

## Formants frequencies variability in French vowels under the effect of various speaking styles

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### Abstract

The paper presents first results of a research aiming at a more refined definition of the so-called *speaking styles*. A speaker is recorded in 6 situations and the formants of his /i/, /a/ and /u/ vowels are studied. New categorizations of the speaking styles are proposed, on the basis of the similarities and dissimilarities in formant frequencies values drawn from the various communication situations.

### 1. Introduction

The last five years have been characterized by a constantly increasing interest of phoneticians in the study of *speaking styles*. Several experiments have shown that changes in communication situations provoke acoustical variations in the speech segments (1-6). Nevertheless, the conceptual framework for the description of speaking styles has remained rather poor. Very often, highly contrasted situations are used, that differ in all respects one from another. For instance, our previous investigations (7-10) have mainly focussed upon two very differentiated styles: the so-called *laboratory speech* (words reading task), *versus* the real *spontaneous speech* (natural conversation). In this paper, we seek to refine the model for categorization of speech samples. Six contrasted situations will be used, on the occasion of 3 recording sessions.

The aim of this exploratory study is to determine whether the concept of *referential speech* can be supported by some homogeneity in the data drawn from different referential situations, as opposed to *laboratory* and *spontaneous* speech. The experiment focusses on the vowels system dynamics in French. Given the complexity of the experimental procedure, and because of the exploratory nature of the research, we nevertheless restrict our observations to the so-called "cardinal" vowels of French, i.e, the more extreme ones in the system: /i/, /a/ and /u/. Moreover, in order to avoid contamination by other surrounding vowels, vowels in CVC structures only are taken into account.

### 2. Experimental procedure

The reported experiment involves a single speaker, recorded on 3 occasions, at one-week intervals. Four situations were set up during the first session, and one in each of the other two.

During the first session, the speaker was asked to describe a cartoon-like picture. This contained no written dialogues or comments; it depicted a very complicated scene where ca. 20 different characters interacted with each other. Each character had very special

particularities, such a yellow foot, a green tongue, a red bow-hat, i.e. the picture showed very unlikely items. The speaker was seated in a sound-proof room, in front of the picture. The following four tasks were proposed to him in succession:

*situation 1:* the experimenter asks the speaker to list the "bizarre details" in the picture;

*situation 2:* the experimenter asks the speaker to make a more comprehensive description of the picture, indicating the relationships between characters and trying to produce a narration;

*situation 3:* same task as in situation 2, but the speaker has been given a headphone and from times to times, an unknown person supposed not to know the picture asks for complementary information through the headset;

*situation 4:* the speaker is told that a new person who has never seen the picture will have to reproduce it on the basis of the information he delivers. That person listens to the speaker and frequently asks him for complementary information through the headset.

During the second session (*situation 5*), the speaker had a spontaneous conversation with an experimenter, who asked him to evoke various themes, such his birthplace, military service, or current occupation. The talk lasted for about half an hour. The whole recording was thereafter manually transcribed. Three sets of vowel sounds (at least 25 for each vowel) were randomly selected for analysis. A list of the words containing the so obtained vowels set was composed.

The third session (*situation 6*) took place a week after the previous one. The same speaker was asked to record all the words of the list, presented in a random order.

All sessions took place in the same room, at the Phonetics Laboratory of Mons University. The subject's productions were recorded by means of a Neuman u87i microphone connected to a Sony PCM digitizing unit; the digitized signals were stored on VHS cassettes (Sony video recorder).

### 3. Acoustical analyzes

All the available sounds from the first 4 situations were retained, together with the 90 from situations 5 and 6. At least 25 samples of each phoneme in each situation is therefore available, leading to a total amount of 859 sounds, i.e., 309 [i], 192 [u] and 343 [a].

The first and second formant of each selected vowel were measured by means of a DSP 5500 KAY analyzer, on the basis of wide band spectrograms and narrow band (10 Hz resolution) spectra. Each formant was measured at its center.

### 4. Statistical analyzes

The available data were statistically analyzed vowel by vowel and formant by formant. For a given formant of a given vowel, 6 independent samples of formant values were available (1 set by situation) and underwent one-way analysis of variance. Table 1 summarizes the results drawn from this treatment. Except for F2 in /u/, the data show significant situation-induced overall variabilities of the formants' values. A paired-situations treatment aimed at locating differences therefore appears fully justified: its results are summarized in table 2 (two-sample Student t-tests).

As these tables show, no differences appear ever between situations 1 and 2. On the whole, situations 1 to 4 are rarely differentiated one from another. No significant differences involving second formants are to be observed. When significant differences appear in this subgroup, they always involve at least situation 3 or situation 4.

In brief, it seems that the spontaneous speech situation is very different from the others. It appears particularly differentiated from situations 1-4 (picture description), which constitute a rather homogeneous group. It is to be noticed that when differences occur in this group, they involve the two situations where exchanges with the experimenter

take place (3 and 4). The words reading task (situation 6) also appears different from the others, i.e. mainly situations 1-4; only two significant differences between situations 5 and 6 are to be observed (F1 of /a/ and F2 of /i/).

	First formant		Second formant	
	F-statistic	Significance	F-statistic	Significance
/i/	6.45	<.0000	8.54	<.0000
/a/	6.48	<.0000	4.06	.0014
/u/	2.93	.0143	1.19	.3110

*Table 1: F-statistic and significance level of analyses of variance performed on each vowel and each formant.*

The more numerous significant differences are those involving situation 5 (spontaneous speech); several differences between situation 6 (words reading task) and others can however be observed.

	first formant						second formant						
	1	2	3	4	5	6	1	2	3	4	5	6	
/i/	1	.	-	*	-	*	*	.	-	-	-	*	-
	2	.	.	*	-	*	*	.	-	-	-	*	-
	3	.	.	.	-	-	-	.	-	-	*	-	-
	4	.	.	.	*	*	*	.	-	-	*	-	-
	5	.	.	.	.	.	.	.	-	-	*	-	-
	6	.	.	.	.	.	.	.	-	-	*	-	-
/a/	1	.	-	-	-	-	*	.	-	-	-	*	*
	2	.	.	-	*	-	*	.	-	-	-	*	-
	3	.	.	.	*	*	*	.	-	-	*	*	*
	4	.	.	.	.	-	-	.	-	-	*	-	-
	5	.	.	.	.	*	*	.	-	-	*	-	-
	6	.	.	.	.	.	.	.	-	-	*	-	-
/u/	1	.	-	-	-	-	-	.	-	-	-	-	-
	2	.	.	-	-	*	-	.	-	-	-	-	-
	3	.	.	.	-	*	*	.	-	-	-	-	-
	4	.	.	.	.	*	-	.	-	-	-	-	-
	5	.	.	.	.	.	-	.	-	-	-	-	-
	6	.	.	.	.	.	.	.	-	-	-	-	-

*Table 2: Results of two-samples between-situations Student t tests performed on each possible pair of situations for the first formant (left-hand matrices) and the second formant (right-hand matrices) of vowels /i/, /a/ and /u/. Each star indicates significance at the .05 level.*

As shown by topologic analyzes of the vowels in the formantic plane, the relationships between the spontaneous speech- and the laboratory speech vowels' clusters are similar to those reported in our previous papers (7-10), i.e., they show a clear tendency to more centralized formant values in spontaneous speech. Generally speaking, the vowels' systems from situations 1-4 show F2 values rather close to those from laboratory speech (few or no significant differences); the first formants' values tend to be lower than those from

spontaneous- and laboratory speech, as if the system had been shifted towards lower F1 frequency values.

## 5. Conclusion

Our results show that the 4 situations where the speaker had to describe a picture share common characteristics. Moreover, the spontaneous speech situation appears very well differentiated from other situations. Words reading task also produces specific behaviors of the vowels. It seems also that, broadly speaking, situations where the speaker has to interact frequently with another person tend to show substantial contrast with the other ones. These observations could be explained by the effects of at least two sources of variation: 1. the more or less communicative aspect of the speech produced; 2. the function of the language involved.

Very temptatively, those findings could lead to the bases of a model for the classification of the speaking styles. This would consist of two main axes. The first one would express a measure of the magnitude of the communicative intent: reading a list of words, without any real intention to communicate could be at an end of the axis, although interacting frequently with another person could be at the other end. The second axis would be a discrete, non hierarchical one, where speech acts could be classified, e. g., following Jakobson's classification of the language's functions; in the very case of our study, picture description would be typically referential, although spontaneous speech would be expressive.

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