Consonant and syllable frequency effects in stop and fricative acquisition in preschool Drehu- and French-acquiring children

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ABSTRACT

Phonological development is often described as reflecting universal constraints, with some consonants or some consonant-vowel sequences assumed to be mastered earlier than others. Differences in order of acquisition are commonly ascribed to universal constraints on production or perception, reflecting biological specificities. Recent studies suggest, however, that language-specific patterns are also observed. To disentangle universal from language-specific constraints, the present study examines Drehu and French acquisition data on stop and fricative consonants (/t/, /d/, /k/, /g/, /s/, /tʃ/), followed by vowels /i, a, u/. Results show that the relative accuracy of stops and fricatives in [i, a, u] contexts in Drehu and French reflect the modulatory influence of language-specific phonotactics on the perceptual and biomechanical constraints claimed to govern the production of consonant and consonant-vowel combinations.

Keywords: Phonological development, frequency, universal, French, Drehu.

1. INTRODUCTION

Influential approaches in language development explain the course of phonological acquisition as reflecting either universal phonological principles, e.g. Optimality theory [1], or universal biomechanical constraints, e.g. frame dominance theory [2], or idiosyncratic trajectories, e.g. templatic theories [3]. Inheriting from Jakobson's [4] view that a child's early productions are unmarked in structure, phonological approaches suggest that order of phoneme acquisition and evolution of child error patterns can be accounted for by progressive re-ranking of markedness and faithfulness constraints. In this view, unmarked coronals will typically be acquired earlier than marked dorsals, and voiceless stops earlier than voiced stops. This claim is corroborated by data on child acquisition, most of which bearing on the acquisition of English or another (Indo-) European language, showing more accurate production of [t] relative to [k] for instance [5, 6]. Cross-sectional studies of children acquiring Greek [7], Japanese [8], and Drehu or French [9], by contrast, suggest that any tendency to produce coronals more accurately than dorsals is modulated by language-specific frequencies. Biomechanical account of child development might argue that this modulation is not due to consonant frequency per se but is related to universal consonant-vowel co-occurrence patterns due to vocal tract constraints: "fronted frames" and "backed frames" constraints for instance [2]. In other words, consonant accuracy alone is not informative, and should be compared across different vowel contexts. To disentangle universal from language-specific constraints, the present study examines Drehu and French data on stop and fricative consonants in different vowel contexts. Drehu is an Austronesian language, with around 15 000 speakers, mostly spoken on Lifou Island in New Caledonia. Although French is present in the environment of Drehu-acquiring children, Drehu is the dominant language at home and at school on Lifou Island [10]. Rather than observing which consonants are spontaneously produced, this study examines consonant accuracy in a word repetition task. This method aims at better describing the way children generalize over their preferred motor schemes, as described in [3], to produce the ambient language words. This study tests the following two predictions that stem from universal constraint approaches, first, that marked phonemes (such as dorsals, fricatives or voiced consonants) are acquired later, and, secondly, that frame-dominant (such as [ti, di, si] or [ku, gu]) are mastered before non-frame dominant sequences (such as [tu, du, su] or [ki, gi]). These predictions are compared with frequency accounts, according to which consonant or syllable frequency might influence consonant accuracy.

2. METHODS

2.1. Children recording

A total of 158 monolingual French-acquiring and 48 Drehu-acquiring children (in bilingual Drehu-French environment) have been recorded (French: 41 2-year, 41 3-year, 40 4-year, 40 5-year olds; Drehu: 14

3-year, 16 4-year and 18 5-year olds). Word-initial consonant-vowel sequences were elicited in a picture-prompted word-repetition task, as in [9]. In this study, we focus on the following 6 target consonants: /t/, /d/, /k/, /g/, /s/, /tʃ/, followed by vowels /i, a, u/. Data are missing for /du, gi, tʃi/ in French and for /di, du/ in Drehu. Supplementary data are available for /ʃa, ʃi, ʃu/ in French. The words were chosen to be as frequent as possible in each language. Each syllable occurred in three different words. Target sounds were transcribed by native speakers. Parts of the corpora were retranscribed by two independent transcribers. In (rare) cases of disagreement, the data were not included.

2.4. Frequency data

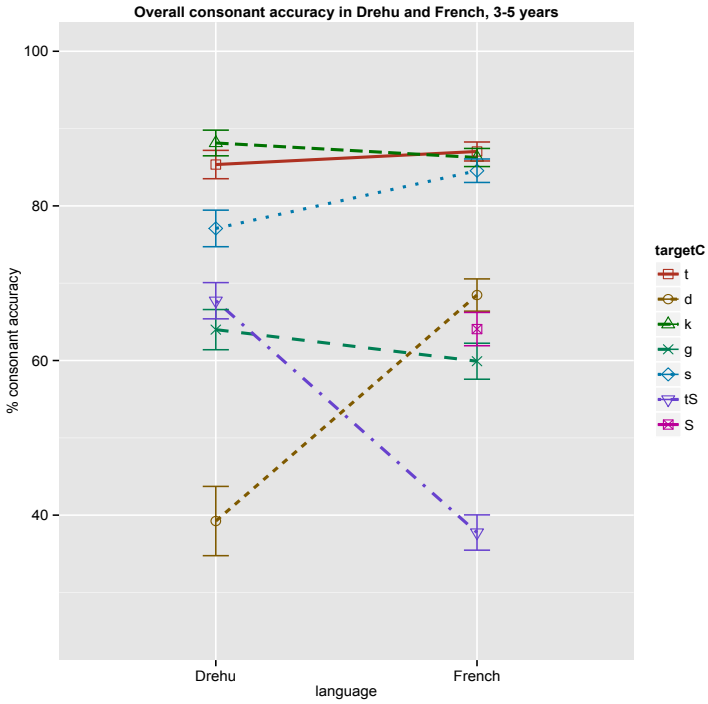
Type frequency data in content words were obtained from recordings of adults speaking to 2-year olds in French and in Drehu. More information on these corpora and their analyses is given in [11]. Frequencies were calculated for consonants (C) as well as for consonant-vowel syllables (CV). Note that /tʃ/ is rare in French and has a low frequency in adult lexicons [12]. In the French CDS corpus, /tʃ/ was in fact absent. Syllable [gu] was also absent. Similarly, [ti] and [da] were absent from the Drehu CDS corpus. Therefore [tʃi, tʃa, tʃu, gu] in French and [ti, da] in Drehu are not taken into account in the correlation analyses below (Table 1).

3. RESULTS

3.1. Overall consonant accuracy in Drehu and French

Mean consonant accuracy for Drehu and French are presented in Fig. 1, for all vowel contexts, and for 3 to 5 year olds grouped together (data not available for Drehu-acquiring 2-year olds). Note that /ʃ/ accuracy is added to the graph for French, although it is not taken into account in the statistical analyses, as Drehu children did not produce this consonant. Mean accuracy across the 6 target consonants for all 3- to 5- year olds is similar in the two languages (74.13% (sd: 29.45) in Drehu vs. 73.72% (sd: 33.48) in French). Individual consonant accuracies show language-specific trends, however. A linear mixed model analysis was carried out, with Language as a between-subject factor and Consonant as a within-subject factor, for children aged 3 to 5 years. Consonant and Language x Consonant interaction are significant (Consonant: $F(5, 2348) = 149.77$, $p > 0.001$; interaction: $F(5, 2348) = 34.51$, $p < 0.001$). These data suggest that the order of consonant acquisition is the following in Drehu: /k, t/ > /s/ > /tʃ, g/ > /d/ (all contrasts significant). In French, a different order is observed: /t, k, s/ > /d/ > /g/ > /tʃ/ (all contrasts significant). Further Student tests show that for /d/, French-acquiring children are significantly more accurate than Drehu-acquiring children, whereas for /tʃ/ the reverse pattern is observed. In summary, Drehu dorsal /k/ is not mastered later than its unmarked counterpart /t/. In French, marked dorsal /k/ and sibilant /s/ are not mastered later than unmarked /t/. Some fricatives are mastered earlier than some stops: in Drehu, /s/ and /tʃ/ before /d/; in French, /s/ before /d/ and /g/.

Figure 1: Mean consonant accuracy for Drehu- and French-acquiring children, aged 3 to 5 years



3.2. Evolution of mean consonant accuracy with age

The evolution of consonant accuracy is shown in Fig. 2, from 2 to 5 years in French and from 3 to 5 years in Drehu. First, overall accuracy in all 6 target consonants increases with age (French: from 48.52% in 2 year olds to 79.71% in 5 year olds, Drehu: from 65.91% in 3 year olds to 80.37% in 5 year olds). Secondly, the language specific pattern described above is maintained during development. Thirdly, only [t] and [k] in Drehu and [t], [k], and [s] in French are fully mastered (>75% accuracy) in 3 year olds. Finally, in 5 year olds, accuracy is above 75% in all consonants but [d] in Drehu and [tʃ] in French.

3.3. Vowel context effect

Fig. 3 displays mean accuracy for the target consonants in each vowel context, as a function of CV frequency in each age group.

In both languages, consonant accuracy is modulated by vowel context. In Drehu-acquiring children, fronted frames (as referred to in [2]) are not more accurate than their non frame-dominant counterparts ([ti] not significantly higher than [tu]; [si] not significantly higher than [su]). In French-acquiring children, some fronted or backed frames are not more accurate than non frame-dominant counterparts ([ti] is significantly lower than [tu]; [gu] is not significantly higher than [ga]). A linear mixed model analysis was carried out for children aged 3 to 5 years. Syllable ($F(13, 2119) = 71.22$, $p > 0.001$) and Language x Syllable ($F(13, 2119) = 13.21$, $p > 0.001$) are significant. Significant differences are observed, with [gu], [tʃi], [tʃa] more accurate in Drehu and [da] more accurate in French.

3.4. Frequency effects

The relationship between consonant accuracy in each CV and CV frequencies in each age group is shown in Fig. 3. Accuracies are plotted for /ti, da/ in Drehu and /tʃi, tʃa, tʃu, gu/ in French, but they were not taken into account in the correlation analyses (see 2.4): correlation lines include these data, but reported r coefficients and p values do not. Table 1 provides correlation between consonant accuracy in each CV and available CV frequency as well as between C accuracy and available C frequency in each language, for each year. In Drehu, correlations with CV frequency are significant (or near significant) in each age, whereas correlations with C frequency are not. In French, all correlations, except with C frequency at 5 years, are significant. In summary, in both Drehu and French, the results show that the more frequent a CV syllable is, the more accurate the consonant is produced in that vowel context, whatever the age. In younger French-acquiring children, the correlation with consonant frequency itself is significant and higher than the correlation with C frequency. These correlations suggest that the lower frequency of [ti] relative to [tu] (in both languages) or of [gu] relative to [ga] (in French) might explain the lower accuracy of [t] in the front context or of [g] in the back context. Similarly, lower frequencies of [gu], [tʃi] and [tʃa] in French relative to Drehu, might explain their lower accuracy in French relative to Drehu. Finally, the lower accuracy of [da] in Drehu relative to French can be related to its lower frequency in Drehu.

4. DISCUSSION

These results first show that overall accuracy for the 6 stops and fricatives of interest is similar in French and Drehu-acquiring 3- to 5- year olds. The order of consonant acquisition differs in the two languages, however. Some consonants are mastered earlier in one language than the other. The earlier-acquired consonants are not always the unmarked ones. For instance, marked consonant /k/ is not mastered later than its unmarked counterpart /t/ in both Drehu and French. In addition some fricatives are mastered earlier than some stops. This suggests that phoneme markedness alone cannot account for these data.

Table 1. Correlation between consonant accuracy and C or CV frequency in Drehu and French at all ages

	Drehu	**Drehu**	**French**	**French**
	CV frequency	C frequency	CV frequency	C frequency
2 year			$r = 0.54$, $p = 0.038$	$r = 0.73$, $p = 0.002$
3 year	$r = 0.67$, $p = 0.024$	$r = 0.39$ $p = 0.237$	$r = 0.58$, $p = 0.022$	$r = 0.73$, $p = 0.002$
4 year	$r = 0.55$ $p = 0.081$	$r = 0.70$, $p = 0.699$	$r = 0.6$, $p = 0.017$	$r = 0.67$, $p = 0.006$
5 year	$r = 0.62$, $p = 0.041$	$r = 0.31$, $p = 0.348$	$r = 0.7$, $p = 0.003$	$r = 0.2$, $p = 0.457$

It has been argued that vowel context should be taken into account when examining consonant accuracy, with some intrasyllabic co-occurrences being more favored than others [2]. These co-occurrences are claimed to be reflective of constraints emerging from mandibular oscillation cycles. Consonant accuracy was therefore examined taking account of frame dominance. The results reveal that, in both Drehu and French, some fronted or backed frames are not more accurate than their non frame-dominant counterparts. Our data therefore suggest that frame-dominance constraints do not fully explain French and Drehu acquisition. Correlation analyses suggest that the relative accuracy of stops and fricatives in [i, a, u] contexts increases with ambient language CV frequency. This suggests that language-specific phonotactics play an influential role in phonological development and modulate the phonological and biomechanical constraints claimed to govern children production of consonant and consonant-vowel combinations. In younger French-acquiring children, the correlation with C frequency is higher than that with CV frequency. This could mean that consonant accuracy is better explained by C frequency than by CV frequency in French. Ongoing analyses of error patterns examine how place, manner and voicing are affected in different vowel contexts. This could shed further light on the relative influences of consonant vs. consonant-vowel frequency.

Figure 2. Growth in mean consonant accuracy for Drehu- and French-acquiring children

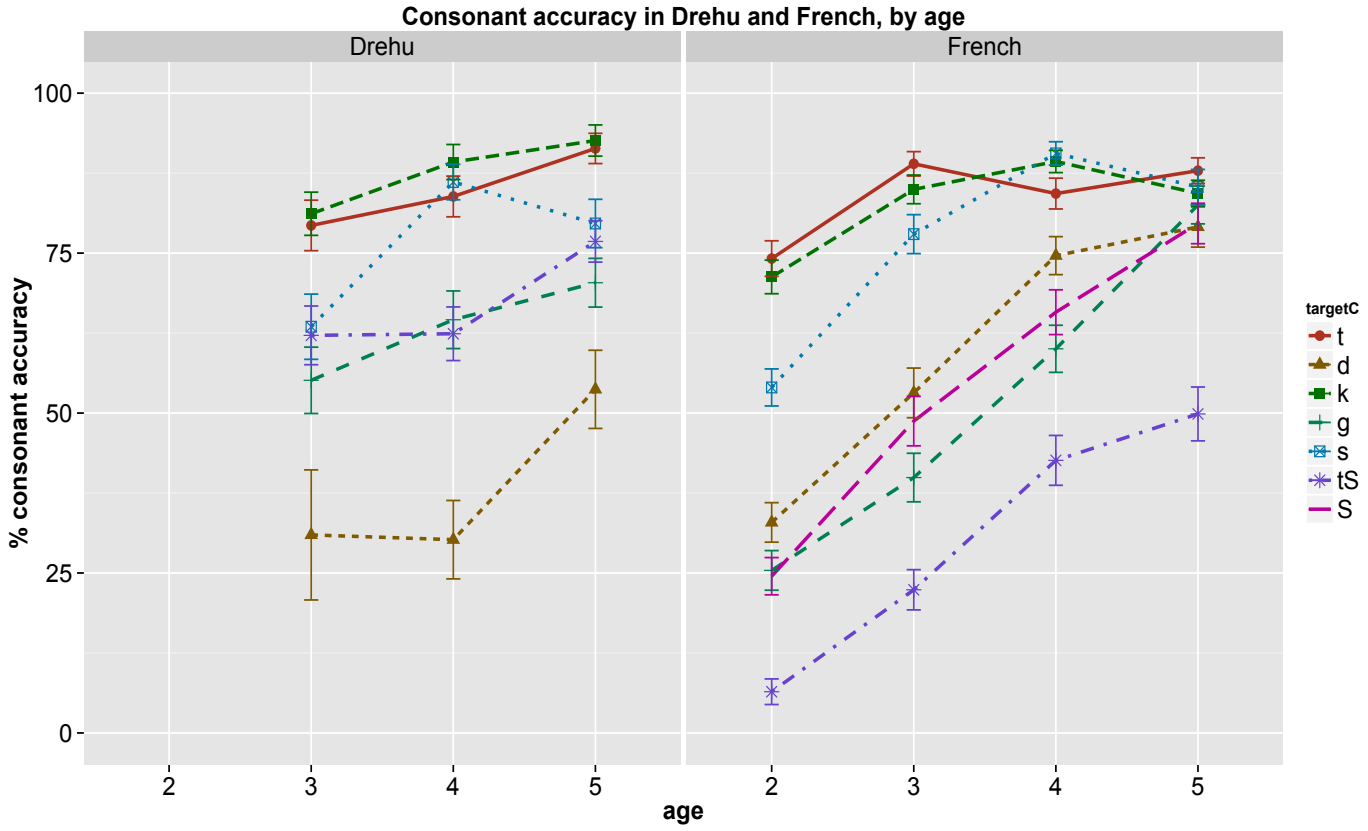
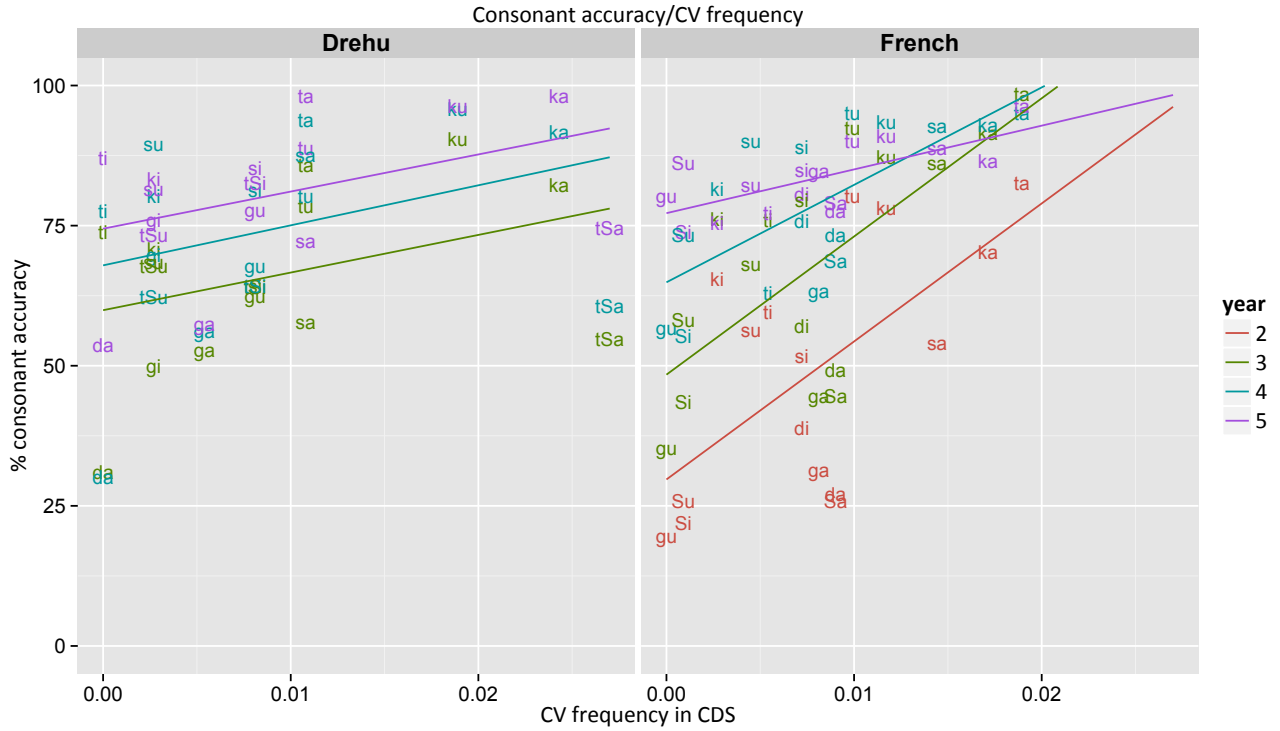


Figure 3. Consonant accuracy by CV frequency, for Drehu-acquiring 3- to 5-yr and French- acquiring 2- to 5-yr-olds.



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