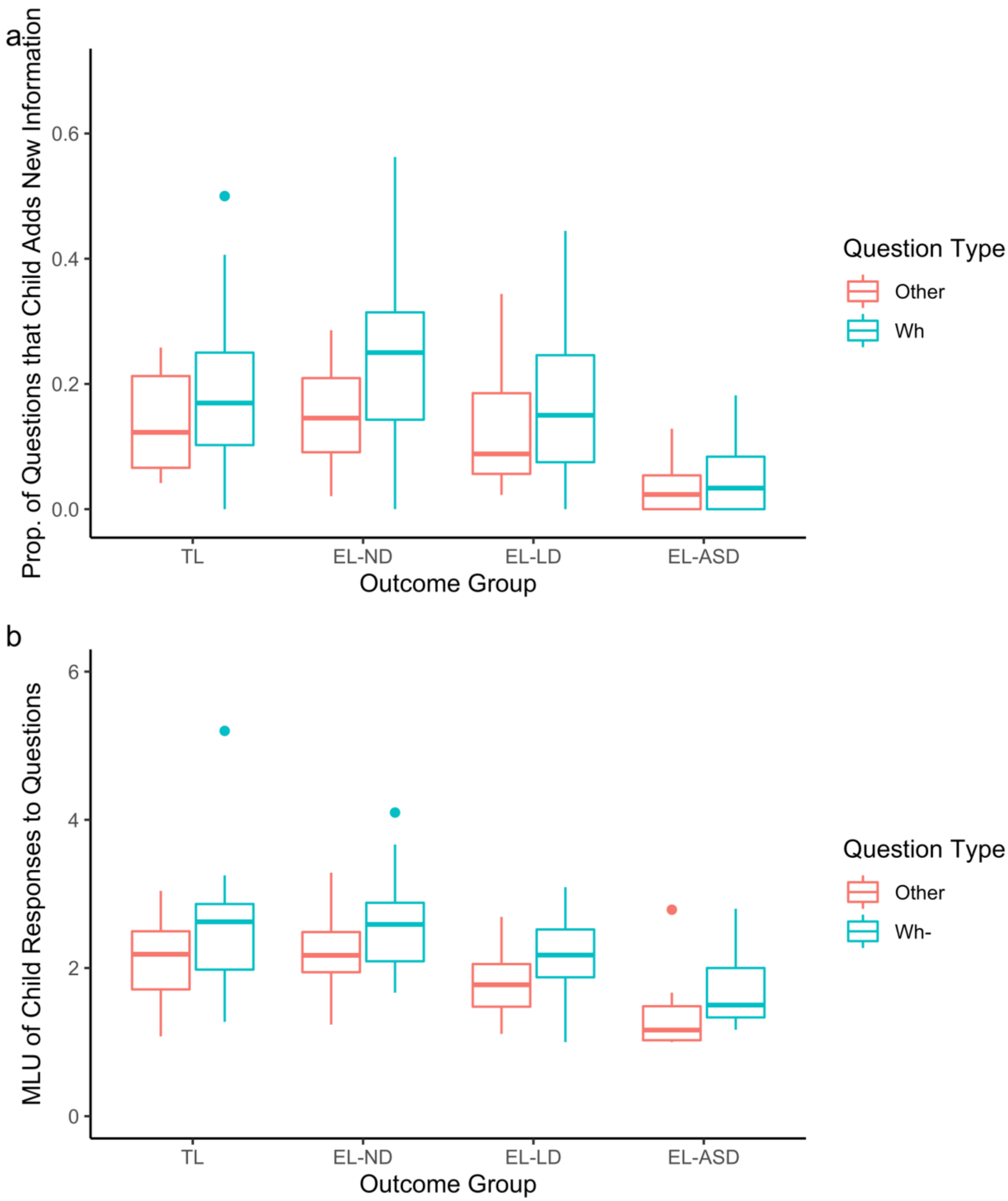

Figure 4. Child Responses to Parent Wh- vs. Other Questions
Note: Boxplots display medians and quartiles for child responses to parent wh- questions (green) and child responses to parent other questions (red); a) Proportion of parent questions that receive a response in which the child adds new information; b) Mean Length of Utterance (MLU) of child responses to parent questions

3.2.4 Summary of results (Aim 2)

In sum, parents were largely similar across outcome groups in their speech in conversations with their 3-year-old children. Parents produced an average of 16 to 20 utterances per minute, with similar proportions of *wh*-questions (11 to 14%) and other questions (20 to 26%) across groups. There were fewer opportunities to produce topic-contingent responses for parents of EL-ASD children given the lower rates of child intelligible utterances, and there were therefore fewer topic-contingent parent responses for EL-ASD children. When children did produce intelligible utterances, all parents were highly likely to respond in a topic-contingent manner to their children (91 to 93% of adjacent parent utterances following a child utterance with words). However, significant differences emerged between groups in parent MLU – parents of EL-ASD children, and to a lesser extent, parents of EL-LD children, produced shorter utterances (3.2 and 3.7 words on average, respectively) than parents of TL children (4.1 words). Examining associations between parent and child speech revealed that parent MLU was positively associated with the rate of child intelligible utterances, the MLU of child intelligible utterances, and the proportion of child contingent utterances that add new information to the conversation. In other words, when children produce fewer intelligible and shorter utterances and do not add much new information to the conversation, their parents are likely to use shorter utterances.

While parents were similar across outcome groups in the extent to which they used *wh*- and other questions, examining child *responses* to parent questions revealed a striking pattern – parent *wh*-questions were more likely to elicit more complex responses from their children than other questions across outcome groups. Specifically, while EL-ASD and EL-LD children produced shorter utterances and EL-ASD children added to the conversation less often than their neurotypical peers, children across outcome groups produced longer responses and were more likely to add new information to the conversation in response to *wh*-questions than other questions.

3.3 Early predictors of 36-month child conversational skills (Aim 3)

The final aim of this study was to examine possible early predictors of child conversational skills in EL siblings. Specifically, we tested a mediation model of coordinated joint engagement, expressive language, and conversational skills. Based on prior research showing relations between coordinated joint engagement and expressive language for EL toddlers (Roemer et al., 2022), and relations between joint attention, expressive language, and school-age pragmatic language (Greenslade et al., 2019), we expected that 18-month coordinated joint engagement would predict 36-month conversational skills (contingent responses and the proportion of those that add new information to the conversation). We also expected that 24-month expressive language (as measured by a standardized assessment, the Mullen Scales of Early Learning) would mediate this relationship. As noted in the methods, these analyses were limited to a subset of the full sample that had complete data for the variables of interest at 18, 24, and 36 months (n=49).

First, Pearson's correlations were conducted between coordinated joint engagement, expressive language, and conversational skills (the proportion of adjacent intelligible responses that were contingent and the proportion of contingent responses that add new information). While 18-month coordinated joint engagement was significantly associated with 24-month expressive language (r = 0.301, p = 0.036), neither 18-month coordinated joint engagement nor 24-month expressive language was associated with the proportion of responses that were contingent (rs = -0.080 and -0.005; ps > 0.58). Therefore, planned mediation analyses with contingent responses as a dependent variable were not conducted. However, 18-month coordinated joint engagement and 24-month expressive language were both significantly associated with 36-month contingent responses that add new information to the conversation (*r*s = 0.319, 0.353; *p*s = 0.025, 0.013). Thus, in conjunction with findings from Aim 1, all groups were highly likely to respond in a topic-contingent manner when they produced intelligible utterances, and early coordinated joint engagement and expressive language were not related to topic contingency. However, EL-ASD children were less likely to add new information to the conversation, and coordinated joint engagement at 18 months and expressive language at 24 months were both associated with the extent to which children added new information to the conversation at 36 months.

To test our proposed mediation model, analyses were conducted using PROCESS software for SPSS (Hayes, 2013). The total effect (i.e., without the mediator in the model) showed 18-month coordinated joint engagement was positively associated with 36-month conversational skills (i.e., proportion of contingent responses that added new information; $c = 0.192$, $p = 0.025$). Mediation analyses were tested using two models. First, 24-month expressive language was regressed onto 18-month coordinated joint engagement (Model 1). Second, 18-month coordinated joint engagement and 24-month expressive language were entered as predictors into a regression model estimating 36-month conversational skills (Model 2). Results of this mediation analysis are presented in Table 11 and displayed in Figure 5, with unstandardized coefficients *a* and *b* representing components of the indirect effect (*ab*) and *c'* representing the direct effect. Children who spent more time in coordinated joint engagement at 18 months had higher expressive language scores at 24 months ($a = 43.58$, $p = 0.036$), and children with higher expressive language scores at 24 months were more likely to add new information to the conversation at 36 months ($b = 0.003$, $p = 0.05$). However, a bias-corrected bootstrap confidence interval based on 10,000 bootstrap samples (an approach widely recommended for inference about indirect effects in mediation; Hayes, 2013) showed the indirect effect (*ab* = 0.051) was not significant (95% CI = -0.014 to 0.141). The direct effect of coordinated joint engagement when including expressive language in the model was also not significant (*c'* = 0.141, *p* = 0.102). Thus, while coordinated joint engagement and expressive language were independent predictors of conversational skills and together explained 17.4% of the variance in the proportion of contingent responses that add new information (R^2 = 0.174, *p* = 0.012), the model did not provide evidence for expressive language acting as a mediator between coordinated joint engagement and conversational skills.

Table 11. Mediation analyses examining early predictors of child conversational skills

		Model 1: Y = 24-month expressive language (MSEL T-score)				Model 2: Y = 36-month proportion topic-contingent responses that add new information		
		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X (18-month coordinated joint engagement)	*a*	18.095	8.368	0.036	*c'*	0.141	0.085	0.102
M (24-month expressive language)		--	--	--	*b*	0.003	0.001	0.050
Constant	i_1	43.576	2.406	<0.001	i_2	0.075	0.066	0.258
Model Summary		R^2 = 0.091 F(1,47) = 4.68, *p* = 0.036				R^2 = 0.174 F(2,46) = 4.86, *p* = 0.012		

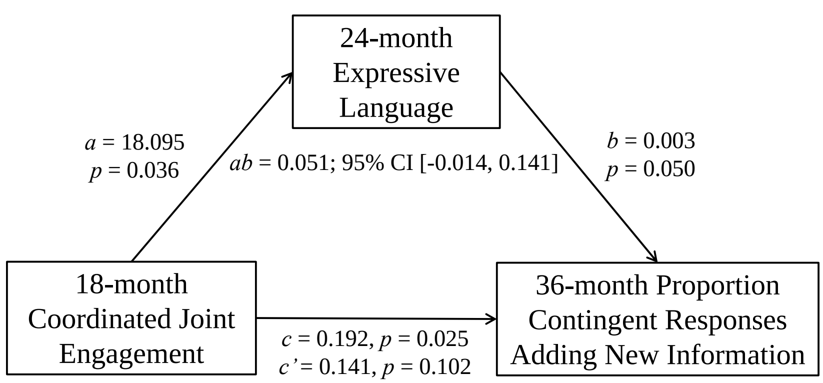

Figure 5. Mediation analyses examining early predictors of child conversational skills
Note: Figure depicts a visualization of mediation analyses reported in Table 11

4.0 DISCUSSION

To our knowledge, this was the first study to examine both caregiver and child contributions to emerging conversational skills in EL siblings prior to mid-childhood. We used natural language sampling to capture child spoken language and conversational skills in the context of toy play interactions with caregivers in the home. We also characterized parent speech and its relation to child language, used a sequential approach to examine responses to parent questions, and leveraged longitudinal data to examine early predictors of conversational skills.

There were four primary sets of findings (see Table 12 for a detailed summary of results relevant to aims 1 and 2). First, EL-ASD children produced fewer intelligible utterances than their TL and EL-ND peers. When utterances were intelligible, EL-LD and EL-ASD children produced shorter utterances but were just as likely to be contingent to the topic of conversation as their peers. However, EL-ASD children were less likely than all other groups to add new information to the conversation, and the extent to which children added new information was positively associated with utterance length and vocabulary diversity across groups. Second, parents of EL-ASD children had fewer opportunities to respond contingently to their child's topic, as their children had fewer intelligible utterances. However, parents across groups were highly contingent to the topic when child speech was intelligible, and complexity of parent speech varied with child spoken language ability and conversational skill. Third, parents produced similar proportions of questions across outcome groups. Regardless of outcome group, *wh*-questions elicited child utterances that were longer and more likely to add new information to the conversation than other questions. Finally, coordinated joint engagement and expressive language in toddlerhood independently predicted conversational skills the following year. Each of these sets of findings are discussed in turn below.

Table 12. Summary of findings for Aims 1 and 2

Aim 1 – Profiles of spoken language and conversational skills	
Child spoken language	*Post-hoc comparisons (p<0.05)*
Rate of utterances per minute	ns
Rate of utterances with words	EL-ASD < TL, EL-ND
Rate of utterances contributing to MLU	EL-ASD < TL, EL-ND
Overall MLU	EL-ASD < TL, EL-ND, EL-LD; EL-LD < TL, EL-ND
NDW per 100 words[a]	ns
Child conversational skills	*Post-hoc comparisons (p<0.05)*
Rate of adjacent utterances	ns
Rate of adjacent utterances w/ words	EL-ASD < TL, EL-ND
Rate of contingent utterances	EL-ASD < TL, EL-ND
Proportion of adjacent intelligible utterances that are contingent	ns
Proportion of contingent utterances that add new information	EL-ASD < TL, EL-ND, EL-LD
Relations between child spoken language and conversational skills	*Findings*
MLU and Proportion contingent	ns
NDW[a] and Proportion contingent	Negative for TL, interaction w/ EL-LD
MLU and Proportion adds new information	Positive relation across groups
NDW[a] and Proportion adds new information	Positive relation across groups

Aim 2 – Parent speech and its relation to child language and conversational skills	
Parent Speech	*Post-hoc comparisons (p<0.05)*
Rate of utterances per minute	ns
Rate of utterances contributing to MLU	ns
Parent MLU	EL-ASD < TL, EL-ND; EL-LD < TL
Rate of utterances adjacent to child utterance	ns
Rate of contingent utterances	EL-ASD < TL, EL-ND, EL-LD
Proportion of adjacent utterances (to child intelligible utterances) that are contingent	ns
Proportion parent utterances that are *wh*-Q's	ns
Proportion parent utterances that are other Q's	ns
Relation between parent and child speech	*Findings*
Partial Correlations (Table 9)	Parent MLU significantly associated w/ - Rate fully intelligible child utterances - Child MLU - Proportion of child contingent responses that add new information
Child responses to wh- vs. other questions	*Findings*
Repeated-measures ANOVAs (Table 10)	- Wh-Q's elicit responses that are longer and add more new info than other questions - Main effect of outcome group - No question type by outcome interactions

[a] NDW analyses exclude EL-ASD group due to insufficient fully intelligible utterances to calculate this variable for 7 out of 10 EL-ASD children; ns = one-way ANCOVA was not significant so post-hoc tests were not conducted

4.1 Profiles of spoken language and conversation in siblings of children with ASD

Extensive prior work has examined the communicative abilities of EL siblings in the first three years of life and shown that younger siblings of children with ASD are not only more likely to develop ASD, but also have an elevated likelihood for non-ASD language delays (e.g., Marrus et al., 2018; Roemer, 2021). While structural and pragmatic language abilities are intertwined (e.g., Wilson & Bishop, 2022) and challenges with pragmatic language are a core feature of ASD (e.g., Tager-Flusberg et al., 2011), few studies have examined the pragmatic abilities of EL siblings prior to mid-childhood (Bruyneel et al., 2019; Miller et al., 2015). The present study used natural language sampling to capture spoken language ability and conversational skills in the context of toy play interactions with caregivers in the home.

Consistent with prior work, children with ASD exhibited a range of challenges in spoken language ability. They produced far fewer intelligible utterances than their peers – on average only 4-5 per minute as opposed to the 9-11 per minute produced by neurotypically developing three-year-old children. In fact, the vast majority of EL-ASD children (7 of 10) did not produce a sufficient number of intelligible utterances in a 10- to 13-minute observation to calculate a standard measure of vocabulary diversity. When utterances were intelligible, EL-ASD children also produced shorter utterances than their peers, consistent with prior work examining spoken language in young children with ASD (e.g., Fusaroli et al., 2019). Further, consistent with hypotheses, EL-ASD children were less likely than children without ASD to add new information to the conversation when they were contingent to the topic.

EL-LD children have been less well characterized in prior research, though they tend to fall between their neurotypical peers and peers with ASD on parent report measures and standardized assessments of expressive language in the first three years of life (e.g., Iverson et al., 2018; Parladé & Iverson, 2015; West et al., 2019, 2020). Building on this prior work, we found that EL-LD children produce shorter utterances at 36 months than same-aged neurotypically developing peers, but longer utterances than their peers with ASD. However, EL-LD children were equivalent to their neurotypical peers on a measure of vocabulary diversity. Prior work has shown that 'late talkers' caught up to their peers by age 3 to 5 in measures of vocabulary but continued to exhibit weaknesses in higher level skills including MLU (Girolametto et al., 2001; Rescorla, Dahlsgaard, et al., 2000; Rescorla, Mirak, et al., 2000). Our findings are consistent with this pattern for EL siblings; at three years of age, when neurotypical children are beginning to speak in longer phrases and sentences, utterance length may be a more sensitive measure of identifying language challenges than vocabulary for EL-LD children by three years of age. Contrary to expectations, EL-LD children did not differ from their neurotypical peers in conversational skills; they were just as likely as the TL and EL-ND groups to add new information to the conversation.

Both utterance length and vocabulary diversity were positively related to the extent to which children added new information to the conversation, and this pattern held across outcome groups. Thus, while EL-LD children did not differ from neurotypical peers at a group level in vocabulary or in their ability to add new information to conversations at three years of age, individual differences across groups in both the length of utterances and the diversity of vocabulary may impact children's developing conversational skills. As children build larger vocabulary repertoires and string words into more complex phrases and sentences, they also become more competent conversational partners, and these building blocks of structural language are intertwined with pragmatic skills (e.g., Wilson & Bishop, 2022). Prior research suggests that some EL children *without* ASD continue to experience challenges with structural language beyond the preschool years (see Roemer, 2021 for a review), and our findings show that EL-LD children use shorter utterances than their TL and EL-ND peers at three years of age. These differences in complexity may have downstream effects on language learning, and future work should examine how these early differences relate to structural and pragmatic skills beyond the preschool years.

The findings reviewed above are consistent with and build on prior work – children with ASD experience challenges across a range of structural and pragmatic language skills, and EL children with a pattern of non-ASD language delays in the first three years catch up to their neurotypical peers in some areas, but not others, by age three. However, the present study also revealed a striking and unexpected pattern – when children produced intelligible speech, including those with ASD and non-ASD language delays, they were *all* very likely to respond in a topic-contingent manner to their parents. Children with ASD produced fewer topic-contingent responses overall (as demonstrated by lower rates than their peers), consistent with extensive literature demonstrating challenges with pragmatic language in ASD. Indeed, difficulty maintaining conversations is a core diagnostic feature (American Psychiatric Association, 2013). However, at three years of age, this appears to be driven by the extent to which children's speech is intelligible. There were no differences between groups in the rates of adjacent utterances (i.e., occurring within 5 seconds of a parent utterance). And for every single child in our sample, including those with ASD, over 78% of intelligible adjacent utterances maintained the parent's topic of conversation.

Of course, we cannot determine whether the many non-word vocalizations and unintelligible utterances children produced following a parent utterance are related to the parent's topic, at least not from verbal content alone. One possibility is that many of these unintelligible utterances produced by children with ASD are not related in any way to the parent's topic, and the few utterances that *are* contingent to the topic are also the few that are intelligible. However, an alternative possibility is that some (or many) of children's unintelligible utterances during play are intended to respond to their parents' topic but are simply not intelligible to transcribers (and likely not intelligible to parents). When researchers and clinicians have taken a strengths-based perspective and assumed children on the autism spectrum *could* communicate if given the right tools, children have far exceeded expectations that were based on their spoken language ability. For example, many minimally verbal individuals on the spectrum learn to communicate with the help of speech devices (see Tager-Flusberg & Kasari, 2013, for a review of interventions for minimally verbal children). While some individuals can only communicate by pointing to a letter board with an aid, a recent eye tracking study shows these individuals have gaze patterns akin to those using more independent methods of communication (Jaswal et al., 2020). Thus, it is important to consider the strengths of young children with ASD, building on their capacity to respond contingently to a topic *and* considering the possibility that attempts at meaningful communication may be intended to respond but are simply not intelligible to the listener.

While beyond the scope of the present study, future work could examine additional cues (i.e., gesture, eye gaze, interactions with objects) to determine whether the unintelligible utterances produced by three-year-old children with ASD are related in some way to the topic of their caregiver's conversation. However, lack of eye contact has often been interpreted as a lack of social interest, despite recent work suggesting that children with ASD often use other strategies to jointly engage with their caregivers (Jaswal & Akhtar, 2019; Roemer et al., 2022; Yurkovic-Harding et al., 2022). Thus, careful consideration of which cues are used to determine communicative intent of unintelligible responses to caregivers would be required, and gaze alone is not likely to be sufficient to determine whether an unintelligible utterance is responding in a meaningful way to the conversational partner's topic.

Regardless of the communicative intent of unintelligible utterances, our findings demonstrate that when preschool-aged children do produce words, they are highly likely to maintain their parent's topic of conversation, regardless of diagnostic status. Further, utterance length and vocabulary diversity were not positively related to children's ability to maintain the topic (and if anything, a few TL children with larger vocabularies were less likely to maintain their parent's topic of conversation). Of course, our study examined conversational skills in a familiar environment where parents were asked to spend 10-13 minutes in uninterrupted play with their child, with toys that are likely to be familiar to most three-year-old children (people and farm animals, teddy bear and bowls/cups/spoons). Maintaining the topic of conversation in this context could be achieved with utterances as simple as "yes" or "bear" when the parent said, "should we feed teddy?". In contexts where caregivers have multiple competing demands, or children are interacting with an unfamiliar adult or peer, the task of maintaining a conversational partner's topic may become more difficult. For example, Martin et al. (2017) found that when children with ASD were asked to complete an ambiguous task, they were less likely than neurotypical peers to signal that they did not understand the experimenter. If responding appropriately requires words or grammatical structures not yet in a child's repertoire or requires understanding beyond their receptive language level, challenges with pragmatic language may become more apparent.

Future work should examine emerging conversational skills across contexts, including with novel conversational partners and in settings that require more complex responses. However, our study represented a first step in examining conversational skills in EL preschoolers, and the context of play with caregivers in the home may be optimal to fully capture strengths to build on in interventions for children with communicative challenges. For example, Kover et al. (2014) found that in interactions with caregivers, children with ASD used more utterances and engaged in more conversational turn-taking than when interacting with experimenters. If children with ASD are highly contingent to their caregivers' topic of conversation in toy play in the home when they produce intelligible speech, similar contexts would likely be well-suited to gaining practice with these emerging conversational skills in interventions.

When children respond contingently to the topic of conversation, interventions targeting spoken language ability would also likely expand children's ability to add to the conversation, as evidenced by our finding of positive relations between utterance length and vocabulary diversity and adding new information across outcome groups. Structural and pragmatic language abilities develop in tandem, and this relation is likely bidirectional – increased vocabulary and longer utterances make it easier to expand on a caregiver's topic, and increased understanding of the social context and ability to expand on a caregiver's contribution in turn increases caregivers' opportunities to build on what they child says, extending conversations and increasing opportunities for language learning (Wilson & Bishop, 2022). Thus, a full understanding of child spoken language and conversational skills requires an understanding of the communicative contexts in which these skills emerge.

4.2 Parent speech is highly contingent and varies in complexity with child language and conversational skills

While prior research on the relation between caregiver speech and conversational skills in EL siblings is sparse, extensive work has examined the role of caregiver speech in the developing language abilities of EL siblings (see Bottema-Beutel & Kim, 2021; Swanson, 2020, for reviews). Consistent with prior research, we found that parents of children across outcome groups were largely similar in the input they provided to their children – parents of EL-ASD and EL-LD children produced similar rates of utterances and questions as parents of TL and EL-ND children. However, children also shape their own opportunities for learning (e.g., Adamson et al., 2020; Edmunds et al., 2019; Iverson, 2021; Sameroff, 2009; Thelen, 2005). We found differences between groups in the rate of parent topic-contingent responses – with EL-ASD children producing only half the rate of intelligible utterances as their neurotypically developing peers, parents had far fewer opportunities to respond contingently to their child's topic of conversation. However, when children *did* produce intelligible utterances, their parents were highly likely to respond in a topic-contingent manner. Examining parent responses adjacent to *intelligible* child utterances, the vast majority of parent responses were contingent to the child's topic – on average over 90% for each outcome group. In fact, with one exception (a parent of a neurotypically developing child who spent most of the interaction stomping around the room saying "no"), over 75% of each parent's adjacent responses to intelligible utterances were contingent to the child's topic of conversation.

Thus, when parents have opportunities to do so, they respond in a highly contingent manner to their children. Of course, our findings may not generalize to all contexts; we provided parents with a set of toys and asked them to play with their child without the distractions of taking care of siblings, working, or other household tasks. However, parent-child toy play in the home is a foundational context for early language learning, and similar activities and contexts are utilized in many parent-mediated interventions for ASD and early language delays (Nevill et al., 2018). Consistent with the idea that caregivers and children create opportunities for one another in conversation, a growing body of research on parent-child interactions provides evidence for reciprocal influences between caregiver and child speech across populations with ASD and in EL siblings (Choi et al., 2020; Fusaroli et al., 2019; Hani et al., 2013).

For example, Fusaroli and colleagues (2019) followed 2- to 5-year-old children with ASD and initially language-matched neurotypical peers across six visits. They found that measures of parent and child speech (sentence complexity, vocabulary) were highly correlated at each visit, and that parent speech predicted child speech the following visit, and vice versa. Similarly, we found that parent speech varied in complexity with child spoken language ability. Parent MLU differed across outcome groups, with parents of both EL-ASD and EL-LD children producing shorter utterances than parents of TL children. Further, parent MLU was positively correlated with both the rate of intelligible child utterances and with child MLU. In other words, parents produced longer utterances when their children produced more intelligible and longer utterances.

The present study also expands on prior literature by examining caregiver speech not only in relation to child spoken language ability, but in relation to emerging conversational skills. We found that parent speech complexity was also positively related to the extent to which children add new information to the conversation. Of course, we cannot determine the directionality of effects. Parents may be adapting to their child's abilities, and in turn, more complex speech from parents may provide more opportunities for language learning. Taken together, our findings show that emerging conversational skills do not develop in isolation. Children practice their developing language skills in the context of dyadic exchanges, and parent speech complexity varies with child spoken language ability and conversational skills.

Extensive research with neurotypically developing children shows that caregivers adapt their input to the communicative skills of their child (Tamis-LeMonda et al., 2018). From the first months of life, caregivers simplify their input to infants – they speak in higher and exaggerated pitches and shorter utterances (often termed "motherese/parentese" or "baby talk"; e.g., Fernald, 1985; Ramírez-Esparza et al., 2017). Parents scaffold their child's language learning frequently and unconsciously, and in many cases, this has been shown to be helpful (e.g., Ramírez-Esparza et al., 2017). However, when a child is already on a path to developmental delays, evidence for the utility of adapting to the child's level – simplifying input when the child shows signs of delay – is less clear. For example, Venker et al. (2015) examined two types of caregiver input: grammatical input, such as "roll the ball" vs. 'telegraphic' input such as "roll ball" (i.e., input that includes content words but omits function words). Both are strategies for providing simplified input that are widely used in language interventions (Venker et al., 2019), but the authors found that telegraphic input was worse for language learning than grammatical input for children with ASD (Venker et al., 2015). Thus, different ways of simplifying input to match a child's abilities may be more or less helpful and matching a child's language level may have unintended negative consequences. Intervention research should therefore carefully consider which types of scaffolding are most beneficial for language learning in populations with developmental delays.

4.3 Wh-questions elicit more complex responses from children across outcome groups

Prior research has shown that *wh*-questions elicit more on-topic and more complex responses from children with neurotypical development and children with developmental delays (Rowe et al., 2017; Yoder et al., 1994). Our findings extended this work to EL siblings and support the idea that *wh*-questions are beneficial for emerging language and conversational skills. There were no differences in either the rate of parent utterances or the proportion of parent utterances that were *wh*-questions across outcome groups. Thus, parents across groups provided similar opportunities for their children to respond to questions. By examining moment-to-moment interactions, we were able to examine how children make use of these opportunities. Regardless of outcome group, *wh*-questions were followed by child utterances that were longer and more likely to add new information to the conversation than other questions. Even children in the EL-ASD group, who produced shorter utterances than their peers, used on average 1.8-word utterances in response to *wh*-questions in contrast to 1.4-word utterances in response to other questions; children in the EL-LD group received a similar boost.

Our findings suggest that parent *wh*-questions elicit longer and more complex responses from their children than other questions, even for those with significant language delays. However, early interventions for ASD and speech delays vary widely in whether and how they encourage or discourage caregivers to use questions in play. As noted above, several interventions emphasize adapting input to the child's abilities (e.g., Venker et al., 2019). In line with this idea, some interventions commonly used with children with ASD discourage caregivers from using questions, suggesting that if a child is not yet able to answer consistently, asking too many questions may discourage the child from initiating (see Curdts, 2019, for a review of question use in interventions for ASD). Other interventions designed to assist caregivers with behavior management across a range of clinical presentations discourage the use of questions, with the rationale that placing too many demands on the child will increase the likelihood of not complying with caregiver requests, reinforcing negative patterns of behavior (e.g., Eyberg et al., 1995; Solomon et al., 2008). These interventions have empirical support for promoting positive caregiver-child interactions in children with ASD (Solomon et al., 2008), and decreasing demands in order to reinforce positive behavior is likely a key part of the success of the intervention.

However, in the context of communicative delays, it is important to also consider the impact of changes in caregiver input on developing language skills. In line with this idea, a recent study on parent question use in an intervention with children with ASD finds that despite the intervention discouraging parent questions, a higher rate of parent questions in the intervention was positively associated with child vocabulary and grammatical complexity (Curdts, 2019). Our findings suggest that *wh*-questions may encourage more complex and on-topic responses from children with delays. Thus, future work should explore whether increasing *wh*-questions in an intervention context boosts language learning for children with communicative delays. Taken together with previous findings, it may be beneficial to initially limit question use to encourage child initiations, then increase *wh*-question use as the child begins to initiate, targeting goals of eliciting more complex speech. However, longitudinal intervention research is needed to test this possibility.

4.4 Joint engagement and expressive language are early predictors of conversational skills

The present study was the first to our knowledge to examine conversational skills prior to mid-childhood in EL siblings. We found that when children produced intelligible speech, they were highly likely to respond to their parents in a topic-contingent manner, regardless of diagnostic status. However, differences emerged in the extent to which children added new information to the conversation, with the EL-ASD group having the lowest proportion of contingent utterances that added to the conversation. The final aim of this study was to examine possible early predictors of these conversational skills. Prior work shows joint attention is a predictor of pragmatic language in school-aged EL siblings and suggests expressive language may mediate the relation between joint attention and pragmatic language (Greenslade et al., 2019). Further, a relation between coordinated joint engagement (i.e., joint engagement with eye contact) and expressive language was shown in the second year of life in the present sample (Roemer et al., 2022). Thus, we hypothesized that coordinated joint engagement at 18 months of age and expressive language scores at 24 months of age would both predict conversational skills, but that expressive language would mediate the relation between coordinated joint engagement and conversational skills.

We initially expected this would be true for both of our measures of conversational skills – topic-contingent responses and the extent to which children added new information to the conversation. However, all groups were highly contingent to their parents' topic when they used intelligible speech. Thus, in a context in which there is little variability in the proportion of responses that are topic-contingent, it is perhaps not surprising that neither coordinated joint engagement nor expressive language scores emerged as predictors. Regardless of these earlier skills, all groups were highly contingent to their parent's topic when they used intelligible speech. However, in line with predictions, both coordinated joint engagement and expressive language scores were positively correlated with the extent to which children added new information to the conversation. Adding new information may be a more challenging task and therefore serve as a more sensitive measure of conversational skills at this age. While 18-month coordinated joint engagement predicted the extent to which children added new information, our findings did not support the proposed model with 24-month expressive language scores acting as a mediator. Rather, coordinated joint engagement and expressive language appear to be independent predictors of conversational skills.

At least two possible explanations exist for our findings. First, while we had a reasonably large sample to test our mediation model (n=49), we had limited power to detect small effects. Both early predictors were significantly associated with the extent to which children added new information to the conversation, but effects were small (*r*s = 0.32 and 0.35). When both coordinated joint engagement and expressive language scores were entered as predictors, together they explained only 17% of the variance in adding new information to the conversation. It is likely that we do not have sufficient power to detect a partial (and potentially small) mediating relationship, and it is also likely that unmeasured early predictors also contribute. The present study represents a first step in examining early predictors of conversational skills, and future research with larger samples should consider more complex models to fully capture the relations between joint engagement and conversational skills across the first three years of life.

A second possibility, which is not mutually exclusive from the first, is that coordinated joint engagement and expressive language skills, while correlated, capture different constructs that independently contribute to conversational skill development. Recent work with neurotypically developing children shows that while structural language skills hold together as a unique factor, pragmatics are more of a "family of skills" representing a cluster of different constructs (Wilson & Bishop, 2022). Coordinated joint engagement reflects children's early ability to coordinate their attention between their own focus and the focus of a social partner, switching gaze between objects and people (Adamson et al., 2009). This skill likely contributes to the development of the ability to consider the perspective of another person, which undoubtedly aids in taking a conversational topic into account and expanding on it with one's own interests.

Expressive language skill, on the other hand, reflects children's growing vocabularies and the ability to place lexical items into phrases, which gives children a larger repertoire to pull from in order to add to a conversation. Thus, coordinated joint engagement and expressive language may represent distinct skills that together make up some of the early building blocks of conversation. Both are likely helpful targets for early interventions aiming to boost pragmatic language, and future research should expand on these findings by considering additional early predictors with larger samples of children with or at elevated likelihood of developing ASD.

4.5 Limitations

While the present study took a first step in enhancing our understanding of conversational skills in preschool-aged TL and EL children, several limitations are important to consider. First, our sample had limited variability in demographic variables, with children who were mostly white, with mostly college-educated mothers. This is a limitation across the field of autism research, and greater efforts need to be made to conduct research with samples that are more representative (e.g., Angell et al., 2018; Mandell et al., 2009). More inclusive research would also enhance our understanding of the gaps in early assessment and intervention, particularly given that the average age of diagnosis in the United States is still over four years of age despite our ability to diagnose much sooner (van 't Hof et al., 2021).

Second, our findings were limited to a relatively brief parent-child interaction in the home. While examining interactions in the home context is a strength of this study and likely to translate to day-to-day interactions caregivers have with their children, we only captured a small subset of the types of interactions children have on a daily basis. Parents were asked to play for 10-13 minutes with their child with a set of toys (while other siblings were otherwise occupied), and in many cases, such toy play may represent a 'peak' of parent and child speech (Bergelson et al., 2019). To fully understand the emergence of conversational skills, future research should extend to more challenging contexts where caregivers and children may be less easily 'tuned in' to each other's conversational topic, and in contexts where children must interact with unfamiliar adults and peers.

Finally, our findings represent a snapshot of developmental time – while we were able to leverage a longitudinal dataset to examine early predictors of conversational skills, we only examined spoken language, conversational skills, and parent input at 36 months of age in the present study. While children across groups were highly likely to respond contingently to a parent's topic when they produced intelligible speech and parent speech complexity varied with child spoken language and conversational skills, these patterns may change as children grow and face increasingly complex interactions in school and with peers. Future research should replicate and extend these findings in longitudinal work extending beyond three years of age and across varying contexts.

4.6 Clinical Implications and Conclusions

While these limitations must be considered in interpreting results, the present study also had notable strengths and suggests several targets for future clinical research. To our knowledge, ours was the first study to examine conversational skills in the context of dyadic exchanges between preschool aged EL siblings and their caregivers. Prior research suggests that natural language sampling in parent-child interactions is an ideal measure to assess children's strength (Barokova & Tager-Flusberg, 2020; Kover et al., 2014). In other words, interactions with caregivers allow us to observe the language that children do have, even if it is limited. We found that in toy play interactions in the home, parents and children are highly contingent to one another's topic of conversation when children produce intelligible speech. Group differences in child conversational skills and in parent opportunities to respond appeared to be driven by intelligibility of child speech, and future research should carefully consider how to increase intelligibility *and* promote multiple routes to communication when speech is mostly unintelligible. Further, by identifying strengths, future work should build on children's capacity to maintain a topic in interactions with caregivers and capitalize on these moments of intelligible speech to build on spoken language skills and promote pragmatic skill development.

Prior work shows that as a group, EL children without ASD are more likely than the general population to exhibit challenges with language, both in toddlerhood (e.g., Marrus et al., 2018) and into the school-age years (Roemer, 2021). However, much of this work has examined EL children with non-ASD outcomes as a single group. It is notable that for EL-ND children, who showed no signs of language delays in their first three years, there were no differences from TL peers in spoken language, conversational skills, or parent responses. Regardless of whether or not they had an older sibling on the autism spectrum, children *without* early language delays were highly contingent to the topic, were adding new information to conversations, and their parents had ample opportunities to respond.

We also found that while EL-LD children did not differ from their neurotypical peers in conversational skills at three years of age, there is wide variability in spoken language ability in this group. While most EL-LD children had caught up with neurotypical peers in vocabulary size, they continued to exhibit delays in the length of utterances, and utterance length was positively related to the extent to which children added new information to conversations. Conversations may become more complex in contexts beyond parent-child toy play in the home, particularly as children enter school and navigate interactions with their peers (e.g., St Clair et al., 2011). Structural language skills for EL children without ASD continue to differ from those of neurotypical peers into school-age (Roemer, 2021). Thus, an important next step for future research is to conduct follow-up studies with EL children to examine how children with varying spoken language abilities at age three either ‘catch up’ or continue to show delays. This work would allow an understanding of individual trajectories of both structural and pragmatic language and inform targeted interventions for those who need them.

By examining toy play interactions with caregivers in the home, we were also able to study the moment-to-moment dynamics of parent questions, and we found that *wh*-questions elicited more complex responses from children than other questions regardless of diagnostic outcome. While interventions vary in whether and how they promote the use of questions (Curdts, 2019), our findings suggest that *wh*-questions provide a boost even for children with substantial communicative delays. While this represents a first step in understanding how EL children respond to caregiver questions in real time and is limited to the context of toy play at three years of age, our findings suggest that *wh*-questions may be a useful target for parent-mediated interventions. Future work should examine what types of *wh*-questions are most likely to elicit more complex responses for children with ASD and non-ASD language delays, and how to selectively utilize these questions in interventions without limiting opportunities for the child to initiate and lead the interaction. Further, intervention research providing parent training could directly test whether *wh*-questions not only elicit longer responses in real time, but whether greater use of *wh*-questions is associated with long-term gains in spoken language ability and conversational skills.

Finally, by leveraging a dense longitudinal dataset, we identified coordinated joint engagement and expressive language as early predictors of conversational skills in preschoolers with and without ASD and non-ASD language delays. These are already two primary targets in early interventions – a growing body of work shows that interventions promoting increase joint engagement have promising effects for young children with and at elevated likelihood of ASD (Kasari et al., 2010; Shih et al., 2021). Our findings suggest that increased joint engagement is likely to promote emerging conversational skills, and future work with larger samples should continue to identify early predictors and the mechanisms by which they relate to boosts spoken language and conversational skills in EL siblings with communicative delays. Taken together, our findings show that caregiver-child interactions play an impactful role in the development of spoken language and conversational skills and can inform parent-mediated interventions for both children with ASD and children experiencing a range of challenges in structural and pragmatic language.

Appendix A Utterance Identification and Parent Transcription Manual

***Note: this manual was adapted by Emily Roemer Britsch from the PLAY transcription manual, a collaborative multi-site project* (https://www.play-project.org/coding.html#Transcription).

PLAY has developed a streamlined process to expedite the transcription of videos. Certain common markers (such as closures of utterances with ".", "!" and ",") are not marked to save time. However, we aim to ensure accuracy around timing, content, and segmenting of utterances, and run reliabilities and quality assurance on those features. We adopted specific rules around segmenting utterances, and so on that apply to English language transcriptions.

Example of 10 minutes of an expert transcribing:
https://nyu.databrary.org/volume/686/slot/45710/-?asset=288269

Transcription workshop (watch sections at 20 to 30 minutes and 40 to 55 minutes):
https://nyu.databrary.org/volume/686/slot/50826/-?asset=288570

Datavyu Arguments

A transcription Datavyu file includes 2 columns which are pre-filled and you should not edit:
Column Name: id
Code: (<id>)
Column Name: task
Code: (<task>, <socialpartner>)

Some files will also include the following 3 columns, which are pre-filled and you should not edit. These are from a previous project and will be used to aid in transcribing child speech.

Column Name: speech
Code: (<transcription>)
Column Name: nonspontaneous
Code: (<nonspontaneous>)
Column Name: speech_comments
Code: (<speech_comments>)

Additionally, you will add to and edit the following columns. To do so, first run the script "Insert-ParentTranscript.rb", located in the Scripts folder. Once you have run this script, hide all other columns except "task", which tells you which sections of the video to code. Do not try to use the speech/nonspontaneous/speech_comments for guidance on this pass, they will be used at a later time to assist in transcribing child speech.

Column name: transcribe
Code: (<source> <content>)

Column name: trans_id
Code: <transcriber>,<trans_startdate>,<trans_finishdate>,<trans_mins>

Column name: trans_comments
Code: <source_mc>,<comment>

Column name: task_uncodable

Use this column to indicate sections of the video lasting longer than one utterance that are not possible to transcribe due to audio issues (e.g., mic cuts out). Code a cell with an onset and offset for the uncodable section, and code 'u' in the cell.

Transcription Conventions and Rules

What is an utterance?

An utterance is a unit of speech separated by grammatical closure, intonation contour, intake of breath, or prolonged pausing, which can function as a natural "break" during speech. Note: Some utterances may contain complete sentences or phrases (e.g., that's a blue truck), and others incomplete ones (e.g., that's a……). As a general rule to aid segmenting when you are unsure based on other cues, prolonged pauses are those over 500ms.

Segmenting speech into utterances

Rules about segmenting utterances are critical to ensure that the data generated from transcriptions are consistent across transcribers in: (a) the number of utterances in a session; (b) the length of utterances or complexity of speech, such as how many words/morphemes comprise an utterance, which may be estimated through calculation such as MLU (mean length utterance) through ***C****hild* ***L****anguage* ***AN****alysis (CLAN in CHILDES).*

Transcribers who fail to segment utterances at points of grammatical closure, for example by running multiple sentences/phrases together (e.g., The ball. The blue ball. Big ball. In a single utterance line), may bias analyses toward more complex utterances. Conversely, if transcribers over-segment, for example by transcribing each word as a new 'utterance', they may bias analyses towards less complex utterances. Transcribing at the utterance level strikes a useful balance.

- Examples: "Here you go. That's a shoe." should be marked as 2 different utterances. But, "shoe, shoe, shoe" without any pauses would be a single utterance.
- If you would write the utterance as two distinct phrases separated by a comma, it should likely be broken into two utterances.
- Utterances that are elongated (e.g., prosody changes throughout the utterance) but are a single thought should be kept together.

- Each "segmented" single utterance is coded as an event/point cell, and separated by gray representing time when no utterance is spoken.

· Only the onset of the utterance is tagged. We do not code the offset for the event. Thus, a single time during the utterance is time coded.

Whose language is transcribed?

The goal for the following rules is to capture the typical language environment between the parent and child in the home. We want to avoid transcribing language that would not occur if the experimenter were not present (i.e., talk to the experimenter).

· Only identify utterances made by the child and parent, and transcribe utterances made by the parent.
· Do not transcribe utterances made by anyone but the parent and child (e.g., experimenter, another caregiver). If the parent is speaking to a person other than the child, do not transcribe it. All other utterances, whether stated out loud to oneself, to a pet, or to the child are transcribed.
· If another caregiver/parent joins the toy play and/or converses with the child for more than 15 seconds, make a comment and notify the primary coder, but do not transcribe the other caregiver's speech. If the child is clearly speaking to another parent/caregiver, still code the child's speech but make a comment in the comments column noting "directed to other".
· Do not transcribe voices of absent people (e.g., voicemail messages, Amazon Alexa or other voice assistants, or phone calls/Skype/Facetime on speakers).
· Do transcribe parent's utterances if speaking to Alexa or another voice assistant.

What should be transcribed?

The goal for the following rules is to strike a useful balance between capturing the home language environment between parent and child, while also ensuring expediency for transcription.
· Transcribe all speech sounds from the parent. Speech sounds should have a phonetic structure and can be babbles such as "baba" da" "ga", etc. even by the parent.
· Use xxx when a speech sound is difficult to transcribe phonetically.
· Do not transcribe vegetative and other non-speech sounds by the parent or child, such as coughs, sneezes, or yawns.
· For parent, do not transcribe hums (e.g., singing "hmmhmmhmm"), whistling, sighs, gasps, or laughs. If unsure whether an utterance is a gasp or an "ah"/"ahhah", consider whether it is voiced. If parent's laugh leads into a word or words, still code the utterance and transcribe the word(s).
· Words during singing or reading are transcribed. However, note "singing" or "reading" in the comments for these utterances.

An exception to this is "songs" without clear words or with repetition of a single "word" – for example, a parent sings "bada-dum bada-dum bada-dum dum dum" or "giddyup giddyup giddyup-up-up, giddyup giddyup giddyup-up-up" to a song-like tune while pretending the horse is running. In cases like these, simply type "soundeffect" and note "singing" in the comments.

· For child, mark all non-word vocalizations (e.g., crying, screaming, grunting, laughs) and all babbling (consonant-vowel combination, such as da, ba, ma) as 'v' for vocalization. For child utterances containing clear words, code 'w' for word.
You will identify both parent and child utterances, but do not attempt to transcribe child utterances on the same pass as parent utterances. For further details on coding conventions see below.

Transcription Codes

<source>

Source is the section of the transcription column where the source of the utterance is tagged in each cell. Only parent and child utterances are tagged.

Sources are tagged using the quick keys function on Datavyu.

p = parent/caregiver

Code 'p' if the parent/caregiver is the source of the utterance. This code will be filled in using quick keys.

c= child

Code 'c' if the child is the source of the utterance. This code will be filled in using quick keys.

<content>

Content is the transcription column where the words or sounds of each utterance by parent and child are coded and/or transcribed with time-locked codes.

Rules for Coding the Content of Child Utterances

v = vocalization by the child that does not contain words

This can include babbling/vowel-consonant sounds by the baby

Use the letter 'v' in the content section of the transcription column when the child emits a vocalization that does not clearly contain a word.

· If you think an utterance may have been a word by the child, but can't make out the word, replay the video 3X. If you still cannot make out a word, mark the utterance as a vocalization (**'v'**) to be conservative (see below for further info on words).
· Cooing/vowel sounds such as ooh aah should be coded as **'v'**.
· Sounds that would be transcribed as "soundeffect" for parents and are not voiced are coded as 'v'. Sounds that would be transcribed as "soundeffect" for parents that **are** voiced (e.g., with a clear meaning, like pretending to make an animal cry with "waa") should be coded as 'w'.
· Babbling/vocalization should be parsed using the same convention as utterances, where a distinct pause indicates the start of a new vocalization.

This can also include vocalizations like crying, screaming, laugh, grunting, audible gasp sound by the baby
· Consonant alone sounds should be coded as 'v' (e.g., sounds without a vowel).
· To segment vocalizations into distinct utterances, there should be a distinct pause or intake of breath between utterances. If the sound is continuous (even with a "hitch" in tone, such as during crying), code it as one utterance.
· Vegetative sounds that the child makes/anything non-syllabic are not coded (e.g., burping, sneezing, coughing).

w = vocalization by the child that clearly contains words

· Use the letter 'w' in the content section of the transcription column when the child emits a vocalization that DOES clearly contain a word or words.
· Utterances from the child that use the same sound pattern to refer to a <u>specific</u> referent on multiple occasions/in different contexts (i.e., contains a speech sound that consistently refer to an object, such as "bah-bah" always refers to a bottle), should be marked as words.
· However, if the same utterance is used widely for many objects (e.g., "bah-bah" to refer to bottle, farmer, and byebye), this should be marked as a vocalization, not a word.
· If the child uses a word approximation (i.e., the majority of the phonemes are present) to clearly refer to a specific referent (e.g. "ha" for "hat"), that should be marked as a word. In general, be conservative – if you can't clearly tell what the word is, don't code it as a word.
· If the child produces an utterance such as "mhmm", "oh", or another similar word from the list of Standardized Spellings (located at the end of this manual), mark it as a word ('w').
· These word vocalizations will be transcribed in a future pass through the data.

<u>Rules for Transcribing the Content of Parent Utterances</u>

If the words in an utterance can be heard clearly then…

· Type what was said in each utterance in the content section of the transcription column.

· Place separate utterances in separate cells.

If one or more of the words in an utterance cannot be heard or made out ….

· If an utterance contains more than one word, and you can only make out part of the utterance, transcribe what can be deciphered and fill in **'xxx'** for the unintelligible parts (e.g., parent says "give me" followed by an unintelligible word, code "give me **xxx**").

· For the parent, if the full utterance is unintelligible, type **'xxx'** as the content of the utterance (e.g., the parent says multiple words, but they are all unintelligible, so the entire code is **'xxx'**).

General rules for transcribing

· Type the complete utterance.

· Type everything in lower case, except for proper nouns of people (e.g., Mommy, I, pet names, characters from movies or shows, etc.), places (e.g., Alaska), or organizations (e.g., BurgerKing, see below).

· For multi-word names or places, such as Burger King or Chuck E. Cheese, you can concatenate these together with capitalization (e.g., BurgerKing, ChuckECheese)

· Titles such as Dr. or Mr. should be written out in capitalized forms, such as Mister, Missus, Doctor (e.g., Mister Rogers)

· You do not have to capitalize the names of brands, products, book titles or companies (e.g., alexa, google, cheerios).

· Any time the child participant's name or nickname is said, type "childname" (without the apostrophes). Any time the sibling's name is said (and it is completely clear from context that it is a sibling's name, not just any made-up name in pretend play), type "sibname". If a pet's name is used (e.g., a dog walks in and parent says "Dukey"), type "petname".

· Use apostrophes correctly for contractions and possessives (e.g., don't, where's, how'd, Daddy's, Lily's). If an apostrophe is used with the child or sib's name, type childname's or sibname's. Not-so-standard contractions can also be used if you would normally type them with an apostrophe (e.g., ain't, Mommy'll, etc.)

· **<u>DO NOT use "," commas.</u>** Commas likely indicate a natural pause or the beginning of a new and distinct phrase which should be a separate utterance.

· Put a question mark "**?**" at the end of any utterance that is a question. If the grammar/structure of the sentence indicates it is a question, put a question mark. If the grammar is unclear, consider conversational and prosodic cues, such as a clear, marked intonation change that suggests the speaker is asking for clarification or response from the child. If there is any doubt (e.g., the utterance is just one word and the parent consistently raises their intonation even when utterances are not questions), do not mark it as a question.

· Do not use exclamation marks "!" as their usage is subjective and does not convey additional content information.

· Avoid using hyphens for words that may typically use hyphens (e.g., play-doh should be typed as playdoh, bye-bye should be typed as byebye)

· Individual letters (e.g., parent spells out zoo as "z" "o" "o") need to be marked with an **@** (at symbol) so that they're not confused with actual words, for example z@ o@ o@. This rule applies to songs with letters (e.g., "Now I know my a@ b@ c@'s…", "old McDonald had a farm e@ i@ e@ i@ o@"...). Make sure there are spaces in between each marked letter (e.g., e@ i@ NOT e@i@). Use existing rules for utterances to decide if each letter is its own utterance.
· Write out the name of numbers (e.g., type "**five** little monkeys", not "5 little monkeys"). Do not use Arabic numerals.

Special Cases for Utterances

Our goal for the following rules in this section is to ensure that we capture the home language environment as fully as possible. We are aware that specific situations may arise in which transcribers may need to make decisions on how to type the content of utterances. In an effort to reduce work and cognitive load to ensure faster transcription, we have established rules for specific situations during transcription.

Retracted/incomplete words

· If the parent starts to say a word but then retracts it (i.e, does not complete the word), type out the full word, and insert a forward slash '/'at the point in which the word is retracted. For example, the parent starts to say 'banana' but then corrects herself, so code "do you want a ba/nana I mean apple?"
· Do this for retracted words where it is clear from context of the video and utterance what the word was (e.g., the parent gestures an action, or the retracted word matches the name of an object on screen).
· Only use the '/' for words where a full syllable or more is missing, not just for words where the last consonant got dropped or isn't clearly articulated. For example, parents occasionally stop abruptly mid-word and switch to a new phrase mid-word.
· In the case that the retracted word is hard to decipher and cannot be inferred from contextual cues, only code the part of the word that can be deciphered and end the word with a forward slash. From the previous example if it is not possible to infer that the parent is saying 'banana' from contextual cues, code "do you want a ba/ I mean apple?"

Assimilated Words

· Parents may sometimes use assimilated words (e.g., 'gonna' instead of 'going').
· When an assimilation is used, transcribe the assimilation in it's "non-standard" spelling (e.g., spell "gonna", do not change to "going to"). Default to using the assimilated spelling instead of the standard spelling unless the words are very clearly differentiated (for example, "gonna" would not be used instead of "going to" if the parent said "we're going to the restaurant".
· Use the "Nonstandard" columns in the following list of spellings for assimilations to maintain consistency in spelling of assimilations across transcriptions (use the "Standard" column to help you in cases where you are unsure what the assimilation means, but do not use that spelling, use the "Nonstandard" spelling).

Nonstandard	**Standard**	**Nonstandard**	**Standard**
coulda(ve)	could have	mighta	might have
dunno	don’t know	need(t)a	need to
dyou	do you	oughta	ought to
gimmie	give me	posta	supposed to
gonna	going to	tryna	trying to
gotta	got to	shoulda(ve)	should have
hadta	had to	sorta	sort of
hasta	has to	wanna	want to
hafta	have to	wassup	what’s up
kinda	kind of	whaddya	why did you
lemme	let me	whatcha	what do you
lostsa	lots of	whyntcha	why didn’t you
betcha	bet you		

Spelling and Pronunciation

· *Our goal for the following rules is to ensure that counts and tokens when analyzing the content of utterances are unbiased (e.g., “sketti” and “spaghetti” are not counted as two different words during analyses).*

· If the adult says a word, that is not assimilation, and clearly refers to a conventional word but with an alternative phonetic structure (e.g., baba for bottle), transcribe the ‘conventional version of the word. For example, if the parent says ‘sketti’ when talking about spaghetti, transcribe as ‘wanna eat your spaghetti?’ This saves transcription time, but also avoids biasing a parent toward more word types, if for example she said “banana? You want nana?”

· If a parent pronounces a word differently due to dialect or accent, use the conventional spelling of the word (e.g., “gettin’” should be spelled as getting)

· Pronunciations such as “workin’”, “how ‘bout” or “‘cause” should be spelled using the conventional spelling for the word (e.g., ‘working’, ‘how about’, ‘because’)

· Transcribe any time a novel word is produced using the conventional spelling when a change in the word is based on accent or intentional.

Adult non-verbal vocalizations and sound effects

· Many sounds that parents make have a clear meaning but are not always said in a way that can be transcribed phonetically (e.g., barking sounds, farm animal sounds, meaningful chewing or biting noises as part of pretend play). If parent makes a sound that conveys meaning to the child, check the list of Standardized Spellings for a way to transcribe the sound. Only transcribe sound effects that are part of communication with the child. Many sound effects are used during communication in symbolic play, so it is important to document them.
· A variety of sounds are often made in play for eating and drinking, and several are included in the standardized spellings. If the sound effect is voiced (i.e., the vocal cords are vibrating), check the standardized spellings and use the closest spelling for the sound that you hear (e.g., "mmm", "ohm", "yum", "nom nom nom", "gulp"). If the sound is not voiced (e.g., lip-smacking sounds, tongue clicking, etc.), default to using 'soundeffect' as described below, regardless of whether the sound is contextually related to eating or drinking.
· If parent makes a sound that approximates crying (for example, making an animal or teddy say "waa waa waa"), use 'soundeffect' once for each utterance (segmented as usual based on distinct pauses, intake of breath, etc).
· If parent makes a sound effect that is not on the list of standardized spellings, type 'soundeffect' (no spaces). If you think it should be added to the list of standardized spellings, make a comment and ask the lead coder on how to proceed.
· If parent is making horse sounds, type 'neigh', if making pig sounds, type 'oink', etc. (see standardized spellings). Only use these if the sound is something the animal would "say"/would come out of their mouth, rather than any sound effect as the parent plays with the animal (for example, if the parent makes the horse go "ch ch ch" to suggest sounds with feet, just use 'soundeffect').
· <u>Note:</u> The list of Standardized Spellings is ongoing and will grow as more transcriptions are completed.

If you cannot decipher the utterance, you can use xxx

<u>Transcribing Using Datavyu [abbreviated for appendix]</u>

Tagging Utterances

Open the .opf file and tag utterances. This is the first part of an iterative pass done for a small section of the video (roughly 1-2 minutes, until a good break in activity is reached).

· Quick Keys mode will be used to insert the source of the utterance: **"p"** for parent and **"c"** for child.
· Onsets are as close to the utterance onset as you possibly can get. Optimize your attention and coding for speed of tagging (reminder: offsets are not coded.).
· <u>Tip:</u> The best strategy is to have an unbroken playback session of 1-2 mins where you just tag utterances without stopping. Stop playback once 1-2 mins have elapsed or you hit a good breaking point in an activity before hitting the 1-2 minute mark (e.g. baby

moves onto playing with a new toy). Try to stop tagging utterances as soon as you tag a new utterance, rather than playing further into silence of the video; that way you can jump to and pick up right where you left off at an utterance for the next tagging pass, instead of potentially re-playing the same part of the video.

· Play the video at regular or ½ speed for tagging during periods of none or few utterances.

Transcribing Utterances

This is the second part of an iterative pass and should be completed after a set of utterances was tagged.

· Turn off Quick Keys (Shift-Cmnd-K).

· Turn on Highlight and Focus Mode by hitting Shift-Cmnd-F. This will highlight each cell (green is the current cell, red cells have past, and white cells are upcoming) as you loop back through the 1-2 mins you just tagged utterances in and put the focus of data entry (cursor) into the first uncoded argument in that cell (which will be <content>).

· Listen to each utterance within the context of the ongoing stream of speech.

· JUMP-BACK and re-listen at least 3 times if you are unsure of the content of the utterance.

· Once you are sure of the utterance, stop playback and transcribe the parent utterance or insert the appropriate code (for the child).

· Tip: Do not start transcription on the first listen of an utterance unless it is a child code ("w" or "v").

· At minimum, the onset of the utterance should occur during the utterance. Do not spend too much time adjusting utterance onset times to be exact, rather make sure they are occurring within the utterance and optimally close to the beginning (never at the end!).

· Turn off Highlight and Focus Mode (SHIFT-CMND-F).

· Save the file with CMND-S.

· Now turn Quick Keys (SHIFT-CMND-K), find [+] the onset of the last cell transcribed, JUMP BACK BY 2s, and revert back to the strategy for tagging utterances. Repeat until all utterances in the video were tagged and transcribed.

Appendix B Child Transcription Manual

This manual was adapted by Emily Roemer Britsch by combining the PLAY transcription manual, a collaborative multi-site project (https://www.play-project.org/coding.html#Transcription) *with documents developed by Eve LeBarton during her time in Jana Iverson's lab (2011).*

NOTE: sections in this manual that are completely redundant with Appendix A have been redacted here for brevity where noted, including definitions of utterances and transcription conventions. Information added or changed (primarily to clarify the more challenging process of transcribing child speech) is included below.

Child Transcription Conventions and Rules

What is an utterance?

[redacted for appendix, redundant with Appendix A]

It is important to note that the first pass through this dataset focused on identifying parent and child speech, and transcribing parent speech, so much of the time, you will be able to simply use the identified cells. However, particularly for child utterances containing words, **you may find that as you transcribe child speech, you decide that one child utterance should actually become two, or that two child utterances should actually be combined into one utterance.** If you make such changes, you need to do so only in the childtranscript column.

A few additional considerations for segmenting child utterances:

a. If a speaker **rapidly repeats** a word, use intonational contours and pauses as cues to establish word boundaries. To the word as a 1 utterance, there should not be a pause in between words. Note that sometimes the speaker will repeat words in one utterance (e.g. *No, no, no!*), then pause, and then produce the word in isolation as a separate utterance. This rule also applies to when the speaker is counting, saying the alphabet, or reciting a list.
b. Sometimes there is a **false start or a brief pause** in an utterance that conveys the same thought. Use intonation and pause cues to determine if the speech should be transcribed as 1 utterance or 2 utterances.
c. If there is a repeated word (e.g., "we we have to get this onto the barn"), type the word twice (or however many times you hear it). However, if they just say the first phoneme (stuttering, e.g., b b bear), just type the word once.

Whose language is transcribed?

The goal for the following rules is to capture the typical language environment between the parent and child in the home. We want to avoid transcribing language that would not occur if the experimenter were not present (i.e., talk to the experimenter).

> If you believe an identified utterance is someone other than the child or parent (e.g., a sibling, an experimenter), do not transcribe the utterance and make a comment.
>
> If another caregiver/parent joins the toy play and/or converses with the child for more than 15 seconds, make a comment and notify the primary coder. If the child is clearly speaking to another parent/caregiver, still code the child's speech but make a comment in the comments column noting "directed to other".

What child speech should be transcribed?

We transcribe all meaningful communicative vocalizations that are intelligible.

The general criterion employed to identify meaningful vocalizations is use of the same sound pattern to refer to a specific referent on multiple occasions or in different contexts. Meaningful vocalizations are either actual English words (e.g. dog, cat, duck, hot, walking) or speech sounds that are consistently used by a particular child to refer to a specific object or event (e.g. using "bah" to refer to a bottle in a variety of different contexts).

Meaningful Vocalizations: includes all words, communicative animal sounds, and indefinite communicative sounds, such as *hmm*, *uh*, etc. When transcribing communicative sounds, consult the list of conventional spellings.

> **a. Do NOT transcribe coughing, sneezing, laughing, crying, raspberries, or vegetative** sounds (e.g. grunts/sounds of exertion and exhales/inhales). When you come across these -- noises and vocalizations, and a vocalization is coded "v", delete the cell in the childtranscript column. If you think any of these sounds (e.g. coughing, laughing, sneezing, crying) is pertinent to the conversation, explain in Comments column. However, if a laugh leads into a word or words in the same utterance, keep the utterance and transcribe the word(s).
>
> **b. Non-speech vocalizations are coded as 'v' and not transcribed.**
> These are important aspects of children's communication particularly as part of verbal pre-linguistic communication. These are simply coded as 'v' in these speech transcripts. Non-speech vocalizations include babbling (vowel and consonant combinations, such as "bababa" or "momanuu") and non-babble productions that do not contain syllabic structure, such as single or multiple vowels ("aaa", "aaaeeeooo") and single or multiple consonants ("mmmmm", "mmmnnn"). High-pitched squeals should also be coded as 'v' unless they clearly include a word.

- To determine whether a sound is a word such as “hmm”, “mmm”, “uh”, “ah”, etc., err on the side of coding as a vocalization unless it is clear from context that it is being used as one of these words

If you are unsure whether a sound is being used as a word, enter “xxx” in Speech Transcription column and explain in the Comments column. Do not enter “xxx” for all non-speech vocalizations—only enter for vocalizations that you think may be being used as a meaningful word, but do not quite meet the criteria for a meaningful word or that have two or more equally plausible alternatives for words you would transcribe. Distinguishing babble from unintelligible words is not always a straightforward process. See the **Unintelligible Speech and Babbling** guide for more details and instructions.

c. If a child is singing, reading, or praying, still transcribe the speech but note “singing” “reading”, or “praying” in the comments column.

d. Do not transcribe utterances spoken in a non-English language. Instead leave the vocalization as “w” and note “non-English language” in the comments column.

Unintelligible utterances are transcribed as “xxx”.

Be conservative. If you are unsure what the child is saying, ask another transcriber for his/her opinion, and do NOT tell the second transcriber what you think the person is saying (that would make it more likely that the transcriber will hear the same thing as you, even if they wouldn’t have otherwise). If you are still unsure, do not transcribe, but do enter what you think the speech may/may not be in the Comments tier. Unintelligible utterances are indicated by a “xxx”. You may use “xxx” to represent the entire utterance or only one word or phrase in the utterance. **See Unintelligible Speech and Babbling Guide for additional details.**

A few guidelines for determining what is unintelligible:

- Avoid transcribing something that you can *only* hear in slow motion. Slow motion is helpful, but if you can’t hear something resembling that word in real time, transcribe as xxx.
- Listen to each utterance more than once (whether it is transcribed immediately or xxx). However, avoid listening to an utterance too many times. You might convince yourself that you hear a word that you don’t. **If you can’t decide = xxx**
- When there is a string of unintelligible sounds, you may transcribe only some of the speech as discrete words (instead of xxx for the entire utterance). However, avoid transcribing a word in the middle of an unintelligible utterance. We can usually be more confident about words at the beginning or end of unintelligible utterances. However, transcribing words in the middle of unintelligible sounds can be tricky.
- Do NOT transcribe only part of a word as xxx. For example, you should never transcribe “*xxxing*” or “*xxxed*”. However, you can enter this information into the Comments column.
- Avoid transcribing a word when equally plausible alternatives exist.

- Avoid transcribing words in an unintelligible utterance when it is unclear where one word would end and another would begin.
- Avoid transcribing a word that you think it is unclear someone else would hear.

Only transcribe speech that you are *certain* that you hear.

Sometimes we have a tendency to 'fill in' words that are not present in speech, but should be. For example, "*a*" and "*the*" may sometimes be dropped (particularly with very young children), but we may think that we hear them because they frequently co-occur with some words, e.g. "*a ball*". If you are still unsure after re-listening, enter "xxx" (e.g. "xxx ball"). In some cases, listening to speech in slow motion will help. Another example is making a word grammatically correct by inserting a word or extending a word (e.g. mistakenly writing "*I'm*" when the child says "*I*").

For utterances that are uncodable due to background noise:

If an utterance is unintelligible due to background noise (e.g., very poor audio quality, siblings in the background are too loud, parent is speaking entirely over the child so you cannot hear), rather than the child speech itself being unintelligible, code 'u' rather than xxx. Due to the naturalistic home environment, there will often be some background noise. Only code 'u' if you cannot distinguish any part of the child's speech and/or you cannot determine if it should be coded as 'v' or 'xxx' due to that noise.

If you can transcribe the speech and there is background noise, transcribe the speech. If you are confident the utterance would be unintelligible even without the background noise, code xxx. If the child utterance is too quiet hear, base your decision on 'xxx' vs. 'u' on whether there is background noise or poor audio quality obscuring the utterance. For example, if a child whispers and you cannot decipher any part of the utterance (even at full volume) but the audio quality is good, code 'xxx'. If the child is quiet because there is poor audio quality, static, siblings making noise in the background, etc., code 'u'.

Word Transcription Rules

This section is intended to convey the way in which you will transcribe things at the word level. The basic method for this transcription system is summed up with the following rule: Transcribe verbatim, but not phonetically. We want to include all of the words that the child says, but phonological development is beyond the scope of this transcribing system. Careful phonetic transcription can provide valuable information on, for example, phonological development. However, we do transcribe at that level of analysis.

Child rules for transcribing:

1. Transcribe the child's word like the adult word. Do not try to spell out the child's immature pronunciation of the words. For example, if a child says, *geen*, and context and other cues (e.g. consistency of use in different contexts) suggest that the child meant *green,* transcribe, *green*. As another example, if the child says 'sketti' when talking about spaghetti, transcribe as 'wanna eat your spaghetti?' This saves transcription time, but also avoids biasing a child toward more word types, if for example she said “banana? You want nana?” If the child says a word, that is not assimilation, and clearly refers to a conventional word but with an alternative phonetic structure (e.g., baba for bottle), transcribe the ‘conventional version of the word.

See sections on unintelligible speech for more details on transcribing children’s imperfect pronunciations of words.

2. **Transcribe each word that the child says**, including indefinite communicative sounds like *hmm* and *uh* It is important that you use the **List of Conventional Spellings (end of this document)** to determine how to spell indefinite communicative sounds. If the item does not appear in the list, consult another transcriber. The item (a) may not be a sound that is transcribed or (b) may need to be added to our list. It can be challenging to determine whether a single “hmm”, “mmm” or “uh” is being used as a word rather than simply vocalizing or playing with vowels and consonant sounds. If it is used in an appropriate context (e.g., “mmm” during play eating; “hmm” or “uh” as if the child is considering their next utterance), transcribe the word. If you cannot tell, defer to coding as a vocalization (‘v’).

3. **Transcribe whole words only, not parts of words**. Do not type ‘*cause* for *because* or ‘*til* for *until*, even if that’s what the speaker says. However, sometimes the non-standard form that is actually used is recorded in the Comments column (e.g. if a word approximation is the child’s version of that word, the word approximation is recorded in the Comments column). There are also specific rules (see below) for how to transcribe some non-standard versions of words and word approximations (including some specific exceptions).

4. However, do not correct grammatical errors. You must transcribe what the speaker says, even if you might not say it that way or it may be grammatically incorrect. Very young children will often produce phrases that are grammatically incorrect or fragments. Transcribe exactly what the child says, not what the grammatically correct version would be. For example, if the child says, “*Where my puppy?*”, transcribe as “*Where my puppy*?”, not as “*Where’s my puppy?*”. This is very important both to obtain an accurate record of what is said, but also because these sorts of errors are reflective of children’s language development (e.g., development of children’s use of auxiliary verbs and other morphemic endings that are sometimes omitted) and may be the focus of further investigation.

If the child has an **unusual use of a word** (and you are certain that the child intends to use that word and it is not a non-speech vocalization—see rules for determining if a vocalization is a word), still transcribe that word. For example, if the child has an unusual use of “a”, transcribe a. (e.g. in one sample a child may produce, “*A mommy eat it.*”, “*A do it.*”, “*A Mommy shoes*.”.)

Additional general rules for transcribing

[redacted for appendix, redundant with Appendix A]

<u>Unintelligible Speech and Babbling Guide</u>

As transcribers, we are constantly trying to stay in the middle of two opposing forces: the tendency to over-attribute and the tendency to under-attribute the child's knowledge of language. Over-attributing means giving the speaker credit for saying words that might not have actually been said. Under-attributing means missing some words that a speaker did say just because you don't feel sure enough about it in a given moment. This can be particularly difficult when transcribing the speech of very young children as they often produce words with imperfect pronunciation. This section is devoted to helping you avoid these two extremes. Note: This section applies to words that are imperfectly produced. If you *do* clearly hear a word, do not avoid transcribing it simply because it is ungrammatical or you are unsure how it fits into the context (it may make perfect sense to the child!).

The **general criterion** employed to discriminate meaningful vocalizations from unintelligible speech is: use of the *same sound pattern* to refer to a *specific referent* on multiple occasions or in different contexts. Meaningful vocalizations include actual English words (e.g. dog, cat, duck, hot, walking), but also may include speech sounds that are *consistently used* by a particular child to refer to a *specific* object or event (e.g. using *bah* to refer to a bottle in a variety of different contexts with seemingly different meanings). There should be only one clear meaning for the vocalization.

Even with these principles, it can be very difficult to determine whether or not the child's pronunciation of the 'word' should be transcribed as a word (e.g. *geen* transcribed as *green*). For this reason, we also have outlined criteria that the *sounds* produced for the 'word' must meet in order to be transcribed as a meaningful word: (1) the 'word' shares at least 1 syllable with the adult pronunciation of the word (if 2+ syllable word), and/or (2) the 'word' shares at least half of its phonemes with the adult pronunciation of the word. This is in addition to the *meaning* requirements (see below).

Mark unintelligible speech by "xxx"

Children, especially when they are very young, unfortunately will not always give you a clear rendition of every word they try to pronounce. For this reason, we have some criteria to determine whether a segment of child speech is a word or not. **A word must meet *either* of criteria (a) and (b) AND must meet criteria (c).**

a. **For two- or more syllable words, the child's pronunciation must share at least on syllable with the adult pronunciation of the word.** For example, if a child says *baba* to mean *bottle*, it could be transcribed as a meaningful word, *bottle*, (provided it also meets (c) below) because it shares the first syllable (*bah*) with the adult word *bottle*.

b. If the child's pronunciation of a word with any number of syllables **shares at least half of its phonemes with the adult pronunciation of the word,** then it can be transcribed as a meaningful word (provided it also meets (c) below). For example, the word *train* has four phonemes: *t, r, ay,* and *n*. If a child says *tay,* then the child has produced two out of the four phonemes correctly and meets this criterion. For communicative sounds on list of standard spellings the speech form should be exact. The only exception is if the child is making an idiosyncratic production (see criteria for determining this and transcribing).

AND

c. **The child's non-adultlike word must appear in at least one appropriate, obvious context in order to be considered a meaningful word**. If the child utters, for example, *baba* to herself without doing something to indicate what she means and without any informative actions or reactions by the parent, we do not know whether she is babbling or that *baba* stands for *bottle* as opposed to another word, e.g. *ball* or *mama*. However, the sound should not appear in many other contexts with potentially different meanings.

To determine whether, for example, *baba* is used to mean *bottle*, you rely on contextual cues such as how the child and adults behave before and after the vocalization is produced, what is happening and what objects are around at the time. You can be liberal about potential meanings. **Avoid relying *only* on the parents' interpretation** of the utterance.

If there are one or more *equally* plausible alternatives that meet the phoneme rule, transcribe as xxx. However, if one alternative is more likely given the context, feel free to transcribe as that word. In general, be more conservative when the sound is only a vowel or a vowel + ambiguous consonant.

<u>If the context of a word is not immediately obvious, use the following procedure:</u>

c.Step1) Type the syllables you hear, followed by an asterisk (*****) and the potential meaning of the word, e.g. *baba*bottle*. Add relevant contextual information in the Comments tier.

c.Step2) After completing the transcript, find each asterisked form. If the word appears twice in two similar contexts, replace the asterisked forms with the adult version of the word. If it only appears once and you are unsure of the meaning, replace it with xxx. Be sure to still record the potential meaning in the Comments tier.

<u>If one of (a) is not met,</u> you can still transcribe, but transcribe as a version of an idiosyncratic word—conventions for transcribing below. However, there are additional requirements for transcribing a word that does not meet point (a). Only transcribe when the **exact** speech form is used in more than 1 instance with the same clearly identifiable meaning (used consistently) and not used in another instance with potentially other meanings (used selectively). In general, though, words not meeting the (a) phoneme rule, should rarely be transcribed.

Procedure for avoiding over-attributing. Sometimes, especially when you are transcribing a child with a lot of hard-to-decipher speech, you may think you hear the child saying something, but be afraid you are over-attributing. <u>Follow these steps:</u>

a. First, ask another transcriber what s/he thinks the child is saying, without telling the transcriber you hypothesis.

b.1) **If the second transcriber hears the same thing** as you, you can be pretty confident transcribing what both of you hear.

b.2) **If the second transcriber doesn't hear the same thing as you**, tell the second transcriber what you think the child is saying and see if they agree. If they agree with you strongly after hearing what you thought it was, and you still feel strongly about what you hear, transcribe what you both think the child said.

b.3) **If the second transcriber continues to disagree** about what the child is saying or is still highly uncertain or skeptical, transcribe as xxx.

Idiosyncratic words: Sometimes children invent words with little or no resemblance to the standard, adult version of the word. For example, a child might say *neenee* to mean *guitar*. If the idiosyncratic word has a clearly identifiable meaning that occurs in at least one obvious context, *transcribe the word as it sounds*, followed by the "**@**" symbol and record the meaning of the word in the Comments column. Parents can be a valuable source of information on these idiosyncratic words, but avoid relying solely on parent report. [Note that the "@" symbol is a general indicator of a word that is non-standard or **unconventional**.]

A General note on "Context"

You will often consider context when determining what and how to transcribe (e.g. disambiguating speech and determining whether a vocalization is meaningful communicative speech or jargon). Context includes both verbal and nonverbal cues. It includes both communicative and non-communicative acts. It includes actions and objects in the environment. When considering context, you can rely on any of the following cues, BUT do not rely exclusively on one. **It is particularly important that you do NOT rely solely on (1) Parent interpretation of child's utterance or (2) Speaker's gesture.**

(a) <u>Conversational</u> context: includes prior and subsequent utterances by the speaker or interlocutor.
(b) <u>Speaker</u> behavior: includes eye contact, communicative nonverbal behaviors (e.g. gesture) and non-communicative nonverbal behaviors (e.g. objects manipulating or attending to). This can include the repetition of the utterance or awaiting a response to the utterances as indicated by looking at the interlocutor, hesitating, or modifying behavior. Do not rely solely on the speaker's gesture (there are many different reasons for this) and be aware that it may unconsciously impact what you think you hear.
(c) <u>Interlocutor</u> behavior: includes communicative and non-communicative nonverbal behaviors as well as the verbal and non-verbal reactions of the interlocutor to the speaker's vocalization. Particularly for children, this *may* include the parent's 'translation' of the child's vocalization. However, do <u>not</u> rely solely on the parent's translation (there are *many* reasons for this including that parents are not always right!). Also, be careful when transcribing vocalizations the parent has translated—it can unconsciously impact what you think you hear.
(d) The <u>environment</u>: consider the environment (e.g. where are the interlocutors?), objects in the environment, and things happening in the environment. Note, allow for some lag between something that has happened and an utterance about it.

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