The mid central vowel [ə] in Thai

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This paper investigates the first two formants of the Thai vowels in both citation and speech forms of a native male speaker. The speech data is obtained from a telephone recording. The degree of vowel centralization in speech is demonstrated and a discussion pertaining to the role of the mid central vowel [ə] in the Thai vowel system is given.

1. Introduction

Thai is known to have nine contrastive vowels with short and long distinctions. The vowels are traditionally labeled with High, Mid, Low height-distinction together with Front, Central or Back Unrounded, and Back (Rounded) distinction. The vowel system has been characterized by linguists of the American school as /i, i̱, or y, u, e, ə, o, ɛ, or æ, a, ɔ/ (Abramson 1962, Haas 1964, Noss 1964, Gedney 1972, Sarawit 1977, etc.), and by those of the British school as /i, ɯ, u, e, ɤ, or ə, o, ɛ, a, ɔ/ (Henderson 1975, Jones in Grierson 1928, etc.). The latter set with /ɤ/ is used by Kalaya and Abramson (1993) to describe Modern Thai. Interestingly, Henderson (1975) suggested /ɯ/ and /ɤ/ being phonetically back unrounded vowels against central vowels /i̱/ and /ə/ and [ə] as the bypassing vowel in multiple vowel nuclei. However, Henderson (1976), in discussing Daniel Jones's description of Thai vowels (cf. Grierson 1928), noted /ɯ/ and /ə/ without /ɤ/, with both /æ/ and /ɛ/ for the low front vowel, and [i̱, ʌ, ə] for /i, u, a/ in diphthongs. The choices of these symbols are impressionistic for some, whereas for others they are the result of an acoustic analysis.

The vowel which is the focus of this study is the so-called 'mid central vowel' or sometimes called 'mid back unrounded vowel', /ə/ in one description and /ɤ/ in another. The phonetic [ə] or [ʌ] is also known as the reduced vowel of /a/ in unstressed syllables (Henderson 1975, Theraphan 1977, etc., also implied by Kalaya and Abramson 1993). Moreover, the phonetic [ə] has been claimed to be the reduced vowel of non-high vowels in unstressed CVC syllables with high vowels reducing to their lax counterparts (Apiluck 1994). Lax high vowels [ɪ, i̱, ʊ] were earlier noted as allophones of /i, i̱, u/ in diphthongs by Sarawit (1977).

Specifically, our inquiries of the Thai vowel system concern, first, the quality of this so-called 'mid central vowel' and its relative position in the acoustic vowel space within the Thai system. Second, whether or not there is a phonemic vowel /ə/ of the [ə] quality at the center of the vowel space in Thai, and third, the

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relationship this 'mid central vowel' /ə/ has with other vowels in unstressed syllables.

2. Thai vowels: citation vs. speech form

The phonetic schwa [ə] is taken to be the 'indeterminate' vowel of the rest position in English, being the reduced vowel with no phonemic status. It is also used to characterize the reduced vowel of many other languages. The phonemic mid central vowels in English are given the symbols /ɛ/ and /ʌ/ (Clark and Yallop 1995, Ladefoged 1993). In the 1993 IPA vowel chart, [ə] is given no specific location in the vowel diagram but is at the center surrounded by four symbols for mid central vowels; /ɘ, ɜ/ for the close and open mid central unrounded vowel respectively, and /ɵ, ɞ/ for the mid central rounded ones (Fig. 1).

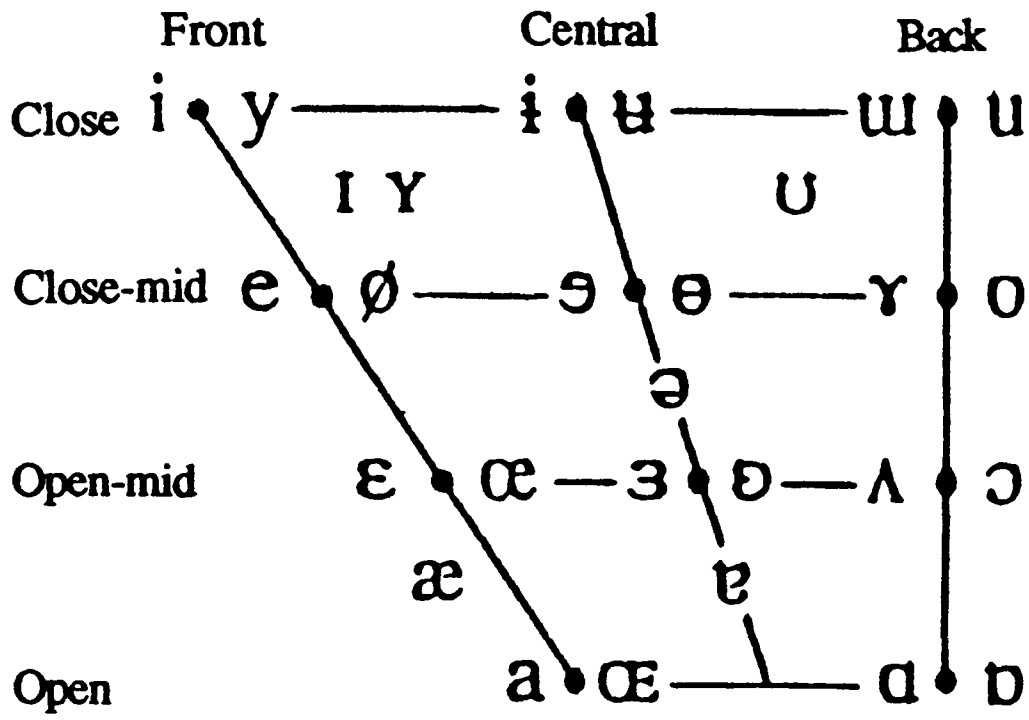

Figure 1. The vowel chart of the International Phonetic Association (IPA), 1993

With the IPA chart and the role of [ə] as the 'default' vowel of the articulatory rest position underlying this study, we investigate the first and second formants of the Thai vowels in both citation and speech forms of an educated male speaker (S), using a Kay Elemetrics CSL 4300 analyzer. The speech data is obtained from a telephone recording. The citation vowels are each recorded in isolated form, long and short, with mid tone, 5 tokens for each vowel. To assure that the data are good representatives of modern Thai, S's citation vowels are compared with the citation vowels obtained from other five educated male speakers, (whose data were partly collected in co-operation with Siriphan Sriwanyong at Mahidol University). The result shows S's vowels very comparable to those of the average five males (Fig. 2, tables. 1 & 2). Especially, the mid central vowel /ə/, S's is very close to that of the average five males. Only his high and low central vowels /i/ and /a/ differ somewhat from other males in the F1 values.

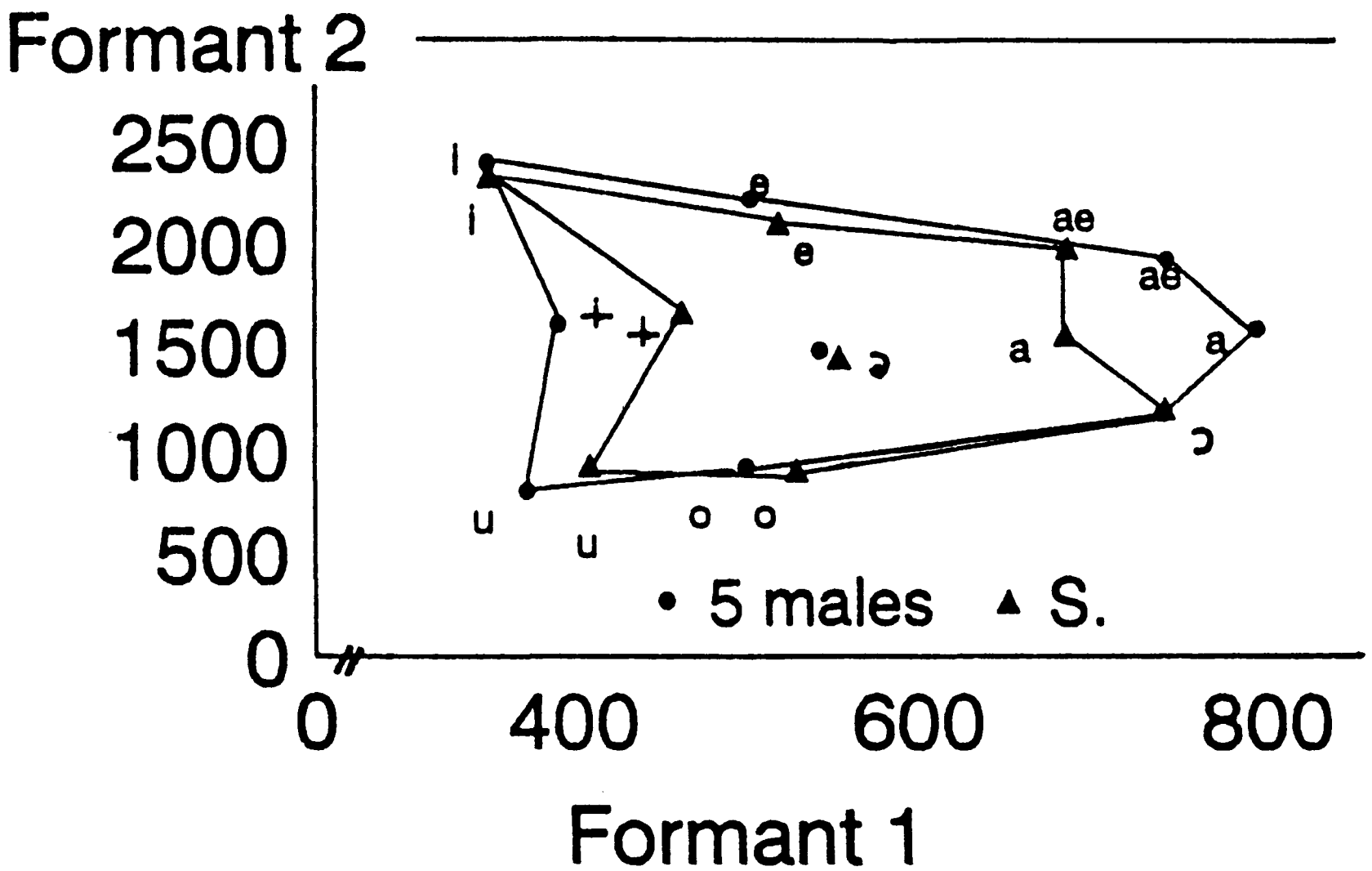

Figure 2. Citation vowels: S's vs. average five males

2.1 The position of /ə/ in the acoustic vowel space

Charting S's citation vowels in an acoustic quadrilateral with the central line drawn (Fig. 3a), /ə/ is found to fall right behind the central line in the mid-height region whereas /ɨ/ and /a/ fall close on the line. However, if the quadrilateral is divided up into three regions for front, central, and back vowels (Fig. 3b), /ə/ falls within the mid central region. Thus, it seems the phonetic description of /ə/ can be either mid central or mid back unrounded vowel, depending on how the vowel quadrilateral is divided up in the acoustic space.

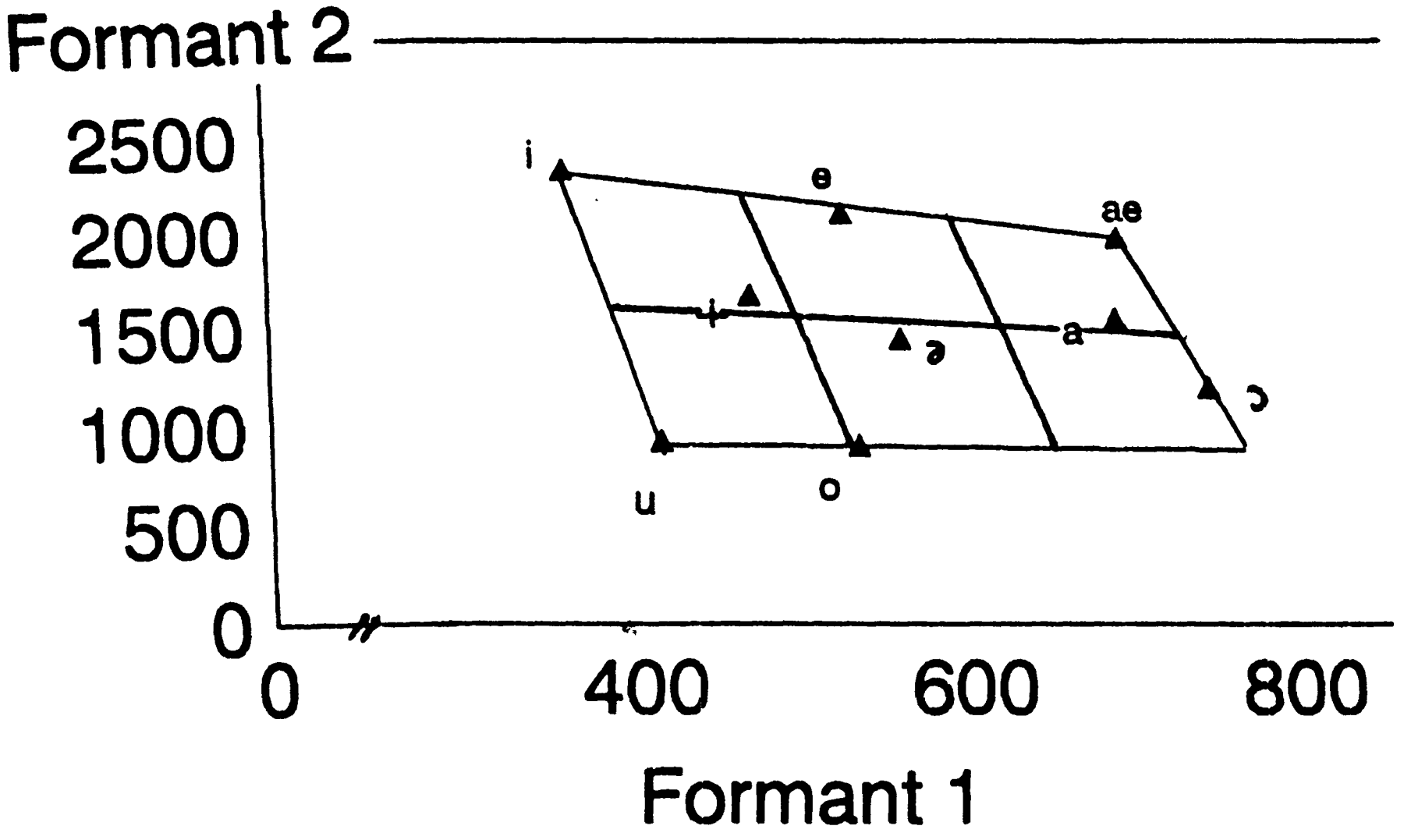

Figure 3a. S's vowels with /ə/ right behind the central line in the mid region

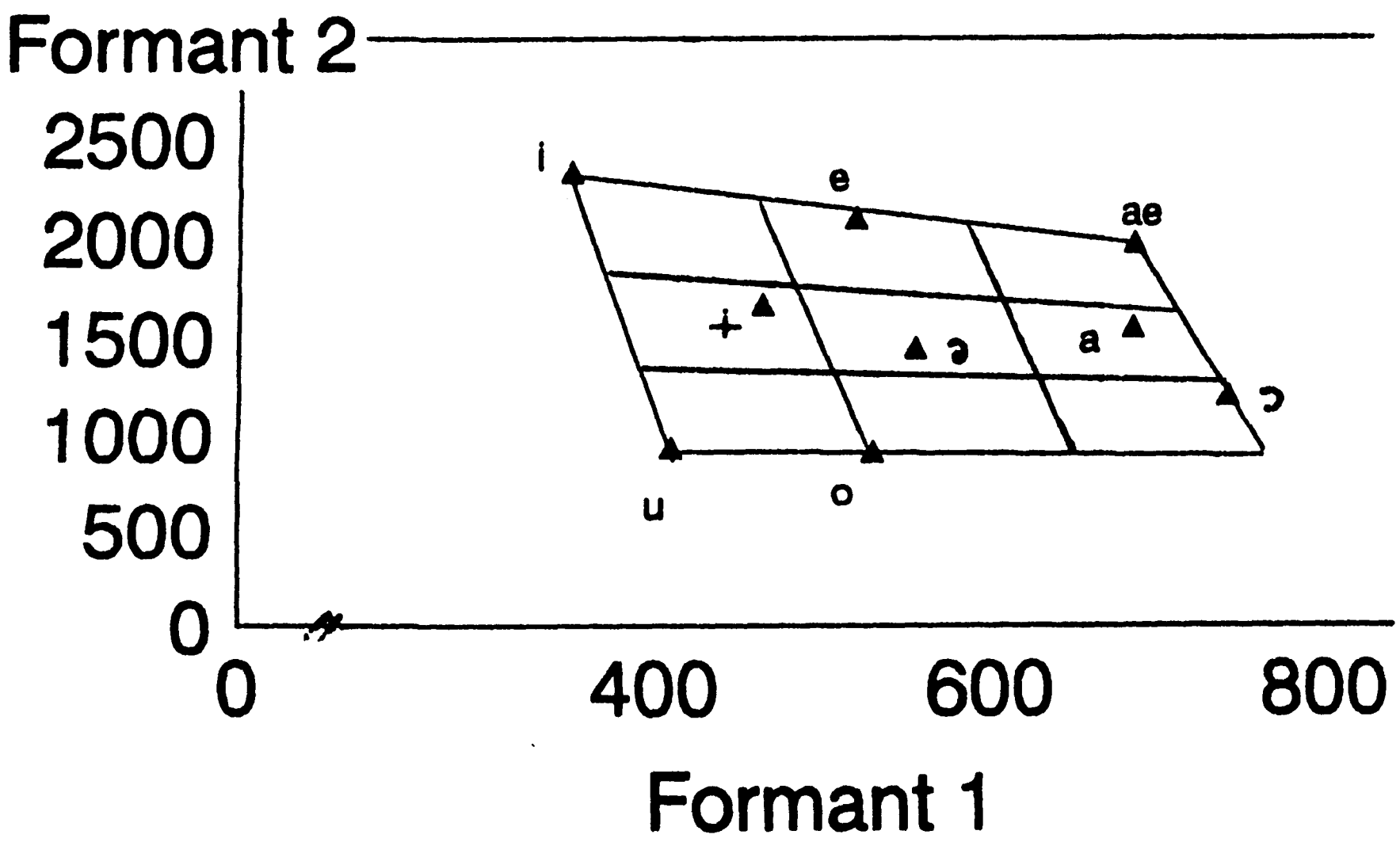

Figure 3b. S's vowels with /ə/ in the mid central region

Table 1. Average first and second formants (in Hz.) of citation vowels (V) from five males

	i	ɨ	u	e	ə	o	æ	a	ɔ
F1	352	393	374	505	545	502	744	796	742
(S.D.)	(40)	(24)	(22)	(45)	(52)	(38)	(51)	(54)	(38)
F2	2400	1611	809	2219	1480	921	1926	1585	1176
(S.D.)	(137)	(144)	(52)	(118)	(120)	(45)	(81)	(79)	(54)
n	24	24	24	24	24	24	24	24	24

Table 2: Average first and second formants (in Hz.) of citation vowels (V) from speaker S (male)

	i	ɨ	u	e	ə	o	æ	a	ɔ
F1	352	465	411	521	556	531	687	686	743
(S.D.)	(22)	(36)	(44)	(13)	(29)	(17)	(13)	(44)	(12)
F2	2335	1674	930	2108	1450	908	1982	1557	1202
(S.D.)	(28)	(41)	(14)	(31)	(17)	(27)	(17)	(40)	(12)
n	5	4	4	5	5	5	5	5	4

Table 3: Average first and second formants (in Hz.) of speech vowels (V) from speaker S (male)

	i	ɨ	u	e	ə	o	æ	a	ɔ
F1	467	483	531	538	548	532	n.a.	603	n.a.
(S.D.)	(55)	(0)	(87)	(34)	(35)	(72)		(64)	
F2	2296	1704	1104	1803	1595	1160	n.a.	1552	n.a.
(S.D.)	(84)	(51)	(220)	(150)	(119)	(139)		(179)	
n	3	2	3	7	4	6	0	62	0

Acoustically, /ə/ seems to occupy the mid central or mid slightly back location in the vowel space. Thus, either /ə/ or /ɤ/, or even /ɘ/ is an appropriate symbol for the vowel in the phonological system. The choice depends on one's perspective on the vowel quadrilateral.

2.2 The centralization of /ə/ in speech

The idealized [ə] of an average Caucasian adult male, according to the Source Filter Theory, has the first three formant F1, F2, and F3 values of 500, 1500, and 2500 Hz., respectively (Clark & Yallop 1995 cf. Fant 1960, Pickett 1980). The average vocal tract length is approximately 17.5 cm. The formant frequencies are compared to the resonances of a uniform tube resonator with one open end, which can be calculated from the equation: $F_n = c *(2n-1)/ 4l$, where c = sound velocity in air (34,000 cm./sec.), and l = vocal tract length. Such is the vowel in the center of the vowel space, the reference vowel of the rest position.

Since the vocal tract length of 17.5 cm. cannot be the average of an adult male speaker of Thai, a measurement was made on an X-ray film of speaker S at the Rama IX hospital, Bangkok. The approximate vocal tract length obtained was 15.5 cm. The measurement was made from lips to glottis during articulators at rest,

i.e., at the position of [ə]. The first and second formant frequencies calculated from this idealized [ə] are 548 and 1645 Hz. accordingly.

To test whether the average value of /ə/ in S's speech (F1 = 548 Hz., F2 = 1595 Hz.) is representative of the rest position at the center of the vowel space, i.e., it does not differ significantly from the idealized vowel [ə], we calculate the difference (δ) of the distance (D_1) between each speech vowel /ə/ and the average speech /ə/, and the distance (D_2) between each speech vowel /ə/ and the idealized [ə]. Then test the significance (pair t-test) of the difference of the two distances. The method is adapted from the test of vowel centralization of Poch-Olivé and Harmegnies (1995).

$$D_1 = \sqrt{(F1 - 548)2 + (F2 - 1595)2}$$

$$D_2 = \sqrt{(F1) - 548)2 + (F2 - 1645)2}$$

$$\delta = D_1 - D_2$$

The result yields no statistically significant differences between the two distances (t = .009, p > .05). This seems to indicate that S's average speech /ə/ is of the quality of the idealized [ə], and its centralization is representative of the vowel of the rest position (Fig. 4)

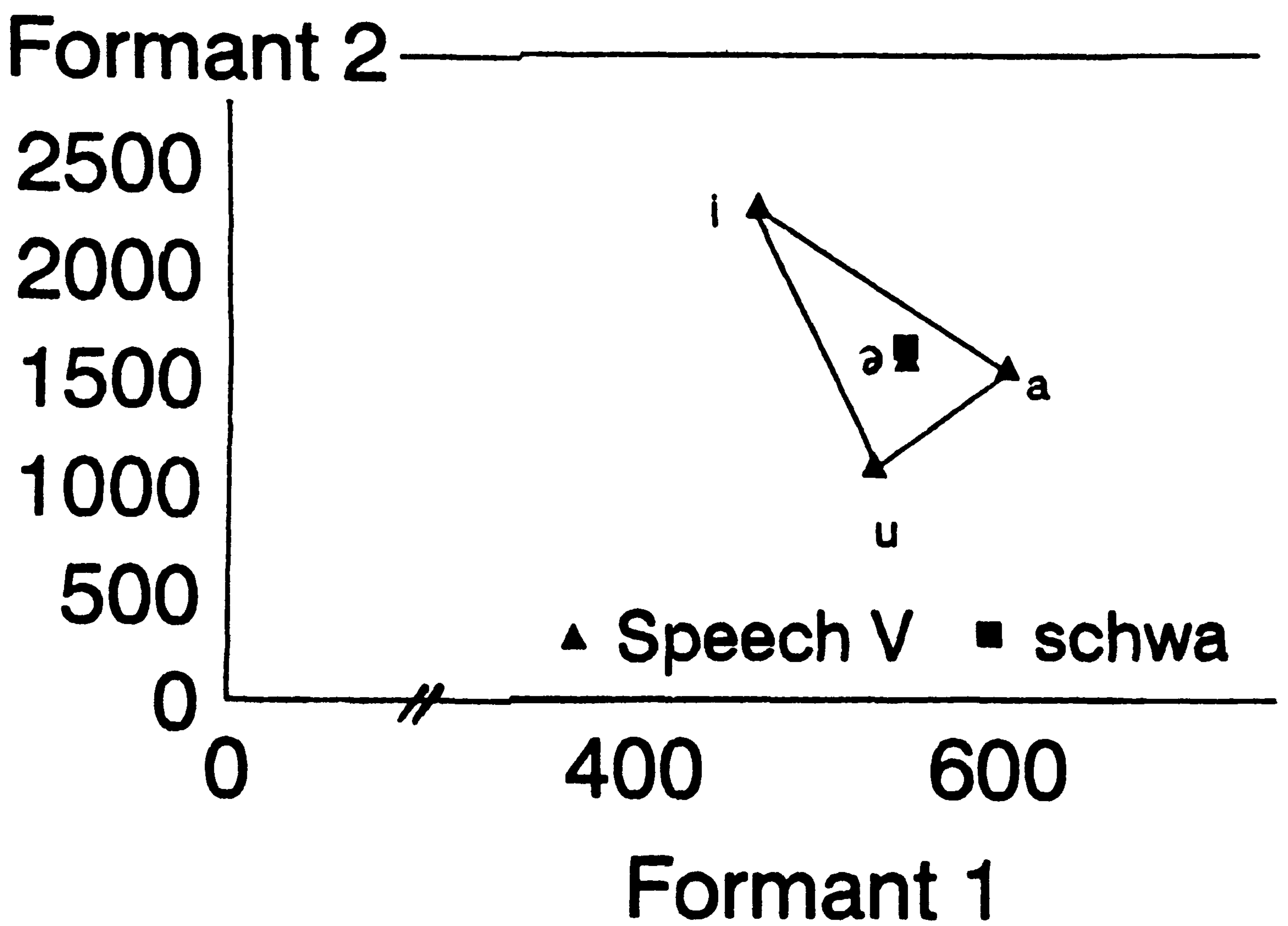

Figure 4. S's speech /ə/ and his idealized [ə].

2.3 Citation /ə/, speech /ə/, and vowel reduction

Thai CVC syllables are usually unstressed when occurring in a non-word-final position (Theraphan 1977, Apiluck 1994, etc.). Single vowels in S's speech data except for /u/ are most likely to be unstressed since they were taken from CVC syllables. Only /u/ was taken from the first member of a diphthong in all the test tokens. The issue that concerns us here is the relationship the mid central vowel /ə/ has with other vowels in unstressed syllables in Thai. Since S's average speech /ə/ has been shown to be comparable to the idealized [ə] of the rest position (cf. 2.2 above), it is not unreasonable to assume it to be the centralized vowel toward which vowel reduction is aimed. The degree of vowel centralization can thus be measured against this vowel, the average /ə/ of S's speech where F1 = 548 Hz. and F2 = 1595 Hz.. Whether or not all of S's citation vowels reduce to [ə] in speech can be demonstrated in their degree of centralization.

Based on Poch-Olivé and Harmegnies (1995), for each vowel V_i, the degree of vowel centralization is measured by the difference (δ) of the distance (D_C) between each citation vowel V_i and the central vowel, and the distance (D_S) between the speech vowel V_i and the central vowel.

$$\delta = D_C - D_S$$

$$D = \sqrt{(F1 - 548)2 + (F2 - 1595)2}$$

The result is summarized in table 4 below.

Table 4. The Degree of Vowel Centralization in Thai by Speaker S (male). (Student's pair t-test)

Vowel	$\delta = D_C - D_S$	t	p
i	77.51	1.7540	n.s.
ɨ	3.25	0.7068	n.s.
u	174.48	1.5039	n.s.
e	250.88	5.9535	< .05
ə	44.66	3.1517	n.s.
o	202.52	4.2753	< .05
a	97.26	6.3694	< .05

For non-high vowels available in the data /o, e, a/, all show a significant degree of vowel centralization (cf. Figs. 5 & 7). For high vowels, /i, ɨ, u/ however, none shows a significant degree of centralization. Most interestingly, /ə/ does not show significant differences in centralization, which can be interpreted as having no significant differences between citation /ə/ and speech /ə/ in general (cf. Figs. 6 & 7).

Speech /e, a/ (Fig. 7) seem to reduce to the mid central region, with /a/ moving toward the low-mid central region. Thus, [ə] seems to be the reduced vowel of both /e/ and /a/. For /o/, the region it reduces to can be represented by either /ə/, /ɤ/, or /ʊ/.

As to the qualities of the reduced high vowels (cf. Fig. 7), the positions of speech /i, ɨ, u/ can be said to be close to those of their lax counterparts [ɪ, ɨ, ʊ] in the acoustic quadrilateral.

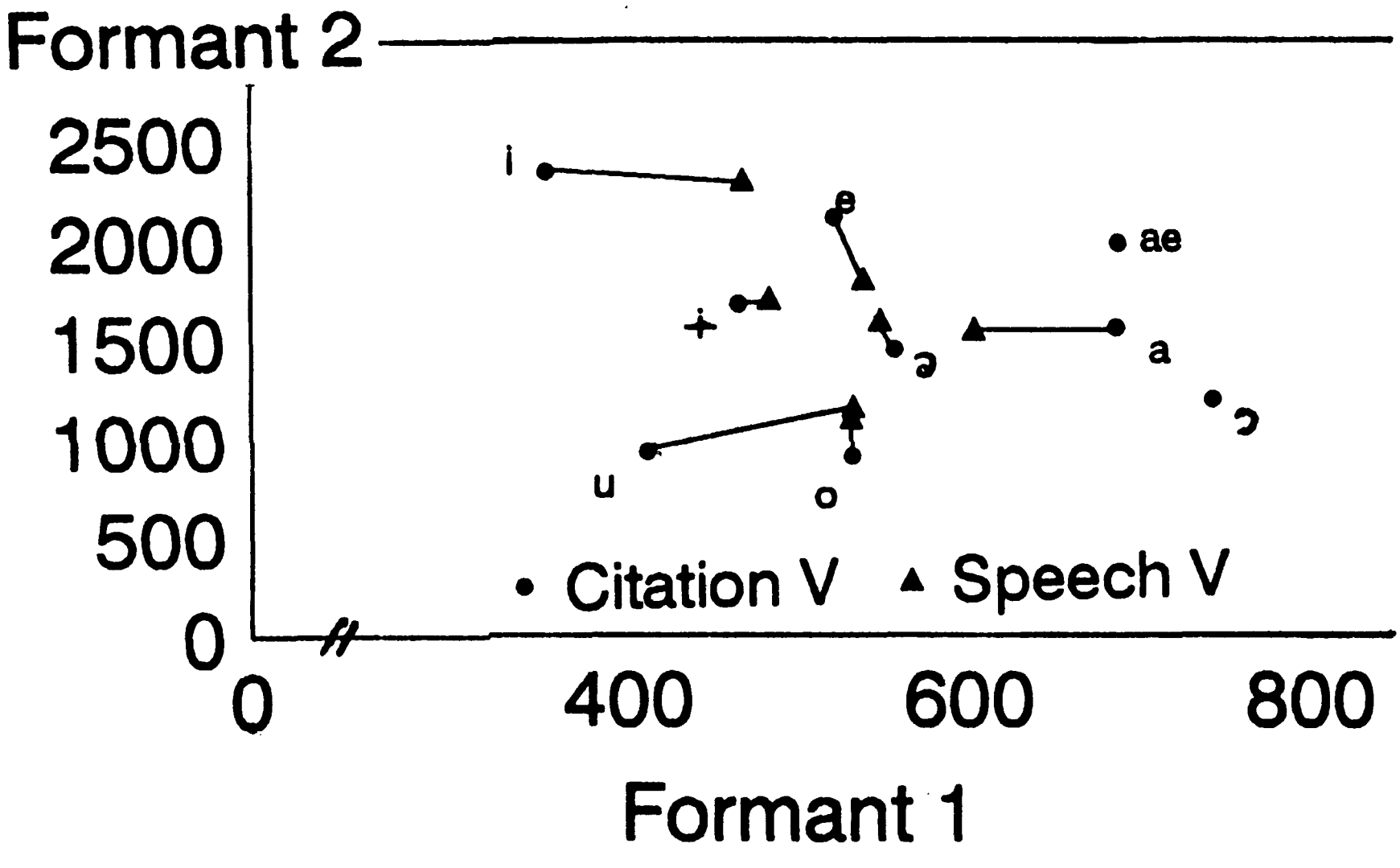

Figure 5. S's citation vs. speech vowels demonstrating vowel movement

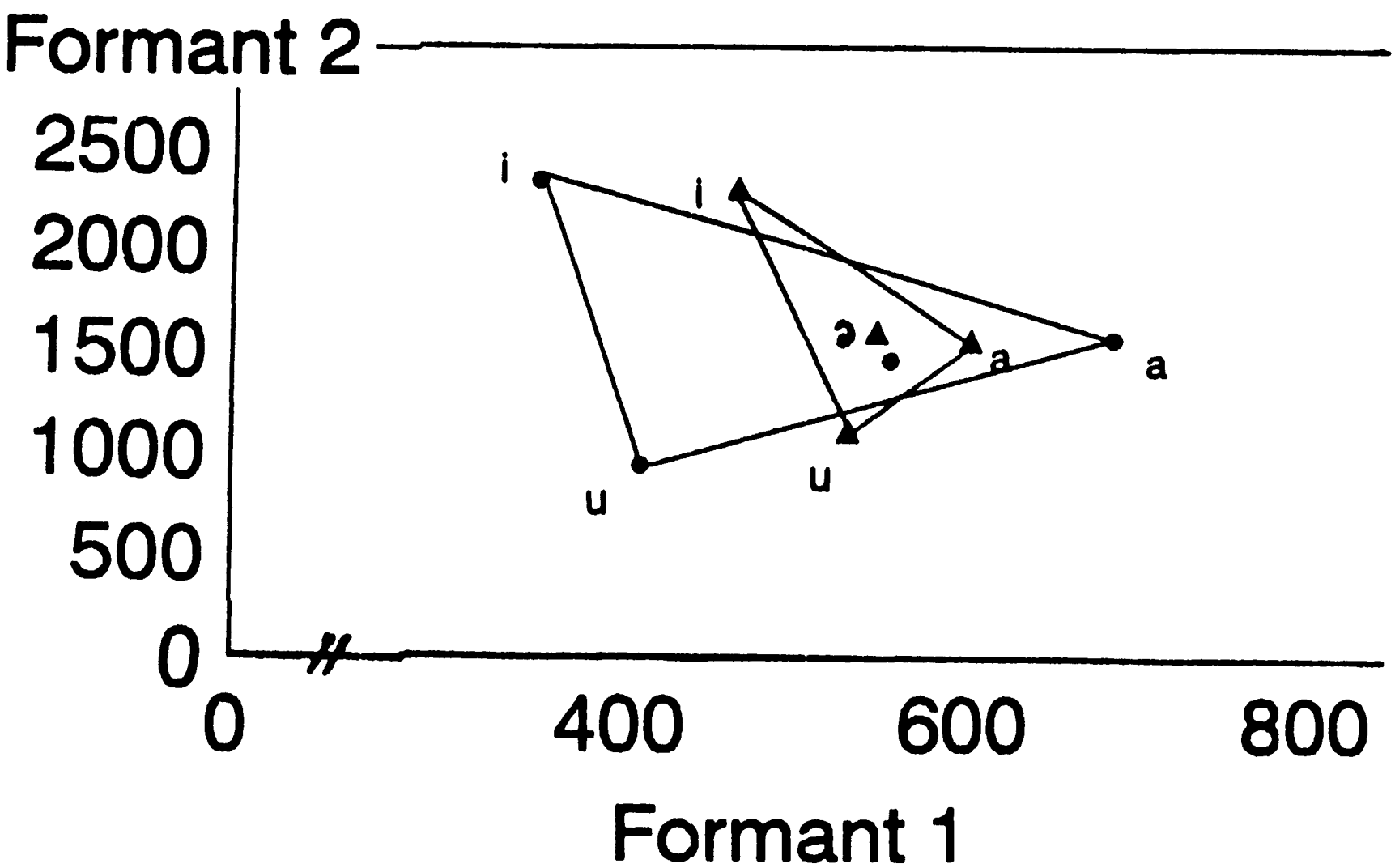

Figure 6. S's citation vs. speech vowel space showing the relative positions of his citation /ə/ and speech /ə/

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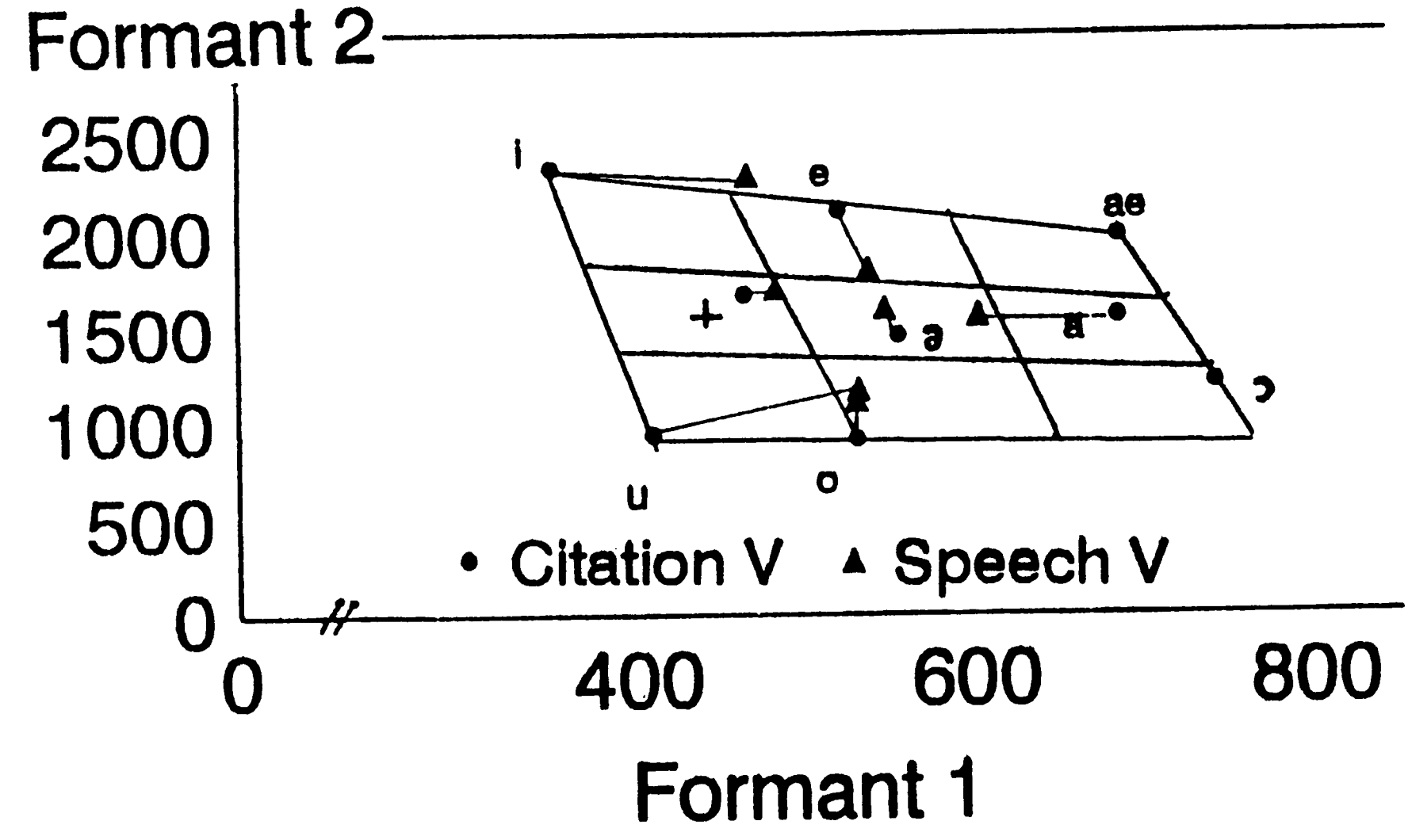


Figure 7. S's citation vs. speech vowels showing relative positions of reduced vowels in the vowel quadrilateral

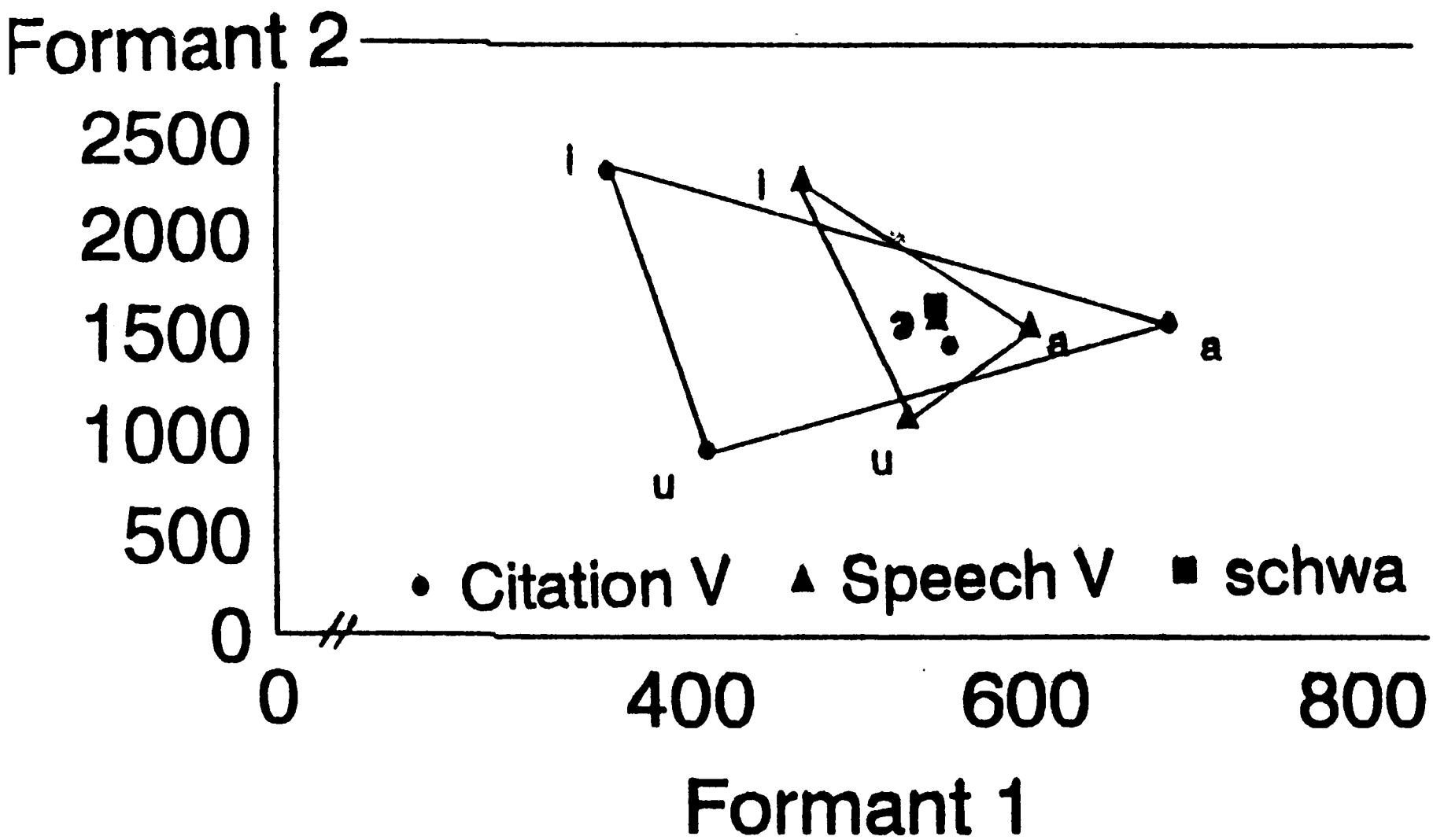


Figure 8. The mid central vowel /ə/ in citation and speech vs. the idealized schwa

The different contributions F1 and F2 values have to the size of δ are quite obvious (Tables 2-4). Since S's speech /ə/ has been shown to be comparable to the idealized [ə], and his citation /ə/ does not differ significantly from the speech /ə/. A phonemic vowel /ə/ of the [ə] quality is not improbable.

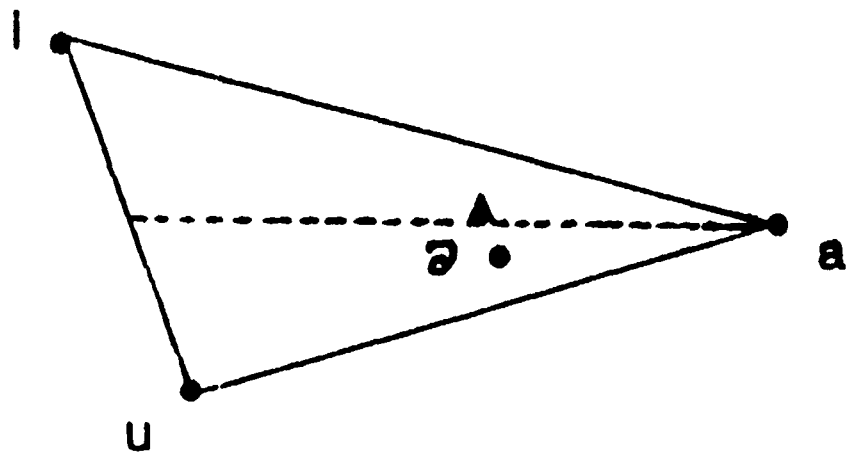
When we compare citation /ə/ with the idealized [ə] in different settings (Figs. 9-12), different inferences can be made about their relationship. First, in an i-a-u citation vowel space, /ə/ either falls in the back region or off the line separating central and back region (Figs. 9a & b), whereas the idealized [ə] is in the central region or on the central line. However, when we compare the idealized [ə] with speech /ə/ in an i-a-u speech vowel space, /ə/ and [ə] are comparable on the central line or within the central region (Figs. 10a & b).

On the other hand, when an acoustic quadrilateral is drawn for the citation vowels, /ə/ and [ə] are drawn apart by the central line (Fig. 11a). But when the quadrilateral is divided into three regions for front, central, and back vowels, both /ə/ and [ə] fall within the central region (Fig. 11b). It is also confirmed in Fig. 12 that both citation and speech /ə/'s are within the mid central region comparable to the idealized [ə]

The implication from these comparisons is that a phonemic vowel /ə/ of the [ə] quality is plausible. The choice, it seems, is the perspective of the linguist. Given the 1993 IPA chart, /ɤ/ as the phonemic symbol is preferable, leaving [ə] to characterize the non-high reduced vowels in Thai.

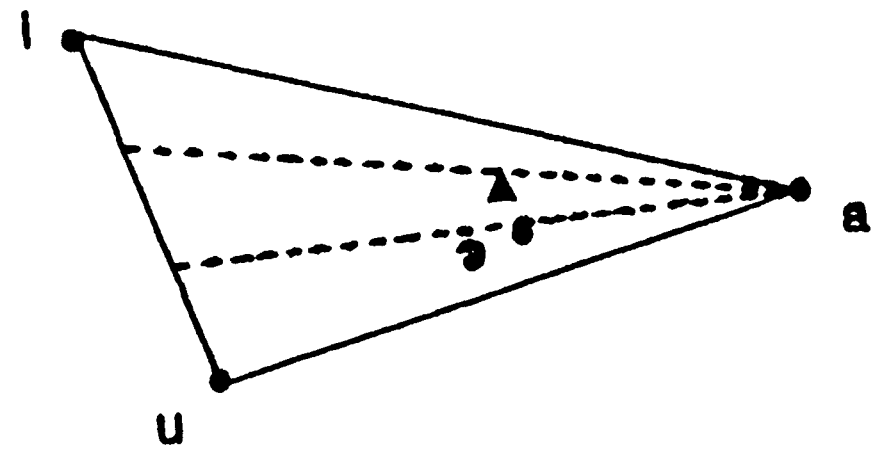
3. Summary

The three issues raised at the beginning seem to have all been answered. The so-called 'mid central vowel' or sometimes 'back unrounded vowel', /ə/ or /ɤ/, has an acoustic quality in the mid central, slightly back region. Either 'central' or 'back' is an accurate description depending on how the vowel space is viewed. A phonemic /ə/ of the [ə] quality is plausible. However, given the IPA 1993 vowel chart, /ɤ/ is the preferred symbol for the vowel (a la Kalaya and Abramson 1993). Finally, non-high vowels /e, o, a/ in this data seem to reduce to or toward a centralized location of [ə] in speech. High vowels, more or less, reduce to their lax conterparts. [ə] is best used to symbolize reduced non-high vowels in unstressed syllables.



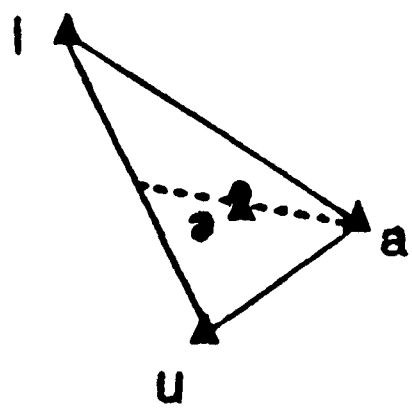
• Citation V ▲ Schwa

Figure 9a. Citation /ə/ vs. idealized [ə] in S's citation vowel space



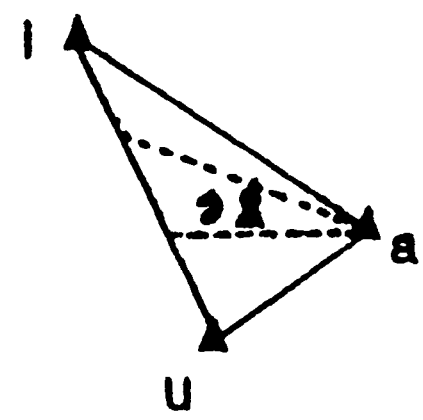
• Citation V ▲ Schwa

Figure 9b. Citation /ə/ vs. idealized [ə] in S's citation vowel space



• Schwa ▲ Speech V

Figuer 10a. Speech /ə/ vs. idealized [ə] in S's speech vowel space



• Schwa ▲ Speech V

Figure10b. Speech /ə/ vs. idealized [ə] in S's speech vowel space

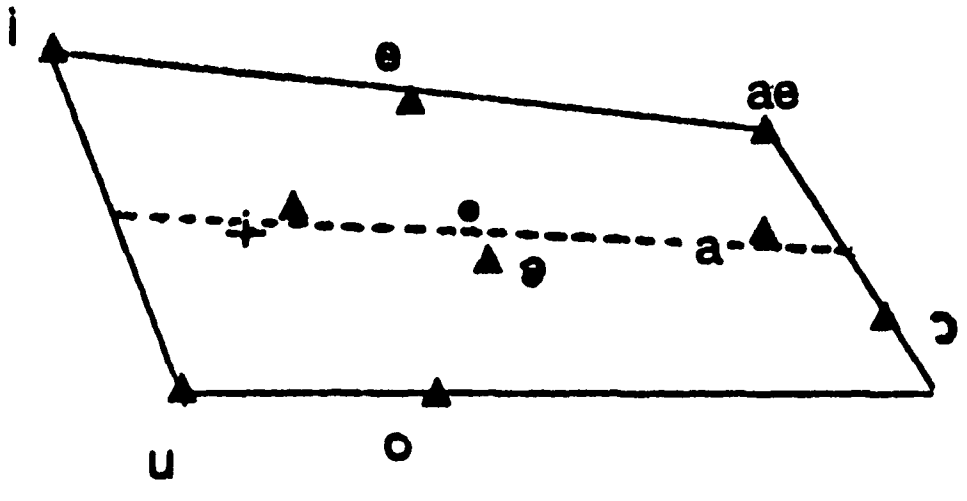


Figure 11a. S's citation /ə/ at the back of of central line

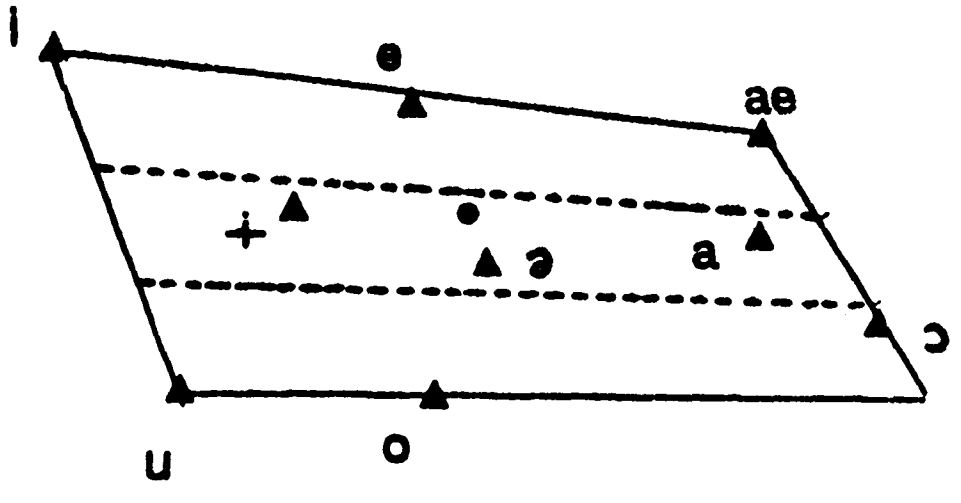


Figure 11b. S's citation /ə/ in the central region of vowel quadrilateral

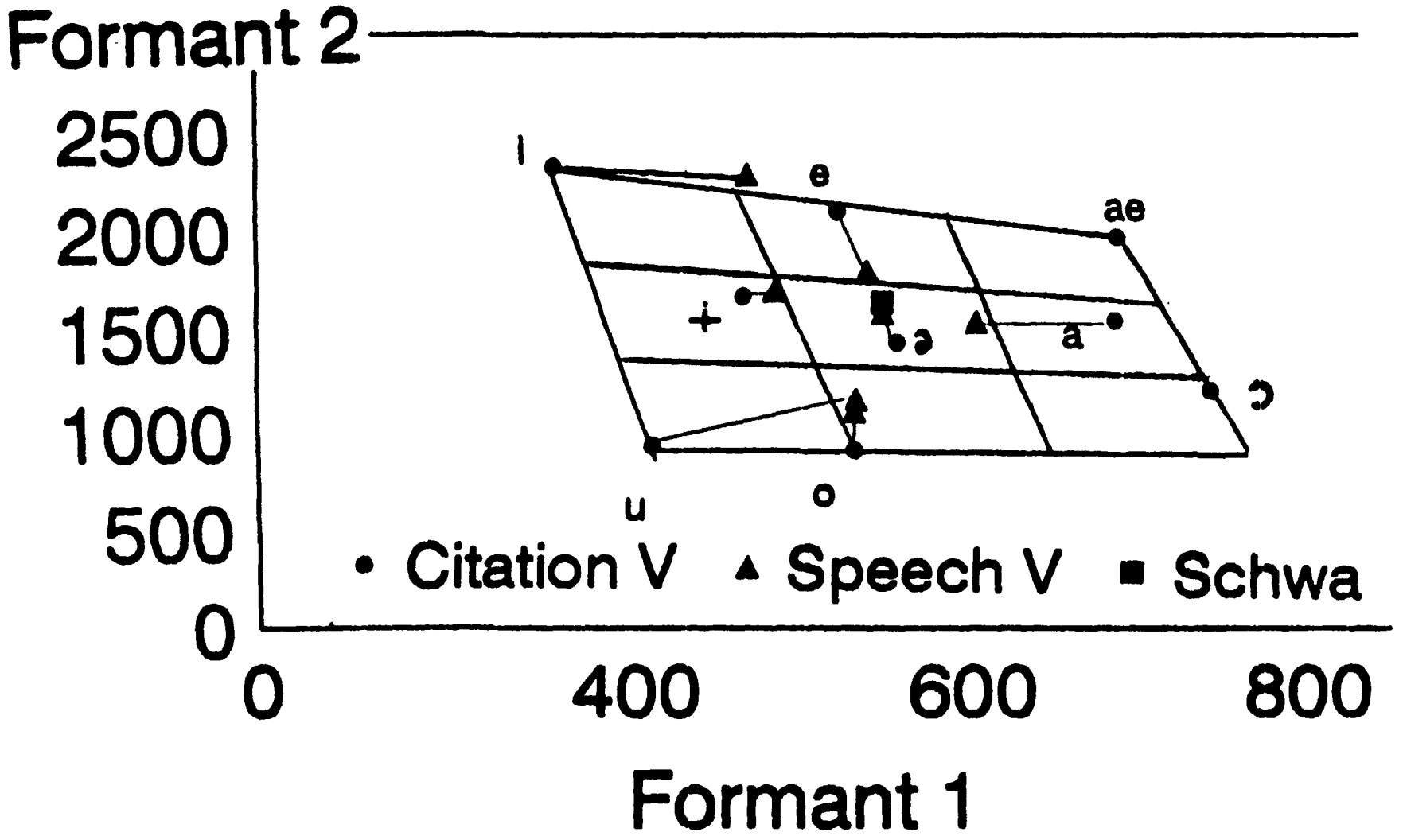


Figure 12. S's citation /ə/, speech /ə/, and idealized [ə] in the mid central region

REFERENCES

Abramson, Arthur S. 1962. *The Vowels and Tones of Standard Thai: Acoustical Measurements and Experiments*. Bloomington: Indiana University.

Abramson, Arthur S., and Nianqi Ren. 1990. "Distinctive vowel length: duration vs. spectrum in Thai." *Journal of Phonetics* 18:79-92.

Apiluck Tumtavitikul. 1994. "The Metrical structure of Thai in a non-linear perspective." Paper presented at the IVth South East Asian Linguistics Society Conference, Bangkok-Chiang Mai. (To appear in *Southeast Asian Linguistic Studies in Honor of Vichin Panupong*).

Clark, John, and Colin Yallop. 1995. *An Introduction to Phonetics and Phonology,* Oxford: Blackwell.

Gedney, William. 1972. "A Puzzle in comparative Tai phonology." In *Tai Phonetics and Phonology,* eds. Jimmy G. Harris and Richard B. Noss, pp. 52-57. Bangkok: Central Institute of English Language.

Grierson, George A. 1928. Linguistic Survey of India, Vol. I, Part II. Calcutta & Delhi: Motilal Banarsidaa.

Haas, Mary. 1964. *Thai-English Student's Dictionary*. Stanford: Stanford University.

Henderson, Eugénie J.A. 1975. "Phonetic description and phonological function: some reflections upon back unrounded vowels in Thai, Khmer and Vietnam." In *Studies in Tai Linguistics in Honor of William J. Gedney,* eds. Jimmy Harris and James Chamberlain, pp. 259-270. Bangkok: Central Institute of English Language.

Henderson, Eugénie J.A. 1976. "Thai Phonetics sixty years ago: gleanings from the unpublished notes of Daniel Jones." In *Tai Linguistics in Honor of Fang-Kuei Li*, eds. Thomas W. Gething, et al., pp. 162-170. Bangkok: Chulalongkorn University.

Ladefoged, Peter. 1993. *A Course in Phonetics*. Forth Worth: Harcourt Brace Jovanovich.

M.R. Kalaya Tingsabhadh and Arthur S. Abramson. 1993. "Thai." *JIPA* 23.1:24-28

Noss, Richard. 1964. *Thai Reference Grammar*. Washington, D.C.: Foreign Service Institute.

Pickett, J. M. 1980. *The Sounds of Speech Communication*. Baltimore: University Park Press.

Poch-Olivé, D. and B. Harmegnies. 1995. "A Dynamic approach of vowels systems in Italian." *The Proceedings of the XIIIth International Congress of Phonetic Sciences*. Stockholm: Royal Institute of Technology and Stockholm University.

Sarawit, Mary. 1977. *Linguistics I: Phonology*. Pisnuloke: Srinakharinwirot University.

Theraphan Luangthongkum. 1977. "Rhythm in Thai." Unpublished Ph.D. dissertation, University of Edinburgh.

Received: 6 November 1995

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