Ann. Bull. RILP, No. 12, 97-112 (1978)

A STUDY OF THE ACCENTUAL EFFECT ON SEGMENTAL AND MORAIC DURATION IN JAPANESE

F. Mitsuya and M. Sugito*

Abstract

It is well known that an accented vowel segment is longer in duration than its corresponding unaccented segment. Whether or not this is systematically true with Japanese was investigated in this study using wide band soundspectrograms for analysis. Attention was also paid to the duration of consonant segments and morae. The material were one- and two-mora nonsense words, framed with a carrier sentence, and the subjects were three Tokyo dialect speakers.

The effect of accent on segmental duration is present only in the vowels of one-mora words. It is not observed systematically in two-mora words. The effect of accent on moraic duration is not consistent in our data. Other factors such as segmental and moraic characteristics, juncture, etc. must have been involved, especially in two-mora words, and they are presumed to be stronger and more dominant factors than accent. Accent is certainly a relevant factor in duration, but only when these other, more dominant factors are absent or less. Though the data in this study are limited in kind and quantity, it is concluded that accent is not a primary factor affecting segmental and moraic duration in Japanese.

1. Introduction

Generally, accented vowel segments are longer in duration than the corresponding unaccented vowel segments. This phenomenon has been shown explicitly in the case of Japanese by Han (1962), Hiki et al. (1968), and Oyakawa (1971). However, these results require more experimentation and analysis to be able to generalize regarding this phenomenon. In addition, it might be interesting to pay attention to moraic duration as a unit affected by accent since the Japanese mora is generally believed to be stable or almost constant in its duration. In this study we investigate the effect of accent on segmental and moraic duration in Japanese.

* Osaka Shoin Women's College

2. Method

In order to obtain systematic data, nonsense words were used. As one-mora words with and without accent, /a/ , /sa/ and /ma/ were chosen and these words were combined to form two-mora words with and without accent. Only /a/ out of the five Japanese vowels was employed since it is the least devoiced. All the words used in this experiment are shown in Table 1. When the nonsense word happens to be an actual word in the Tokyo dialect, its meaning is included in parentheses.

Table 1. Test words

	Without accent	With accent	
One-mora words	a, sa, ma	$\bar{a}$, $\overline{sa}$, $\overline{ma}$	
Two-mora words	asa	$\bar{a}$sa('morning')	a$\overline{sa}$ ('linen')
	ama ('nun')	$\bar{a}$ma('fisherman')	a$\overline{ma}$
	sasa('bamboo grass')	$\overline{sa}$sa	sa$\overline{sa}$
	sama	$\overline{sa}$ma	sa$\overline{ma}$('Mr. or Ms.')

Each of these test words was framed with a carrier sentence, "Sore o ____ to iu" ('We call that ____'), and the sentence containing the word was repeated twelve times by the subjects. These sentences (216 in all) were randomized in a list. Each of the three Tokyo dialect speakers read the list with his own natural speed for recording. Wide band sound-spectrograms were taken from these recordings. Each utterance of each test word was segmented on the spectrogram according to the following criteria:

/a/: from the onset of voicing or periodic striation in the formants to the cessation of voicing or periodic striation in the formants.

/s/: from the onset to the cessation of frication.

/m/: from the onset of closure to the release.

The mora duration was defined as the length from the initiation of a consonant to the initiation of the next consonant in CVCV words, and that from the initiation of /a/ to the initiation of the next consonant in VCV words.

Thus, all the proper tokens of the test words were measured and examined. Some improper utterances were excluded: for example, utterances that were said wrong and were not corrected by repeating the whole sentence.

3. Results and Remarks

3.1. One-Mora Words

3.1.1. /a/ vs. /ā/

The /ā/ is longer in duration than the /a/ for the speakers M.S. and S.K. H. D's /a/ and /ā/ were not compared because he tended to put a pause before the word /ā/. As Fig. 1 shows the duration of each of M. S.'s and S. K. 's tokens and their cumulative frequencies, the /a/ and /ā/

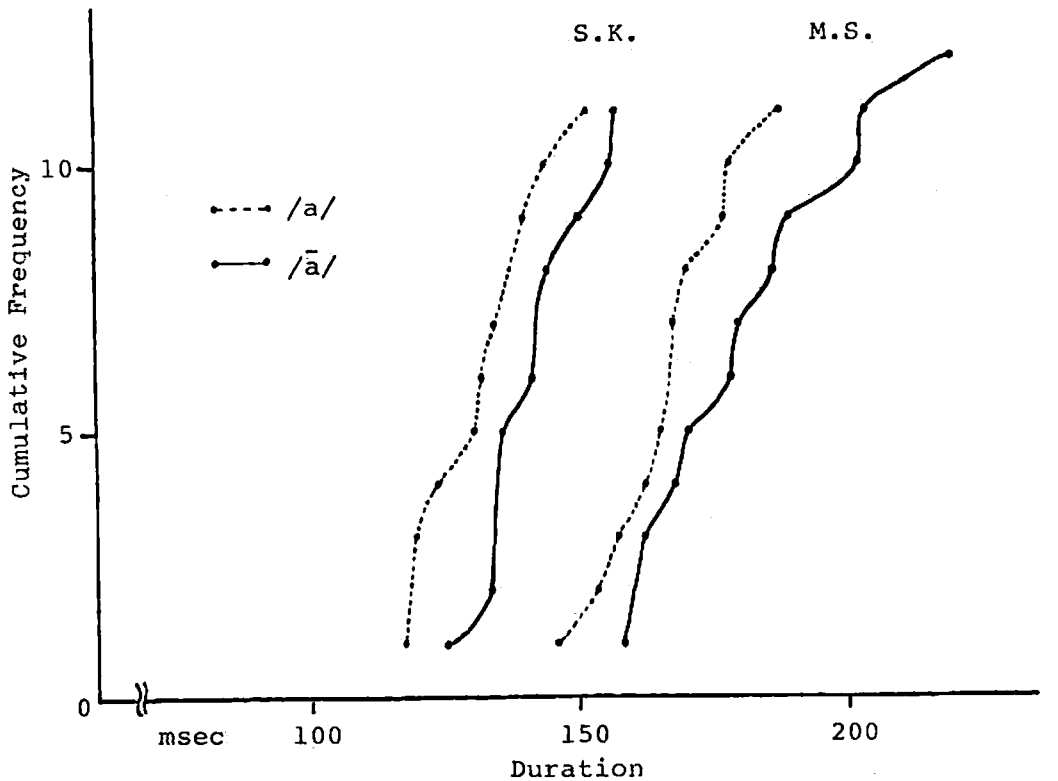

Fig. 1. The duration and frequency of /a/ and /ā/ by M. S. and S. K.

frequency curves of each speaker remain separate. This indicates that the durational difference between /a/ and /ā/ is significant, and this difference is considered to be due to the accentual difference. This significant difference is also certainly reflected in the mean duration of each word, which is shown in Table 2.

Table 2. The /a/ and /ā/ duration

	M S		S. K.	
	/a/	/ā/	/a/	/ā/
Mean	167msec (11)	182msec (12)	132msec (11)	142msec (11)
S. D.	11.9	19.3	11.3	9.8

S. D. : standard deviation

The number in parentheses after the mean value represents the number of utterances used in calculation.

3.1.2. /sa/ vs. /s̄a/ and /ma/ vs. /m̄a/

In these words, too, /ā/ is longer than /a/ for all of the subjects, as shown in Table 3. It is interesting to note in this table that the length of the consonantal segment varies with the individual speakers. In the /sa/ vs. /s̄a/ pair, /s̄/ is longer than /s/ for S. K. and H. D. while /s̄/ is shorter than /s/ for M. S. The same is true with the difference between

Table 3. Durations in /sa/ vs./s̄a/ and /ma/ vs. /m̄a/

/sa/ vs. /s̄a/

		/s/	/a/	/sa/	/s̄/	/ā/	/s̄a/
		msec	msec	msec	msec	msec	msec
M.S.	Mean	124	89	214 (12)	115	93	208 (11)
	S.D.	11.0	6.1	9.7	7.5	7.1	9.5
S.K.	Mean	105	61	165 (12)	109	69	178 (12)
	S.D.	10.8	8.3	6.1	10.5	6.1	9.9
H.D.	Mean	94	51	146 (12)	105	56	161 (12)
	S.D.	4.7	3.1	6.1	8.7	6.8	8.4

/ma/ vs. /m̄a/

		/m/	/a/	/ma/	/m̄/	/ā/	/m̄a/
		msec	msec	msec	msec	msec	msec
M.S.	Mean	82	97	179 (12)	76	102	178 (12)
	S.D.	11.3	5.3	10.6	8.6	7.1	9.3
S.K.	Mean	88	84	172 (12)	94	89	183 (12)
	S.D.	14.2	5.1	14.5	11.2	5.1	14.1
H.D.	Mean	70	69	139 (12)	79	74	151 (12)
	S.D.	5.1	8.1	7.5	8.4	5.1	6.3

/m/ and /$\bar{m}$/ in /ma/ vs. /$\overline{ma}$/. Moreover, turing to moraic duration, we find /$\overline{sa}$/ and /$\overline{ma}$/ much longer than /sa/ and /ma/, respectively, for S. K. and H. D.; while M. S. 's /$\overline{sa}$/ is a little shorter than her /sa/, and her /$\overline{ma}$/ and /ma/ are almost the same length. Thus, in S. K. 's and H. D. 's speech accent affects the duration of every segment and accordingly that of the mora as a whole. On the other hand, in M. S. 's speech, only the vowel segment is lengthened by accent, and as a result the consonant is shortened. Individual characteristics of speakers can be a factor in segmental duration as well as in other speech phenomena. In any case, what is common here is that accent has lengthened the vowel segment of all three speakers.

3.2. Two-Mora Words

3.2.1. Accent on the First Mora

3.2.1.1. /a_1sa_2/ vs. /$\bar{a}_1sa_2$/ and /a_1ma_2/ vs. /$\bar{a}_1ma_2$/

The data of M. S. and S. K. are analyzed as shown in Table 4. The speaker H. D. 's data are not considered here because of his tendency to put a pause before /āsa/ and /āma/.

In the pair /a_1sa_2/ vs. /$\bar{a}_1sa_2$/, the effect of accent is observed in /$\bar{a}_1$/ for both speakers: /$\bar{a}_1$/ is longer than /a_1/. There is little difference in the length of /s/ and /a_2/ for M. S. and S. K., and consequently no difference in the mora /sa_2/ itself. The difference in the first mora appears to be reflected in the difference in the duration of the word The word /$\bar{a}_1sa_2$/ is longer than /a_1sa_2/.

Table 4 (Part I)

/a_1sa_2/ vs. /$\bar{a}_1sa_2$/

			a_1	s	a_2	sa_2	a_1sa_2
			msec	msec	msec	msec	msec
M.S.	/a_1sa_2/	Mean	152	102	93	194	348 (12)
		S.D.	9.9	5.1	4.3	6.9	10.2
	/$\bar{a}_1sa_2$/	Mean	168	102	91	193	362 (12)
		S.D.	15.3	3.9	4.5	4.5	15.6
S.K.	/a_1sa_2/	Mean	124	77	62	139	264 (12)
		S.D.	8.5	11.3	8.2	8.1	10.5
	/$\bar{a}_1sa_2$/	Mean	132	78	61	139	272 (11)
		S.D.	11.5	15.0	12.8	6.4	14.0

Table 4 (Part II)

$/a_1ma_2/$ vs. $/\bar{a}_1ma_2/$

			a_1	m	a_2	ma_2	a_1ma_2
			msec	msec	msec	msec	msec
M.S.	$/a_1ma_2/$	Mean	145	69	112	181	325 (12)
		S.D.	13.3	7.8	8.7	8.8	21.0
	$/\bar{a}_1ma_2/$	Mean	146	74	115	188	341
		S.D.	15.0	5.5	4.9	7.6	22.7
S.K.	$/a_1ma_2/$	Mean	117	67	85	153	270 (12)
		S.D.	11.3	7.0	5.2	7.1	12.4
	$/\bar{a}_1ma_2/$	Mean	123	64	87	151	275 (12)
		S.D.	9.4	4.9	6.4	6.3	9.5

Though the duration of $/\bar{a}_1ma_2/$ is longer than $/a_1ma_2/$, in this pair the accentual influence on duration appears differently on the segment and mora. Individual variations are seen in $/a_1ma_2/$ vs. $/\bar{a}_1ma_2/$. For S. K., the $/a_1/$ and $/\bar{a}_1/$ difference is manifested mostly in his $/a_1/$ and $/\bar{a}_1/$ duration in this pair, as well as in the pair of $/a_1sa_2/$ vs. $/\bar{a}_1sa_2/$. However, for M. S. the duration of $/\bar{a}_1/$ is not significantly influenced by accent. It is the /m/ of the second mora that is most affected by the accent of the first mora, and consequently the second mora $/ma_2/$ as a whole shows a difference in duration. The segmental difference between /s/ and /m/ must be relevant in these results. Besides the individual speaker's idiosyncrasies, segmental characteristics and the compensatory mechanisms within morae and within a word should be taken into account.

3.2.1.2. $/s_1a_1s_2a_2/$ vs. $/\overline{s_1a_1}s_2a_2/$ and $/sa_1ma_2/$ vs. $/\overline{sa_1}ma_2/$

Looking over the mean duration of every segment in $/s_1a_1s_2a_2/$ and $/\overline{s_1a_1}s_2a_2/$, we find that the accented vowel segment $/\bar{a}_1/$ is longer than the unaccented $/a_1/$ by 1 - 22 msec for all speakers as shown in Table 5. The 1-msec difference does not establish the effect of accent on duration. Besides $/a_1/$, we also find that the $/\bar{s}_1/$ is longer than the $/s_1/$ by 3 - 29 msec. Consequently, the first mora $/\overline{s_1a_1}/$ as a whole is lengthened.

As for the segments of the second mora, there is no consistent fluctuation in segmental duration. The moraic duration of $/s_2a_2/$ as a whole shows no significant difference. The total duration of $/\overline{s_1a_1}s_2a_2/$ is longer than $/s_1a_1s_2a_2/$ for every speaker.

Table 5

$/s_1a_1s_2a_2/$ vs. $/\overline{s_1a}_1s_2a_2/$

		s_1	a_1	s_2	a_2	$s_1a_1s_2a_2$	$\bar{s}_1$	$\bar{a}_1$	s_2	a_2	$\overline{s_1a}_1s_2a_2$
		msec	msec	msec	msec	msec	msec	msec	msec	msec	msec
M.S.	Mean	105	86	87	87	367 (12)	108	87	85	90	371 (12)
	S.D.	6.5	6.3	6.3	6.9	7.6	8.6	4.2	6.7	6.4	10.8
S.K.	Mean	92	56	75	74	300 (12)	100	61	77	71	310 (12)
	S.D.	12.7	9.8	12.4	9.7	11.8	8.1	8.6	8.4	8.3	12.8
H.D.	Mean	90	49	77	72	286 (12)	119	71	88	56	332 (10)
	S.D.	7.7	7.9	8.7	5.1	8.4	7.4	7.1	8.4	6.0	14.4

In $/sa_1ma_2/$ vs. $/\overline{sa}_1ma_2/$ all segments in the first mora accented are more or less lengthened as far as their mean values are concerned. However, M. S. 's /s/ difference is very small (1 msec), and H. D. 's $/\bar{a}_1/$ is longer than his $/a_1/$ by only 0. 5 msec. This difference is too small to establish an accentual influence on duration. In H. D. 's speech the difference in /s/ is much bigger (15.5 msec) and significant.

This segmental variation is more intelligible in Fig. 2. The frequency curves of H. D. 's $/a_1/$'s cross each other twice. This indicates that the durations of $/a_1/$ and $/\bar{a}_1/$ may be the same. In this case, there is no accentual effect on the vowel duration considered. On the other hand, his /s/ frequency curves in Fig. 2 are separate from each other, and this shows some effect of accent on segmental duration. Just the opposite is true with S. K. 's segments as is shown in Fig. 3. The difference in segmental duration is hardly seen in M. S. 's case, shown in Fig. 4.

However, regarding moraic duration, both H. D. 's and S. K. 's first mora are equally lengthened as a whole though M. S. 's difference is not significant. Despite inconsistent differences in segmental duration, the influence of accent becomes consistent for H. D. and S. K. if we set up the mora /sa/ as a unit (Mitsuya, 1976) receiving the accentual effect.

There is no consistent difference for the second mora, except that /m/ in $/\overline{sa}_1ma_2/$ is shorter than that in $/sa_1ma_2/$ for all subjects. The word duration varies with the individual subjects, as Figs. 2-4 show.

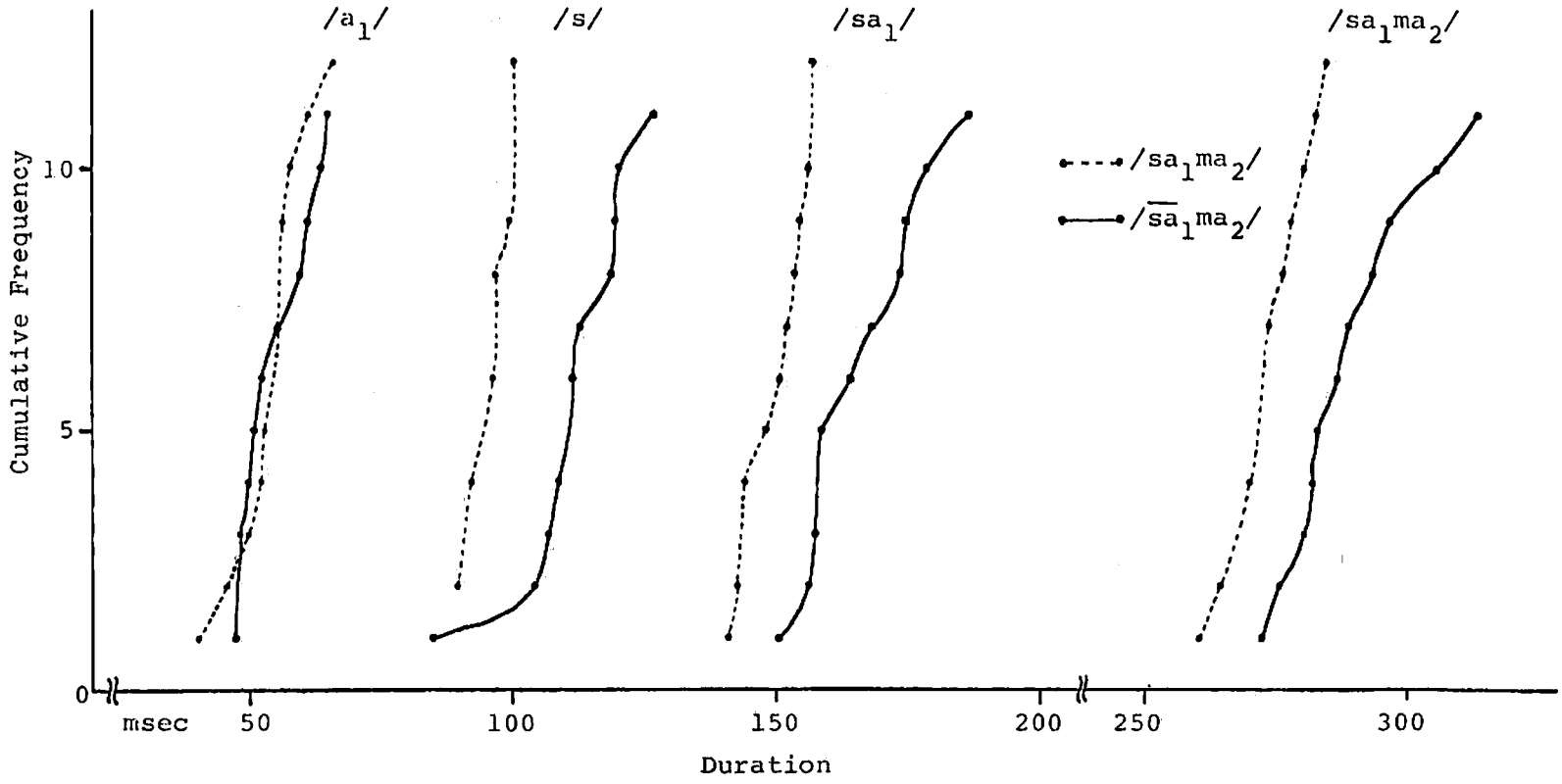

Fig. 2. The duration and frequency of H. D. 's /sama/ and /s̄ama/ and those of the first mora and its components.

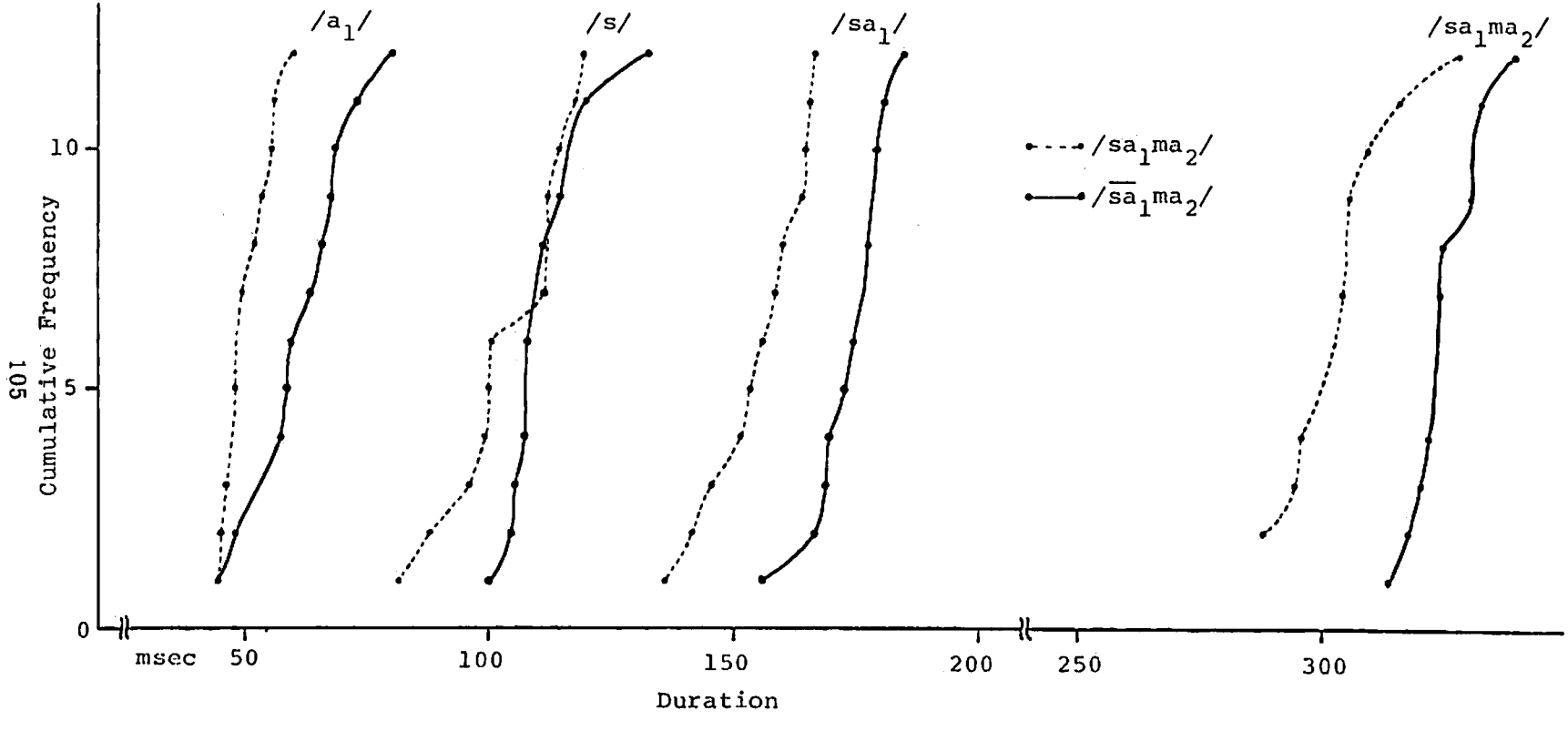

Fig. 3. The duration and frequency of S. K. 's /sama/ and /s̄ama/ and those of the first mora and its components.

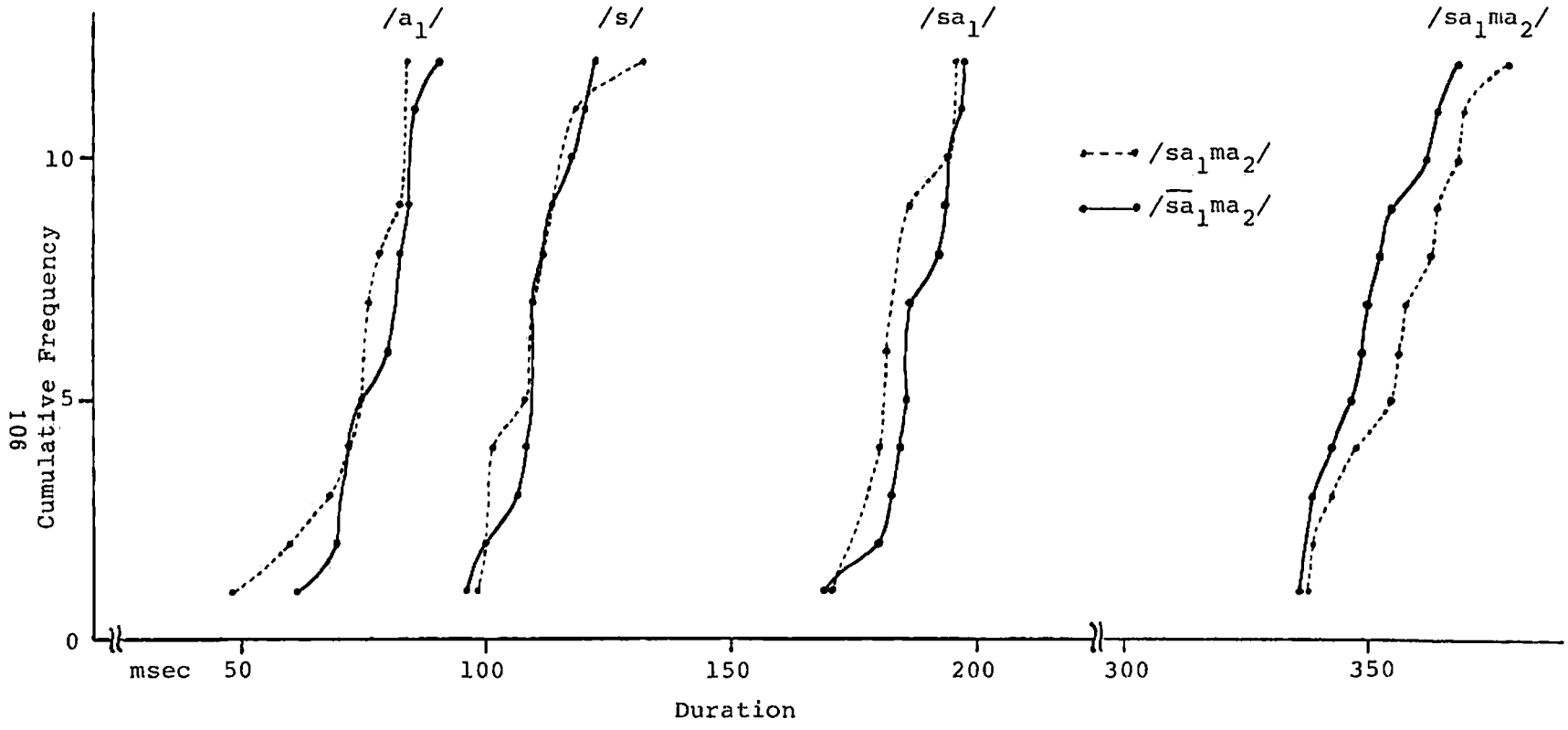

Fig. 4. The duration and frequency of M. S. 's /sama/ and /s̄ama/ and those of the first mora and its components.

3.2.2. Accent on the Second Mora

3.2.2.1. $/a_1 sa_2/$ vs. $/a_1 \overline{sa_2}/$ and $/a_1 ma_2/$ vs. $/a_1 \overline{ma_2}/$

As Figs. 5-7 show, in $/a_1 sa_2/$ vs. $/a_1 \overline{sa_2}/$ the accentual effect both on segments and on morae is different. For H. D. in Fig. 5., the greatest durational difference is seen in the first mora $/a_1/$, which itself has no accent. The same is true with S. K. in Fig. 6. In addition, S. K. 's $/\overline{s}/$ and $/\overline{a_2}/$ seem only a little longer than his /s/ and $/a_2/$, respectively, and the second mora $/sa_2/$ as a whole shows a clear durational difference produced by accent. In M. S. 's speech in Fig. 7, none of the segments or morae show a significant difference in duration, and no influence of accent is visible.

In $/a_1 ma_2/$ vs. $/a_1 \overline{ma_2}/$, also, almost the same results are observed. The difference in both segmental and moraic duration is so varied among the speakers that a consistent effect of accent on duration cannot be concluded. Moraic components and their characteristics, and the position of the accented segment and mora in a word should be considered as factors affecting duration.

3.2.2.2. $/s_1 a_1 s_2 a_2/$ vs. $/s_1 a_1 \overline{s_2 a_2}/$ and $/sa_1 ma_2/$ and vs. $/sa_1 \overline{ma_2}/$

In these pairs of test words, the accented vowel segment is not always longer than its unaccented counterpart. For H. D. the $/\overline{a_2}/$ in $/s_1 a_1 \overline{s_2 a_2}/$ is a little shorter than the $/a_2/$ in $/s_1 a_1 s_2 a_2/$. In his case the $/\overline{s_2}/$ is lengthened instead. For M. S. none of the segments in the second mora show a recognizable durational difference in either the /sasa/ or /sama/ pairs. Furthermore, the segments in her first mora also show little difference except that the $/a_1/$ in $/s_1 a_1 \overline{s_2 a_2}/$ is a little shorter than the $/a_1/$ in $/s_1 a_1 s_2 a_2/$. The compensatory mechanisms within morae seem to work differently among individuals.

Moving our attention to the duration of morae, we find no significant difference in common among the three subjects.

These segmental and individual variations are not resolved even if we look at the mora as an accent unit. The position of the accented mora in a word might be a more important factor than accent per se with regard to duration. In section 3.2.1.2., where the two-mora $\overline{CVCV}$ words have accent on the first mora, there is a consistent durational difference in the accented mora for H. D. and S. K. As a matter of fact, there is a juncture before the first mora of the test word. Juncture is naturally considered to affect the duration of neighboring segments. In any case, we conclude that in this experiment the accented segment is not always strongly lengthened.

3. 3. CVCV Constructed Words

The difference in segmental duration is so complex in the two-mora words that a general explanation will not be presented for it. Looking back over the mora duration in the two-mora CVCV words, we notice some interesting phenomena common to each subject's utterance.

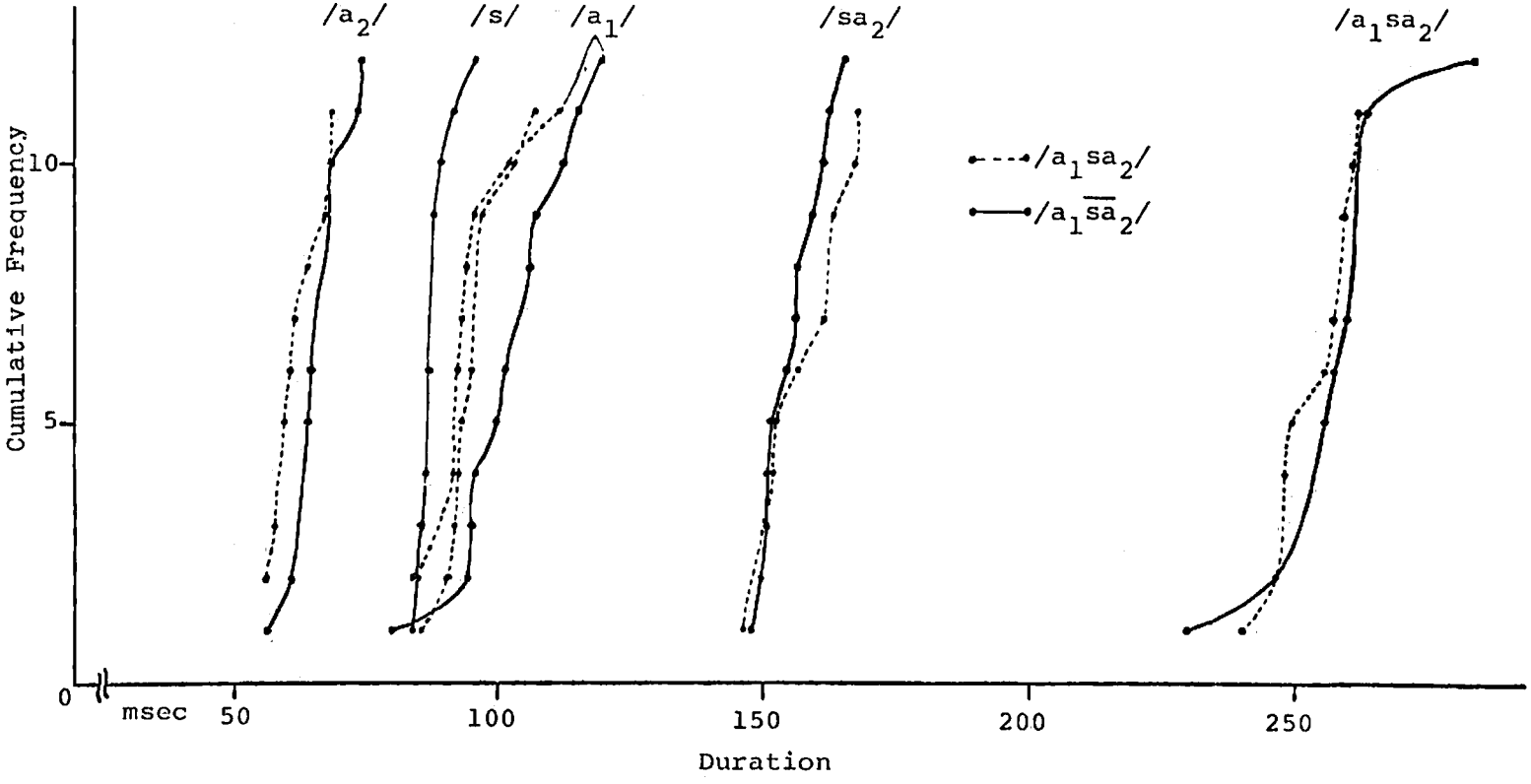

Fig. 5. The duration and frequency of H. D. 's /asa/ and /a$\overline{sa}$/ and those of each of their morae and segments.

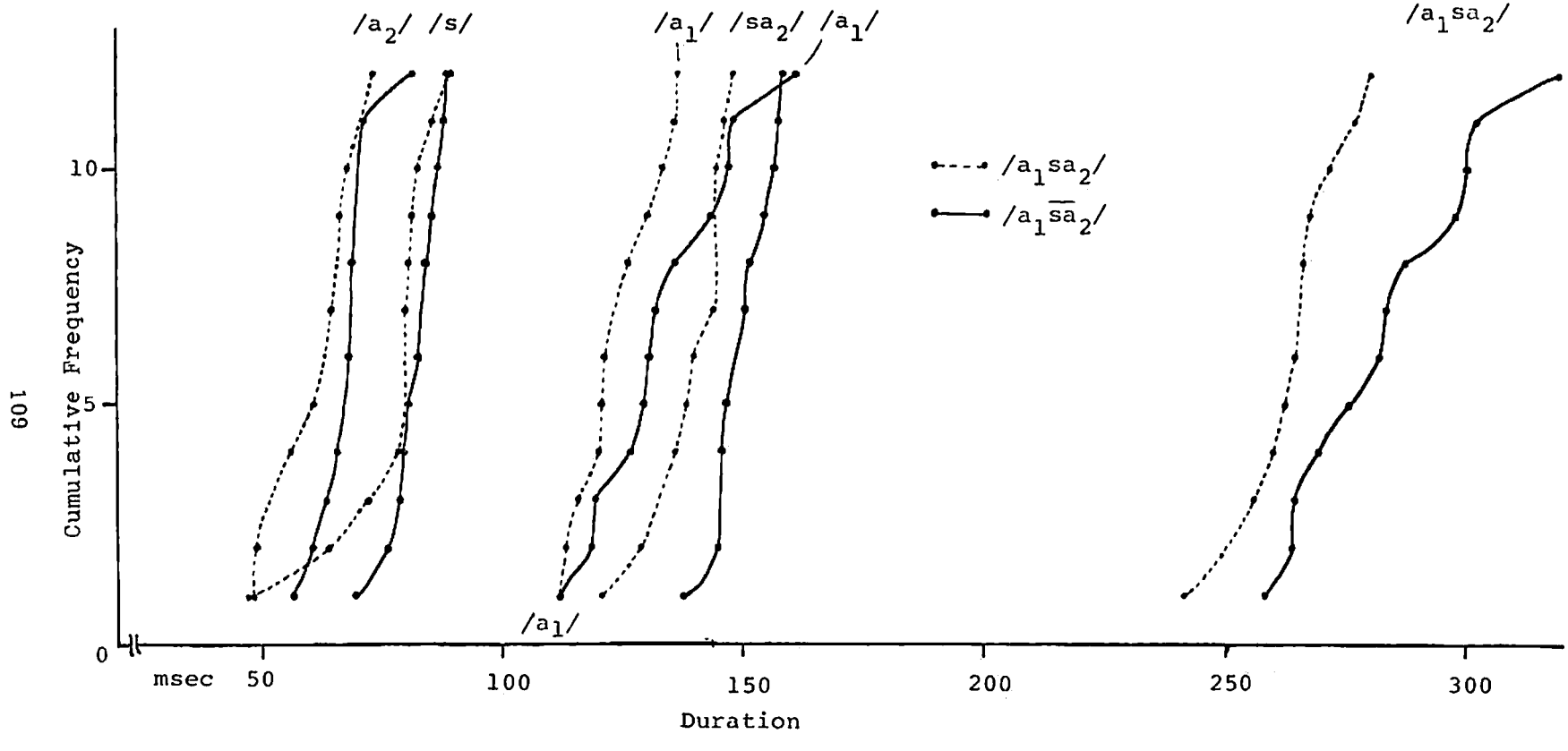

Fig. 6. The duration and frequency of S. K. 's /asa/ and /as̄a/ and those of each of their morae and segments.

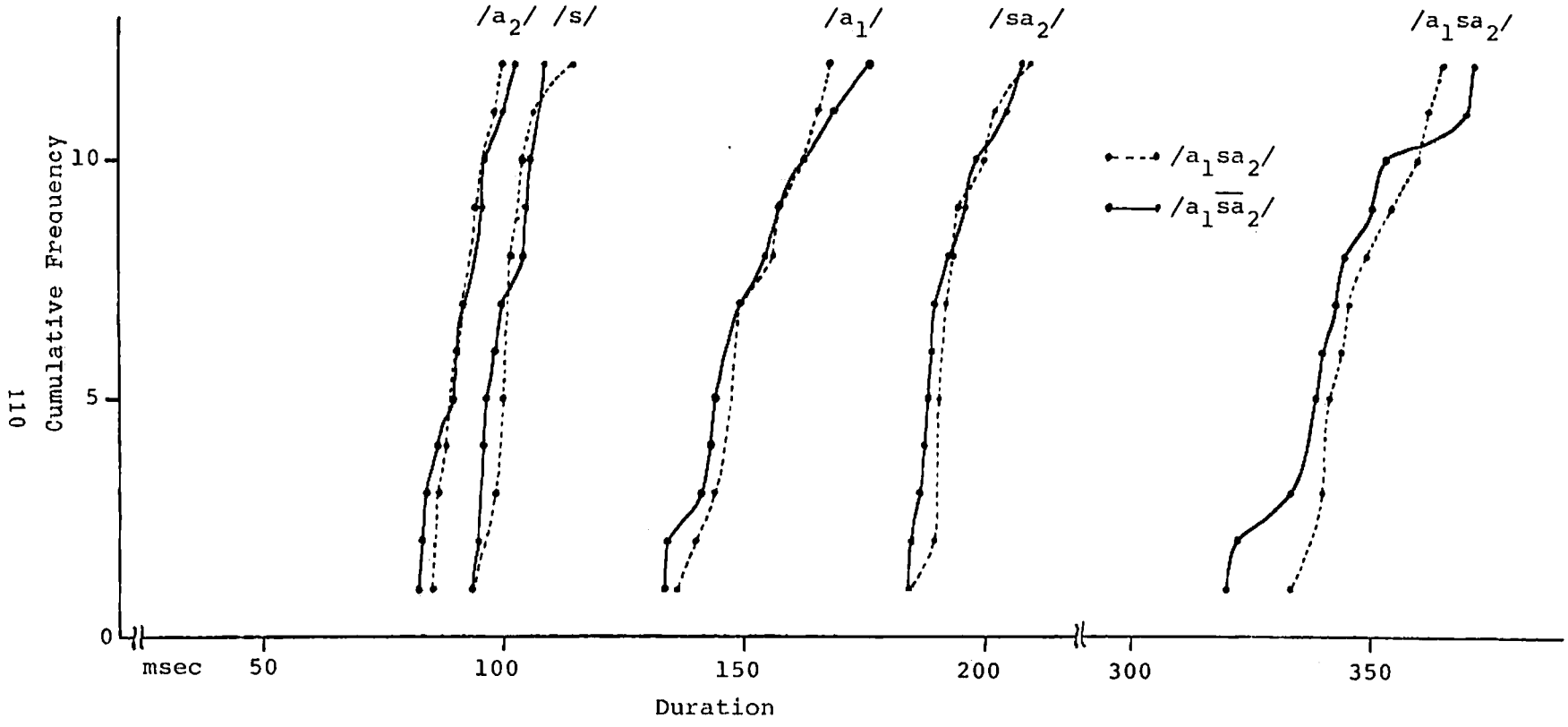

Fig. 7. The duration and frequency of M. S. 's /asa/ and /a$\overline{sa}$/ and those of each of their morae and segments.

In Table 6 the mean duration of each mora in /sasa/ and /sama/ is listed for each speaker, and the durational movement from the first mora to the second in each word is shown by an upward or downward arrow. Focusing our attention on the words /s̄asa/ and /s̄ama/ in the middle of the table, we find all of the arrows downward for all subjects, i. e., the first mora is longer than the second whenever there is accent on the first mora. Furthermore, as the table shows, in the three kinds of /sama/ all of the arrows are downward for all subjects. This means that the first mora is always longer than the second in /sama/ regardless of accent. This result leads us to conclude that segmental characteristics and juncture may be stronger factors in durational matters than accent, i. e., they may dominate accent in affecting duration.

Table 6. Means of Mora Duration

	sa		sa		s̄a		sa		sa		s̄a	
	msec		msec		msec		msec		msec		msec	
M. S.	191	367	175	↘	196	371	175	↘	186	363	176	↘
S. K.	149	300	150	↗ (?)	161	310	149	↘	158	318	160	↗ (?)
H. D.	138	286	149	↗	189	332	144	↘	149	303	154	↗

	sa		ma		s̄a		ma		sa		m̄a	
M. S.	185	356	170	↘	187	350	160	↘	184	355	171	↘
S. K.	155	304	147	↘	174	325	151	↘	163	313	151	↘
H. D.	150	274	123	↘	166	289	122	↘	155	288	133	↘

↗ : The second mora is longer than the first.

↘ : The first mora is longer than the second.

4. Conclusion

In this study a durational effect of accent on segments in Japanese was observed only for the vowel of one-mora words, i.e., the accented vowel segment was longer in duration than its unaccented counterpart. In two-mora words this effect varied greatly with the individuals tested. In some cases the consonant segment of the accented mora was lengthened more by accent than was the vowel segment.

As for moraic duration, the accented mora as a whole was lengthened in many cases, but this effect was not consistent through our data. These variations are considered to be due to other factors such as segmental and moraic characteristics, the number of morae in a word, compensatory mechanisms within a mora, the position of the accented mora in a word, the kind of carrier sentence, the unnaturalness of nonsense test words, and the subjects' own idiosyncrasies. Some of these factors must have worked more strongly on the two-mora words than accent and may have been dominant over accent.

These various factors must be involved so intricately in the determination of durational effect that we cannot definitely conclude what factors are dominant and crucial for duration. Accent is no doubt a relevant factor in duration, but it functions recognizably as a durational influence only when other, dominant factors are absent or less. Although the data in this study are limited in kind and quantity, it is concluded that accent is not a primary factor affecting segmental and moraic duration in Japanese.

References

Han, M. S. (1962). Japanese Phonology: An Analysis Based upon Sound Spectrograms, Tokyo: Kenkyusha, pp. 104-106.

Hiki, S., Y. Kanamori and J. Oizumi (1968). "On the Duration of Phonemic Segment in Connected Speech,". The Report of the Research Institute of Electrical Communication (Sendai: Tohoku University), XX, No. 1, 1-12.

Mitsuya, F. (1976). "Effect of Consonant Voicing on the Preceding Mora in Japanese, " M. A. thesis, California State University, Fresno.

Oyakawa, T. (1971). "On the Duration of Japanese Short Vowels, " Monthly Internal Memorandum (Berkeley: University of California) February, 69-92.

Sugito, M. and F. Mitsuya (1977). "On the Influence of Accent on the Duration of Segments and Morae in Japanese, " Shoin Kokubungaku, No. 15, 100-119 (in Japanese).