From Babbling to First Words: Phonological or Lexical Selection?

Suzanne V.H. van der Feest, Hoyoung Yi, and Barbara L. Davis

1. Introduction

At the very onset of word production, potential interactions between children's articulatory capacities for producing the sounds of their language (*how* they produce sounds in words) and their early vocabulary (*what* words they choose to say) are dominant factors determining early word choice. Children in the earliest stages of word production may choose words without much regard for the sound structure of those words (selecting words purely based on meaning), or they may choose to mainly say words consisting of sounds they have already mastered. These two options can be summarized as Phonological versus Lexical Dominance approaches. According to a Phonological Dominance theory, the child's articulatory system and sound production capacities are the main factor driving word choices. These "Lexical Selection" or "Selection and Avoidance" theories have argued that children initially predominantly choose to say words containing sounds they have already mastered and tend to avoid words with more complex phonological characteristics that they are not yet able to produce well (e.g. Schwartz, Leonard, Frome Loeb & Swanson, 1987). Alternatively, a Lexical Dominance theory suggests that children choose salient words to say regardless of their sound characteristics, even in the earliest period of word productions when production system mastery is far from adult-like. Previous studies have argued that especially children four years and older choose the words they say regardless of whether they are fully capable of producing all sounds in those words (e.g. Beckman, Munson & Edwards, 2007. For an overview of this debate, see Stoel-Gammon, 2011).

In an earlier study, we looked at the phonological properties of spontaneous words produced by six children age 8 to 35 months. We compared sound patterns in their early *word targets* versus their *actual productions* or realizations of the sound patterns in those target words. (Davis, Van der Feest & Yi, 2018). Those results challenged an 'either / or' approach to the lexical versus phonological

* Suzanne V.H. van der Feest, The Graduate Center, City University of New York, svanderfeest@gc.cuny.edu; Hoyoung Yi, Texas Tech University Health Sciences Center, hoyoung.yi@ttuhsc.edu; Barbara L. Davis, The University of Texas at Austin, babs@mail.utexas.edu. We would like to thank Yvan Rose for help with Phon, Sally Amen and Erika Hale for statistical consulting, and all parents and children who participated in this study.

 Proceedings of the 45th annual Boston University Conference on Language Development, ed. Danielle Dionne and Lee-Ann Vidal Covas, 217-230. Somerville, MA: Cascadilla Press.

dominance question in children at the very onset of word use. Distributions of five phonological dimensions, including coronal, labial, dorsal; and oral stop place and fricative and stop manner, in both word initial and final position were analyzed. In word initial position, more support was found for Phonological Dominance, on 4 out of 5 dimensions: labial, coronal, dorsal place and oral stop manner showed similar sound distributions in word *targets* and *actual* word productions. However, there were more fricatives in word *targets* than in children's *actual* productions (the children attempted to say words with fricatives, even if they could not yet accurately produce them). This finding supports a Lexical Dominance approach. In word initial position, no change over time was found; as children's vocabularies grew, there was no difference in the sound distributions of word targets and children's actual word productions. In word final position, analyses revealed more support for Lexical Dominance, as well as an effect of vocabulary size, indicating that children were producing words with any type of word-final sounds in them regardless of whether they were able to produce these sounds well. Davis et al. (2018) argued that one explanation for these results may be that fricatives in general, and all sounds in word-final position, may be represented later in the lexicon or have a less prominent role for word identification, compared to word-initial stops. Overall highlighted the importance of considering multiple factors (such as the type of phonological contrast and word position) when investigating the production of sound patterns in children's earliest words.

In the current study, we further investigate the possibility of Phonological rather than Lexical Dominance at the very beginning of meaningful word productions by comparing sound patterns in children's early words productions with patterns in the same children's earliest spontaneous vocalizations or *babbling*. Children start produce speech-like syllables several months before they produce their first meaningful word forms, starting on average around 6 months of age. Many studies of babbling have been pursued including comparisons of structures in babbling and early words (e.g. Davis & MacNeilage, 1995; Blake & De Boysson-Bardies, 1992; DePaolis, Vihman & Nakai, 2013; Morgan & Wren, 2018), but none have considered how sound patterns in babbling relate directly to first words within the same children's spontaneous productions. Our hypotheses are, that if the child's articulatory system and sound production capacities drive their choices of words to say (i.e. a Phonological Dominance approach) spontaneously produced early words will exhibit *similar distributions of sounds* to those in children's babbling (i.e. we expect to find no significant differences between sound distributions in words versus babbling). If children mainly choose words to say regardless of their sound characteristics (i.e. a Lexical Dominance approach) we predict that distributions of phonological dimensions analyzed in spontaneously produced early word targets will *not* be overall similar to the sound patterns in babbling. The consideration of sound patterns in babbling, which are considered meaningless in semantic terms, versus those in first meaningful word forms, afford a test case for further evaluation of previous mixed findings regarding the possible influence of children's articulatory capacities on their earliest productions of words.

2. Method
2.1. Participants

Spontaneous speech from six monolingual American English-learning children (4 females) was analyzed for this study. The data is part of the Texas Davis Database (e.g. Davis, MacNeilage & Matyear, 2002) which is publicly available on PhonBank (Rose et al., 2006). The age range of the participants was between 8 and 35 months. Participants had no history of hearing issues or speech-language delays as reported by their parents. All participants passed a basic hearing screening (500, 1000, 2000, 4000 Hz) at the University of Texas at Austin Speech and Hearing Clinic, and all had typical motor / cognitive development based on results of the Battelle Developmental Screening Inventory (Guidubaldi, Newborg, Stock, Scinicky & Wneck, 1984). (See Table 1 for more specific participant information).

Table 1. Participant Characteristics

child	gender	age range (years;months)	total # of sessions	age at ~100 word types	# sessions < 100 word types
BEN	M	0;11-2;4	21	1;10	17
KAE	F	1;0-2;1	13	1;7	10
NAT	M	0;10-2;8	24	1;8	20
CHA	F	0;10-2;11	44	1;9	21
GEO	F	0;8-2;11	45	1;7	20
HAN	F	0;11-2;3	28	1;11	20

2.2. Apparatus and Procedure

All recordings were made approximately bi-weekly in each child's home environment. Recorded interactions were always between the child and one caregiver, plus the researcher. Interactions were not structured and included a range of situations and objects or toys present in the environment, so the variety in conversational topics was large. Audio was recorded using an Audio-Technika ATW1031 remote microphone clipped to the child's shoulder. Broad phonetic transcriptions were done offline after the session by two separate coders. Reliability measures for individual consonant transcriptions were reported for the original database (Davis et al., 2002). During the session, if a particular word target was not entirely clear, the researcher that was present discussed this in real time with the caregiver, and noted the caregiver's judgment. All verbal expressions that could not be identified as meaningful words by the original transcribers in agreement with the caregivers are marked specifically in the original transcriptions. This marking and inclusion of "spontaneous vocalizations" or babbling, in addition to the transcribed word targets, is a unique characteristic of this database, making it especially suitable for the current study.

2.3. Data Analyses

Spontaneous vocalizations (babbling) were pulled out from the original database and were entered in a separate Phon database consisting only of babbling. We then analyzed sound patterns in the children's meaningful words separately from the sound patterns in their babbling database. The distributions of stop consonants with labial, coronal and dorsal places of articulation were compared in babbling and words, in both babble/word-initial and -final positions. We compared these distributions relative to the number of utterances in a session. For example, the total number of coronals was counted in a given session, and the number of coronal sounds was then divided by the total number of utterances (babbles or words) in that session. Four separate analyses are presented in the next section: (1) Distributions of place of articulation in stop consonant sounds in *initial* position in all sessions combined. (2) The data set for each child was divided, and the sessions up until the point where the child produced their first 100 word types were analyzed separately. Next, we analyzed distributions in *final* position, (3) in all sessions combined, followed by (4) final distributions considering only the sessions until the first 100 word types were produced.

3. Results and Discussion

For each of the four data sets we applied a generalized linear mixed model (GLMM), with a negative binomial distribution using the glmmTMB package (Brooks et al., 2017) in R version 3.6.3 because the data (i.e., the dependent variable) were over-dispersed. Fixed effects included age (in months), sound type (babbling or words), place of articulation (labial, coronal, or dorsal), and an interaction between sound type and place of articulation. To account for baseline individual differences across the children, we included a by-child intercept as a random effect. The reference levels were babbling, labial, and mean age in months. We tested the interaction between production type and place of articulation by comparing the model with the interaction and a model with the three main factors. We examined the main effects of age, type, and place of articulation by comparing the base model, which only included the random effect, to the same model with the addition of age, production type or place of articulation. Model comparisons were achieved using the likelihood ratio. Post hoc analysis for significant main effects with more than two levels and significant interaction were carried out by Bonferroni's tests using the 'emmeans' function (Lenth, 2020). Below, we will first discuss the results for word- and babble-initial position in Section 3.1, followed by the results for word- and babble-final position in Section 3.2.

3.1. Word-Initial Sounds

Results for the analyses of word initial sounds are illustrated in Figure 1. Comparing sound patterns in babbling with sound patterns in words in all the sessions (Figure 1, top panel a), the results of the GLMM showed significant main effects of age, $\chi2(1) = 59.929$, $p < 0.01$, sound type, $\chi2(1) = 19.604$, $p < 0.01$, and place, $\chi2(2) = 379.0$, $p < 0.01$. A post hoc analysis for the significant main effect of place demonstrated that proportions of labials and coronals were not significantly different, $\beta = 0.0141$, $SE = 0.0509$, $t(885) = 0.276$, $p = 1.000$. The proportion of labials was higher than dorsals, $\beta = 1.2313$, $SE = 0.0689$, $t(885) = 10.339$, $p < 0.01$, and the proportion of coronals was higher than dorsals, $\beta = 1.2172$, $SE = 0.0694$, $t(885) = 17.544$, $p < 0.01$. This can be seen in Figure 1.

The model yielded a significant interaction effect between type and place of articulation $\chi2(2) = 18.339$, $p < 0.01$, denoting that distributions of consonant places of articulation are different in babbling versus words. A post hoc analysis for the significant interaction revealed that for both babbling and words, the proportions of labials and coronals produced were higher than the proportions of dorsals: labials vs. dorsals in babbling: $\beta = 1.510$, $SE = 0.1007$, $t(885) = 14.995$, $p < 0.01$, coronals vs. dorsals in babbling: $\beta = 1.361$, $SE = 1.361$, $t(885) = 13.341$, $p < 0.01$, labials vs. dorsals in words: $\beta = 0.952$, $SE = 0.0921$, $t(885) = 10.339$, $p < 0.01$, and coronals vs. dorsals in words: $\beta = 1.073$, $SE = 0.0912$, $t(885) = 11.774$, $p < 0.01$. In both babbling and words, the proportions of labials and coronals were not significantly different, labials vs. coronals in babbling: $\beta = 0.149$, $SE = 0.0730$, $t(885) = 2.045$, $p = 0.1235$, and labials vs. coronals in babbling: $\beta = -0.121$, $SE = 0.0703$, $t(885) = -1.723$, $p = 0.2559$. Even though the proportions of labials and coronals were not significantly different, in babbling children produced labials relatively more than coronals. In words, by contrast, they produced labials less than coronals (as can be seen in Figure 1). These results support the notion of Lexical Dominance, i.e. children select words to say regardless of whether those words sound patterns match the distributions of sounds they have practiced in their productions of babbling.

To further investigate the differences in patterns between babbling and words for the significant interaction between sound types and place of articulation a post hoc analysis was performed comparing each contrast in babbling versus words. The proportions of labials between babbling and words were not significantly different, $\beta = 0.0545$, $SE = 0.0731$, $t(885) = 0.746$, $p = 0.4561$. However, children produced coronals in words significantly more than coronals in babbling, $\beta = -0.2159$, $SE = 0.0737$, $t(885) = -2.930$, $p < 0.01$. The proportion of dorsals in words was also significantly higher than the proportion of dorsals in babbling, $\beta = -0.5033$, $SE = 0.1150$, $t(885) = -4.376$, $p < 0.01$. Overall, these results show that the sound distributions in babbling and first words differ from each other in significant ways, which supports a Lexical Dominance hypothesis.

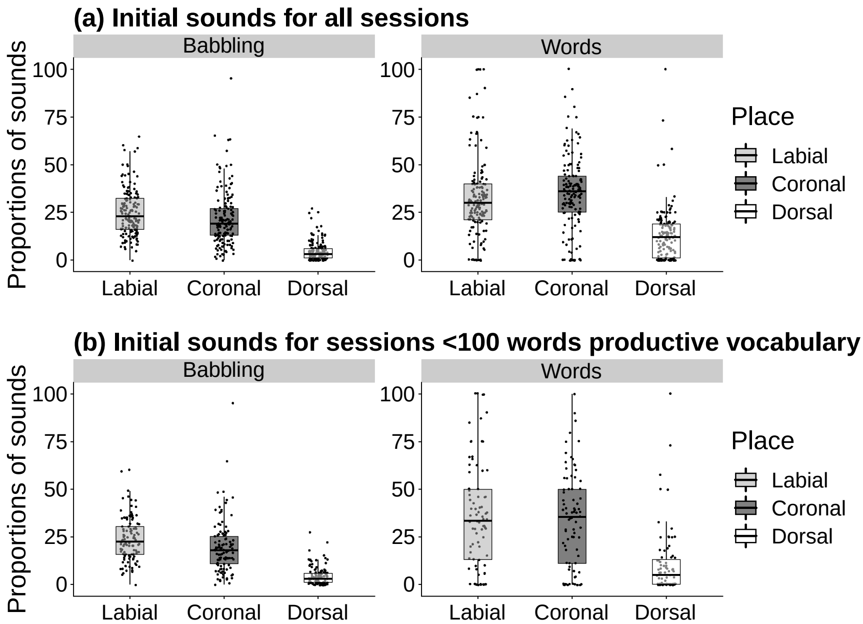

Figure 1. Average proportions of sounds in babbling versus words in initial position. Box plots illustrate distributions of place of articulation, comparing proportions of labials (light gray), coronals (dark gray) and dorsals (white). Top panel (a) shows proportions of sounds in babbling (left bars) versus *all words* (right bars). Bottom panel (b) shows proportions of sounds in babbling (left bars) versus *words when productive vocabulary size is <100 words* (right bars). Center lines on each box plot indicate median score, edges denote 25th and 75th percentiles, whiskers extend to data points within 1.5 times the interquartile range. Dots are sound proportions of individual sessions (of all children).

The analyses comparing sound patterns in babbling with sound patterns in words up until each child produced their first 100 word types (Figure 1, bottom panel b), showed significant main effects for age, $\chi 2(1) = 11.122$, $p < 0.01$, and place, $\chi 2(2) = 207.22$, $p < 0.01$. The result of a post hoc analysis for the significant main effect of place revealed that proportions of labials and coronals were not significantly different, $\beta = 0.0993$, $SE = 0.078$, $t(555) = 1.273$, $p = 0.6108$. The proportion of labials was higher than that of dorsals, $\beta = 1.3293$, $SE = 0.103$, $t(555) = 12.932$, $p < 0.01$, and the proportion of coronals was higher than that of dorsals, $\beta = 1.2300$, $SE = 0.104$, $t(555) = 11.783$, $p < 0.01$. Unlike in the analysis looking at *all* sessions, in the sessions containing only the first 100 word types, the main effect of sound type was not significant, $\chi 2(2) = 207.22$, $p = 0.6947$. Thus, there were no significant differences in sound proportions between babbling and words. The model yielded a non-significant interaction between type and place of articulation $\chi2(2) = 1.531$, $p = 0.47$, indicating that place of articulation distributions (labial, coronal, dorsal) was not different in sounds between babbling and words up until 100 different word types produced in each child. These results for the earliest stages of word learning, where productive vocabulary size is smaller than 100 words, are in line with a Phonological Dominance hypothesis; the sound distributions in babbling and words in these earliest sessions were not different from each other. In word-initial position, only within sessions up until children produced 100 different word types, the proportions of sound were also not significantly different between babbling and words. Results for the entire data set revealed that the sound distributions were significantly different between babbling and words. Taken together, these outcomes support lexical dominance in children when their vocabulary size increases. Regarding sound proportions of place of articulation, at the earliest stage of vocabulary development (sessions for < 100 word types), the post hoc analysis for the main effect of place of articulation revealed that no significant differences in sound proportions between labials and coronals. However, for sound proportions in words, children produced coronals relatively more than labials as productive vocabulary size increases (total sessions).

3.2. Word-Final Sounds

Children overall produced very few sounds in word-final position. When children produced no final labials, coronals, and dorsals in words in an entire session, the session was excluded. In total, 60 sessions were excluded because children did not produce any final consonants (35.7% of all sessions). [1] The results for the analyses of word final sounds are illustrated in Figure 2. Comparing sound patterns in babbling with sound patterns in words in all the sessions (Figure 2, top panel a), the results of the GLMM showed significant main effects for age, $\chi2$ (1) = 82.925, $p < 0.01$, type, $\chi2$ (1) = 19.033, $p < 0.01$ and place $\chi2$ (2) = 192.13, $p < 0.01$. For the place of articulation, post-hoc analysis revealed that the proportion of labials was significantly lower than coronals, $\beta = -0.428$, $SE = 0.0757$, $t(786) = -5.656$, $p < 0.01$. The proportion of labials was significantly higher than dorsals, $\beta = 1.095$, $SE = 0.1015$, $t(786) = 10.790$, $p < 0.01$, and coronals were produced more than dorsals, $\beta = 1.524$, $SE = 0.0999$, $t(786) = 15.252$, $p < 0.01$. The model also demonstrated a significant interaction between type and place of articulation, $\chi2$ (2) = 102.86, $p < 0.01$, indicating that distributions of consonant places of articulation are different in babbling versus words. A post hoc analysis for the significant interaction revealed that in babbling, the proportion of labials was significantly higher than the proportion of coronals, $\beta = 0.275$, $SE = 0.104$, $t(786) = 2.655$, $p = 0.0243$. In contrast, in words the

[1] Total number of deleted sessions: BEN (10); KAE (2); NAT (15); CHA (13); GEO (9); HAN (11). All deleted sessions were part of the set of early sessions, before 100 word types were produced.

proportion of labials was significantly lower than coronals, $\beta = -1.132$, $SE = 0.107$, $t(786) = -10.537$, $p < 0.01$. In both babbling and words, proportions of labials and coronals were significantly higher than proportions of dorsals; labials vs. dorsals in babbling, $\beta = 1.818$, $SE = 0.152$, $t(786) = 11.990$, $p < 0.01$, coronals vs. dorsals in babbling, $\beta = 1.543$, $SE = 0.156$, $t(786) = 9.889$, $p < 0.01$, labials vs. dorsals in words, $\beta = 0.372$, $SE = 0.134$, $t(786) = 2.772$, $p = 0.0171$], and coronals vs. dorsals in words, $\beta = 1.504$, $SE = 0.120$, $t(786) = 12.506$, $p < 0.01$.

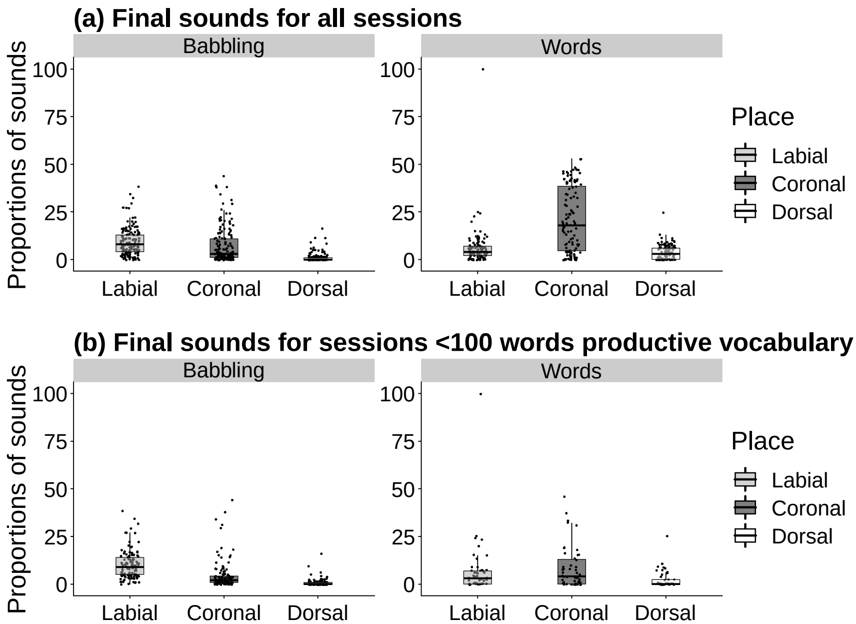

Figure 2. Average proportions of sounds in babbling versus words in final sounds. Box plots depict word initial patterns of place of articulation, comparing proportions of labials (light gray), coronals (dark gray) and dorsals (white). Top panel (a) shows proportions of sounds in babbling (left bars) versus all words (right bars). Bottom panel (b) shows proportions of sounds in babbling (left bars) versus words when productive vocabulary size is <100 words (right bars). Center lines on each box plot indicate median score, edges denote 25th and 75th percentiles, whiskers extend to data points within 1.5 times the interquartile range. Dots are sound proportions of individual sessions (of all children).

For sessions up until each child produced 100 different word types (Figure 2, bottom panel b), the model also yielded significant main effects for age, $\chi2$ (1) = 6.7154, $p < 0.01$, and place $\chi2$ (2) = 159.23, $p < 0.01$. The post-hoc analysis for the main effect of place revealed proportions of labials and coronals were not significantly different, $\beta = 0.28$, $SE = 0.132$, $t(459) = 2.113$, $p = 0.1054$, whereas the proportion of labials was higher than dorsals, $\beta = 1.55$, $SE = 0.176$, $t(459) = 8.838$, $p < 0.01$, and the proportion of coronals was higher than dorsals, $\beta = 1.27$, $SE = 0.175$, $t(459) = 7.279$, $p < 0.01$.The main effect of type was not significant [$\chi2$ (1) = 2.1924, p = 0.1387]. There was again a significant interaction between type and place of articulation, $\chi2$ (2) = 24.441, $p < 0.01$. The result of the post hoc analysis demonstrated that in babbling, the proportion of labials was significantly higher than that of coronals, $\beta = 0.876$, $SE = 0.132$, $t(459) = 6.610$, $p < 0.01$ whereas in words, the proportions of labials and coronals were not significantly different, $\beta = -0.316$, $SE = 0.226$, $t(459) = -1.399$, $p = 0.4879$. In both babbling and words, proportions of labials and coronals were significantly higher than proportions of dorsals: labials vs. dorsals in babbling, $\beta = 2.112$, $SE = 0.186$, $t(459) = 11.371$, $p < 0.01$, coronals vs. dorsals in babbling, $\beta = 1.236$, $SE = 0.197$, $t(459) = 6.290$, p < 0.01, labials vs. dorsals in words, $\beta = 0.995$, SE = 0.296, $t(459) = 3.361$, $p < 0.01$, and coronals vs. dorsals in words., $\beta = 1.311$, $SE = 0.288$, t (459) = 4.560, $p < 0.01$. To summarize, in contrast with findings in word initial position, overall results for word final position show differences between sound distributions in babbling and words, supporting Lexical Dominance.

3.3. Individual Patterns

Individual patterns are illustrated in Figure 3 below. In word-initial position, individual children demonstrated patterns consistent with overall group results (as shown in section 3.1). Proportions of coronals and dorsals were higher in words than those in babbling. They also demonstrated similar proportions of labials in babbling versus words. For the earliest sessions up to 100 word types, individual patterns also were largely in line with the group pattern; proportions of labials and coronals were higher than dorsals in both babbling and words, showing no differences in sound distributions between babbling and words. When looking at each child's graph, we do see individual differences in the proportions of labials and coronals in the sessions with <100 word types: Three children (KAE, NAT, and CHA) demonstrated similar proportions of labials and coronals in both babbling and words, consistent with the overall group pattern. BEN and GEO showed a higher proportion of labials than coronals, but did so both in babbling and words. HAN showed a higher proportion of coronals than labials in both babbling and words. Importantly, all children show similar patterns of sound distributions between babbling and words in the earliest sessions, regardless of whether their individual patterns were similar to the overall group patterns.

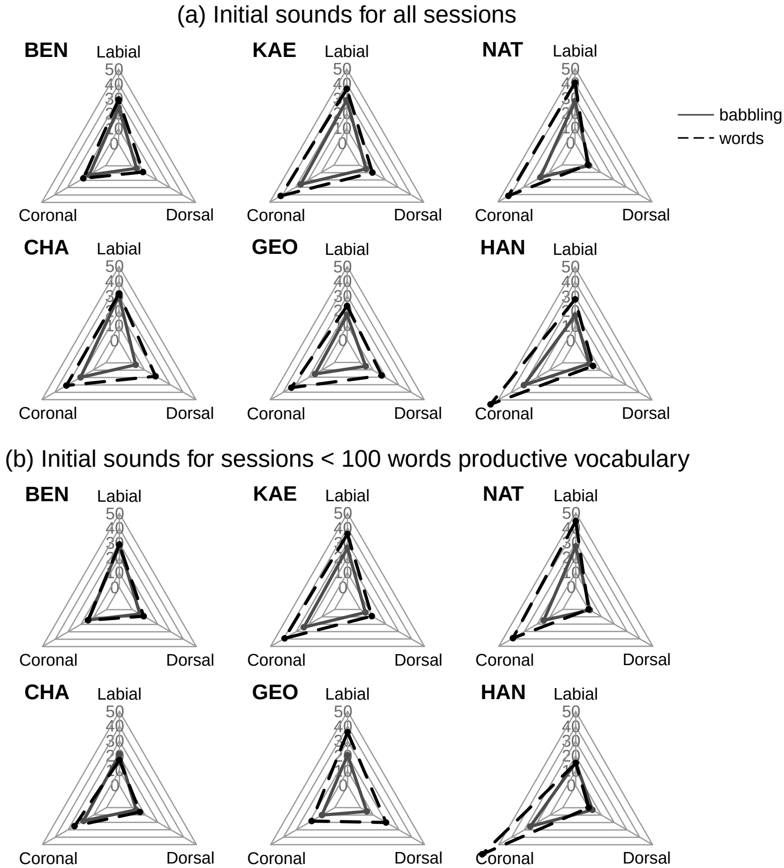

Figure 3. Individual patterns, initial position. Top panel (a) shows proportions of sounds in babbling (dark grey lines) versus all words (light grey lines). Bottom panel (b) shows proportions of sounds in babbling (dark grey lines) versus words when productive vocabulary size is <100 words (light grey lines). The three points of the triangle indicate the median values of proportions of labials, coronals, and dorsals. The central point represents zero, the numbers increases toward the edge of the triangle.

Individual patterns in word-final position are illustrated in Figure 4 below. In the full data set, the significant discrepancy between babbling and words described in section 3.2 came from the difference between sound proportions of labials and coronals: in babbling, the proportion of labials was significantly higher than that of coronals whereas in words, the proportion of coronals was significantly higher than the proportion of labials. Individual children appeared to produce labials more than coronals in babbling. In words, four children (NAT, CHA, GEO, and HAN) showed a higher proportion of coronals than labials. BEN and KAE showed similar proportions of labials and coronals. CHA and HAN showed higher proportions of coronals than labials, but they still showed dissimilar patterns in babbling and words. In sum, while there were individual differences, all children with the exception of KAE demonstrated different sound proportions between babbling and words in word final position (both for the full and the <100 word type datasets).

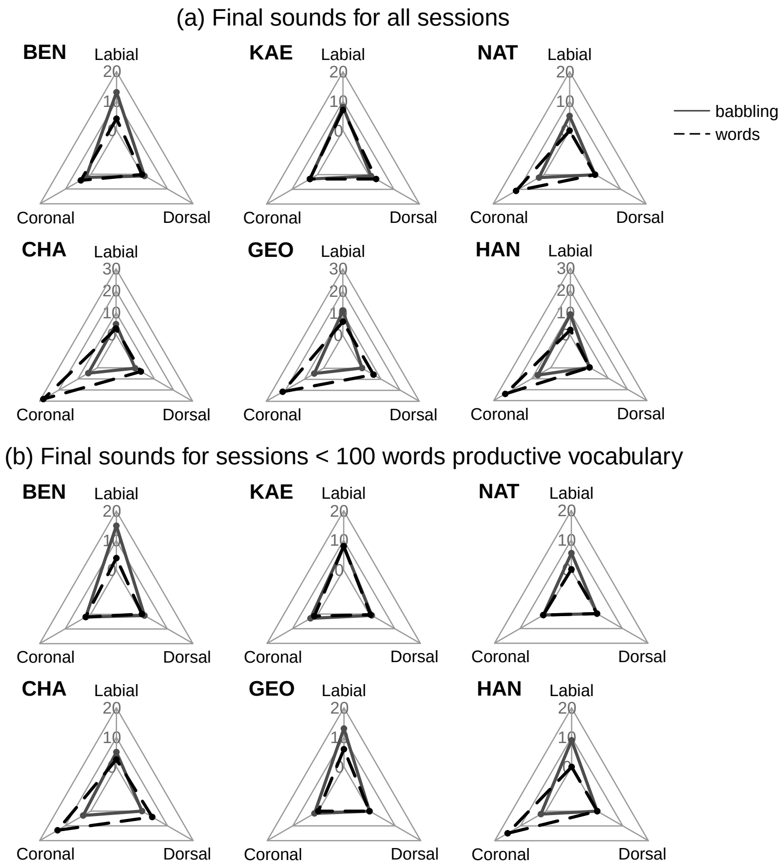

Figure 4. Individual patterns, final position. Top panel (a) shows proportions of sounds in babbling (dark grey lines) versus all words (light grey lines). Bottom panel (b) shows proportions of sounds in babbling versus words when productive vocabulary size is <100 words (light grey lines). The three points of the triangle indicate the median values of proportions of labials, coronals, and dorsals. The central point represents zero, the numbers increases toward the edge of the triangle.

4. General Discussion

Patterns of place of articulation were analyzed within a large corpus of spontaneous speech, as they emerged in babbling and changed during the early word period for the same children. Results provide clear support for Phonological Dominance at the very beginning of word use, with a shift towards Lexical Dominance as vocabulary size increases. Importantly, in this study the earliest stage of word use was defined based on each child's productive vocabulary size rather than their chronological age. In word-initial position, at the earliest stage of vocabulary development we found no significant differences in proportions of sounds between babbling and speech, indicating that when children choose their first words to say, they accommodate their own sound production repertoire. In contrast, we found significant differences in proportions of sounds between babbling and speech when vocabulary size increased: children choose words to say regardless of the words' sound patterns. Taken together, these findings indicate that differences between sound patterns in babbling and words found in previous studies (e.g. Davis et al, 2018) are not driven by the earliest stages of word use.

In word-final position however, we found significant differences in sound proportions between babbling and words across the entire analyzed period. These results could possibly be interpreted as support for lexical dominance regardless of vocabulary size. However, as is typical for English-learning children's earliest words (e.g. Vihman, 1996), very few sounds in word-final position were produced at the earliest stages, which may have to do with articulatory constraints. It is therefore possible to argue that in the period of Phonological Dominance, word final position is not taken into account when children select words to say. In the rarer cases when children produced word final sounds, they chose words they were capable of producing. In addition to considering additional phonological factors, future studies should consider the kinds of words where final consonants are produced versus deleted, and analyze relevant factors including word frequency, overall phonetic complexity of the words, and the semantic structure of children's words. The differences between sound distributions in initial versus final positions is consistent with findings of Davis et al., 2018. These differences may also be an indication that word-final position is less important for early word recognition and may be specified later in early lexical phonological representations, in line with several earlier studies on speech perception and word recognition (e.g. Nazzi & Bertoncini, 2009; Swingley, 2009; Redford & Diehl, 1999).

As we saw in section 3.3., not all individual children exhibited the same patterns, but they produced fairly similar patterns of sound distributions. In both word-initial and final positions, the change in the proportion of coronals in words showed a consistent pattern. At the earlier stage of word use, children demonstrated no significant difference in sound proportions between coronals and labials in initial position of babbling or words, and in final position of words. However, when they produced more words, the proportion of coronals increased regardless of the position of sounds. In word-initial position, children showed significantly higher proportions of coronals in words than coronals in babbling. In word-final position, the proportion of coronals was significantly higher than labials in words. Another possible factor in addition to a growing vocabulary is the maturation of articulator coordination. At the onset of word use, control of the tongue tip and laminal portion is less developed. As children mature, they gain more motor coordination of their articulators for speech sound positioning, increasing their ability to use coronals in words.

To summarize, these results enable further evaluation of Lexical versus Phonological Dominance, and support the notion that children start producing their first words with an approach consistent with a Phonological Dominance theory, before moving to a Lexical Dominance approach as they mature and their productive vocabulary size increases. These results are not only interesting from a theoretical perspective investigating the role of phonology in the earliest stages of lexical development: They support the proposal that children initially choose to produce words with speech sounds they have produced during canonical babbling. It could therefore be important and beneficial to consider sounds in children's babbling (and / or non-meaningful spontaneous vocalizations) when planning clinical intervention protocols to facilitate word use for older children functioning at the earliest period of word production.

References

Beckman, Mary E., Munson, Benjamin, & Edwards, Jan (2007) The influence of vocabulary growth on developmental changes in types of phonological knowledge. In Jennifer Cole & José Hualde (Eds.), *Laboratory Phonology, 9*, 241–264. New York: Mouton de Gruyter.

Blake, Joanna, & De Boysson-Bardies, Bénédicte (1992). Patterns in babbling: A cross-linguistic study. *Journal of Child Language*, *19*(1), 51-74.

Brooks, Mollie E., Kristensen, Kasper, van Benthem, Koen J., Magnusson, Arni, Berg, Casper W., Nielsen, Anders, Skaug, Jans J., Machler, Martin & Bolker, Benjamin M. (2017). glmmTMB balances speed and flexibility among packages for zero-inflated generalized linear mixed modeling. *The R journal*, *9*(2), 378-400.

Davis, Barbara L., & MacNeilage, Peter F. (1995). The articulatory basis of babbling. *Journal of Speech, Language, and Hearing Research*, *38*(6), 1199-1211.

Davis, Barbara L., MacNeilage, Peter F., & Matyear, Christine L. (2002). Acquisition of serial complexity in speech production: A comparison of phonetic and phonological approaches to first word production. *Phonetica*, *59*(2-3), 75-107.

Davis, Barbara L., Van der Feest, Suzanne V.H., & Yi, Hoyoung (2018). Speech sound characteristics of early words: influence of phonological factors across vocabulary development. *Journal of child language*, *45*(3), 673.

DePaolis, Rory A., Vihman, Marilyn M., & Nakai, Satsuki (2013). The influence of babbling patterns on the processing of speech. *Infant Behavior and Development*, *36*(4), 642-649.

Guidubaldi, John, Newborg, Jean, Stock, John R., Svinicki, John, & Wneck, Linda (1984). *Battelle Developmental Inventory.* Allen, TX: DLM Teaching Resources.

Lenth, Russell V. (2020). emmeans: Estimated marginal means, aka least-squares means (Version 1.4. 2) [R package].

MacNeilage, Peter F., Davis, Barbara L., Kinney, Ashlynn., & Matyear, Christine L. (2000). The motor core of speech: A comparison of serial organization patterns in infants and languages. *Child Development*, *71*(1), 153-163.

Morgan, Lydia, & Wren, Yvonne E. (2018). A systematic review of the literature on early vocalizations and babbling patterns in young children. *Communication Disorders Quarterly*, *40*(1), 3-14.

Nazzi, Thierry, & Bertoncini, Josiane (2009). Phonetic specificity in early lexical acquisition: New evidence from consonants in coda positions. *Language and Speech*, *52*(4), 463-480.

Redford, Melissa A., & Diehl, Randy L. (1999). The relative perceptual distinctiveness of initial and final consonants in CVC syllables. *The Journal of the Acoustical Society of America*, *106*(3), 1555-1565.

Rose, Yvan, MacWhinney, Brian, Byrne, Rodrigue, Hedlund, Gregory, Maddocks, Keith, O'Brien, Philip, & Wareham, Todd. (2006) Introducing Phon: a software solution for the study of phonological acquisition. In David Bamman, Tatiana Magnitskaia, & Colleen Zaller (Eds.), *Proceedings of the 30th Annual Boston University Conference on Language Development.* (pp. 489-500). Somerville, MA: Cascadilla Press.

Schwartz, Richard G., Leonard, Laurence B., Frome Loeb, Diane, & Swanson, Lori A. (1987) Attempted sounds are sometimes not: an expanded view of phonological selection and avoidance. *Journal of Child Language, 14,* 411-18.

Stoel-Gammon, Carol (2011) Relationships between lexical and phonological development in young children. *Journal of Child Language, 38,* 1–34.

Swingley, Daniel (2009). Onsets and codas in 1.5-year-olds' word recognition. *Journal of memory and language*, *60*(2), 252-269.

Vihman, Marilyn M. (1996) *Phonological development: the origins of language in the child.* Oxford: Blackwell Publishing.

Proceedings of the 45th annual Boston University Conference on Language Development

edited by Danielle Dionne
and Lee-Ann Vidal Covas

Cascadilla Press Somerville, MA 2021

Copyright information

ISSN 1080-692X
ISBN 978-1-57473-067-8 (2 volume set, paperback)

Ordering information

To order a copy of the proceedings or to place a standing order, contact:

Cascadilla Press, P.O. Box 440355, Somerville, MA 02144, USA
phone: 1-617-776-2370, sales@cascadilla.com, www.cascadilla.com