From *um* to Words: The Role of Disfluency Interactions in Shaping Early Language Development

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1. Introduction

Speech disfluencies are interruptions in the flow of speech. Although they are often reduced in controlled laboratory settings, they are common in everyday conversation, where different disfluency types can serve different communicative functions (Owens et al. 2016; Orena et al. 2015; Kidd et al. 2011). Importantly, disfluencies are not merely linguistic "noise." They can also shape listeners' expectations in real time. For example, listeners often treat a disfluency as a cue to upcoming new information in the discourse or mentioning a novel object in the environment (Yoon et al. 2020; Beattie et al. 1979; Tily et al. 2009; Arnold et al. 2007; Arnold et al. 2011; Arnold et al. 2003; Fox Tree 2001), and children as young as two to three years old distinguish disfluencies from non-linguistic noises (e.g., construction noises, beeps) and use them to guide their sentence processing (Orena et al. 2015; Yoon et al. 2020).

Previous work also suggests that disfluencies are related to both comprehension and production. On the comprehension side, they can direct listeners' attention and often facilitate the processing of upcoming information (Fraundorf et al. 2011; Arnold et al. 2007; Arnold et al. 2011; Arnold et al. 2003; Fox Tree 2001). On the production side, they are associated with higher planning and monitoring demands and tend to occur around low-frequency words or more complex linguistic structures (Fox Tree 1995; Gordon et al. 1989). In development, disfluencies also change with children's growing linguistic and cognitive capacities, making them informative both from children's own productions and from the environmental input around them (Fichman et al. 2024).

By analyzing both children's own disfluencies and their exposure to adult disfluencies in naturalistic adult–child interaction, this study extends prior work beyond controlled laboratory settings. It asks whether disfluencies in everyday

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input co-vary with children's developing language outcomes and, thus, whether disfluency patterns may serve as a behavioral marker of language development.

This article is organized as follows. Section 2 reviews evidence on how disfluencies relate to language comprehension and production. Section 3 describes different types of disfluency in naturalistic speech. Section 4 describes the associations between disfluencies and language development. Sections 5 and 6 present the methods and results, respectively. Section 7 discusses the findings, and Section 8 concludes.

2. The Influence of Disfluencies on Language Comprehension and Production

Previous research suggests that disfluencies affect real-time comprehension. From the listener's perspective, disfluencies can shift the listener's attention and facilitate the processing of upcoming information (Fraundorf et al. 2011). For example, after hearing a disfluency, both children and adults are more likely to anticipate new information from the previous discourse and less frequent words (Arnold et al. 2004; Soderstrom et al. 2007). Listeners often interpret disfluency as a signal that the upcoming information may be less expected or more difficult to plan or retrieve (Fraundorf et al. 2011; Arnold et al. 2007; Arnold et al. 2011; Arnold et al. 2003).

The comprehension effects also align with production patterns. From a production perspective, speakers tend to produce disfluency more frequently with infrequent words, new discourse information, and complex linguistic structures (Beattie et al. 1979; Tily et al. 2009). This tendency has been reported in both monolingual and bilingual adults and children (Arnold et al. 2007; Rojas et al. 2023).

Taken together, these findings suggest a close link between disfluency, comprehension, and production. As speakers produce more disfluencies in longer or more structurally complex utterances, listeners might spontaneously treat disfluency as a cue that the upcoming information is likely to be novel or less expected.

3. Different Types of Disfluency in Naturalistic Speech

In spontaneous speech, disfluencies can take multiple forms, including fillers (e.g., *uh*, *um*), pauses (e.g., short silent breaks within an utterance), retracings (e.g., self-repairs or revisions), and repetitions (e.g., repeated words or phrases). These forms may serve different communicative functions, such as reformulation, speech planning, self-correction, and emphasis (Nafissi et al. 2017) (also see Table 1). For example, fillers frequently occur at clause boundaries and before less expected or more demanding material, consistent with their role in incremental planning (Arnold et al. 2007). Retracings, by contrast, reflects overt self-monitoring and repair, and can support effective communication by updating the message when speakers detect an error or mismatch.

Table 1: Types of Disfluencies in the Current Naturalistic Corpus; Communicative Functions Summarized from (Nafissi et al. 2017).

Disfluency Type	Example from Corpus	Purpose
Filler	That's a soda **uh** pops. (1;09 Child Production)	Reformulation
Pause	I sit down **(pause)** here! (1;09 Child Production)	Speech Planning
Retracing	Cake **cupcake**. (2;06 Child Production)	Self-Correction
Repetition	No sit here **no sit here**. (2;09 Child Production)	Emphasis

4. The Associations Between Disfluencies and Language Development

Disfluencies are also a common feature of typically developing (TD) toddlers' speech. Developmentally, children show sensitivity to disfluent speech in both comprehension and production. For comprehension, disfluencies guide children's online expectations about what comes next, including expectations for novel referents or objects (Yoon et al. 2020). Notably, these effects are weaker or absent when the disruption is a non-speech noise (e.g., a construction sound), suggesting that children treat disfluencies as linguistically informative rather than as generic acoustic interruptions (Arnold et al. 2007; Saryazdi et al. 2021). Disfluencies can also influence children's syntactic prediction, as listeners may shift their parsing strategies and consider alternative structures in response to disfluencies. Using disfluency as a cue has been hypothesized to resolve both syntactic and lexical ambiguities (Ferreira et al. 2004; Arnold et al. 2011).

For production, both longitudinal and cross-sectional work suggests that disfluency rates can increase after roughly age 2;6 and peak during periods of rapid language change, with estimates of several disfluencies per 100 words depending on task and coding practices (Rojas et al. 2023; Nafissi et al. 2017; Guitar 2013). Children often use fillers to manage production planning (Nafissi et al. 2017), and disfluency rates can rise under higher task demands (e.g., open-ended responses) or heightened affective states (e.g., frustration or excitement) (Rojas et al. 2023). Overall, these patterns support the view that disfluencies index temporary production difficulties and planning loads in naturalistic interactions.

In summary, children's disfluency patterns also change with development. Disfluency rates tend to increase as children's lexical and grammatical abilities expand (Bortfeld et al. 2001; Brundage et al. 2022; Tumanova et al. 2014; Ganger et al. 2004). This developmental link raises an open question. Beyond children's sensitivity to adult disfluencies during comprehension, how do children's own disfluencies and their input exposure to adult disfluencies in everyday interaction relate to their language outcomes (e.g., measures of **grammatical complexity** and

lexical diversity)? This question motivates the present study and our analysis of naturalistic adult-child interaction.

5. Current Study

5.1. Research question and predictions

Despite extensive research on disfluencies in controlled experimental settings, our understanding of how disfluency patterns naturally emerge and influence language development during naturalistic adult-child play contexts remains limited.

To address these gaps, the present study examines the longitudinal relationship between disfluencies and children's language development outcomes in two domains (**grammatical complexity** and **lexical diversity**) during naturalistic adult-child interactions, focusing on both child-produced and adult-produced disfluencies, and poses the following research questions and predictions:

(**RQ 1**): What's the relationship between proportions of disfluencies and children's language outcomes in grammatical complexity and lexical diversity?

(**RQ 2**): What's the difference between the production of different types of disfluency among adults and children?

As outlined in previous sections, prior work suggests that disfluencies can facilitate language comprehension, especially by signaling upcoming new or low-frequency vocabulary. In particular, higher proportions of disfluencies produced by both children and adults may be associated with higher values on children's language outcome measures. In language production, disfluencies reflect increased processing demands for both children and adults, and different types of disfluency serve distinct communicative functions. Given developmental differences in production abilities and communicative functions, adults and children may therefore differ in their production of disfluency.

5.2. Corpus

We analyzed naturalistic adult–child play sessions from a longitudinal monolingual English corpus in CHILDES (Hadley et al. 2014). The corpus includes recordings collected at three-month intervals from ages 1;9 to 3;0 (six time points: 1;9, 2;0, 2;3, 2;6, 2;9, 3;0), spanning approximately 1.25 years. At each time point, each child completed two 30-minute observation sessions: one with their primary caregiver(s) (e.g., mother or father) and one with an experimenter, with the caregiver(s) present. The corpus originally included 44 TD monolingual English-learning toddlers. Four participants were excluded due to incomplete data collection, leaving a final sample of 40 participants.

5.3. Data Cleaning

Utterances with utterance-final fillers (e.g., *You are smart, huh?*) and single-word fillers (e.g., *huh?*, *um?*) were excluded from analysis. These forms often serve pragmatic purposes, such as maintaining conversational flow or signaling hesitation, rather than indexing grammatical or lexical development. Excluding these pragmatic expressions ensures that the analysis focuses on disfluencies in rich linguistic contexts, offering a clearer view of developmental changes in language production.

5.4. Statistical Modeling

We extracted repetitions, retracings, fillers, and pauses from both child and adult speech, and computed disfluency rates as proportions (e.g., number of disfluent utterances divided by total utterances) for each speaker. Subtype proportions were later summed to obtain an overall disfluency proportion because of low proportions for specific subtypes (e.g., repetitions). Because proportion measures were positively skewed, both child- and adult-produced disfluency proportions were log-transformed and mean-centered before modeling. The children's ages and child ID were coded as factors. Language measures were computed in CLAN using *kideval* for child measures and *eval* for adult measures (MacWhinney 2014), which are widely used metrics in child language research (MacWhinney 2000; MacWhinney 2014).

We fit nine linear mixed-effects models to test whether child disfluency, adult disfluency, child age, and their interactions predict children's language outcomes. Outcomes spanned **Grammatical Complexity** (three measures: mean length of utterance in morphemes, mean length of utterance in words, and mean length of the first 50 utterances in morphemes; Models 1–3 in the Appendix) and **Lexical Diversity** (six measures: number of different types of words (word types), different number of words, verbs per utterance, vocabulary diversity measured by VOCD, type–token ratio, and number of distinct words in the first 100 words; Models 4–9 in the Appendix). All models included by-child random intercepts and by-child random slopes for age. Complete model formulas and outcome-specific specifications are reported in the Appendix due to space constraints.

6. Results

6.1. How Child and Adult Disfluencies Relate to Children's Language Outcomes

Overall, we found a positive association between both children's and adults' disfluency proportions and children's lexical diversity. Still, this association is age-sensitive, especially for two linguistic outcomes: verbs per utterance and word types. No other models showed significant effects. Due to space constraints, the formulas for all models and their outcomes are provided in the Appendix.

In the **verbs per utterance** model (Model 6 in the Appendix), we fit a linear mixed-effects model predicting children's verbs per utterance from child-produced disfluency and adult-produced disfluency (log-transformed), age (factor), and all interactions among these predictors. Child and adult disfluency proportions were log-transformed and centered. The model included a by-child random intercept and a by-child random slope for age to account for repeated observations within children across age points. At the reference age level (with the other predictor held at its mean), child-produced disfluency showed a significant positive association with verbs per utterance ($\beta = 0.16$, $p < 0.05$), and adult-produced disfluency also showed a significant positive association ($\beta = 0.16$, $p < 0.05$). The child and adult disfluency interaction was significant ($\beta = 0.06$, $p < 0.05$), indicating that the association between disfluency and children's verb use differs as a function of the other speaker's disfluency level. Given the inclusion of interactions with age, these associations are permitted to vary across age points (Figure 1).

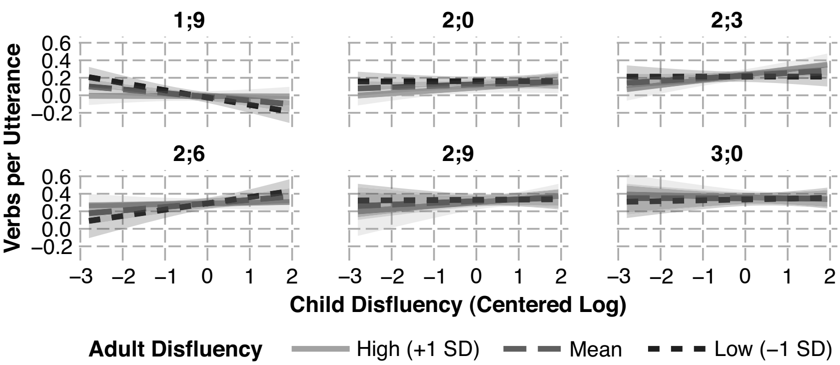

Figure 1: Child and Adult Disfluency Relate to Children's Verbs per utterance (six ages correspond to the corpus recording time points)

A post-hoc analysis was conducted to further examine the interaction between child disfluency and adult disfluency across age in predicting verbs per utterance. Pairwise comparisons of the effect of child disfluency at three levels of adult disfluency (−1 SD, mean, +1 SD) were significant at 1;9, but not at later ages. Specifically, the slope of child disfluency differed between low vs. mean adult disfluency ($\beta = -0.04$, $p < 0.05$) and between low vs. high adult disfluency ($\beta = -0.08$, $p < 0.05$). The contrast between mean vs. high adult disfluency was also significant ($\beta = -0.04$, $p < 0.05$). These results indicate that, at the earliest age point (1;9), the effect of child disfluency on verbs per utterance changes as adult disfluency increases. From 2;0 onward, the estimated slopes were positive, indicating that higher disfluency from both children and adults is associated with more verbs per utterance, suggesting that this effect is age-sensitive (see Figure 1).

In the **word types** model (Model 4 in the Appendix), we fit a linear mixed-effects model predicting children's word-type production from child-produced disfluency and adult-produced disfluency (log-transformed), age (factor), and all interactions among these predictors. Child and adult disfluency proportions were log-transformed and mean-centered. The model included a by-child random intercept and a by-child random slope for age to account for repeated observations within children across age points. Holding child disfluency at its mean (and at the reference age level), adult-produced disfluency showed a significant positive association with children's word types (β = 33.66, $p < 0.05$), indicating greater lexical diversity when adult disfluency was higher. Child-produced disfluency showed a marginal effect in the same direction (β = 32.18, p = 0.06). Notably, the child and adult disfluency interaction was significant (β = 11.43, $p < 0.05$), indicating that the association between one speaker's disfluency and children's lexical diversity depends on the other speaker's disfluency level. Overall, the model implies that the association between child disfluency and lexical diversity is more positive at higher levels of adult disfluency (Figure 2).

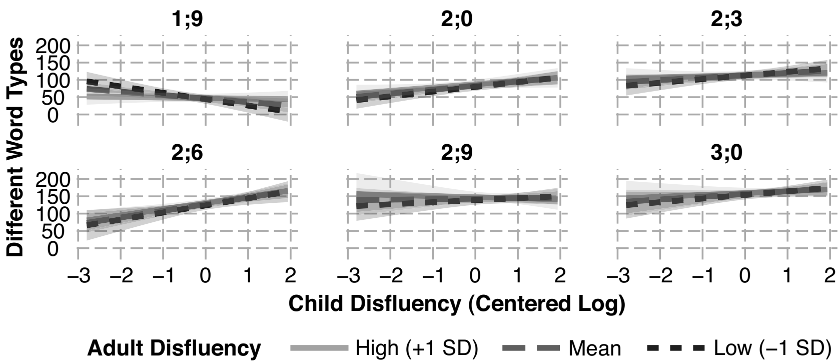

Figure 2: Child and Adult Disfluency Relate to Children's Word Types (six ages correspond to the corpus recording time points)

A post-hoc analysis was conducted to further examine the interaction between child disfluency and adult disfluency across age in predicting word types. Pairwise comparisons of the simple slope of child disfluency at three levels of adult disfluency (−1 SD, mean, +1 SD) were significant at 1;9, but not at later ages. However, at the earliest age point (1;9), the contrasts were significant: low vs. mean adult disfluency ($\beta = -8.40$, $p < 0.05$) and low vs. high adult disfluency ($\beta = -16.80$, $p < 0.05$), and mean vs. high adult disfluency ($\beta = -8.40$, $p < 0.05$). These results indicate that, at the earliest age point of 1;9, the influence of child disfluency on the child's word types changes as adult disfluency increases. However, they were not significant at any other age points. From 2;0 onward, the estimated slopes were positive, indicating that more disfluency from both children and adults is associated with more word types, suggesting that this influence is age-sensitive. These patterns are visualized in Figure 2.

6.2. Different Types of Disfluency Production Among Children and Adults

As shown in Figure 3, all four disfluency types (fillers, repetitions, pauses, and retracings) were observed in both children's and adults' speech. However, their relative proportions varied across age points and disfluency types, consistent with prior developmental work (Nafissi et al. 2017; Redford 2013; Rojas et al. 2023). We found children's disfluency rates increased with age, whereas adults' rates remained relatively stable (e.g., were not dependent on the age of the child interlocutor). Across all sessions, children also produced more disfluencies than adults, a pattern widely reported in the developmental literature (Rispoli et al. 2008; Kidd et al. 2011; Jansson-Verkasalo et al. 2021). The increase in children's disfluency rates may reflect greater demands on speech planning and utterance formulation as their productions become longer and more structurally elaborated. Across both speakers and all ages, fillers were consistently the most frequent disfluency type, in line with previous findings (Fox Tree 1995; Clark et al. 2002) and plausibly reflecting their role in maintaining conversational flow.

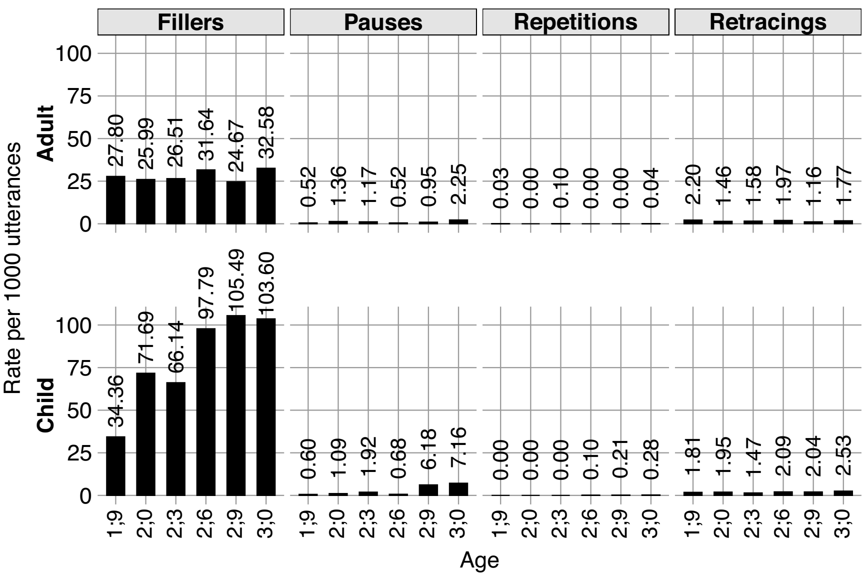

Figure 3: Disfluency proportions in child production and adult input (shown as rates per 1,000 utterances to improve visualization and readability)

7. Discussion

This study examined associations between child- and adult-produced disfluencies and children's own language outcomes in naturalistic adult–child interaction, focusing on two domains of language outcomes (e.g., **grammatical complexity** and

lexical diversity). The findings underscore the complex role of speech disfluencies in early language development, their association with lexical diversity measures, and the different patterns of disfluency production observed in children and adults. Because the present analyses are correlational, we interpret these patterns as co-variation rather than evidence of causal effects.

We found that both child- and adult-produced disfluencies were positively associated with some measures of children's vocabulary diversity (e.g., verbs per utterance, word types). This pattern is consistent with the view that disfluencies may index increased cognitive effort during lexical access in spontaneous speech (Fichman et al. 2024; Orena et al. 2015; Nafissi et al. 2017). In particular, lexical items that follow child-produced disfluencies can often carry new information in the discourse (e.g., new salient objects in the environment), or low-frequency vocabulary (Beattie et al. 1979; Tily et al. 2009). This pattern was particularly evident in the association between disfluency proportions and verbs per utterance and word types, suggesting that disfluency is linked to greater lexical diversity.

The relationship between disfluencies and vocabulary development appears to be age-sensitive. One possibility is that after the earliest age point of 1;9, children enter a period of faster lexical growth (cf. the vocabulary spurt), making co-variation easier to detect (Ganger et al. 2004). This developmental trajectory suggests that disfluencies may serve as a developmental marker for lexical learning or language development, particularly during periods of rapid vocabulary growth. Still, the influence of disfluency on lexical development is age-sensitive.

The age-dependent nature of these associations suggests that children's ability to process and utilize disfluencies in speech input develops over time. From a production perspective, children's own disfluencies may serve as self-generated learning opportunities, allowing them to engage in language development and vocabulary acquisition actively. From a comprehension perspective, adult-produced disfluencies may signal upcoming novel words or objects in the discourse and environment, potentially co-occurring with the flow of linguistic information to children, particularly in vocabulary learning (e.g., learning names of new objects in the environment or low-frequency vocabularies).

We also observed age-related changes in the overall rate and distribution of disfluency types. While prior work often reports increases in disfluency after approximately 2.5 years (Guitar 2013; Rojas et al. 2023; Nafissi et al. 2017), our results suggest that disfluency production can increase after age 1;9 in naturalistic settings, slightly earlier than reported in the previous literature. This pattern is consistent with the possibility that multiple factors, including cognitive load, emerging planning abilities, and discourse-pragmatic pressures, influence disfluency production. In line with prior findings, children produced relatively more retracings than adults (Kidd et al. 2011), and increases in fillers and pauses with age may reflect greater production of longer or more syntactically complex utterances (Bortfeld et al. 2001; Brundage et al. 2022; Tumanova et al. 2014).

Overall, these findings suggest that disfluencies, by signaling greater cognitive effort during speech production, may support more effective speech planning and provide more opportunities for children to acquire more diverse vocabulary from their input (Rispoli 2003). This study contributes to a deeper understanding of the language development patterns in preschoolers, particularly in naturalistic adult-child play settings. The complex role of disfluencies in comprehension and production suggests that they may be informative as potential developmental indicators of active language learning rather than as speech errors to be corrected.

8. Conclusion

This study examines associations between child- and adult-produced disfluencies and children's early language outcomes in naturalistic adult–child interaction. Across age points, higher disfluency rates in child and/or adult speech were positively associated with lexical diversity measures of the child's speech (e.g., verbs per utterance, word types), and this association is age-sensitive. In contrast, associations between disfluency and grammatical complexity were not robust. The production of disfluency types also differed between children and adults, consistent with the view that disfluency can serve as a marker of developmental change in early lexical growth.

Appendix

Models:
Note. Model specifications are shown in R formula notation. Models 1 - 3 are grammatical complexity models, and models 4 - 9 are lexical diversity models.

Model 1: mean length of utterances by morphemes
MLU_Morphemes ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 2: mean length of utterances by words
MLU_Words ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 3: mean length of the first 50 utterances by morphemes
MLU50_Morphemes ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 4: number of different types of words (word types)
FREQ_types ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 5: different number of words (tokens)
FREQ_tokens ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 6: different verbs per utterance
Verbs_Utt ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 7: vocabulary diversity measured using VOCD
VOCD_D_optimum_average ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 8: type-token ratio
FREQ_TTR ~ child_r * adult_r * Age + (1 + Age | child_id)

Model 9: number of different words in the first 100 words in the sample
NDW_100 ~ child_r * adult_r * Age + (1 + Age | child_id)

Model Outcomes:

Note. Tables report fixed effects from the full model; Age terms and higher-order interactions are omitted for brevity. * $p < .05$, ** $p < .01$, *** $p < .001$. Models 1 - 3 are grammatical complexity models, and models 4 - 9 are lexical diversity models.

Table 2: The outcome of Model 1 (mean length of utterances by morphemes)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	0.4371	0.5968	0.732	0.4643
Child disfluency (child_r)	-0.2899	0.1804	-1.607	0.1088
Adult disfluency (adult_r)	-0.2326	0.1655	-1.406	0.1606
Child × Adult (child_r:adult_r)	-0.0799	0.0502	-1.592	0.1122

Table 3: The outcome of Model 2 (mean length of utterances by words)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	0.3393	0.5440	0.624	0.5332
Child disfluency (child_r)	-0.2810	0.1646	-1.707	0.0887
Adult disfluency (adult_r)	-0.2528	0.1507	-1.677	0.0943
Child × Adult (child_r:adult_r)	-0.0803	0.0458	-1.754	0.0803

Table 4: The outcome of Model 3 (mean length of the first 50 utterances by morphemes)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	1.3860	1.0573	1.311	0.1907
Child disfluency (child_r)	-0.0282	0.3144	-0.090	0.9285
Adult disfluency (adult_r)	0.3123	0.2945	1.060	0.2897
Child × Adult (child_r:adult_r)	0.0597	0.0876	0.681	0.4961

Table 5: The outcome of Model 4 (number of different types of words - word types)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$	
(Intercept)	141.7960	56.6930	2.501	0.0128	*
Child disfluency (child_r)	31.9830	16.8280	1.901	0.0580	
Adult disfluency (adult_r)	33.6590	15.7590	2.136	0.0333	*
Child × Adult (child_r:adult_r)	11.4310	4.6820	2.441	0.0150	*

Table 6: The outcome of Model 5 (different number of words (tokens)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	6.7690	238.7760	0.028	0.9770
Child disfluency (child_r)	39.4530	69.7730	0.565	0.5720
Adult disfluency (adult_r)	40.4760	66.2100	0.611	0.5410
Child × Adult (child_r:adult_r)	13.5210	19.3810	0.698	0.4860

Table 7: The outcome of Model 6 (verbs per utterance)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$	
(Intercept)	0.4662	0.2522	1.848	0.0654	
Child disfluency (child_r)	0.1630	0.0733	2.225	0.0267	*
Adult disfluency (adult_r)	0.1638	0.0697	2.349	0.0193	*
Child × Adult (child_r:adult_r)	0.0557	0.0203	2.746	0.0063	**

Table 8: The outcome of Model 7 (vocabulary diversity measured using VOCD)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	39.5121	20.5491	1.923	0.0552
Child disfluency (child_r)	7.2594	6.0937	1.191	0.2342
Adult disfluency (adult_r)	7.4784	5.7033	1.311	0.1905
Child × Adult (child_r:adult_r)	2.3619	1.6941	1.394	0.1640

Table 9: The outcome of Model 8 (type-token ratio)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	0.2027	0.1584	1.279	0.2016
Child disfluency (child_r)	-0.0310	0.0463	-0.668	0.5046
Adult disfluency (adult_r)	-0.0744	0.0440	-1.693	0.0914
Child × Adult (child_r:adult_r)	-0.0199	0.0128	-1.549	0.1223

Table 10: The outcome of Model 9 (number of different words in the first 100 words in the sample)

	Estimate	Std. Error	t value	$Pr(>\|t\|)$
(Intercept)	-10.8260	18.6670	-0.580	0.5623
Child disfluency (child_r)	-10.8574	5.4962	-1.975	0.0510
Adult disfluency (adult_r)	-2.9319	5.1501	-0.569	0.5695
Child × Adult (child_r:adult_r)	-1.3690	1.5170	-0.902	0.3674

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