

SPEAKERS' AWARENESS OF SOME NON-SEGMENTAL ASPECTS
OF FOREIGN ACCENT

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0. INTRODUCTION. It is well known that adult foreign language learners may pronounce speech sounds in a foreign language according to the sometimes inappropriate phonetic norms of their native language (Barry, 1974). However, it appears that not all of these measureable phonetic differences between native and accented speech will necessarily lead listeners to perceive the substitution of one sound for another (Flege, 1980). There are several such non-segmental phonetic differences between Spanish-accented English and native English which provide us with an opportunity to test a hypothesis concerning how listeners actually do perceive foreign accent. It has been suggested that listeners may experience foreign accent as a "whole" or "gestalt" without being aware of the many specific phonetic deviations from native language norms which are responsible (Jonasson and McAllister, 1972). If this is true, then listeners hearing their native language produced with a foreign accent may notice only segmental substitutions, filtering out purely phonetic deviations while interpreting the phonetically inaccurate sounds produced by foreigners in terms of phoneme classes of their native language (Trubetzkoy, 1969: 51ff.; Strange and Jenkins, 1978).

The present experiment was designed to determine if listeners, in addition to segmental substitutions, might also be aware of non-segmental phonetic aspects of foreign accent. We devised a paradigm in which native speakers try to imitate foreign accent. If Americans imitating Spanish-accented English produce some of the non-segmental phonetic differences which are known to distinguish native and Spanish-accented English, in addition to the more obvious segmental substitutions (Flege and Hammond, 1980a,b), it would indicate that even naive listeners without special training in phonetics are aware (at some level) of some of the purely phonetic aspects of foreign accent.

We performed an instrumental analysis of two non-segmental phonetic dimensions in the speech of Americans imitating a Spanish accent. The first was Voice-onset time (VOT), a readily measurable acoustic parameter which often serves to distinguish categories of stop consonants (Lisker and Abramson, 1964, 1967) and which may provide a sufficient perceptual cue to the phonological contrast

between English syllable-initial voiced and voiceless stops (Abramson and Lisker, 1970, 1973). VOT is defined as the interval of time between the release of a stop closure and the onset of voicing (glottal pulsing). The stops found in human languages generally fall into two or three distinct VOT categories although the actual VOT values of the stops representing those categories, may vary somewhat from language to language (Lisker and Abramson, 1964). A stop is said to have been produced with lead VOT when voicing onset precedes stop release; with short-lag VOT when voicing begins at or shortly after stop release; and with long-lag VOT when voicing onset is delayed until considerably after stop release (Figure 1).

Adult foreign language learners often seem to have difficulty in correctly producing the stops of a foreign language if their VOT specification differs from that of stops found in the native language (Jones, 1948; Suomi, 1976; Flege, 1980). The voiceless unaspirated /ptk/ of Spanish differ from the voiceless aspirated /ptk/ of English in that the former are produced with short-lag VOT and the latter with long-lag VOT (Lisker and Abramson, 1964; Zlatin, 1974; Williams, 1977). As a result of such cross-language phonetic differences, English speakers may tend to produce Spanish /ptk/ with too much aspiration (that is, with VOT values that are too large) while Spanish speakers may seriously underaspire English /ptk/ (producing them with VOT that is too short by English standards; Stockwell and Bowen, 1965; Williams, 1979).

It is uncertain whether phonetic interference of this kind normally results in confusion of the stop voicing pairs /p-b/, /t-d/, and /k-g/. Given the perceptual importance of the VOT dimension we might expect American listeners, for example, to hear some of the /t/s produced by Spanish speakers of English as /d/ because both Spanish /d/ and English /t/ fall in the short-lag VOT category (Lisker and Abramson, 1964). However, cross-language differences in VOT may not necessarily result in the perception of segmental substitutions by monolingual listeners (Flege and Port, 1980; cf. Monsen, 1976; Figs. 1-3). This is because listeners may use many non-phonetic cues when listening to a foreign speaker and make use of acoustic dimensions in addition to VOT when perceiving the voiced-voiceless contrast (Lisker, 1978a). It may also be the case that listeners are able to adjust their perceptual expectations when listening to accented speech (Elman, Diehl, and Buchwald, 1977; cf. Lisker, 1978b). Moreover, English-learning children frequently de-aspire prevocalic /ptk/, but it seems that at least some English speaking adults nevertheless hear such stops as voiceless. (Eilers and Oller, 1976; Rebecca Eilers, personal communication). Thus, an

American listener may identify a de-aspirated /t/ produced by a Spanish speaker of English as an accented /t/ rather than as a /d/, especially if he has been previously exposed to Spanish-accented English (see Monsen, 1978). If listeners do perceive non-segmental aspects of foreign accent, then we would expect subjects imitating Spanish accent to produce VOT values for /t/ that are much shorter than normal for English, even if they do not typically perceive /d/-for-/t/ substitutions in the speech of Spanish speakers of English.

The second phonetic dimension we examined in the present study was final-syllable lengthening. This phenomenon refers to the relatively greater length of a syllable found at the end of an utterance (or syntactic constituent) compared to a similar syllable occurring prior to the end of the utterance (or constituent). Final lengthening is a prosodic dimension which appears to be widespread in human languages, although its magnitude seems to vary considerably from language to language. The size of the effect in English appears to be much larger than in other languages such as Spanish. A syllable found at the end of an English utterance may be more than 60% (or 100 msec.) longer than the same syllable found utterance-medially, while the effect may be less than half as large in Spanish (Delattre, 1966; Oller, 1973; 1977).

Adult foreign language learners seem to show the same kind of predictable phonetic interference for final lengthening as they do for VOT. Spanish speakers of English have been found to produce English utterances with about the same relatively small amount of final-syllable lengthening found in Spanish (Pinkerton-Hutchinson, 1973a,b). Since the probable difference between how much final syllables are lengthened in native vs. Spanish-accented English falls within the range of detectable duration differences (Lehiste, 1970) it seems quite possible that our subjects will be aware of this phonetic dimension of Spanish-accented English if they do perceive non-segmental aspects of foreign accent. Just as for VOT, a smaller magnitude of final lengthening in imitated Spanish-accented English than in native English would suggest that listeners attend to at least some non-segmental prosodic dimensions when perceiving foreign accent.

1. **METHODOLOGY.** Subjects were asked to read English sentences with what they considered to be a typical Spanish accent. We established that all 50 subjects in the present study had previously been exposed to Spanish-accented English by setting three subject selection criteria: (1) all were long-time residents of Florida, a state

in which there are many native Spanish speakers; (2) all indicated that they knew native Spanish speakers on a questionnaire administered before the experiment; and (3) all were enrolled in first-quarter Spanish classes taught by native speakers of Spanish who speak English with an accent. The experiment was carried out in the language laboratory at the University of Florida, where subjects recorded the test material on similar Wollensak tape recorders equipped with fixed head-set microphones. The test material consisted of 21 English sentences of the form "The ___ is on the ___". The two blanks were filled with a number of different C(C)VC test words, all nouns. Present in each of the test words was one of six different English sounds which are known to be replaced by other sounds in the speech of at least some Spanish speakers of English ([I, U, v, š, z, n]). In earlier studies (Flege and Hammond, 1980a, b) we found that subjects substituted some of these sounds when imitating Spanish accent in a manner which is consistent with the hypothesis that they are aware of segmental substitutions produced by Spanish speakers of English. In addition, a number of sentences contained test words in which /t/ preceded a tense vowel (tape, tube, toad). None of the /t/s produced in the earlier study by speakers imitating Spanish accent were heard as /d/ by either of two phonetically trained judges. Three of these words with /t/ occurred in the sentence-medial blank, and three in the sentence-final blank.

From the larger population two groups of speakers were chosen: the ten subjects who produced the greatest number of sound substitutions (labelled Group A1) and the ten who had produced the fewest (labelled Group A2). The difference in the frequency with which these two extreme groups produced segmental substitutions associated with Spanish accent--a range of 17-27 for Group A1 and 0-4 for Group A2--was significant ($p < .01$ by Chi-square analysis).

For purposes of comparison, a control population of ten speakers producing unaccented English was established. These speakers (Group U) produced the same 21 sentences previously produced by speakers imitating Spanish accent. The control group was recorded in a sound-proof booth on an Ampex (Model 602) tape recorder, a constant mouth-to-microphone distance insured by means of a cephalostat. Care was taken to neutralize any between- or within-group variations in signal intensity when the original recordings of all three speaker groups (A1, A2, U) were dubbed onto a Crown tape recorder (Model 700 for spectrographic analysis on a Voiceprint (Model 700) sound spectrograph. From the six sentences containing test words with /t/ three acoustic intervals were measured by hand to the nearest 5 milliseconds: (1) Voice-onset time of /t/ was measured from the beginning of the transient noise burst signalling stop release to the first vertical striation signalling voicing onset; (2) the following

vowel duration was measured from onset to offset of energy in the region of the first formant; and (3) utterance duration was measured from the onset of the vowel in the first (utterance-medial) test word to the offset of the final vowel of the utterance (occurring in the second test word). Analyses of variance were performed to test the significance of differences according to position in the utterance (medial, final) and speaker group (A1, A2, U) on these three dependent measures.

2. RESULTS. The speech of subjects imitating a Spanish accent differed from that of speakers producing unaccented English along all three of the phonetic dimensions measured (Table 1).

	Speaker Group		
	A1	A2	U
<u>Voiced-onset time</u>			
<u>medial</u>			
\bar{x}	43	54	79
s.d.	(25)	(24)	(16)
n	30	30	30
<u>final</u>			
\bar{x}	48	62	87
s.d.	(28)	(27)	(18)
n	30	30	30
<u>Vowel duration</u>			
<u>medial</u>			
\bar{x}	194	201	141
s.d.	(73)	(67)	(29)
n	30	30	30
<u>final</u>			
\bar{x}	184	209	217
s.d.	(54)	(74)	(56)
n	30	30	30
<u>Utterance duration</u>			
\bar{x}	1181	1179	999
s.d.	(293)	(220)	(111)
n	60	48	60

Table 1. Mean duration (in msec.) of acoustic intervals produced by the best imitators of Spanish accent (A1), the worst imitators (A2) and speakers producing unaccented English (U); standard deviations are in parentheses, 'n' indicates number of tokens analyzed.

First, the effect of speaker group on mean VOT was significant [$F(2,174) = 41.66, p < .01$]. The VOT of /t/ produced by speakers of

unaccented English (Group U) agrees closely to values reported previously for English stops in a similar phonetic context (e.g., Summerfield, 1975; Port and Rotunno, 1979), while VOT produced by the two accent groups (A1, A2) averaged 25-36 msec. less (Figure 2). Post-hoc tests (Fisher's LSD, $\alpha=.01$) revealed that the mean VOT of both medial and final stops produced by the two accent groups (A1, A2) was significantly shorter than that produced by speakers of unaccented English (Group U), and that the more successful imitators of Spanish accent (Group A1) produced even shorter VOT values than the relatively less successful imitators of a Spanish accent (Group A2). As displayed in a frequency histogram (Figure 3) it can be seen that VOT produced by speakers imitating Spanish accent ranged from 10 to 110+ msec., while none of the stops produced by the speakers of unaccented English was shorter than 50 msec. In fact, the mode VOT value produced by both Group A1 and A2 was shorter than any value produced by speakers of unaccented English. Thus, our hypothesis that speakers imitating Spanish accent would deaspirate /t/ in accordance with this phonetic dimension of Spanish-accented English is confirmed.

Our finding that speakers in both Groups A1 and A2 produced /t/ with shorter VOT than speakers producing unaccented English (Group U) might potentially be due to an effect of speaking rate on VOT rather than the result of their modifying English VOT in imitation of a foreign accent. It has been shown that stops found in utterances produced at a fast speaking rate will have shorter VOT than stops in utterances produced at a normal or slow rate (Summerfield, 1975; Port, 1976). However, the speakers imitating Spanish accent seemed to speak more slowly than speakers producing unaccented English so that rate should have had an effect opposite, if any, to that observed. In fact, measurement of utterance duration showed that the sentences produced by speakers imitating Spanish accent (Groups A1 and A2) were about 20% (or 180 msec.) longer than sentences produced by the speakers of unaccented English (Group U) even after pauses introduced by some speakers imitating Spanish accent had been subtracted from the total utterance length¹ (Figure 4). This effect of speaker group on utterance duration was significant at the .01 level [$F(2,165)=12.99$]. Protected t-tests ($\alpha=.01$) revealed that the mean duration of sentences produced by Groups A1 and A2 were not significantly different and that the sentences of the two accent groups were longer than those produced by speakers of unaccented English. Thus the observed differences in VOT do not appear to be the result of differences in speaking rate between the speaker groups.

Second, there were several differences in the mean duration of vowels produced by the three speaker groups. Vowels occurring in

the final syllable of the sentence were significantly longer than the same vowels occurring earlier in the sentence [$F(1,174)=7.437$, $p<.01$]. In addition to the significance of the main effect of position within the sentence, the interaction of the main effects of speaker group (A1, A2, U) and position (medial, final) on mean vowel duration was also significant [$F(2,174)=16.58$, $p<.01$]. The interaction term appears to be significant because only one of the three speaker groups--the group producing unaccented English--made vowels occurring at the end of a sentence longer than vowels found within the sentence (Figure 5). The final vowels produced by Group U were 54% (or 76 msec.) longer than the same vowels occurring in the first (utterance-medial) noun of the sentence; those of Group A2 only 4% (or 8 msec.) longer. The vowels produced by Group A1 were actually somewhat shorter (by 5% or 10 msec.) at the end of a sentence than in non-final position. Post-hoc tests (Fisher's LSD, $\alpha=.01$) revealed that only for Group U was the difference in duration between utterance-final vowels and the same vowel occurring utterance-medially significant.

The lack of a final lengthening effect in the speech of subjects imitating Spanish accent appears to have two sources. As seen in Figure 5, the medial vowels produced by Groups A1 and A2 are significantly longer than the medial vowels produced by Group U (by Fisher's LSD, $\alpha=.01$), and the final vowels produced by the two accent groups are somewhat shorter (although not significantly) than the vowels produced by speakers of unaccented English (Group U). Thus the lack of a final lengthening effect in the speech of Groups A1 and A2 is due partly to the fact that they failed to lengthen their utterance-final vowels as much as the speakers of unaccented English, but mostly to the fact that medial vowels produced by the two accent groups are relatively much longer than medial vowels produced by speakers of unaccented English. To produce a final lengthening effect the speakers in Groups A1 and A2 would have had to increase their final vowels substantially beyond the duration of final vowels produced by speakers in Group U, or else appropriately shorten their medial vowels. The failure of speakers in the accent groups to lengthen their final vowels to the extent that they would be longer than medial vowels by the same proportion as the final-medial vowels produced by Group U may stem from some upward limit on how much vowels can be lengthened at the end of a sentence without appearing to be noticeably distorted.

Finally, we found that the VOT of stops found in the final syllable of the sentence was about 12% or 7 msec. longer than the VOT of stops found in an utterance-medial syllable [$F(1,174)=4.28$, $p<.05$]. The size of this effect was comparable in the speech of all

three speaker groups, and is somewhat larger than that noted in a previous study by Summerfield (1975). One might perhaps suppose that the lengthening of VOT in the final syllable of an utterance is linked to the lengthening of vowels in the same position. This cannot be the case, however, since only Group U showed final-syllable lengthening while all three speaker groups showed approximately the same amount of final-syllable VOT lengthening.

3. SUMMARY AND CONCLUSIONS. The present analysis of the speech produced by subjects trying to imitate a Spanish accent seems to show that listeners are indeed aware of non-segmental phonetic characteristics of foreign accent in addition to the more overtly obvious segmental differences between native and accented speech. In producing VOT values which would seem to typify Spanish-accented English (Williams, 1979) speakers in this study showed that they can apparently modify laryngeal timing patterns to produce stops with VOT values that are not characteristic of their native language. Both the groups of speakers who were relatively successful and unsuccessful in imitating Spanish accent (as measured by the number of segmental substitutions produced) made the VOT of /t/ much shorter than normal for an English /t/. Although the speakers imitating foreign accent made sentences about 20% longer than speakers producing the same sentences without accent their tendency to de-aspirate /t/ did not seem to be due to their relatively slower speaking rate. It has been shown that as speaking rate decreases (and individual sounds become longer) VOT values tend to increase (Summerfield, 1975; Port, 1976). What we observed, however, for speakers imitating Spanish accent was a substantial decrease in VOT rather than the increase one would expect on the basis of the observed change in speaking rate. Moreover, it is highly unlikely that the duration of vowels which immediately followed the VOT intervals was responsible for the observed modification of VOT by speakers imitating Spanish accent. Several studies have shown that VOT values tend to increase when a following vowel is relatively long (Port and Rotunno, 1979; Weismer, 1979a) but the two accent groups in the present study produced substantially decreased VOT values (as compared to the unaccented group), while at the same time producing vowels which were generally longer than those produced by speakers of unaccented English.

The present finding is directly relevant to determining to what extent speakers have direct control of the duration of the VOT intervals in their speech. Adults are generally observed to produce stops with VOT values falling into one of several language-specific ranges of values (Lisker and Abramson, 1964). One might wonder if languages generally possess stops falling into the lead, short-lag, or long-lag VOT categories simply because the speech production

mechanism favors such categories for physiological reasons, or because VOT values intermediate to these modal categories cannot be produced with as much accuracy or reliability as values within these categories.

At present it remains an "open question" as to whether speakers can produce a continuous range of VOT values (Lisker and Abramson, 1971:770). If speakers are able to exert a fairly direct control of VOT as suggested by Lisker and Abramson (1971:778) then one would expect them to be able to produce a continuous range of values, including values which fall between the modal VOT categories normally observed in human languages (cf. Port and Rotunno, 1979). It has been argued, however, that speakers do not typically control--at least in a direct or conscious fashion--the onset of events in the larynx which are responsible for when voicing begins during stop production. According to Weismer (1979) voiced sounds are generally produced with the vocal folds together (so there is no need for direct control of timing) and voiceless stops are produced with a 'preprogrammed' devoicing gesture whose course is highly automatic and whose initiation is linked to the moment of stop closure. If this view correctly characterizes the normal mechanism by which the duration of a VOT interval is specified then it would seem somewhat unlikely for speakers to be able to vary Voice-onset time values at will. However, in the present study we found that when speakers try to imitate a foreign accent they are indeed capable of modifying VOT. Our subjects produced a wide range of VOT values that spanned the short-lag and long-lag VOT categories of English. The observed between-groups difference in VOT seems to be the result of a conscious modification of laryngeal timing by speakers imitating foreign accent. If our subjects had simply shifted VOT from the long-lag range to the short-lag range we would have concluded that they were simply switching from one pre-established pattern of laryngeal timing (that of /t/) to another (that of /d/) rather than actively modifying laryngeal timing. However, their VOT values were generally longer than those normally observed for the short-lag English /d/ (Lisker and Abramson, 1967) but shorter than those of the long-lag English /t/. Thus we must agree with Lisker and Abramson (1971) that there are apparently no absolute physical limitation on a speaker's ability to produce a continuous range of VOT, including those values not normally found in human languages. The present findings also suggest that speakers are at least capable of active manipulation of VOT, whether or not they actually do so in normal speech production.

Speakers imitating Spanish accent in the present study seemed to produce modifications in VOT and vowel duration so that they tended to resemble values of these same dimensions in Spanish-accented English. The question remains, however, as to whether the observed

phonetic differences were produced in direct imitation of Spanish-accented English. The possibility exists that our English-speaking subjects might have produced identical phonetic modifications in imitation of any variety of accented English. For example, German speakers of English do not tend to deaspirate English /t/ because the /t/ of German is also aspirated in the same phonological environments (Jones, 1948). Would subjects familiar with German-accented English (as subjects in this study were familiar with Spanish-accented English) deaspirate /t/ if asked to imitate a German accent in English? If they did, it would suggest that speakers adopt a special mode of laryngeal timing when attempting to produce the general acoustic effect of 'accent.' Such a pattern of laryngeal modification, if it exists, might underly the observed amelioration of disfluency by stutterers imitating a 'foreign dialect' (Wingate, 1976:213). A change in VOT such as the one observed here might also reflect a relative decrease in the complexity of laryngeal timing patterns. It would be very interesting to learn if Spanish imitators of English-accented Spanish would shift VOT from the short-lag values of Spanish /t/ towards the relatively more 'complex' long-lag VOT category of an English /t/ when imitating an English accent in Spanish (see Kewley-Port and Preston, 1974). These questions must be answered before we can know with certainty if our subjects were actually imitating specific phonetic dimensions of Spanish-accented English or whether they were adopting a more generalized phonetic 'disguise' or 'accent' mode.

If subjects in our study did modify vowel duration and VOT in direct imitation of these dimensions in Spanish-accented English it would indicate that such temporal dimensions of speech form an important part of what is perceived as foreign accent. Pinkerton-Hutchinson (1973a,b) found that speakers' control of still another temporal dimension of speech--duration as a correlate of linguistic stress in English--was a good predictor of how native English listeners would rate the English produced by Spanish speakers. She found, interestingly, that the large final lengthening effect of English was acquired more slowly than English stress timing by Spanish learners. Thus control of English final lengthening might be necessary for a speaker to sound native-like. If so, instruction should be aimed at teaching this dimension, for the present results seem to show that it can be learned rather easily.

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NOTE

¹Twelve sentences produced by speakers in Group A2 had such long pauses that they exceeded the duration of a spectrogram (2.4 sec.). Since their duration could not be accurately measured they were excluded from the present comparison.

FIGURES

- Figure 1. The three most common VOT categories found in human languages. Stops produced with these modal VOT values would be identified as voiced (e.g., /b/) or voiceless (e.g., /p/) by Americans.
- Figure 2. Mean VOT of /t/ in utterance-medial and final position produced by three speaker groups, in msec. Each data point is based on 30 observations.
- Figure 3. Frequency histogram representing the number of stops produced by three speaker groups, with VOT values at 10 msec. intervals.
- Figure 4. Mean duration of sentences produced by three speaker groups, in msec. N is 60 for Group U and A1, 48 for Group A2.
- Figure 5. Mean duration of vowels occurring in utterance-medial and final position produced by three speaker groups, in msec. Each data point is based on 30 observations.

VOT

- ① lead (prevoicing)
- ② short lag
- ③ long lag

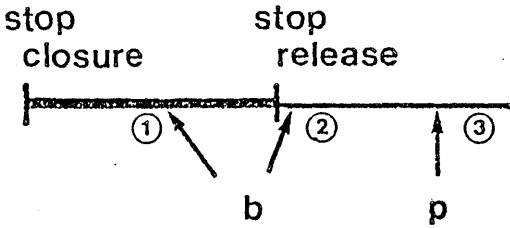


FIGURE 1

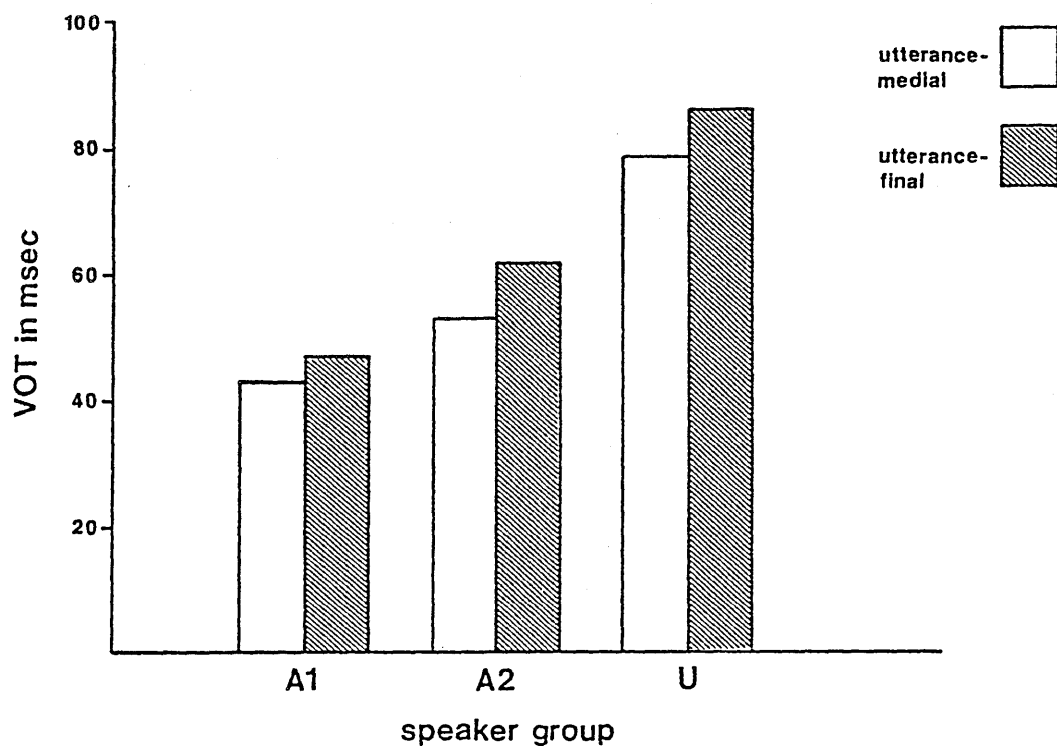


Figure 2

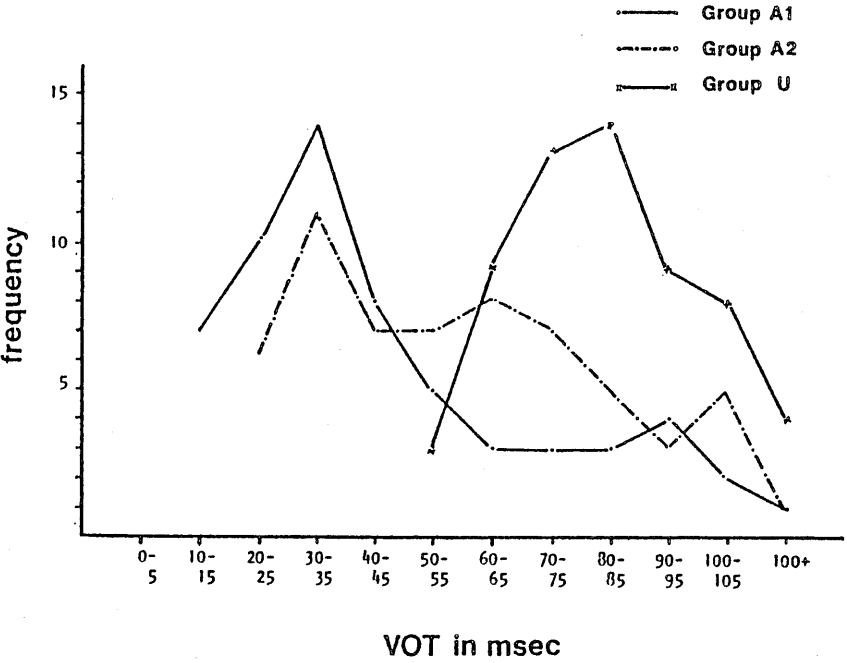


Figure 3

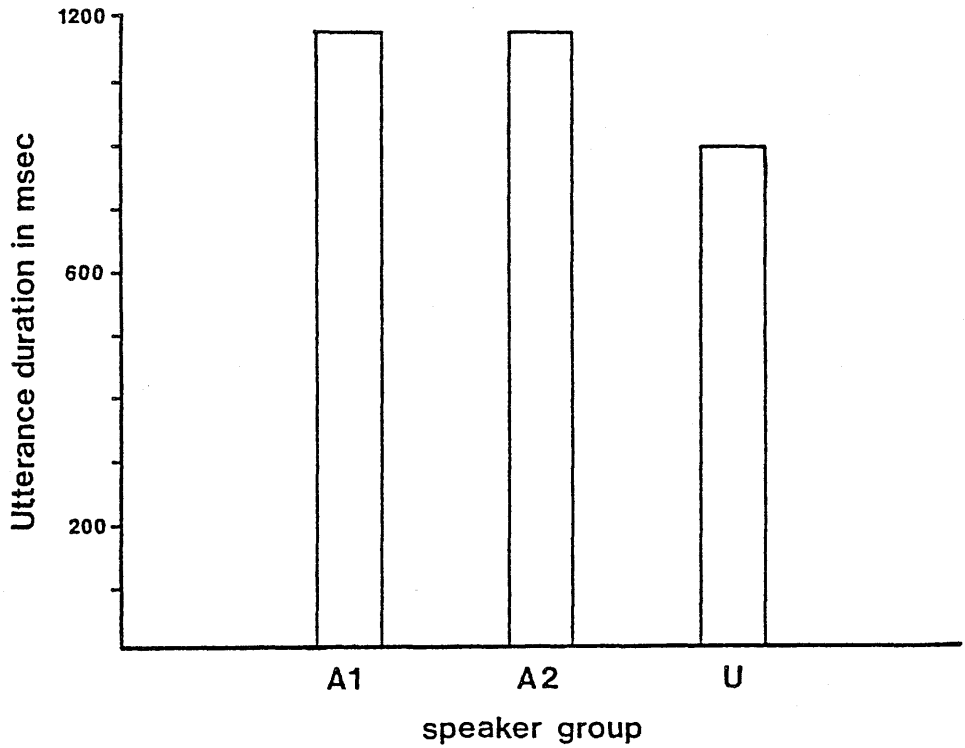


Figure 4

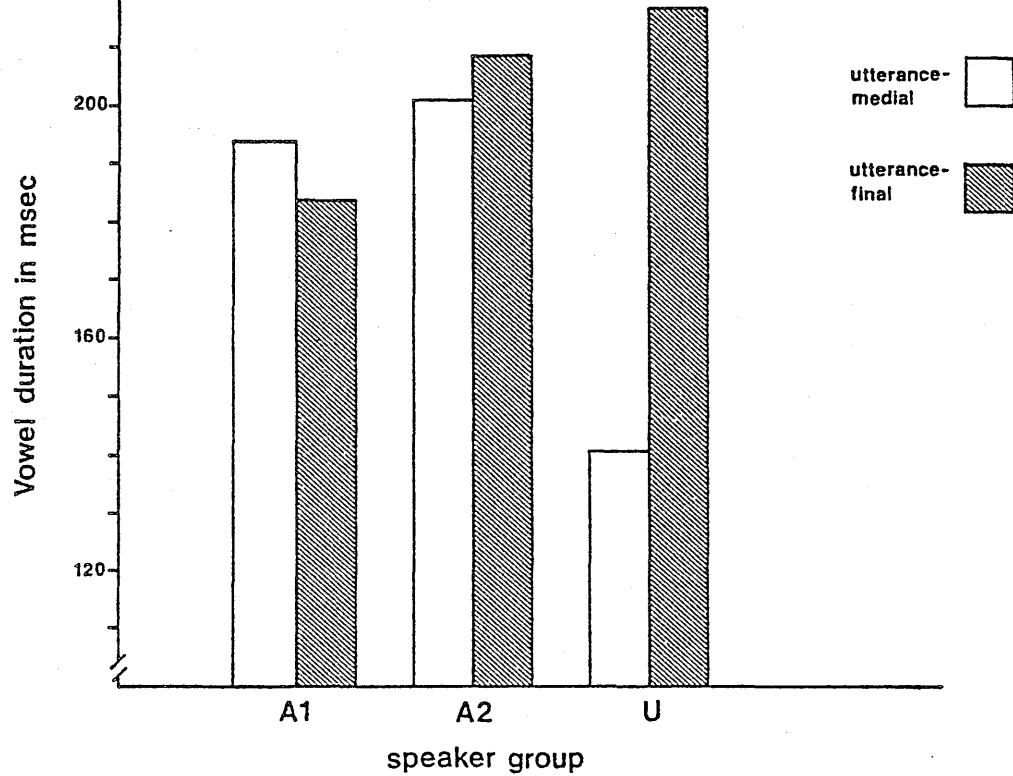


Figure 5

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