

DETECTING GHOST PHONEME : THE "LIAISON ENCHAÎNÉE" IN FRENCH

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ABSTRACT

This paper presents 2 experiments in which the detection of latent consonant of the "liaison enchaînée" in French is observed. Results suggest that the specific phonological nature of this segment impedes the subjects in locating word's boundaries. Apparently, they do not treat the words one by one in a strictly left-to-right parsing but rather use the phonological organisation of the speech stream to find word boundaries.

Key-words: Psycholinguistics, Speech Segmentation, Prosody.

1-SEGMENTATION AND "LIAISON ENCHAÎNÉE" IN FRENCH.

"Understanding" spoken language is first of all a process of recognition of discrete words in continuous speech signal. This means that the hearer must locate the boundaries between words of each utterance that he hears. Now, contrary to a written text where words are isolated by blanks, speech signal does not comprise clear and systematic cues signalling the beginning and the end of a word. This is particularly true for French language in which the phonological phenomenon of "liaison enchaînée" (Encrevé, 1988) can remove the left boundary of word beginning with a vowel

The "liaison enchaînée" consists of the following double phenomenon : when two vowels are in contact at a word boundary, a latent consonant appears at the boundary between the two words and it is resyllabified at the attack of the second word : ie "bon ami" (good friend): "bon" [bɔ̃] and "ami" [ami] when the words are produced separately, but [bonami] when they appear together (figure 1).

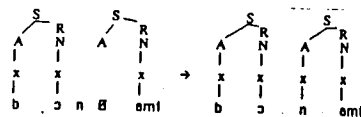


Figure 1 : The "liaison enchaînée"

The resyllabification of latent consonant occurs over the word boundaries. The consequence of such a phenomenon is the lack of correspondence between syllable boundaries and word boundaries and the creation of an erroneous beginning of word (*nami does not exist in French).

Moreover, this latent consonant has a singular status. As a matter of fact, it belongs lexically and morphologically to the first word (it is used in derivation "bon" [bɔ̃] / feminine "bonne" [bon]) but when it is realized, it appears in the surface structure, it is located on the attack of the following word.

One can assume that this fact creates a difficulty for the segmentation process. How can a hearer locate the left boundary of a word when this word he has to access, has on the attack of the first syllable, a consonant that does not belong to its deep representation. In other words, how can the hearer treat this latent consonant on-line, how can he recover [bɔ̃] and [ami] in the following utterance [bonami] which would be syllabified as following : [[bo/na/mi] ?

In the following experiences we observed how the hearers resolve these questions during their perception of continuous speech.

2-EXPERIMENTS

2-1: Experiment 1

Because of the actualisation of the latent consonant on the attack of the first syllable of the word "ami" in "bon ami", the hearer must recognize on-line the specificity of this latent consonant in order to avoid a wrong segmentation (ie "bɔ̃ nami"). In order to test if the hearer showed a particular sensitivity with regard to this specific consonant, we used the Generalized Phoneme Detection (GPD) proposed by Frauenfelder & Segui (1989). This task consists in detecting target phonemes that might appear anywhere in an utterance. Thus, the subjects do not know where the target phoneme can appear. They cannot build a "expectation strategy" based on the place of the target in the word. The assumption was the following : if the subjects show a greater difficulty in detecting the phoneme (ie "n") in "un bon ami" [ɛ̃bonami] than in "un bon navire" [ɛ̃bɔ̃navir], this means that this segment must be treated specifically and must be distinguished from the initial consonant. Consequently, this means that this kind of boundary requires a specific process which permits to remove the ambiguity. On the contrary, if there is no difference of treatment between initial consonants and liaison consonants, this might suppose that the subjects are not sensitive to the specificity of this segment.

Materials

8 pairs of sentences were built : each comprising one item with /t/ as initial phoneme and one with /t/ as liaison phoneme (i.e. "un grand éléphant" / "un grand téléphone"). They were inserted in test sentences. Test sentences were inserted in two lists of 70 sentence fillers. Half of them contained the target either at the beginning of the word (tapis), or inside the word (beauté), or in the end of the word (Colette). Each sentence contains only one target phoneme /t/. There were also 20 practice items. Half of them contained liaison /t/

Procedure

Sentences were read by a masculine speaker who did not know the aim of the experiment so that he should produce the

liaison /t/ in a completely natural way. They were recorded on a REVOX 516 and digitized on Macintosh II. On a second channel, inaudible for the subjects, clicks were placed on the burst of the stop consonant targets. These clicks triggered a clock, which was stopped by the subject's keypress response. The burst of the stop consonants were watched on a spectrogram.

Subjects first listened to the 20 practice items over stereo headphones. They were instructed to respond as rapidly as possible by pressing a response key when they heard the target phoneme /t/ anywhere in each sentence. At the end of these practice trials, when the subjects did not detect any liaison /t/, they were explicitly asked to detect also the liaison phonemes. Then began the experimental trials.

Subjects

The subjects were 23 undergraduate students from the University of Paris V. They were French native speakers without any known hearing disabilities.

Results

For the analysis of the data, the reaction times below 100 milliseconds and those above 2,000 milliseconds were eliminated.

	Liais /t/	Init /t/	Diff
RT	619	573	46
% miss	7,8%	4,6%	

Table 1 : Reaction times (RT) in milliseconds and missing percentage (% miss) in detection of the target /t/ in pairs like "un grand éléphant" (liais /t/) and "un grand téléphone" (init /t/)

A Student test was performed taking the initial / liaison condition as random factor. The t values are given for subjects (t) and for items (t'). The analysis shows a significant difference of reaction times between the initial condition and the liaison condition for items (t'(1,8) = 2,87 p= 0.02) as for subjects (t (1,19) = 2,89 p = 0.0009).

Discussion

The results confirm the assumption that we have formulated above : the liaison consonants have been detected

more slowly than the initial ones. The process of this kind of segments is apparently more complex than the monitoring of initial phonemes. In "un grand éléphant" [ɛgratɛlaf], the resyllabification of the consonant induces some ambiguity with respect to the boundary. The subjects have a great difficulty to remove this ambiguity in order to be able to locate the left boundary and to access the word "éléphant" because of the realization of /t/ at the beginning of the word.

As we have seen, the "liaison enchaînée" implies a *phonetic* alteration of the speech signal but that is bound by *phonological* constraints. As a matter of fact, the actualization and the resyllabification of the liaison segment does not occur anywhere in the speech stream. The frequency and the distribution of the liaisons are bound by the nature of the phonological domain in which they appear (De Jong 1990). Thus, the liaison is considered obligatory in the clitic group (i.e. "un ami") and quasi-obligatory in the phonological phrase ("un bon ami"). De Jong has shown that it is actualized by 99% of speakers in CG and by 75 % of speakers in PP. The more syntactically cohesive the group, the more obligatory the liaison. One can assume that this phonological production constraint also comes into play during the perception. In order to examine if this phonological constraint is a factor of the perceptual process of liaison phoneme, we replicated the first experiment but with liaisons in clitic groups.

2-2 Experiment 2

Materials and procedure

Materials was built in strictly identical way except for the nature of the domain in which the liaison appears. In this experiment, the target phoneme was /n/ as initial phoneme as liaison phoneme (i.e. "un navire" a ship [ɛnavir / "un avion" a plane [ɛnavjo]). The procedure was strictly the same. The subjects were 37 undergraduate students from the University of Paris V.

Results

Subjects have had many difficulties in performing the task. In spite of the

increase of the number of subjects, the number of detected liaison target phonemes was insufficient to perform a statistic analysis. Then, the missing detections had been systematically analyzed.

	Liais /n/	Init /n/
% miss	40 %	14 %

Table 2 : missing detections (% miss) for detection of the target /n/ in pairs like "un avion (liais /n/) and "un navire"t (init /n/)

A Student test was performed taking the initial / liaison condition as random factor. The t values are given for subjects (t) and for items (t'). The analysis shows a significant difference of percentage of detection between the initial condition and the liaison condition for items (t'(1,7) = 4,22 p= 0.0039) as for subjects (t (1,36) = 5,75 p = 0.00002). Although, the subjects had been explicitly asked to detect also the liaison consonants, they missed many target phonemes. They didn't seem to perceive this kind of segment, as if they were deaf in regard to these liaison consonants.

Although the results of experiment 1 (RT) cannot be directly compared with those of experiment 2 (% of missing responses), in both cases the subjects have shown many difficulties to detect liaison consonants, but most characteristically in clitic groups. This detection seems quite impossible as if the more obligatory the liaison, the more difficult the target detection.

3-DISCUSSION

This difficulty can be interpreted in two ways. One can first make the hypothesis that initial consonants and liaison consonants do not have the same acoustic realization. In that case, the differences between liaison condition and initial condition could be assigned to a subject's sensitivity to this kind of information. Thus, this would mean that they have used low-level acoustic information to locate the words' boundaries and process the segmentation of the speech stream.

Acoustic hypothesis

It is traditionally and generally admitted in phonological literature that the realization of initial consonant, and liaison consonant, are acoustically identical (Encrevé, 1988). However, a few results (Durand, 1953; Bradley & Dejean, 1990; Bresson & Grosjean, 1994) showed that the initial consonant in PP was significantly longer than the liaison consonant. More particularly, Dejean has shown that VOT and occlusion's duration are shorter in the case of liaison consonants.

We made the same measurements of our materials. The measurements were made on spectrograms in Unice (table 2).

	Init	Li	Dif	t 1,7	p
VOT	49	43.5	5.5	1.14	0.29
Occl	69.7	49.7	20	3.42	0.01
Dur	120	95	25	4.145	0.0043

Table 3: VOT, occlusion's duration (occl) and consonant's duration (dur) of /t/ in pairs like "un grand éléphant" / "un grand téléphone"

Our results confirm the inferences made by Dejean : the initial phonemes are longer than liaison consonants. One can think that this difference of duration explains the difference of RT. However, we have calculated a correlation between the results of the experiment 1 (RT) and the durations that we have measured (VOT, occl, dur), and we have found no significant correlation between the RT and the durations of the consonants. Moreover we have also compared acoustic realizations of initial /n/ and liaison /n/ and we have found no significant difference (table 4).

	Init	Li	Diff	t 1,7	p
Dur	61	57,8	3,2	1.15	0.29

Table 4 : duration (dur) of /n/ in pairs like "un navire" / "un avion".

This would mean that this kind of acoustic information is not preferentially used by the hearers to resolve the ambiguity created by a liaison on a word's boundary.

One can also make the hypothesis that the phonological specificity of the liaison

consonant is what the subjects have to consider.

Phonological hypothesis

In those experiments, the results have shown that the subjects have many difficulties in performing the phoneme-monitoring task for the liaison phonemes as if they could not isolate them as "phonemes". Moreover, the cohesion of the phonological domain in which this liaison appears seems to be a factor of the subjects incapacity to isolate the target from the group and to recognize it. This would mean that this kind of groups is processed as a single unit and is not split in two or three words (ie article, adjective, noun) that are isolated and successively accessed. Besides, this kind of free lexemes could be lexicalized in French (ie un bon homme (a good man) > un bonhomme (a fellow)).

Thus those results suggest that the segmentation in French, as it has been proposed by Christophe (1993) could be processed by phonological units larger than the words in which the lexical access could occur.

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