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## Phonetic Validation of Distinctive Features: A Test Case in French

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Much of the phonological literature shows little concern for recent phonetic data. Even in a provocative overview of Jakobsonian phonology (Jakobson and Waugh, 1979) that does give much attention to recent phonetic research, the latter is not exploited very convincingly in defining certain distinctive features. A case in point is the notorious French chestnut embodied in *vous la jetez* vs. *vous l'achetez*, a pair of expressions traditionally said to be distinguished by a voicing feature in the palatal fricatives, which appear here as initial elements in consonant clusters with /t/. It is reported, however, that the /ʒ/ of *jetez* is devoiced through assimilation to the following /t/, and it is argued that a feature of 'fortisness' or 'tensity' is therefore needed. We have tested two hypotheses: (1) Such pairs are likely to be distinguished in production and perception. (2) When they are distinguished, the phonetic basis is glottal adduction vs. abduction. Readings by native speakers of standard French of written sentences terminating in *la jeter* and *l'acheter* were collected and those tokens in which the terminal items were pronounced as disyllables were presented to French listeners for identification. Their responses suggest instability of the distinction, with a perceptual bias toward /ʃ/, thus largely negating the first hypothesis. Insofar as the distinction is maintained, spectrographic analysis and perceptual tests involving the manipulation of /ʒ/ and /ʃ/ noise segments do not argue against a hypothesis of laryngeal control.

### 1. INTRODUCTION

The once intimate connection between phonetics and phonology has in recent decades been stretched to the point where many linguists practice in one area to the neglect of developments in the other. For some linguists the neglect may well be 'benign,' but for many it would seem to have become a matter of principle. Ilse Lehiste, whom we honor in this volume, is among the very few linguists who refuse to divorce phonological from phonetic concerns, and to make of phonology a purely formal exercise in the elaboration of ostensibly phonetic statements whose scientific respectability derives more from traditional opinion than from rigorous testing. If phonology is to

be taken seriously as more than an elaborate spelling exercise – in other words, if the assertions of phonetic fact are not just objects to be manipulated but rather statements whose truth values are thought relevant to linguistic description – then they deserve the respect implied by careful and appropriate testing. Terms such as ‘voiced’ and ‘fricative’ have physical meanings that are generally recognized. Provided that the linguist who says that a given utterance type involves a voiced fricative grants physical meaning to those terms, the statement may be checked against physical observation. Linguists may not want to test their phonetic judgments, even though ostensibly they are making claims about the physical nature of speech signals. Quite frankly we find such an attitude deplorable, even if we acknowledge that beliefs about the nature of the world are also facts worth studying. Some kinds of phonetic judgments are, moreover, not easily translated into terms that allow ready testing. An outstanding example is the claim that two utterance types are distinguished by a difference in force of articulation, where the so-called ‘fortis-lenis’ distinction is attributed to particular segments. It might be argued that if the fortisness of a particular segment is a matter of belief that is widely shared, then it may not be dismissed as groundless just because laboratory phoneticians have failed to find an appropriate measure. But there is a difference between taking such a belief seriously and regarding it as sacrosanct. We prefer to take it seriously, and that means to view it critically.

The claim that a phonological distinction is based on a fortis-lenis difference is not easily tested for another reason, namely because most often a non-controversial difference is present, one that *is* physically interpretable. Only rarely is an alleged fortis-lenis difference unaccompanied. One of these cases seems to be in French, a language that distinguishes two sets of obstruents, one usually voiced and the other voiceless. A number of linguists (e.g., Armstrong, 1932; Delattre, 1941; Malmberg, 1943), most recently Jakobson and Waugh (1979), have said that the palatal fricatives /ʒ/ and /ʃ/, usually voiced and voiceless respectively, are lenis and fortis as well. They claim, moreover, that in the phrase *Vous la jetez* ‘You throw it’ a common pronunciation omits the schwa that in a more deliberate style separates the /ʒ/ and the /t/, and also devoices the fricative. The resulting form, it is further said, is distinguishable from the semantically different expression *Vous l’achetez* ‘You buy it,’ despite the alleged absence of any voicing difference. The aim of the exercises to be reported here was to test the proposition that the distinction just described cannot be attributed to a difference in laryngeal action, and that we must look for something else that can plausibly be regarded as a consequence of a difference in articulatory force. The strongest acoustic evidence for a difference in laryngeal management would be the presence of glottal pulses during the fricative noise of /ʒ/, and the absence of such pulses during the /ʃ/ noise. The acoustic indices of articulatory force that are commonly proposed are duration and intensity

level, in this case the relative durations and intensities of the /ʒ/ and /ʃ/ noises. (It must be pointed out that, on the one hand, the absence of glottal pulses during the /ʒ/ noise does not conclusively demonstrate that the laryngeal action is the same for /ʒ/ and /ʃ/, while a difference in either noise duration or intensity may as plausibly be attributed to a difference in laryngeal management as to one of articulatory force.)

## 2. THE TESTS

Three tests were run: first, native speakers of French recorded a set of sentences read from a written list, and the recordings were played back to French listeners for identification of the intended target forms; second, selected sentence tokens were edited so that fricative intervals from well-identified *jeter* and *acheter* were interchanged; finally, the intensities of the fricative intervals were varied to determine whether this would affect listeners' identifications of the sentences.

The first test was run just to make sure that sentences meant to differ only as to whether they contained *jeter* or *acheter* could be distinguished if pronounced with fricative-stop clusters. Three speakers of standard French were recorded in readings of the following sentences. The sentences were listed in a random order.

Il faut la jeter.

Il faut l'acheter.

Il ne faut pas la jeter.

Il ne faut pas l'acheter.

Il devrait la jeter.

Il devrait l'acheter.

On a fini par la jeter.

On a fini par l'acheter.

Elle a fini par la jeter.

Elle a fini par l'acheter.

J'ai décidé de la jeter.

J'ai décidé de l'acheter.

Elle ne pouvait pas la jeter.

Elle ne pouvait pas l'acheter.

Est-ce que vous voulez la jeter?

Est-ce que vous voulez l'acheter?

On dit que vous voulez la jeter.

On dit que vous voulez l'acheter.

Moi, j'ai peur de la jeter.

Moi, j'ai peur de l'acheter.

Moi, je ne veux pas la jeter.

Moi, je ne veux pas l'acheter.

Est-ce que vous ne voulez pas la jeter?

Est-ce que vous ne voulez pas l'acheter?

One speaker read all the sentences containing *jeter* with this word pronounced as a disyllable. Since her productions could not be used to test our hypothesis, they were discarded. A second speaker always pronounced *jeter* as a monosyllable, while the third nearly always did so. Randomizations of the sentences recorded by these latter two speakers were played back to native listeners, both the speakers and others. The listeners' judgments as to the identity of the final words (if you like, their judgments as to the speakers' intentions) are presented in Table 1. Speaker G.P., who pronounced all his tokens of *jeter* as monosyllables, very clearly produced sentences that were ambiguous; roughly two thirds of both intended *jeter* and *acheter* were judged to be the latter by the three listeners who rendered a total of 280 responses. In the case of D.E.'s readings, although intended *acheter* were more often reported as *acheter* than were intended *jeter*, it can hardly be said that the 704 responses by four listeners provide strong evidence that the /ʒ/-/ʃ/ distinction can survive deletion of the schwa of *jeter*. D.E.'s intended *jeter* were so identified just at chance; her *acheter* tokens, reported 60% as *acheter*, were perhaps more often produced with fully voiceless fricative-stop clusters, combinations that might predispose listeners to report *acheter*. Chi-square tests of individual listeners' responses revealed only a single case in which a speaker's intended forms were correctly identified at better than chance: D.E. as listener was able to identify her own recorded sentences at a level better than  $p < .001$ .

Table 1. Labeling of Original Recordings

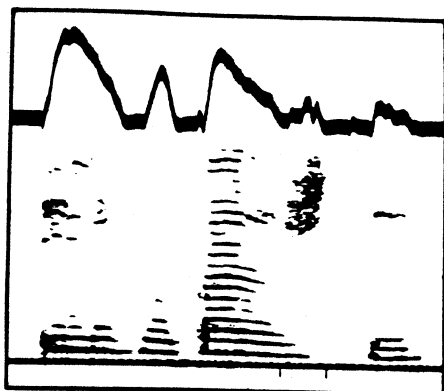
Speaker: G.P. 3 listeners 280 responses		
Intended	Reported	
	<i>jeter</i>	<i>acheter</i>
<i>jeter</i>	34%	66%
<i>acheter</i>	30%	70%
Speaker: D.E. 4 listeners 704 responses		
Intended	Reported	
	<i>jeter</i>	<i>acheter</i>
<i>jeter</i>	51%	49%
<i>acheter</i>	40%	60%

The data of our first test suggest that there is little basis, at least for these speakers and listeners, for the claim made as to the robustness of the /ʒ/-/ʒ/ contrast in the context under study. The fortis-lenis difference, so hard for the laboratory phonetician to lay hands on, seems to be no less elusive for our French speakers and listeners. Of course, while our test subjects are certifiably native speakers of French, and the claim is about French, somewhere there may be whole communities of speakers who behave as the claim we are testing says speakers of French do generally. But at the moment we do not know whether or where they are to be found.

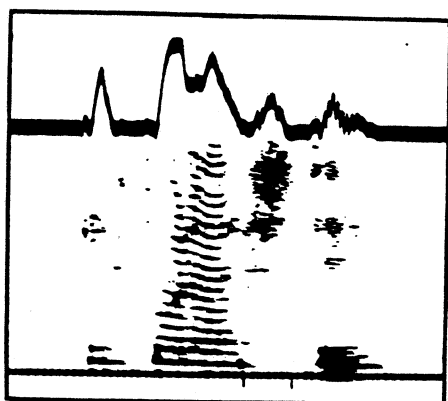
At this point we might have dropped the whole matter. We were persuaded to continue, however, by the following consideration. If we could find *any* sentence tokens with intended *jeter* that were so identified, and that we could say were produced in accord with the schwa-deletion rule, and if we also found other tokens regularly judged to contain *acheter*, then we might still pose the original question: does a difference in labeling responses require us to recognize a phonetic basis other than laryngeal? Of the more than 40 sentences that D.E. recorded containing intended *jeter*, just three were reported, at 90% or better, as ending with *jeter*. Of an equal number of tokens with intended *acheter* there were six that were as often so reported.

Our data do not compel the conclusion that these particular tokens reflect real auditory/phonetic differences, since purely random labeling behavior might have yielded the results obtained. On the other hand, we cannot absolutely reject the possibility that these *jeter* and *acheter* tokens differ acoustically in a way that can explain why listeners reported them differently. We proceeded therefore to examine spectrographically all the unambiguously labeled sentence tokens, looking for differences that might consistently distinguish members of the two sets, and, if such were to be found, determining whether they were of laryngeal or extra-laryngeal origin.

Figure 1 reproduces narrow-band spectrograms of two sentence tokens with well-identified *jeter* and *acheter*. The short vertical lines at the base of each spectrogram mark off the fricative noise intervals. The two intervals differ very little in duration (perhaps 5%), but they do differ in two other aspects. The amplitude profile for the fricative of *acheter* has a higher peak value, and this is as proponents of a fortis-lenis distinction would predict, although it is also consistent with the higher airflow that should result from the abduction of the vocal folds that occurs in voiceless fricatives. The other difference is in the extent to which the harmonic pattern that characterizes both signals just before the fricative intervals persists past the onset of the noise. In the upper spectrogram of Figure 1 the harmonics fill well over half the fricative interval; in the lower one they damp out much earlier. The spectrograms do not tell us whether amplitude or voicing is perceptually significant, but they suggest that perhaps one or both of them may play some role.



Il ne faut pas la jeter.



Il faut l'acheter.

Fig. 1. Narrow-band spectrograms of sentences with well-identified tokens of *jeter* and *acheter*. The short vertical lines mark off the fricative noise intervals.

In order to see whether the category assignments of the items differently labeled can be ascribed to the fricative segments, we selected four sentence tokens, two for each reported word, for further testing. For each token the fricative segment was first excised with the help of a waveform editing program, and then each of the four segments was in turn introduced into the gaps left in each of the sentences. The 16 acoustically different signals were then presented in random order to three of our French listeners. Their responses are represented in Table 2. Each number in the table represents the averaged responses to four stimuli. For example, the four combinations of the two /ʒ/ noise segments and the two contexts that originally included those segments elicit an average of 77% *jeter* identifications. The four combi-

nations of those same contextual signals with /ʃ/ noises elicited, on the average, only 35% *jeter* judgments. Combinations of /ʃ/ noises with their proper contexts were reported 75% as containing *acheter*. The same contexts with /ʒ/ noise yielded stimuli that were quite ambiguous.

When the responses of each listener were submitted to a simple Chi-square test of significance, only one was found to distinguish reliably between the two classes of stimuli ( $p < .001$ ). Possibly it is significant that this listener was the speaker D.E. The fact that two of our three listeners failed to distinguish two categories makes still more doubtful the proposition that *jeter* and *acheter* maintain phonetic distinctiveness in contexts of the kind tested, in the absence of the schwa that elsewhere marks *jeter*, even if there seem to be differences in the extent to which voicing accompanies friction. The fact that the percentage 'correct' scores obtained were lower than the 90% obtained for the test tokens in the initial labeling test is not readily explained, but it can be pointed out that three of the four stimuli on which each of the values given in Table 2 is based were 'unnatural' combinations of frication noises and sentence contexts, and the process of cutting and recombining may well have introduced incongruities of intensity, duration and fundamental frequency that could contribute to listener uncertainty.

Our last test involved no commutation of segments. Instead, the four noise intervals were presented in their native contexts, but at two intensity levels. In the *acheter* sentences the fricative segments were played back at their original levels and also with 10 dB attenuation. The corresponding segments in the *jeter* sentences were also replayed at their original intensities, and at intensities 10 dB higher. As Table 3 shows, the effects of modifying the intensities of these segments are not spectacular; *acheter* responses decreased little more than 10% with decreased noise intensity, while *jeter* responses actually increased with increased intensity, possibly reflecting the effect of the increased salience of the voicing harmonics. Chi-square tests of the responses of the four listeners who underwent this test showed that varying the noise intensities had no statistically significant effect on labeling behavior.

Table 2. Responses to Cross-Matched Fricative Noises

Speaker: D.E. 3 listeners 192 responses					
Fricative noise from <i>jeter</i>			Fricative noise from <i>acheter</i>		
Context from	Reported		Context from	Reported	
	<i>jeter</i>	<i>acheter</i>		<i>jeter</i>	<i>acheter</i>
<i>jeter</i>	77%	23%	<i>jeter</i>	35%	65%
<i>acheter</i>	50%	50%	<i>acheter</i>	25%	75%

Table 3. Responses to Fricative Noises at Two Intensity Levels

Speaker: D.E. 3 listeners 160 responses	
Intended	Reported
<i>jeter</i>	<i>jeter</i> 0 dB 75%
<i>acheter</i>	<i>acheter</i> -10 dB 73%
	+10 dB 80% 0 dB 85%

To conclude, we have little reason, on the basis of the data gathered in the course of this study, to believe that speakers of standard French reliably maintain the contrast between a sentence pair *vous la jetez* and *vous l'achetez* in the absence of differences of vocalization and voicing. Thus the alleged basis for an independent fortis-lenis contrast in French seems to us to be very possibly entirely illusory. However, even if sporadically we find well-identified fricative-stop clusters that hint at a contrast, we find no compelling evidence to reject an explanation in terms of a difference in laryngeal behavior.

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