

## DURATION OF FRENCH VOWELS BEFORE FRICATIVES \*)

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According to the general opinion as regards vowel duration in French, only the final (stressed) vowel of a tone group can be prolonged. The traditional rule tells that in this position the prolongation applies to 1) all vowels before voiced fricatives and [r], 2) [o], [ø], [ɑ] before any pronounced consonant, and 3) the nasal vowels likewise before any pronounced consonant.

The main purpose of this work was to examine the validity of 1) and 2) - with exception of the position before [r] due to difficulties in determining the boundaries of this sound on a mingogram. - Furthermore the duration of the fricatives was examined. - Four Frenchmen (two men: AM 57 and SM 26 years old and two women: CHH 30 and ThM 17 years old) were used.

The following vowels and positions were examined (mainly based upon Straka's vowel scheme in Bulletin de la faculté des lettres de Strasbourg (1950), pp. 220 and 373):

stressed vowel	before
i y u o ɔ ε a - - œ	f / v
i y u o - ε a ɑ ø -	s / z
i y u o ɔ ε a ɑ - -	ʃ / ʒ

As it might be of some interest to see whether vowel duration is influenced by a following voiced fricative when the vowel is not stressed, some examples were set up in which the vowel occurred in an unstressed open syllable, the next syllable beginning with a fricative. The following vowels were examined:

unstressed vowel	before
i u o a -	f / v
i u o - a	s / z
i u o a a	ʃ / ʒ

\*) Thesis work for the cand.art. degree, completed in November 1966. The results will appear in a more detailed form in Revue Romane.

\*\*) The examples in this position were deleted by mistake during the recordings.

The conditions are not alike in the two positions, the syllable in stressed position being closed, that in unstressed open. It was rather difficult to find a sufficiently large material in closed unstressed syllable, as it was required that the conditions should be quite alike in stressed and unstressed position.

The preceding consonants were for the most part unvoiced stops or unvoiced fricatives.

All stressed as well as all unstressed vowels appeared in two examples each recorded three times. Thus for each subject there are six measurements in every position. - The material was recorded in random order.

The examples were presented in short sentences, stressed vowels in utterances like, for instance, 'C'est un homme actif qui fait bien des choses', 'On le voit qui bouge mais on n'entend rien', unstressed vowels in, for instance, 'Elle va l'attifer et c'est très mauvais', 'Il vient de bouger malgré mes conseils'.

The rate of speech was controlled. There was no considerable variation.

A material consisting of the above-mentioned examples presented isolated in a sort of enumeration was also recorded, but it turned out to be inadequate due to uneven accentuation and varying rate of speech.

The recordings were made in the acoustical laboratory of the Technical High School (Danmarks Tekniske Højskole), and mingo-grams were made at the Institute of Phonetics showing pitch and intensity in linear as well as logarithmic display. A fourth trace presented a duplex oscillogram. Segmentation of the sounds were made by comparing the different traces. A control by spectrograms gave evidence that the delimitations were correct.

### I. Relative vowel duration.

The following averages have been calculated for the duration of the stressed vowels (measured in centiseconds):

( AM )

( SM )

before:	[f]	[v]	[s]	[z]	[ʃ]	[ʒ]	[f']	[v']	[s']	[z']	[ʃ']	[ʒ']
[i]	10.9	27.9	9.6	16.3	9.1	17.4	12.2	18.0	12.5	22.0	11.1	23.6
[y]	9.8	18.8	9.9	17.0	11.3	15.3	10.4	19.2	14.2	20.8	14.8	22.2
[u]	10.4	19.8	12.0	15.8	11.1	25.2	10.8	22.9	13.8	24.1	13.9	26.4
[o]	16.1	16.7	21.2	23.2	16.8	22.0	14.8	22.2	18.2	19.8	16.3	24.6
[ɔ]	12.4	15.6	-	-	13.8	18.4	15.1	23.1	-	-	12.3	23.6
[ɛ]	10.6	21.9	10.6	22.9	11.5	18.3	12.8	16.6	12.0	21.7	12.8	17.2
[a]	17.0	19.9	13.7	20.5	14.0	18.6	17.8	23.6	13.8	22.8	15.3	26.2
[ɑ]	-	-	14.7	26.2	21.2	22.9	-	-	16.8	25.2	18.9	23.5
[ø]	-	-	18.9	24.7	-	-	-	-	-	-	-	-
[œ]	11.0	22.8	-	-	-	-	13.2	20.1	-	-	-	-

( ThM )

( CHH )

[i]	10.3	13.5	10.3	16.7	11.7	15.8	8.5	12.5	9.2	14.1	9.8	14.1
[y]	12.3	16.2	11.9	18.1	12.8	16.3	8.4	10.8	8.7	12.8	11.0	11.3
[u]	11.3	15.2	12.9	18.0	12.8	20.4	9.0	12.0	10.3	14.4	9.4	16.4
[o]	15.6	18.4	15.2	18.6	15.7	20.2	10.5	13.2	13.2	14.7	12.8	15.8
[ɔ]	17.1	19.6	-	-	15.2	20.9	11.6	14.8	-	-	11.6	16.6
[ɛ]	11.9	16.9	15.8	20.3	16.1	20.3	9.6	13.1	11.3	14.6	12.7	15.5
[a]	17.8	18.7	16.3	22.9	18.3	20.0	13.7	18.8	12.7	17.3	12.1	15.5
[ɑ]	-	-	17.5	22.5	18.7	23.0	-	-	11.3	17.5	14.3	16.0
[ø]	-	-	15.8	19.9	-	-	-	-	12.3	18.3	-	-
[œ]	14.7	18.0	-	-	-	-	12.4	12.1	-	-	-	-

A rather stable tendency toward shortest duration for the closed [i y u] and toward longest duration for the open [a ɑ] is seen. The half-closed [o ø] are rather long for AM and SM before unvoiced fricative. The half-open [ɛ œ ɔ] fluctuate between the durations of the shortest and the longest vowels. ([ɛ] is throughout rather short.) (Fig. 1 illustrates the relations for ThM.) The durations and differences are throughout smaller for ThM and CHH than for AM and SM. - In spite of the exceptions which can be found in the table, it seems reasonable to state that the duration of the vowels - except for [o ø] - tends to be proportional to the degree of opening.

i	u	ε	y	ø	o	ɔ	a	[f]	
12	14	16	18	20	22				
i	y	u	o	ε	ø	a	α	[s]	
12	14	16	18	20	22				
i	y,u	ɔ	o	ε	a	α		[ʃ]	
12	14	16	18	20	22				
	i	u	y	ε	ø	o	ɔ	[v]	
12	14	16	18	20	22				
			i	u	yo	ø	ε	α	[z]
12	14	16	18	20	22				
			iy		ə	o	ε	u	[ʒ]
12	14	16	18	20	22				

Fig. 1

The relative vowel duration. ThM.

f	s	ʃ	v	z	ʒ	[i]	
10	12	14	16	18			
fs	v	ʒ	z			[y]	
10	12	14	16	18			
f	ʃ	s	v	z	ʒ	[u]	
10	12	14	16	18			
	f	ʃ	v,s	z	ʒ	[o]	
10	12	14	16	18			
		f,ʃ	v	ʒ		[ɔ]	
10	12	14	16	18			
f	s	ʃ	v	z	ʒ	[ε]	
10	12	14	16	18			
		ʃ	s	f	ʒ	z	[a]
10	12	14	16	18			
	s	ʃ	ʒ	z		[ɑ]	
10	12	14	16	18			
		s		z		[ø]	
10	12	14	16	18			
		vf				[œ]	
10	12	14	16	18			

Fig. 2

Influence from the place of articulation of the following consonant and from voicing. CHH.

The following averages have been calculated for the duration of the unstressed vowels (measured in centiseconds):

	( AM )						( SM )					
before:	[f]	[v]	[s]	[z]	[ʃ]	[ʒ]	[f]	[v]	[s]	[z]	[ʃ]	[ʒ]
[i]	7.3	9.8	8.7	12.8	8.3	12.9	6.3	8.4	6.1	9.9	5.9	10.9
[u]	9.2	9.5	9.3	11.6	8.7	14.3	6.3	8.1	7.5	8.3	7.4	11.8
[o]	9.7	13.2	11.9	17.4	13.2	18.6	8.9	9.6	9.0	10.4	9.7	11.9
[a]	11.4	13.8	-	-	11.3	13.6	8.3	11.2	-	-	10.2	13.1
[ɑ]	-	-	10.8	16.2	13.1	18.1	-	-	8.5	12.0	9.8	12.7

	( ThM )						( CHH )					
[i]	5.7	6.4	5.4	6.1	5.3	6.7	4.8	6.1	6.8	7.0	5.3	8.2
[u]	5.8	5.2	5.3	8.4	5.8	10.8	7.3	6.0	5.6	5.9	5.6	8.7
[o]	6.4	7.1	7.8	9.4	7.7	11.2	7.2	7.5	7.9	9.3	7.9	11.0
[a]	8.8	9.7	-	-	9.9	11.2	9.2	9.4	-	-	7.8	10.9
[ɑ]	-	-	7.8	12.5	10.8	12.2	-	-	8.3	12.2	11.0	12.7

In this position the degree of opening is easily seen to be a determining factor for duration except for [o]. The differences are small, but rather stable. These facts should not surprise: the unstressed vowels examined here are - except for [o] - articulatorily in extreme positions and therefore the overlapping is naturally smaller. Furthermore the unstressed syllable can be considered to be less exposed to influences from (greater or smaller) changes in stress, rate of speech, and intonation. The latitude of variation is thus smaller for the unstressed than for the stressed vowels.

## II. Influence from the place of articulation of the following consonant.

An examination of the influence due to place of articulation of the following fricative (illustration fig. 2, CHH) reveals in stressed syllable a tendency for the vowel length to be shortest before [f/v], in unstressed syllable only before [f]. The relations are throughout rather unstable for the remaining fricatives, - however, a certain tendency can be seen in stressed syllable toward longest duration before [ʃ/ʒ], in unstressed only before [ʒ].

The theory according to which a larger movement conditions a longer duration can explain the relative vowel duration as well as the influence due to place of articulation of the following consonant. As consonants are characterized by stop or fricative articulation, closed vowels are more similar and open vowels less similar to the surrounding consonants. Open vowels consequently need longer duration than closed vowels. - The half-closed [o ø] form an exception. Their long duration might be explained as diachronic compensatory prolongation. - According to the theory back vowels should be longer than the corresponding front vowels, the back of the tongue articulating more slowly than the front of the tongue. Furthermore rounded vowels should be longer than the corresponding unrounded, the rounding being a rather complicated articulation. This material does not confirm these two points. - The movement of articulation from vowel to [f/v] does not imply any change in tongue position. The movement consequently has no prolongating effect. The relatively complicated movement of articulation of [ʃ/ʒ] might explain the few tendencies toward longest vowel duration before these fricatives.

### III. Influence of voicing.

As regards the influence from the voiced counterparts of the six fricatives upon vowel duration, a prolongation is quite clearly seen in stressed position; it is less evident but still relatively stable in unstressed position. (See fig. 2, CHH, stressed position). ThM and CHH pronounced practically all [v z ʒ] (partly) unvoiced. The preceding vowels did, however, show a significantly longer duration than the vowels followed by [f s ʃ]. The average prolongation was in stressed position for AM 7.1 cs, for SM 8.1 cs, for ThM 4.3 cs, and for CHH 3.6 cs. In unstressed position the prolongation was for AM 3.8 cs, for SM 2.6 cs, for ThM 1.9 cs, and for CHH 1.6 cs. The differences are thus smallest for ThM and CHH.

A calculation of the percentual average prolongation in stressed position gave the following results:

	[i]	[y]	[u]	[o]	[ɔ]	[ɛ]	[a]	[ɑ]	[ø]	[œ]	
AM:	156.4	90.7	90.5	3.6	25.5	107.1	17.1	-	-	106.8	[v/f]
	69.6	71.7	31.9	9.5	-	116.5	50.1	78.4	30.7	-	[z/s]
	91.7	35.6	127.1	31.3	33.3	59.4	32.9	8.3	-	-	[ʒ/ʃ]
SM:	48.0	84.1	111.5	50.0	53.0	29.7	32.8	-	-	52.6	[v/f]
	76.0	47.1	75.1	9.2	-	80.5	65.1	49.5	-	-	[z/s]
	112.6	50.0	89.9	51.3	92.5	34.4	70.6	24.3	-	-	[ʒ/ʃ]
ThM:	31.7	31.1	33.8	18.2	14.6	42.0	4.7	-	-	22.8	[v/f]
	62.5	40.2	39.5	22.6	-	28.4	41.0	28.6	25.8	-	[z/s]
	35.8	28.1	59.1	28.7	37.9	26.4	9.6	23.3	-	-	[ʒ/ʃ]
CHH:	47.1	28.8	33.3	25.3	28.1	36.5	37.8	-	-	neg.	[v/f]
	53.7	47.1	39.5	11.4	-	29.6	36.3	54.5	48.7	-	[z/s]
	43.2	3.0	74.4	22.8	43.2	22.4	28.3	12.3	-	-	[ʒ/ʃ]

The table reveals that the percentual prolongation differs according to the degree of opening: The closed vowels tend to show a larger percentual prolongation than the open vowels, [o], and [ø]. The half-open vowels, however, show no quite clear tendencies. Except for these vowels, the percentual prolongation is thus inversely proportional to the relations found for the relative vowel duration. The fact that the "long" vowels are not prolonged to the same extent as the "short" vowels, can be considered as a certain tendency to limit the sound duration.

#### IV. Duration of the fricatives.

Finally as well as initially (for instance in 'actif'/'active' 'attifer'/'activer') the unvoiced fricatives of AM and SM showed a longer duration than their voiced counterparts. (Figs. 3 and 4 show this relation for SM). [v z ʒ] of ThM and CHH, too, which were pronounced (partly) without voicing showed a significantly smaller duration than the corresponding [f s ʃ]. Thus the duration of the fricatives is inversely proportional to the duration of the preceding vowel: a short vowel is followed by a long fricative, and vice versa. A calculation proved that the group vowel + unvoiced fricative and

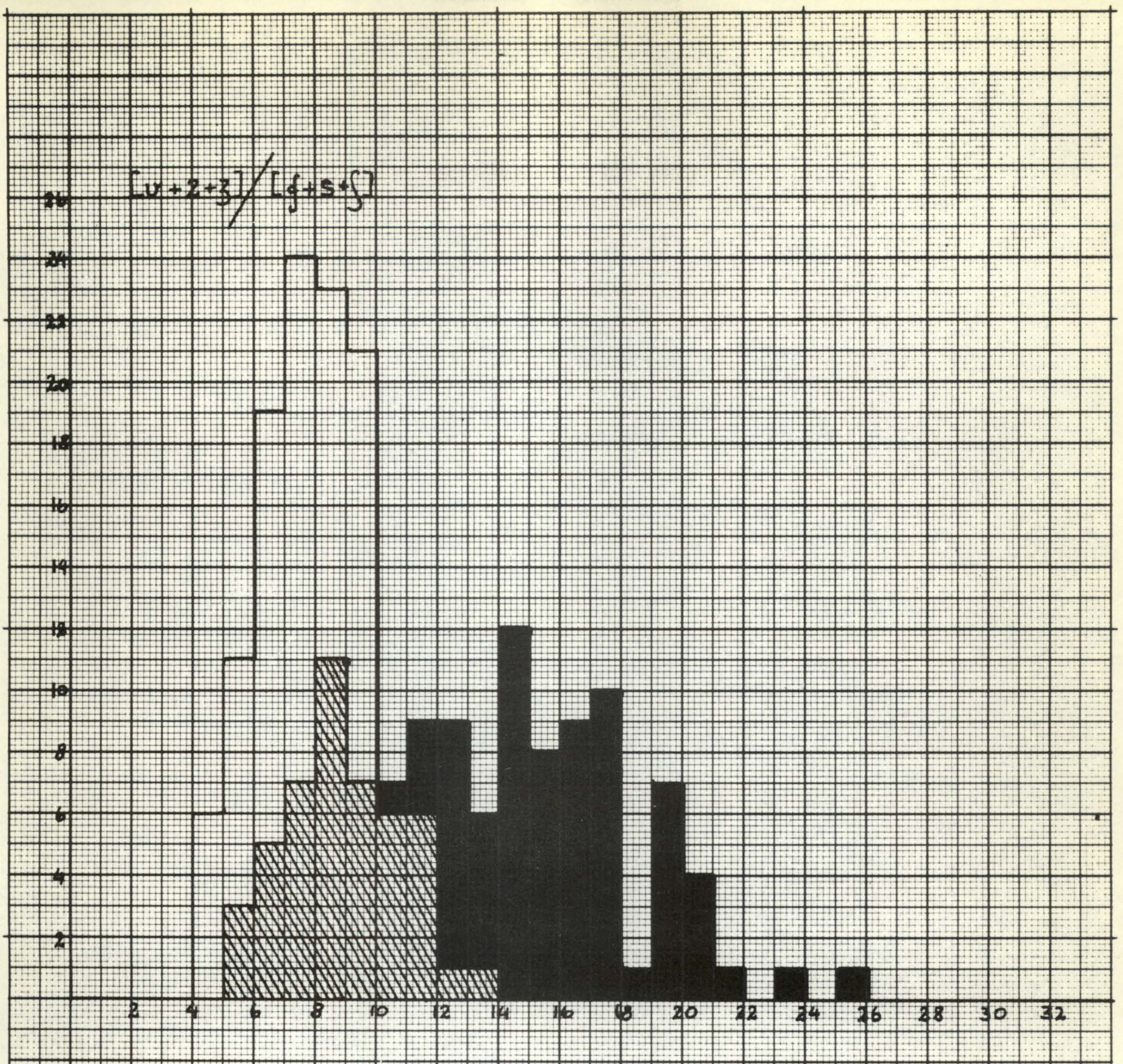


Fig. 3

Duration of the final stressed fricatives. SM.

Average (centiseconds):  $v+z+3$  : 7,8  
 $f+s+f$  : 13,0

White areas = voiced fricatives

Black areas = unvoiced fricatives

Hatched areas = overlapping voiced and unvoiced fricatives.



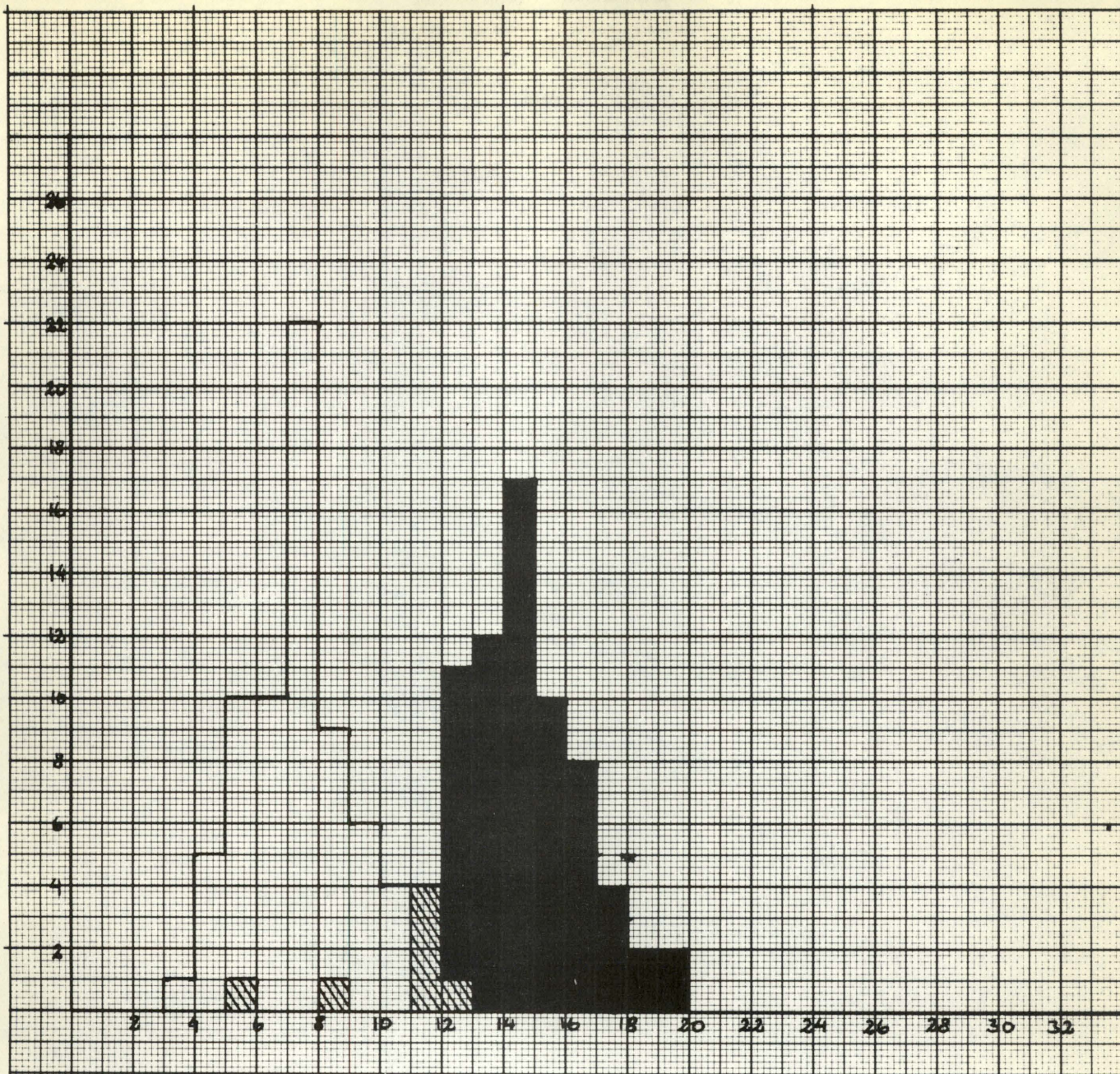


Fig. 4

Duration of the initial stressed fricatives. SM.

Average (centiseconds):  $v+z+3$  : 7,3  
 $f+s+f$  : 14,2

White areas = voiced fricatives

Black areas = unvoiced fricatives

Hatched areas = overlapping voiced and unvoiced fricatives.

the group vowel + voiced fricative tend to be quantitatively alike. - Furthermore the final fricative showed a considerably larger latitude of variation than the initial fricative. -

The prolongation before voiced fricatives and the relatively large percentual prolongation of "short" vowels may both be explained as a tendency to maintain a certain rhythm. Thus the varying duration is due to compensation. - It would be of great interest in this connection to examine why unvoiced fricatives are longer than their voiced counterparts.

It remains to be mentioned that a calculation of the significance of the various distributions gave satisfying results.

Reference:

E. Fischer-Jørgensen, "Sound Duration and Place of Articulation", Zeitschrift für Phonetik 17, Heft 2-4 (1964), pp. 175-207.