

THE ACQUISITION OF FINAL CONSONANTS

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The open CV syllable is the basic, 'unmarked' syllable type in the world's languages and in the phonological development of children. This paper charts the course of acquisition of final consonants by children acquiring a language rich in such consonants and proposes four major characteristics: (1) The number of different consonant phone types in final position is equal to or less than the number in initial position; (2) fricatives and liquids are more likely than stops and nasals to be acquired first in final position; (3) final velars are more likely to be attempted than non-final velars or final non-velars; and (4) final voiced consonants pose a special problem for children, and some children may make use of nasals in attempting to produce them. These characteristics are systematically related to the occurrence of final consonants in children's babbling, to the distribution of final consonants in the world's languages, and to strength hierarchies proposed for consonants.

INTRODUCTION

The open CV syllable is the basic, 'unmarked' syllable type in the world's languages and in the phonological development of children. Reflecting on the vocalizations of their 13-month-old subjects, Kent and Bauer [1] comment on the "primacy" of the CV syllable shape, which may be viewed as a "simplest form...or a kind of atom in the formulation of speech" (p. 527). Although many languages have syllable-final and word-final consonants and even consonant clusters, these final consonants are much less frequent than initial consonants (both types and tokens). Also, final consonants are of very low incidence in babbling, regardless of the language spoken around the child. The acquisition of final consonants can thus be expected to pose a phonological challenge for children, from either a linguistic-universal or a biological-developmental perspective.

The identification and explanation of constraints on types of consonants occurring in final position in the world's languages constitute a significant part of the total characterization of the phonological structure of human languages ('phonological universals'), and analysis of the phenomena of final consonant acquisition can contribute to this 'universal phonology' ([2]).

Word-initial position is typically the position of greatest consonantal diversity in phonological inventory, though medial position in some languages for some classes of segments may be greater; final position is typically the position of least diversity, though preconsonantal position may be even more limited. These constraints may be expressed in terms of strength hierarchies of optimal syllable-initial segment classes and their mirror image for syllable-final position: stops, fricatives, nasals, liquids, glides, vowels ([3], ch. 10). Such hierarchies are intended to show universal relations, but admit of some language-specific variation. Whatever perceptual, articulatory, cognitive processing, and social/conventional constraints account for those hierarchies may be expected to result also in developmental patterns of order of acquisition and types of substitution and assimilation. Thus it may be expected that final fricatives, nasals, and liquids will not only be more frequent than final stops and occur in languages without final stops, but will also be acquired earlier. The present paper explores the actual phenomenon of acquisition of final consonants in the light of this expectation. English is an especially appropriate language for the investigation since the incidence of initial, medial and final consonants in running text is virtually identical (36% initial vs. 32% each medial and final: [4]). We will restrict ourselves here to the analysis of word- (or vocalization-) final consonants, since syllable-final consonants which are not also word-final are extremely rare in children's early productions.

Final consonants in babbling

Several careful accounts of the phonetic characteristics of babbling have documented the relative rarity of final consonants [1, 5-8]. On the other hand, in an analysis of consonant frequency in the babbling and word production of 10 English-learning subjects, Vihman, Ferguson and Elbert [8] found the mean proportion of final consonants to increase gradually with growth in the children's use of words, ranging from a mean of 6% final consonants early on to 17% when 25 or more words could be identified.

Differences have also been reported in the incidence of different manner categories in initial vs. final position in babbling. Oller et al. [5] reported a 10 to 1 ratio of stops to fricatives and affricates in initial position and a 3 to 1 ratio of final fricatives to stops (based on tokens).

Similarly, deBoysson-Bardies et al. [6] reported a 9 to 1 ratio of initial stops to fricatives and affricates and an 8 to 1 ratio of final fricatives to stops in the babbling of their French subject.

In inventories of consonant types used in babble only a slightly higher proportion of fricative and liquid segments were found in final position (29%) as compared with initial position (22%), based on the true consonant categories of stop and nasal (non-continuant) and fricative and liquid (continuant): [8]. Overall, only 19% of all initial consonants were continuant, while 32% of all final consonants were continuant. As increasing numbers of final consonants began to be used in words, the slight initial bias toward continuants in final position was strengthened.

Recent work on the transition from babbling to speech has strongly demonstrated the continuity in phonetic tendencies across that transition [5, 9, 10]. Accepting Locke's assertion that the beginnings of phonological development antedate the child's first use of adult-based words [9], it is important to consider the process by which final consonants are incorporated into the system in the course of acquiring a language characterized by heavy use of final consonants.

Final consonants in early word use

In general, final consonants are rare in early words, as the finding of continuity from babbling to speech leads us to expect, and the range of occurring segments is correspondingly small. In her longitudinal study of the phonetic inventories of early words for 33 children Stoel-Gammon [11] found that the typical inventory of initial phones tended to be about twice as large as the typical inventory of final phones.

The total incidence of initial and final consonant segment types in words and babble reported in Vihman et al. [8] for two lexical points is given in Table 1. Only 10% of the inventory consonants occurred in final position. While the overall proportion of consonants occurring in words was smaller (40%) than the proportion occurring in babble, a somewhat higher proportion of all final consonants occurred in words (48%). Some growth of consonant use as the children "enter into" English is apparent in the breakdown by lexical stages: At the earliest stage of word use final consonants accounted for only 9% of all consonant segments used, while at the later stage analyzed they accounted for 11%. There are no data available at present comparing consonant incidence in babble and words for other languages. However, the emergent influence of an adult language rich in final consonants appears to underlie these tendencies.

Focus on word-final consonants

Recent work in child phonology has emphasized the individual differences among children learning the same language (e.g., [12]). Differential attention to consonants in final position is one such individual characteristic. Menn [13] described her son Daniel's early phonological strategy as a decision "to disregard almost all information about the initial segments of a stop-final monosyllable" (p.226). Daniel seemed to select his earliest words so as to avoid those with contrasting initial and final consonants; after the first 30 words, he attempted many more words with such a contrast but

Table 1. Incidence of initial vs. final consonant types in babbling and words (based on [4], Table 5).

Initial consonants			
stage ¹	babble	words	
4-word	123	59	
15-word	94	79	
Total	217	138	
Final consonants			
stage ¹	babble	words	
4-word	11	7	
15-word	10	12	
Total	21	19	

¹"Stage" = 4-word point (4+ words used in one session: 10 subjects) and 15-word point (15+ words: 7 subjects). The figures represent the sum of different consonants used 4 or more times by any child in any one of three weekly half-hour sessions.

applied regressive consonant harmony, adapting the initial consonant to the place of articulation of the second. A very similar pattern of development is described for one of three children in Stoel-Gammon and Cooper [14].

Vihman and Hochberg [15] found that of 550 early words used by 7 children, a mean of 25% were sometimes produced with a final consonant. Only two children exceeded the mean. An analysis of the early phonological patterning of one of those children, Molly, is presented in Velleman and Vihman [16], supported by acoustic data. At 12 months Molly began to produce a number of obstruent-final words with heavily aspirated final stops or even affricates (e.g., *oops*, *up*, *hot*, *book*, *peek*, *teeth*). In the following month she began to produce nasal-final words as well, developing an idiosyncratic pattern in which the final nasal of the adult form was lengthened and followed by [i] or [ə]: *bang* [bæŋ:i], *down* [t'æ n:ə]. This pattern appeared to represent a phonetic rapprochement between the obstruent-final words, with their heavy aspiration, and the nasal-final words. Both word patterns subsequently proved highly productive, even attracting new words with nasals or affricates in other positions (*Nicky* [ɛn:i]; *cheese* [(a)Itʃ]). Like the children described in [13] and [14], Molly focused her attention on final consonants, developed a workable production strategy or "word recipe" and then used the patterns arrived at to add large numbers of new words to her lexicon. At present it is not possible to estimate the proportion of normally

developing children who focus on final position, but it is probably not large.

CHARACTERISTICS OF FINAL CONSONANTS

Continuants and final position

Ferguson [17] suggested that "production of fricatives is easiest to acquire in post-vocalic, final position or intervocalically, and may precede the acquisition of stops in these positions" (p.661). We have seen that there is some association of continuancy with final position in babble. In an exhaustive longitudinal study of fricative acquisition by 6 subjects (aged 1;5 to 2;3 at the outset) Edwards [18] found that, as in earlier studies, the fricatives were generally acquired relatively late, after stops and nasals. Most of her subjects tended to produce fricatives correctly most often in final position (especially the interdental, voiceless sibilants, and /v/), though there was considerable individual variation.

Similarly, Stoel-Gammon [11] noted that the inventories of her 15- to 21-month old subjects typically included stops, nasals and glides only, with fricatives and liquids appearing only in the 24-month inventories. Comparing initial and final phones within each manner class, Stoel-Gammon found that presence of a final stop or nasal in an inventory implied the presence of an initial stop or nasal. Fricatives and affricates showed great individual variation. Nine subjects had inventories with initial fricatives preceding final ones, while 7 subjects had inventories with final fricatives preceding initial ones. However, liquids showed a clear-cut association with final position. Of 25 subjects whose inventories contained liquids, only 5 had a liquid in initial position before they had one in final position.

In summary, the evidence (from English data) suggests that liquids are likely to be acquired first in final position, that stops and nasals are likely to be acquired first in initial position, and that fricatives may be too variable for a definite statement.

Velars and final position

Velar obstruents tend to be acquired later than labials and dentals by most children. A few children make relatively high use of velars in their early words, however, and these same children may favor final position. Ingram [19] hypothesized that consonants appearing early in a (child's) word are likely to be anterior, while consonants occurring later in the word will be back. Vihman and Hochberg [15] examined this hypothesis on the basis of data from 7 children. They found that one child used a high proportion of both velar and consonant-final words, but there was no overall correlation between velar and consonant-final word use. Considering stops and nasals only, the children as a group were found to favor initial position less and final position more for velars than for labials and alveolars, though in general the child bias in favor of initial consonants was very strong. Lastly, the children were found to attempt more word-final velars than labials or alveolars, and also more velars in medial and final position than in initial position. However, fully 73% of the adult word-final velars targetted were either produced in non-final position (e.g., *dog* [gɔ:]) or were spread to non-final position as well by

consonant harmony (e.g., *book* [kuk]). Word-final labials and alveolars were less often subject to these changes. Vihman and Hochberg concluded that "while children are attracted perceptually to words with velars in final position, they show no particular preference for producing velars word-finally" (p.46).

Stoel-Gammon [11] found that while the presence of labials or alveolars in an inventory of final phones implies their presence in initial position, in 7 out of 31 cases (25%) velars were present only in final position. As in the case of fricatives among manner categories, velars were found to involve the most individual differences among place categories.

Final voiced stops

The acquisition of voicing appears to present problems for children in general [20, 21]. Some unusual production strategies have been identified for voiced stops in final position. Clark and Bowerman [22] noted that a typical progression in the acquisition of final consonants is (1) omission, (2) production of voiceless stops and nasals, and only later (3) production of voiced stops. Voiced stops may be devoiced in early production attempts, sometimes with distinctive lengthening of the preceding vowel. Clark and Bowerman documented for two children a stage intermediate between (2) and (3), in which final voiced stops were systematically replaced by the homorganic nasals, sometimes followed by the corresponding voiceless stop: *rug* [rʌŋk], *bib* [bɪm] (Damon, aged 1;8-1;10); *egg* [æŋk], *seed* [di:n(t)] (Eva, aged 1;5-1;8). Both children had mastered the production of nasals in both initial and final position and at all three places of articulation before making use of this strategy. It is perhaps worth noting that both children seem to have first applied this strategy to velar-final words, Damon so producing only velar-finals for the first three weeks that the strategy was recorded.

Fey and Gandour [23] reported that their two-year-old English-speaking subject Lasan distinguished between voiced and voiceless obstruents only in the case of final stops. Final voiceless stops were consistently produced with an aspirated release, while final voiced stops were regularly produced with a nasal release: *bad* [bæd̥], *pig* and *big* [bɪg̃]. Fey and Gandour note further that the only continuants to occur finally were nasals, and that the contrasts between stops and fricatives and between alveolars and velars were first made word-finally. Thus Lasan provides another example of a child who chose to focus on word-final position as he expanded his system of contrasts.

It is striking that nasals or nasal release should be used as part of a strategy for producing final voiced stops. This lends further support to the idea of a natural hierarchy of segment classes in a given syllabic position. That is, nasals may be more "natural" in final position than stops, though less so than the continuant consonants.

SUMMARY AND CONCLUSIONS

Study of the acquisition of word-final consonants in English yields the following generalizations.

(1) Word-final consonants are acquired later than initial consonants. At any point in development, the number of different consonant phone types in final position is equal to or less than the number in initial position. However, a few children utilize a strategy of making final position more salient than initial for consonant variety and stability.

(2) Continuants are more likely than non-continuants to be acquired first in final position. Of the continuants, liquids are most likely to be acquired first in final position; fricatives are more variable.

(3) Velar consonants have a special affinity for final position. Final velars are more likely to be attempted than non-final velars or final non-velars.

(4) Final voiced consonants pose a special problem for children, and some children adopt unusual strategies for producing them (e.g., nasal and stop clusters, nasal offglides, vowel lengthening).

These characteristics are systematically related to the occurrences of final consonants in children's babbling, to the distribution of final consonants in the world's languages, and to strength hierarchies proposed for consonants. This systematic relationship is the essence of Jakobson's influential model of phonological development [24,25]. The child language data give further specification to the relationship and also in effect extend the Jakobson model to pre-speech, where he denied its relevance, and to final position, which he did not consider. The evidence for final consonants also strongly suggests that where there is relative infrequency and variability in phonological systems world-wide we may expect to find corresponding patterns of individual variation among children acquiring a particular language.

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