Journal of Child Language (2020), 1–14
doi:10.1017/S0305000920000379

CAMBRIDGE
UNIVERSITY PRESS

BRIEF RESEARCH REPORT

Fine lexical tuning in infant directed speech to typically developing children

Lotte ODIJK and Steven GILLIS

University of Antwerp, Computational Linguistics & Psycholinguistics (CLiPS) Research Center, Belgium
Address for correspondence: Lotte Odijk, University of Antwerp, Computational Linguistics and Psycholinguistics (CLiPS) Research Center, Prinsstraat 13, 2000 Antwerpen, Belgium
Email: lotte.odijk@uantwerpen.be

(Received 24 September 2019; revised 19 March 2020; accepted 4 June 2020)

Abstract

Do parents fine-tune the MLU of utterances with a particular word as the word is on the verge of appearing in the child's production? We analyzed a corpus of spontaneous interactions of 30 dyads. The children were in the initial stages of their lexical development, and the parents' utterances containing the words the children eventually acquired were selected. The main finding is that the MLU of the parental utterances containing the target words gradually decreased up to the point of the children's first production of those words. This suggests that parents fine-tune their utterances to support the children's linguistic development.

Keywords: infant directed speech; word acquisition; language development; mean length of utterance

Introduction

Parents usually use a simplified register when talking to their infants: a special register commonly referred to as Infant Directed Speech (IDS). IDS is characterized by adaptions in speech and language (for a review, see Soderstrom, 2007). IDS exhibits linguistic simplifications, such as shorter and less complex utterances (Kavanaugh & Jirkovsky, 1982; Phillips, 1973; Snow, 1977) and a simplified lexicon (Phillips, 1973). In addition, caregivers speak with a higher-pitched voice and wider pitch variations and use longer pauses compared to Adult Directed Speech (ADS) (Fernald, Taeschner, Dunn, Papousek, De Boysson-Bardies & Fukui, 1989; Fischer & Tokura, 1996). Caregivers also speak slower by articulating slower and lengthening their vowels in IDS, particularly utterance-final vowels (Fischer & Tokura, 1996; Soderstrom, 2007). Similar properties of speech to infants were found across different cultures and languages (Soderstrom, 2007).

What is the function of this specific register? In addition to the obvious affective function of IDS (Benders, 2013), characteristics of IDS appear to be effective in attracting and maintaining the infant's attention (Wang, Houston & Seidl, 2018). Indeed, studies have found that infants, even newborns and 1-month-old infants, show a preference for IDS over ADS (Cooper & Aslin, 1990; Fernald, 1992). In addition to maintaining the infant's attention, IDS seems to have a didactic function: infants who hear more IDS are more efficient in processing familiar words (Weisleder & Fernald, 2013). Furthermore, the amount of IDS appears to influence the expressive vocabulary: the more IDS children hear, the larger their expressive vocabulary tends to be (Hart & Risley, 1995; Weisleder & Fernald, 2013). Additionally, this may lead to a more rapid growth of vocabulary (Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991). Not only the quantity, but also the quality, of IDS seems to have an influence. The diversity of the vocabulary in caregiver's speech is a predictor of children's vocabulary production (Pan, Rowe, Singer & Snow, 2005).

IDS should not be conceived as a static phenomenon, but as dynamic and responsive to the child: parents fine-tune their speech to the child's (linguistic) interactional functioning. The fine-tuning hypothesis refers to the idea that IDS changes to adapt to the changing linguistic requirements and needs of the child (Snow & Ferguson, 1977). Mean length of utterance (MLU) is an example of a characteristic of IDS that seems to be adapted to the changing needs of the child (Ko, 2012; Murray, Johnson & Peters, 1990; Sherrod, Friedman, Crawley, Drake & Devieux, 1977). Much research has shown a decrease in the caregiver's MLU in the second half of the first year of the infant's life. This is probably because infants begin to show some understanding of several common words from around the age of 6 months onwards (Bergelson & Swingley, 2012). In response to this changing level of comprehension, caregivers may begin to fine-tune their utterances by adjusting their MLU (Genovese, Spinelli, Romero Lauro, Aureli, Castelletti & Fasolo, 2020; Murray et al., 1990; Sherrod et al., 1977). This general use of shorter utterances in response to the limited abilities of the child is called coarse lexical tuning (Roy, Frank & Roy, 2009). However, not every study found a change in MLU before and after the onset of lexical items (Kavanaugh & Jirkovsky, 1982; Phillips, 1973; Snow, 1977).

Roy et al. (2009) explored fine lexical tuning (i.e., the adjustment of IDS) at the level of individual lexical items in a case study. They identified for every word in the child's vocabulary its "birth", i.e., the first time that the word was produced by the child. Then a time-series was created for each word, consisting of the MLU of the utterances containing that particular word in each consecutive month. A systematic decrease in MLU was found preceding the child's first production of that word. After word birth, the MLU did not immediately rise again. This suggests that there appears to be fine lexical tuning in IDS, because parents seem to modify their own utterances based on the child's knowledge of words.

These results imply that IDS should not be seen as a static phenomenon, but as dynamic and responsive to the child's needs. If IDS is dynamic, the evolution of IDS needs to be identified preferably in a longitudinal approach. Previous research often involved children at one particular age or points in time that were quite far apart (e.g., Phillips (1973) compared IDS to infants of 8, 18 and 28 months). It is difficult to detect a detailed developmental path of IDS under those circumstances. To capture possible changes in the characteristics of IDS, repeated samples need to be taken relatively closely spaced over a sufficiently long period of time. Furthermore, chronological age may not be the most appropriate measure: if IDS is responsive to the child changing needs, then linguistic measures are required instead of chronological age since children of the same chronological age may develop at a different rate. For example, a ten-month-old infant may start producing words, while another one may only be starting to babble at that age. Thus, if IDS is sensitive to when children begin to use words, chronological age is not the most appropriate predicting variable. This is why linguistic milestones and measures of language development derived from a longitudinal corpus of caregiver-child interactions will be used in the present research.

Words in isolation

The fine-tuning hypothesis suggests that the MLU of the caregiver decreases when children start to produce their first words. Shorter MLU's can be the result of more words spoken in isolation. Brent and Siskind (2001) found that 9% of IDS are isolated words. In a study by van der Weijer (1998), this percentage was 6.9% when fillers, vocatives and social expressions were excluded. Brent and Siskind (2001) also showed that the odds that a child would learn a word increased if that word was uttered frequently in isolation. This was a better predictor than the total frequency of that word. Furthermore, around 40% of the infant productive vocabulary were words that were spoken in isolation in IDS. A similar result was found by Swingley and Humphrey (2018): 12- and 15-month old children understood and produced more often words that were heard in isolation or in shorter utterances.

In a study on novel word learning, Keren-Portnoy, Vihman, and Lindop Fisher (2019) showed that 12-month-olds were better in recognizing words presented in isolation than words that were presented sentence-finally. Isolated words were contrasted with sentence-final words, because parents often use unknown words sentence-finally in IDS. Furthermore, words at the edges of an utterances appear to be easier to segment for infants (Seidl & Johnson, 2006). However, when these same words were presented in passages of text, neither words presented in isolation nor words presented sentence-finally were recognized. One reason that words in isolation are easier to learn concerns word segmentation. Infants have difficulties segmenting words in fluent speech, especially from the middle of a multiword utterance (Mattys & Jusczyk, 2001; Seidl & Johnson, 2006).

Not only words in isolation are helpful for learning words, but also shorter utterances. Grimm, Cassani, Gillis, and Daelemans (2019) showed that the more a word occurs in short utterances in IDS, the earlier that word is produced by the child. Shorter utterances are better for predicting the time course of when a word is learned than a word's overall frequency. On the other hand, Arnon and Clark (2011) showed that children pay attention to the lexical frame around a word. In an elicitation study, 4;6-year-old children performed better in producing irregular plurals when there was a highly correlated lexical frame present. The children performed poorly when they had to produce the words in isolation. Of course, these children were older than the children in the studies discussed before, so this could explain the different results.

Current research

The research question of the current study is: do parents tune their utterances to the emergence of words in the infant? Although there are many studies about coarse lexical tuning (Genovese et al., 2020; Murray et al., 1990; Sherrod et al., 1977), there is much less known about fine lexical tuning. The research of Roy et al. (2009) on fine lexical tuning was a case study. The findings of Roy et al. (2009) indicate that adults tune their utterances to the emergence of words in the infant. Can the results of this study also be found with multiple subjects? In the current study, their research will be expanded to 30 typically developing children and their caregivers. From this corpus, the MLU of the parent's speech interacting with their child over time will be measured. Children will not be compared on their chronological age for this purpose, but on linguistic milestones. Specifically, word births will be used, as did Roy et al. (2009).

In order to answer the research question, the MLU in IDS of utterances containing specific words that enter a child's vocabulary at a particular moment will be calculated and compared over time. The expectation is that the MLU exhibits a U-shaped curve, with longer utterances as the child does not yet produce the word, followed by a decrease in MLU immediately before the child's first production of that word, and a corresponding rise afterwards. This expectation is based on the results of the case study by Roy et al. (2009). The study will also explore if the number of words a child already knows influences the fine-tuning of utterances. Arnon and Clark (2011) showed that older children paid attention to the lexical frames around a word; thus it is expected that the more words a child produces, the higher the MLU of parent's speech around new word births will be.

Method

Participants

The data for the current study were taken from the CLiPS Child Language Corpus (CCLC), a collection of longitudinal recordings. This corpus consists of audio and video recordings of spontaneous speech of 30 Belgian Dutch acquiring monolingual typically developing children and the spontaneous interactions with their primary caretakers. The parents of all children were native speakers of Dutch, normally hearing, and from a mid-to-high SES background The children had no health and developmental problems and were monolingually raised (Molemans, 2011; van den Berg, 2011; Van Severen, 2011). Monthly recordings were collected between 6 months and 24 months of age. A total of 570 recordings were available. Recordings lasted on average 64 minutes (median = 63 minutes, range = 33 minutes to 114 minutes).

The current study was approved by the Ethical Committee for the Social Sciences and Humanities of the University of Antwerp (EASHW_17_53). All parents of the children signed an informed consent form.

Data collection and transcription

For the observation sessions, the parents were asked to interact with their children as they normally do in daily routines and free play. Of each original recording a selection of 20 minutes was made for transcription and coding by the researcher who was present at the recording. This selection was made in order to find a pragmatic balance between collecting a reasonable amount of speech material from each recording and keeping the transcription time within reasonable limits (the time-investment per transcription was about 14 hours). The researcher aimed for a selection in which the child was vocally active. Only uninterrupted interactions were selected, and long pauses and noisy parts were avoided. Each selection was transcribed using CHILDES' CLAN program according to the CHAT conventions (MacWhinney, 2000). Children's and parents' productions were orthographically and phonemically transcribed with stress marking. Target words of children's production were also transcribed phonemically: this meant that the adult equivalent of the word was added.

Ten percent of the corpus was used for an interrater reliability check: another transcriber retranscribed the utterances orthographically. The original and the retranscribed transcriptions were compared on two aspects: the content (identical words) of the utterances and the length of the utterances. The re-annotation of utterance content resulted in a percentage of agreement of 82%. For utterance length, the percentage of agreement was 91%. For intrarater reliability, 5% of the corpus was retranscribed by the original transcriber. The same process as the interrater reliability check was used. This resulted in a percentage of agreement of 88% for the re-annotation of utterance content and 93.5% for utterance length (Molemans, 2011; van den Berg, 2011; Van Severen, 2011).

Language measures

First, children's expressive vocabulary was collected using the CLAN software (MacWhinney, 2000). A Python script was written to create a cumulative word list and each word's first use and the child's age at that point were marked. Word types were added cumulatively: if a child produced a specific word type in a recording session, this word was added to the child's cumulative vocabulary if it was not already present. This is called a 'word birth' (Roy et al., 2009). The result was a list of word births combined with the age when the word was first produced. Before the script was run, the list was lemmatized. This was done to ensure that inflectional variants of acquired words were not considered as new words. Furthermore, only the content words were kept for the current study.

Another Python script was written to compute the MLU based on number of words in IDS. For each word in the child's cumulative word list, utterances were identified in their parent's speech (main tier *ADU) containing that word. Then, for each month, the MLU was calculated from those utterances by dividing the number of words by the number of utterances. A time series of the MLUs for each word for each parent was the result. The time series were aligned by the time the word was first produced by the child. This means that the month when the word was first produced by the child was set at month zero, and consequently the month before was month -1, and the month after month 0 was set to month + 1, etc.

Statistical analysis

Statistical analyses were done in the software R (R Core Team, 2018) using Multilevel Modeling (MLM) (package *lme4*) (Bates, Maechler, Bolker & Walker, 2015). MLM consists of a random and a fixed part. The dependent variable of the model was the MLU of words in IDS. The fixed effects were the linear, quadratic and cubic effects of time, measured as months from the child's first production of a word, the child's cumulative vocabulary, and possible interactions between two effects.

Child and word were introduced as the random effects. The model contained at the level of children and words both random intercepts and random slopes for the linear effect of time. As such, the variation between children and between words was considered, assuming that the effect of time may differ between children and between words.

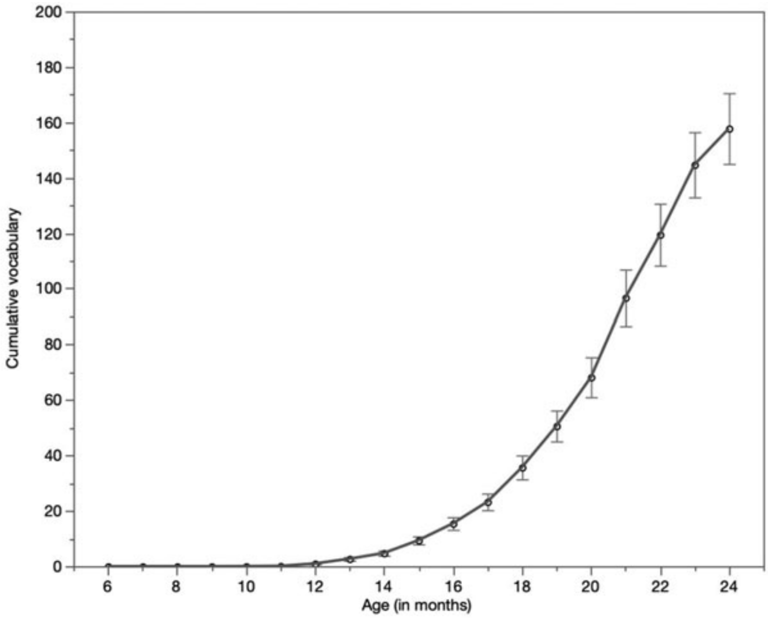

Figure 1. Study children's development of cumulative vocabulary

The models were built step by step first entering random effects and then adding the fixed effects one by one. If a fixed effect improved the model, the effect was kept in the model; otherwise, it was left out of the model. The cut-off level of significance for the analysis was set at $p = 0.05$. The best fitting model is reported. For the data analyses, the MLU of words from 17 months before word birth, to nine months after word birth, were analyzed. The other months were excluded, because there were too few data points ($N < 100$).

Results

Cumulative vocabulary

From the transcripts, 5,375 word births for the children were extracted. The mean age of the children was 1;1.16 when they used their first word (median = 1;1.7, range = 0;11.0 to 1;4.2). The children had on average a cumulative vocabulary of 179 words (median = 197, range = 56 to 247) at the age of 24 months. These word births led to 18,684 data points of MLU in infant directed speech.

Figure 1 shows the development of the cumulative vocabulary: per month the mean cumulative number of words is plotted, together with 95% confidence intervals. The individual cumulative vocabulary counts are presented in Appendix 1.

Development of MLU of utterances with target words

Do parents tune their utterances relative to the emergence of words in infants? A multilevel model was fitted with random effects for each child and each word for the

Table 1. Parameters estimates of parent MLU of utterances with target words

	Estimate	SE	t value	*p*
Intercept	4.4	0.12	37.1	<0.0001
Months from word birth	-0.06	0.014	-4.71	<0.0001
Quadratic months from word birth	0.004	0.0016	2.34	0.02
Cubic months from word birth	0.0003	0.0004	3.56	0.003
Cumulative vocabulary	0.0004	0.0004	1.04	0.3
Months from word birth * Cumulative vocabulary	0.0004	0.0001	2.63	0.009

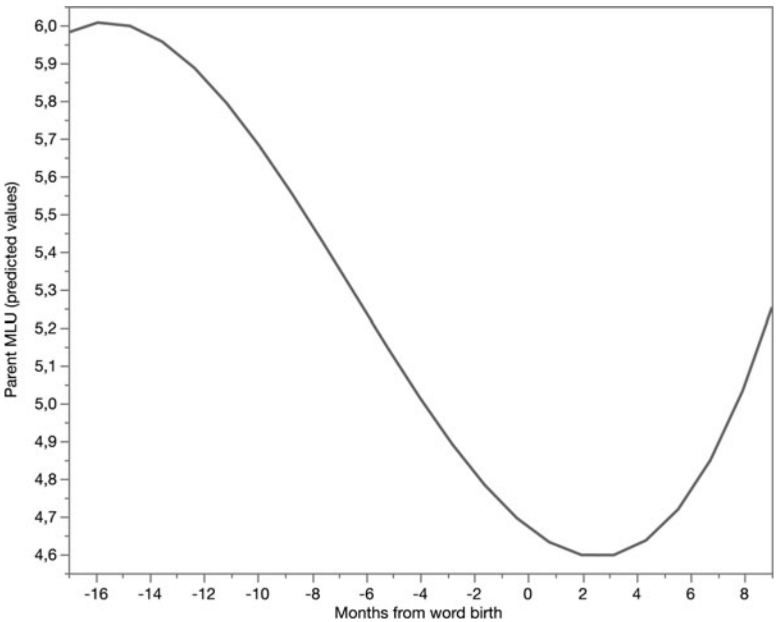

Figure 2. Development of MLU in IDS relative to word births (predicted values).

linear effect of time. This resulted in random intercepts and slopes for each child at each month and for each word at each month. The corresponding model can be found in Table 1. The results revealed variations in MLU depending on the number of months from word birth ($p < 0.0001$). Specifically, the modification of MLU in IDS followed a U-curve according to a significant quadratic and cubic trend ($p < 0.05$), shown in Figure 2. MLU decreased as word birth approached and increased again shortly after word birth. There was no significant main effect of cumulative vocabulary, meaning that the U-shaped curve occurred irrespective of the child's cumulative vocabulary level. However, parents increased their utterance length more over time as the child acquired a larger vocabulary, shown by the significant

Table 2. MLU in IDS at the time of word birth

	Estimate	SE	t value	*p*
Intercept	3,8	0.11	33.2	<0.0001
Cumulative vocabulary at month 0	0.003	0.0007	3.96	<0.0001

interaction between cumulative vocabulary and number of months from word birth ($p < 0.05$). Age, the quadratic effect of age and other interactions between effects did not improve the model, so these effects were not included in the model reported in Table 1.

MLU at the time of word birth

Does the child's vocabulary size have an influence on the parents' MLU at the time of new word births? In order to answer this question, the MLU of the parents at the month a child first produced a word (month 0) was extracted for each word. The cumulative vocabulary of the child at that age was added. A multilevel model was constructed with both random intercepts and random slopes for the linear effect of cumulative vocabulary at the level of children and words. With this addition, it is assumed that each child and each word can have different intercepts and that the effect of cumulative vocabulary can differ for each child and each word. The corresponding model can be found in Table 2.

The results revealed that vocabulary size influenced the MLU of parents at the time of new word births. This is shown by a significant main effect of cumulative vocabulary at month 0 ($p < 0.001$), as depicted in Figure 3. Parents used longer utterances with a particular target word when the child had a higher cumulative vocabulary at the moment that word was first produced by the child. A quadratic effect of cumulative vocabulary did not improve the model, so it was not included in the model.

Discussion

The current research addressed the question whether parents tune their utterances to the emergence of words in the infant. Our results demonstrated that the length of the utterances with a particular target word decreased as the child's production of that target word came closer. The utterance length increased again afterwards, but not to the level it was at the beginning of the period. This finding is in accordance with the finding reported by Roy et al. (2009). The change in MLU suggests that parents use some level of fine lexical tuning in their speech to children in addition to coarse fine tuning, the general use of shorter utterances.

Why do parents shorten their utterances containing words that are on the verge of appearance in their children's spontaneous speech? A possible explanation is that they try to scaffold their children with word learning. Shorter MLU's can mean that there are more words spoken in isolation. A previous study by Brent and Siskind (2001) found that children learned words better when they occurred in isolation. The frequency of hearing a word in isolation was a better predictor of word learning than the total frequency of that word's exposure (see also Keren-Portnoy et al., 2019; Ninio, 2016; Swingley & Humphrey, 2018). Next to words in isolation, shorter utterances are also

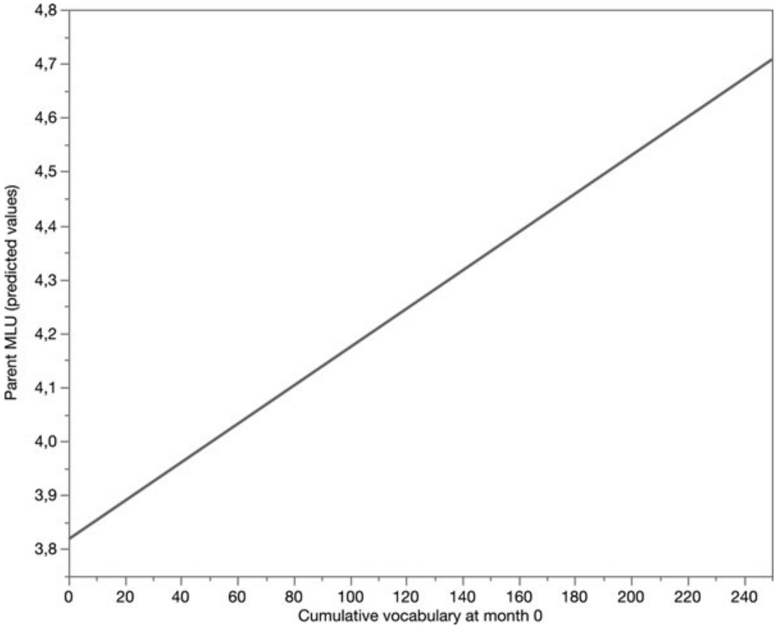

Figure 3. Parent MLU of target words in IDS at the time of word birth (predicted values).

helpful for learning words (Grimm et al., 2019; Swingley & Humphrey, 2018). These results are in line with the finding of the present study that parents' MLU decreases around the time a word is first produced, a finding similar to the one reported by Roy et al. (2009) in a case study.

The decrease in MLU is seen prior to word birth. This may be attributed to the well-known phenomenon that young children's comprehension precedes production (Benedict, 1979), and parents possibly act on their child's understanding of a word by shortening their utterances containing that word. However, this hypothesis can only be corroborated by investigating when a word is first understood by the child, and by relating parents' MLU relative to that point.

However, according to Arnon and Clark (2011), children pay attention to the relation between words, and such lexical frames help children acquire words. For instance, "brush your teeth" is more helpful in acquiring "teeth" than that word in isolation. In this respect, the occurrence of a particular word in a specific lexical frame would be more helpful, and not the occurrence of that word in short(er) utterances around word birth *per se*. This alternative was not explicitly addressed in the current study: however, the mean estimated MLU was never lower than 3. This may indicate that the majority of the words are not spoken in isolation, but in lexical frames. Furthermore, the children in the current study were younger than in the experimental study of Arnon and Clark (2011). In the current study, the children were followed from 6 months until 2 years old. The children in the study of Arnon and Clark (2011) were 4;6 years old. Possibly, older children, who have a larger cumulative vocabulary, benefit more from framing than from shorter utterances. This is supported by our data, as vocabulary size had an influence on the MLU of parents at the time of new word births: the more words children knew, the higher the MLU of parent's speech around word birth. This could mean that there is less fine-tuning in terms of MLU of a new word when children get older and have larger vocabularies.

There are some limitations of the current study. First, the children were only recorded once a month. Most probably not all the word births in the current study are estimated completely accurately. We looked at the first time a child produced a word in the transcriptions, but it could be that this word was already in the expressive vocabulary of the child. Furthermore, the current study contained less dense data than the study of Roy et al. (2009), because they followed a single child every day from birth until the child's third birthday. This makes the current study less precise.

Conclusion

The current study demonstrated that parents modify their utterances relative to the emergence of words in their children. Parents shorten their utterances with a particular word as the word is on the verge of appearing in the child's production. This study replicated the finding of the case study of Roy et al. (2009), now with a larger number of subjects. In conclusion, this indicates that parents use fine-lexical tuning when talking to their children: parents use shorter sentences to scaffold children's word learning.

Acknowledgements. We would like to thank the families and infants that participated in the study, and K. Schauwers, I. Molemans, R. van den Berg and L. Van Severen for collecting the CLiPS Child Language Corpus. The research reported in this article was supported by grant G.0235.18 of the Research Foundation Flanders (FWO) to S. Gillis.

References

Arnon, I., & Clark, E. V. (2011). Why 'brush your teeth' is better than 'teeth': children's word production is facilitated in familiar sentence-frames. *Language Learning and Development*, *7*(2), 107–129. doi:10.1080/15475441.2010.505489

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. doi:10.18637/jss.v067.i01

Benders, T. (2013). Mommy is only happy! Dutch mothers' realisation of speechsounds in infant-directed speech expresses emotion, not didactic intent. *Infant Behavior & Development*, *36*, 847–862. doi:10.1016/j.infbeh.2013.09.001

Benedict, H. (1979). Early lexical development: comprehension and production. *Journal of Child Language*, *6*(2), 183–200. doi:10.1017/S0305000900002245

Bergelson, E., & Swingley, D. (2012). At 6–9 months, human infants know the meanings of many common nouns. *PNAS*, *109*(9), 3253–3258. doi:10.1073/pnas.1113380109

Brent, M. R., & Siskind, J. M. (2001). The role of exposure to isolated words in early vocabulary development. *Cognition*, *81*, B33-B44. doi:10.1016/s0010-0277(01)00122-6

Cooper, R., & Aslin, R. (1990). Preference for infant-directed speech in the first month after birth. *Child Development*, *61*(5), 1584–1595. doi:10.2307/1130766

Fernald, A. (1992). Human maternal vocalisations to infants as biologically relevant signals: an evolutionary perspective. In J. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 391–428). Oxford: Oxford University Press.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., De Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language*, *16*, 477–501. doi:10.1017/s0305000900010679

Fischer, C., & Tokura, H. (1996). Acoustic cues to grammatical structure in infant-directed speech: cross-linguistic evidence. *Child Development*, *67*(6), 3192–3218. doi:10.2307/1131774

Genovese, G., Spinelli, M., Romero Lauro, L. J., Aureli, T., Castelletti, G., & Fasolo, M. (2020). Infant-directed speech as a simplified but not simple register: a longitudinal study of lexical and syntactic features. *Journal of Child Language*, *47*, 22–44. doi:10.1017/S0305000919000643

Grimm, R., Cassani, G., Gillis, S., & Daelemans, W. (2019). Children probably store short rather than frequent or predictable chunks: quantative evidence from a corpus study. *Frontiers in Psychology*, *10*, 80. doi:10.3389/fpsyg.2019.00080

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore: Brookes Publishing.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: relation to language input and gender. *Development Psychology*, *27*, 236–248. doi:10.1037/0012-1649.27.2.236

Kavanaugh, R. D., & Jirkovsky, A. M. (1982). Parental speech to young children: a longitudinal analysis. *Merrill-Palner Quarterly*, *28*(2), 297–311.

Keren-Portnoy, T., Vihman, M., & Lindop Fisher, R. (2019). Do infants learn from isolated words? An ecological study. *Language Learning and Development*, *15*(1), 47–63. doi:10.1080/15475441.2018.1503542

Ko, E. (2012). Nonlinear development of speaking rate in child-directed speech. *Lingua*, *122*, 841–857. doi:10.1016/j.lingua.2012.02.005

MacWhinney, B. (2000). *The CHILDES project: tools for analyzing talk*. Mahwah: Lawrence Erlbaum

Mattys, S., & Jusczyk, P. (2001). Do infants segment words or recurring contiguous patterns? *Journal of Experimental Psychology*, *27*(3), 644–655. doi:10.1037//0096-1523.27.3.644

Molemans, I. (2011). *Sounds like babbling. A longitudinal investigation of aspects of the prelexical speech repertoire in young children acquiring Dutch: normally hearing children and hearing-impaired children with a cochlear implant*. (PhD), Universiteit Antwerpen, Antwerpen.

Murray, A. D., Johnson, J., & Peters, J. (1990). Fine-tuning of utterance length to preverbal infants: effects on later language development. *Journal of Child Language*, *17*, 511–525. doi:10.1017/s0305000900010862

Ninio, A. (2016). Learning transitive verbs from single-word verbs in the input by young children acquiring English. *Journal of Child Language*, *43*(5), 1103–1130. doi:10.1017/S030500091500046X

Pan, B. A., Rowe, M. I., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development*, *76*(4), 763–782. doi:10.1111/1467-8624.00498-i1

Phillips, J. R. (1973). Syntax and vocabulary of mothers' speech to young children: age and sex comparisons. *Child Development*, *44*(1), 182–185. doi:10.2307/1127699

R Core Team. (2018). R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Roy, B. C., Frank, M., & Roy, D. (2009). Exploring word learning in a high-density longitudinal corpus. *Proceedings of the Thirty-First Annual Conference of the Cognitive Science Society, July 29-August 1, 2009, Vrije Universiteit, Amsterdam, Netherlands.*

Seidl, A., & Johnson, E. (2006). Infant word segmentation revisited: edge alignment facilitates target extraction. *Developmental Science*, *9*(6), 565–573. doi:10.1111/j.1467-7687.2006.00534.x

Sherrod, K. B., Friedman, S., Crawley, S., Drake, D., & Devieux, J. (1977). Maternal language to prelinguistic infants: syntactic aspects. *Child Development*, *48*, 1662–1665. doi:10.2307/1128531

Snow, C., & Ferguson, C. (Eds.). (1977). *Talking to children: language input and acquisition*. Cambridge: Cambridge University Press.

Snow, C. E. (1977). The development of conversation between mothers and babies. *Journal of Child Language*, *4*(1), 1–22. doi:10.1017/s0305000900000453

Soderstrom, M. (2007). Beyond babytalk: re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review*, *27*, 501–532. doi:10.1016/j.dr.2007.06.002

Swingley, D., & Humphrey. (2018). Quantitative linguistic predictors of infants' learning of specific English words. *Child Development*, *89*(4), 1247–1267. doi:10.1111/cdev.12731

van den Berg, R. (2011). *A longitudinal study of the development of syllable types in toddlers acquiring Dutch: a comparison between hearing impaired children with a cochlear implant and normally hearing children*. (PhD), Universiteit Antwerpen, Antwerpen.

van der Weijer, J. (1998). *Language input for word discovery*. (PhD), Katholieke Universiteit Nijmegen, Nijmegen.

Van Severen, L. (2011). *A large-scale longitudinal survey of consonant development in toddlers' spontaneous speech*. (PhD), Universiteit Antwerpen, Antwerpen.

Wang, Y., Houston, D. M., & Seidl, A. (2018). Acoustic properties of infant-directed speech. In S. Frühholz & P. Belin (Eds.), *The Oxford Handbook of Voice Perception* (1 ed., pp. 93–116). Oxford: Oxford University Press.

Weisleder, A., & Fernald, A. (2013). Talking to children matters: early language experience strenghtens processing and builds vocabulary. *Psychological Science*, *24*(11), 2143–2152. doi:10.1177/0956797613488145

Cite this article: Odijk L, Gillis S (2020). Fine lexical tuning in infant directed speech to typically developing children. *Journal of Child Language* 1–14. https://doi.org/10.1017/S0305000920000379

Appendix 1. Overview of the cumulative vocabulary of children

Subject	Age in months																		
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
S1	0	0	0	0	0	0	0	0	1	12	14	26	48	58	78	115	149	191	235
S2	0	0	0	0	0	0	1	6	11	25	41	52	63	72	85	102	144	178	233
S3	0	0	0	0	0	0	0	0	0	4	9	20	41	61	105	145	178	241	
S4	0	0	0	0	0	0	0	3	10	25	49	62	92	122	147	183	247		
S5	0	0	0	0	0	1	2	3	4	6	6	9	23	28	41	75	103	136	178
S6	0	0	0	0	0	0	0	0	0	1	3	6	12	19	25	32	49	61	65
S7	0	0	0	0	0	0	0	0	0	0	1	5	17	24	37	63	103	139	195
S8	0	0	0	0	0	0	1	2	2	2	5	8	18	30	39	56	81	136	178
S9	0	0	0	0	0	0	0	0	0	7	21	48	66	104	145	195			
S10	0	0	0	0	0	0	0	0	0	2	4	6	11	27	40	62	100	140	208
S11	0	0	0	0	0	0	0	0	0	0	1	3	5	13	23	33	48	70	108
S12	0	0	0	0	0	0	0	0	0	0	1	7	14	21	32	43	54	65	77
S13	0	0	0	0	0	0	0	0	5	14	18	30	45	76	95	199			
S14	0	0	0	0	0	0	3	9	10	10	16	29	41	73	93	124	153	210	
S15	0	0	0	0	0	0	0	0	0	0	8	8	8	13	16	29	57	93	133
S16	0	0	0	0	0	1	3	8	8	13	15	18	19	21	23	27	31	54	89
S17	0	0	0	0	0	0	4	5	12	18	23	27	41	57	80	100	148	184	227
S18	0	0	0	0	0	0	1	4	11	19	27	35	50	69	94	133	185	243	

(*Continued*)

Appendix 1. (*Continued.*)

	Age in months																		
Subject	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
S19	0	0	0	0	0	0	0	2	5	6	15	20	27	34	38	95	133	158	192
S20	0	0	0	0	0	0	2	5	8	14	18	31	47	66	86	106	131	161	199
S21	0	0	0	0	0	0	0	0	2	3	7	16	24	40	55	93	143	209	
S22	0	0	0	0	0	0	4	4	7	12	20	31	40	44	66	82	110	172	215
S23	0	0	0	0	0	0	2	8	14	18	32	46	64	85	110	148	174	212	
S24	0	0	0	0	1	1	1	14	19	26	39	53	98	116	148	194	214	227	
S25	0	0	0	0	0	0	1	4	5	8	12	20	32	48	64	74	99	112	137
S26	0	0	0	0	0	0	0	0	2	4	4	5	10	14	16	19	35	45	56
S27	0	0	0	0	0	0	0	1	2	9	15	24	39	77	118	193	236		
S28	0	0	0	0	0	1	3	6	7	11	25	32	37	47	56	66	83	119	156
S29	0	0	0	0	0	0	0	0	1	6	7	8	13	21	42	52	75	107	144
S30	0	0	0	0	0	0	0	0	2	2	8	14	27	40	51	65	83	100	131