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ARTICLE

Impact of talker variability on language development in two-year-olds

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Abstract

This research investigated the impact of the number of talkers with whom children engage in daily conversation on their language development. Two surveys were conducted in 2020, targeting two-year-olds growing up in Japanese monolingual families. Caregivers reported the number of talkers in three age groups and children's productive vocabulary via questionnaires. The results demonstrated significant effects of variability in talkers in fifth grade or above in Study 1 (N = 50; male = 23; r = .372) and in adult talkers in Study 2 (N = 175; non-nursery going; male = 76; r = .184) on children's vocabulary development, after controlling for language exposure time and demographic variables. Possible mediating factors are discussed. This research extends previous findings from immigrant bilingual children to monolingual speakers in Japan, suggesting the potential contribution of available talkers other than caregivers in conversational environments.

Keywords: talker variability; number of talkers; vocabulary; language development; toddler

Introduction

Pre-schoolers expand their vocabulary rapidly even though the pace varies from child to child (e.g., Fenson, 2007; Mayor & Plunkett, 2011). To explain this individual difference in lexical acquisition pace, research has focused on the contribution of language input (the quantity and quality of language exposure) from primary caregivers (e.g., Huttenlocher et al., 1991, 2002; Rowe, 2008; Weisleder & Fernald, 2013). However, inputs are not exclusively restricted to primary caregivers as children in natural settings also spend time with other family and non-family members (Bergmann & Cristia, 2018). Shneidman et al. (2013) observed children's interactions with multiple individuals in households at 2;6 years old and found that the total number of word tokens children heard from non-caregivers at 2;6 also significantly predicted their vocabulary at 3;6. The results suggest the significance of input from other individuals in children's vocabulary

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growth, together with those from primary caregivers. Hence, this current research focuses on the impact of children's interactions with multiple people on their language development.

Talker variability

Children usually interact with a few caregiver(s) frequently, along with brief interactions with a sizeable number of other talkers. These interlocutors may live in different places, work under diverse circumstances, and provide vocabulary that differs from that of a primary caregiver. Studies have shown that pre-schoolers can learn novel words after minimal exposure or ostensive labelling (Carey & Bartlett, 1978; Waxman & Booth, 2000; Remon et al., 2020; see Jaswal & Markman, 2001 for a review). Therefore, children might acquire new words after hearing them once or twice from other interlocutors. Accordingly, it is important to consider the number of interlocutors children interact with, i.e., talker variability, when explaining children's vocabulary growth in natural settings. Such research extends the scope of studies on input from primary caregivers to other interlocutors, which facilitates our understanding of language development, emphasising the contribution of diversity in conversational environments.

Previous studies focusing on bilingual immigrant children have demonstrated that talker variability facilitates immigrant children's proficiency in their heritage language. Gollan et al. (2015) investigated the impact of talker variability on the language abilities of Hebrew–English bilingual children growing up in the United States (M_{age} = 7.6 years) and analysed the effect by statistically controlling the impact of the amount of language input time, a critical factor explaining a substantial part of individual differences in vocabulary (e.g., Bedore et al., 2012; Weisleder & Fernald, 2013). The explanation rate of the variance of children's proficiency in Hebrew significantly improved from 18% to 33% when adding the number of Hebrew talkers with whom the children talked regularly into the regression model.

Evidence of the positive effect of talker variability on language development among toddlers has also been reported. Place and Hoff (2011) analysed diary records of immigrant bilingual children aged 2;1 and found that the children's vocabulary of each language positively correlated to the number of native talkers of that language with whom they interacted (i.e., English vocabulary size correlated with the number of English native talkers; and similar with Spanish). A similar result was found among bilingual children aged 2;6 (Place & Hoff, 2016).

To conclude, talker variability is directly related to the vocabulary size of immigrant bilingual children, even while excluding for the effect of amount of exposure to the language. However, does talker variability correlate with vocabulary size outside a bilingual society? We believe that studies of talker variability's effect in monolingual environments are also necessary. Notably, talkers and conversation circumstances encountered by bilingual immigrant children in each language are limited and their interactions with the heritage language speakers is reflective of the family's culture and language preference. This hinders the theorical generalisation of the discovered talker variability effect on other populations. Exploring talker variability's effect in monolingual societies (an essential part of the global population) eliminates such potential confounding effects, enriching the understanding of the talker variability effect in different languages, inspiring future research on its mechanisms. Furthermore, although the effect is found across multiple languages (Spanish, Hebrew, and English) in the aforementioned studies, all were conducted among U.S. immigrants.

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Thus, studies of children residing in other countries are required to validate the talker variability effect in different languages and cultures.

Therefore, this current research focuses on Japanese monolingual children. Regarding talkers, we included not only adults but also child talkers as in Bergmann and Cristia (2018)'s study, given that infants preferably listen to children's voices and presumably learn from them (Polka et al., 2014). Furthermore, we assumed that talkers in different age groups influence children's vocabulary acquisition to different extents for two reasons: 1) talkers' accuracy and richness in productive vocabulary varies with age (e.g., Fenson, 2007), and 2) their awareness of the interlocutor varies along with their development, which leads to modifications in speech to different extents when communicating to young children, known as child-directed speech (CDS; Hoff-Ginsberg & Krueger, 1991; Prime et al., 2014). CDS has been shown to facilitate word learning compared to adult-directed speech (Graf Estes & Hurley, 2013; Ma et al., 2011).

Studies have reported that not only school-aged children but some pre-schoolers are able to modify their speech, using and repeating short sentences when talking to younger children (Dunn & Kendrick, 1982; Loukatou et al., 2022), however, overall, their speech is not rich in lexical and grammar, and their awareness of interlocutors is still developing (Piaget, 1964). Hoff-Ginsberg and Krueger (1991) regarded child talkers as less supportive conversational partners than adults. Therefore, we categorised talkers into three groups: pre-school talkers, child talkers (first to fourth graders), and mature talkers (fifth graders and above; positioned within the formal operational stage by Piaget's theory (1964)) in Study 1 for further examination. Given some differences reported in CDS between adults and younger mature talkers, we re-adjusted the talker categorisation accordingly in Study 2 (see more in the Discussion section of Study 1).

Current studies: Study 1 and Study 2

This research comprised two studies. In Study 1, we conducted a preliminary survey with a relatively small sample to examine the effect of talker variability on vocabulary development of children at approximately 2;6. Considering that it is challenging for mothers whose children attended a nursery to estimate their child's communication environment in the nursery, they were queried on the number of talkers the child interacted with and the duration of conversations outside a nursery. The data were analysed regardless of the children's nursery school attendance. However, not counting the regular interactions children had in a nursery underestimated the children's actual conversational environment. Therefore, in Study 2, we conducted a larger sample survey to focus on children who had never attended nursery facilities.

Study 1

Study 1 investigated whether the effect of talker variability on vocabulary development exists in Japanese monolingual toddlers while classifying the talkers by their age.

Method

Participants

To meet the G*power analysis standard (G*power >. 8 for a medium effect size. 25; Fritz & MacKinnon, 2007), a sample larger than 55 participants is preferred. For Study 1, we

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recruited 57 mothers with two-year-old children living in Nara and Kyoto, two medium-sized cities in the western area of Japan. They were recruited from a database of parents who agreed to join the child development research of the laboratory with which the second author is affiliated. All the children were monolingual Japanese speakers without developmental delays (M_{age} = 26.70 months, SD = 2.05 months, range: 2;0–2;8). Seven sets of data were excluded after screening: outlier data beyond three standard deviations (vocabulary size = 2 (1); number of pre-school talkers = 20 (1)), blank data (2), and *zero* for all the talkers (3). Though slightly smaller than the ideal size, 50 valid responses were included in the final analysis (boys = 23).

Of the total sample, 23 children were single children or first-born (46.0%); 19 did not attend a nursery, 26 attended five days a week, four children attended once or twice a week, and one child attended once and quit. Regarding the academic level of mothers, two had education below high school (4.0%), 19 graduated from a junior college or vocational school (38.0%), and 29 graduated from a college or above (58.0%). Concerning the fathers, six each had education below high school and junior college or vocational school (12.0%), and 38 graduated from college or above (76.0%). One family (2.0%) had an annual household income of less than 2.5 million, six (12%) had income of 2.5–5 million, 22 (44.0%) had income of between 5–7.5 million, and 21 (42.0%) reported an income above 7.5 million Japanese yen.

Procedure

The survey was conducted from July to October 2020. The Japanese government had announced a State of Emergency, calling for social distancing and school closure (from elementary to high school) from March to April 2020 in response to the COVID-19 pandemic, although nurseries continued to accept a limited number of children. This survey was conducted after the relaxation of the emergency declaration.

Participants were recruited for a series of research, including Study 1. After consenting to study participation, the mothers received questionnaires in physical form from the lab, which they mailed back on completion. All study procedures were approved by the Research Ethics Committee of the organisation with which the second author is affiliated.

The questionnaire comprised two parts, one assessing children's productive vocabulary and the other focused on the children's conversational environment.

Instruments

Productive vocabulary

Children's productive vocabulary size was measured using the Japanese vocabulary checklist for infants and young children, developed by NTT Communication Science Laboratories (Kobayashi et al., 2016). The checklist was developed based on the data collected from approximately 800 caregivers with Japanese-speaking zero-to-three-year-olds using a web diary method. Caregivers checked for the words their children could speak. The total number of words (2,052 words at maximum) checked was scored as the child's productive vocabulary size.

Conversational environment questionnaire

This questionnaire included questions regarding children's demographic information and conversational environment. Demographic information included the academic level

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of both parents (final degree), annual household income, and the child's birth order and nursery attendance status. The child's (in months) and parents' ages (in years) were also collected.

Language exposure

To assess the children's exposure time to language, we asked the duration the child was directly talked to every day, on a weekday and a weekend day. Mothers whose children attended a nursery answered the duration of time their child engaged in conversations outside the nursery environment. We calculated the average daily conversation time from the following equation:

$$\begin{aligned}&\text{Daily conversation time (h)}\\&= (\text{average daily conversation time on a weekday} \times 5\\&+ \text{average daily conversation time on a weekend day} \times 2)/7\end{aligned}$$

The average duration of media watching by the children on a weekday and a weekend day were collected and was calculated as follows:

$$\begin{aligned}&\text{Daily media time (h)}\\&= (\text{daily media time in a weekday} \times 5\\&+ \text{daily media time on a weekend day} \times 2)/7\end{aligned}$$

Examples are available on OSF (see the link in the *Data Accessibility* section).

Talker variability

We queried the number of individuals who talked to the child for more than 20 minutes a week (mothers whose children attended a nursery answered the number of talkers their child interacted with outside a nursery) for a score on talker variability. This standard is stricter than that of Gollan et al. (2015) as monolingual children may have more exposure to talkers of their native language compared to immigrant children interacting with talkers of their heritage language.

Parents reported the total number of mature (fifth graders and above), child (first to fourth graders), and pre-school talkers separately, in addition to the number of family member talkers in each language level, i.e., the numbers of six types of talkers: 3 (mature, child, pre-school) × 2 (total, family members only).

Data analysis

The productive vocabulary size exhibited a normal distribution (one-sample Shapiro-Wilk Test, $p = .155$). Consequently, the actual data were used for the subsequent analysis without any transformations. Talker variability indexes showed skewed distributions (skewness > 1 for all but pre-school family talkers (.697)). We coded all the talker variability indexes into dummy variables to avoid validity loss brought by skewed variables. A total of 22 out of 50 children talked to no more than two mature talkers (two had one mature talker and 20 had two mature talkers), 33 children talked to zero child talkers, and 36 talked to zero pre-school talkers. We coded talkers in different ways based on the data distribution and interpretability. For mature (family) talker variability,

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children who talked to two or less mature talkers were coded as 0, while children who talked to three or more were coded as 1. For child and pre-school (family) talkers, children interacting with zero child or pre-school talkers were coded as 0, otherwise they were coded as 1. Point-biserial correlation coefficients were calculated to evaluate the relation between talker variability and vocabulary size. A hierarchical regression analysis was conducted to quantify the contribution of talker variability on language development along with other factors. Data were analysed using SPSS, Version 26.0 (IBM).

Results

Table 1 shows descriptive statistics of collected items of conversational environment (actual number of talkers were reported) and vocabulary size.

Zero-order correlation (association)

A preliminary examination was conducted by calculating the zero-order correlation (association) between vocabulary size and other collected variables (Table 2). Associations between talker variability and the other categorical variables were reported using Cramer's *V*. Parents' academic level and annual household income are regular indicators of socio-economic status (SES) (Paradis, 2011). We chose the mother's academic level as the representative SES index for further analysis due to its correlation to both the father's academic level (Cramer's $V = .315$, $p = .025$) and annual household income (Cramer's $V = .504$, $p < .001$). None of the demographic variables correlated to vocabulary size significantly (gender, $r = .100$, $p = .489$; birth order (first-born or single child versus later-born), $r = -.169$, $p = .240$; mother's academic level, $r = .137$, $p = .344$).

As expected, children's vocabulary size positively correlated with age ($r = .417$, $p = .003$), as well as with daily conversation time ($r = .369$, $p = .008$), suggesting the impact of exposure time on language development. The correlation between vocabulary size and daily media time was not significant. Importantly, the variability in total mature talkers

Table 1. Descriptive statistics of children in total ($N = 50$)

Variables	*Mean*	*SD*	Range
Age in Months	26.70	2.05	24–32
Daily Conversation Time (hours)	7.50	3.20	2–15
Daily Media Time (hours)	1.00	0.92	0.04–4.29
Total Mature Talkers [a]	3.74	2.11	1–10
Mature Family Talkers [a]	2.24	0.89	1–7
Total Child Talkers [a]	0.40	0.61	0–2
Child Family Talkers [a]	0.34	0.59	0–2
Total Pre-school Talkers [a]	0.70	1.11	0–5
Pre-school Family Talkers [a]	0.34	0.48	0–1
Vocabulary Size	446.40	307.01	35–1133

Note. [a] All the variables about talkers = the actual number of corresponding talkers.

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Table 2. Bivariate correlations between variables in two-year-olds in Study 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Productive Vocabulary Size	1														
2 Gender	.100	1													
3 Birth Order	–.169	.195	1												
4 Mother's Academic Level	.137	.144	.189	1											
5 Father's Academic Level	.153	.225	.197	.315*	1										
6 Annual Household Income	.079	.310	.166	.504***	.337	1									
7 Age in Months	.417***	–.136	–.117	.119	.328*	.085	1								
8 Daily Conversation Time (h)	.369**	.239	.026	.123	–.098	-.139	-.023	1							
9 Daily Media Time (h)	.164	–.065	–.012	.032	.179	–.061	.052	–.016	1						
10 Total Mature Talker [a]	.372**	.091	.010	.231	.178	.294	.167	.099	.052	1					
11 Mature Family Talker [a]	.045	.090	.025	.327	.303	.447*	.145	–.026	–.076	.358*	1				
12 Total Child Talker [a]	–.061	.069	.408**	.412*	.162	.334	.064	.023	.088	.041	.197	1			
13 Child Family Talker [a]	–.112	.129	.576***	.417*	.214	.280	.048	–.004	.118	.075	.262	.869***	1		
14 Total Pre-school Talker [a]	.012	.054	.460**	.087	.147	.254	–.034	.190	–.107	.020	.343*	.098	.170	1	
15 Pre-school Family Talker [a]	–.149	.154	.662***	.215	.294	.286	–.102	.044	–.157	.129	.290*	.159	.071	.843***	1

Note. * $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed).
[a]All were dummy-coded talker variability indexes. Mature talkers 0 = two or less talkers, 1 = three or more talkers; Child and Pre-school talkers 0 = zero talker, 1 = one or more talkers.

was significantly related to vocabulary size ($r = .372$, $p = .008$). No change in the result was observed when the two cases in which the children had only one mature talker were excluded. None of the other talker variability indexes correlated to vocabulary size significantly.

Total child and pre-school talker variability were strongly associated with the corresponding family talker variability ($p < .01$), suggesting that variability came from the existence of siblings. Associations between child or pre-school talker variability and birth-order ($p < .01$) indicate that later-born children are more likely to be engaged in conversations with certain child or pre-school talkers (siblings). The multicollinearity regarding child/pre-school talker variability and birth-order were not discussed further since none of these variables correlated to vocabulary size significantly.

Based on the correlation results and concern of multicollinearity, we included the total mature talker variability among all the talker variability indexes in the subsequent regression analysis.

Hierarchical regression analysis predicting productive vocabulary scores

To quantify the contribution of the total mature talker variability to language development after controlling for demographic background and exposure time, a hierarchical regression analysis, setting productive vocabulary as a dependent variable, was conducted (Table 3).

Although there were no significant correlations with vocabulary size, demographic variables were included in the model as control variables in the first step, as they have been identified as meaningful factors in previous studies (Byers-Heinlein et al., 2013; Place & Hoff, 2016; Pine, 1995). This step did not significantly predict vocabulary size ($R^2 = 6.5\%$, $F\,(3,46) = 1.058$, $p = .376$).

We added age and daily conversation time as the exposure time variables in the second step. Both variables were significant predictors of children's vocabulary (age in months $\beta = .417$, $p = .002$; daily conversation time $\beta = .352$, $p = .008$), resulting in an increase in explanation rate of 28%. The model at this step was significant ($F\,(5,44) = 4.621$, $p = .002$).

Thereafter, to test the unique contribution of talker variability, we entered the total mature talker variability in the last step, which significantly improved the model fit from 27.0% to 34.5%. The model in Step 3 significantly predicted vocabulary size ($F\,(6,43) = 5.292$, $p < .001$). The total mature talker variability accounted for 8.0% of the variance ($\beta = .291$, $F\,(1,43) = 6.016$, $p = .018$) in children's productive vocabulary after controlling for demographic and exposure indexes. The order of entry was planned to provide a conservative test of the talker variability effect. No multicollinearity was found in the predictor variables.

Discussion

In this study, we examined the effect of talker variability on two-year-olds' language development while categorising talkers into mature (fifth graders and above), child (first to fourth graders), and pre-school talkers. The results showed that only the variability of total mature talkers, and not the variability of mature talkers only within the family, was significantly correlated to children's vocabulary development. It remained a significant predictor after controlling for demographic background (SES, birth order, and gender) and the amount of language exposure, i.e., age and daily conversation time, emphasising

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Table 3. Hierarchical regression analyses predicting productive vocabulary scores from demographic factors, amount of exposure and talker variability

	Predictor	R^2_{adj}	ΔR^2	β
Step 1			.065	
	Gender			.150
	Birth Order			.133
	Mother's Academic Level			−.185
Step 2		.270	.280***	
	Gender			.106
	Birth Order			−.146
	Mother's Academic Level			.039
	Age in Months			.417**
	Daily Conversation Time (h)			.352**
Step 3		.345	.080*	
	Gender			.138
	Birth Order			−.153
	Mother's Academic Level			.057
	Age in Months			.370**
	Daily Conversation Time (h)			.312*
	Total Mature Talker Variability			.291*
N	50			

Note. * p <. 05, ** p <. 01 (two-tailed).

the importance of interacting with multiple mature talkers on children's vocabulary development. In contrast, the results also suggest that toddlers do not benefit much from talkers whose vocabulary and toddler-friendly speech modifications are still immature and developing.

Moreover, the effect of the variability of mature family talkers was not statistically significant, whereas the variability of total number of mature talkers was. This seems puzzling given that children spend substantial time with family talkers, a circumstance that should promote children's vocabulary growth. The insignificance of mature FAMILY talkers could be attributed to its small variability across children (86.0% of the children had two or less mature family talkers – that is, their parent(s)). Meanwhile, the total mature talker variability predicted the individual difference in vocabulary size, suggesting that children benefit from conversing with diverse talkers regularly, even though some interactions are not as intensive as with family members. Mature talkers are likely to adapt their speech flexibly when communicating with children, introducing additional topics and novel words beyond what children encounter at home.

There are some concerns regarding the analysis of Study 1. Mothers of nursery-attending children were queried on the number of talkers outside the nursery, since they could not observe their children's life in nursery. However, mature talkers inside a nursery should also contribute to children's language development. Thus, data obtained from

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these mothers might not capture children's talker environment accurately. Nevertheless, we analysed all the data without differentiating children by their nursery attendance status to prevent a reduction in statistical power (this is plausible, as no unique influence on vocabulary brought by nursery-related variables was identified; see analysis in supplementary material).

In Study 2, we surveyed a larger sample of children who did not attend a nursery and re-examined the effect of talker variability. Moreover, categorisation of talkers was reconsidered and changed in two ways.

As for the criteria for being considered a talker, we adopted two standards. One was similar to Study 1 (individuals who interact with the child for more than 15 minutes a week). The other standard referred to talkers interacting with the child at least once every two weeks. The latter criterion was adopted in Study 2 following a previous study on immigrant bilingual children (Gollan et al., 2015). We assumed that the variability of talkers who meet this loose standard is also beneficial to children, given toddlers' proficiency in learning novel words even with limited exposure (Jaswal & Markman, 2001).

The second adjustment was regarding the age classification of talkers. We distinguished adults from older child (adolescent) talkers, which were categorised into the same category in Study 1. Thus, the talkers were recategorised into adult (eighteen-year-olds or older), child (six- to seventeen-year-olds) and pre-schoolers, This adjustment is plausible given that although adolescents modify their speech when speaking to younger children (Kempe, 2009), their CDS is less supportive compared to adults in terms of quality and quantity (less diverse vocabulary: Hoff, 2006; fewer utterances in joint attention and object labelling: Culp et al., 1996; also see evidence of older children: Harkness, 1977; Nwokah, 1987).

Study 2

We re-examined the talker variability effect found in Study 1, focusing on two-year-olds who had never attended nursery, aiming to gain solid evidence of talker variability in a monolingual environment.

Method

Participants

Participants were recruited through a commercial survey company. The same as in Study 1, over 55 samples were needed to meet the G*power analysis standard (G*power >. 8; a medium effect size. 25). The survey was conducted in October 2020. The questionnaires were mailed to 400 mothers living in Japan who had a two-year-old child and consented to participate in the study. We received 361 responses (return rate = 90.3%), among which 210 children had no nursery experience, 136 attended nursery regularly, and 15 had attended nursery once but quit. We focused on data from mothers whose children did not attend a nursery. Of the 210 responses, 33 responses were excluded from analyses due to low birth weight (less than 2.0 kg) (23), age mismatch (aged 3;6) (1), age not reported (1), and blank responses (8). Two more responses were excluded for suspicious data; one response with outlier data beyond three standard deviations (daily conversation time = 19.00 h/day), and one unusual case (daily conversation time = 0.00 h/day).

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No questions or comments regarding the questionnaires were received by the survey company. The final sample comprised 175 responses from mothers of two-year-old children without any diagnosed developmental delays and no nursery experiences (76 boys; M = 31.13 months, SD = 3.06 months, range: 1;10–3;0). All children were from Japanese monolingual families. A total of 75 children were first-born or single children. Currently, it is not common in Japan to have baby-sitters or other family members (such as grandparents) take care of the children apart from the parents (Chen, 2007). The co-residence member at home in Study 2 showed that 163 out of 175 children not attending nursery lived only with their parents and (or) siblings. Hence, we assumed that final samples came from parents who spent sufficient time with their children, ensuring the accuracy of their knowledge of their children's conversational environment.

We investigated the SES of each family, similar to Study 1. For mothers' academic level, 35 graduated from high school or lower (20.6%), 52 graduated from junior college or vocational school (29.7%), and 88 graduated from college or above (50.3%). For fathers, 42 graduated from high school or lower (24.0%), 25 graduated from a vocational school or junior college (14.3%), and 98 had a college degree or above (61.7%). Three families had an annual household income of less than 2.5 million yen (1.7%); 72 families had an annual income of 2.5–5 million yen (40.7%); 66 families (37.7%) had an income of 5–7.5 million yen; and 34 families (29.5%) had an annual income of over 7.5 million Japanese yen.

Procedure and instruments

After consenting to research participation, the mothers received questionnaires in physical form from the survey company, which they mailed back after completion. Three hundred Japanese yen was offered to every mother for participation. All study procedures were approved by the Research Ethics Committee of the university with which the first author is affiliated.

The questionnaire comprised two parts: 1) the Japanese MacArthur Communicative Development Inventory investigating children's productive vocabulary, and 2) the children's conversational environment.

Japanese MacArthur Communicative Development Inventory

In Study 2, we switched to the Japanese MacArthur Communicative Development Inventory (JM-CDI): Words and Grammar (for children aged from 1;4 to 3;0; Watamaki & Ogura, 2004) to measure productive vocabulary size. It is the standardised Japanese parallel version of the MacArthur–Bates Communicative Development Inventories (MB-CDI; Fenson, 2007); a caregiver-report instrument evaluating language ability in vocabulary comprehension of children (Fenson et al., 1993; Watamaki & Ogura, 2004). We used JM-CDI, with established reliability and validity internationally, to facilitate comparisons with other studies in various language societies. Moreover, we only utilised the word section that comprises 711 words. We expected the smaller number of words to reduce the burden of answering and increase the return rate of the questionnaire. Caregivers followed the manual instructions and checked the words their children were able to produce. Children's vocabulary size score was the total number of checked words.

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Conversational environment questionnaire

Children's language exposure time and the number of talkers were surveyed.

The language exposure time was collected in the same way as in Study 1. Caregivers reported the age of their children, the average daily conversation time (overhearing excluded), media watching time and child-oriented media (e.g., Sesame Street) watching time of their children for a weekday and a weekend day, separately. The average daily conversation time, media time, and child-oriented media time were calculated in the same way as in Study 1 (see formulas used for calculation and examples in OSF).

For the number of talkers, two standards were adopted: 1) the number of individuals who talked to the children for more than 15 minutes every week (the number of intensive talkers), and 2) the number of individuals who talked to the children at least once every two weeks, with no requirement for the length of time (the total number of talkers). Thus, the total number of talkers was the sum of the number of intensive talkers and non-intensive talkers (those who talked to the children for less than 15 minutes a week but at least once every two weeks). Both types of talkers were divided into three age groups: adult talkers (eighteen-year-olds and above), child talkers (aged six- to seventeen-year-olds), and pre-school talkers (younger than six-year-olds). Caregivers thus reported the number of six types of talkers: talker's age (3; adults, children, pre-schoolers) × frequency of communication (2; at least once every two weeks, more than 15 minutes a week).

Data analysis

The productive vocabulary size exhibited a normal distribution (one-sample Kolmogorov-Smirnov Test, $p = .062$), and was used for the following analysis without any transformations. Skewness was observed in all talker variability indexes. A total of 118 out of 175 children talked to zero child talkers, 76 talked to zero pre-school talkers, and zero children talked to fewer than two adult talkers. Despite the mean number of adult talkers being 4.69, the largest proportion of children were engaged in conversations with two adult talkers (52 out of 175, 29.7%). Therefore, we coded talker variability in the same way as in Study 1. Children who interacted with two (intensive) adult talkers were coded as 0, while those who talked to three or more were coded as 1. Child or pre-school talker variability was coded as 0 if the children did not have any corresponding talkers, and otherwise were coded as 1.

Correlation coefficients were calculated to evaluate the relation between talker variability and vocabulary size. Hierarchical regression analyses were conducted to examine the contribution of talker variability on vocabulary development along with other factors. Data were analysed using SPSS, Version 26.0 (IBM).

Results

Table 4 shows the descriptive statistics for the measured items.

Zero-order bivariable correlation (association)

In the preliminary examination, we calculated the zero-order bivariate correlation (association) between vocabulary size and other variables (Table 5). The mother's academic level was chosen as the representative SES index, similar to Study 1, for further

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Table 4. Descriptive statistics for conversational environment and productive vocabulary size (JM-CDI) in Study 2 (N = 175)

Items	*Mean*	*SD*	Range
Age in Months	31.13	3.06	22 – 36
Daily Conversation Time (h)	8.05	3.45	0.93 – 14.50
Daily Media Time (h)	2.52	1.48	0.00 – 10.00
Daily Child-Oriented Media Time (h)	1.60	1.42	0.00 – 14.29
Total Adult Talkers [a]	4.69	2.78	2 – 15
Total Child Talkers [a]	0.62	1.18	0 – 10
Total Pre-school Talkers [a]	1.20	1.71	0 – 10
Intensive Adult Talkers [a]	3.41	1.84	1 – 12
Intensive Child Talkers [a]	0.54	1.00	0 – 8
Intensive Pre-school Talkers [a]	0.82	1.34	0 – 10
Vocabulary Size	413.14	155.76	4 – 699

Note: [a] All the variables of talkers = the actual number of corresponding talkers.

analysis. Neither the mother's academic level (r = .120, p = .071) nor the child's birth order (r = .050, p = .507) correlated to vocabulary size. A marginal significant correlation was found between gender and vocabulary size (r = .147, p = .051); girls had a larger vocabulary size than boys (t = – 2.014, p = .046).

Exposure time

No significant relation was found between vocabulary size and exposure time indicators (age in months, r = .040, p = .602; daily conversational time, r = -.001, p = .987).

There was no correlation between age and vocabulary size since some younger toddlers had large vocabularies while some older toddlers possessed a limited vocabulary. The insignificant relation between conversation time and vocabulary size was not explicable by the extreme data since the invalid and outlier data were excluded. Although the daily media time significantly correlated to vocabulary size (r = -.152, p = .045) and to SES (r = -.160, p = .035), the partial correlation between daily media time and vocabulary size was insignificant as in Study 1 when controlled for SES index (r = -.135, p = .076). The relation remained insignificant for the child-oriented media time (r = -.108, p = .154).

Talker variability

The variability of total adult talkers (r = .184, p = .015) and intensive adult talkers (r = .155, p = .040) were positively correlated to vocabulary size. Neither child talker nor pre-school talker variability significantly correlated to vocabulary size. Similar to Study 1, although the correlations between the child (pre-school) talker variability and birth order were significant (p < .001), the correlation between birth-order and vocabulary size was insignificant. Therefore, child and pre-school talker variability are not discussed

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further. The total adult talker variability was associated with intensive adult talker variability ($p < .001$).

Hierarchical regression analyses predicting productive vocabulary scores

Based on the correlation analysis, we further quantified the contribution of total and intensive adult talkers' variability on vocabulary growth in hierarchical regressions (Table 6).

Notably, the variability of total adult talkers comprised intensive and non-intensive adult talkers (people that the child talked to less than 15 minutes a week). The non-intensive talker variability should also contribute to vocabulary growth if children can benefit from short-term but regular interactions. Hence, we included non-intensive adult talker variability into the regression.

The non-intensive adult talker variability was calculated as follows. First, we calculated the actual number of non-intensive talkers ($M = 3.41$, $SD = 1.84$) by subtracting the number of intensive adult talkers from the total number of adult talkers. Then, the non-intensive adult talker variability was coded as 0 if there was no non-intensive adult talker ($N = 95$) and coded as 1 otherwise ($N = 80$).

Regression analyses were conducted using variability of (*a*) total adult talkers and (*b*) intensive adult and non-intensive adult talkers.

(a) Similar to Study 1, in the first step, the mothers' academic level, birth order, and gender were entered as control variables. These demographic variables accounted for 3.6% of the variance in productive vocabulary ($F(3,171) = 2.149$, $p = .096$). In the second step, age and daily conversation time, indicators of exposure time, were entered and no significant changes were observed ($\Delta R^2 = 0.1\%$, $F(2,169) = .128$, $p = .880$). In the third step, we entered the total adult talker variability. This increased the explanation rate by 3.7%, significantly improving the model ($F(1,168) = 6.683$, $p = .011$). The model significantly predicted vocabulary size ($F(6,168) = 2.312$, $p = .036$). Total adult talker variability was the only significant predictor ($\beta = .195$, $p = .011$) among all six variables (see (*a*) in Table 6).

(b) We replaced total adult talker variability with intensive and non-intensive adult talker variability in the regression model (see (*b*) in Table 6). Step 1 and 2 remained the same. The model in Step 3 explained 3.9% of the variance in vocabulary size marginally ($F(7,167) = 2.015$, $p = .056$). The explanation rate changed by 4.0% with the inclusion of intensive and non-intensive adult talker variability ($F(2,167) = 3.632$, $p = .029$). However, neither the intensive ($\beta = .127$, $p = .105$) nor the non-intensive ($\beta = .134$, $p = .095$) adult talker variability were significant factors. The relation between intensive adult talkers and vocabulary size was insignificant in the regression analysis but not in the correlation. This discrepancy may be attributed to the decrease in detection sensitivity due to dummy-coded variables. The order of entry was planned to provide a conservative test of the effect of talker variability. No multicollinearity was observed in any of the models.

Surprisingly, the effect of intensive adult talker variability did not reach statistical significance in the regression analysis in Study 2, despite a comparable category of talkers (total mature talkers) in Study 1. This discrepancy might be attributed to the fact that the children in Study 2 ($M = 31.13$ months, $SD = 3.06$) were older than those in Study 1 ($M =$ 26.70 month, $SD = 2.05$). As toddlers progressively become proficient learners of novel words (Jaswal & Markman, 2001), it is plausible that older two-year-olds may not demand intensive exposure for novel word acquisition, whereas the younger ones may require

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Table 5. Bivariate correlations (associations) between variables in Study 2 (N = 175)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 Vocabulary Size	1															
2 Gender	.147†	1														
3 Birth Order	.050	.033	1													
4 Mother's Academic Level	.120	.189	.151	1												
5 Father's Academic Level	.003	.152	.212	.309***	1											
6 Annual Household Income	.063	.046	.205	.148	.249***	1										
7 Age in Months	.040	.026	–.167*	.090	.080	–.013	1									
8 Daily Conversation Time (h)	–.001	–.020	–.112	–.072	.041	.080	–.002	1								
9 Daily Media Time (h)	–.152*	.060	–.045	–.160*	–.155*	–.035	–.026	.187*	1							
10 Daily Child Media Time (h) [b]	–.114	-.048	–.145	.037	.097	–.020	.117	.108	.362***	1						
11 Total Adult Talker [a]	.184*	.015	.007	.161	.113	.138	.142	.007	.086	.079	1					
12 Intensive Adult Talker [a]	.155*	.109	.043	.170	.112	.145	.056	.080	.111	.049	.717***	1				
13 Total Child Talker [a]	.000	.068	.306***	.218	.108	.235*	–.080	–.046	.080	–.092	.078	.091	1			
14 Intensive Child Talker [a]	–.022	.051	.320***	.069	.076	.233*	-.073	–.041	.061	–.115	.048	.048	.948***	1		
15 Total Pre-school Talker [a]	.025	.023	.406***	.179	.154	.159	–.090	–.147	–.115	-.029	.137	.178*	.006	.050	1	
16 Intensive Pre-school Talker [a]	.003	.008	.436***	.159	.184	.116	–.178*	–.034	–.162*	–.143	.064	.134	.000	.026	.861***	1

Note. †$p \leq .06$, * $p < .05$, ** $p < .01$, *** $p < .001$ (two-tailed).
[a]All the talker variability indexes were dummy coded. (Intensive) Adult Talkers 0 = two talkers, 1 = three or more talkers; (Intensive) Child / Pre-school Talkers 0 = zero talker, 1 = one or more talkers.
[b]Daily Child-Oriented Media Time (h)

Table 6. Hierarchical regression analyses predicting productive vocabulary scores from demographic factors, exposure time, and adult talker variability

		(a). Total Adult Talkers			*(b). Intensive and Non-intensive Adult Talkers*		
	Predictors	R^2_{adj}	ΔR^2	β	R^2_{adj}	ΔR^2	β
Step 1			.036			.036	
	Gender			.138			.138
	Birth-Order			.049			.049
	Mother's Academic Level			.112			.112
Step 2		.009	.001		.009	.001	
	Gender			.137			.137
	Birth-Order			.057			.057
	Mother's Academic Level			.110			.110
	Age in Months			.036			.036
	Daily Conversation Time			.016			.016
Step 3		.042	.037*		.039	.040*	
	Gender			.140			.139
	Birth-Order			.053			.060
	Mother's Academic Level			.126			.125
	Age in Months			.004			.009
	Daily Conversation Time			.011			.011
	Total Adult Talker Variability			.195*			
	Intensive Adult Talker Variability						.127
	Non-intensive Adult Talker Variability						.134
N	175						

Note. * p <. 05, ** p <. 01 (two-tailed).

such exposure. To examine this possibility, we conducted hierarchical regression analyses for children aged below 2;6 (N = 47) and for those aged 2;6 or above (N = 128) separately in Study 2 (see supplementary material). Children younger than 2;6 were more inclined to benefit from intensive talkers (β = .284, p = .081) rather than non-intensive ones (β = .030, p = .856), whereas older children exhibited a trend of benefiting from non-intensive adult talkers (β = .156, p = .084) but not from intensive talkers (β = .055, p = .540). While none of the talker variability indexes reached statistical significance, results indicated a tendency consistent with our hypothesis.

Discussion

In Study 2, we made two adjustments regarding the categorisation of talkers: 1) a broader standard of talkers was used in addition to a stringent one as in Study 1 and 2) adult talkers

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were distinguished from older child talkers. With these adjustments and focus on children with no nursery experience, Study 2 confirmed the effect of talker variability on two-year-olds' vocabulary development. The variability of the total number of adult talkers with whom toddlers regularly (at least once every two weeks) conversed positively correlated to their productive vocabulary after controlling for demographic information (gender, birth order, and mothers' academic level) and exposure time indicators (age and daily conversation time).

The effect of talker variability found in Study 1 persisted in Study 2 when the standard for talkers was broadened to those who talk to toddlers at least once every two weeks. These findings imply that each talker contributes to a child's vocabulary development even when the interactions are not frequent. Surprisingly, the effect of intensive adult talker variability (adult talkers who talked to children over 15 minutes a week) did not reach statistical significance in the regression analysis, although a similar category of talkers in Study 1 (total mature talkers who talked to children over 20 minutes a week) did. The samples in two studies varied in nursery-attending status (a mixed sample in nursery status in Study 1 and no-nursery-attending children in Study 2). However, following analyses and comparisons related to nursery experiences covered in Study 1 (see supplementary material), we assumed that the disparity in nursery status is unlikely to account for the insignificance in intensive talker variability in Study 2.

An alternative reason of the discrepancy in results of total mature talkers in Study 1 and intensive adult talkers in Study 2 may be attributed to the difference in children's age distributions (Study 1: M = 26.70 months, SD = 2.05 months, range: 2;0–2;8; Study 2: M = 31.13 months, SD = 3.06 months, range: 1;10–3;0). The hierarchical regression analyses in Study 2 suggested that children in the first half of their third year were more inclined to benefit from intensive talkers rather than non-intensive talkers (whereas the older children tended to benefit from non-intensive talkers). From this point, the impact of total mature talker variability on vocabulary acquisition noted in Study 1 is consistent with the observed tendency indicating the influence of intensive adult talkers among younger two-year-olds in Study 2. However, the age of participants in Study 2 distributed a wider range, covering not only children younger than 2;6 but also older ones. Consequently, the effect of intensive talker variability should be counterbalanced in the analysis when including all the participants.

Regarding the age categorisation of talkers, we distinguished adults from adolescents and older children in Study 2, while we grouped them together as mature talkers in Study 1. Children's vocabulary size significantly correlated to the variability of adult talkers but not to talkers younger than eighteen-years-old, highlighting that it is the adult talkers that strongly affect the vocabulary development of two-year-olds.

These results may be attributed to the higher-quality conversations provided by adults compared to younger talkers (Hoff, 2006). Adults use richer vocabulary and grammar, take more care, and fine tune the timing and speed of talking in conversing with children (as in CDS modifications across cultures; Ferguson, 1964) than younger talkers (Culp et al., 1996; Nwokah, 1987), facilitating children's lexical acquisition. Additionally, the prioritised status of adult talkers might also stem from children's inclination to learn from individuals who consistently produce CDS with accurate information. Pre-schoolers monitor the accuracy status of talkers and preferably learn words from knowledgeable sources over ignorant or inaccurate ones (Pasquini et al., 2007). Compared to child and adolescent talkers, adults typically emerge as more reliable informants, from whom toddlers might learn novel words more favourably.

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General discussion

Children acquire language by listening and talking to people around them. Studies have focused on input from primary caregivers and demonstrated how it affects children's language development. However, empirically, children not only interact with primary caregivers but also with other family members and individuals outside the household such as parents of other children at the playground. Interactions, including occasional and short-term ones, expose children to novel words. Exploring the inputs to children aside from a primary caregiver enriches our understanding of the influence of conversational environment on children's language development.

Studies on immigrant children growing up in bilingual environments showed that the number of individuals who talk to children impacts their language development (Gollan et al., 2015; Place & Hoff, 2011, 2016). To extend the finding in bilingual societies to other language backgrounds, this research examined the talker variability effect among monolingual Japanese two-year-olds. Furthermore, we categorised talkers by age, assuming that only mature (fifth-graders or above) or adult talkers have a significant influence on two-year-olds' vocabulary.

The results revealed a positive correlation between mature (adult) talker variability and children's vocabulary, after controlling for the language exposure time and demographic variables. This positive relation was found not only in a small sample of children without differentiating for their nursery attendance status (Study 1) but also in a larger sample of children who did not attend a nursery (Study 2). Thus, this research replicated the findings of immigrant bilingual children living in the U.S. (Place & Hoff, 2011, 2016) and confirmed the positive impact of talker variability on language development. Additionally, the talker categorisation revealed that adults, not younger talkers, significantly contributed to two-year-olds' vocabulary development. Adults, compared to younger talkers, presumably use a wider variety of words and grammar with higher accuracy, and skilfully adapt their speech to the needs of very young children (Street & Cappella, 1989) that facilitates learning. However, so far, all the studies were conducted in industrial societies (Japan, U.S.) where parents are the primary caregivers and the major source of language input to children. More surveys in different language backgrounds should be conducted before discussing the generalisability of these results (see other types of societies in Cristia et al., 2019; Loukatou et al., 2022).

This research indicated that two-year-olds learn words from talkers they interact with regularly, including some they meet for a short time. This is possible given that two-year-olds acquire basic vocabulary knowledge and are proficient in segmenting words from fluent speech (Houston & Jusczyk, 2000; Singh et al., 2004) and associating words with their referent swiftly (Carey & Bartlett, 1978; Remon et al., 2020; Werker & Hensch, 2015) by utilising grammatical knowledge (Arunachalam & Waxman, 2010; de Carvalho et al., 2019). As such proficient learners, it is beneficial for two-year-olds to encounter a wide variety of words. Previous studies show positive relations between toddlers' vocabulary size and lexical diversity in inputs (Hart & Risley, 1995; Hoff & Naigles, 2002; Rowe, 2008, 2012). Accordingly, the effect of talker variability on children's language development after controlling for the input quantity (age and conversation time in this research) may reflect the critical contribution of the lexical diversity brought by different talkers.

Regarding the reason behind the contribution of talker variability to children's language development, Gollan et al. (2015) hypothesised that talker variability positively impacts children's vocabulary acquisition through the elaboration of children's listening abilities. We possess a wide range of phonological categories of acoustic space (Klatt,

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1986) to recognise spoken words consistently. Developmentally, listening to considerably varied examples contributes to such an acoustic space. Variability in talkers facilitates fourteen-month-olds' discrimination of similar words rather than a single talker (Hohle et al., 2020; Rost & McMurray, 2009, 2010). Thus, toddlers who interact with more talkers in daily life might be exposed to more pronunciation variations and, in turn, be better at speech discrimination which promotes their word acquisition. In Study 2, we tentatively investigated children's listening ability by asking mothers how frequently their children fail to identify a familiar word spoken by a non-family member (see results in the supplementary material). However, this question might not be appropriate to probe children's listening ability as children exposed to more talkers also encounter more challenging moments leading to misrecognition of words. In future research, children's listening ability measured by controlled direct methods is expected to investigate its relation with talker variability.

Another plausible pathway linking talker variability and children's vocabulary development is that talker variability might be indicative of the diversity of places children visit, potentially influencing their vocabulary development. Aside from commonly used words across home settings, there are unique words used in specific activities and settings (Tamis-LeMonda et al., 2019). Exposures to new environments (places) may provide children with opportunities to engage with additional 'scripts' involving novel activities and objects (new words), as well as encounters with more individuals, thereby promoting lexical growth.

Interestingly, a significant predictor of two-year-olds' vocabulary was not the variability of mature talkers within the family but the total mature talkers in Study 1. The insignificant effect of mature family talker variability might be due to its little variability across children (86.0% of the children had two or less mature family talkers). Thus, the results do not reject the impact of mature family members on children's language development but suggest the benefits of interaction with non-family members in contexts where nuclear families are prevalent.

In Study 2, the variability of total adult talkers who talked to the children at least once every two weeks significantly contributed to children's vocabulary development, whereas the effect of the variability of intensive adult talkers, who interacted with the children with roughly the same duration as the mature talkers in Study 1, did not. We assumed this discrepancy regarding intensive talkers to be due to the age differences in the two studies and verified this tendency in Study 2. Children who participated in Study 1 were at the first half of their third year, younger than those in Study 2, and probably needed more intensive interactions to acquire words because of their less mature and still-developing word-learning abilities.

These developing patterns lead us to the following question: Do children other than two-year-olds benefit from talker variability? This needs to be answered with caution for infants. Bergmann and Cristia (2018) detected no relation between talker variability and vowel discrimination ability for four- and six-month-old infants. Seven- to nine-month-olds failed to learn object labels after being trained by multiple talkers while succeeding under single-talker condition (Bulgarelli & Bergelson, 2022). In contrast, fourteen-month-olds repeatedly presented with a word pronounced by multiple speakers could discriminate it from a similar-sounding word (Hohle et al., 2020; Rost & McMurray, 2009, 2010). Thus, talker variability is likely to start to benefit children's language development around their first birthday, when other studies show the establishment of phonetic categories of mother tongue in children (Bergelson & Swingley, 2018; Houston & Jusczyk, 2000). Such developed phonological ability should facilitate learning the phonetic information of a word by listening to multiple talkers.

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Furthermore, evidence supports the consistent benefits of talker variability on children older than two years. Richtsmeier et al. (2009) found that four-year-olds learned words pronounced by multiple speakers more easily than by a single speaker. Gollan et al. (2015) demonstrated that school-aged children ($M = 7.6$ years) who interacted with more talkers of their heritage language had a larger vocabulary in that language.

To summarise, talker variability may have a positive impact on children's language development from as young as approximately one-year-old, though the language aspect fostered by talker variability may vary depending on the children's age or language level. The talker variability effect on other aspects of children's language development (grammatical or pragmatic abilities) at different stages of development should be explored in the future.

Regarding the influence of the COVID-19 pandemic, this research was conducted between July and October in 2020 after the relaxation of the emergency declaration in Japan. Studies showed no significant changes in two-year-olds' daily routine in Japan, including nocturnal sleep time and outdoor play time during the outbreak (between March 2020 and March 2019: Shinomiya et al., 2021; between October and April 2020: Hagihara et al., 2022). However, in response to the pandemic, most people children met outside wore face masks which might have distorted their voice. Nevertheless, this current research evidenced the effect of these non-family talkers in children's language development.

However, the pandemic constrained the measurements utilised in this research, and data were collected exclusively via questionnaire. Mothers whose children had no nursery experience are supposed to spend sufficient time to grasp their children's language environment and their answers in conversation time were similar between two studies. Nonetheless, variables concerning language exposure time could be better captured using objective measures. We expect studies adopting a more direct measurement (i.e., daily recordings) to substantiate the current findings in the future.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S0305000924000084.

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Data accessibility. The conversational environment questionnaire and a raw data are available at https://osf.io/buvwy/?view_only=c550293b053b4f03ab663cfb7a80e004. To understand children's conversational environment better, additional questions not related to the concern of the current research were also collected in the questionnaire of Study 2. These data were not covered in this article.

Competing interest. The authors declare none.

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