

A surface-level account of French word-initial [w]
in sandhi and non-sandhi contexts

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Abstract

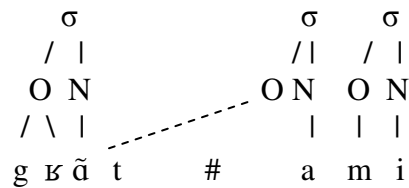
This study aims to determine whether French word-initial [w] exhibits different phonetic properties depending on whether or not sandhi phenomena are permitted. We also explore the question of whether or not these properties are lexically determined and therefore consistent across contexts. Minimum F2 value for [w] as well as the duration until 80% of the F2 transition from [w] to the following vowel are analyzed. The study involves a preliminary elicitation of experimental items from four native subjects both in sentences and in isolation. The results suggest that recent phonological analyses are not wholly correct in positing underlyingly onset or underlyingly nuclear word-initial glides, since the surface-level post-lexical syllabification seems to determine whether word-initial [w] will be more consonant-like (onset) or vowel-like (nuclear). We propose a revision to these phonological analyses in light of the new phonetic data. This study serves as a contribution to the growing literature on the phonetic properties of segments involved in sandhi phenomena in French.

§1. Introduction.

French contains a number of external sandhi processes that have been widely discussed in the theoretical literature (Clements & Keyser, 1983; Prunet, 1992; Paradis & El Fenne, 1995). The three primary processes—liaison, enchainment, and elision—involve the phonetic realization (or non-realization) of certain final segments which are sensitive to the syllabic structure of the following word, mainly, whether or not this following word is onset-initial or nucleus-(vowel-)initial, according to proposed phonological analyses.

In liaison, a word-final latent consonant (i.e. not anchored to a temporal slot in syllabic structure) may be realized by association if the onset of the initial syllable of the following word is empty. For example,

grand ami ‘great friend’: /gʁɑ̃(t)#ami/ → [gʁɑ̃.ta.mi]



Enchainment (*enchaînement*) involves the realization of a stable word-final consonant as the onset of the following syllable if this position is available (the following word is vowel-initial). For example, in the phrase *grande amie* /gʁɑ̃d#ami/ → [gʁɑ̃.da.mi], [d] is enchainned to the following syllable by association. Finally, elision involves the deletion of a word-final schwa (as described in traditional analyses, though realized as [œ]) before a vowel-initial word, and the onset of this first syllable (the one ‘originally’ with the schwa) becomes the onset of the following vowel-initial syllable:

l’ami ‘the friend’: /lə + ami/ → [la.mi] (cf. *le garçon* ‘the boy’ /lə + gaʁsɔ̃/ → [lə.gaʁ.sɔ̃])

There are two types of onsets that seem to act idiosyncratically with regard to these sandhi phenomena, namely, what is traditionally called *h aspire* and initial glides in specific words. This study will focus on the latter phenomenon.

Word-initial glides (in French, [w], [j] and [ɥ]) may or may not permit sandhi phenomena, and this property is lexically determined: cf. *le oui* [lə.wi] ‘the yes’ vs. *l’ouïe* [lwi] ‘the sense of hearing’. Recent autosegmental analyses (Clements & Keyser, 1983; Prunet, 1992) have suggested that syllabic structure can explain the difference in behavior vis à vis sandhi phenomena, i.e., that a word like *oui* (c.f., *le oui* [lə.wi]) contains a glide in onset position whereas a word like *ouïe* (c.f. *l’ouïe* [lwi]) contains a branching nucleus consisting of an onglide and a vowel (i.e. a diphthong). Since words like *ouïe* have no onset, they permit sandhi phenomena, whereas the onset-glide-initial words like *oui* do not.

Our study aims to observe if there are any phonetic properties that might shed light on two important aspects of these analyses: 1) What are the phonetic properties of the first sound (glide) in each word? That is, how do phonetically similar words that behave the opposite way with regard to sandhi phenomena compare to one another? 2) Are there phonetic differences (extreme F2 values, formant transitions) between glides purportedly in onset position and those

in nuclear position? Does a phonetic analysis support the phonological claims made in the French linguistics literature? We have restricted the present study to [w].

Some previous phonetic analyses have been offered concerning post-lexical sandhi phenomena, most notably concerning word boundary recovery after enchainment (Fougeron, to appear; Fougeron et al., 2002) and the resyllabification of stranded consonants after schwa deletion (Fougeron & Steriade, 1997; Rialland, 1986). None of these studies, however, discuss the phonetic properties of word-initial glides, which either permit or forbid sandhi phenomena in two lexically-determined groups. This study aims to provide a preliminary look at the phonetic properties of these words as a contribution to the phonetic analysis of post-lexical sandhi phenomena.

Hypotheses

As not to rely on the typology (onset-glide, nuclear-glide) posited in the phonological analysis we are testing, a basic structural terminology will be used to characterize the different types of data used for this study. There are three relevant types of environment in which [w] may occur: (1) those where [w] is morpheme-initial as well as syllable-initial (i.e. non-sandhi words, such as *le oui* [_σ[_mlœ]] [_σ[_mwi]]), (2) those where [w] is morpheme-initial but syllable-internal (i.e. sandhi words, as in *l'ouïe* [_σ[_ml]] [_mwi]); and (3) those where [w] is morpheme-internal as well as syllable-internal (i.e. word-internal [w], as in *trois* 'three' [_σ[_mtχwa]]). The question arises whether there are similar phonetic properties associated with syllable-internal position (in what will be referred to as types 2 and 3) or with morpheme-initial position (in what will be referred to as types 1 and 2). In following with Clements & Keyser (1983) and Prunet (1992), our main hypothesis is that position within the syllable will be the determining factor for phonetic differences, if there are any. There are two primary phonetic factors of consideration that will be discussed: (1) minimum F2 level of the glide and (2) duration of the glide.

We expect that morpheme-initial, syllable-initial (type 1) [w] will exhibit the most extreme constriction, which will be shown by a lower minimum F2. In other words, we predict that syllable-initial [w] should consistently exhibit greater constriction than syllable-internal [w] (as in types 2 and 3), regardless of position with regard to the left edge of the morpheme boundary. We characterize this difference by noting that syllable-initial [w] should be more consonant-like whereas syllable-internal [w] should be more vowel-like.

In addition, we expect that syllable-initial [w] (type 1) should therefore exhibit longer duration from the minimum F2 until the maximum F2 of the following vowel than in syllable-internal position (types 2 and 3), where it should behave more like a vowel than consonant. This duration measurement may be affected by the quality of the following vowel, since a vowel with an F2 value similar to [w] will require less time for transition. The position of [w] within the morpheme should not influence the formant transitions, and therefore types 2 and 3 should be similar in this respect.

In order to test the hypothesis that syllable position will be the determining factor for differentiating phonetic properties, we examined words that were pronounced both in isolation and in sentences. Since the phonetic properties of the glides in the words have been characterized as lexically determined, we also expect that [w]-initial words in isolation will reflect the same phonetic properties as the same word embedded in a larger context. In addition, we expect that word-internal [w] (as in *boit* '(he) drinks' [bwa]) should exhibit the same extreme frequency and formant transitions as word-initial diphthongs (as in *l'oiseau* 'the bird' [lwa.zo]).

§2. Methods.

Linguistic Corpus

The data analyzed in this experiment were taken from a set of 19 isolated words and 8 sentences constructed by the authors. We included sentences as well as isolated words to test the phonetic properties of initial glides in both their natural sandhi contexts (syntax) as well as in isolation (in production of single words). In addition, we hoped to encourage natural production from the subjects by incorporating full sentences. We included isolated words in order to contrast the various contexts of glide-initial words when no external sandhi processes could operate on them.

There were four categories of words in the data set. The experimental items were controlled for syllable structure so that only open syllables were examined (because of the possibility of altered nucleus length depending on the presence or absence of a coda). The first three categories reflect the syllabic and morphemic structures discussed above. That is, type 1 words contained glides that were morpheme-initial as well as syllable-initial, meaning that the words did not permit sandhi phenomena (e.g. *les weekends* ‘the weekends’ [le.wi.kænd], but not *[le.zwikænd]). In type 2 words, glides were morpheme-initial but syllable-internal, meaning that the words permitted sandhi phenomena (e.g. *petit oiseau* ‘little bird’ [pə.ti.twa.zo]). In type 3 words, glides were morpheme-internal as well as syllable-internal, meaning that the glides were word-internal (e.g. *boire* ‘to drink’ [bwaʁ]). The fourth category included control words that did not fall into any of the other three experimental categories, as distractors. The data set included each of these four categories of words in both the isolated words and in the sentences. In the sentences, the three types of words containing [w] were placed in the middle of the sentences to control for prosodic effects due to initial or final prosodic effects.

The items analyzed in this experiment consisted of eleven words from four speakers for a total of 44 tokens. Of the eleven words used in the present experiment, five words were recorded as isolated words and the remaining six were embedded in sentences. We will refer to these words as context 1 words (spoken in isolation) and context 2 words (spoken in sentences). In both contexts, there were three types of words corresponding to the three experimental categories described above. Two words of each type were produced in context 1, and context 2 contained two words of type 1 and 2 as well as one word from type 3. The words chosen for this experiment minimally or near-minimally contrast in their licensing or non-licensing of external sandhi phenomenon by the initial glide segment. In addition, two of the words from context 1 (one of type 1 and one of type 2) are replicated in context 2. The words used in each context are given in Table 1 and in (1a)-(3b) (target words are given in bold).

Table 1: Target words.

		Position within morpheme	Position within syllable	Sandhi permitted?
Type 1	weekend [wi.kɛnd] ‘weekend’ oui [wi] ‘yes’	morpheme-initial	syllable-initial	no
Type 2	ouïe [wi] ‘sense of hearing’ oiseau [wa.zo] ‘bird’	morpheme-initial	syllable-internal	yes
Type 3	trois [tʁwa] ‘three’ boire [bwaʁ] ‘to drink’	morpheme-internal	syllable-internal	---

- (1a) Géraud va tous **les weekends** [le.wi.kɛnd] à Rouen pour se promener dans le quartier medieval. / ‘Every weekend, Gerard goes to Rouen to walk around the medieval quarter.’
- (1b) Marc buvait **son whisky** [sɔ̃.wi.ski] au Café Lutèce. / ‘Marc was drinking his whisky at the Café Lutèce.’
- (2a) Le **petit oiseau** [pœ.ti.twa.zo] s’est perché sur la branche du peuplier. / ‘The little bird landed on the poplar tree branch.’
- (2b) Monsieur Poirier donnait à manger **aux oies** [o.zwa] tous les matins. / ‘Mr. Poirier fed the geese every morning.’
- (3a) Monsieur **Poirier** [pwa.ʁje] donnait à manger aux oies tous les matins. / ‘Mr. Poirier fed the geese every morning.’
- (3b) Nicole aime **boire** [bwaʁ] un verre de vin chaque vendredi après le boulot. / ‘Nicole likes to drink a glass of wine every Friday after work.’

Because of experimenter error, subject 4 did not have a word of type 3 (morpheme-internal, syllable-internal) in context 1 (isolated words).

Speakers

The speakers were four native French speakers from northern France. Two speakers (1 and 3) were from Lille and two were from Strasbourg (2 and 4). To control for dialectal and sociolectal differences, all of the speakers were educated Master’s or doctoral students, female, and between the ages of 25 and 35.

Elicitation Technique

In order to elicit the words from each category, we asked each of the four subjects to read a list of words followed by a list of sentences. A sample experimental handout may be found in Appendix A. All subjects were given the same words and sentences. All four categories of words described above were included in both lists, and some words from the isolated word list were repeated in the sentence list. To control for any ordering effects, each speaker was given a different randomization of the list of words and sentences.

Recording Technique

We recorded the subjects’ productions with a microphone headset directly into a laptop computer using the digital audio software Audacity (version 1.2.4). All of the recordings were

sampled at 16000 Hz. The recordings took place in a quiet room free from distraction. Subjects were not informed of the purpose of the study until after the recordings were made.

Data Processing Technique

In analyzing the selected data (five words taken from context 1, the isolated words, and six words taken from context 2, the words in sentence context), we used the audio software WaveSurfer (version 1.8.5). The primary measurements we took concern (1) the duration of the F2 change from the glide to the following vowel and (2) the minimum F2 value of the glide. Using a waveform, we observed where the glide of each word began (first peak of the glide's waveform). We then selected another point that was near the mid-point of the following vowel (that is, after the complete transition of F2 from glide to vowel). We generated a formant plot and then extracted the F2 values over this period (from the beginning of the glide to the end of the F2 transition into the vowel). The analysis window length was set at 50 ms, and the frame interval was also set at 50 ms. This interval was chosen because it allowed for a precise measurement to be taken and yet maintained a fairly smooth representation of formant transition in the formant plot. The values were then imported into Microsoft Excel and the minimum F2 value for each word was extracted automatically.

We chose to measure the duration of the formant transition by measuring just 80% of the formant change from the minimum F2 timestamp to the maximum F2 timestamp. We used 80% of the transition instead of the entire formant transition in order to control for inaccuracy in estimating the end of the F2 transition from glide to vowel. To do this, we used Excel's MAX function in order to find the maximum F2 value. Minimum and maximum F2 values were double-checked on the Excel spreadsheet. We then subtract the minimum F2 value from the maximum F2 value and multiplied this differential by .8. This number was added to the minimum F2 value to find the 80% mark of the formant transition from glide to vowel. The formula used to find this 80% can be stated as the following:

$$(\Delta F2 \times .8) + \min(F2)$$

or

$$[(\text{maximum F2} - \text{minimum F2}) \times .8] + \text{minimum F2}$$

Using Excel's LOOKUP function, we estimated the timestamp of the 80% mark. We then subtracted the timestamp of the minimum F2 value from that of the 80% mark in order to find the duration of 80% of the F2 transition from glide to vowel.

§3. Results.

The raw data extracted from the recordings can be found in Tables (6a-d) in Appendix B.

Minimum F2 value

The minimum F2 values for [w] segments in the experimental items are given in Table (2)¹:

¹ See Appendix B for a translation of all experimental items.

Table 2. Minimum F2 values for experimental items, per subject (in Hz).

Data item	Subject 1	Subject 2	Subject 3	Subject 4	Averages
<u>Context 1: isolated words</u>					
Type 1:					787.55
7. weekend	1063.83	688.26	1023.47	852.60	907.04
8. oui	658.12	661.35	709.05	643.75	668.07
Type 2:					623.52
9. ouïe	528.32	672.63	801.61	552.60	638.79
10. oiseau	571.32	578.37	418.22	865.08	608.25
Type 3:					1177.32
11. trois	834.80	828.73	1868.43	N/A	1177.32
<u>Context 2: sentences</u>					
Type 1:					995.77
1. les weekends	1831.66	755.74	1012.91	1033.29	1158.40
2. son whisky	978.49	747.68	811.65	794.70	833.13
Type 2:					1163.57
3. petit oiseau	1553.47	1320.36	1532.97	1246.95	1413.44
4. aux oies	857.37	694.99	1172.40	930.07	913.71
Type 3:					1066.21
5. Poirier	1064.73	1065.98	1905.54	887.33	1230.89
6. boire	1016.19	870.25	838.29	881.35	901.52

The most salient difference between experimental contexts is that minimum F2 values for glides pronounced syllable-initially at surface-level (regardless of phonological analyses of syllable structure)—that is, type 1 and 2 words produced in isolation and type 1 words produced in sentences—are generally lower than those that are pronounced syllable-internally (type 2 and 3 words produced in sentences and type 3 words produced in isolation). Even though the patterning is not fully consistent across speakers or within speakers, in most cases this division seems to hold.

Duration measurements for formant transitions

The duration measurements for formant transitions to 80% of F2 for vowel following [w] are summarized in Table (3). Averages for each type and context are given in bold to the right of the four subjects.

Table 3. Duration between minimum F2 and 80% of total F2 differential (Formant Transition Time), per subject (in s).

Data item	Subject 1	Subject 2	Subject 3	Subject 4	Averages
<i>Context 1: isolated words</i>					
Type 1:					.076
7. weekend	.070	.070	.065	.050	.064
8. oui	.050	.135	.085	.080	.088
Type 2:					.078
9. ouïe	.085	.075	.075	.011	.062
10. oiseau	.125	.095	.095	.070	.096
Type 3:					.068
11. trios	.105	.040	.060	N/A	.068
<i>Context 2: sentences</i>					
Type 1:					.048
1. les weekends	.045	.070	.030	.045	.048
2. son whisky	.020	.060	.055	.055	.048
Type 2:					.059
3. petit oiseau	.080	.045	.055	.035	.054
4. aux oies	.060	.070	.050	.075	.064
Type 3:					.055
5. Poirier	.075	.035	.020	.060	.048
6. boire	.065	.075	.105	.005	.063

Again, in keeping with the general pattern discussed above for minimum F2, type 1 and 2 words produced in isolation and type 1 words produced in sentences have transitions that last longer (are slower) than those occurring syllable-internally at surface-level (as in type 3 words produced in isolation and type 2 and 3 words produced in sentences). This is to be expected, considering that the formant transitions should take longer beginning from a lower F2 value, all things being equal.

Minimum F2 x Duration of formant transition

In order to combine the minimum F2 data with the durational measures for each experimental item, we have represented the two independent variables for each of the four subjects in a scatter-plot graph, as shown in Figures (1a-d).

Figure 1a. Minimum F2 values for the glide [w] versus duration measurements for formant transitions from [w] to vowel (Subject 1)

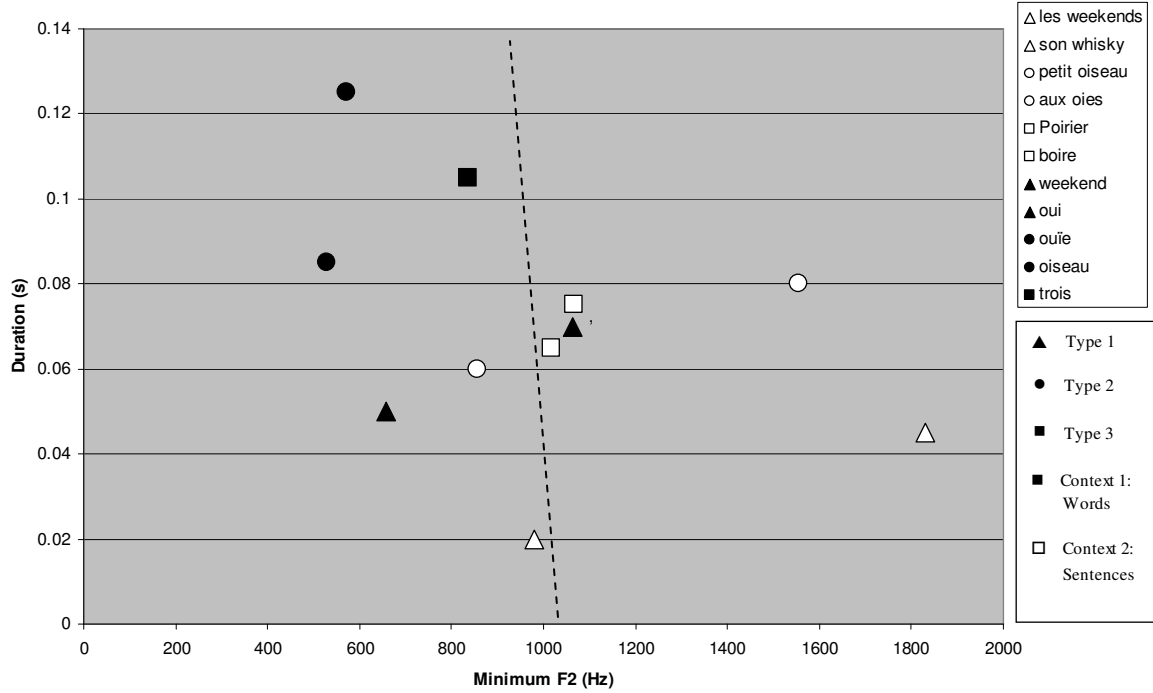


Figure 1b. Minimum F2 values for the glide [w] versus duration measurements for formant transitions from [w] to vowel (Subject 2)

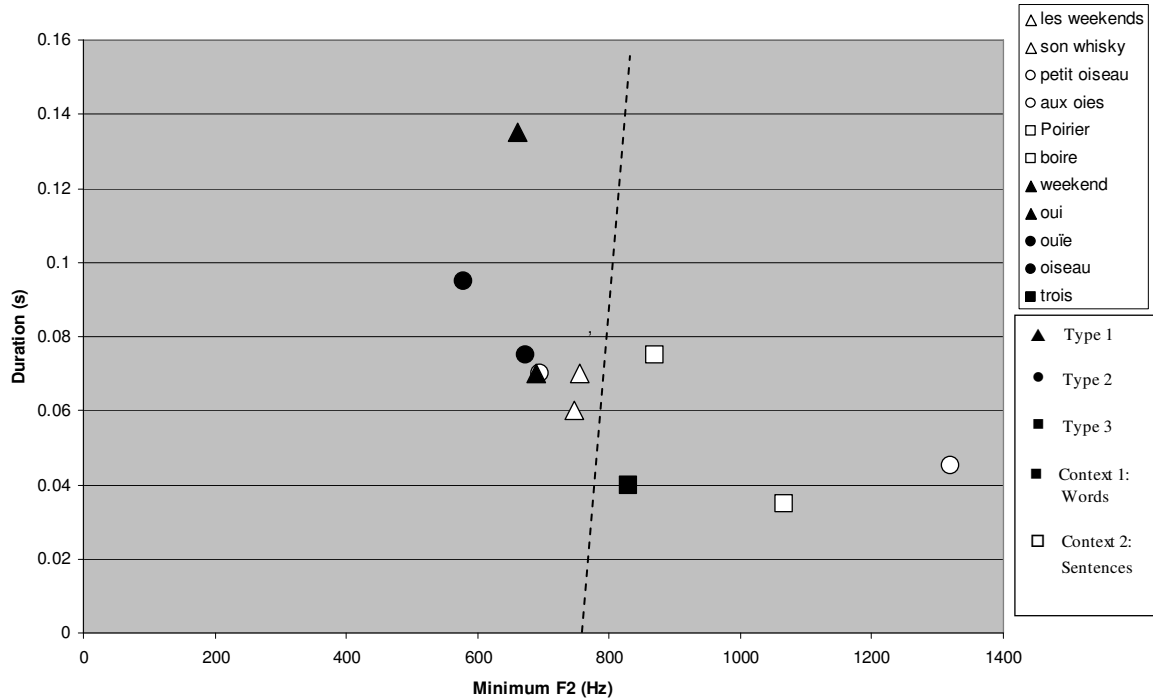


Figure 1c. Minimum F2 values for the glide [w] versus duration measurements for formant transitions from [w] to vowel (Subject 3)

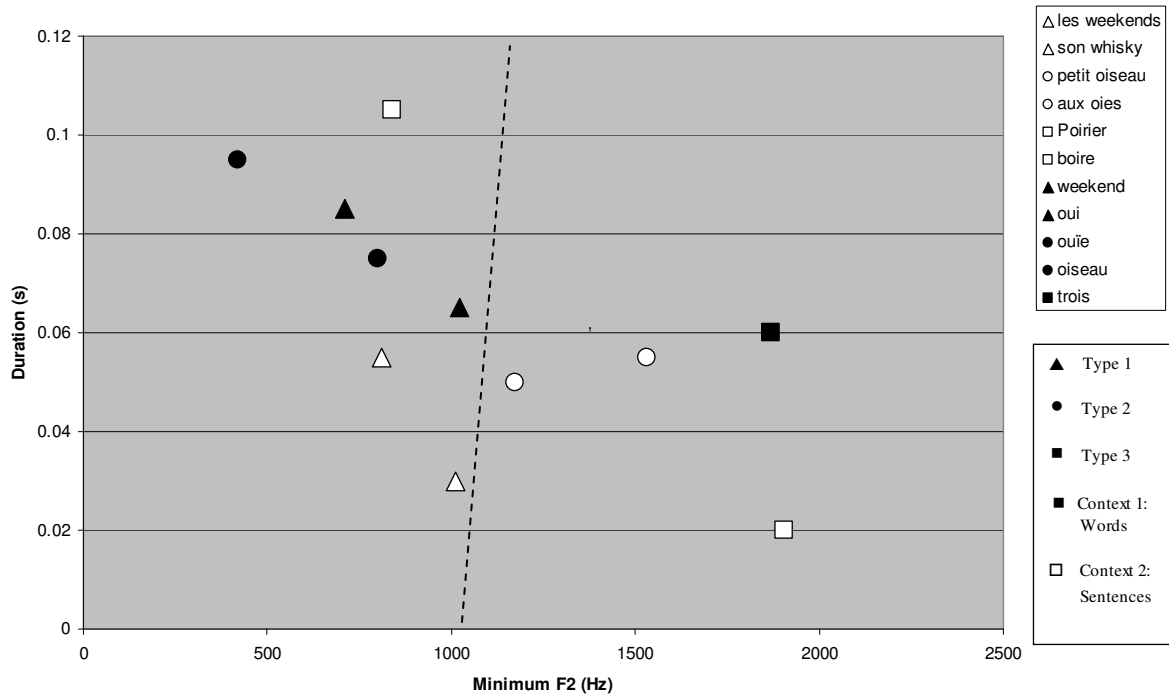
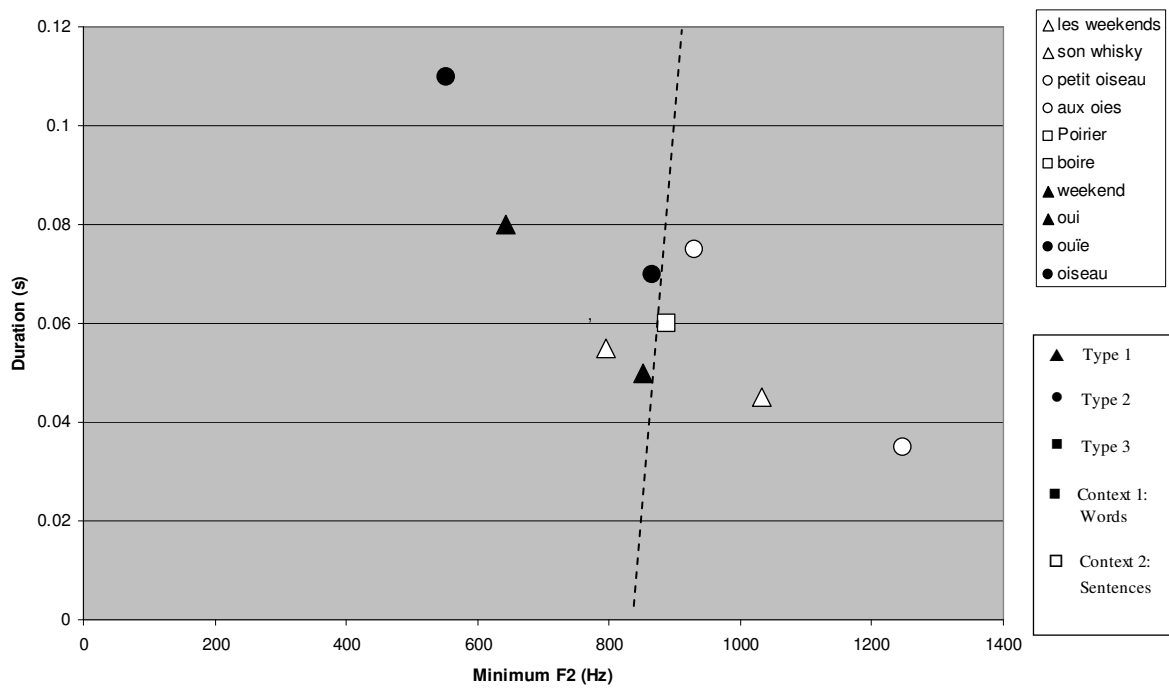


Figure 1d. Minimum F2 values for the glide [w] versus duration measurements for formant transitions from [w] to vowel (Subject 4)



The distribution of word-initial [w] appears to fall into two main categories of questionable significance. Contrary to the hypothesis that [w] in type 1 words should consistently differ from [w] in types 2 and 3, it appears that [w] segments act similarly depending on whether or not they are *pronounced* syllable-initially or not (regardless of supposed phonological syllable structure). That is, type 1 words from both contexts 1 and 2 pattern with type 2 words from context 1 only, because in their isolated pronunciation, the initial [w] is not preceded by another consonant in the onset of the syllable (e.g. *les weekends* [le.wi.kɛnd] and *weekend* [wi.kɛnd] pattern with *oiseau* [wa.zo] pronounced in isolation). On the other hand, type 2 words produced in sentences pattern with type 3 words produced both in sentences and in isolation, apparently because they all contain another consonant in initial onset position (e.g. [w] in *petit oiseau* [pœ.ti.twa.zo] patterns with [w] in *Poirier* [pwa.ʁje] in sentences and with [w] in *trois* [tʁwa] in isolation). We have superimposed a dashed line to illustrate the proposed patterning division. The general distribution of this patterning suggests the following division into two categories, surface-level syllable-initial (Category 1) and surface-level syllable-internal (Category 2):

Table 4. Summary of patterning of experimental contexts in terms of minimum F2 value of [w] and duration measures for formant transitions.

Category 1: Surface-level syllable-initial	Category 2: Surface-level syllable-internal
▲ (Type 1, Context 1)	○ (Type 2, Context 2)
△ (Type 1, Context 2)	■ (Type 3, Context 1)
● (Type 2, Context 1)	□ (Type 3, Context 2)

In most cases, Category 1 [w] exhibits a lower minimum F2 as well as a longer duration for formant transition (it is slower), while Category 2 exhibits a higher minimum F2 as well as a shorter duration for formant transition (it is faster). The two independent variables appear to be in an inverse relationship; that is, as minimum F2 increases, duration measures for formant transitions decrease. This is readily visible in the scatter-plot graphs.

Within-subject and across-subject differences appear rampant in the data, with regard to both independent variables. This suggests some degree of variation especially across speakers, but also within speakers. A stronger control of phonological environment (surrounding segments) in future studies may serve to correct data exceptions which seemingly clash with the patterning proposed. Although the results do not appear conclusive beyond any doubt (there are some items that do not conform to the general pattern, especially for subject 1), the patterning does seem to suggest that syllable-initial position at surface-level determines the phonetic characteristics of French [w]. Further comparison across contexts for specific words will help bear out this conclusion.

Our second hypothesis that the phonetic properties (minimum F2 and duration of formant transition) should remain consistent across experimental contexts (that is, whether pronounced embedded in syntax or as an isolated word) appears not to be correct for all experimental contexts. Specifically, the patterning of doublets (words repeated in both experimental contexts) suggests that the analysis concerning surface-level syllable position is on the right track.

Table 5a. Minimum F2 values for [w] in items repeated in the two experimental contexts (isolated words and sentences), per subject (in Hz).

	Data Item	Subject 1	Subject 2	Subject 3	Subject 4	Average
Type 1						
Context 1	weekend	1063.83	688.26	1023.47	852.60	907.04
Context 2	les weekends	1831.66	755.74	1012.91	1033.29	1158.40
Type 2						
Context 1	oiseau	571.32	578.37	418.22	865.08	608.25
Context 2	petit oiseau	1553.47	1320.36	1532.97	1246.95	1413.44

Table 5b. Duration of formant transition in items repeated in the two experimental contexts (isolated words and sentences), per subject (in s).

	Data Item	Subject 1	Subject 2	Subject 3	Subject 4	Average
Type 1						
Context 1	weekend	0.070	0.070	0.065	0.050	0.063
Context 2	les weekends	0.045	0.070	0.030	0.045	0.048
Type 2						
Context 1	oiseau	0.125	0.095	0.095	0.070	0.096
Context 2	petit oiseau	0.080	0.045	0.055	0.035	0.054

A graphical representation of these forms will better illustrate the relationships between repeated items. Consider, for example, a comparison of *les weekends* (type 1, context 2) and *weekend* (type 1, context 1) in terms of both minimum F2 value (Figure (2a)) and duration of formant transitions (Figure (2b)).

Figure 2a. Minimum F2 values for 'weekend' (context 1) and 'les weekends' (context 2), per subject (in Hz)

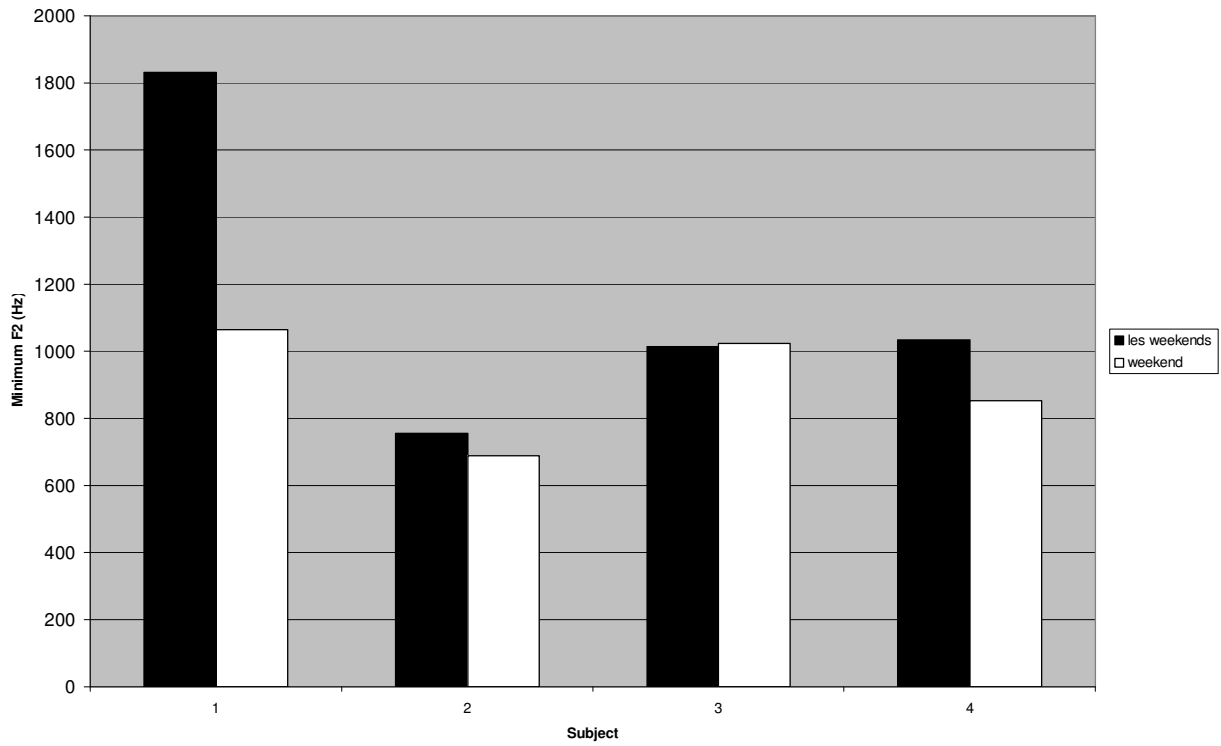
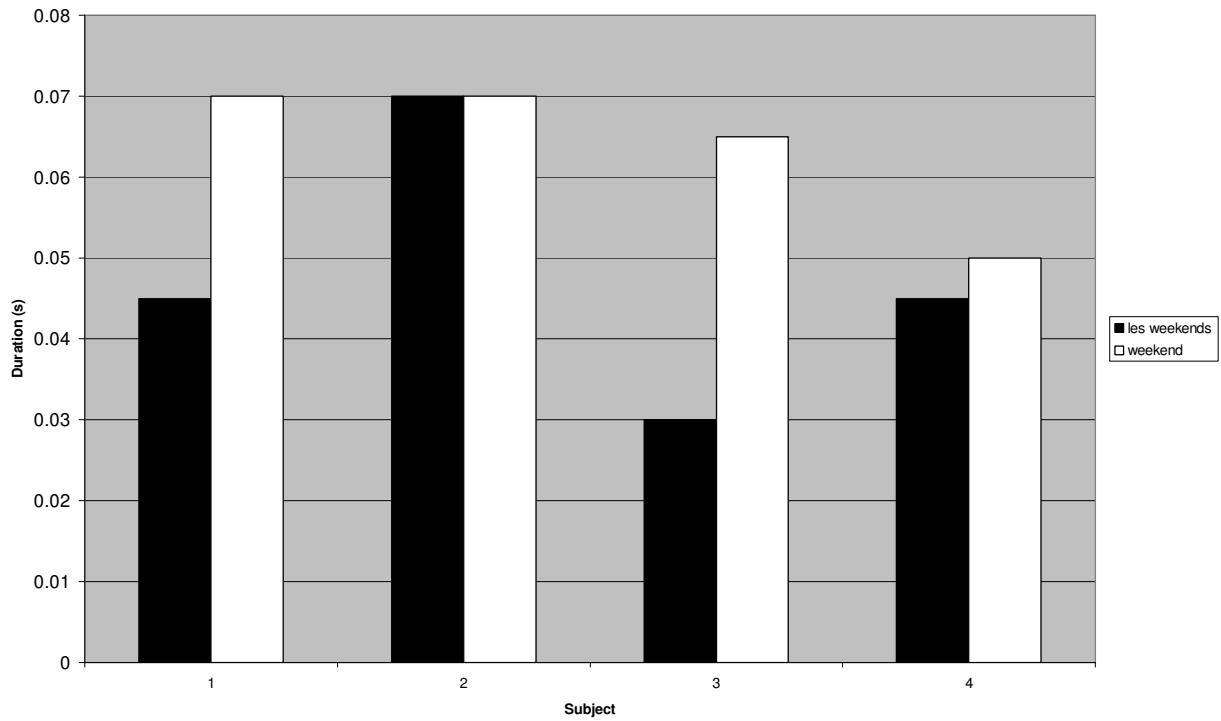


Figure 2b. Duration of formant transition for 'weekend' (context 1) and 'les weekends' (context 2), per subject (in s)



As expected, minimum F2 value between experimental contexts appears stable for type 1, context 2 (*les weekends*) versus type 1, context 1 (*weekend*), except for subject 1, who deviates from the other subjects. In terms of duration of formant transitions, the expected pattern of similar duration is less obvious, exhibited only by subjects 2 and 4. However, bearing in mind that subject 1 had a high F2 value, the indirect relationship between the variables of F2 value and length (namely, that high F2 values may be associated with shorter duration), may explain the short duration of her formant transition. The difference between subject 3's duration measurements remains unresolved. Still, the general tendency appears to support the common patterning of type 1, context 2 and type 1, context 1.

A comparison of type 2 between experimental contexts, and compared with a type 3 item, strongly supports the proposed analysis that surface-level syllabic position determines the phonetic realization of French [w]. This comparison is shown in Figures (3a-b).

Fig 3a. Minimum F2 values for 'petit oiseau' (type 2, context 2), 'oiseau' (type 2, context 1), and 'Poirier' (type 3, context 2), per subject (in Hz)

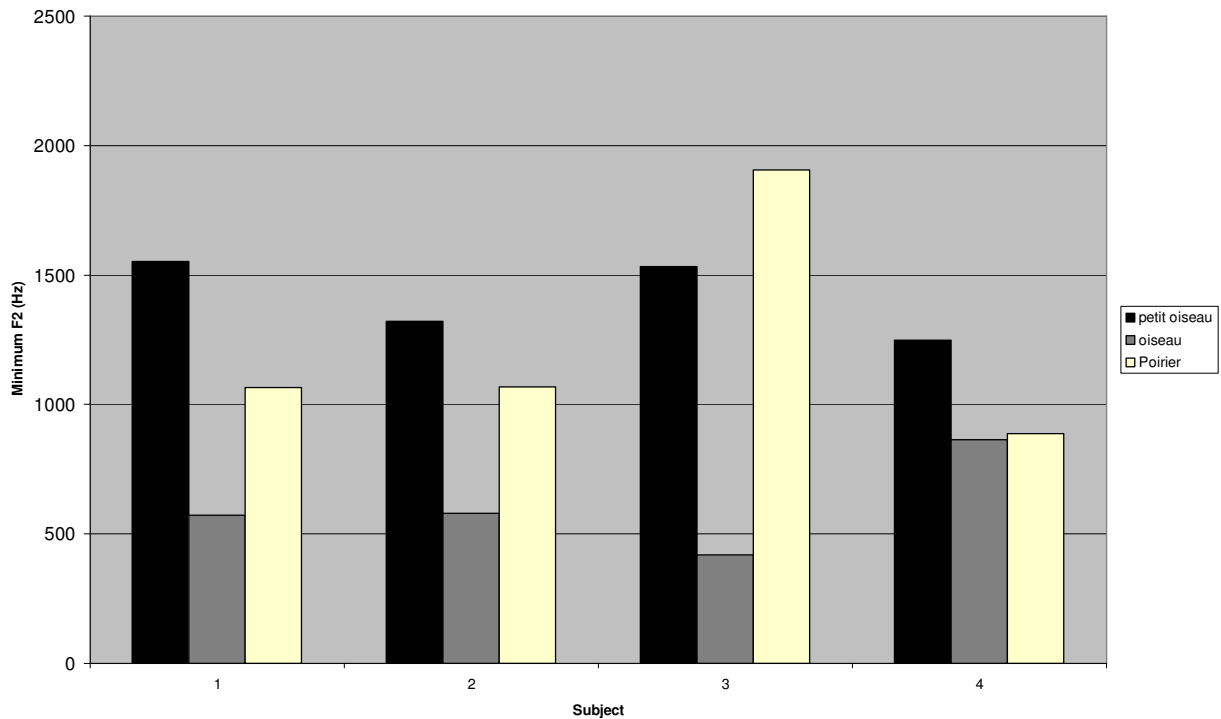
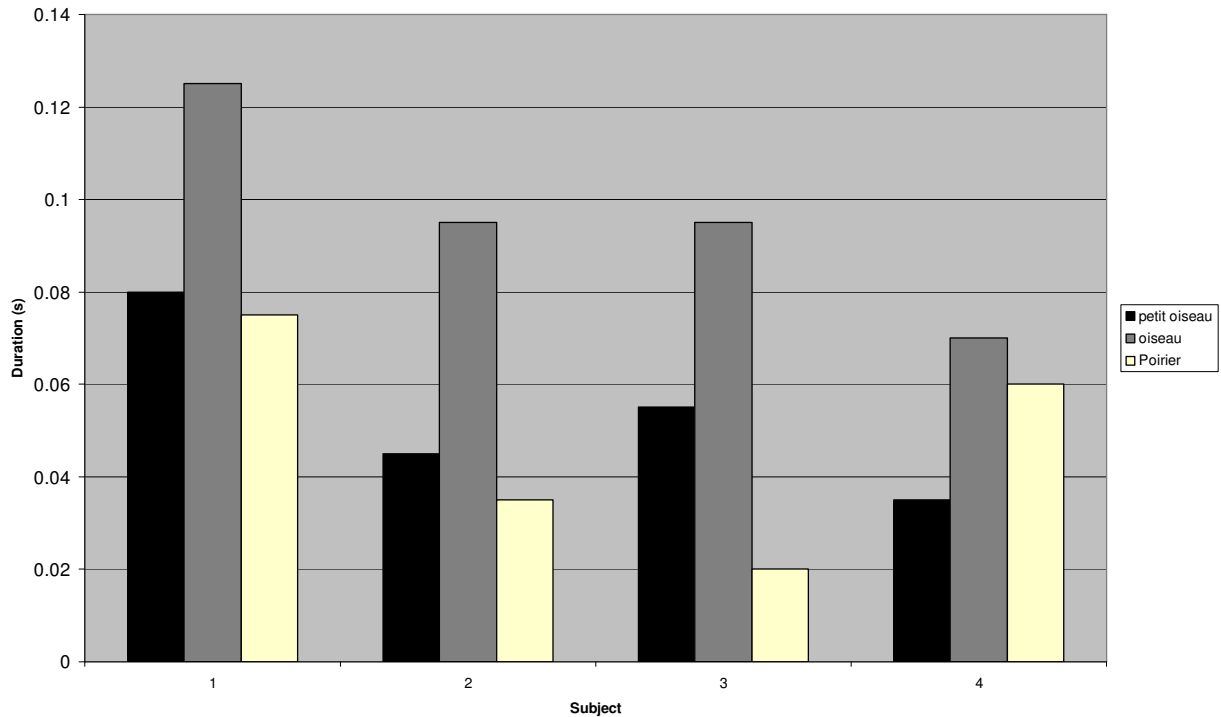


Figure 3b. Duration of formant transition for 'petit oiseau' (type 2, context 2), 'oiseau' (type 2, context 1), and 'Poirier' (type 3, context 2), per subject (in s)



Here, the joint patterning of surface-level syllable-internal [w]—type 2, context 2 (*petit oiseau*) and type 3 (*Poirier*)—is readily apparent, in sharp contrast to type 2, context 1 (*oiseau*). Type 2, context 2 and type 3 (in both contexts) exhibit much higher minimum F2 values as well as much shorter formant transitions (as proposed in the typological division above). On the other hand, type 2, context 1, pronounced in isolation, has much lower minimum F2 values and much slower formant transitions. This provides further evidence that surface-level syllable position determines the phonetic properties of morpheme-initial French [w].

Finally, we will consider the case of the one minimal pair included in the data: *oui* [wi] ‘yes’, which does not permit sandhi phenomenon, and *ouïe* [wi] ‘sense of hearing’, which does. A comparison within experimental context 1 (words pronounced in isolation) strongly suggests that the initial [w]’s of these two forms do not differ from one another, despite phonological claims that they occupy different locations in the syllable. If underlying syllable structure determined the phonetic realization of [w], we would have expected these two words to pattern differently:

Figure 4a. Minimum F2 values for 'oui' (type 1) and 'ouïe' (type 2), per subject (in Hz)

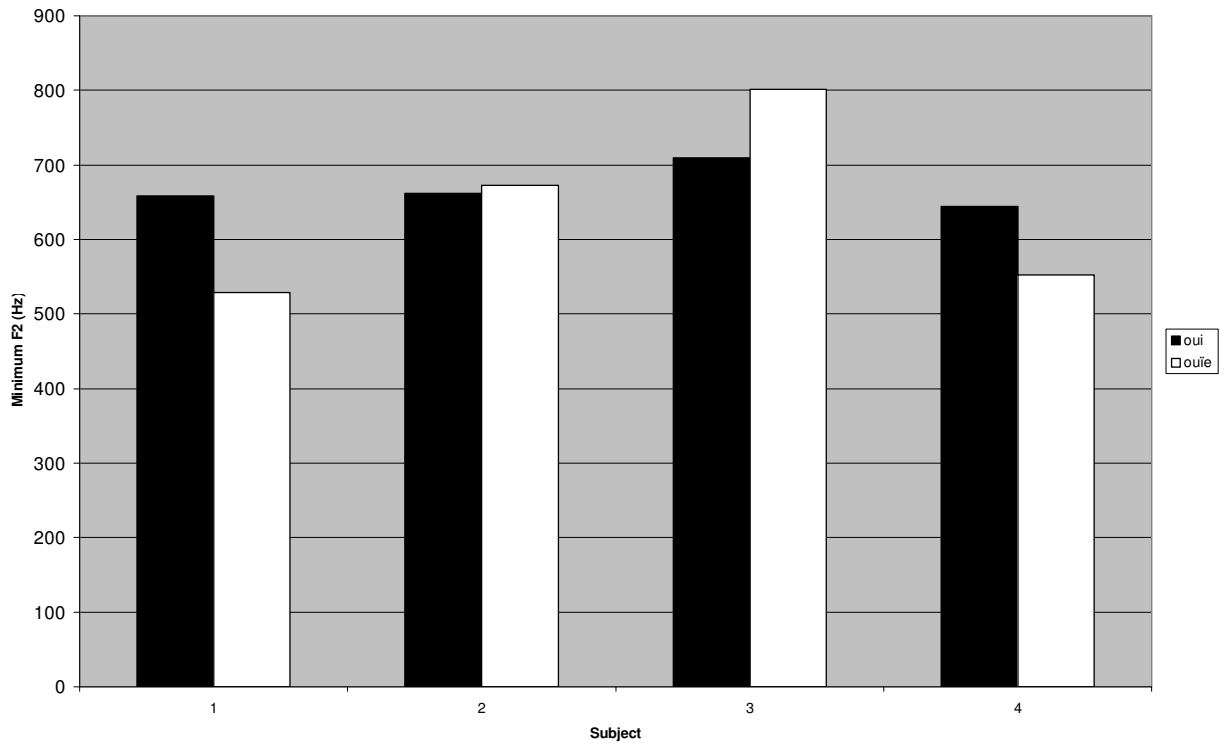
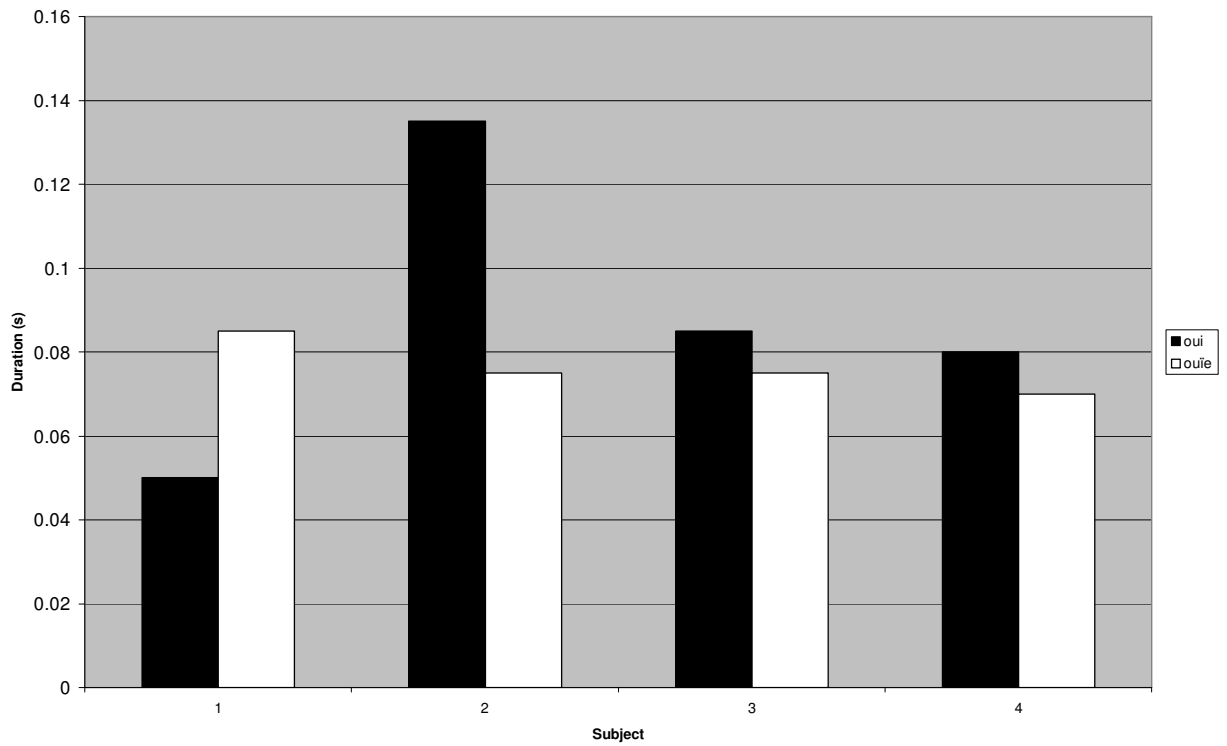


Figure 4b. Duration of formant transition for 'oui' (type 1) and 'ouïe' (type 2), per subject (in s)



Figures (4a-b) sufficiently illustrate that there is little or no difference in the minimum F2 values and duration measurements of formant transition for this minimal pair. Despite the fact that phonological analyses place the word-initial [w]'s in different syllable positions, they in fact pattern the same when the [w] is syllable-initial at surface-level. Subject 2 is exceptional to this in the durational differentiation between these two items. Further studies with a larger corpus would most likely suggest that in embedded contexts, these two words should differentiate, with *oui* patterning with Category 1 and *ouië* (in liaison, e.g. *l'ouië* [lwi]) patterning with Category 2. In isolation, however, they pattern together.

§4. Discussion

Methodological concerns

A number of methodological issues must first be raised concerning the execution and structure of this preliminary study. First, follow-up studies should make use of a larger corpus and more subjects, so that it can be determined whether items that fall outside the general distribution across the Category 1-Category 2 division are exceptional or represent important variants. In addition, the number of tokens and subjects used does not permit us to make any definitive conclusions about whether the proposed pattern of distribution is representative. More speakers and tokens are necessitated to support our proposed division.

Furthermore, follow-up studies should reflect stricter controls on [w]'s surrounding segmental (especially vocalic) environment. With enough tokens, it should be possible to separate different sequences of segments and compare them to one another rather than analyze different segmental sequences together (e.g. [wi] in *weekend* compared to [wa] in *oiseau*). Surrounding consonantal environment should also be consistent, or at least numerous enough to allow separate analyses according to specific sequences.

Finally, potential regional differences may have played a role in the values obtained for certain experimental items. Although no clear differentiation can be drawn between the Strasbourg and Lille subjects, stronger controls on geographical provenance might help fix some inconsistencies found in the data. On the other hand, a larger number of subjects might have served the same purpose despite different geographical provenance.

Theoretical concerns

The results presented above suggest that the division suggested in our hypothesis—that is, that type 2 will consistently pattern with type 3, whereas type 1 should stand alone—does not wholly reflect the actual distribution of word-initial French [w]. This division was strongly implied by generally-accepted autosegmental analyses of word-initial French glides, by which an underlyingly onset glide does not permit liaison but an underlyingly nuclear glide does. The phonetic properties studied here (minimum F2 value and duration of formant transition), at least for [w], suggest that the phonological division proposed by Clements & Keyser (1983) and Prunet (1992) is not parallel to the division reflected in the phonetics. The important division appears to be one of surface-level syllabic position, not underlying syllabic position as proposed in the phonological literature.

That is, when [w] is syllable-initial, regardless of its potential to allow sandhi phenomena, it reflects specific phonetic properties, mainly, a lower minimum F2 and a slower formant transition to the following vowel. Syllable-initial [w] is in fact more consonant-like, in that it exhibits a lower F2, which corresponds to a tighter constriction of the lips. The more

consonant-like quality of syllable-initial [w] corresponds to the fact that it should be analyzed phonologically as the onset of the syllable in which it appears.

On the other hand, surface-level syllable-internal [w], regardless of whether it is initial or internal to its morpheme, exhibits the opposite phonetic characteristics: a higher minimum F2 as well as a faster formant transition to the following vowel. In opposition to syllable-initial [w], syllable-internal [w] is more vowel-like since it exhibits a higher F2 (greater aperture at the labial region). Syllable-internal [w], then, corresponds to the alleged nuclear glide of recent phonological literature. Morpheme-initiality or internality does not play a role in phonetic realization, as predicted in our hypotheses.

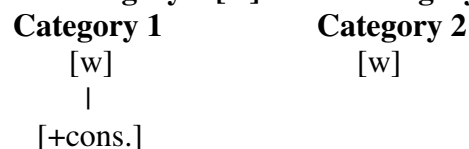
Type 2 words are crucial for the proposed division between surface-level syllable-initial and syllable-internal [w]. This is because in experimental context 1, type 2 contains a syllable-internal, but morpheme-initial, [w] (e.g. *petit oiseau* [pœ.ti.twa.zo]), whereas in experimental context 2, the [w] is both syllable-initial and morpheme-initial in surface form when pronounced in isolation (e.g. *oiseau* [wa.zo]). The rather consistent differentiation of these two contexts (sentence and isolation) underscores the fact that the surface syllabification determines the phonetic properties of word-initial [w]. That type 2, context 2 [w] patterns with type 3 items (syllable-internal, morpheme-internal) supports this position.

What we appear to have in type 2 words is a variable realization based on post-lexical surface syllabification. In type 1 words, however, [w] is always syllable-initial regardless of contextualization (sentences or isolation). These words never permit sandhi processes and this characteristic is lexically determined. The grammar of the language must account for the fact that the [w] of type 1 words is invariable whereas the [w] of type 2 words depends on post-lexical syllabification. At the same time, it appears that [w] varies on the surface level according to whether or not it supports resyllabification, suggesting that there are in fact two types of [w] in French.

A possible modification to the “onset-nuclear glide” opposition championed in the literature would be one that permits the contextually-determined variation in phonetic realization of type 2 [w]. When another consonant occupies the onset of these words, the [w] assumes the properties of a more vowel-like [w] (a nuclear [w]); when there is no consonant to occupy this position, however, type 2 [w] is more consonant-like, suggesting that it actually is syllabified as an onset. Since the phonetic realization of type 2 [w] depends on environmental factors and sandhi, this differentiation must occur at the post-lexical level.

How might we modify the phonological analysis of word-initial glides to account for the distribution discussed above? Since type 1 [w] must solely occupy the onset of its syllable (it does not permit syllabification of another consonant into its onset), this must be marked in the grammar; we propose that type 1 [w] is marked lexically with the feature [+consonantal], requiring it to be syllabified as an onset by a constraint against consonantal segments in nuclear position (it is worthy to note that there are no syllabic consonants in French). On the other hand, the unmarked type 2 [w] does not carry this specification, and therefore will permit syllabification at the post-lexical level depending on contextual factors:

Figure 5. Representation of category 1 [w] versus category 2 [w]: markedness relation.



Since category 2 [w] (henceforth unmarked [w]) does not carry any specification for the feature [consonantal], it can allophonically be realized as either a vocalic [w] (unmarked) or like category 1 [w] (henceforth consonantal [w]) if the phonological context requires it.

This characterization of consonantal [w] versus unmarked [w] reflects the characterization of segmental markedness evoked in Ghini (2003) in his study of Miogliola Ligurian, a minor Gallo-Italian dialect. According to Ghini, markedness relations are better expressed as the presence of a feature on the marked segment alongside the underspecification with respect to this feature in the unmarked contrasting segment. This is his analysis of the distribution of /n/ and /ŋ/, the latter of which may be realized as both [n] (the unmarked of the pair) and [ŋ]. When there is no contrastive markedness relation (e.g. voicing for nasals in French), the feature is understood as not specified in the feature geometry. Since the consonantal-unmarked contrast is meaningful for French sandhi phenomena, this type of analysis is preferable as it permits the variability necessary to account for the distributional patterns illustrated by the data of this study. It is worth noting that marked, consonantal [w] appears mainly in fully or partially lexicalized loan words in French (e.g., *weekend* and *walkman*, borrowed from English), and perhaps this offers an explanation for its differing behavior.

This analysis implies an Onset constraint for French that will realize unmarked [w] as consonantal [w] if there is no other onset available. The existence of an Onset constraint seems justified considering the enchainment of word-final consonants into the following syllable's onset as well as liaison, in which latent consonants which are not realized in isolation or before a consonant-initial word are in fact realized as onsets before onset-less words. The preference for phonetically realizing unmarked [w] as consonantal [w] when there are no other available onset consonants fits well into the phonological system at large.

§5. Conclusions.

This study aimed to determine whether French word-initial [w] exhibits different phonetic properties depending on whether it permits or does not permit sandhi phenomena to occur with the preceding word. It examined three specific structural types—syllable-initial, morpheme-initial; syllable-internal, morpheme-initial; syllable-internal, morpheme-internal—as well as two experimental conditions, namely, items embedded in sentences and items in isolation. The phonetic properties examined were minimum F2 value for [w] as well as the duration of the formant transition into the following vowel (measured to 80% transition).

The hypothesis that type 1 would differ from types 2 and 3 systematically was not wholly supported; rather, there was a contextual effect along the embedded-isolated axis that grouped isolated type 2 with type 1 and embedded type 2 with type 3. However, the predicted way in which type 1 would differ from type 3 was supported, in that type 1 exhibited both a lower minimum F2 as well as longer formant transitions than type 3. Type 2 proved the crucial context for indicating that surface-level syllable position is the determining factor for the realization of [w]. Our second hypothesis that the behavior of [w] was always lexically determined and would therefore remain constant across experimental conditions also did not prove wholly true; type 1 items remained generally stable, but type 2 items differed depending on post-lexical syllabification.

The study sought to apply its findings to recent phonological accounts for the differing behavior of word-initial glides in French (Clements & Keyser, 1983; Prunet, 1992). According to these analyses, word-initial glides must underlyingly be linked to an onset or nuclear position, thus accounting for whether or not they permit sandhi phenomena. This characterization appears too simple to account for the findings of this study. We therefore propose a featural analysis of markedness to account for the differing behavior of type 1 and type 2, the former being marked for the feature [+consonantal] and the latter not carrying any specification.

Future work must involve the study of other word-initial glides in French ([j] and [ɥ]) to observe whether they display a similar distribution. In addition, a larger corpus and more subjects are needed in future studies to allow for better sampling, as well as stronger controls for segmental context. It is our hope that further study on the phonetics of word-initial glides in French will help refine the analyses proposed in the French linguistics phonological literature.

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Appendix A: Example of Experimental Handout

Name _____

Part 1: Please clearly read the following words, pausing briefly in between each word:

1. yacht
2. grandeur
3. oiselier
4. bien
5. oisiveté
6. oui
7. porte
8. ouistiti
9. trois
10. hiatus
11. Walkman
12. marée
13. heureux
14. ouïe
15. ciel
16. weekend
17. implication
18. oiseau
19. tiers

Part 2: Please clearly read the following sentences.

1. Géraud va tous les weekends à Rouen pour se promener dans le quartier médiéval.
2. On sait bien que vous n'êtes pas allée à la banque comme vous nous aviez dit.
3. Monsieur Poirier donnait à manger aux oies tous les matins.
4. Nicole aime boire un verre de vin chaque vendredi après le boulot.
5. Alice mangeait le yaourt avec une faim de loup.
6. Le petit oiseau s'est perché sur la branche du peuplier.
7. Marc buvait son whisky au Café Lutèce.
8. Il faut s'appliquer de l'iode si on a une coupure.

Appendix B: English Translation of Experimental Handout

Part 1

	<u>French word</u>	<u>English gloss</u>
1	yacht	yacht
2	grandeur	size
3	oiselier	bird shop
4	bien	good, well
5	oisiveté	idleness
6	oui	yes
7	porte	door
8	ouistiti	marmoset
9	trois	three
10	hiatus	hiatus
11	Walkman	walkman
12	marée	tide
13	heureux	happy
14	ouïe	sense of hearing
15	ciel	sky
16	weekend	weekend
17	implication	implication
18	oiseau	bird
19	tiers	third

Part 2

<u>French sentence</u>	<u>English translation</u>
1 Gérard va tous les weekends à Rouen pour se promener dans le quartier médiéval.	Gerard goes to Rouen every weekend to walk in the medieval quarter.
2 On sait bien que vous n'êtes pas allée à la banque comme vous nous aviez dit.	We know very well that you didn't go to the bank like you had told us.
3 Monsieur Poirier donnait à manger aux oies tous les matins.	Mr. Poirier fed the geese every morning.
4 Nicole aime boire un verre de vin chaque vendredi après le boulot.	Nicole likes to drink a glass of wine every Friday after work.
5 Alice mangeait le yaourt avec une faim de loup.	Alice was eating yogurt with a wolf's appetite.
6 Le petit oiseau s'est perché sur la branche du peuplier.	The little bird landed on the poplar tree branch.
7 Marc buvait son whisky au Café Lutèce.	Mark was drinking his whiskey at Cafe Lutece.
8 Il faut s'appliquer de l'iode si on a une coupure.	You must apply iodine if you have a cut.