IDENTIFICATION OF ARGENTINE SPANISH VOWELS

MIGUELINA GUIRAO AND ANA MARIA B. DE MANRIQUE

1. INTRODUCTION

This paper summarizes a spectrographical analysis of Argentine Spanish Vowels. There is no similar study, with the exception of papers by Skelton (1950) and Cárdenas (1960). The present study was motivated chiefly by a need for a simple but definitive 'map' of the spectrum of the principal vowels of this language: the data are of interest *per se*, and for the comparison with the formants of (a) the cardinal vowels and (b) North American English vowels. It is assumed that the phonemic system of Argentine Spanish includes five vowel phonemes /i, e, a, o, u/. Throughout the paper, 'English vowels' refer to United States English vowels and 'Spanish vowels' refer to Argentine Spanish vowels.

2. PROCEDURE

Isolated and sustained vowels were spoken for about 300 ms. Isolated vowels were used because it was assumed that they are clearly differentiated either by physical or perceptual aspects. We attempted to make a direct comparison with the cardinal vowels as defined by Daniel Jones. The speech material was recorded on an Ampex AG 440-2 tape reproducer and copied to a Kay Sonagraph 7029-A Analyzer. The records were made in two frequency ranges, 40-4000 Hz and 80-8000 Hz, and in two bandwidths of filters, 300 Hz and 45 Hz. Five men and five women were instructed to maintain a constant level on the VU meter connected with the tape recorder and to repeat each sound three times. In order to evaluate the calibration of the equipment, four of the recorded voices were also analyzed with a Kirsta Sound Spectrograph (Department of Audiology and Speech Sciences, Michigan State University). No differences in the spectrograms shown by the two types of analyzers were apparent.

3. RESULTS

Formants were identified as the average value of the central frequency of maximum amplitude on the Sonagraph sectioner. These values were read at the mid-points

of the segments of the vowels. The separate values of the three samples were averaged. The sonagrams of [i], [e], [a] allowed the isolation of the three formants, but for [o] and [u] only two formants. Thus, for consistency the data for all values are displayed as $F1$ versus $F2$ in Figure 1. The values are shown in Hz and in mels. The ranges include the points which correspond to the average for each of the ten subjects (square symbols indicate male voices and circles female voices).

As was expected, there was no overlap among the five sounds. The chart was compared with the graph of cardinal vowels as drawn by Ladefoged (1969) and of

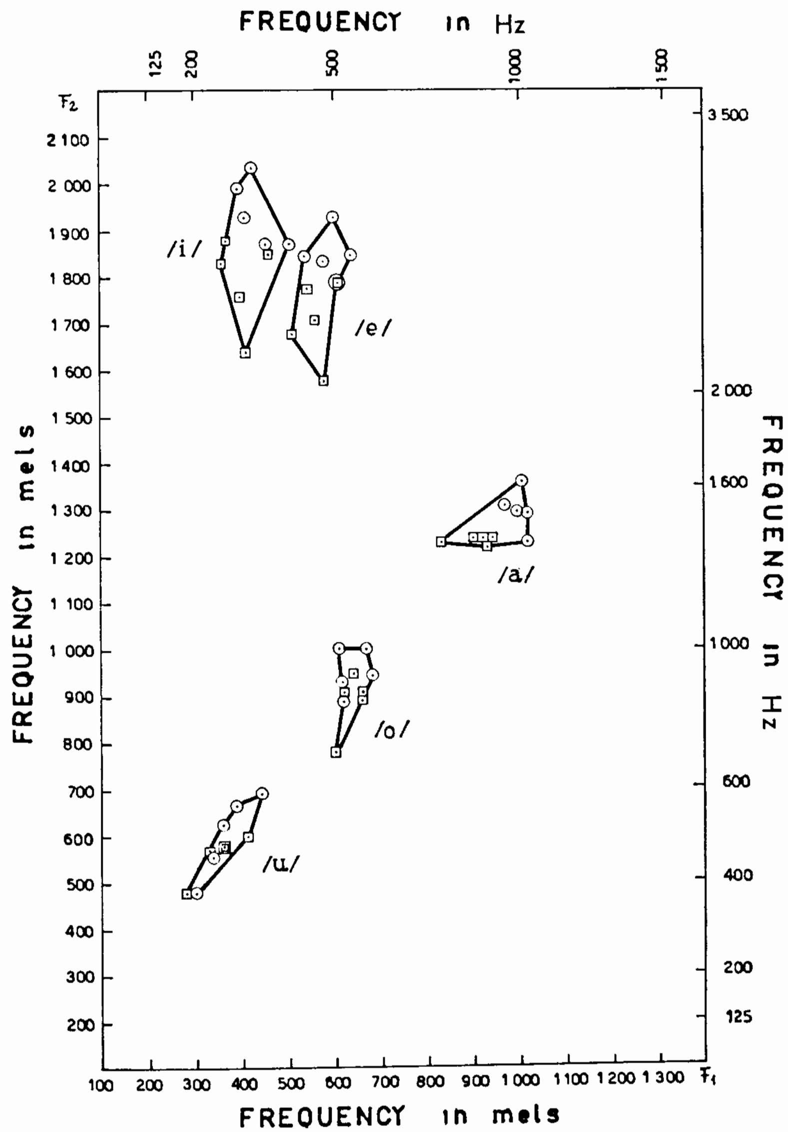

Fig. 1. Areas for two formants of five Argentine Spanish vowels.

English vowels by Peterson and Barney (1952).

1. *Relation of the five main Spanish vowels to the cardinal vowel system.* — Figure 2 shows that the areas of the three Spanish vowels [i], [e], and [o] coincide with the Cardinal vowels 1, 2 and 6. The difference in Hz to be noted between Cardinal vowels 1 and 2 and the corresponding Spanish vowels suggest differences in the register of the speakers. Otherwise, the Spanish [a] has a lower $F2$ than Cardinal 4 and Spanish [u] has a lower $F2$ than Cardinal 8.

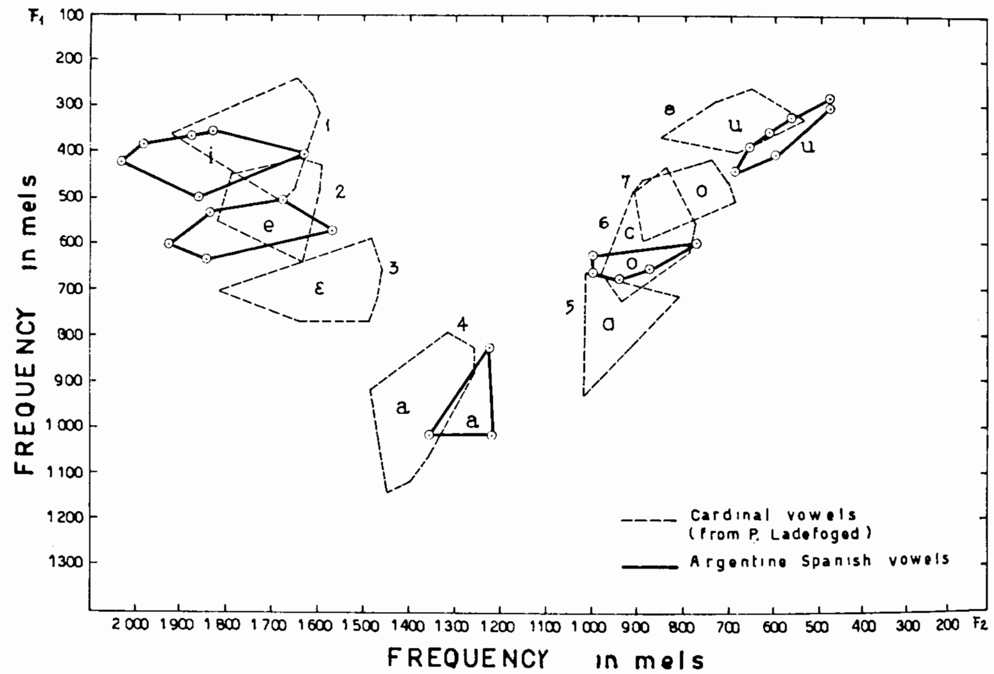

Fig. 2.

2. *Comparison between Argentine Spanish vowels and American English vowels.* — the formants of the Spanish vowels and English vowels are compared in Figure 3. The two sets of vowels bear an acoustic resemblance. Spanish [i] falls well within the area of the [i] in *heed* [hid]; Spanish [e] is very much akin to the vowel sound in *hid* [hɪd] (not *hate*). Spanish [a] falls between the vowel in *hud* [hʌd] and the more open one in *hod* [hɑd]. Spanish [o] bears a strong resemblance to the vowel in *hawed* [hɔd] and is slightly related to the one in *hood* [hʊd]. The $F2$ of the Spanish [u] is lower in frequency than in the instance of the English [u] in *who'd* [hud]; in fact, their areas scarcely overlap.

The peak intensity level of each of the formants was studied in the sonagrams of two talkers, a man and a woman. By inspection the sonagrams seemed to represent their groups. Figure 4 shows the profiles of the formants. Three formants are evident for [i], the second one being less intense than the other two; in contrast, in [a] $F3$ is quite weak; in [e] no difference in intensity among the three formants is evident

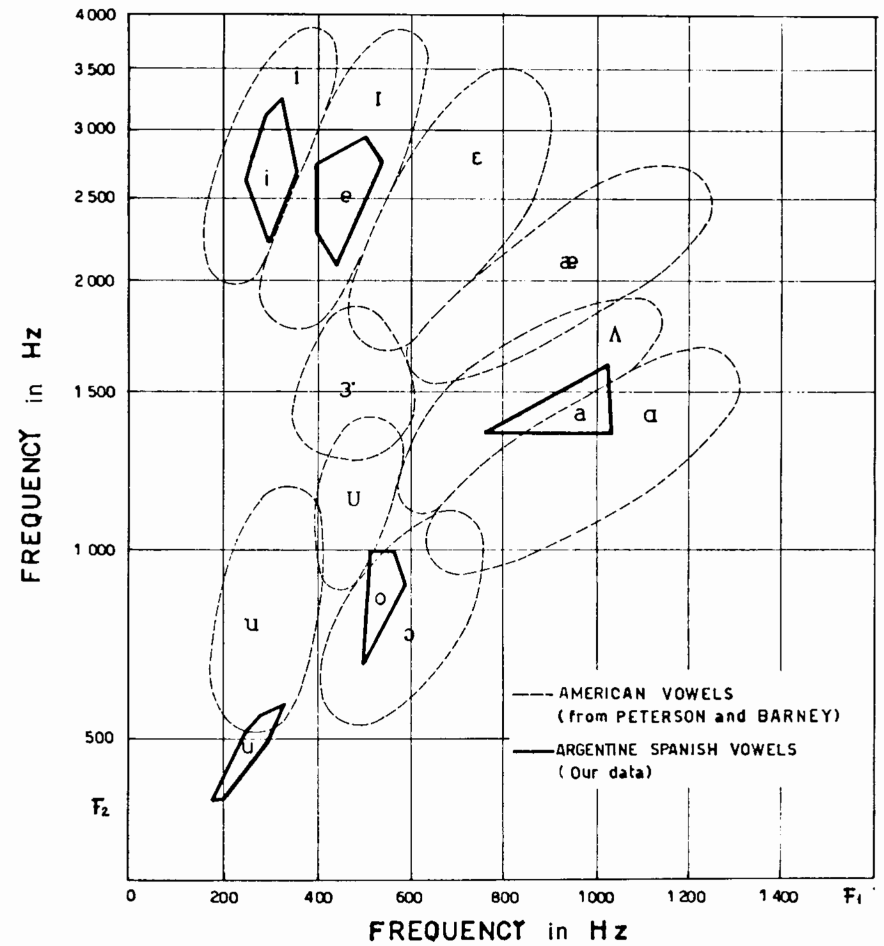

Fig. 3.

and in vowels [o] and [u] $F3$ is not apparent. Thus, the general picture is that the amplitude of $F2$ increases as it approaches $F1$. It may also be worth noting that the intensity of the second formant increases as it becomes lower in frequency. The dashed lines in Figure 4, which correspond to female voices, shift consistently upward (higher frequencies).

3. *Effects of Vowel Duration.* — in order to test the importance of duration upon vowel identification (when the vowel is bounded by noise), an experiment was designed in which segments of vowels were presented as stimuli between two bandwidths of white noise 250-4500 Hz. The noise from a Grason-Stadler noise generator (901-B) was filtered by an Allison filter (AL-2B), and was controlled in duration by a Grason-Stadler interval timer (471) synchronized with a Grason-Stadler Electronic Switch (829-E). The vowels were recorded on an Ampex AG 440-2 and associated amplifier. Both signals fed headphones via a mixing pad, voltmeter and oscilloscope. The sound

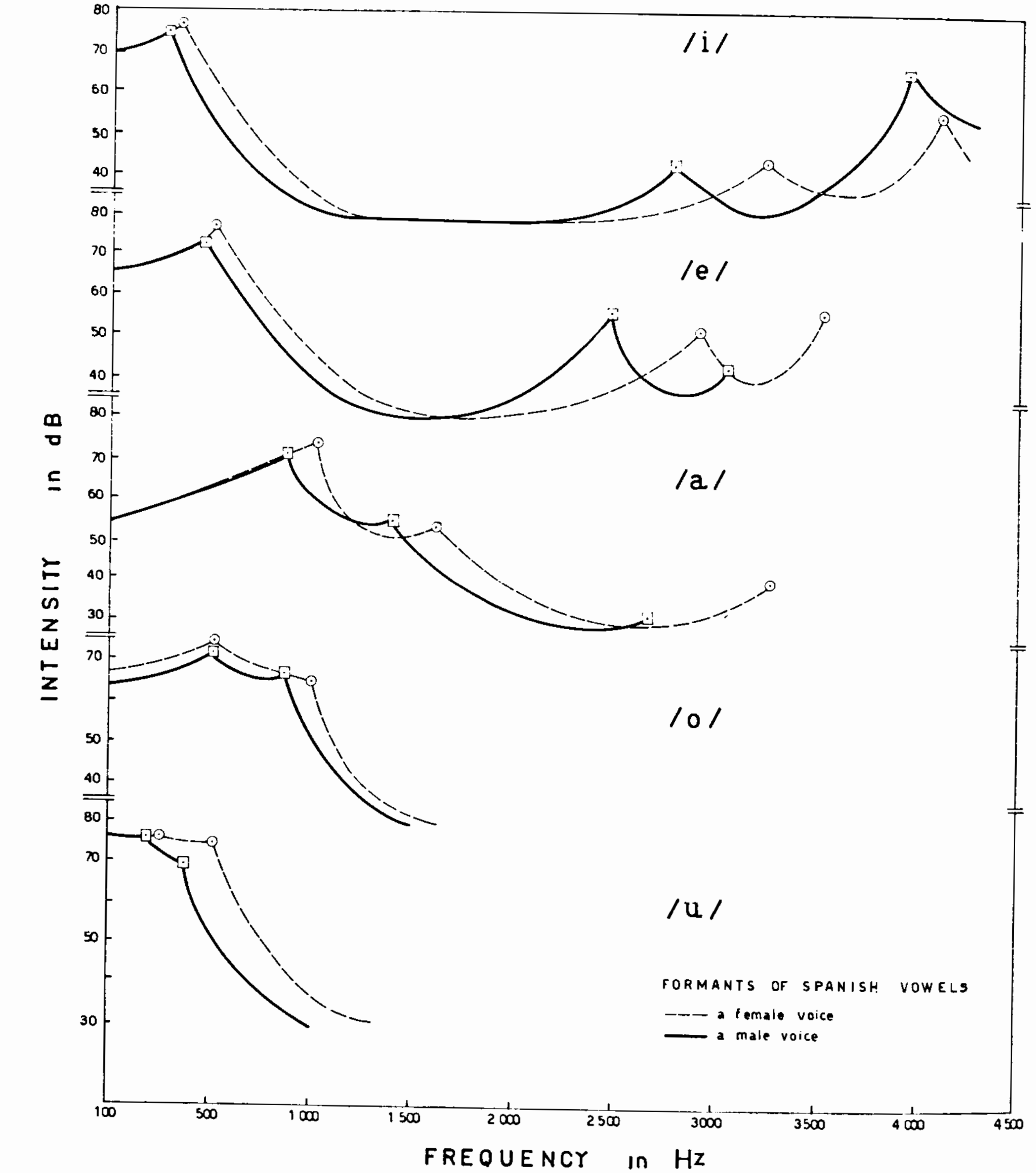

Fig. 4.

pressure levels of the vowels and noise were controlled by the experimenter. The duration of each burst of noise was 300 ms and the duration of the vowel was adjustable. The temporal sequence of the alternate presentations were controlled. Vowels were presented in a random order. In one series the signal-to-noise ratio was -15 dB and in another, -20 dB. Listeners were instructed to increase the duration of the sound between bursts of noise until a given vowel was clearly recognized.

Listeners adjusted the duration of the vowel using a knob on the Electronic Switch. Following preliminary instructions, in one session they were told to set the thresholds of recognition in an ascending series, in another, in a descending series. Listeners with no training in phonetics reported that they detected first a vowel-like sound. Then, as they increased the duration of the vowel there was an interval of uncertainty. This interval was shorter for [i] than for [e] and [u]. These experiments yielded thresholds of identification with a mean duration for each vowel of about 25 ms. The range varied, subject by subject, but was approximately 10 ms for all vowels except [u] in which case the range was about twice as large. Experimental results remained essentially unchanged when the intensity level was raised by 5 dB. When errors of identification occurred the confusions were with the adjacent vowels of the map.

4. CONCLUSIONS

Data from the foregoing experiments yield a preliminary answer to questions about the boundaries of the five 'classical' Spanish vowels in Argentine. Three of the sounds overlap with three cardinal vowels and acoustically are almost equivalent to three North American English vowels. Those instances are [i] as in *heed*, [ɪ] as in *hid* (not hate) and [ɔ] as in *hawed*. Spanish [u] seems to have no close correspondence either in the cardinal vowels nor in the North American English system. Because of a low *F*2 this vowel is in the lowest position of all that are shown on the maps. Finally, Spanish [a] falls between the vowels of *hud* and *hod*. This vowel is near the Cardinal [a]. As for the recognition of Spanish vowels when the sounds are presented between two adjacents bandwidths of white noise, duration seems to remain essentially the same. Perhaps the noise is partially masking the vowel-like sounds until the threshold of recognition is reached. Once identified — at about 25 ms — all vowels are equally intelligible.

Laboratorio de Investigaciones Sensoriales
Facultad de Medicina
Universidad de Buenos Aires

BIBLIOGRAPHY

Cárdenas, D.
1960 "Acoustic Vowel Loops of Two Spanish Idiolects", *Phonetica* 5:9-34.
Ladefoged, P.
1969 *Three Areas of Experimental Phonetics* (London, Oxford University Press).
Peterson, G.E. and H.L. Barney
1952 "Control Methods Used in a Study of Vowels", *Journal of the Acoustical Society of America* 24:175-184.
Skelton, R.
1950 "Spectrographic Analysis of Spanish Vowel Sounds", unpublished Ph.D., dissertation (University of Michigan).

DISCUSSION

GREGG (Vancouver)

In some dialects of English — the Scotch-Irish group — a stressed vowel like that in "bit" may undergo lengthening and is articulated as [e:] 'normal' Scotch-Irish [bɪt] 'boot', South Irish dialect of N. Antrim [be:t] 'boot'. In open syllables the corresponding vowel is [e:] in almost all South Irish dialects: [de:] 'do' (as well as [de:] 'day').

GODFREY (Dayton, Ohio)

Can you compare isolated vowels with vowels in context?

GUIRAO

Our first aim was to calibrate our vowels and the cardinal vowels are still useful for that purpose. As for the English vowels, it seems to me that we don't have in our system the equivalent for the h/d context. We don't have at the beginning of a syllable an aspiration preceding a vowel.