FORMANT FREQUENCIES OF LONG AND SHORT DANISH VOWELS[1]

SR: 8b
Lyd og lydsystem

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1. The material

The spectrograms on which the present formant measurements are based were taken in MIT in 1952. They have since then been amply used for teaching purposes, but the measurements have never been published. - The material is very restricted, but since there were nine speakers, who all show the same tendencies, it may nevertheless be of some value. It consists of a series of isolated long vowels i:, e:, ɛ:, a:, y:, ø:, œ:, u:, o:, ɔ: and a word list containing these vowels and the corresponding short vowels in similar surroundings, i.e. in the stressed syllable of a dissyllabic word and, as far as possible, preceded by /h/ or zero and followed by the consonant l (or at least a dental), namely: ile, hele, hæle, hale, hyle, øde, høne, hule, Ole, åle, ilde, inde, hælde, halve, hylde, øllet (participle), hønse, hulde, hullet (participle), holde; in traditional phonemic transcription: / i:lə, he:lə, hɛ:lə, ha:lə, hy:lə, ø:ðə, hœ:nə, hu:lə, o:lə, ɔ:lə, ilə, enə, hɛlə, halə, hylə, øləð, hœnsə, hulə, holəð, hɔlə /. (In the recordings of one of the subjects the words with back vowels had a labial consonant after the vowel). Moreover the word hare, containing the variant [ɑ:] of /a:/ before /r/ was included.

The list was spoken only once by each informant, with the exception of EFJ, who has spoken the list twice, and of JK and VL, who have spoken the isolated vowels twice. In these cases an average of the two recordings was taken. The informant PD did not speak the words in isolation.

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1) This paper is a shortened version of a paper which will appear in a Festschrift in the autumn 1972.

2. The speakers

The list was spoken by one female and eight male speakers of Standard Danish, born between 1905 and 1930. The speech of five of the informants can be characterized as Copenhagen Standard, mainly on the basis of intonation features, one speaker has certain Funish characteristics, and the speech of the remaining three subjects has hardly any local features.

3. Recordings

The recordings were made on professional tape recorders. In almost all cases both narrow and wide band spectrograms were taken, and in half of the cases they were supplemented by sections.

4. Results

The average frequencies of the first three formants of the male speakers are given in the following table.

Formant frequencies of eight male speakers

1. isolated long vowels
2. long vowels in words, and
3. short vowels in words

	/i/			/e/			/ε/		
	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
1. lg. is.	225	2197	3189	286	2186	2865	371	2049	2635
2. lg. w.	219	2169	3238	286	2231	2922	373	2099	2722
3. sh. w.	239	2208	3070	295	2200	2878	386	2007	2607

	/y/			/ø/			/oe/		
1. lg. is.	235	1919	2235	289	1671	2107	402	1462	2202
2. lg. w.	240	1903	2234	283	1694	2131	384	1563	2137
3. sh. w.	256	1756	2105	303	1594	2113	403	1556	2278

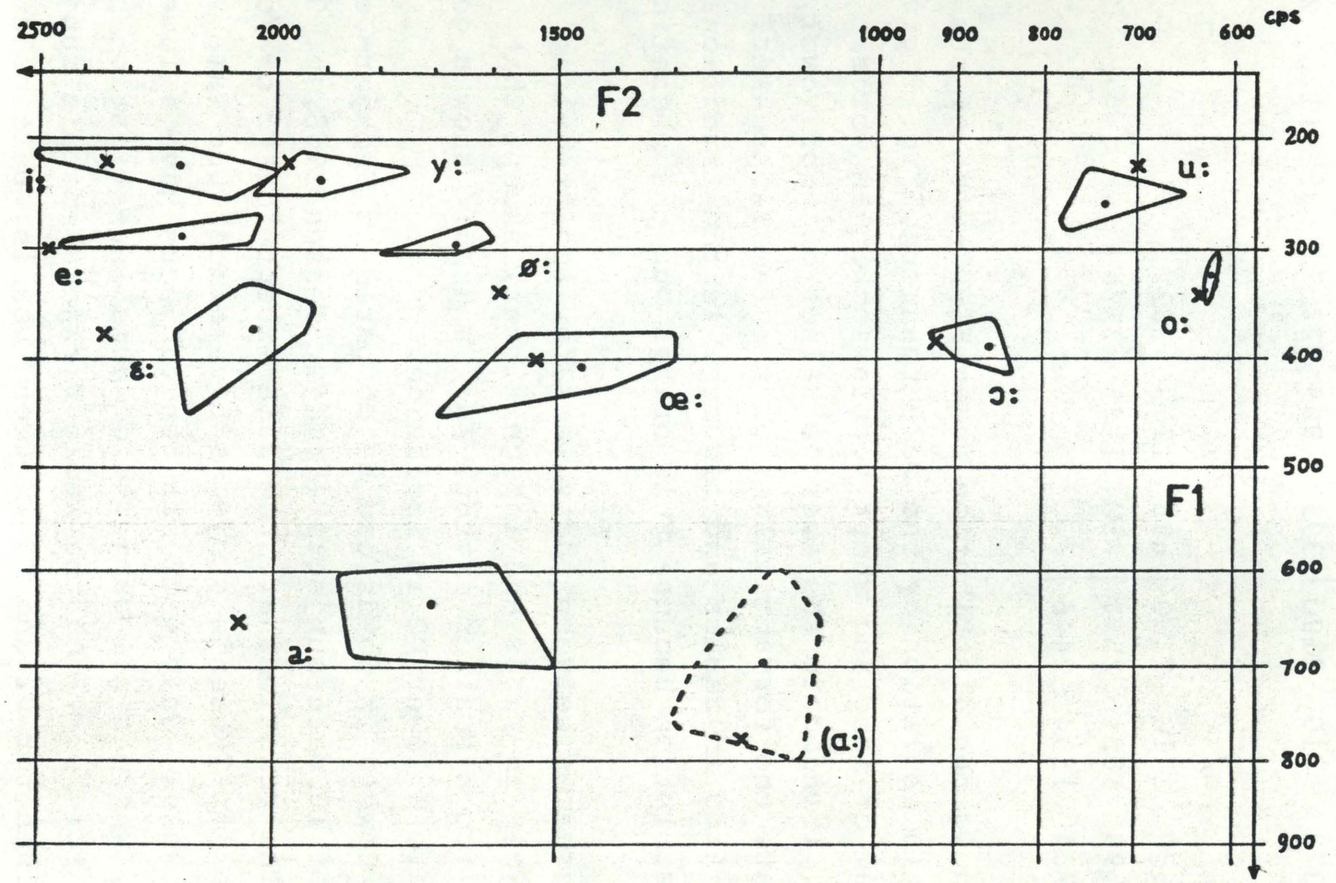

Fig.1. Danish long vowels spoken in isolation by 7 male speakers.
x = formants of the female speaker.

	/u/			/o/			/ɔ/		
1. lg. is.	257	732	2117	323	623	2375	387	865	2392
2. lg. w.	254	781	2013	308	659	2413	376	912	2333
3. sh. w.	273	819	2190	399	969	2207	588	1126	2298

	/a/			/ɑ/		
1. lg. is.	630	1710	2490	696	1179	2632
2. lg. w.	598	1831	2518	750	1185	2568
3. sh. w.	734	1594	2446			

Fig. 1 shows the distribution in an F1-F2-plot of the long vowels spoken in isolation by the male speakers. Fig. 2 gives a similar diagram of long and short vowels spoken in words. The points in Fig. 1 indicate the average values of each vowel, the crosses indicate the formant values of the female speaker. The transcription, also in tables and figures, is the traditional phonemic transcription because this brings out the phonetic deviations.

The differences between the values for isolated long vowels and vowels in words are insignificant, except that /oe:/ /a:/ and (to a smaller extent) /u:/ and /ɔ:/ show a general tendency to have a lower F2 in isolation.

The long vowels in words can be compared to Frøkjær-Jensen's measurements of 10 male subjects (Frøkjær-Jensen 1968, p. 35 and diagram I). The relations are the same except for F2 of /o:/ and /u:/. Frøkjær-Jensen's subjects have almost the same value for the two vowels: Only 4 of his ten subjects have a lower value in /o:/, whereas all subjects of this investigation have a lower value for /o:/. On the whole Frøkjær-Jensen's subjects have lower values for F2 and F3 in front vowels, particularly front unrounded vowels, whereas the deviation for F1 are very small, except for /a:/, which has a somewhat lower F1.

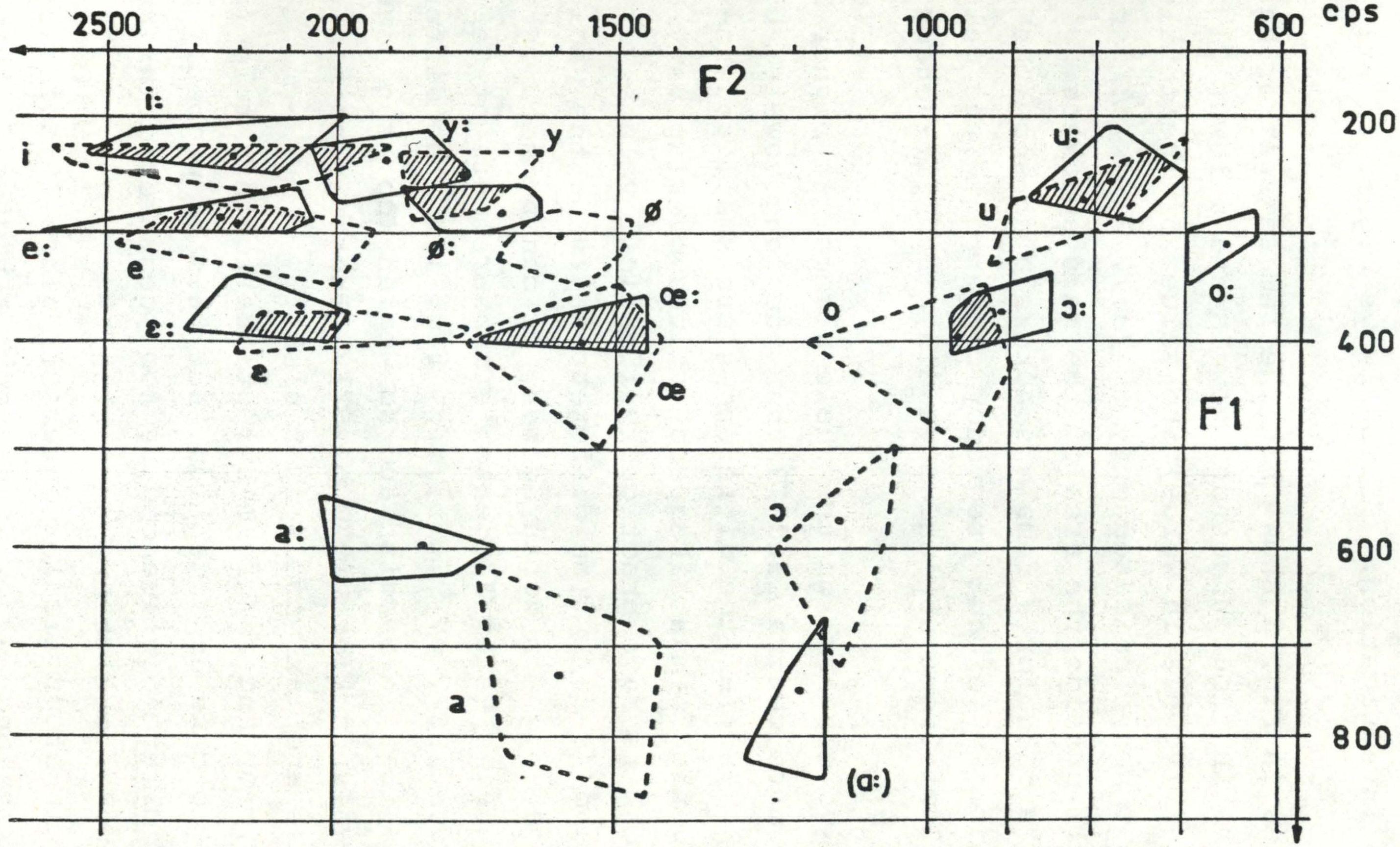

Fig. 2. Danish long and short vowels spoken in words by 8 male speakers.

In both groups some subjects have a lower F2 in /i:/ than in /e:/, but the tendency is somewhat stronger for the subjects of the present investigation. F3 is always higher in /i:/ than in /e:/.

The crosses in Fig. 1 show that the female speaker has higher F2 values in front unrounded vowels and a lower F1 in /ø:/. In Fig. 2 (vowels in words) the values of the female speaker have not been indicated; only in /a:/, /a/, /ɑ:/ and /ɔ/ do they fall outside the area of the male speakers. Frøkjær-Jensen's data for 9 female speakers also show the greatest increase in formant frequency compared to the male speakers for F2 of front unrounded vowels, (Frøkjær-Jensen 1967, 4 and p. 6).

The short vowels have on the whole a somewhat higher F1 and a slightly more centralized F2 than the long vowels, but apart from /o/ and /a/ the differences are small and inconsistent, and the formant frequency values overlap very much. Some speakers have practically identical values for /i-i:/ /e-e:/ and /ɛ-ɛ:/. The differences are on the whole much smaller than e.g. in North German, as can be seen by a comparison with Hans Peter Jørgensen's measurements of German vowels (Jørgensen 1967, p. 77 ff, e.g. Fig. 1). The difference is also smaller than in Swedish and Norwegian (cp. the diagram for Swedish vowels in Elert 1970 p. 67). There is no basis for talking of tense and lax vowels in Danish.

Short /a/, /o/ and /ɔ/ form exceptions to this rule (short /ø/ also seems to make an exception, but this is probably due to the example øllet ('influenced by too much beer-drinking'), which invites to affective pronunciation).

Short /o/ is of particular interest, since it coincides more or less with long /ɔ:/. It has even a higher F1 than /ɔ:/ in the speech of 6 of the nine speakers and higher F2 in the speech of 7 speakers. Three have a slightly lower F1 in /o/, but their speech is rather conservative.

The cross-over of short /o/ and long /ɔ:/ raises a phonological problem. Short [o] might be identified with /ɔ:/ rather than with /o:/. This problem, which is complicated by the fact that short [o] is found in the cases of shortened [o:] and in some foreign words, is treated by Jørgen Rischel (Rischel 1969, p. 180). He also treats the phonological problem of describing the four degrees of aperture in Danish vowels.

The lowering and fronting of the short back vowels might be considered as the result of a tendency to greater phonetic distance between phonemes. But in this case one should also expect a lowering of the long back vowels and of the front vowels, and such a tendency is not found. On the contrary, in modern Copenhagen pronunciation, long /ɛ:/, /œ:/ and /a:/ are even more close than for most speakers in the present study. (The youngest of the speakers shows a certain tendency in this direction). But even these rather conservative speakers show a conspicuous crowding of phonemes in the upper part of the diagram.

This can also be shown by placing the average values of Danish long isolated vowels in an acoustic diagram of Jones' cardinal vowels, obtained by calculating the average frequencies of formant 1 and 2 in Ladefoged's measurements of the cardinal vowels spoken by a number of British male phoneticians (Fig. 3). It can be seen that almost all Danish vowels are placed in the upper third of Jones' diagram, and according to IPA conventions Danish /ɛ:, œ:, ɔ:/ should thus be written [e:, ø:, o:], and the long /a:/ should be written [ɛ:]. This crowding explains why almost all foreigners find it difficult to distinguish the various degrees of aperture in Danish vowels.

In Figs. 1, 2 and 3 the frequency values are indicated in hz (cps), but the scale is the mel scale. This is in accordance with normal conventions, and it facilitates a

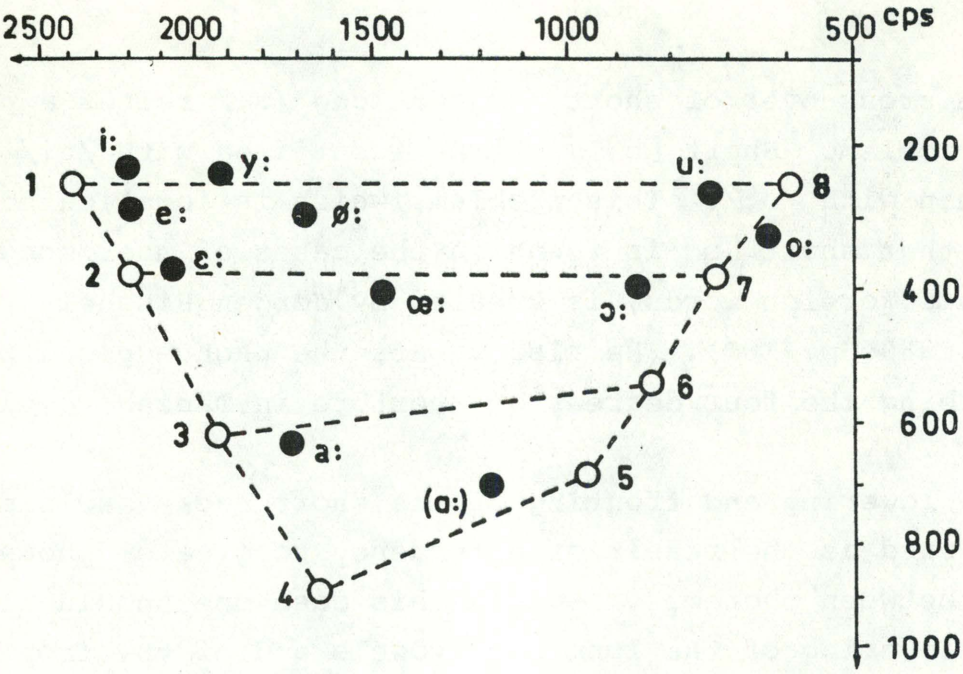

Fig. 3. Isolated Danish long vowels placed in an acoustic cardinal vowel diagram (mel scale).

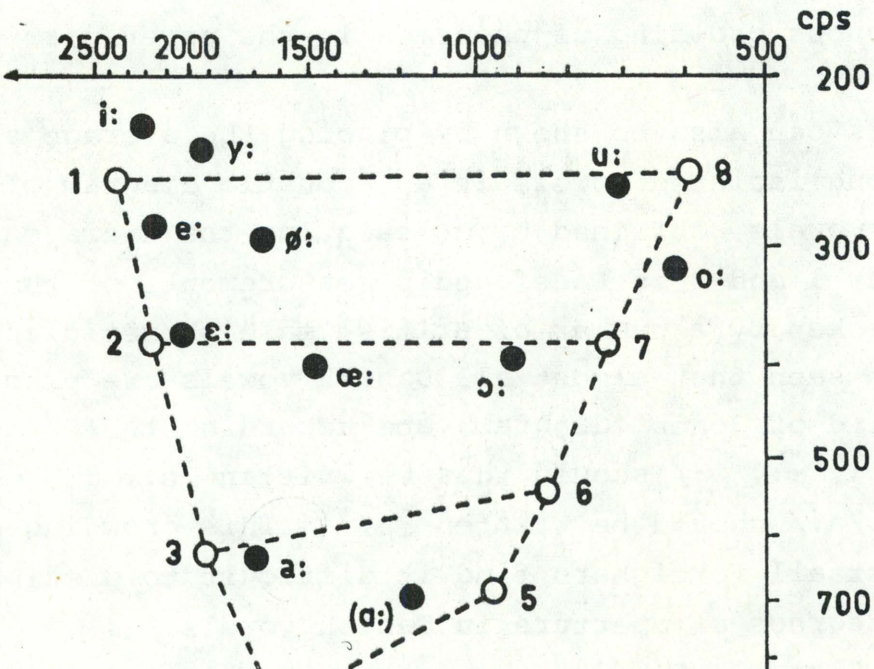

Fig. 4. Isolated Danish long vowels placed in an acoustic cardinal vowel diagram (log. scale).

comparison with the diagrams in the papers by Frøkjær-Jensen and Hans Peter Jørgensen. But there is some evidence that a logarithmic scale would be in better accordance with the auditory impression. The logarithmic scale (see Fig. 4) makes the figure look more like the normal cardinal vowel quadrangle, which is based more or less on auditory impressions of equal distances, and more like the figures found in more recent articles on auditory dimensions of vowels. Moreover, an auditory similarity test applied to the six Danish vowels [iː yː uː ɛː œː ɔː] presented in triads gave the result that the answer to twelve out of 59 questions about relative similarity were in better agreement with a logarithmic scale than with the mel scale. There were no counter examples to this.

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