Phonological versus Lexical factors in Children's Productions at the Onset of Word Use

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1. Introduction

At the earliest onset of word use, the growing number of recognizable and consistent attachments of vocalizations to particular word targets requires increasing precision in interactions of the systems supporting speech and language development (e.g. Davis & Bedore, 2013; Meltzoff, Kuhl, Movellan & Sejnowski, 2009). A major issue in fully understanding children's formative stages of word-based speech and language acquisition relates to potential interactions between their available phonological and/or articulatory capacities (*how* they produce sound patterns) and their early lexical choices (*what words* they want to say) (e.g Stoel-Gammon, 2011). To consider the factors motivating observable speech output patterns, the question arises of whether children at the onset of word use mainly attempt to produce words consisting of sounds they can already produce, or whether young children pick word targets without much regard for the sounds in those words. Another relevant factor that we will consider here is vocabulary growth (i.e., how large is the child's vocabulary overall?) Several studies have looked at the potential role of lexical versus phonological factors experimentally (e.g., Edwards, Munson & Beckman, 2011). However, few studies to date have concurrently analyzed phonological and lexical factors in children younger than four. Throughout this study, phonological production patterns will refer to children's ability to execute speech movements, without making implications about the potential underlying phonological system involved in early speech production.

Diverse theoretical perspectives consider potential interactions between phonological and lexical factors in the early stages of language acquisition. For example, a continuity assumption springing from a lexical dominance hypothesis

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suggests that word choice factors may dominate even in the earliest period when production system mastery is farther from adult capacities (see e.g. Pierrehumbert, 2001; Beckman, Munson & Edwards, 2007; Edwards et. al., 2011) Under such a view, children are motivated from the outset by ideas they wish to convey to those around them.

In contrast, phonological capacities are a potentially important influence on children's choices of early word forms to express meanings, in addition to factors such as frequency of phonemes and phoneme sequences, and phonological neighborhood density (Stoel-Gammon, 2011). Words children say have also been shown to share phonological features of stress, number of syllables, and segment types (Vihman, 1996). Earlier researchers also supported a proposal of dominance for phonological factors in early word forms children choose to say. Ferguson & Farwell (1975) proposed a theory of 'Lexical Selection', where phonological factors were said to direct the word types children attempted in the earliest stages of word use, which was more extensively argued for in their later 'selection and avoidance' proposal, (Leonard, Schwartz, Morris & Chapman, 1981; Schwartz & Leonard, 1982; Schwartz, Leonard, Loeb & Swanson, 1987). According to this perspective, children choose to say words with sounds they can produce and avoid other words with more complex phonological characteristics.

Overall, consideration of perspectives on the early word period does not reveal a consensus. Conceptualizations suggesting that the lexicon dominates word choices (e.g., Pierrehumbert, 2001; Edwards et al., 2011) are largely based on studies of children 4 years of age and older. In contrast, studies suggesting the importance of child phonological capacities (i.e., Stoel-Gammon, 2011; Vihman, 2009) center on children in the earliest periods of word use. Considering that children's linguistic capacities develop dramatically between the earliest word onset period and the age of 4 years, and this period is characterized by a rapid growth in vocabulary size, theoretical modeling of the issue of lexical and phonological interfaces across this period would ultimately be well served by longitudinal methods. Accordingly, our goal was to consider the relationship between expressive vocabulary development and speech production patterns in the earliest period of word learning. To consider this question, we analyzed longitudinal data in children between the ages of 0; 8 and 2; 11.

Sound production capacities available to the child's articulatory system drive lexical selections under a phonological dominance hypothesis. If phonological factors dominate in these early stages, we predict that patterns for spontaneously produced word targets that children attempt will be *similar* to phonetic patterns found in the children's actual output patterns for those targets. This outcome would indicate selection of word targets with phonological characteristics within the child's production repertoire. Alternatively, under a lexical dominance hypothesis, lexical knowledge and word salience for the child most heavily influences word choices in children's output even in the earliest period when production system mastery is far from adult-like. In other words, if lexical factors are dominant, we predict that the target sound patterns for spontaneously produced early word targets (SW-T) may be significantly different from children's actual output patterns (SW-T) for those targets.

2. Methods

2.1 Participants

Six monolingual English-learning children age 0;8 to 2;11 years participated. There were four females and two males. All six children were located through informal referrals from the Austin, Texas community. Normal motor/cognitive development and hearing was established.

2.2 Procedures

Data came from the Texas Davis database (e.g., Davis et al., 2002) available on PhonBank (Rose, MacWhinney, Byrne, Hedlund, Maddocks, O'Brien & Wareham, 2006). Each child's spontaneous vocal output was audiotaped in a home environment. Sessions included playing, eating, and other daily experiences familiar to the children. In addition, the *MacArthur-Bates Communicative Development Inventory* (CDI - Fenson, Dale, Reznick, Thal, Bates & Hartung, 1993; Fenson et al., 2007) was used by the parents in order to report on their child's productive vocabulary growth around the date of *each* spontaneous data collection session. CDI results were analyzed to evaluate potential biases in the topics within the spontaneous speech samples.

2.3 Data analysis

Three types of data were included for each child. First, *Spontaneous Words types - Targets* (SW-T) indicated a perceptually syllable-like form, designated as a 'word-based target' because it had a clear meaningful 'target word' or communicative function (see Davis et al., 2002). Second, each child's *actual productions* of the SW-T types were analyzed. They were termed *Spontaneous Words – Actual* (SW-A*)*. For example, in the case of a session with three SW-Ts, /bɔl/, /dɑg/ and /kændi/ the child's actual productions, or SW-As, might be /bɔ/, /dɑ/ and /bæ/. SW-T included one labial, one coronal, and one dorsal in initial position, and SW-A contained two labials, one coronal and no dorsal in that positions. We analyzed the overall phonological patterns for each session for all SW-Ts versus all SW-As, without looking at 'accuracy' at the individual word level. This analysis is thus related to general pattern matching for dimensions of place and manner between word targets attempted (SW-T) and actual child production patterns (SW-A) in output. Lack of significant difference between targets and actual productions when children have achieved a high level of accuracy, would signal accurate productions of individual sounds in individual words. However, given that the children in our sample were very young, it is highly unlikely that evidence for early dominance for phonological factors would indicate complete mastery of their target language's sound system. All data was transcribed and analyzed using Phon conventions (Rose et al., 2006). SW-Ts and SW-As occurring spontaneously in the sample were phonetically transcribed by the same transcriber for each infant. Standard broad transcriptions available in Phon were used. The third analysis focused on the words reported by parents to be produced by their child on the *CDI (W-CDI)*. Following the procedures for the SW-T data**,** standard transcriptions of words that children were reported to produce on the MacArthur-Bates CDI - Words and Sentences subscale were analyzed in Phon.

For each data type (i.e., SW-T, SW-A and W-CDI) we analyzed 10 phonological dimensions. The dimensions were labial, coronal and dorsal place of articulation, and fricative and oral stop manner in word-initial and in word-final positions. The palatal [j] was classified as a coronal, and the glide [w] was classified as a labial and velar based on conventions in Phon. Counts of the total number of attempted SW-T and W-CDI word types were used to establish two measures of vocabulary growth across the period of the study. All participants showed a slow growth in number of word types until approximately 20-22 months, followed by a steeper increase. More marked differences in word growth for individual children occurred in the later (>200 word) period.

3. Results and Discussion

3.1 W-CDI and SW-T

W-CDI word type patterns on the 10 phonological dimensions were descriptively compared to patterns in SW-T word types, to verify that the spontaneous samples did not show environmental biases for individual participants. Relative proportions of all dimensions were calculated, as the total number of words per session was typically much higher for SW-T than for W-CDI. Descriptive statistics included the comparisons of differences in medians between W-CDI and SW-T. The difference between W-CDI and SW-T ranged from 0.6 to 4.8 percent. W-CDI and SW-T showed the same patterns of relationship based on proportions for all dimensions of place and manner in initial and final position. For most children, distinct patterns for all dimensions in both word positions began to emerge only when they began to produce approximately fifty word types (i.e. SW-T) and were reported as producing that number on CDI reports (W-CDI). This finding is consistent with Stoel-Gammon's (2011) discussion of a potential 'vocabulary spurt' around 50 words. Importantly, this first descriptive analysis indicates that the data in the spontaneous speech samples are representative for the children's productions overall, despite the fact that the spontaneous communicative environment was not controlled.

3.2 SW-A and SW-T

To consider potential dominance of lexical and/or phonological factors in the children's spontaneous data samples, SW-T and SW-A patterns were compared for each phonological dimension relative to vocabulary growth. Note that we focus here on how speech production capacities and lexical choice may relate to vocabulary size, without making claims about the emergence of abstract phonological features.

To compare patterns in SW-T versus SW-A for the 10 phonological dimensions of place and manner over time, we applied a generalized linear mixed model (GLMM), with a negative binomial distribution because the data was over-dispersed (Fournier et al. 2012). The dependent variable was the number of sounds based on either place (labial, coronal, dorsal) or manner (oral stop and fricative) of articulation. Data included four groups including initial-place, initial-manner, final-place, and final-manner with their own regression models. The model of initial-place included fixed effects for vocabulary size, spontaneous word measure (SW-T vs. SW-A) and place (coronal vs. dorsal vs. labial). In addition, interaction terms for spontaneous word measure by vocabulary size, and spontaneous word measure by place or manner were evaluated. To validate the models with a random intercept of children and a random slope of vocabulary size, a likelihood ratio test was used to compare the likelihood of each pair of models with and without the random effects. AIC (Akaike Information Criterion) was also compared for each pair of models to validate the models with random effects.

3.3 Initial word position

An F-test was used to test the overall effect of fixed factors in generalized linear mixed regression effect models. (See Table 1). For phonological place of articulation in initial word position, there was no significant difference between SW-T and SW-A ($F(1,895)=1.079$, $p=0.299$). There was also no significant interaction of vocabulary size by the difference between SW-T and SW-A ($F(1,895)=0.904$, $p=0.342$), and no interaction of spontaneous word measure (SW-T and SW-A) by place of articulation ($F(2,895)=0.056$, $p=946$). For manner of articulation in initial word position, comparison of fricatives with oral stops revealed no interaction between vocabulary size and the difference between SW-T and SW-A, $F(1,595) = 0.250$, $p=0.617$. However, there was a significant interaction effect of manner with spontaneous word types (SW-T vs. SW-A), $F(1,595) = 11.133$, $p<0.001$ in addition to a significant difference between SW-T and SW-A, $F(1,595) = 9.706$, $p=0.002$. Interaction analysis was performed using the phia package in R (Martinez, 2015). Pairwise contrasts evaluated with Bonferroni adjusted significance showed that *fricatives* were significantly more frequent in SW-T than in SW-A, $X^2(1, N=595) = 6.841$, $p=0.018$ whereas oral stops showed no significant difference between SW-T and SW-A, $X^2(1, N=595) = 0.249$, $p=1.000$.

Table 1. Results of the generalized mixed effects negative binomial regression on spontaneous word measures in word initial position

	Initial place					Initial manner			
	Est[a]	SE	z val	p		Est	SE	z	p
(Intercept)	8.786	0.327	6.65	<0.001	(Intercept)	3.800	0.334	4.00	<0.001
vocab	1.011	0.003	4.27	<0.001	Vocab	1.011	0.003	4.25	<0.001
SW-Aplace	0.876	0.128	-1.04	0.299	SW-Aman	0.620	0.153	-3.12	0.002
dorsal	0.343	0.116	-9.26	<0.001	oral stop	1.916	0.119	5.46	<0.001
labial	0.790	0.113	-2.09	0.037	--	--	--	--	--
voca[b]:SW-A	1.000	0.000	0.95	0.342	voca:SWA	1.000	0.000	0.50	0.617
SWAdorsal	0.968	0.163	-0.20	0.841	SWA:oralst	1.749	0.168	3.34	<0.001
SWA:labial	1.044	0.160	0.27	0.789	--	--	--	--	--

Estimate a: exponential estimate; voca[b]: vocabulary

Note: The intercept represents the reference condition: spontaneous word measure was SW-T, and place was coronal or manner was fricative.

Figure 1 illustrates changes in relative frequencies of the dimensions of place and manner in initial position in SW-T and SW-A, as a function of vocabulary growth. At a small vocabulary size, the scale of vocabulary growth was smaller whereas at a larger vocabulary size, vocabulary growth was accelerated and the gaps in vocabulary size became larger. Thus, distribution of the data in the period of larger vocabulary sizes was sparse in comparison to the distribution of the data at smaller vocabulary sizes.In initial place, SW-T and SW-A showed similar patterns across growth in vocabulary size, illustrating the non-significant interactions of type with vocabulary size. For initial manner, patterns of differences between SW-T and SW-A showed no change over vocabulary size increases. The lack of significant differences between SW-T and SW-A with increases in vocabulary size supports the finding that children at the onset of word use mainly attempt to produce words consisting of sounds they can already produce. However, the significant differences in relative frequencies of fricatives between SW-T and SW-A indicates that children attempt word targets regardless of their phonological capacities for manner of articulation.

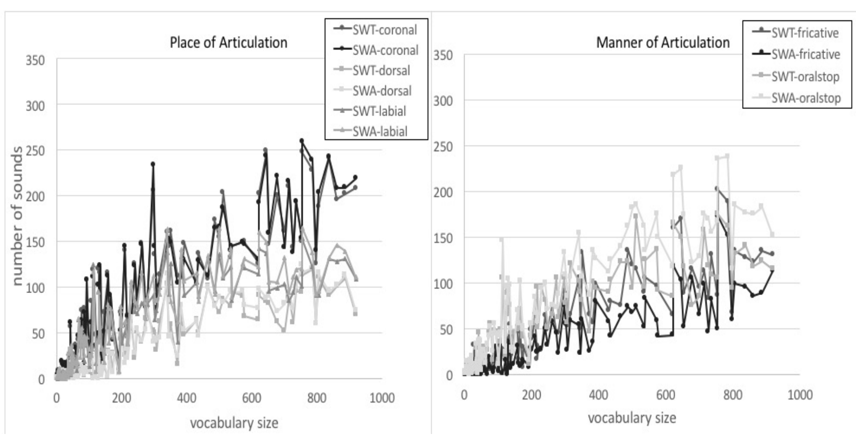

Figure 1 - Frequencies of phonological dimensions of word-initial place of articulation (Left Panel) and manner of articulation (Right Panel) in SW-T and SW-A, as a function of vocabulary growth

3.4 Final word position

We analyzed differences between SW-T and SW-A in word final position across the phonological dimensions of manner and place of articulation. Comparisons between SW-T and SW-A were also evaluated using a generalized linear mixed model (GLMM, See Table 2). An F-test was used to test the overall effect of fixed factors in generalized linear mixed regression effect models. The spontaneous word measure (SW-T vs. SW-A) by final place interaction was significant, $F\ (2,\ 895) = 3.697$, $p = .025$. Pairwise contrasts evaluated with Bonferroni adjusted significance showed that word-final coronal and dorsal showed significant differences between patterns in SW-T and SW-A. Both coronals ($X^2(1, N{=}895) = 40.799$, $p<0.001$) and dorsals ($X^2(1, N{=}895) = 15.632$, $p<0.001$) were more frequent in SW-T than in SW-A. However, there was no significant difference between SW-T and SW-A for word-final labials ($X^2(1, N{=}895) = 4.052$, $p=0.132$). The spontaneous word measure (SW-T vs. SW-A) by final manner interaction was significant, $F\ (1, 595) = 15.922$, $p<0.001$. Oral stops in SW-T were significantly more frequent than in SW-A, $X^2(1, N{=}595) = 19.433$, $p<0.001$. In contrast, there was no significant difference between frequencies of final fricatives in SW-T and SW-A, $X^2(1, N{=}595) = 4.199$, $p=0.081$.

Relative to vocabulary size, there were significant interaction effects of spontaneous word type (SW-T vs. SW-A) with vocabulary growth for both final place, $F\ (1,\ 895) = 32.985$, $p<0.001$, and manner $F\ (1,\ 595) = 15.808$, $p<0.001$. Differences between SW-T and SW-A tended to *decrease* with growth in vocabulary size for both place and manner in final position.

Table 2. Results of the generalized mixed effects negative binomial regression on spontaneous word measures in word final position

	Initial place					*Initial manner*			
	Est[a]	SE	z val	p		Est	SE	z	p
(Intercept)	11.967	0.353	7.02	<0.001	(Intercept)	2.986	0.361	3.03	0.002
vocab	1.010	0.003	4.12	<0.001	Vocab	1.011	0.003	4.08	<0.001
SW-Aplace	0.230	0.157	-9.36	<0.001	SW-Aman	0.479	0.166	-4.44	<0.001
dorsal	0.192	0.132	-12.46	<0.001	oral stop	0.479	0.134	4.96	<0.001
labial	0.163	0.132	-13.73	<0.001	--	--	--	--	--
voca[b]:SW-A	1.002	0.000	5.74	<0.001	voca:SWA	1.002	1.002	3.98	<0.001
SWAdorsal	1.020	0.192	0.1	0.919	SWA:oralst	0.463	0.463	-3.99	<0.001
SWA:labial	1.679	0.191	2.71	0.007	--	--	--	--	--

Est a: exponential estimate; voca[b]: vocabulary

Note: The intercept represents the reference condition: spontaneous word measure was SW-T, and place was coronal or manner was fricative.

Figure 2 illustrates averaged frequencies of SW-T and SW-A respectively across growth in vocabulary size for final place and manner dimensions for all six children. For final place and manner, SW-T and SW-A showed changes with increase in vocabulary size.

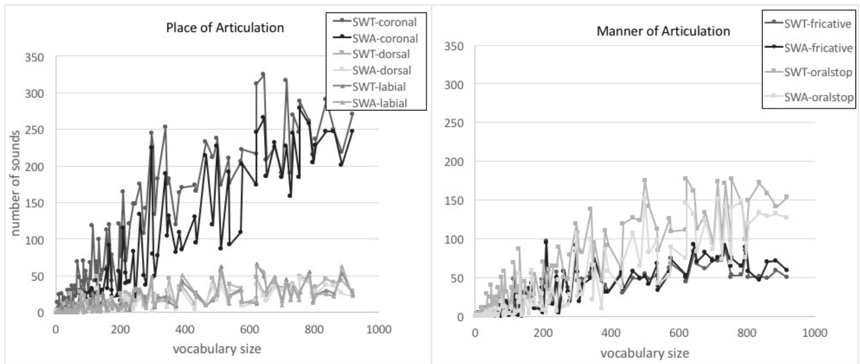

Figure 2. Frequencies of phonological dimensions of word-final place of articulation (Left Panel) and manner of articulation (Right Panel) in SW-T and SW-A, as a function of vocabulary growth

To interpret the significant interaction of word final position between the spontaneous word measure (SW-T, SW-A) with vocabulary growth which is a numerical variable, three pairwise contrasts with Bonferroni adjusted significance at vocabulary sizes of 40, 197 and of 600 were evaluated using ls means package in R (Lenth, 2015). These points were chosen because qualitative changes occurred when the children were producing approximately 40 word types (see Figures 3 and 5 and the discussion above); mean vocabulary size was 197; and 600 was a peak vocabulary level for this group of children.

Final place and manner analyses showed identical outcomes. For final place, when vocabulary size was relatively smaller (40 or 197), differences between SW-T and SW-A were significant (40: $z= 6.461$, $p< 0.001$, 197: $z= 4.474$, $p< 0.001$). When vocabulary size was larger (600), the difference between SW-T and SW-A was not significant, $z= 0.007$, $p =0.994$. For final manner, the differences between SW-T and SW-A were significant at a vocabulary size of 40 ($z= 5.490$, $p< 0.001$, and 197, $z= 3.761$, $p< 0.001$), but not when vocabulary size was relatively large (600) ($z= 0.014$, $p=0.989$). Figure 5 illustrates these results and shows the predicted means for SW-T and SW-A based on the regression with growth of vocabulary size for place and manner in initial and final positions. For word-final position, the significant differences between SW-T and SW-A suggest children do not accommodate their phonological capacities in the words they choose to say. However, the significant interactions of the differences between SW-T and SW-A with vocabulary growth support indicate that vocabulary size impacts how children choose words to say relative to their speech production capacities.

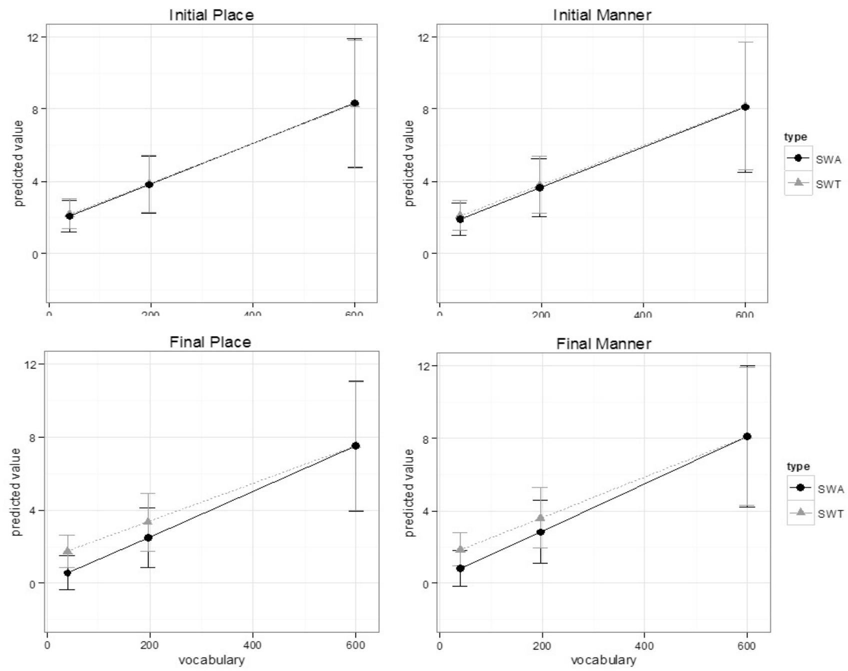

Figure 5. Interaction of word-initial and -final place and manner of articulation with vocabulary size at 40, 197, and 600 word types. Upper panels show predicted values based on the regression models across phonological dimensions for word-initial position; lower panels for word-final position.

To summarize, different overall patterns were observed in initial and final word position. In initial position, there were no significant interactions of spontaneous word measure (SW-T vs. SW-A) with vocabulary size. SW-T and SW-A comparisons revealed no significant differences for place and manner except for fricatives: in word-initial position, fricatives were significantly more frequent in SW-T word than in SW-A. In contrast, in word-final position results revealed a significant interaction between Spontaneous Word measure (SW-T, SW-A) and vocabulary size, for both place and manner. In addition, there were significant differences between final SW-T and SW-A for both place and manner: coronal and dorsal place and oral stop manner were significantly more frequent in SW-T than in SW-A. However, there were no differences between relative frequencies of final labials and fricative manner. Vocabulary growth also interfaced with final position in that there were significant differences between SW-T and SW-A at small (40) and medium (197) vocabulary levels, but no significant differences at large (600) vocabulary levels in this cohort of children.

4. General Discussion

The goal of this study was to consider lexical and/or phonological influences in the types of words typically developing children choose to say during the period of language development before 36 months. To evaluate the relationship of vocabulary size to the words children choose to say, we evaluated vocabulary size rather than a simple measure of chronological age. This study uniquely incorporated statistical analyses of both the children's lexicon and phonological dimensions of description of their production capacities across an extended period of early vocabulary expansion between word onset and 2;11. Overall findings of this longitudinal study indicate a multidimensional explanation for words children produce early in development. Previous studies of spontaneous output have considered much smaller data sets with diverse procedures for data collection and analyses often analyzed descriptively.

In *word-initial position*, there were no significant differences between SW-T and SW-A for phonological place (i.e. labial, coronal, and dorsal) or oral stop manner. As we have argued, a lack of significant differences may indicate that phonological properties are involved in the words these children chose to say in this very early period; the sounds they could produce influenced the word targets they attempted to say. Significant differences in word-initial position between SW-T and SW-A occurred only for fricatives; the number of fricatives was significantly higher in word targets (SW-T) compared to children's actual productions (SW-A). Fricatives are described as later to develop in phonological inventories (Gildersleeve-Neumann, Davis & MacNeilage, 2000), and have also been argued to have a different (and later-specified) status than oral stops in early phonological lexical representations based on perceptual word-recognition experiments (Altvater-Mackensen, Van der Feest & Fikkert, 2014). The outcome of this analysis indicates that children are choosing to say salient words containing fricatives, even though those sound patterns are likely not in their own production inventory; a lexical strategy. Thus, while a phonological strategy may appear to dominate in word initial position in this early period, children are still attempting word targets with initial fricatives, even when they may not actually be able to produce fricatives word initially.

In *word final position*, there was far more variability in factors influencing output patterns. It should be noted when evaluating word final position, that final consonant deletion is a prominent and persisting strategy characterizing children's output. For example, Kim and Davis (2015) found final consonant deletion occurring 22% in CVC word forms in an analysis of 20,255 tokens produced by 10 children from the same database analyzed for this study. In the present analysis, both place and manner dimensions showed significant differences between SW-T and SW-A. In particular, coronal and dorsal place and oral stop manner were significantly more frequent in SW-T than in SW-A word-finally. Thus, these children were attempting word targets (SW-T) containing tongue-engaged sounds (i.e., coronals and dorsals) and oral closure sounds (i.e. oral stops) at significantly higher rates than they actually produce those sounds (SW-A). Coronals and oral stops are described as occurring frequently in English (Maddieson, 1996) and in child inventories (e.g., Davis et. al., 2002); dorsals are not reported as being frequent at the earliest stages (Aoyama, Peters & Winchester, 2010; Stoel-Gammon, 1985). However, all three are present at significantly higher frequencies in these children's word targets than in their actual output in producing word targets. This outcome clearly indicates a lexical strategy, as final consonant deletion and the occurrence of dorsals reflect lack of production system maturity and would not be present in word targets if phonological capacities were dominant in the children's choices of words to say. In contrast, labial place and fricative manner did not show significant differences in word final position between SW-T and SW-A. Labials occur early in children's inventories (McCune & Vihman, 2001). As noted above, fricatives are later-developing sounds. These diverse findings for different components of the phonological system in word final position would profit from exploration of differences observed in children's output in experimental paradigms.

Overall, our results for word final position are less straightforward than the results for word initial position. Several factors may have influenced these outcomes, including final consonant deletion and typical age of mastery of sound types by young children. As a result, word final position is a site of relatively less stability in understanding SW-T and SW-A relationships. Importantly, influences of both phonological (capacities) and lexical (salience) factors can be observed.

Relative to the *interface of vocabulary size* with these results, findings indicate that children's word use before they reached a 50-word productive vocabulary, a high level of variability was apparent in all dimensions of analysis. This result is consistent with earlier literature on the first 50 words in both phonological (Locke, 1983, 1989; Vihman & Croft, 2007) and vocabulary development (Stoel-Gammon, 2011).

Overall, our findings suggests that final position patterns are not predictable based on knowledge of patterns in word initial position. Most studies to date have focused on word-initial position to evaluate the influence of lexical versus phonological factors in early word productions (e.g., Edwards et. al., 2011). Our findings are also consistent with early perception studies, showing that in early word-recognition children may focus more on phonological detail in word-initial than word-final position (e.g., Swingley 2009). However, since CVC monosyllables are the dominant word form in English language input (Maddieson, 1996), both word positions seem cogent to fully understanding lexical-phonological relationships in production.

Several issues arise that should be accounted for in order to interpret all aspects of the multifactorial determinants of these results. In the earliest period of word use, before acquisition of 40-50 word types, our results suggest that neither lexical nor phonological factors clearly dominate. Instability in both words attempted and actual production patterns children used to realize them precludes generalization. After that period, in word initial position, there is more evidence of phonological dominance consistent with Stoel-Gammon (2011) and the earlier proposal by Schwartz & Leonard (1987). In that regard, both production and perception studies of this early period indicate that word initial position is a "stronger" position with reference to use of sound types in the child's production inventory (e.g., Davis et. al., 2002) as well as perceptual access (e.g., Swingley, 2009). In addition, there is more stability over time based on relationships between target word and actual production characteristics and vocabulary growth across the period analyzed in this study.

In contrast, final position shows a contrastive tilt toward a lexical strategy, where children produce word targets largely based on lexical salience rather than production system capacities. Word final position is characterized by less perceptual access and persistence of final consonant deletion as well as a less robust phonetic inventory overall. Use of target words that likely do not match children's production capacities suggests that a lexical strategy consistent with Pierrehumbert's (2001) proposal and Munson et al.'s (2011) assertions for children older that four seems to fit the outcomes of these analyses of younger children.

Our analyses enable a broad picture of relationships between word targets children attempt and their actual realizations across an early period of acquisition of lexical and phonological components of language. However, it does not consider some aspects of early acquisition that effect word choices in this age range. Perception of input frequencies (i.e. word and phoneme frequencies, neighborhood density) and subsequent cognitive processing, including memory, storage, and retrieval capacities based on these input relationships, have been proposed as dominating expansion of the lexicon during this early period (e.g., Storkel, 2009; Storkel & Lee, 2011). Analysis of phonological characteristics of production output might provide an additional dimension to understanding of cognitive processing dimensions of acquisition. Accuracy analysis of word forms might also add precision to understanding the pattern of results. For instance, it is probable that they were accurately matching word forms attempted by the time they had achieved 600 word types. This assertion could be explored in future studies by a longitudinal analysis of accuracy in word final position.

What do these outcomes mean for theoretical constructions of the nature and interactions of lexical-phonological properties in this stage of vocabulary growth? Our results challenge previous studies arguing for an 'either-or' dominance of phonological versus lexical factors. Overall, analyses of this large longitudinal corpus indicates diverse influences on these children's patterns of output across this early period. Considerations of these potential influences are properly interpreted as multifactorial rather than indicating 'either-lexical-or-phonological' approach to word selections in this period.

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