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OF ENGLISH, SPANISH, HUNGARIAN AND THAI :
A TAPE-CUTTING EXPERIMENT

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THE PERCEPTION OF ENGLISH STOPS BY SPEAKERS OF ENGLISH, SPANISH, HUNGARIAN, AND THAI: A TAPE-CUTTING EXPERIMENT*

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American English stops, including *residual* stops, i.e., stops in /s/-clusters after the removal of the /s/, were presented in front of stressed vowels for identification on the one hand to native speakers of American English, on the other, to native speakers of Puerto Rican Spanish, Hungarian, and Thai, languages with differences in the phonetic composition of their stop phonemes. Speakers of American English identified the residual stops with the voiced (lenis) stop; the others, with the voiceless stop. The results suggest that there is a hierarchic organization among the features of these stops: the lack of aspiration tends to force the evaluation of stops in the direction of /b,d,g/ in American English, whereas in the languages where other distinctions exist, the evaluation is different.

This paper presents some data on the interpretation of speech sounds by speakers of different languages, and the evaluation of the relative importance of cues present in the acoustical stimulus within the framework of the phonemic system of each language. Specifically, the investigation deals with reactions to a set of stop consonants on the one hand by native speakers of American English, on the other hand by native speakers of Puerto Rican Spanish, Hungarian, and Thai, languages with differences in the distinctions among their stop phonemes. In particular, the evaluation of *residual* stops, i.e., American English stops preceding a stressed vowel in /s/-clusters after the removal of the fricative, was studied.

RESPONSES OF SPEAKERS OF AMERICAN ENGLISH

The project originated with a problem in English phonemics. (The linguistic evaluation of the results will not be presented here.) As is well known, before an initial stressed vowel, there occur a voiceless aspirated *fortis* stop and a voiced unaspirated *lenis* stop; after /s/ only one kind of stop occurs in initial clusters, an unaspirated voiceless stop, as in *spill*. Now, if the /s/ were not there, would native

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speakers of American English associate and identify this stop with the initial aspirated stop or with the voiced stop in a forced-choice situation? The stop after /s/ differs from both, from the /p/ in the lack of aspiration and from the /b/ in the lack of voicing, whatever other cues there are.

The following experiment was devised to investigate this problem. A set of 18 monosyllabic words was prepared, chosen so that all single stops and stops in /s/-clusters occurred, and these stops and clusters occurred before one front and one back vowel. The following matrix sums up the stimuli:

<i>pill</i>	<i>till</i>	<i>kill</i>
<i>bill</i>	<i>dill</i>	<i>gill</i>
<i>spill</i>	<i>still</i>	<i>skill</i>
<i>pore</i>	<i>tore</i>	<i>core</i>
<i>bore</i>	<i>door</i>	<i>gore</i>
<i>spore</i>	<i>store</i>	<i>score</i>

The words were recorded by three native speakers of American English. Then the initial friction in the words beginning with /s/ was removed, and a randomized tape was made containing the remaining portions and the other words. The stops occurring in the original /s/-clusters, thus mutilated, will be called *residual stops*, symbolized in the figures by (s). The stops were tested in the context of words rather than in isolation, so that they could be identified as parts of meaningful utterances instead of isolated segments. The tape was offered to 35 native speakers of American English, who were asked to identify each stimulus with one of the 12 words having initial stops.

Fig. 1 shows the format in which we have tabulated the responses. The labels at the bottom indicate our interpretation of the results. A check of the tape after the test revealed that one *score* and one *spill* were defectively recorded.

The results, which had been anticipated, can be interpreted in the following way. Initial aspiration is a stronger cue for fortis stops in English than lack of voicing, hence the residual stops—lacking both aspiration and voicing—were identified with voiced lenis stops, rather than with the aspirated fortis ones.

One aspect of the mutilation of the /s/-clusters, however, must be justified. Removal of the initial friction also obliterates the bounded silence between the end of the friction and the release of the stop, and we know from other experiments that a silent stretch between speech sounds can affect the judgment in the opposition among stops. That this is not the case in our experiment can be inferred from the following considerations. (Because the residual stops were identified with voiced stops, we have to show only that the distortion did not alter them in the direction of voiced rather than aspirated stops.):

1. There is no evidence that silence produces the effect of aspiration. Experiments have shown that the duration of a gap has a significance for the *fortis/lenis* (or *unvoiced/voiced*) opposition of stops in intervocalic position, but not for *voice* versus *aspiration*.
2. The aspiration is clearly sequential to the closure in time; in reversed speech the aspiration is heard as preceding the stop closure. It is improbable, therefore, that

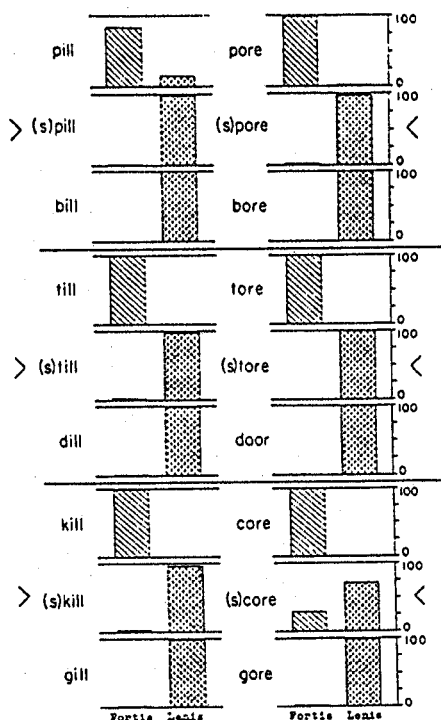


Fig. 1. Per cent responses of American subjects.

a sound feature that precedes the stop release in normal speech would produce the effect of aspiration.

3. Moving the frictional part, corresponding to /s/, back and forth along the time axis with reference to the explosion does not produce any effect of aspiration. This is the most decisive argument. Increasing the gap by a factor of four dissociates the friction from the rest, which is then heard with a voiced initial stop. When the distance is decreased, the stop effect either remains unaltered or it disappears.

RESPONSES OF SPEAKERS OF OTHER LANGUAGES

The second part of the experiment deals with the reactions of native speakers of Puerto Rican Spanish, Hungarian, and Thai to these stimuli. The two poorly recorded versions of *spill* and *score* were re-recorded and inserted in the tape; otherwise, the tape submitted for judgment was identical with the one used for the American listeners. Here the experimental situation is different from the first one. The subjects were asked to identify the stimuli with stops in their native phonemic systems, and of

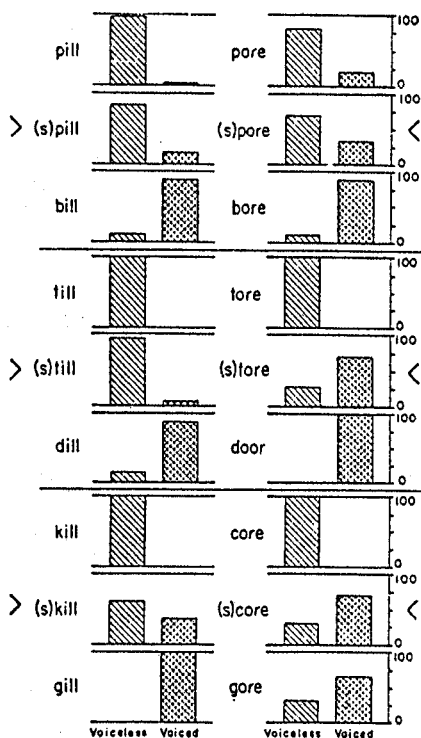


Fig. 2. Per cent responses of Puerto Rican subjects.

course the words were not necessarily meaningful for them. This set of experiments also seeks an answer to the question whether voicing is present in the residual stops, which might have led the American listeners to identify these stops with /b, d, g/, since in these three languages the phonetic feature of the distinction is clearly *voicing* versus *lack of voicing*.

1. Puerto Rican Spanish

In Puerto Rican Spanish, stops are distinguished on the basis of voicing with no aspiration present. The responses of the 12 Puerto Ricans are shown in Fig. 2. As can be seen, the trend here is to identify the English aspirated stops as voiceless and the English voiced stops as voiced. The residual stops were heard as voiceless in four out of six cases. Before the back vowels, however, the stops produced with the tongue (apical and dorsal) were predominantly judged as voiced, the labial stop as voiceless. This seems to indicate that the two extremes, aspirated voicelessness and voice, are clearly judged in terms of the speakers' own phonemic opposition, while the residual stops were judged to be, on the whole, voiceless.

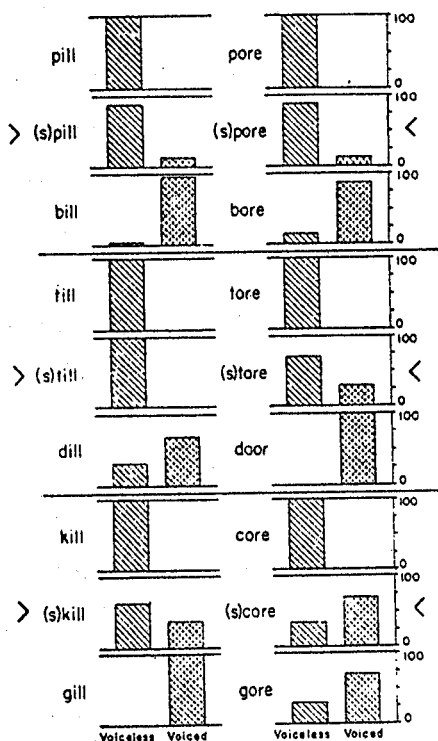


Fig. 3. Per cent responses of Hungarian subjects.

2. Hungarian

Hungarian, like Spanish, has an opposition between unvoiced and voiced stops, with no strong aspiration present. Five subjects took the test, one four times and one twice, so the total number of tests was nine. (The repeaters' internal consistency was high.) Fig. 3 shows their responses. Here the results for the residual stops are more clear-cut. They were by and large called voiceless. Only the residual velar stop before the back vowel was largely evaluated as voiced. There is also a definite trend to identify the aspiration as voiceless and the voice as voiced.

3. Thai

In the Thai phonemic system there is a three-way opposition among voiceless aspirated, voiceless unaspirated and voiced stops and, in addition, a distinction among three places of articulation: labial, apical, and dorsal. The voiced dorsal is missing. Thus, the phonemic system of stops is:

	LABIAL	APICAL	DORSAL
<i>Aspirated-voiceless</i>	/ph/	/th/	/kh/
<i>Unaspirated-voiceless</i>	/p/	/t/	/k/
<i>Unaspirated-voiced</i>	/b/	/d/	

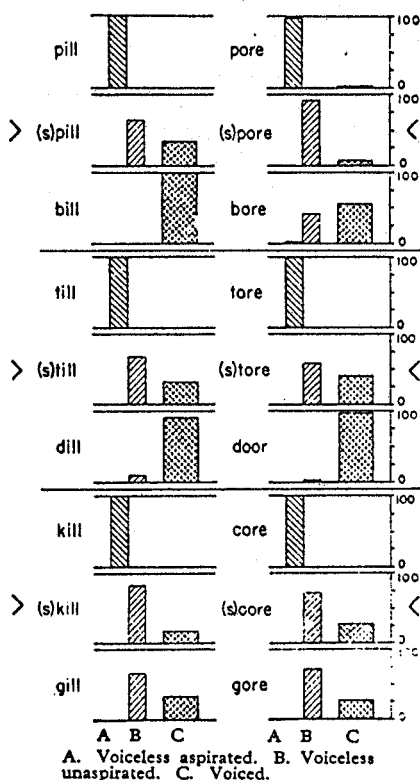


Fig. 4. Per cent responses of Thai subjects.

Twelve subjects took the test, three of them twice, giving 15 scores. The subjects were instructed that they could use the letter *g* for the /*g*/ sound if they wished. The results are shown in Fig. 4. Aspirated voiceless stops were identified as aspirated voiceless stops in the Thai system, the residual stops for the most part as voiceless unaspirated stops, and the voiced stops as voiced stops. There was considerable confusion about the /*g*/, which does not occur in the lattice of the Thai phonological system of stops.

CONCLUSIONS

The results are less clear-cut for the foreign than for the American listeners. This is attributable to differences in phonetic make-up between the stimuli and the related sounds in the various languages, differences for example in the onset and degree of voicing, the release for the aspiration, and the force of the explosion. However, aspiration for listeners whose languages lack this feature, contributes to the evaluation of these sounds as voiceless. Vowel quality also has some effect on the judgement; back vowels tend in some cases to make the consonants sound voiced. In order to get

more complete data, one would have to record the stops of these languages and investigate their evaluation by other speakers, including those of American English.¹

The results indicate that there is a hierarchy among the cues in the acoustic stimulus for the perception of these sounds in various languages. For American English, the lack of aspiration is a dominant cue for forcing the evaluation of the stops in the direction of /b,d,g/, whereas in the languages where other distinctions exist, the evaluation is different. Our modest data exemplify the reflection of the linguistic categories of the listener's native language in his interpretation of speech sounds.

Our hope is that this kind of study will contribute to the understanding of the relative importance for the perception of speech of various cues present in the acoustic stimulus as well as an understanding of the role of the linguistic system in the evaluation of stimuli. Such studies might also contribute information that will be useful in the teaching of languages.

¹ A remark about the identification of the place of articulation in the above four sets of experiments is in order. There was practically no confusion in this respect, except by some Hungarian speakers, who identified the labial stops of pill and spill with their /t/.