

ARTICULATORY GENERALIZATIONS IN ACOUSTIC PHONETIC RESEARCH: A COMPARISON OF DATA FROM FRENCH AND ENGLISH

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ABSTRACT

Simultaneous articulatory and acoustic data were recorded for 21 French speakers and 20 English speakers uttering phrases containing the coronal consonants /t,d,n,l,s,z/. It was found that, in both languages, individual variation in articulation of these consonants makes it difficult to make precise language-specific generalizations in terms of both place of articulation and apicality. The formant patterns in the acoustic signal, however, are much more homogeneous and suggest that the difference in consonant production in these two languages lies more in the general shape of the tongue body behind the constriction than in the placement of the constriction itself.

1. INTRODUCTION

The coronal consonants of French and English have been claimed to be articulated differently in terms of place of articulation and apicality. For example, French coronal stops are regularly described as dental, either with the tip of the tongue on the upper incisors (apical), or with the tip down behind the lower incisors and the blade making contact (laminal). English coronals, on the other hand are usually said to have an apical alveolar constriction. Such information forms the basis not only of foreign language pronunciation instruction, but also of acoustic phonetic analysis, where data from acoustic recordings of speakers of the same language are assumed to originate from a homogeneous set of articulations. The present study seeks to

discover to what extent the articulation of an individual can be predicted by language community affiliation. Is the precise point of articulation as given on a traditional consonant chart really crucial to the pronunciation of a given language or are there other factors which are more important?

The articulatory data presented here is in the form of palatograms and linguagrams taken by the direct method to ascertain the point of contact on the upper surface of the vocal tract, as well as the part of the tongue used to make the constriction. Audio recordings were also made synchronous with the palatograms and linguagrams, in order to be certain that each given acoustic signal corresponded to an articulation with known articulatory characteristics. Data from 21 French speakers (northern standard pronunciation) and 20 English speakers (west coast American) were recorded of the consonants /t,d,n,l,s,z/ in both word-initial and word-final position, in the environment of a low vowel ([æ] in English, [a] in French).

2. ARTICULATORY DATA

Place of articulation was determined from the palatograms in the manner described in detail in Dart [2], briefly as follows: if the vertical surface of the back of the upper central incisors was contacted, either completely or partially, the articulation was called *dental*; *alveolar* articulations were those where the most forward part of the contact was in an area extending from the base of the teeth to approximately 5 mm back; and

articulations made behind this area were called *postalveolar*. The linguagraphic categories into which the data were sorted are *apical*, where only the tip and rim of the tongue were contacted; *laminal*, where only the blade made contact; and *apicolaminal*, where both the tip and blade were contacted. The fricatives were classified as either *apical* or *laminal*, depending upon whether the tip or only the blade was contacted. Table 1 below gives the results of the articulatory study.

tokens which are not dental. Clearly, a number of French speakers articulate farther back than was previously supposed.

The point of view of the sources consulted on fricative articulation was more open to variation, with both dental and alveolar articulations mentioned (although only one source allowed for both possibilities). Most sources, however, stated quite firmly that French /s/ and /z/ were laminal. It is clear from

Table 1. Percent of the total number of tokens for each place of articulation and apicality classification. A= apical, L= laminal, AL= apicolaminal.

French		/t,d,n/			/s,z/		/l/		
dental		6.3	12.7	39.7	15.8	26.3	2.4	---	2.4
alveolar		13.5	16.7	11.1	7.9	30.3	69	2.4	---
post-alveolar		---	---	---	7.9	11.8	23.8	---	---
		A	L	AL	A	L	A	L	AL
English		/t,d,n/			/s,z/		/l/		
dental		6.7	6.7	4.2	20	2.5	34.2	2.6	13.2
alveolar		59.6	5	12.6	22.5	31.2	31.6	---	15.8
post-alveolar		5	---	---	---	23.8	2.6	---	---
		A	L	AL	A	L	A	L	AL

It is clear from the table that the greatest number of French speakers produced an apicolaminal dental articulation for /t,d,n/. This accords with the claims in the literature that these segments are apical dental, it being difficult for a speaker with normal dentition to produce a purely apical dental, without the blade of the tongue also contacting the alveolar ridge. Some authors have also claimed tip-down laminal dental articulation for these segments and 12.7% of the data support this. There remain, however, 41% of the data left unaccounted for, that is all those

the table that, although the majority of tokens were indeed laminal, still nearly a third were apical, and thus not accounted for by the descriptions.

In English, 59.6% of the data for /t,d,n/ are, indeed, apical alveolar as predicted. 11.7% of the tokens are also apical, but either dental or postalveolar, and 17.6% are also alveolar, but use a different part of the tongue. A total of 17.6% of the tokens are dental and 28.5% are either laminal or apicolaminal.

The fricatives /s/ and /z/, usually said to be either apical or laminal alveolar in English, were indeed divided between

these two ways of articulating, the laminal predominating with over half (57.5%) of the tokens. Again, most of the tokens were alveolar or postalveolar (77.5%).

As it turns out, the English laterals are far more likely to be dental than their French counterparts, going against the neat organization of the consonant charts, which usually put /t,d,n,l,s,z/ in the same column. Exactly half of the /l/ tokens were dental in the English data (as compared to 4.8% of French tokens), in spite of the general acceptance in the literature that such English segments should be alveolar, just as the French are assumed to be dental. Even the apical articulation of the lateral, which was nearly universal for the French speakers (95%) was less strong in English (68%), the quintessential "apical" language. It seems, then, that /l/ need not necessarily share the articulatory characteristics of the other coronal consonants in any given language.

The articulatory data thus shows that, although the articulation of these consonants may be predicted in a general way for the majority of speakers, the variation is such that one cannot assume an articulation to be of a certain type only on the basis of the native language of the speaker.

3. ACOUSTIC DATA

Formant transition frequencies were measured from wide band spectrograms for all tokens: for the word-initial tokens immediately after the closure, and for word-final tokens immediately before the closure. To normalize for absolute frequency differences between speakers, the difference was calculated between the transition formant values and the average steady-state formant values of the adjacent vowel. The resulting number was used for comparison rather than the raw formant frequencies. The formant values of the steady-state vowel were comparable between the two languages except for the value of the second formant, which was higher in English.

Two general differences between

French and English articulation were noted: the value of the F1 transition in French was always lower in relation to the steady-state vowel than the corresponding English value for all the coronal consonants, no matter what method of articulation was used. Similarly, the transition value of F4 was always higher in French than in English. These differences suggest different tongue shapes behind the constriction in the two languages. A lower F1 could indicate a wider pharyngeal cavity and a higher F4 a smaller sublingual cavity in front for French. In addition to these general characteristics, a specific tongue shape difference between apical alveolar articulations in the two languages was inferred from the formant data, particularly in fricatives. French apical alveolar fricatives have lower transitional F1 values and higher transitional F2 values than do apical dental fricatives, whereas the reverse is true for English. Similarly, French apical consonants have higher F2 values than laminals, whereas in English F2 is higher in laminals.

One interpretation of these facts would be to posit a differently shaped tongue behind the constriction in the apical and alveolar articulations in the two languages. The F1 and F2 evidence suggests that the body of the tongue in French is high and forward during these consonants, thereby diminishing the area of the cavity directly behind the constriction and enlarging the pharyngeal cavity. The English apicals, on the other hand, would come up to the constriction from a lower and more posterior position in the mouth, thus creating a larger cavity behind the constriction and a more constricted pharynx. Both kinds of apical alveolar articulations can be seen in the x-ray literature, as exemplified by the two tracings in Figure 1. The tracing on the top is of French /s/ (after Bothorel et al. [1]) and resembles an apical alveolar tongue position like that posited for the French speakers, and the tracing on the bottom is of English /s/ (after Subtelný et al. [3]), and has a descending tongue

shape as posited for the English speakers in the present study.

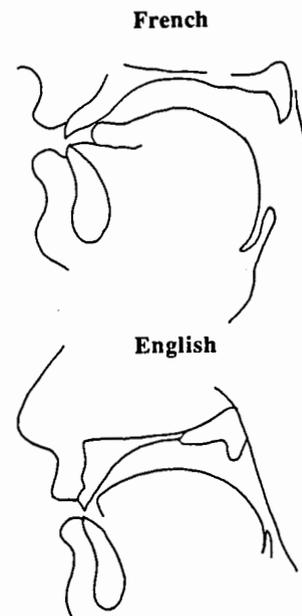


Figure 1. X-ray tracings of French (after Bothorel et al [1]) and English (after Subtelný et al [3]) showing two different tongue shapes in apical alveolar /s/.

In order to explore the possibility of such an articulatory difference as that suggested by the acoustic data, additional articulatory measurements were taken from the palatographic data in conjunction with palate casts from each speaker. It was presumed that a higher tongue position would show up on the palatograms as a wider contact area behind the constriction and, indeed, such a difference seemed to be evident from the palatograms. Accordingly, the contact area from each articulation was measured inwards from the base of the first molar and this measurement given as the ratio of the contact area on one side to half of the total distance following the curve of the palate from first molar to first molar. These measurements were shown to be

significantly larger in French by one factor, repeated measures analyses of variance for all apical and alveolar stops, nasals and fricatives.

4. CONCLUSION

With the abovementioned facts taken together, there appear to be language-specific characteristics affecting the formant values, which are associated with vocal tract shapes that are not fully specified by simply characterizing the segments in terms of the articulatory contact involved. The difference between French and English coronal consonant production, rather than being one of place of articulation and apicality, would seem to be better described as a difference in the overall shape given to the tongue body in the two languages.

5. REFERENCES

- [1] Bothorel, A., P. Simon, F. Wioland and J-P. Zerling (1986), "Ciné-radiographie: des voyelles et consonnes du Français", Strasbourg: Institut de Phonétique.
- [2] Dart, S.N. (1991), "Articulatory and acoustic properties of apical and laminal articulations", UCLA PhD dissertation, *UCLA Working Papers in Phonetics* 79.
- [3] Subtelný, J.D., N. Oya and J. Subtelný (1972), "Cineradiographic study of sibilants", *Folia Phoniatrica* 24, 30-50.