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Voice onset time in two French dialects

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Abstract: Caramazza, Yeni-Komshian, Zurif & Carbone (1973), have shown that voice onset time is not sufficient as a phonological cue for Canadian French speakers to make a categorical distinction between the voiced and voiceless forms of stop consonants. The present study was an attempt to determine if this fact could be generalized to other French dialects or if the particular nature of Canadian French could be ascribed to the peculiar development of a language in contact (with Canadian English in this case). The obtained results suggest that, unlike the case of Canadian French, voice onset time is phonemic in French. Further the pattern of results obtained for French, Canadian French and Canadian English could be explained in terms of an hypothesis of linguistic change.

Lisker & Abramson (1964) have demonstrated that voice onset time (VOT), that is, the temporal relationship between changes in the glottal aperture and supraglottal gestures, is a sufficient cue for the phonemic distinction of the voiced from the voiceless stop consonants in various languages. In a recent study (Caramazza, Yeni-Komshian, Zurif & Carbone, 1973), however, it was observed that in Canadian French VOT is not a sufficient cue to separate the voiced from the voiceless stop consonants. The question can be asked whether the results obtained in this latter study can be generalized to all French speaking communities or whether it is restricted to Canadian French. That is, it might be the case that these results cannot be generalized to other instances of French and that instead they reflect a peculiar situation due to the deviant historical development of a language in contact (Weinreich, 1954).

In the Caramazza *et al.* study the perception and production of bilabial, alveolar and velar stop consonants in Unilingual Canadian French (UCF), Unilingual Canadian English (UCE), and French English Bilingual (FB and EB) speakers were investigated. Perception was assessed by having subjects label synthetic speech sounds that differed in VOT, while spectrographic analyses of spoken stop-initial words were used to assess production. The perceptual functions for the three homorganic consonant pairs are presented in Fig. 1 for the UCF group and Fig. 2 for the UCE group. In each of these figures the percentage of "voiceless" responses (p, t and k) is plotted as a function of VOT.

The three curves for the UCF group are characterized by a non-monotonic function (with a "peak" near zero VOT and a "dip" within the range of 10 to 15 ms voicing lag). The UCE functions instead, are clearly monotonic and with clear cross-over boundaries. A schematized relationship between UCF and UCE perception curves is shown in Fig. 3.

It can be seen from Fig. 3 that the upper end of the UCF curve tends to approach the

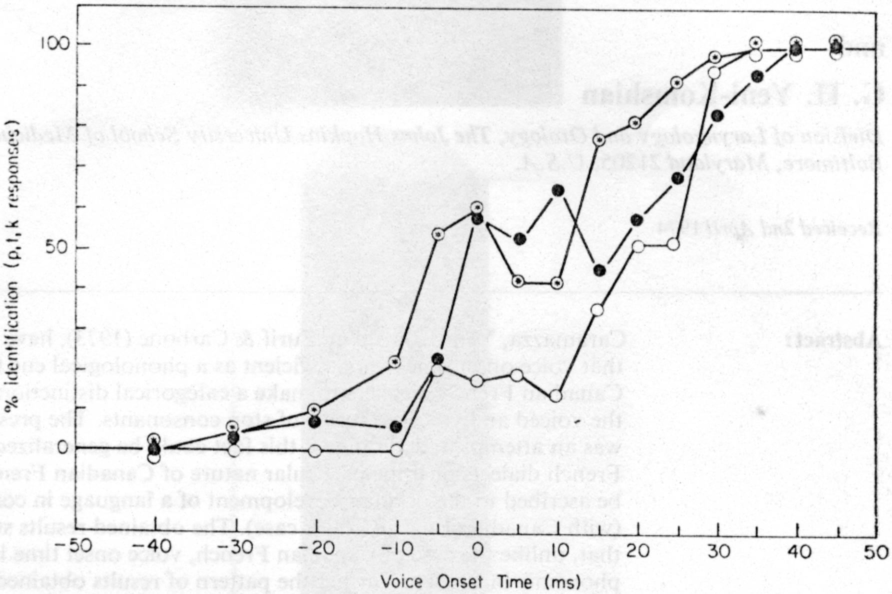

Figure 1 Perceptual identification of stops as a function of VOT by Unilingual Canadian French (UCF) speakers. ⊛—⊛, /b/ *vs.* /p/; o—o, /d/ *vs.* /t/; ●—●, /g/ *vs.* /k/.

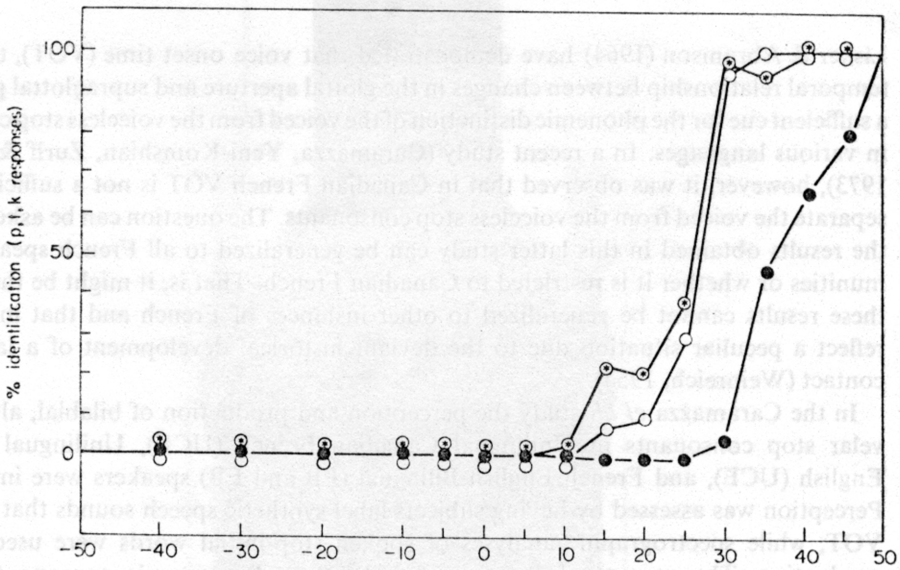

Figure 2 Perceptual identification of stops as a function of VOT by Unilingual Canadian English (UCE) speakers. ⊛—⊛, /b/ *vs.* /p/; o—o, /d/; *vs.* /t/ ●—●, /g/ *vs.* /k/.

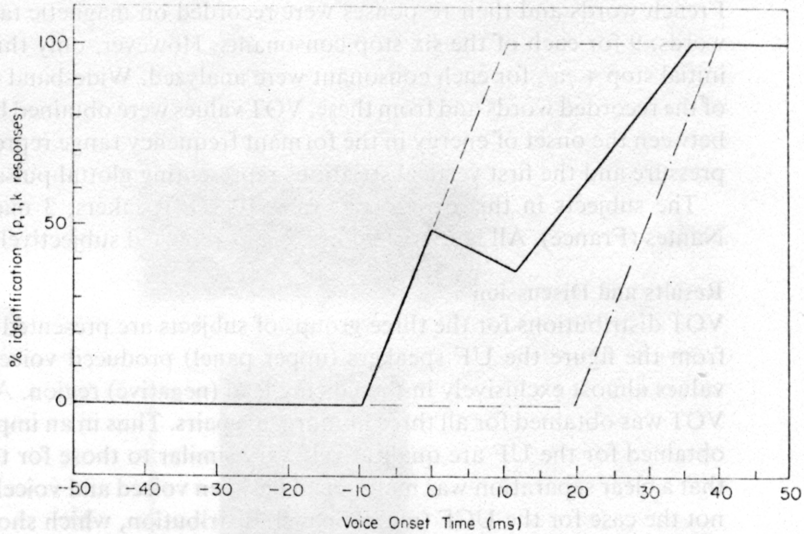

Figure 3 Schematized hypothetical relationship of the perceptual identification of stops as a function of VOT for Unilingual Canadian French (UCF), Unilingual Canadian English (UCE) and Unilingual French (UF). ---, UF; —.—, UCE; —— UCF.

UCE curve while the initial segment of the curve if allowed to increase linearly would produce a curve with a cross-over boundary on the VOT continuum at around zero ms. From this it might be proposed that if VOT is phonemically functional in French, then it should have a clear cross-over boundary at about zero. In addition we can account for the peculiar shape of the UCF curves by the suggestion that the influence of Canadian English on Canadian French has contributed to the shift of VOT values in the direction towards the range usually occupied by English. If this interpretation is correct, then, it can still be the case that VOT is phonemic in French and the irregularities in Canadian French can be accounted for in terms of linguistic change. This, of course, does not resolve the problem of establishing the phonological cues for discriminating the voiced from the voiceless forms of stop consonants in Canadian French. It does however point to some interesting properties of historico-geographical factors in linguistic change.

A direct test of the linguistic change hypothesis is not possible but we can test whether Unilingual speakers of a dialect of French (UF) which has not been in contact with English will produce stop consonants with VOT values in the hypothesized range or in the range occupied by UCF speakers. Thus the relevant information is the relative location of the phonemic cross-over boundary for UF speakers in relation to UCF and UCE speakers. Ideally we should compare both perception and production of stop consonants. Unfortunately, however, we were unable to obtain the relevant data on the perception of stop consonants for the UF speakers. Experimentally, then, what we did was to compare the production of stop consonants in a group of UF speakers against a group of UCF and a group of UCE speakers. We already had data on UCF and UCE speakers (Caramazza *et al.*). For this study we collected additional data on 10 UF speakers.

Procedure

The experimental procedure for the production of the stops was identical to that reported in Caramazza *et al.* Subjects were required to read aloud a set of common stop-initial

French words and their responses were recorded on magnetic tape. Each subject read 54 words, 9 for each of the six stop consonants. However, only three words, those with an initial stop + /a/, for each consonant were analyzed. Wide-band spectrograms were made of the recorded words and from these, VOT values were obtained by measuring the distance between the onset of energy in the formant frequency range representing the release of air pressure and the first vertical striations representing glottal pulsation.

The subjects in this experiment were 10 UF speakers, 3 males and 7 females, from Nantes (France). All had normal hearing as reported subjectively.

Results and Discussion

VOT distributions for the three groups of subjects are presented in Fig. 4. As can be seen from the figure the UF speakers (upper panel) produced voiced consonants with VOT values almost exclusively in the voicing lead (negative) region. A clear separation at zero VOT was obtained for all three homorganic pairs. Thus in an important respect the results obtained for the UF are qualitatively very similar to those for the UCE (lower panel) in that a clear separation was maintained between voiced and voiceless consonants. This was not the case for the UCF (middle panel) distribution, which showed a substantial degree of overlap between voiced and voiceless consonants. This overlap is not an artifact due to averaging across subjects since it was observed also within subjects.

A more detailed statistical analysis was carried out comparing the UF to the UCF distributions. Parametric statistical techniques could not be used to analyze the VOT values for the voiced consonants because of the markedly discontinuous distributions obtained for the UCF speakers. However, chi-square tests comparing the UF and UCF speakers on the frequency of voicing lead to voicing lag VOT values for the words starting with "voiced" consonants (Table I) yielded significant results for all three consonant types at well beyond the 0·001 level. For all three consonant types the UF group had a significantly larger proportion of voicing lead than the UCF group. An analysis of variance comparing the means of the three types of voiceless consonants (Fig. 5) between the same two groups again revealed a significant difference with UF speakers having significantly shorter voicing lag than the UCF speakers.

Table 1 Frequencies of lead and lag VOT values for voiced consonants for Unilingual Canadian French and Unilingual French

	/b/		/d/		/g/	
	UF	UCF	UF	UCF	UF	UCF
Lead	26	10	29	15	29	13
Lag	3	20	1	15	1	17

Thus it would seem that UF and UCF speakers differ in quite a substantial way in their production of stop consonants. Most important of all, however, is the fact that our prediction of a zero cross-over boundary for UF speakers was upheld. These results suggest that, unlike the case of UCF speakers, VOT can be phonemic for UF speakers. The clearly separated VOT distributions for the voiced and voiceless consonants for the UF group strongly support this latter inference. Secondly, the fact that the cross-over boundary was at the zero VOT point as predicted would tend to support the linguistic change hypothesis. It should be remembered that this study is not a direct test of the process of linguistic change, but the formulated hypothesis can account fairly well for the pattern of data obtained for the three groups of subjects.

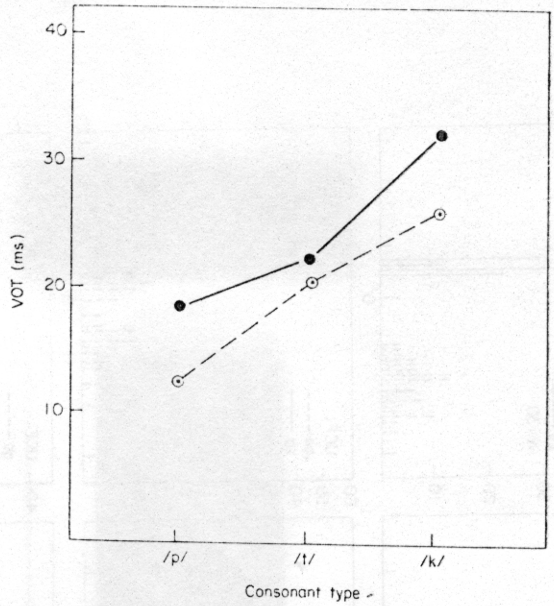

Figure 5 Mean VOT values for production of voiceless stops in Unilingual Canadian French (UCF), ●—●; and Unilingual French (UF), ⊛---⊛.

The relationship between the two French dialects can be described as follows: Canadian French and French (France) were initially identical in their use of VOT as a phonological cue for the separation of stop consonants into the voiced and voiceless phonemes. The present difference is to be accounted for by the different historical developments of the two dialects. In the case of French (France) its development was *not* heavily influenced by contacts with English. Canadian French, on the other hand, developed in constant contact with English. It is the influence of this contact that has produced the observed changes in Canadian French.

If this explanation is accepted it raises another important question. Was the change unidirectional, affecting only Canadian French and not Canadian English, and if so, why? A superficial comparison of our data for UCE speakers with the data obtained by Lisker & Abramson (1964) on American English shows that there is no appreciable difference for the three stop consonant pairs between these two dialects. It would thus seem that the change was most probably unidirectional. There are a number of factors that may account for this situation. One of these is a geopolitical one: Canadian French is an island in a sea of English. English speakers in Quebec have greater mobility and in addition are in constant contact with the rest of English speaking North America. The Canadian French, on the other hand, are geographically isolated. A more important reason, however, may be the relative socio-economic status of the two languages, and their respective communities, in the past 200 years. English has been the dominant language culturally, socially and economically while French has had an inferior status (Lambert, 1969). These historico-geographical factors have no doubt played an important part in the transformation of Canadian French to the language it is today.[1]

To conclude, then, it has been suggested that VOT is a sufficient phonological cue for

[1]See M. Chen (1972) for a theoretical account of the influence of these factors on phonological change.

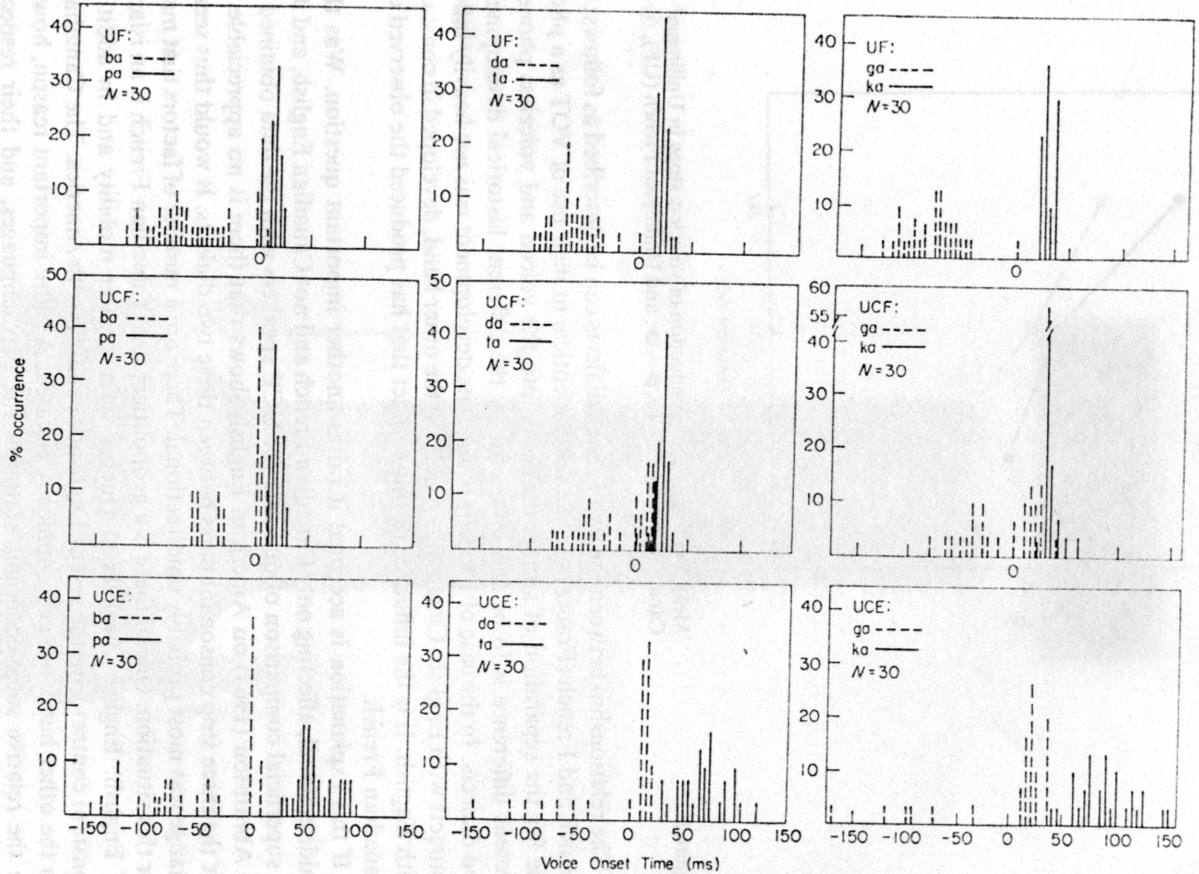

Figure 4 VOT distributions for the production of stops by Unilingual Canadian French (UCF), Unilingual Canadian English (UCE) and Unilingual French (UF).

the distinction of the homorganic stop consonant pairs in French (France). We have also proposed an explanation for the observed difference between French and Canadian French based on a linguistic change hypothesis.

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References

Caramazza, A., Yeni-Komshian, G. H., Zurif, E. B. & Carbone, E. (1973). The acquisition of a new phonological contrast: The case of stop consonants in French-English bilinguals. *Journal of the Acoustical Society of America* **54**, 421–428.

Chen, M. (1972). The time dimension: Contribution toward a theory of sound change. *Foundations of Language* **8**, 457–498.

Lambert, W. (1969). Psychological studies of the interdependencies of the bilingual's two languages. In (Jaan Puhvel, Ed.) *Substance and Structure of Language*. Berkeley and Los Angeles: University of California Press.

Lisker, L. & Abramson, A. (1964). A cross language study of voicing in initial stops: Acoustical measurements. *Word* **20**, 384–422.

Weinreich, U. (1964). *Languages in Contact*, 2nd printing, The Hague: Mouton.