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ON THE PHONEMIC STATUS OF LABIAL APPROXIMANTS IN DUTCH

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Abstract

In Dutch, the phonological relation between the labiodental spirant approximant [ʋ], found in word-initial position, and the labial–velar semi-vowel [w], found in word-final position, has been a subject of interest for several scholars. Most of them agree that these two sounds should be regarded as allophonic variants of the phoneme /ʋ/. This assumption, however, has never been tested empirically, and the supposed allophonic realizations have never been acoustically measured.

The present thesis provides solid empirical evidence that the assumed status of [w] and [ʋ] as allophones of the same phoneme in Dutch is, at the very least, debatable. An acoustic analysis performed on intervocalic <ww> clusters, on the one side, and on the two intervocalic coda and onset "control" conditions, on the other, shows that the cluster <ww> should actually be regarded as a perfect, plain sequence of coda [w] and onset [ʋ]: it never degeminates, as it would be expected, instead, if coda [w] and onset [ʋ] were the same phoneme. The parameters measured in the acoustic analysis are: duration, F2 (average F2 and F2 rise), intensity (average intensity and intensity fall), and harmonicity (average harmonicity and harmonicity fall).

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1. Introduction

In Dutch, the phonological relation between the labiodental spirant approximant [ʋ], found in word-initial position (as in *wind* [ʋɪnt] 'wind'), and the labial–velar semi-vowel [w], found in word-final position (as in *leeuw* [leːw] 'lion'), has been a subject of interest for several scholars. Most of them agree that these two sounds should be regarded as allophonic variants of the phoneme /ʋ/.

Gussenhoven (1999) clearly states that the relationship between the labiodental spirant approximant [ʋ] and the labial–velar semi-vowel [w] (or rather the bilabial spirant approximant [β̞], according to Gussenhoven) in Dutch should be considered to be of an allophonic nature. This would be motivated by the complementary distribution they display with regard to each other, as [ʋ] only occurs in onset position and the bilabial sound only in coda position: "/ʋ/ is [ʋ] in the onset, and [β̞] in the coda".

Booij (1995) also assumes that the two sounds should be regarded as allophones of /ʋ/: "[…] in prevocalic position the /ʋ/ is a non-vocoid" (Booij 1995: 42); "The /ʋ/ […] [is realized] In coda position […] as a bilabial vocoid, without contact between the two articulators, as in *nieuw* [niu̯][1] 'new', *leeuw* [leu̯] 'lion', and *ruw* [ryu̯] 'rough'. […] In other positions it is a labiodental approximant, for example, in *water* /ʋatər/ 'id.' […]".

Table 1 provides a picture of Booij's (1995) inventory of Dutch consonants. Note that only /ʋ/ (and not /w/) is listed as a phoneme, and that it is included among the glides.

Table 1: The consonants of Dutch according to Booij (1995:7)

	Bilabial	Labio dental	Alveolar	Palatal	Velar	Glottal
Plosives	p, b		t, d		k, (g)	
Fricatives		f, v	s, z		x, ɣ	h
Nasals	m		n		ŋ	
Liquids			l,r			
Glides		ʋ		j		

In contrast with Gussenhoven (1999), Collins & Mees (1981) and Booij (1995) claim that the bilabial spirant approximant [β̞] is only used in the south of the Netherlands and in Belgium as a variant of the labiodental spirant approximant in onset (rather than in coda) position. In the context of the present paper, we will stick to their account. Collins & Mees (1981: 198-9) also state, with regard to Southern Dutch, that "Many Belgian speakers have [instead of [ʋ]] a labial–palatal approximant [ɥ] […], particularly before close front vowels, e.g. *weten*, *wit*. […]".

To sum up, phonologists overall agree that Dutch labiodental spirant approximant [ʋ] and labial–velar semi-vowel [w] should be regarded as distributional allophones of the same phoneme /ʋ/, despite the lack of consensus about the actual phonetic realization of the variant

[1] Note that we assume [u̯] and [w] to be different notations for the same sound.

occurring in word-final position. This assumption, however, has never been tested empirically, and the supposed allophonic realizations have never been acoustically measured.

Moreover, there seems to be some intra- and inter-speaker variation with regard to the sounds which occur word-medially in intervocalic position. Theoretically, we would expect Dutch <w> to be pronounced as [ʋ] in contexts such as *zeewind* ‘sea breeze’ (where <w> belongs to the second lexical morpheme of the compound; we will call this context “onset” for the sake of simplicity), and as [w] in contexts such as *eeuwig* ‘eternal’ (where it belongs to the first lexical morpheme of the compound; we will call this context “coda”), but this may not always be the case. The complementarity of the distribution of two sounds has to be proved to be clear-cut in every possible context for them to be reliably called allophones, and this variability between [ʋ] and [w] in intervocalic position may actually threaten the assumption about the allophonic status of the two sounds in question.

The present thesis aims to provide a contribution to the subject in question by means of an acoustic analysis of intervocalic <w> as it occurs in onset and in coda position, and as a cluster (<ww>). The role played by the cluster condition in answering the question as to whether Dutch [w] and [ʋ] are indeed allophones of the same phoneme will be made clearer in the following.

Section 2 introduces the category of approximants and the nomenclature which will be used throughout the paper. Section 3 focuses on some crosslinguistic, phonological, impressionistic-phonetic, and acoustic aspects which differentiate semi-vowels from spirant approximants. Section 4 presents our research questions and general predictions. Section 5 thoroughly describes the methods employed in the experiment on which the study is based, whereas Section 6 gives the specifics of the subsequent analysis. Section 7 provides the results, and Section 8 concludes.

2. Approximants

In this section, the sound category “approximant” is presented through a set of definitions phoneticians have proposed in the last 50 years, and the subcategorization and the nomenclature adopted in the paper for approximants are also introduced.

The term “approximant” was first used by Ladefoged (1964:25), who defined it as a “sound that belongs to the phonetic class vocoid or central resonant oral, and simultaneously to the phonological class consonant in that it occurs in the same phonotactic patterns as stops, fricatives and nasals”. Later, Ladefoged (1975:277) provides a more impressionistic-phonetic description of approximants, as “The approach of one articulator towards another but without the vocal tract being narrowed to such an extent that a turbulent airstream is produced”, a definition which is basically still followed by the IPA usage (IPA 1999). Trask (1996:30) gives these segments an even more precise collocation in the phonetic sound system by placing them somewhere between vowels and fricatives in terms of degree of constriction, which for an approximant “[…] is typically greater than that required for a vowel but not radical enough to produce turbulent air flow and hence friction noise, at least when voiced”. Although this view is nowadays met by general consensus, researchers sometimes disagree as to what kind of segments are to be included under the “approximant” heading. Here, we follow the IPA usage

(IPA 1999) in dismissing the (high) vowels and the consonant [h] from the category (for a different treatment of these sounds, see Ladefoged 1975, Catford 1977, and Laver 1994).

The IPA (IPA 1999) classifies [ʋ ɹ ɻ j ɰ] as approximants proper, and [l ɭ ʎ ʟ] as lateral approximants (as opposed to lateral fricatives); both groups are included in the "pulmonic consonants" table. The sounds [w ɥ], on the other hand, are found under "other symbols" (due to their special double articulation). Among the diacritics, a special openness diacritic [˕] is found which can be used below other symbols to indicate approximant-like versions of voiced fricatives, e.g. [β̞] (Ball and Rahilly's (2011:231) "frictionless continuants"). This classification makes clear that "approximant" should not be regarded as a homogeneous category, but rather as a superordinate term which encompasses several, quite diverse subcategories; it does not, however, provide a good insight into the peculiarities of each subclass. Martínez-Celdrán (2004:202), therefore, suggests that approximant subcategories should rather coincide with the following sound groups:

(1) a. laterals: [l ɭ ʎ ʟ]
  b. non-laterals (or centrals): [ʋ ɹ ɻ] and [β̞], to be further distinguished in
    i. rhotics: [ɹ ɻ]
    ii. non-rhotics, or "spirant approximants" (Martínez-Celdrán (2005:205)): [ʋ β̞] and other approximant-like versions of voiced fricatives
  c. semi-vowels: [j ɰ w ɥ]

Figure 1 shows a summarizing scheme of Martínez-Celdrán's (2004) proposal for the sub-categorization of approximants, which will also be adopted in the present paper.

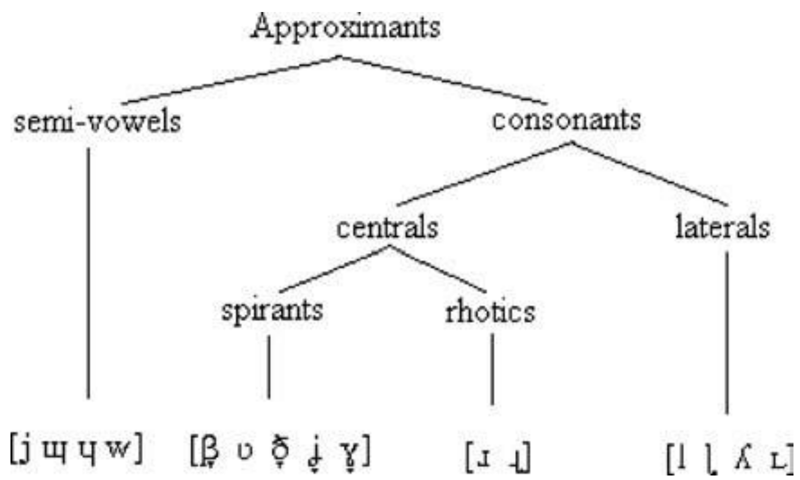

Figure 1: Subcategories of approximants (Martínez-Celdrán 2004:209)

Moreover, Martínez-Celdrán (2004:208) proposes the nomenclature in (2) for some of the sounds which already have a dedicated symbol in IPA. This nomenclature will also be used throughout the paper.

(2) [j] voiced palatal semi-vowel approximant
  [w] voiced labial–velar semi-vowel approximant
  [ɥ] voiced labial–palatal semi-vowel approximant
  [ɰ] voiced velar semi-vowel approximant
  [ʋ] voiced labiodental spirant approximant

[ɹ] voiced alveolar rhotic approximant

[ɻ] voiced retroflex rhotic approximant

3. Semi-vowels vs spirant approximants

Since the focus of the present paper is on Dutch labial–velar semi-vowel approximant [w] and labiodental spirant approximant [ʋ], our attention will, from now on, be restricted to semi-vowels and non-rhotic central approximants. In this section, some crosslinguistic, phonological, impressionistic-phonetic, and acoustic considerations on these two subclasses of approximants will be presented: special attention will be paid to the acoustic properties which differentiate semi-vowels from spirant approximants.

3.1 Crosslinguistic data

According to Maddieson (1984:91), semi-vowels, or at least some of them, are crosslinguistically very common: “The great majority of languages, 86.1%, have a voiced palatal approximant /j/ or a closely similar segment […]. Substantially fewer languages, 75.7%, have a voiced labial–velar approximant /w/ or a closely similar segment.”. Other semi-vowels, on the other hand, are comparatively rarer, occurring in less than 2 percent of the world’s languages (Maddieson 1984, Ladefoged & Maddieson 1996).

Spirant approximants are, unlike semi-vowels, crosslinguistically rare: only “6 [out of 317 of the world’s] languages (1.9%) have a bilabial approximant /β̞/ and 6 have a [labiodental] approximant /ʋ/” (Maddieson 1984:96). The scarce diffusion of this subset of approximants is probably the reason why they have received so little attention by researchers in the literature on phonetics and phonology.

3.2 Phonological and impressionistic-phonetic considerations

Semi-vowels can be regarded as occupying an intermediate position between consonants and vowels, sharing some properties with both. In phonological representation, pairs such as /i/-/j/ and /u/-/w/ are regarded as having identical feature specifications, but also as filling mutually exclusive positions in syllable structure: vowels occur as syllable nuclei, whereas semi-vowels occur as syllable onsets and/or codas (Hayward 2000)[2]. According to Ladefoged & Maddieson (1996:322), these sounds “[…] have also been termed 'glides', based on the idea that they involve a quick movement from a high vowel position to a lower vowel. This term, [however,] and this characterization of the nature of these sounds is inappropriate; as with other consonants they can occur geminated, for example in Marshallese, Sierra Miwok and Tashlhiyt.”

Not much has been written on spirant approximants, but they assumedly share the same function as semi-vowels in syllable structure, namely they occur as onsets and/or (?) codas. However, they do not share the vowel-like quality of semi-vowels, and are closer to the corresponding fricatives, from which they can be distinguished due to the lack of turbulence in their production (which is, in turn, due to either lesser articulatory precision, or insufficient narrowing of the vocal tract, cf. Martínez-Celdrán 2004).

[2] However, note that, in analyses of diphthongs as being composed of a vowel + semi-vowel, the semi-vowel could also be regarded as belonging to the nucleus.

3.3 Acoustic considerations

Reetz and Jongman (2011:186-188) describe the production of semi-vowel approximants in acoustic terms as such:

> In the production of [semi-vowel] approximants, two articulators approach each other without severely impeding the flow of air. The acoustic properties of [semi-vowel] approximants are therefore quite similar to those of vowels produced at a comparable location in the vocal tract. Their formant pattern is clear but somewhat weaker than for the vowels because of the approximants' slightly greater constriction, which results in a shorter steady-state portion and lower acoustic energy […].

Note that spectrograms of semi-vowels may or may not show an identifiable constriction/consonant interval; a more defining characteristic lies in the slow transitions into and out of the approximant, which are quite pronounced in both frequency range and duration (Hayward 2000, Reetz and Jongman 2011). All these traits are visible in Figure 2 which shows a spectrogram for the utterance [iwi]: "During the labial–velar approximant, F1 and F2 are low and close together while F3 remains relatively steady at approximately 2,300 Hz, similar to the vowel [u]." (Reetz and Jongman 2011:186-188)

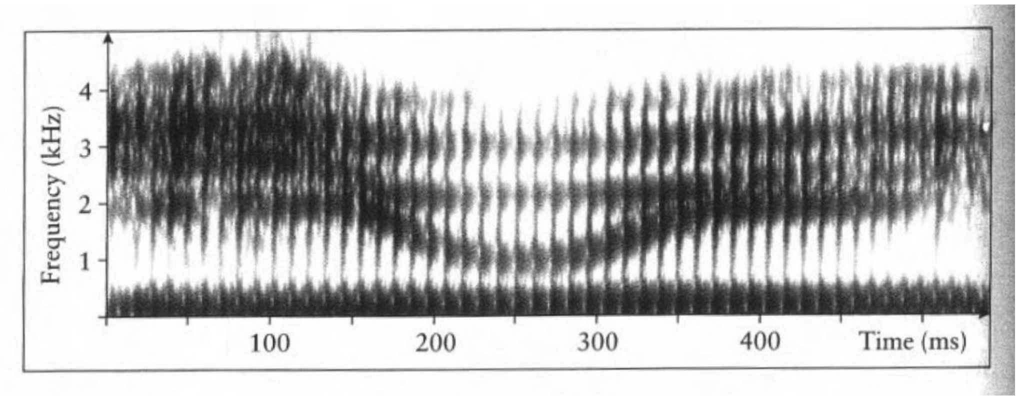

Figure 2: Spectrogram of the utterance [iwi]
spoken by a male native speaker of English, from Reetz and Jongman (2011:188)

Not much has, on the other hand, been written on the acoustic properties of spirant approximants. Some insight into the formant patterns of the labiodental spirant approximant [ʋ] has been provided, unexpectedly, by studies focusing on variants of /r/ in English. In their account of the dissimilar perception of some approximants by speakers of American English and Standard Southern British English, Dalcher, Knight, and Jones (2008) refer to "labiodental /r/", symbolized as [ʋ] and described in the literature as a labiodental approximant, as a non-standard realization of /r/ in some parts of England. This variant, despite not showing the low F3 typical of rhotics, functions as a rhotic for those speakers who use it. Dalcher, Knight, and Jones (2008) compare the formant frequency values of postalveolar [r], labiodental [ʋ], and labial–velar [w] approximants in adult male speech (cf. Figure 3), and argue that the labiodental spirant approximant shares some acoustic qualities with both postalveolar [r] and labial–velar [w]: "the labiodental's second formant is similar to the mid-range formant frequency of [r], while its third formant is similar to the high F3 of [w]." (Dalcher, Knight, and Jones 2008:64)

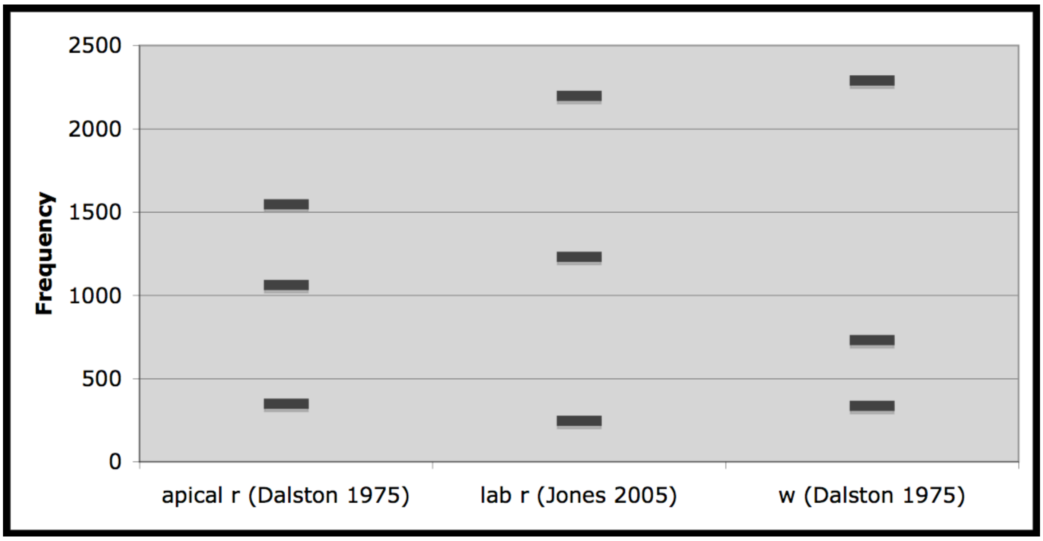

Figure 3: Formant frequencies of apical [r], labiodental [ʋ], and labial–velar [w],
from Dalcher, Knight, and Jones (2008:64)

Martínez-Celdrán (2004) also adds to the scarce literature on the phonetic differences between semi-vowels and related spirant approximants through his comparison of Spanish palatal semi-vowel [j] and palatal spirant approximant [ʝ̞]. According to his acoustic data, the semi-vowel [j] (on the left side of Figure 4, below) "[…] is shorter and is usually a merely transitory sound. It can only exist together with a full vowel and does not appear in syllable onset.". On the other hand, the spirant approximant [ʝ̞] (on the right side of Figure 4) "[…] has a lower amplitude, mainly in F2. It can only appear in syllable onset. It is not noisy either articulatorily or perceptually. [ʝ̞] can vary towards [ʝ] in emphatic pronunciations, having noise (turbulent airstream). [Moreover,] […] the first sound cannot be rounded, not even through co-articulation, whereas the second one is rounded before back vowels or the back semi-vowel." (Martínez-Celdrán 2004:208).

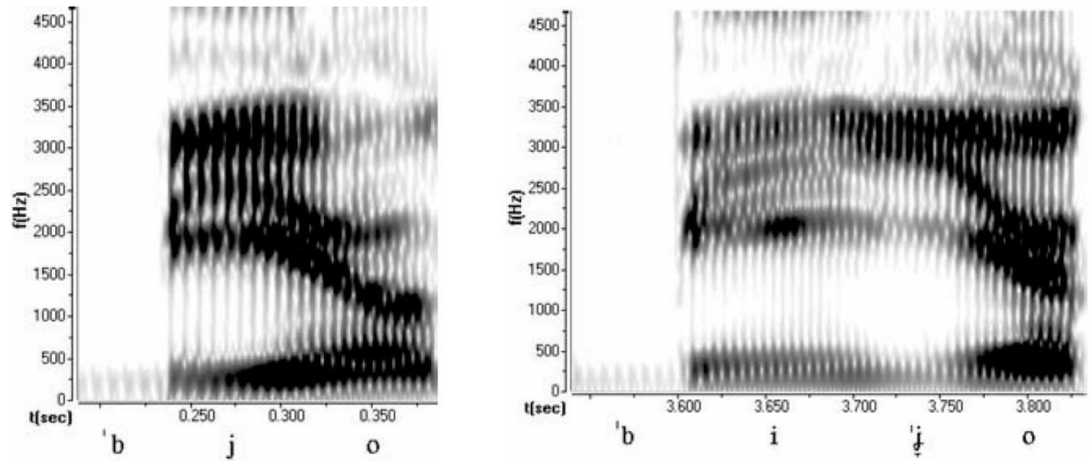

Figure 4: Spectrograms of the Spanish sequences ['bjo] *vio* 's/he saw'
and ['bi'ʝ̞o] *vi yo* 'it was I who saw',
showing the acoustic differences
between semi-vowel [j] and spirant approximant [ʝ̞].
From Martínez-Celdrán (2004:206-207)

3.3.1 Acoustics of labiodental [ʋ] in Dutch

As far as Dutch is concerned, again, not much has been written on the acoustic traits which characterize spirant approximants in general and labiodental [ʋ] in particular. In their analysis of the acoustic differences between German and Dutch labiodentals, however, Hamann and Sennema (2005) report the following measurements for some acoustic parameters of Dutch [ʋ] in onset position: the mean duration is 0.096 seconds; the mean values for the harmonicity median is 18.8 dB; the mean value for centre of gravity is 1133 Hz.

4. Research questions

The main research question this paper aims to answer is, as already mentioned, whether the labiodental spirant approximant [ʋ] and the labial–velar semi-vowel [w] in Dutch should be considered allophones of the same phoneme (either /ʋ/ or /w/).

In order to be able to answer this question, we will first investigate what happens intervocalically: we will try to verify whether there is actually variation in the pronunciation of <w> in the same morphological position (be it "onset", i.e. in *zeewind*, or "coda", i.e. in *eeuwig*. We will do so by comparing some acoustic parameters for intervocalic <w> in onset and in coda position.

As a second step, we will consider contexts/target items displaying an intervocalic <ww> cluster, either due to compounding, as, for instance, in *eeuwwisseling* 'turn of the century', or due to the natural co-occurring of two words in a phrase or sentence, as in *schreeuw welkom* 'cry out "welcome"' or *(wanneer) sneeuw wordt (verwacht…)* '(when) snow is (expected…)'. Given such contexts, we will verify how these <ww> clusters are realized: the three options we hypothesize are illustrated through the recourse to the example *eeuwwisseling* in (3). The outcome may be: a perfect sequence of word-/syllable-final [w] and word-/syllable-initial [ʋ], as in (3a); a degeminated sound (cf. Section 4.1 on consonant degemination in Dutch) featuring either only [w], as in (3bi), or only [ʋ], as in (3bii); a fused sound, acoustically "intermediate" between the original two, as in (3c).

(3) *eeuwwisseling* 'turn of the century'

- a. sequencing: [eːwʋɪsəlɪŋ]
- b. degemination:
  - i. [eːwɪsəlɪŋ]
  - ii. [eːʋɪsəlɪŋ]
- c. fusion: [eː$^{w}_{ʋ}$ɪsəlɪŋ]

Note that only *-eeuw#/-ieuw#* contexts will be taken into account here because we expect the realizations of *-ouw#* to be affected by the diphthongal status of <ou> in Dutch. Given the lack of time and space to carry out two separate analyses investigating the three conditions for *-eeuw#/-ieuw#* on the one hand, and for *-ouw#* on the other, it was resolved to restrict the scope of the investigation to intervocalic <(w)w> preceded by <i/eeu>.

4.1 Consonant degemination in Dutch

Booij (1995:151) refers to consonant degemination as the process according to which, "When two identical consonants come together within a complex word or phrase, one of them may be deleted (or they may be said to become one consonant […])". According to Booij (1995:68), "Dutch does not allow for geminate consonants within prosodic words. Consequently, degemination is obligatory within prosodic [complex] words as soon as a cluster of two identical consonants arises. In larger domains such as compounds and phrases the rule is optional.". Examples are provided in (4), and the rule for consonant degemination (also from Booij 1995) is given in (5).

(4) *zette* /zɛt+tə/ 'to put' (past tense) → [zɛtə]

ik koop /ɪk kop/ 'I buy' → [ɪkop]

(5) Degemination

Xi Xi → Xi

[+cons] [+cons] [+cons]

Domain: Obligatory in prosodic words, optional in larger domains

4.2 General predictions

As for the question as to whether the intervocalic cluster <ww> is phonetically realized as [wʋ], [w], [ʋ], or fused [$^{w}_{\upsilon}$], consonant degemination can play an important role in helping us decide whether [w] and [ʋ] are allophones because, degemination being a phonological rule in Dutch, we can expect any set of prosodic words to conform to it. Thus, degeminated realizations (as either [w] or [ʋ]) of the intervocalic cluster <ww> within prosodic words may be good indicators that [w] and [ʋ] are indeed allophones of the same consonantal phoneme in Dutch (cf. (6) for an example based on *eeuwwisseling*). On the other hand, lack of degemination in the phonetic realization, i.e. plain sequencing ([wʋ]), would rather suggest that [w] and [ʋ] are not the same phoneme (cf. (7) for an example again based on *eeuwwisseling*). Lastly, fusion ([$^{w}_{\upsilon}$]) would provide conflicting clues as to whether [w] and [ʋ] are the same phoneme: shorter duration than the one expected for plain sequencing would advocate for some sort of degemination, but a consonant quality different from both [w] and [ʋ] would suggest the opposite (cf. (8) for an example again based on *eeuwwisseling*).

(6) *eeuwwisseling* 'turn of the century'

[euw]+[ʋɪsəlɪŋ] → ? [eːwɪsəlɪŋ], [eːʋɪsəlɪŋ]

(7) *eeuwwisseling* 'turn of the century'

[euw]+[ʋɪsəlɪŋ] → ? [eːwʋɪsəlɪŋ]

(8) *eeuwwisseling* 'turn of the century'

[euw]+[ʋɪsəlɪŋ] → ? [eː$^{w}_{\upsilon}$ɪsəlɪŋ]

5. Methods

5.1 Informants

The present study features 19 informants, of which 7 are males, and 12 females[3]; the age covered ranges quite homogeneously from 19 to 50. Nearly all the informants are native Dutch

[3] Originally, 20 people, 7 males and 13 females, were recruited and recorded: one female participant had to be excluded due to her atypical linguistic background (born of Dutch parents, she was raised in the US and only came back in the Netherlands when she was 14 years old) and distinctive American accent.

speakers with Dutch parents[4], and all of them have spent most of their lives in the Netherlands: most of them are from Noord-Holland, but the provinces of Limburg, Gelderland, Zuid-Holland, and Noord-Brabant are also covered in the sample. Nearly all the participants have a high level of education (WO/HBO), and none had received any linguistic training.

5.2 Considerations on type of task and speech material

The experiment consists of a production test. Several options were considered during the selection of the type of speech material to be used, and three main criteria were taken into account: first, naturalness/spontaneousness of speech on the part of the speaker; second, non-transparency of the purpose of the test; third, feasibility. Eventually, a text to be read aloud was chosen as speech material for the test.

As far as naturalness/spontaneousness on the part of the speaker is concerned, the safest choice for a production test would generally be either an elicitation task or, even better, the collection of the speakers' casual speech. Such task types, as a matter of fact, are generally regarded as assuring the highest approximation to naturalness in an interview setting, given that such a setting can never lead to the production of "true" natural speech anyway, due to raised self-consciousness in the speakers and other psychological factors. Elicitation tasks and the collection of casual speech are also among the least "transparent" test types, in that their design and underlying motivations and purposes are usually difficult for the speakers to spot/uncover.

Unfortunately, however, these task types could not be chosen for the present study due to the extreme specificity of the conditions needed. There are actually only few words and contexts in Dutch presenting the desired conditions, and most of them would be extremely difficult to elicit. The choice of either task, thus, would have entailed the risk of getting too few target sounds. As an additional downside, both tasks would have implied a mastery of Dutch that the researcher did not have.

A more feasible option would have implied the use of a word (and sentence) list, which would have easily solved the problem of the scarcity of the items meeting the conditions. Such speech material, however, would also have been problematic for several other reasons. A word list to be read aloud can hardly be regarded as spontaneous speech: the task of reading aloud always carries with it the risk of conveying an impression of formality and great expectation which intimidates the speakers, making them nervous and self-conscious about "doing it right". This is reinforced by the fact that this type of task is usually very time-consuming (due to the massive amount of distractors needed to make the aim of the test less transparent), very predictable, and therefore tedious, so that it is impossible for the speakers to focus on anything other than their own performance (unlike what happens in a spontaneous conversation or during an elicitation task, when the speakers feel engaged in and challenged by the task).

Eventually, it was resolved to use a coherent text as speech material for the production experiment. As in the case of a word list, a text to be read aloud can hardly be regarded as spontaneous speech, but the text format certainly makes the test more engaging, and thus less prone to be uncovered in its purpose. As a matter of fact, the post-recording interviews indeed showed that the text format was generally successful in distracting the speakers from the design

[4] One participant, M21P, has a non-Dutch parent, but he is not bilingual; another one, F45M, has a half-Czechoslovakian parent, but she was also not raised as a bilingual.

behind the test. The decision to use a whole ready-made text for the task also made additional fillers unnecessary and reduced the need for interventions by the researcher, thus increasing feasibility.

A piece from the online rubriek *Nader Verklaard* from the *KNMI* (*Koninklijk Nederlands Meteorologisch Instituut*) website was selected due to the significant amount of items conforming to the conditions V#wV (intervocalic onset), Vw#V (intervocalic coda), and Vw#wV (intervocalic cluster) which it included. A paragraph taken from another KNMI piece was added to the text so as to increase the number of target items. A few words (including the original title, *Sneeuwweetjes*, which was a tongue-breaker and could have drawn attention to the purpose of the test) were changed, and commas added to improve fluency when reading aloud; captions of pictures were removed.

The text was checked by a second-language proficient speaker of Dutch and by a Dutch native speaker before the pilot; it was also checked by two other native speakers during the pilot, and by an additional native speaker afterwards. The form of the text was slightly changed (in terms of punctuation, grammatical and lexical choices, word order, etc.) according to the advice provided by the native speakers.

The final version of the text used as speech material for the test can be found in the Appendix.

5.3 Variables and more detailed expectations

The independent variables in the experiment are:

- speaker
- type
- item

As already mentioned, the study features 19 speakers, hence the “speaker” variable. The “type” variable refers to the three investigated conditions: intervocalic <w> in onset position (V#wV), intervocalic <w> in coda position (Vw#V), and intervocalic cluster <ww> (Vw#wV). The “item” variable refers to the different items displayed for each type/condition: 9 items for the first (V#wV) condition, 18 for the second (Vw#V), 8 for the third (Vw#wV).

Note that the test only includes *-eeuw#* items, but the results should be generalizable to *-ieuw#* contexts as well (but not to *-ouw#*: cf. Section 4 above).

The dependent variables are:

- duration
- F2 at 25% of the target sound/tier interval (cf. Section 6 below), henceforth $F2_{25\%}$
- F2 at 75% of the tier interval, henceforth $F2_{75\%}$
- intensity at 25% of the tier interval, henceforth $intens_{25\%}$
- intensity at 75% of the tier interval, henceforth $intens_{75\%}$
- harmonicity at 25% of the tier interval, henceforth $harm_{25\%}$
- harmonicity at 75% of the tier interval, henceforth $harm_{75\%}$

The hypothesis that F2 may play a role in differentiating [w] from [ʋ] is inspired by Dalcher, Knight, and Jones’s (2008) findings about the F2 of [ʋ], cf. Section 3.3 above. The idea of taking acoustic energy (in our case, intensity[5]) into account as a factor differentiating semi-vowels from spirant approximants comes from Martínez-Celdrán (2004), cf. also Section 3.3 above. Duration is more obviously related to the degemination vs sequencing vs fusion hypothesis (cf. Section 4 above); harmonicity refers to the "degree of acoustic periodicity" (cf. Praat manual) of a sound, and can help distinguishing sounds which are know to have different levels of friction. As previously mentioned, Hamann and Sennema (2005) provide average values for the duration and the harmonicity median for onset [ʋ].

We expect:

1. phonetic realization as [ʋ] for V#wV and as [w] for Vw#V;
2. comparable durations for: V#wV, Vw#V, (hypothetical) degeminated Vw#wV, and (hypothetical) fused Vw#wV (Hamann and Sennema (2005) give 0.096 seconds as average duration for Dutch onset [ʋ]);
3. a longer (2×) duration for (hypothetical) sequential Vw#wV;
4. an essentially homogeneous F2 throughout the whole <w> sound, with average F2 between 1000 and 1500 Hz for V#wV, and (hypothetical) degeminated Vw#wV realized as [ʋ];
5. an essentially homogeneous F2 throughout the whole <w> sound, with average F2 between 500 and 1000 Hz for Vw#V, and (hypothetical) degeminated Vw#wV realized as [w];
6. a non-homogeneous, rising F2 for (hypothetical) sequential Vw#wV, with $F2_{25\%}$ being close to the average F2 for Vw#V (500 Hz < F2 < 1000 Hz), and $F2_{75\%}$ being close to the average F2 for V#wV (1000 Hz < F2 < 1500 Hz);
7. an essentially homogeneous F2 for (hypothetical) fused Vw#wV;
8. an average F2 close to their $F2_{25\%}$ and $F2_{75\%}$ for Vw#V, V#wV, and (hypothetical) degeminated Vw#wV;
9. an average F2 intermediate between the ones for V#wV and Vw#V for (hypothetical) sequential Vw#wV and (hypothetical) fused Vw#wV;
10. a negligible F2 rise for V#wV, Vw#V, (hypothetical) degeminated Vw#wV, and (hypothetical) fused Vw#wV;
11. a substantial F2 rise for (hypothetical) sequential Vw#wV;
12. a homogeneous, lower intensity (cf. Martínez-Celdrán 2004), for V#wV and (hypothetical) degeminated Vw#wV realized as [ʋ];
13. a homogeneous, higher intensity (cf. Martínez-Celdrán 2004), for Vw#V and (hypothetical) degeminated Vw#wV realized as [w];
14. a non-homogeneous, falling intensity for (hypothetical) sequential Vw#wV, with $intens_{25\%}$ being close to the average intensity for Vw#V, and $intens_{75\%}$ being close to the average intensity for V#wV;
15. a homogeneous intensity for (hypothetical) fused Vw#wV;

[5] We will be measuring intensity (i.e. power per unit area, cf. Hayward 2000) instead of amplitude (i.e. how far a sine wave departs from its baseline value, cf. Hayward 2000) because of ease of computation in Praat: since we are only interested in relative amplitude (and relative intensity is proportional to the square of relative amplitude, cf. Hayward 2000), we can regard the two measures as being equivalent for our purposes.

16. an average intensity close to their $intens_{25\%}$ and $intens_{75\%}$ for Vw#V, V#wV, and (hypothetical) degeminated Vw#wV;
17. an average intensity intermediate between the average ones for V#wV and Vw#V for (hypothetical) sequential Vw#wV and (hypothetical) fused Vw#wV;
18. a negligible intensity fall for V#wV, Vw#V, (hypothetical) degeminated Vw#wV, and (hypothetical) fused Vw#wV;
19. a substantial intensity fall for (hypothetical) sequential Vw#wV;
20. a homogeneous, lower harmonicity (about 10-20 dB; Hamann and Sennema (2005) give 18.8 dB as average for the harmonicity median for [ʋ] as an onset) for V#wV and (hypothetical) degeminated Vw#wV realized as [ʋ];
21. a homogeneous, higher harmonicity (closer to the 40 dB of [u]) for Vw#V and (hypothetical) degeminated Vw#wV realized as [w];
22. a non-homogeneous, falling harmonicity for (hypothetical) sequential Vw#wV, with $harm_{25\%}$ being close to the average harmonicity for Vw#V (about 40 dB), and $harm_{75\%}$ being close to the average harmonicity for V#wV (about 10-20 dB);
23. a homogeneous harmonicity for (hypothetical) fused Vw#wV;
24. an average harmonicity close to their $harm_{25\%}$ and $harm_{75\%}$ for Vw#V, V#wV, and (hypothetical) degeminated Vw#wV;
25. an average harmonicity intermediate between the ones for V#wV and Vw#V for (hypothetical) sequential Vw#wV and (hypothetical) fused Vw#wV;
26. a negligible harmonicity fall for V#wV, Vw#V, (hypothetical) degeminated Vw#wV, and (hypothetical) fused Vw#wV;
27. a substantial harmonicity fall for (hypothetical) sequential Vw#wV.

5.4 The pilot

The test was piloted on two native Dutch Research Master's Linguistics students who were aware of the purpose of the test. The main aim of the pilot was to verify the extent of time required for the whole task to be performed, and whether the task was tiring enough to require any breaks. After the pilot, it was resolved that each participant would read the text aloud twice with a short break inbetween. The pilot also offered the chance for the speech material to be checked again by two additional highly educated native speakers in its grammar and its internal cohesion. After that, the text was also thoroughly checked prior to the actual experiment by a third Dutch Research Master's Linguistics student, who had not taken part in the pilot, but who was also aware of the purpose of the test.

No interviews were administered to the Linguistics students taking part in the pilot.

5.5 The actual recording

The recording took place at the Opnamestudio-1 (Bungehuis, kamer 344-346) at the University of Amsterdam. Each participant was tested individually in an acoustically isolated room which was almost empty apart from a table, a Sennheiser MKH 105 T microphone, and a chair where the participant could sit, separated from the researcher by a glass window: the researcher was thus able not only to hear the participants perfectly and communicate with them (thanks to an interphone), but also to visually check whether everything was going according to plan and provide eventual guidance. An amplifier with low-pass filter at < 80 Hz and a TASCAM CD-RW 900 Professional CD recorder completed the provided equipment.

The same instructions were given individually to the participants before the recording session that they should read the whole text twice with a short break inbetween. Most of them knew that the experiment was linguistics-related, but they did not know beforehand that it had specifically to do with phonetics/phonology [6]. They were also asked to keep the printed text on the table in order not to produce any additional noise[7]. Prior to the recording, each participant was asked to read a few lines in order to check for both the position of the microphone and the volume of the recording.

A CD was recorded for each recording session (1-3 participants, tested individually), with every break creating a new audio track on the CD. The audio tracks were later extracted as *.wav* sound files to make them readable in Praat.

After the recording, the participants were interviewed individually and asked about their background (age, place of birth and current place of residence, where they had spent most of their lives, origins of their parents, level of education, whether they were bilingual and whether they had had any linguistic training) and the experiment (whether they had felt self-conscious, and what they thought it was about). The first four participants were asked about their background first, which heavily influenced their assumptions about the purpose of the experiment: for this reason, the order of the questions was then changed so as to start with the experiment and conclude with the personal background.

The whole task, including the interview, took 20-25 minutes for each participant.

Only 2 out of 18 participants[8] managed to get close to guessing the purpose of the test: they hypothesized that the research question may have been related to the Dutch sound cluster *-eeuw.* At the end of the interview, all the participants were informed about the aim of the experiment.

As far as the informants' feedback is concerned, it is interesting to note that, despite the fact that the text had been checked by four native speakers, some informants still found that there were some grammatically imperfect or unnatural-sounding sentences. Several participants remarked that the sentences were unnaturally long for Dutch, and that the punctuation was too scarce. The dearth of commas in the text was indeed found to have an effect on the production of the speakers, and thus on the quality of the collected data (see Section 6 below).

6. Analysis

6.1 Preliminaries

As already mentioned, each participant was recorded twice. Due to the number of errors, hesitations, rephrasings, and unnatural intonation and pauses generally heard in the first recordings, it was resolved to only make use of the second readings for the analysis. These

[6] This is true for every informant other than speaker F20M, who overheard a conversation between the researcher and the participant before her, so she knew about the purpose of the test before taking it.
[7] This turned out to be a problem for speaker F45M who could not do so due to a painful whiplash which prevented her from bending her neck. The result is a recorded speech which sounds far more disconnected than the other participants', even in the second reading.
[8] Speaker F20M is not included in the count for the reasons explained in note 6.

always sound more natural, more spontaneous (as far as reading can be spontaneous), and more “connected” than the preceding ones, probably due to the familiarity with the text that the speakers gained (surprisingly quickly) between the two readings. Thus, for each participant only one of the two recording files, the second, was segmented and analysed.

Each of these files contains 35 (9 of the V#wV type, 18 of the Vw#V type, and 8 of the Vw#wV type) target items. Prior to the analysis, all the recording files were opened one by one through Praat and all the target items were manually segmented and labelled.

6.2 Manual segmentation with Praat

Segmentation is performed through Praat by applying borders on tiers, “[…] blank bands located underneath the sound waves shown in the Praat sound window […] [, on which] intervals are added in correspondence both to the beginning and to end of the parts of the sounds we are interested in.” (Dalmasso 2012:16). The labelling of each tier interval, which will be described in the next section, immediately follows the segmentation phase. Both segmentations and labels are saved in a separate file, which shares the same name (and directory) as the original sound file, but has a different format: *.TextGrid*.

Machač and Skarnitzl (2009:13) write about manual segmentation that it has several disadvantages: “First, it is known to be time-consuming […]. Second, […] [it] is demanding in terms of labeller expertise. Many researchers have criticized it as inherently subjective and therefore inconsistent and irreproducible. […] both inter-labeller and intra-labeller consistency is an issue in manual segmentation.”. In order to keep inconsistencies to the minimum and “[…] speed up the preparation of […] [a] corpus without compromising the reliability of the segmentation”, Machač and Skarnitzl (2009) propose a set of segmentation guidelines that we follow in our data segmentation. Note that, in the present study, both the segmentation and labelling were performed by one single labeller, the researcher: inter-labeller consistency is therefore not an issue.

According to the guidelines by Machač and Skarnitzl (2009:23-24), “[…] we try to place boundaries next to (or between) […] formant columns (i.e., the dark vertical areas in the spectrogram, representing the peaks of acoustic energy in each glottal pulse). […] If there is a transition phase (an uncertain, “grey” portion of the signal in which low acoustic contrast does not allow unambiguous boundary placement […]), the boundary will be placed in the temporal midpoint of this area […]. Boundaries will be placed at zero crossing (a point in which the waveform crosses the amplitude axis)”.

Most of the time, intervocalic glides and spirant approximants can already be recognized during the segmentation phase (and prior to the analysis) due to the very different relative intensity of their formants compared to that of the neighbouring vowels (see Figure 5 and 6 below).

In the case in which an intervocalic <w> could be recognized as a labiodental approximant [ʋ] due to its lower relative formant intensity compared to the preceding and following vowels, its difference in relative intensity “[…] may [also] be [a] sufficient [clue] for comparatively straightforward segmentation” (Machač and Skarnitzl 2009:47). Otherwise, features such as changes in formant structure, energy in the high frequencies, changes in overall intensity and waveform shape (e.g. slightly lower amplitude in the waveform) may all play a role in helping the labeller identify the beginning and end points of the sound in question. If none of the previous helps, Machač and Skarnitzl (2009) recommend using listening, at least to confirm the visual cues.

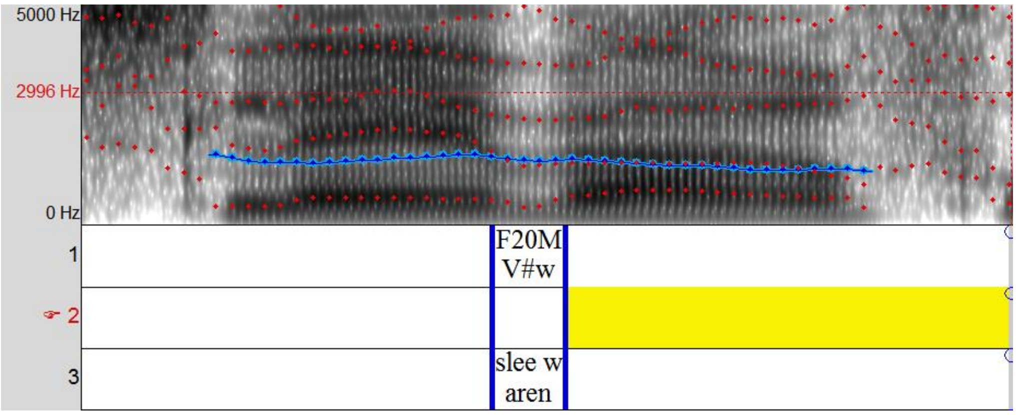

Figure 5: Spectrogram of *[…] slee waren […]* performed through Praat.
Note the high contrast between <w> (realized as a spirant approximant)
and the neighbouring vowels in terms of relative formant intensity.

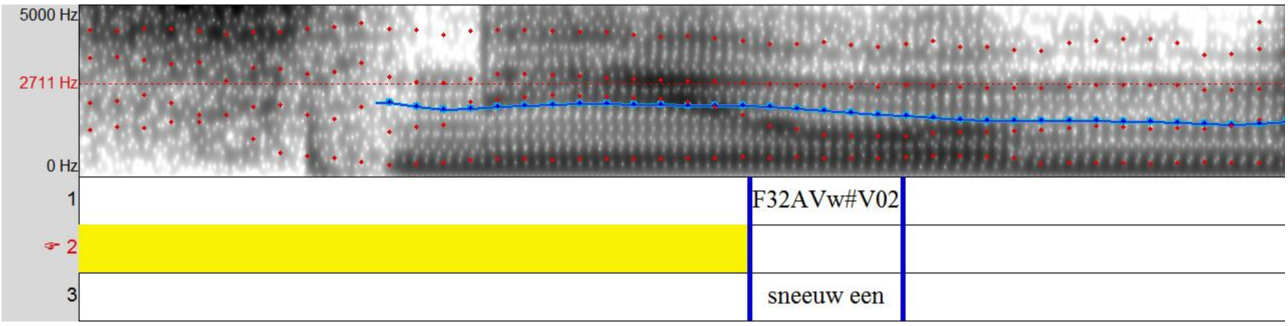

Figure 6: Spectrogram of *[…] sneeuw een […]* performed through Praat.
Note the low acoustic contrast between <w> (realized as a glide)
and the neighbouring vowels in terms of relative formant intensity.

According to Machač and Skarnitzl (2009:80), intervocalic glides are to be regarded as the most problematic group of sounds from the perspective of segmentation: "The spectral contrast between them and the neighbouring vowels is typically quite low, and tends to consist only in a slightly different formant pattern. […] Frequently we will have to resort to the rule placing the boundary near the midpoint of the transition phase.". For these glides, Machač and Skarnitzl (2009) propose two alternative approaches to segmenting: one based on acoustic cues and one based on perceptual cues. In the present study the perceptual approach was followed. A detailed description of this approach is given below for an imaginary sound sequence /oja/:

> In some instances, the acoustic contrast between a glide and a neighbouring vowel is so low that the auditory impression must be applied as the primary guideline, with visual information regarded merely as auxiliary. […] When locating the boundary by means of listening, the task is to find the moment when we can still hear the sequence /oj/ or /ja/ as monosyllabic (and not as a sequence of two syllables). When we want to locate the right boundary of [j], we try placing the boundary further to the right, into [a]. Then we start shifting the boundary in the transition phase between [j] and [a] leftwards, according to the auditory impression, until we can hear a monosyllabic (diphthongal) sequence [oj], not something like [ojᵃ] (i.e., no vocalic element). The left boundary will be located analogously: we place the boundary into [o] and proceed to the right, until we hear monosyllabic [ja] and not a disyllabic [ᵃja]. […] Obviously, we can still hear transitions of [j], especially in the following vowel. […] The advantage of the perceptual method is its universal character, in that it uniformly applies not only to straightforward cases, but also to unclear cases in which we can hear [j] or 'something like [j]' although there are no obvious visual cues for its segmentation available in the

> spectrogram. On the other hand, this approach is time-consuming, demanding in terms of the labeller's concentration and [...] more subjective. (Machač and Skarnitzl 2009:82-83)

Note that the perceptual approach yields segmented glides with considerably shorter duration than the acoustic approach, and it does not result in the "false auditory impression of syllabicity of the glide" (Machač and Skarnitzl 2009:82) typical of the latter approach.

Note that if a sound was not immediately recognized as either [ʋ] or [w] thanks to the overall and/or relative formant intensity during the segmentation, the perceptual approach was always followed.

6.3 Labelling with Praat

Following Dalmasso (2012), three interval tiers were set up. The first tier, named *type*, hosts the interval boundaries created during segmentation, thus determining the portion of sound which is to be analysed; moreover, it associates an identifying code to the target sound. This code univocally defines the target sound in terms of speaker (gender, age, initial of the first name), type/condition (V#wV, Vw#V, or Vw#wV,), and item number for that condition. For example, the label M21PV#wV01 identifies the first item (01) of the intervocalic onset condition V#wV (which is the <w> in *[...] juni wel [...]*) for speaker M21P, who is a male aged 21 years old whose first name begins with a P.

The interval boundaries on the second and third tier were also conventionally added in proximity of the interval boundaries on the first one, in that those tiers are only meant for adding notes about the sound (tier 2) and the word context to which it belongs (tier 3), whereas the first tier is the one from which the data are extracted.

More specifically, the second tier, named *clues*, was originally intended for writing down cues on the type of sound based on the observation of the spectrogram. It ended up, however, being, most of the time, either filled with notes about reasons to exclude the sound from the analysis (see Section 6.4 for more details about the excluded items), or left blank. An overview of all the possible annotations on the second tier is shown in Table 2.

Table 2: All the possible cues on tier 2

Annotation on tier 2	Meaning	Consequence for the analysis
1!/[ww]!	(long) uniform <w> sound in intervocalic cluster condition Vw#wV	uniform F2, intensity, harmonicity likely to be found at 25% and 75% of sound
clearly 2	<w> in intervocalic cluster condition Vw#wV clearly made up of two different sounds	expected to be realized as sequential [wʋ]
V	vowel-like realization of <w> in intervocalic coda condition Vw#V	different harmonicity?
[w]!	unexpected [w] realization in intervocalic onset condition V#wV	different F2, intensity, harmonicity than what expected for the condition
[v]!	unexpected [v] realization in intervocalic onset condition V#wV	different harmonicity than expected
misread	item misread or realized as non-intervocalic (cf. Table 3)	item excluded from the analysis

The third and last tier, named *words*[9], detects the target words. Note that, since the investigated conditions, more often than not, imply that <w> occurs right before or right after a word boundary, target words are usually to be intended as target word clusters. For example, the already mentioned item M21PV#wV01 is identified on tier 3 as *juni wel* instead of just *wel*.

Figure 7 shows an instance picture of a Praat textgrid window during the segmentation and labelling phase.

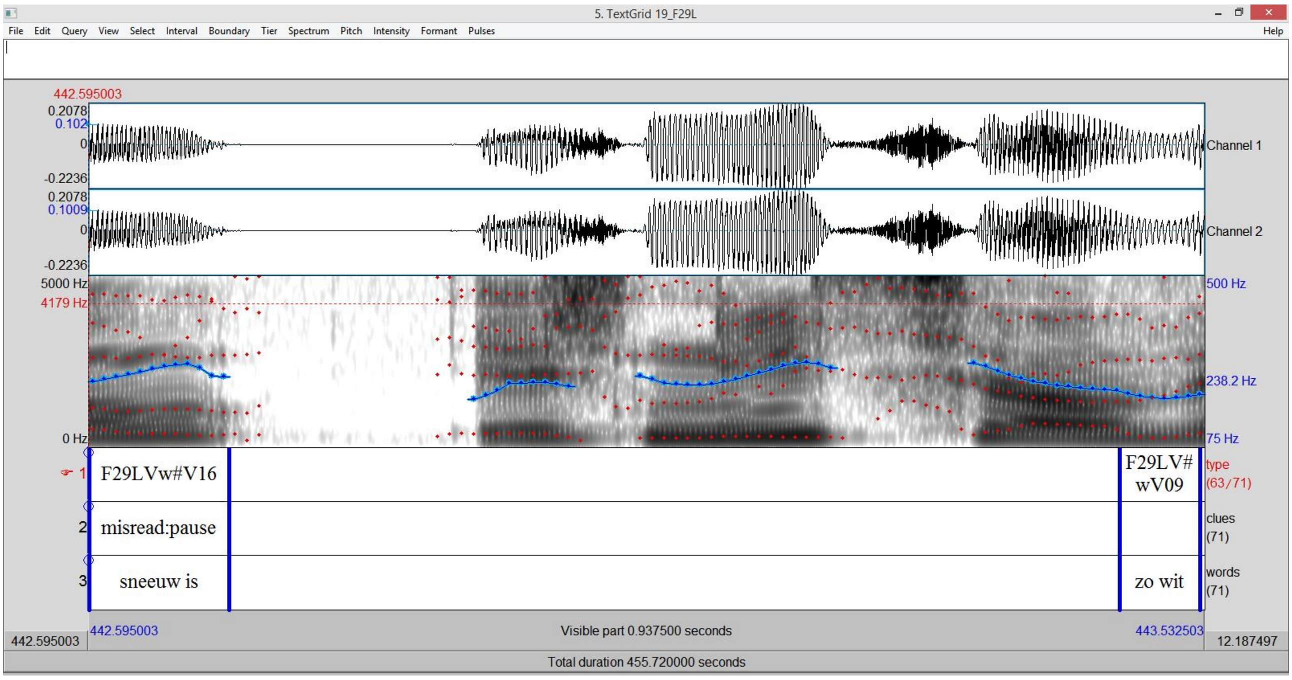

Figure 7: A Praat textgrid window during segmentation and labelling.
From top to bottom: the sound waves window, the spectrogram window,
and the three tiers; the names of these can be read on the right margin.

6.4 Excluded items

The total number of target items is 665 (=(9+8+18)×19), but the number of items included in the analysis is only 325. As a matter of fact, several items had to be excluded during the segmentation and labelling phase. Most of the excluded items display either a pause or a glottal stop at word-boundary, either before (for the V#wV condition) or after the <w> (for the Vw#V condition), or inbetween the two <w>s (for the Vw#wV condition). Pauses and glottal stops make the target items unconnected to what precedes or follow, thus compromising the items' intended intervocalic status. The intervocalic coda Vw#V condition is the most affected by this problem, probably due to the (random) weaker cohesion the <-eeuw#> items generally display with the item which follows in the cluster compared to the <#w-> items with the one which precedes (e.g. […] *sneeuw een* […] vs […] *kilo wegen* […]). Since the Vw#V condition, however, displays nearly twice the number of items of the other two, the exclusion of some of those due to the presence of pauses/glottal stops at word boundary should not be too problematic.

Table 3 shows all the possible sources of misreading that are labelled on tier 2. Note that, phonetically, glottal stops "[…] may assume several forms, by far the most frequent ones being

[9] For tier 3, the boundaries of the intervals could have been placed in correspondence of the beginning and end points of the words in question, as Dalmasso (2012) did, instead of keeping them in line with the intervals on tier 1.

a canonical plosive and creaky voice" (Machač and Skarnitzl 2009:125); hence the distinction between "gs" and "creaky gs" in our labelling.

Table 3: All the possible "misread" labels on tier 2

Annotation on tier 2	Meaning	Consequence for the analysis
(creaky) gs	(creaky) glottal stop either preceding or following <w> or occurring inbetween the <ww> cluster, compromising the intervocalic status of the target item	item excluded from the analysis
(long) pause	(long) pause either preceding or following <w> or occurring inbetween the <ww> cluster, compromising the intervocalic status of the target item	item excluded from the analysis
stuttering/hesitation/filled pause	variation of an empty pause, compromising the intervocalic status of the target item	item excluded from the analysis
any of the previous + …	combination of any of the previous factors, compromising the intervocalic status of the target item	item excluded from the analysis
wrong word order	switched words (e.g. *sneeuw gefallen is* instead of *sneeuw is gefallen*) compromising the intervocalic status of the target item	item excluded from the analysis
problem: .wor. = V	a whole syllable realized as a vowel; no more <w>	item excluded from the analysis
missing sound	missing target sound	item excluded from the analysis
dropped <i>	following vowel dropped, compromising the intervocalic status of the target item	item excluded from the analysis
creaky	whole word cluster realized with creaky voice, making it impossible to detect an eventual creaky glottal stop	item excluded from the analysis

Note that the already mentioned scarcity of commas and "prescribed pauses" through punctuation, and consequent extreme length of sentences, in the speech material may have played a big role in causing undesired pauses in speakers' utterances. In order to prevent (or at least reduce) such pauses at target word boundaries, it would have been better to: first, keep the sentences quite short overall, and, second, "guide" the performance of the speakers by inserting strategic commas in the immediate neighbouring context of the target items.

6.5 Observations preliminary to the analysis

Based on the observation of the spectrogram and the impressions gathered during the segmentation and labelling phase, some generalizations can already be sketched out before the actual analysis.

First, the overall tendency seems for speakers to realize codas as [w] and onsets as [ʋ][10]. Only very few speakers occasionally do otherwise, and it is always that onsets are realized as [w] and never the other way around; it seems more a matter of free rather than systematic variation, even though it indeed seems more systematic in some speakers[11].

Second, as for the cluster condition, the tendency seems for speakers to realize it as a sequence [wʋ] (cf. sequencing hypothesis, Section 4.2). Realizations such as [ww] do occur, but variations here seem even less systematic than for the onset condition.

Third, it appears that the duration of <w> in the intervocalic cluster Vw#wV condition is visibly longer than <w> in the other two conditions, which, if confirmed by the data, would also validate the sequencing hypothesis.

Third, spectrograms of the same condition seem to show that the two <w>s are, nearly without exception, distinct sounds. This is clearly visible in the very different overall and relative formant intensity displayed by the two halves of the target sounds: the first half nearly always of higher intensity, and the second half of lower intensity. This, again, would validate the sequencing hypothesis. An instance of a target Vw#wV sound performed through Praat is given in Figure 8 for illustrative purposes. Note that, in this specific case, the waveform (e.g. its amplitude) also contributes to conveying the impression that we are dealing with two different sounds.

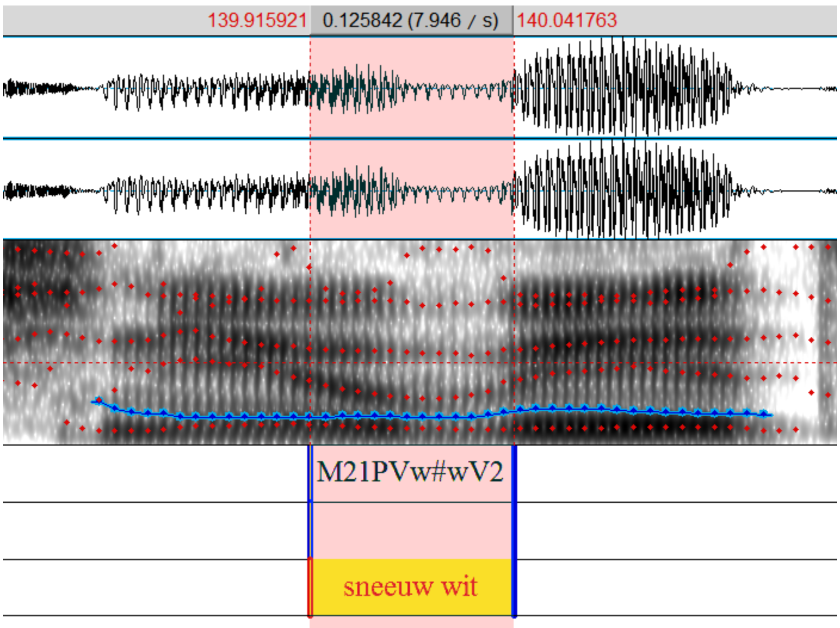

Figure 8: Instance of a Vw#wV sound performed through Praat.
Note the difference in overall and relative formant intensity
between the first and second half of the <w> sound.

[10] Speaker F45M occasionally seems to realize the onsets as fricatives [v], but she is the only one to do that.
[11] For instance, in speaker M30E, grown up in Gelderland.

6.6 Praat script and settings

The first step of the actual analysis consists of running a script (specifically conceived for the purposes of this study) through Praat. The script, when saved in a *.Praat* file format in the same directory as the 19 pairs of *.wav* and *.TextGrid* files, opens these pairs one at a time in Praat, and, combining the information on both the sound file and the related TextGrid, extracts all the desired measurements related to each of the target sounds in the text. More specifically, the script provides us with data about the duration, second formant, intensity, and harmonicity of our target sounds. Note that the latter three are all measured at 25% and 75% of each interval tier.

The script is written according to Praat's specific programming syntax; it is inspired by scripts by Antoniou and by Lennes (cf. References). A copy of the script is given in the Appendix, and the main settings are presented in the following subsections (note that many of them conform to the indications provided in the Praat manual).

6.6.1 Formant settings

The frequency values of the second formants of each target sound are extracted automatically through Praat at 25% and 75% of the interval tier from a Formant object created according to the settings presented in the following. The time step, i.e. the time between the centres of consecutive analysis frames, is set at 0.001 seconds. The maximum number of formants per frame is five, as is the case for most analyses of human speech. The maximum formant, i.e. the ceiling of the formant search range, is set to a value suitable for the speakers depending on their gender: the standard value of 5500 Hertz is suitable for an adult female, 5000 Hertz for an adult male. The window length, i.e. the effective duration of the analysis window, is set at 0.040 seconds, so that the values of the frequencies are drawn each 40 milliseconds of sound. The pre-emphasis value is set from 50 Hertz.

6.6.2 Intensity settings

The intensity values of each target sound are extracted automatically through Praat at 25% and 75% of the interval tier from an Intensity object created according to the settings presented in the following. The minimum pitch, i.e. the minimum periodicity frequency in the signal, is set at 100 Hertz. The time step is set, as in the formant settings, at 0.001 seconds. The third and last setting "[…] allows Praat to subtract from the pressure of the recorded sound the constant air pressure that many devices, such as the microphone employed for the recording session, might have added. This drawback results in a non-zero value of the intensity in the sound wave even in silent phases of the recordings. Praat computes its mean and subtracts it from the intensity of the actual recorded speech." (Dalmasso 2012:41). The "subtract mean" setting is thus set to yes.

6.6.3 Harmonicity settings

The harmonicity values of each target sound are extracted automatically through Praat at 25% and 75% of the interval tier from a Harmonicity object created according to the settings presented in the following. The preferred method, according to the Praat manual, is cross-correlation, as it presents a much better time resolution than the autocorrelation method. The time step is, this time, set at the default value of 0.01 seconds: a test was previously run on a small selection of the files with the 0.001 seconds setting to see whether it was feasible, and the amount of time required to perform the analysis was huge, thus convincing the researcher to opt for the 0.01 seconds setting. The minimum pitch, which determines the length of the analysis window, is set at the default value of 75 Hertz. The silence threshold is also set at the default value of 0.1: this means that the frames that do not contain amplitudes above this threshold are considered silent. The number of periods per window is also kept at the standard value of 4.5, which, according to the Praat manual, is best for speech.

6.6.4 Summary

To sum up, the analysis of the target sounds in the recorded files is performed by a script written in Praat syntax and run through the Praat software. The script commands that, after loading all the 19 paired sound and TextGrid files, Praat creates a Formant, an Intensity, and a Harmonicity object. After that, if the interval on tier 1 has some text as a label, and the interval on tier 2 does not report "misread", the measurements of duration, F2 at 25% and 75% of the interval tier, intensity at 25% and 75% of the interval tier, and harmonicity at 25% and 75% of the interval tier, are extracted, and presented in a tab-separated table together with the indication of speaker, type of condition, and number of item.

The summary statistics related to the dependent variables and the statistical analysis proper are then performed with R.

6.7 Statistics performed with R

The tab-separated table produced through Praat (including: speaker, type, and item as independent variables, and duration, $F2_{25\%}$ and $F2_{75\%}$, $intens_{25\%}$ and $intens_{75\%}$, and $harm_{25\%}$ and $harm_{75\%}$ as dependent variables) was imported into R as a dataset, and the summary statistics computed. Averages and standard deviations were computed for duration, average F2, F2 rise ($F2_{75\%}$ - $F2_{25\%}$), intensity, intensity fall ($intens_{75\%}$ - $intens_{25\%}$), harmonicity, harmonicity fall ($harm_{75\%}$ - $harm_{25\%}$). For F2 rise, intensity fall, and harmonicity fall, confidence intervals were also computed.

Boxplots displaying the distribution of the data as a function of type were also drawn with R for each of the aforementioned parameters.

The summary statistics and boxplots are reported in the following section. The complete R script is given in the Appendix, together with the complete set of data obtained through Praat.

6.7.1 The analysis

For our analysis in R, the model we employ is a linear mixed model fit by maximum likelihood (*lmer*) in which type acts as a fixed factor and speaker and item act as interaction factors.

First, we carry out an omnibus test, i.e. a test as to whether the explained variance in a data set is overall significantly greater than the unexplained variance. We compare a *lmer* model of the whole dataset, including type as a fixed factor, with the same *lmer* model, but without type as a factor, through ANOVA, using a Chi-squared test. From the ANOVA comparison we obtain a p value for the influence of type: if this omnibus p value is small enough (i.e., $p < 0.05$), we can assume that type indeed plays an important role in determining the pronunciation of <w> in the three different conditions.

This being ascertained, the following concern is to determine which groups of means may have had an effect on the significance of our ANOVA analysis. If p value < 0.05, we can assume that, among the groups considered, at least two means are significantly different: thus, we want to know which of the means for our three type groups are significantly different from the others. To do that, we use the Least Significant Difference (LSD) post hoc method originally developed by Fisher, which "explores all possible pair-wise comparisons of means comprising a factor using the equivalent of multiple t-tests." (Stevens; cf. References).

Thus, we create subsets of the data so as to be able to compare two types at a time (i.e. onset and cluster, onset and coda, cluster and coda), and run a t-test for each pair of means. From each t-test, we obtain the t-values and confidence intervals that will be reported in the next section. Lastly, for each subset we compare models with and without type again through ANOVA in order to obtain the relevant p values (which *lmer* does not provide). Next section will also present p values, along with the related t values and confidence intervals.

7. Results

This section presents the results of the test in terms of pair-wise comparisons of averages for the three condition. Each subsection is dedicated to an acoustic parameter among the following: duration, average F2, F2 rise, average intensity, intensity rise, average harmonicity, and harmonicity rise.

7.1 Duration

According to our data, the onset and coda condition display, on average, slightly different, but comparable durations, whereas the cluster condition presents much longer durations, approximately twice the ones in the other two conditions. Note that such a ratio, if confirmed by the post hoc tests for significance, would be compatible with the sequencing hypothesis (cf. Section 4.2), which regards the <w> in the intervocalic cluster condition as being realized as a sequence of the <w>s in the coda and onset condition, respectively.

Table 4 lists the average durations, standard deviations, and confidence intervals for each of the three types, whereas Figure 9 offers a depiction of the three groups through their quartiles: the bottom and top of the boxes are the first and third quartiles, the horizontal bands inside the boxes are the second quartiles or medians, the vertical lines extending outside the boxes indicate variability outside the first and third quartile, and the small circles represent outliers.

Table 4: Duration as a function of type

Type	Average duration (s)	Standard deviation (s)	Conf. int. (s) (2.5% – 97.5%)
V#wV	0.055	0.012	0.051 – 0.059
Vw#V	0.062	0.012	0.059 – 0.067
Vw#wV	0.123	0.029	0.114 – 0.132

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on duration is $9.08 \cdot 10^{-20}$ ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

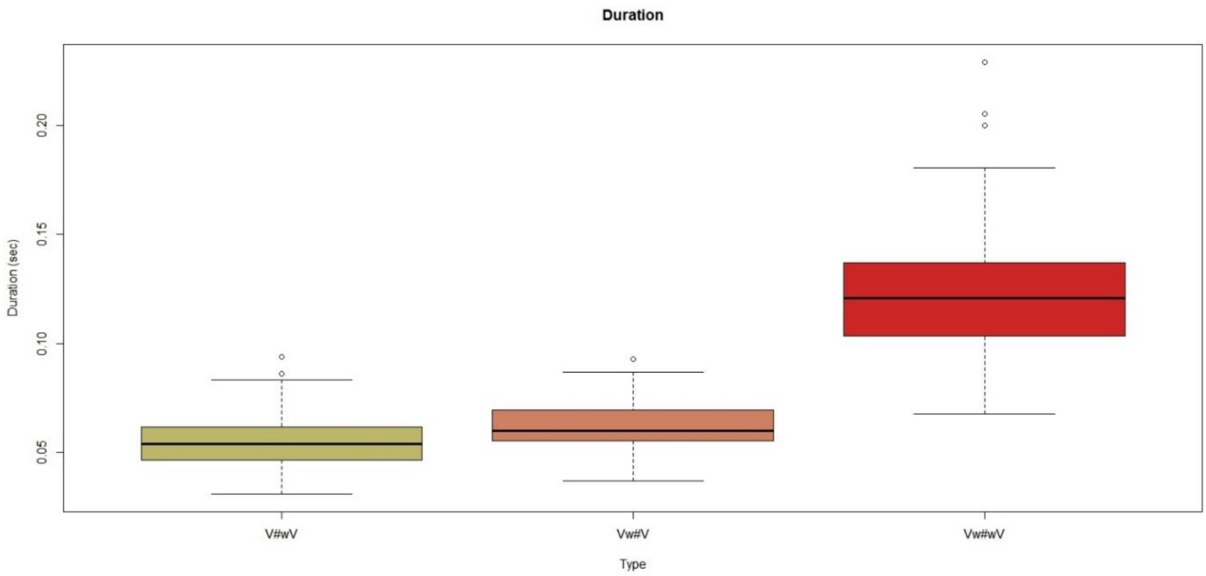

Figure 9: Duration as a function of type

7.1.1 Difference in duration between onset and cluster type

The fixed effects (estimate, standard error, t value), confidence intervals, and p value (from the ANOVA subset comparison) related to the role of type on the difference in terms of duration between onset and cluster are reported in Table 5.

Table 5: Difference in duration between onset and cluster type

	Estimate (s)	Std. error (s)	t value	Conf. int. (s) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	0.055	0.003	19.68	0.049 – 0.061	$8.40 \cdot 10^{-14}$
typeVw#wV	0.068	0.003	20.78	0.061 – 0.074	

Note that “(Intercept)” refers to the onset type, which is used here as a reference for the second type: thus, the duration estimate for the cluster type has to be read as “being 0.068 seconds longer than the one for the onset type”. The p value, that is, the probability of such a difference in terms of duration occurring randomly, i.e. without type playing a prominent role, is very low ($p = 8.40 \cdot 10^{-14} < 0.05$); therefore, we can regard the difference in duration between onset and cluster as significant.

It seems, thus, that Dutch speakers display a noticeable difference in terms of duration in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.1.2 Difference in duration between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of duration between onset and coda are reported in Table 6.

Table 6: Difference in duration between onset and coda type

	Estimate (s)	Std. error (s)	t value	Conf. int. (s) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	0.055	0.002	30.71	0.051 – 0.059	0.002
typeVw#V	0.008	0.002	3.37	0.003 – 0.013	

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the duration estimate for the coda type has to be read as "being 0.008 seconds longer than the one for the onset type"; note that the difference here is much lower than the one estimated in the previous case. The p value is still quite low, despite being less low than in the previous case ($p = 0.002 < 0.05$); therefore, we can regard the difference in duration between onset and coda as significant.

It seems, thus, that Dutch speakers display a (slight) difference in terms of duration in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.1.3 Difference in duration between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of duration between cluster and coda are reported in Table 7.

Table 7: Difference in duration between cluster and coda type

	Estimate (s)	Std. error (s)	t value	Conf. int. (s) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	0.123	0.004	34.14	0.115 – 0.130	$9.64 \cdot 10^{-14}$
typeVw#V	-0.057	0.004	-15.15	-0.065 – 0.050	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the duration estimate for the coda type has to be read as "being 0.057 seconds briefer than the one for the cluster type". The p value is very low ($p = 9.64 \cdot 10^{-14} < 0.05$), more or less as low as for the onset/cluster difference; therefore, we can regard the difference in duration between cluster and coda as significant.

It seems, thus, that Dutch speakers display a noticeable difference in terms of duration in the pronunciation of their intervocalic <w>s depending on whether these occur in coda position or as a cluster.

7.1.4 Duration: conclusion

Our data show that the onset and the coda condition present slightly different, but still comparable average durations, which supports expectation no. 2 (cf. Section 5.3) as far as duration in onset and coda position is concerned. Both onsets and codas are on average considerably shorter in duration than expected based on Hamann and Sennema (2005); note, however, that they use nonwords in isolation in their experiment, which explains the (apparent) discrepancy between their findings and ours. On the opposite, the cluster condition presents a very different average duration, which, being approximately twice the ones in the other two conditions (as predicted in expectation no. 3), is definitely compatible with the sum of the durations of the other two (cf. sequencing hypothesis).

The non-overlapping, very narrow confidence intervals and low p values in all the pair-wise comparisons also enable us to confidently confirm the sequencing hypothesis as far as duration in the cluster condition is concerned, and reject the other two hypotheses (i.e. degemination and fusion).

7.2 Average F2

According to the data, average F2 is higher in the onset condition than in the coda condition, which conforms to our original expectations. We also expected the cluster condition to display an average F2 which could be regarded as an average of the averages of the other two conditions, but this is not the case: the average F2 values for Vw#V and Vw#wV are actually extremely close, and the one for the coda condition (which should have been the lowest of the lot with 500 Hz < F2 < 1000 Hz) is actually slightly higher than the one for the cluster condition.

Table 8 lists the average F2 frequency values, standard deviations, and confidence intervals for each of the three types, whereas Figure 10 offers a depiction of the distribution of the three groups through their quartiles.

Table 8: Average F2 as a function of type

Type	Average F2 (Hz)	Standard deviation (Hz)	Conf. int. (Hz) (2.5% – 97.5%)
V#wV	1381	257.1	1244 – 1514
Vw#V	1209	212.8	1139 – 1267
Vw#wV	1207	246.3	1120 – 1293

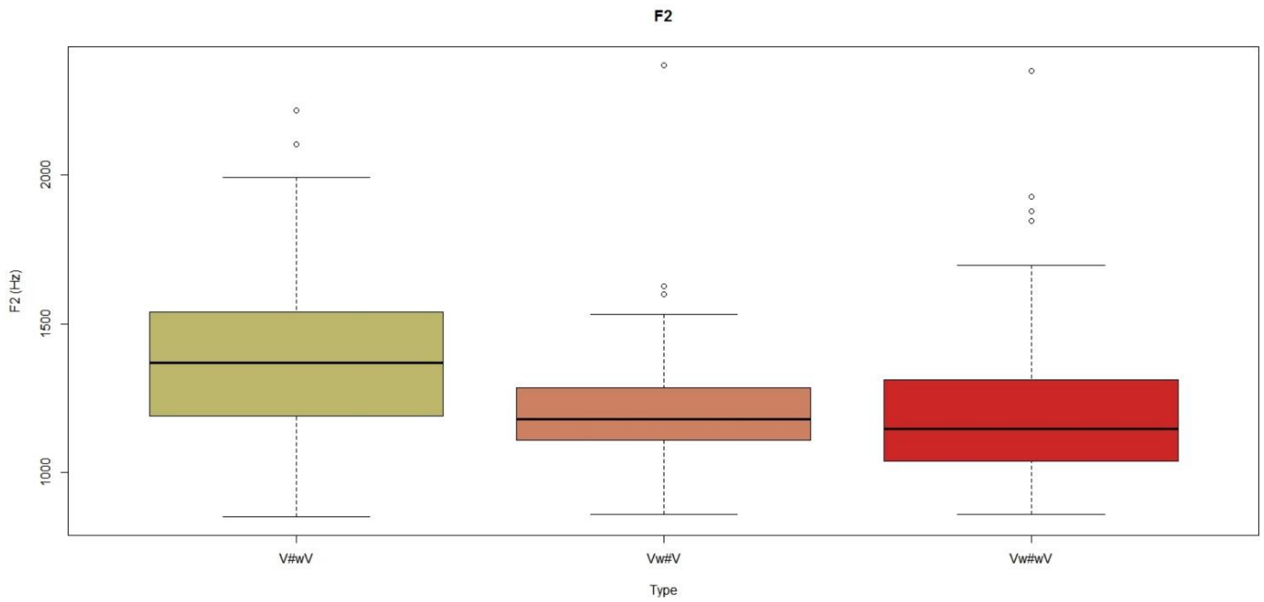

Figure 10: Average F2 as a function of type

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on average F2 is 0.01 ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

7.2.1 Difference in average F2 between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 between onset and cluster are reported in Table 9.

Table 9: Difference in average F2 between onset and cluster type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	1379	51.55	26.76	1274 – 1484	0.02
typeVw#wV	-169.1	65.97	-2.56	-305.7 – -32.07	

Here, "(Intercept)" refers to the onset type, which acts as a reference for the second type: thus, the F2 estimate for the cluster type has to be read as "being 169.1 Hz lower than the one for the onset type". The p value is rather low ($p = 0.02 < 0.05$); therefore, we can regard the difference in average F2 between onset and cluster as significant.

It seems, thus, that Dutch speakers display a difference in terms of average F2 in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.2.2 Difference in average F2 between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 between onset and coda are reported in Table 10.

Table 10: Difference in average F2 between onset and coda type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	1378	49.04	28.09	1278 – 1477	0.02
typeVw#V	-147.4	59.20	-2.49	-268.8 – -27.52	

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the F2 estimate for the coda type has to be read as "being 147.4 Hz lower than the one for the onset type". The p value is rather low ($p = 0.02 < 0.05$); therefore, we can regard the difference in average F2 between onset and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of average F2 in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.2.3 Difference in average F2 between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 between cluster and coda are reported in Table 11.

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the F2 estimate for the coda type has to be read as "being 3.33 Hz higher than the one for the cluster type". The p value is not low enough this time ($p = 0.94 > 0.05$) for us to state the significance of the difference between the averages of cluster and coda.

Table 11: Difference in average F2 between cluster and coda type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	1205	36.89	32.68	1129 – 1280	
typeVw#V	3.33	41.83	0.08	-82.21 – 88.82	0.94

7.2.4 Average F2: conclusion

Our data show that average F2 is highest in the onset condition with 1000 Hz < F2 < 1500 Hz, which conforms to expectation no. 4 about F2 in V#wV. However, we also expected average F2 to be much lower in the coda condition with 500 Hz < F2 < 1000 Hz (as predicted in expectation no. 5), but this is actually not the case. The reason for the unexpected higher F2 found for codas is likely to lie in the fact that coda [w] consistently occurs right after <ee> in our target items (e.g. *[...] sneeuw onder [...]*): thus, F2 transitions from the high vowel (with high F2) produce a higher average F2 than expected for low-F2 [w]. The same phenomenon does not occur for onsets, which overall display more variation in terms of preceding vowels. Note that controlling for the quality of neighbouring vowels in all conditions in future research will probably yield results which better conform to the predictions (e.g., here, lower average F2 for the coda condition).

Lastly, based on the results obtained for duration (i.e. the validation of the sequencing hypothesis), we expected average F2 for the cluster condition to be an average of the F2s for onset and coda (cf. expectation no. 9), as to further validate the hypothesis of cluster <w> being a sequence of coda <w> plus onset <w>. This, however, is not confirmed by the data: the average F2 for the coda condition is actually slightly higher than the one for cluster, but so slightly so that the difference between cluster and coda condition is not even significant. Of course, however, this is a consequence of the unexpectedly higher F2 values found for codas (see above).

7.3 F2 rise

We expected the onset and coda condition to present a negligible F2 rise (or fall) due to the assumed homogeneousness of the <w>, but this is not what we find in the data: note, in particular, the considerable F2 fall found for the coda condition. We also expected a more substantial F2 rise for the cluster condition, which indeed occurs.

Table 12 lists the average values for F2 rise, standard deviations, and confidence intervals for each of the three types. Note that the confidence interval for Vw#wV does not include zero, which means that the F2 movements are indeed significant for the cluster condition.

Figure 11 offers a depiction of the distribution of the three groups through their quartiles.

Table 12: F2 rise as a function of type

Type	Average F2 rise (Hz)	Standard deviation (Hz)	Conf. int. (Hz) (2.5% – 97.5%)	p value
V#wV	21.38	268.7	-60.78 – 110.9	> 0.05
Vw#V	-218.4	228.0	-283.6 – -157.0	< 0.05
Vw#wV	193.7	490.9	36.71 – 367.0	< 0.05

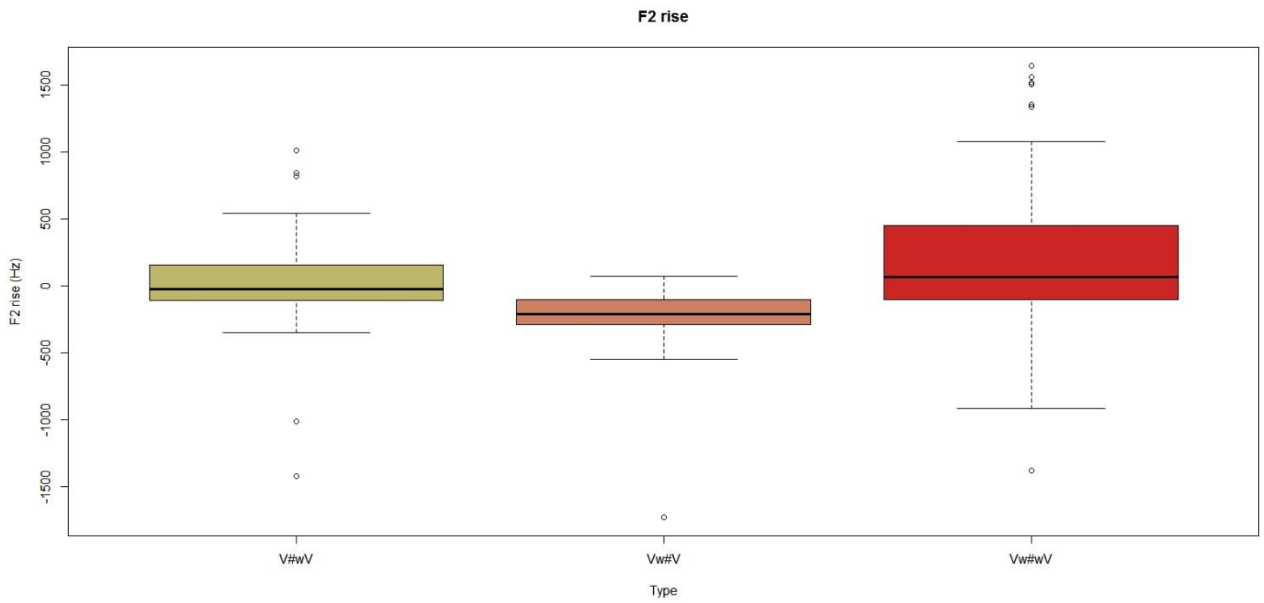

Figure 11: F2 rise as a function of type

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on F2 rise is $2.84 \cdot 10^{-6}$ ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

7.3.1 Difference in F2 rise between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 rise between onset and cluster are reported in Table 13.

Table 13: Difference in F2 rise between onset and cluster type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	28.11	53.11	0.53	-80.48 – 137.4	
typeVw#wV	171.3	68.19	2.51	30 – 314.8	0.02

Here, "(Intercept)" refers to the onset type, which acts as a reference for the second type: thus, the F2-rise estimate for the cluster type has to be read as "being 171.3 Hz higher than the one for the onset type". The p value is rather low ($p = 0.02 < 0.05$); therefore, we can regard the difference in F2 rise between onset and cluster as significant.

It seems, thus, that Dutch speakers display a difference in terms of F2 rise in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.3.2 Difference in F2 rise between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 rise between onset and coda are reported in Table 14.

Table 14: Difference in F2 rise between onset and coda type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	22.76	33.50	0.679	-46.79 – 92.59	$4.70 \cdot 10^{-5}$
typeVw#V	-243.2	49.75	-4.887	-343.9 – 141. 7	

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the F2 variation estimate for the coda type has to be read as "being 243.2 Hz lower than the one for the onset type". The p value is very low ($p = 4.70 \cdot 10^{-5} < 0.05$); therefore, we can regard the difference in F2 rise between onset and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of F2 rise (or fall) in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.3.3 Difference in F2 rise between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of F2 rise between cluster and coda are reported in Table 15.

Table 15: Difference in F2 rise between cluster and coda type

	Estimate (Hz)	Std. error (Hz)	t value	Conf. int. (Hz) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	197.2	57.76	3.41	79.50 – 316.8	$9.47 \cdot 10^{-6}$
typeVw#V	-391.1	70.36	-5.56	-535.7 – -247.6	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the F2 variation estimate for the coda type has to be read as "being 391.1 Hz lower than the one for the onset type". The p value is very low ($p = 9.47 \cdot 10^{-6} < 0.05$); therefore, we can regard the difference in F2 rise between cluster and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of F2 rise (or fall) in the pronunciation of their intervocalic <w>s depending on whether these occur in coda position or as a cluster.

7.3.4 F2 rise: conclusion

Our data show that the coda condition presents a more substantial F2 variation (more specifically, a more substantial F2 fall, rather than F2 rise) than predicted in expectation no. 10. Note, however, that we probably could (and should) have expected a quite considerable average F2 fall in coda position based on the consistent presence of <ee> as the vowel preceding [w] in all the target items (cf. also Section 7.2 on average F2). As has been pointed out previously, controlling for the quality of neighbouring vowels in all conditions in future research will most likely yield results which better conform to the predictions (e.g., here, a positive F2 rise or, at least, a less considerable F2 fall for the coda condition).

Expectations no. 6 and 11 about the cluster condition, on the other hand, are fulfilled, with Vw#wV displaying, on average, a considerable F2 rise; note that this complies with the sequencing hypothesis. Moreover, the confidence interval for Vw#wV does not include zero, which means that the F2 (rising) movements are indeed significant in the cluster condition: this also fulfills the sequencing hypothesis, which regards cluster <w> as a sequence of coda <w> and onset <w>, and allows us to reject the other two hypotheses.

7.4 Average intensity

As far as average intensity is concerned, all our predictions are confirmed: intensity is, on average, higher in the coda condition than in the onset condition, and the cluster condition shows an intensity intermediate between those of the other two.

Table 16 lists the average intensities, standard deviations, and confidence intervals for each of the three types, whereas Figure 12 offers a depiction of the distribution of the three groups through their quartiles.

Table 16: Intensity as a function of type

Type	Average intensity (dB)	Standard deviation (dB)	Conf. int. (dB) (2.5% – 97.5%)
V#wV	66.17	4.535	63.90 – 68.08
Vw#V	70.31	3.830	68.89 – 72.33
Vw#wV	68.21	3.968	66.48 – 69.95

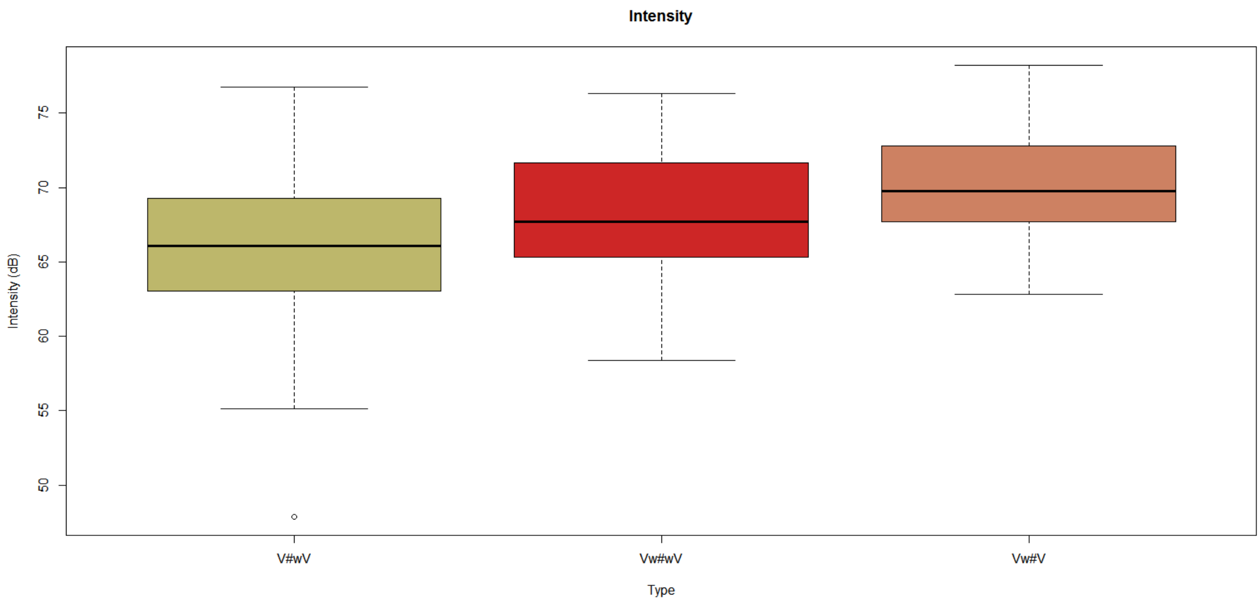

Figure 12: Intensity as a function of type

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on average intensity is $7.76 \cdot 10^{-7}$ ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

7.4.1 Difference in average intensity between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in intensity between onset and cluster are reported in Table 17.

Here, "(Intercept)" refers to the onset type, which acts as a reference for the second type: thus, the intensity estimate for the cluster type has to be read as "being 2.201 dB louder than the one for the onset type". The p value is rather low ($p = 0.02 < 0.05$); therefore, we can regard the difference in intensity between onset and cluster as significant.

Table 17: Difference in average intensity between onset and cluster type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	66.04	0.911	72.48	64.19 – 67.88	0.02
typeVw#wV	2.201	0.848	2.59	0.443 – 3.961	

It seems, thus, that Dutch speakers display a difference in terms of intensity in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.4.2 Difference in average intensity between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of intensity between onset and coda are reported in Table 18.

Table 18: Difference in average intensity between onset and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	66.04	0.903	73.13	64.21 – 67.86	$1.65 \cdot 10^{-6}$
typeVw#V	4.822	0.785	6.15	3.22 – 6.41	

Here, "(Intercept)" refers to the onset type, which acts as a reference for the second type: thus, the intensity estimate for the coda type has to be read as "being 4.822 dB louder than the one for the onset type". The p value is very low ($p = 1.65 \cdot 10^{-6} < 0.05$); therefore, we can regard the difference in intensity between onset and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of intensity in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.4.3 Difference in average intensity between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in intensity between cluster and coda are reported in Table 19.

Table 19: Difference in average intensity between cluster and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	68.27	0.838	81.46	66.57 – 69.96	0.001
typeVw#V	2.516	0.626	4.02	1.215 – 3.784	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the intensity estimate for the coda type has to be read as "being 2.516 dB louder than the one for the cluster type". The p value is quite low ($p = 0.001 < 0.05$); therefore, we can regard the difference in intensity between cluster and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of intensity in the pronunciation of their intervocalic <w>s depending on whether these occur in coda position or as a cluster.

7.4.4 Average intensity: conclusion

Our data show that intensity is, on average, higher in the coda condition than in the onset condition (as predicted in expectations no. 12 and 13), and that the cluster condition is characterized by an intensity intermediate between those of the other two (as predicted in expectation no. 17). Note, however, that we cannot confidently confirm the sequencing hypothesis based on the information about average intensity only, because the patterns described here perfectly comply with both the sequencing hypothesis and the fusion hypothesis (cf. again expectation no. 17).

7.5 Intensity fall

We expected negligible changes in intensity within both the onset and the coda condition, and a more substantial decrease in intensity within the cluster condition. Our predictions are overall confirmed: the onset and coda condition present only a very slight fall in intensity, whereas the cluster condition displays a more considerable one (even though it is still quite a small one).

Table 20 lists the average values for intensity rise, standard deviations, and confidence intervals for each of the three types. Note that the confidence interval for Vw#wV does not include zero, which means that the intensity movements are indeed significant for the cluster condition.

Figure 11 offers a depiction of the distribution of the three groups through their quartiles.

Table 20: Intensity fall as a function of type

Type	Average intensity fall (dB)	Standard deviation (dB)	Conf. int. (dB) (2.5% – 97.5%)	p value
V#wV	-0.959	2.053	-1.518 – -0.399	< 0.05
Vw#V	-1.640	1.731	-2.469 – -1.229	< 0.05
Vw#wV	-6.995	3.361	-8.148 – -5.809	< 0.05

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on intensity fall is $1.24 \cdot 10^{-13}$ ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

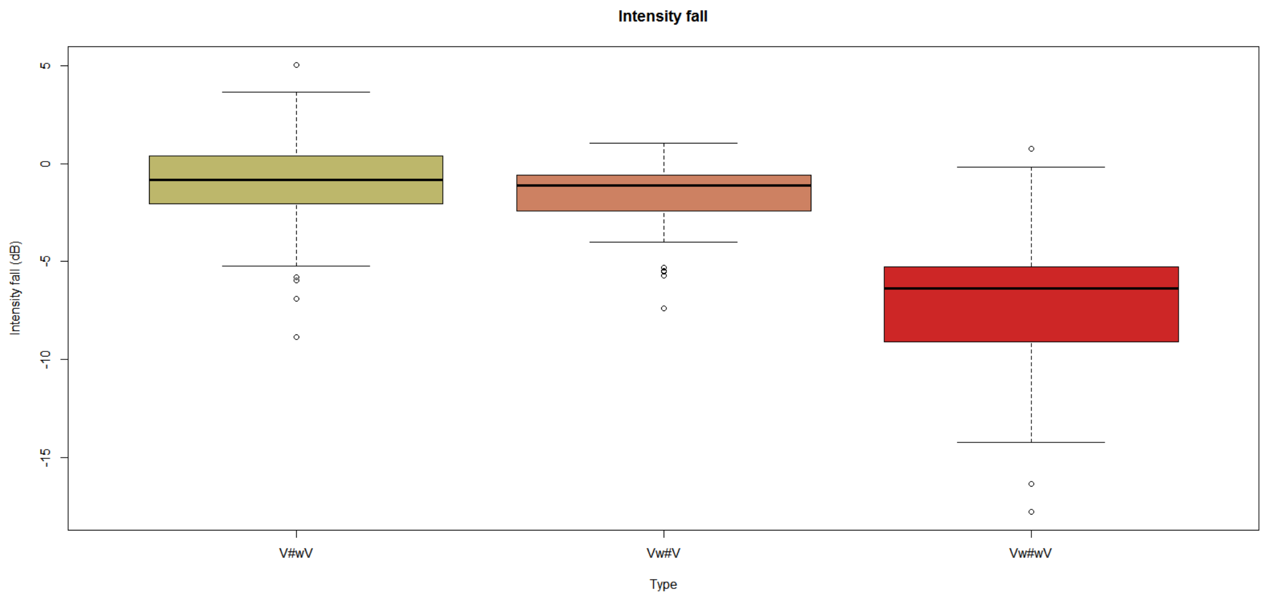

Figure 13: Intensity fall as a function of type

7.5.1 Difference in intensity fall between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in intensity fall between onset and cluster are reported in Table 21.

Table 21: Difference in intensity fall between onset and cluster type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	-0.974	0.380	-2.56	-1.756 – -0.193	$1.05 \cdot 10^{-9}$
typeVw#wV	-5.995	0.513	-11.69	-7.047 – -4.918	

Here, "(Intercept)" refers to the onset type, which acts as a reference: thus, the intensity fall estimate for the cluster type has to be read as "being 5.995 dB less loud than the one for the onset type". The p value is very low ($p = 1.05 \cdot 10^{-9} < 0.05$); therefore, we can regard the difference in intensity fall between onset and cluster as significant.

It seems, thus, that Dutch speakers display a difference in terms of intensity fall in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.5.2 Difference in intensity fall between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in intensity fall between onset and coda are reported in Table 22.

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the intensity fall estimate for the coda type has to be read as "being 0.786 dB less loud than the one for the onset type". The p value is rather low ($p = 0.02 < 0.05$); therefore, we can regard the difference in intensity fall between onset and coda as significant.

Table 22: Difference in intensity fall between onset and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	-0.963	0.222	-4.336	-1.424 – -0.503	0.02
typeVw#V	-0.786	0.331	-2.378	-1.476 – -0.111	

It seems, thus, that Dutch speakers display a significant difference in terms of intensity fall in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.5.3 Difference in intensity fall between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in intensity fall between cluster and coda are reported in Table 23.

Table 23: Difference in intensity fall between cluster and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	-7.016	0.435	-16.15	-7.901 – -6.124	$1.50\cdot10^{-9}$
typeVw#V	5.017	0.530	9.459	3.911 – 6.079	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the intensity rise estimate for the coda type has to be read as "being 5.017 dB louder than the one for the cluster type". The p value is very low ($p = 1.50\cdot10^{-9} < 0.05$); therefore, we can regard the difference in intensity fall between cluster and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of intensity fall in the pronunciation of their intervocalic <w>s depending on whether these occur in coda position or as a cluster.

7.5.4 Intensity fall: conclusion

Our data show a negligible fall in intensity within onset and coda, as predicted in expectation no. 18, and a more prominent fall within the cluster condition, as predicted in expectations no. 14 and 19. Note, moreover, that the confidence interval for cluster Vw#wV does not include zero, which means that the intensity (falling) movements are indeed significant in the cluster condition, complying with the sequencing hypothesis.

Overall, we can say that the patterns of intensity found for the three conditions (cf. also Section 7.4 on average intensity) support the sequencing hypothesis, which regards cluster <w> as a sequence of coda <w> and onset <w>, and enable us to reject the other two hypotheses.

7.6 Average harmonicity

According to our predictions, harmonicity should have been around 10-20 dB for the onset type, and higher (closer to the 40 dB of [u]) for the coda type. Actually, the data show that both conditions display an average harmonicity of around 10 dB, even though the coda type presents a larger confidence interval, a greater degree of variability, and a larger interquartile range.

We also expected the cluster condition to present an intermediate average harmonicity, but this is also not the case: its average harmonicity is actually higher than the ones of the other two.

Table 24 lists the average harmonicity values, standard deviations, and confidence intervals for each of the three types, whereas Figure 14 offers a depiction of the distribution of the three groups through their quartiles.

Table 24: Average harmonicity as a function of type

Type	Average harmonicity (dB)	Standard deviation (dB)	Conf. int. (dB) (2.5% – 97.5%)
V#wV	10.24	3.751	8.823 – 11.38
Vw#V	10.70	5.340	7.883 – 12.65
Vw#wV	12.26	4.182	10.68 – 13.67

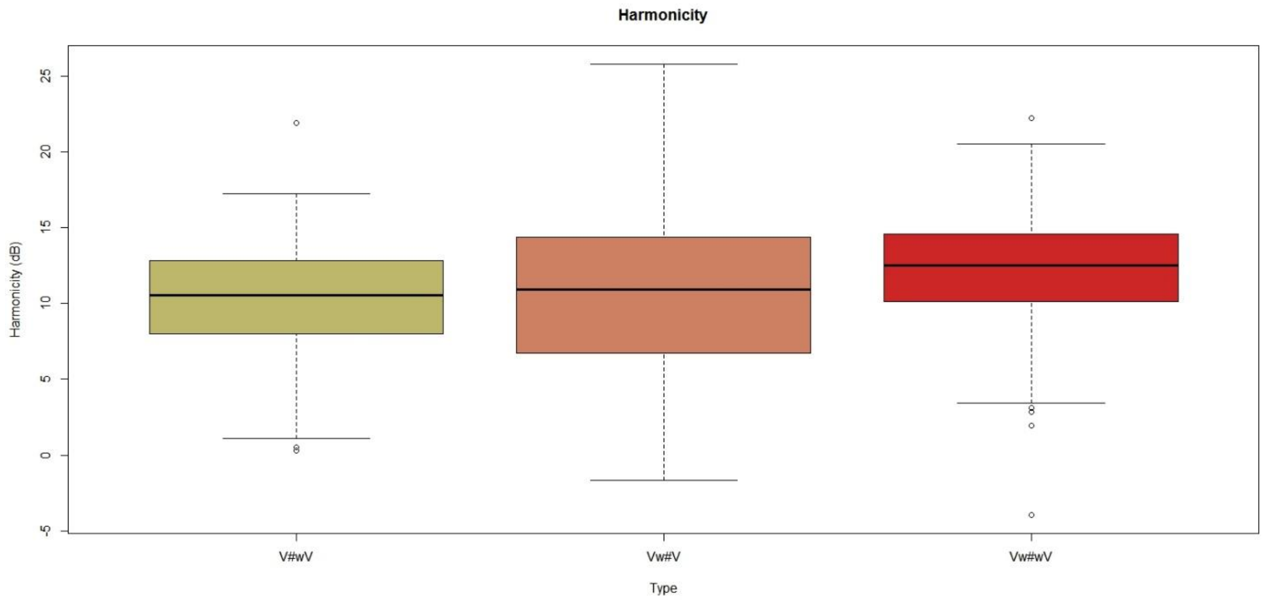

Figure 14: Average harmonicity as a function of type

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on average harmonicity is $5.92 \cdot 10^{-4}$ ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

7.6.1 Difference in average harmonicity between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity between onset and cluster are reported in Table 25.

Here, "(Intercept)" refers to the onset type, which acts as a reference: thus, the harmonicity estimate for the cluster type has to be read as "being 2.043 dB louder than the one for the onset type". The p value is quite low ($p = 0.4 \cdot 10^{-3} < 0.05$); therefore, we can regard the difference in harmonicity between onset and cluster as significant.

Table 25: Difference in average harmonicity between onset and cluster type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	10.13	0.656	15.40	8.776 –11.47	$0.4 \cdot 10^{-3}$
typeVw#wV	2.043	0.481	4.252	1.067 – 3.079	

It seems, thus, that Dutch speakers display a difference in terms of harmonicity in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.6.2 Difference in average harmonicity between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity between onset and coda are reported in Table 26.

Table 26: Difference in average harmonicity between onset and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	10.12	0.698	14.49	8.679 – 11.55	0.24
typeVw#V	0.634	0.535	1.184	-0.444 – 1.711	

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the harmonicity estimate for the coda type has to be read as "being 0.634 dB louder than the one for the onset type". The p value is not low enough ($p = 0.24 > 0.05$) for us to state the significance of our results.

7.6.3 Difference in average harmonicity between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity between cluster and coda are reported in Table 27.

Table 27: Difference in average harmonicity between cluster and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	12.12	0.822	14.75	10.43 – 13.80	0.03
typeVw#V	-1.242	0.564	-2.202	-2.361 – -0.130	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the harmonicity estimate for the coda type has to be read as "being 1.242 dB less loud than the one for the onset type". The p value is rather low ($p = 0.03 < 0.05$); therefore, we can regard the difference in harmonicity between cluster and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of harmonicity in the pronunciation of their intervocalic <w>s depending on whether these occur in coda position or as a cluster.

7.6.4 Average harmonicity: conclusion

Our data show that harmonicity is, on average, significantly higher in the cluster condition, and a little lower, and not significantly different, in the other two (whereas we expected those two to be very distinct, i.e. about 10-20 dB for the onset – which is what is indeed found – versus about 40 dB for the coda, cf. expectations no. 20 and 21). This does not seem to comply with the sequencing hypothesis and with our expectation that the average harmonicity of the cluster should appear as an average of the harmonicities of the other two conditions (cf. expectation no. 25).

7.7 Harmonicity fall

In our predictions, harmonicity should have shown negligible variations within onset and coda, and a more substantial fall within the cluster condition. Actually, the data show that harmonicity decreases a little in all conditions, with the cluster condition showing a fall intermediate between the other two types.

Table 28 lists the average harmonicity fall values, standard deviations, and confidence intervals for each of the three types. Note that the confidence interval for Vw#wV does not include zero, which means that the harmonicity movements are indeed significant for the cluster condition.

Figure 15 offers a depiction of the distribution of the three groups through their quartiles.

Table 28: Harmonicity fall as a function of type

Type	Average harmonicity fall (dB)	Standard deviation (dB)	Conf. int. (dB) (2.5% – 97.5%)	p value
V#wV	-0.618	3.834	-1.874 – 0.626	> 0.05
Vw#V	-3.399	4.537	-5.377 – -2.351	< 0.05
Vw#wV	-3.047	5.378	-4.720 – -1.537	< 0.05

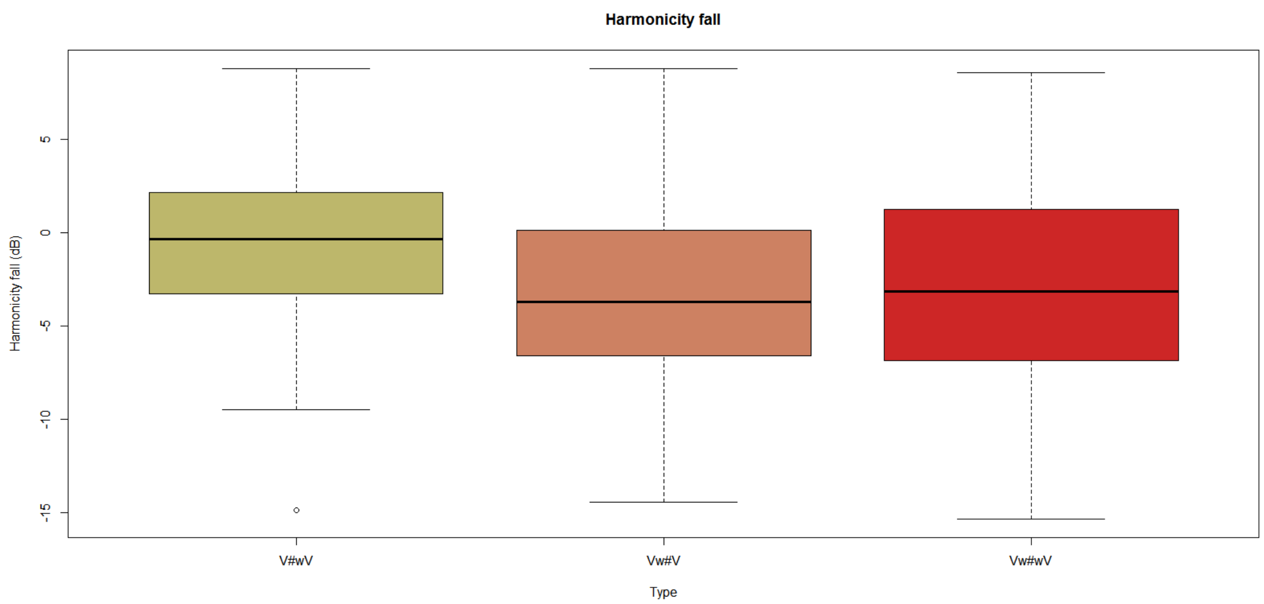

Figure 15: Harmonicity fall as a function of type

The omnibus p value obtained from the ANOVA testing the significance of the influence of type on harmonicity fall is 0.003 ($p < 0.05$), which allows us to perform Fisher's post hoc pair-wise comparisons.

7.7.1 Difference in harmonicity fall between onset and cluster type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity fall between onset and cluster are reported in Table 29.

Table 29: Difference in harmonicity fall between onset and cluster type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	-0.625	0.591	-1.059	-1.863 – 0.612	0.01
typeVw#wV	-2.495	0.885	-2.819	-4.346 – -0.657	

Here, "(Intercept)" refers to the onset type, which acts as a reference: thus, the harmonicity fall estimate for the cluster type has to be read as "being 2.495 dB less loud than the one for the onset type". The p value is rather low ($p = 0.01 < 0.05$); therefore, we can regard the difference in harmonicity fall between onset and cluster as significant.

It seems, thus, that Dutch speakers display a difference in terms of harmonicity fall in the pronunciation of their intervocalic <w>s depending on whether these occur in onset position or as a cluster.

7.7.2 Difference in harmonicity fall between onset and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity fall between onset and coda are reported in Table 30.

Table 30: Difference in harmonicity fall between onset and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% – 97.5%)	p value (ANOVA)
(Intercept)	-0.626	0.589	-1.064	-1.852 – 0.600	0.001
typeVw#V	-3.077	0.838	-3.674	-4.821 – -1.387	

Again, "(Intercept)" refers to the onset type, which acts as a reference: thus, the harmonicity fall estimate for the coda type has to be read as "being 3.077 dB less loud than the one for the onset type". The p value is quite low ($p = 0.001 < 0.05$); therefore, we can regard the difference in harmonicity fall between onset and coda as significant.

It seems, thus, that Dutch speakers display a difference in terms of harmonicity fall in the pronunciation of their intervocalic <w>s depending on whether these occur in onset or coda position.

7.7.3 Difference in harmonicity fall between cluster and coda type

The fixed effects, confidence intervals, and p value related to the role of type on the difference in terms of harmonicity fall between cluster and coda are reported in Table 31.

Table 31: Difference in harmonicity fall between cluster and coda type

	Estimate (dB)	Std. error (dB)	t value	Conf. int. (dB) (2.5% - 97.5%)	p value (ANOVA)
(Intercept)	-3.104	0.632	-4.908	-4.458 – -1.779	0.63
typeVw#V	-0.450	0.923	-0.487	-2.383 – 1.418	

Here, "(Intercept)" refers to the cluster type, which acts as a reference: thus, the harmonicity fall estimate for the coda type has to be read as "being 0.450 dB less loud than the one for the cluster type". The p value is not low enough ($p = 0.63 > 0.05$) for us to state the significance of our results.

7.7.4 Harmonicity fall: conclusion

Our data show that harmonicity decreases very little in all conditions, with the cluster condition showing a fall intermediate between the other two types; what was expected, instead, was a substantial fall in harmonicity only for the cluster condition (cf. expectations 22, 26, and 27).

Overall, the pair-wise comparisons do not seem to provide any support for the sequencing hypothesis as far as harmonicity in general is concerned (cf. also Section 7.6 on average harmonicity). The (falling) harmonicity movements in the cluster condition, however, are found to be significant, in that the confidence interval for Vw#wV does not include zero: this, at least, complies with the sequencing hypothesis, which regards cluster <w> as a sequence of coda <w> and onset <w>, and enables us to reject the other two hypothesis.

8. Conclusion

8.1 Intervocalic <w>

As far as the distribution of [w] and [ʋ] in intervocalic position is concerned, the present research has confirmed that, overall, we indeed find [w] in coda position and [ʋ] in onset position, as predicted (cf. expectation no. 1, Section 5.3); both the recordings and the spectrograms clearly show it, and the pair-wise post hoc comparisons also confirm it by displaying a significant difference in some expected direction between onset and coda for most of the investigated parameters.

8.2 Intervocalic cluster <ww>

The present research has provided solid empirical evidence that the assumed status of [w] and [ʋ] as allophones of a same phoneme in Dutch is, at the very least, debatable.

Among our three hypotheses, the sequencing hypothesis, i.e. that cluster <ww> should actually be regarded as a perfect, plain sequence of coda <w> ([w]) and onset <w> ([ʋ]), has been confirmed based on an acoustic analysis performed on the target cluster condition, on the one side, and on the two coda and onset "control" conditions on the other; the parameters considered in the acoustic analysis are duration, F2 (average F2 and F2 rise), intensity (average intensity and intensity fall), and harmonicity (average harmonicity and harmonicity fall). Especially crystalline with regard to the validation of the sequencing hypothesis are the measurements obtained for the cluster average duration, which has been found to be as long as the sum of the durations for coda and onset. The substantially rising or falling movements in F2, intensity, and harmonicity within the cluster condition, moreover, have also been found to be significant, which also complies with a hypothesis which claims a "compositional" nature for cluster Vw#wV.

But how does this "compositional" nature of cluster <w> help us answering the question as to whether [w] and [ʋ] are allophones of a same phoneme or rather different phonemes in Dutch? As previously mentioned in Section 4.1, phonologists have claimed that the phonological rule of degemination compulsorily applies to any set of prosodic words in Dutch as soon as a cluster of two identical consonants arises. Therefore, the fact that cluster <ww> is never realized as degeminated [w] or [ʋ], but always as a sequence [wʋ], in the prosodic words in our test, strongly suggests that either <w> is an exception to this rule, or coda [w] and onset [ʋ] are not the same phoneme in Dutch.

8.3 Consequences for the Dutch consonant system

If the results hereby presented were confirmed in further research on [w] and [ʋ], a "new" consonantal inventory of Dutch could (and should) be proposed, listing both /ʋ/ and /w/ as phonemes, and differentiating semi-vowels from spirant approximants. An inventory as such is presented in Table 32, to be compared with the consonant inventory by Booij (1995) displayed in Table 1 (Section 1).

Table 32: Proposal for a "new" consonant inventory of Dutch

	bilabial	labio-dental	alveolar	palatal	velar	labial–velar	glottal
plosives	p b		t d		k (g)		
fricatives		f v	s z		x ɣ		h
spirant approx.		ʋ					
nasals	m		n		ŋ		
laterals			l				
rhotics			r				
semi-vowels				j		w	

8.4 Suggestions for further research on [ʋ] and [w]

Under the heading "suggestions for further research" we would like to include both suggestions for improvement based on the methodological procedures we followed and the problems we faced, and unexplored questions to which our investigation could productively be extended.

As far as the suggestions for improvement are concerned, we have already mentioned the difficulties caused by the use of a text with such scarce punctuation as speech material (cf. Section 6.4): if more attention had been paid to this aspect, and, in general, to the revision and refinement of the text, many more target items could have been kept/spared and used in the analysis, instead of having to be excluded. Moreover, the quality of the results would have certainly improved through the exertion of a strict(er) control on the target items and their context, especially in terms of neighbouring (i.e. following) vowels, and stress. Accurately verifying the status of each of the target word clusters as prosodic words would also have helped.

As far as the unexplored questions are concerned, the first possible research question relates to the (hypothetical) peculiarities of -*ouw#w*- with respect to -*eeuw#w*-: as previously stated in Section 4, what we expect is that the realization of -*ouw#* and -*ouw#w*- would in some way be affected by the diphthongal status of <ou> in Dutch. Secondly, another interesting investigation would be to compare different groups of informants to see whether the occasional variations found in the pronunciation of coda [w] and onset [ʋ] (cf. Section 6.5) are systematic (rather than free) and dependent on sociolinguistics factors. A third option for further research would be to focus on coda [w] and verify whether its articulation is indeed labial–velar (as stated by Booij 1995) or bilabial (as stated by Gussenhoven 1999) by means of video recordings and subsequent measurings of lip breadth, lip distance, rounding, and pouching. Lastly, one final intriguing matter would be to empirically test whether degemination, which we assume here to be an obligatory phonological rule, actually acts as expected by Booij (1995; cf. Section 4.1) on undoubtedly attested phonemes of Dutch (e.g. /t/).

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Appendix

i. Speech material

Source: *Nader Verklaard*: *Sneeuwweetjes* and *Sneeuwstorm*, KNMI website (cf. References)

DINGEN DIE JE NOG NIET WIST OVER SNEEUW

24 februari 2013 – De huidige winterperiode heeft gemiddeld over het land al 16 sneeuwdekdagen opgeleverd tegen 11 sneeuwdekdagen normaal tussen november en maart (1981-2010). De laatste jaren lag er in de winterperiodes vaak sneeuw.

Zo telde de winter van 2010 43 dagen met een sneeuwdek en die van 2011 28. Heel anders dan de winters van 2007 en 2008, toen er op respectievelijk slechts 2 en 4 dagen sneeuw lag. In de winters 1989 en 1990 lag er slechts één dag sneeuw.

Sneeuw valt in ons land gewoonlijk weinig, landelijk op 30 dagen per jaar. Veel valt er meestal niet, en vaak is het natte sneeuw bij temperaturen boven nul. Een sneeuwlaag die dagen blijft liggen, komt nog minder voor. In sommige winters helemaal niet, maar meestal ligt er wel even sneeuw. In Zeeland en Zuid-Holland op 10 dagen per jaar, in het oosten van Groningen, Drenthe en op de Limburgse heuvels ligt in verschillende winters op zeker 25 dagen sneeuw. In het binnenland valt gemiddeld eens per 10 jaar meer dan 20 cm en eens per 50 jaar meer dan 35 cm. De vroegste datum met een sneeuwtapijt in De Bilt is 13 oktober (1975), de laatste 17 mei (1935). Sneeuwvlokken zijn ook in september of juni wel eens gezien.

Ontstaan van sneeuw

Vrijwel alle neerslag begint als sneeuw. Water van de aarde verdampt, gaat over in druppels en die vormen een wolk. Door verdamping van waterdruppels slaat de waterdamp neer op de nietige ijskristallen die reeds gevormd waren. De ijskristallen groeien steeds verder aan ten koste van de waterdruppels waardoor de ijskristallen steeds groter en zwaarder worden en op gegeven moment zullen gaan vallen. De ijskristallen verkleven nog verder met elkaar. De sneeuw(vlok) is dan geboren! Als de lucht op de aarde koud genoeg is, smelten ze niet en valt de neerslag als sneeuw of smeltende sneeuw.

Kleur van sneeuw

Waarom is sneeuw wit? In tegenstelling tot ijs is sneeuw wit, omdat sneeuw een minder dichte samenstelling heeft. Sneeuw bevat lucht, waardoor licht wordt weerkaatst. Bij sneeuw is de weerkaatsing voor alle kleuren gelijk en daardoor zijn de vlokken wit. Alleen tegen een donkere achtergrond, zoals een donkere lucht, lijkt sneeuw grijs.

Geluid van sneeuw

Door de lucht die sneeuw bevat werkt sneeuw als geluiddemper en het is dan veel stiller op straat. De toonhoogte van voetstappen in sneeuw is hoger bij lagere temperaturen. Bij temperaturen boven nul smelt de sneeuw onder de voetstappen en wordt smeltwater opgezogen. Vriest het meer dan vijf graden, dan wordt de sneeuw vrijwel geruisloos samengedrukt onder de voeten. Vriest het meer dan twaalf graden, dan kraakt de sneeuw wanneer je er over loopt, omdat je dan de ijskristallen stuk trapt. Dat geeft een knisperend geluid.

Afkoeling door uitstraling

Boven sneeuw, vooral boven verse sneeuw, koelt het 's nachts onder een heldere hemel sterker af dan boven een onbedekte bodem. Sneeuw, en vooral verse sneeuw, bevat veel lucht dat sterk isoleert. Daardoor kan het verschil in temperatuur tussen het bovenste laagje en de onderste sneeuw heel groot worden. De bovenste centimeters zijn het koudst, dieper in de sneeuw loopt de temperatuur op tot nul bij de aarde. Door de temperatuurverschillen in de sneeuw ontstaat een transport van waterdamp. Onderin de sneeuw is de druk het grootst zodat het watertransport van onder naar boven gaat. Als de damp vanuit de diepte in de toplaag komt, zal het vocht vastvriezen op het al aanwezige sneeuwijs en kan een korstje vormen. De aangroei van boven gaat ten koste van sneeuw beneden die verdampt.

Sneeuwpatronen

In sneeuw die op een terras valt is het legpatroon van de tegels bij temperaturen boven nul te herkennen. De eerste sneeuw smelt en het smeltwater loopt in de voegen. Daardoor koelt de voeg af tot het vriespunt en daar kan zich nieuwe sneeuw ophopen. Pas na een tijd is de ondergrond zo koud dat de sneeuw ook op de tegels blijft liggen. De laag is dan dunner dan op de voegen, waar de eerste vlokken ook al bleven liggen.

Gewicht van sneeuw

Vooral natte sneeuw kan problemen en gevaar opleveren voor daken, met name voor platte daken. Een kubieke meter poedersneeuw weegt 50 kilo. Dezelfde hoeveelheid samengedrukte plaksneeuw weegt zo'n 200 kilo en die hoeveelheid als natte sneeuw kan meer dan 500 kilo wegen.

Sneeuwstatistiek

Klimatologisch is weinig bekend over sneeuw. In vorige eeuwen kwam men niet op het idee een liniaal in de sneeuw te steken en pas halverwege de vorige eeuw begonnen de weerkundigen met het aanleggen van reeksen met sneeuwmetingen. In dagboeken uit de zeventiende en achttiende eeuw wordt wel vermeld of er sneeuw is gevallen en of dat veel was, maar indertijd gaf sneeuw voor de samenleving veel minder problemen dan tegenwoordig met het drukke verkeer. Paard en slee waren vroeger ideaal om een weg te banen door de sneeuw en de grootste problemen ontstonden pas als de sneeuw ging smelten. Juist op de modderige wegen was er geen doorkomen aan.

Driftsneeuw

Sneeuw levert vooral problemen op als het ook hard waait. Bij temperaturen onder het vriespunt stuift de sneeuw en die fijne stuifsneeuw kan door de kleinste kieren en gaten binnendringen, het zicht tot een paar honderd meter beperken en grote overlast veroorzaken. De van de grond opwaaiende sneeuw wordt driftsneeuw genoemd en daarbij wordt onderscheid gemaakt tussen lage en hoge driftsneeuw. Lage driftsneeuw stuift alleen dichtbij het aardoppervlak en hoge driftsneeuw beperkt het zicht ook op ooghoogte. Wanneer sneeuw wordt verwacht bij windkracht 6 of 7 geeft het KNMI een weeralarm uit voor sneeuwjacht. Bij windkracht 8 of meer en sneeuw geldt een weeralarm voor sneeuwstorm.

Smelten van sneeuw

Het smeltproces van sneeuw begint al bij de stenen waarop het valt. Die slorpen veel straling op en worden dus warmer. In een stedelijke omgeving smelt sneeuw ook sneller, omdat de neerslag door rook en stof is vervuild. Vuile sneeuw smelt dus sneller dan schone sneeuw.

Oudere sneeuw is niet zo wit als verse sneeuw en neemt meer zonlicht op dan[12] warmte. Vuiligheid verlaagt bovendien het smeltpunt en zorgt er voor dat de sneeuw eerder smelt, net als strooisel bij gladheid.

ii. Praat code

```
writeInfoLine ("label", tab$, "speaker", tab$, "type", tab$, "item", tab$, "duration", tab$,
                        "f2_25", tab$, "f2_75", tab$, "intens25", tab$, "intens75", tab$, "harm25",
                        tab$, "harm75")

# load file list
Create Strings as file list... list *.TextGrid

numberOfFiles = Get number of strings

for ifile to numberOfFiles
      select Strings list
      fileName$ = Get string... ifile
      name$ = fileName$ - ".TextGrid"

      appendInfoLine ("Working on file ", name$)

      # read in TextGrid (label) and Sound (wav) files
      Read from file... 'name$'.wav
      Read from file... 'name$'.TextGrid

      # create Formant object
      select Sound 'name$'
      speakerGender$ = mid$(name$, 4, 1)
      if speakerGender$ == "F"
            # for females
            noprogress To Formant (burg)... 0.001 5 5500 0.040 50
      else
            # for males
            noprogress To Formant (burg)... 0.001 5 5000 0.040 50
      endif

      # create Intensity object
      select Sound 'name$'
      noprogress To Intensity... 100 0.001 yes

      # create Harmonicity object
      select Sound 'name$'
      noprogress To Harmonicity (cc)... 0.01 75 0 4.5

      # work on intervals
      select TextGrid 'name$'

      numberOfIntervals = Get number of intervals... 1

      # loop through all the intervals
      for interval from 1 to numberOfIntervals
            select TextGrid 'name$'
            label$ = Get label of interval... 1 interval
            labelMisread$ = Get label of interval... 2 interval

            # if the interval has some text as a label and it was not misread, then calculate the
                        duration
            if label$ <> "" and left$(labelMisread$, 7) <> "misread"
                  start = Get starting point... 1 interval
                  end = Get end point... 1 interval
                  duration = end - start
                  pos25 = 'start' + ('duration' * 0.25)
                  pos75 = 'start' + ('duration' * 0.75)

                  select Intensity 'name$'
                  intens25 = Get value at time... 'pos25' Cubic
```

[12] A hypercorrection by one of the Dutch proofreaders: this word should have been “als”.

```
                intens75 = Get value at time... 'pos75' Cubic

                select Formant 'name$'
                f2_25 = Get value at time... 2 'pos25' Hertz Linear
                f2_75 = Get value at time... 2 'pos75' Hertz Linear

                select Harmonicity 'name$'
                ha_25 = Get value at time... 'pos25' Linear
                ha_75 = Get value at time... 'pos75' Linear

                # send to output
                speaker$ = left$(label$, 4)
                num$ = right$(label$, 2)
                type$ = mid$(label$, (length(speaker$) + 1), (length(label$) - length(speaker$)) -
                      (length(num$)))
                item$ = type$ + num$

                appendInfoLine (label$, tab$, speaker$, tab$, type$, tab$, item$, tab$,
                      fixed$(duration, 4), tab$, fixed$(f2_25, 3), tab$, fixed$(f2_75, 3), tab$,
                      fixed$(intens25, 3), tab$, fixed$(intens75, 3), tab$, fixed$(ha_25, 3),
                      tab$, fixed$(ha_75, 3))
          endif
      endfor

      # remove unneeded objects
      select Sound 'name$'
      plus TextGrid 'name$'
      plus Intensity 'name$'
      plus Formant 'name$'
      plus Harmonicity 'name$'
      Remove
endfor
```

iii. R code

```
# load library
library (lme4)

table <- read.delim (file.choose())

# summary statistics + boxplots
# duration
aggregate (formula=duration~type, data=table, FUN=mean)
aggregate (formula=duration~type, data=table, FUN=sd)
boxplot(table$duration~table$type, main="Duration", xlab="Type", ylab="Duration (sec)",
                        col=c("darkkhaki","lightsalmon3", "firebrick3"))
# f2
table$f2 = (table$f2_75 + table$f2_25) / 2
aggregate (formula=f2~type, data=table, FUN=mean)
aggregate (formula=f2~type, data=table, FUN=sd)
boxplot(table$f2~table$type, main="F2", xlab="Type", ylab="F2 (Hz)",
                        col=c("darkkhaki","lightsalmon3", "firebrick3"))
# f2rise
table$f2rise = table$f2_75 - table$f2_25
aggregate (formula=f2rise~type, data=table, FUN=mean)
aggregate (formula=f2rise~type, data=table, FUN=sd)
boxplot(table$f2rise~table$type, main="F2 rise", xlab="Type", ylab="F2 rise (Hz)",
                        col=c("darkkhaki","lightsalmon3", "firebrick3"))
# intensrise
table$intensrise = table$intens75 - table$intens25
aggregate (formula=intensrise~type, data=table, FUN=mean)
aggregate (formula=intensrise~type, data=table, FUN=sd)
boxplot(table$intensrise~table$type, main="Intensity fall", xlab="Type", ylab="Intensity fall
                        (dB)", col=c("darkkhaki","lightsalmon3", "firebrick3"))
# harm
table$harm = (table$harm75 + table$harm25) / 2
aggregate (formula=harm~type, data=table, FUN=mean)
aggregate (formula=harm~type, data=table, FUN=sd)
boxplot(table$harm~table$type, main="Harmonicity", xlab="Type", ylab="Harmonicity (dB)",
                        col=c("darkkhaki","lightsalmon3", "firebrick3"))
# harmrise
table$harmrise = table$harm75 - table$harm25
aggregate (formula=harmrise~type, data=table, FUN=mean)
```

```
aggregate (formula=harmrise~type, data=table, FUN=sd)
boxplot(table$harmrise~table$type, main="Harmonicity fall", xlab="Type", ylab="Harmonicity fall
                        (dB)", col=c("darkkhaki","lightsalmon3", "firebrick3"))
# intens
table$intens = (table$intens75 + table$intens25) / 2
aggregate (formula=intens~type, data=table, FUN=mean)
aggregate (formula=intens~type, data=table, FUN=sd)
table$type<-factor(table$type, levels =c("V#wV", "Vw#wV", "Vw#V"))
boxplot(table$intens~table$type, main="Intensity", xlab="Type", ylab="Intensity (dB)",
                        col=c("darkkhaki","firebrick3", "lightsalmon3"))

# post hoc pair-wise comparisons
# duration: whole dataset
model = lmer (duration ~ type + (1 | speaker) + (1 | item), table, REML = FALSE)
summary (model)
confint(model)
modelWithoutType = lmer (duration ~ (1 | speaker) + (1 | item), table, REML = FALSE)
summary (modelWithoutType)
confint(modelWithoutType)
anova (model, modelWithoutType, test = "Chisq")
# duration: subset onset+cluster
tableNoCoda = subset (table, type != "Vw#V")
model = lmer (duration ~ type + (1 | speaker) + (1 | item), tableNoCoda, REML = FALSE)
summary (model)
confint(model)
modelWithoutType = lmer (duration ~ (1 | speaker) + (1 | item), tableNoCoda, REML = FALSE)
summary (modelWithoutType)
confint(modelWithoutType)
anova (model, modelWithoutType, test = "Chisq")
# duration: subset onset+coda
tableNoGeminate = subset (table, type != "Vw#wV")
model = lmer (duration ~ type + (1 | speaker) + (1 | item), tableNoGeminate, REML = FALSE)
summary (model)
confint(model)
modelWithoutType = lmer (duration ~ (1 | speaker) + (1 | item), tableNoGeminate, REML = FALSE)
summary (modelWithoutType)
confint(modelWithoutType)
anova (model, modelWithoutType, test = "Chisq")
# duration: subset coda+cluster
tableNoOnset = subset (table, type != "V#wV")
model = lmer (duration ~ type + (1 | speaker) + (1 | item), tableNoOnset, REML = FALSE)
summary (model)
confint(model)
modelWithoutType = lmer (duration ~ (1 | speaker) + (1 | item), tableNoOnset, REML = FALSE)
summary (modelWithoutType)
confint(modelWithoutType)
anova (model, modelWithoutType, test = "Chisq")

# repeat for: f2, f2rise, intens, intensrise, harm, harmrise
# […]

# estimate main effects
# subset cluster
tableNoCodaNoOnset = subset(table, type!="Vw#V" & type!="V#wV")
model = lmer (f2rise ~ (1 | speaker) + (1 | item), tableNoCodaNoOnset, REML = FALSE)
confint(model)
model = lmer (intensrise ~ (1 | speaker) + (1 | item), tableNoCodaNoOnset, REML = FALSE)
confint(model)
model = lmer (harmrise ~ (1 | speaker) + (1 | item), tableNoCodaNoOnset, REML = FALSE)
confint(model)
# subset onset
tableNoCodaNoGem = subset(table, type!="Vw#V" & type!="Vw#wV")
model = lmer (f2rise ~ (1 | speaker) + (1 | item), tableNoCodaNoGem, REML = FALSE)
confint(model)
model = lmer (intensrise ~ (1 | speaker) + (1 | item), tableNoCodaNoGem, REML = FALSE)
confint(model)
model = lmer (harmrise ~ (1 | speaker) + (1 | item), tableNoCodaNoGem, REML = FALSE)
confint(model)
# subset coda
tableNoOnsetNoGem = subset(table, type!="V#wV" & type!="Vw#wV")
model = lmer (f2rise ~ (1 | speaker) + (1 | item), tableNoOnsetNoGem, REML = FALSE)
confint(model)
```

```
model = lmer (intensrise ~ (1 | speaker) + (1 | item), tableNoOnsetNoGem, REML = FALSE)
confint(model)
model = lmer (harmrise ~ (1 | speaker) + (1 | item), tableNoOnsetNoGem, REML = FALSE)
confint(model)

# repeat for: duration, f2, intens, harm
# […]
```

iv. Data

label	speaker	type	item	duration	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
M21PV#wV01	M21P	V#wV	V#wV01	0.0497	1390.717	1345.402	62.643	60.241	10.167	9.481
M21PV#wV02	M21P	V#wV	V#wV02	0.0369	1347.671	1282.349	68.628	68.568	8.197	8.762
M21PVw#wV01	M21P	Vw#wV	Vw#wV01	0.1169	1285.745	1218.301	69.664	63.016	16.695	5.753
M21PVw#wV02	M21P	Vw#wV	Vw#wV02	0.1258	1270.476	1156.635	68.613	58.568	12.292	9.148
M21PVw#V02	M21P	Vw#V	Vw#V02	0.0928	1232.347	1110.605	72.912	72.567	15.944	8.887
M21PVw#V03	M21P	Vw#V	Vw#V03	0.0735	1435.330	1357.955	72.386	72.139	20.857	18.050
M21PV#wV03	M21P	V#wV	V#wV03	0.0465	1310.569	1223.741	66.524	65.161	8.345	8.158
M21PVw#wV03	M21P	Vw#wV	Vw#wV03	0.1735	1044.223	1373.632	70.288	53.940	14.395	4.823
M21PVw#V07	M21P	Vw#V	Vw#V07	0.0540	1234.006	1027.336	70.334	69.749	11.747	12.003
M21PVw#V08	M21P	Vw#V	Vw#V08	0.0795	1219.076	1165.889	72.740	72.643	13.915	13.921
M21PVw#V09	M21P	Vw#V	Vw#V09	0.0643	1175.527	1003.274	69.380	68.252	12.656	6.680
M21PVw#V10	M21P	Vw#V	Vw#V10	0.0484	1201.125	970.553	68.583	68.438	11.534	8.022
M21PVw#V11	M21P	Vw#V	Vw#V11	0.0559	1112.836	990.870	70.157	70.280	13.223	8.033
M21PVw#wV05	M21P	Vw#wV	Vw#wV05	0.1097	1023.738	1060.986	69.001	64.743	15.412	9.292
M21PV#wV04	M21P	V#wV	V#wV04	0.0593	1005.515	1129.105	59.742	58.262	3.338	6.553
M21PVw#wV06	M21P	Vw#wV	Vw#wV06	0.1118	1014.276	877.887	71.638	69.698	13.546	13.365
M21PVw#V12	M21P	Vw#V	Vw#V12	0.0603	1191.859	1210.261	68.273	67.157	13.125	15.856
M21PV#wV05	M21P	V#wV	V#wV05	0.0587	1168.144	1121.842	65.567	65.232	6.330	9.795
M21PV#wV06	M21P	V#wV	V#wV06	0.0735	1099.598	1026.969	64.558	63.145	10.197	13.712
M21PVw#wV08	M21P	Vw#wV	Vw#wV08	0.1082	994.777	867.158	72.491	71.512	12.336	16.929
M21PV#wV07	M21P	V#wV	V#wV07	0.0511	1383.918	1378.122	60.870	59.744	8.734	7.853
M21PV#wV08	M21P	V#wV	V#wV08	0.0473	1388.006	1382.833	61.112	59.413	9.511	6.979
F32AV#wV01	F32A	V#wV	V#wV01	0.0308	1512.759	1399.623	65.195	64.460	14.293	13.331
F32AV#wV02	F32A	V#wV	V#wV02	0.0341	1439.181	1287.016	67.756	65.518	13.795	12.445
F32AVw#wV01	F32A	Vw#wV	Vw#wV01	0.1055	1098.556	1586.053	69.682	62.824	13.084	9.744
F32AVw#wV02	F32A	Vw#wV	Vw#wV02	0.1224	984.689	1925.125	68.471	62.144	14.897	21.259
F32AVw#V02	F32A	Vw#V	Vw#V02	0.0563	1403.373	1162.372	72.388	73.330	10.250	7.860
F32AVw#V03	F32A	Vw#V	Vw#V03	0.0577	1493.205	1085.831	71.116	70.066	14.926	6.755
F32AVw#V04	F32A	Vw#V	Vw#V04	0.0556	1346.012	981.849	71.478	69.754	14.952	9.988
F32AVw#V05	F32A	Vw#V	Vw#V05	0.0473	1392.391	1352.662	70.119	69.444	11.364	7.634
F32AVw#V06	F32A	Vw#V	Vw#V06	0.0567	1210.642	859.460	67.982	67.389	7.758	5.276
F32AV#wV03	F32A	V#wV	V#wV03	0.0468	1500.410	1413.008	62.697	63.690	11.568	13.314
F32AVw#wV03	F32A	Vw#wV	Vw#wV03	0.0857	1244.804	898.806	69.813	64.134	12.994	12.584
F32AVw#V10	F32A	Vw#V	Vw#V10	0.0369	1401.462	977.867	68.215	67.546	13.014	8.800
F32AVw#wV04	F32A	Vw#wV	Vw#wV04	0.0840	1220.885	1316.886	68.683	63.324	14.113	12.965
F32AVw#wV05	F32A	Vw#wV	Vw#wV05	0.1109	1275.542	1375.239	68.231	59.154	12.281	4.329
F32AV#wV04	F32A	V#wV	V#wV04	0.0476	1239.372	1396.041	61.751	60.142	9.806	4.586
F32AVw#wV06	F32A	Vw#wV	Vw#wV06	0.0963	801.227	2307.668	67.254	62.686	15.148	14.580
F32AVw#V12	F32A	Vw#V	Vw#V12	0.0470	1315.455	1043.142	67.245	65.458	14.550	16.450
F32AV#wV05	F32A	V#wV	V#wV05	0.0569	1544.458	1276.635	58.657	60.190	11.803	4.824
F32AVw#wV07	F32A	Vw#wV	Vw#wV07	0.0979	1010.059	2347.864	68.623	63.703	11.705	11.614

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
F32AV#wV06	F32A	V#wV	V#wV06	0.0425	950.970	931.220	64.936	64.194	10.733	14.528
F32AV#wV07	F32A	V#wV	V#wV07	0.0750	1376.995	1919.428	61.955	60.031	8.230	6.799
F32AV#wV08	F32A	V#wV	V#wV08	0.0681	1646.125	1517.085	67.656	67.542	11.464	9.718
F32AVw#V15	F32A	Vw#V	Vw#V15	0.0458	1584.303	1371.647	67.951	68.874	17.644	13.878
F32AVw#V16	F32A	Vw#V	Vw#V16	0.0503	1515.900	1413.449	67.003	66.359	13.380	11.539
M30EV#wV01	M30E	V#wV	V#wV01	0.0834	1228.340	1126.205	66.982	65.385	9.118	2.540
M30EV#wV02	M30E	V#wV	V#wV02	0.0801	809.370	892.658	73.574	73.773	10.635	13.392
M30EVw#wV02	M30E	Vw#wV	Vw#wV02	0.1227	2385.288	1007.897	69.581	66.115	2.331	3.938
M30EV#wV03	M30E	V#wV	V#wV03	0.0429	1053.474	1011.219	71.378	71.714	13.465	18.049
M30EVw#wV03	M30E	Vw#wV	Vw#wV03	0.0994	968.039	1019.937	70.498	64.936	12.136	9.901
M30EVw#V09	M30E	Vw#V	Vw#V09	0.0630	971.806	775.331	70.435	69.064	7.816	5.326
M30EVw#V10	M30E	Vw#V	Vw#V10	0.0563	2347.812	2393.968	72.849	69.095	7.524	2.100
M30EVw#wV04	M30E	Vw#wV	Vw#wV04	0.1185	2447.359	2255.392	71.959	60.219	12.846	7.344
M30EV#wV04	M30E	V#wV	V#wV04	0.0553	896.388	1022.227	64.873	62.356	-1.028	1.630
M30EVw#wV06	M30E	Vw#wV	Vw#wV06	0.1659	874.113	1141.518	70.167	57.788	13.108	5.659
M30EVw#V12	M30E	Vw#V	Vw#V12	0.0535	822.557	894.890	69.375	67.435	0.494	-3.799
M30EV#wV05	M30E	V#wV	V#wV05	0.0772	899.246	840.898	74.550	71.025	11.585	10.587
M30EV#wV06	M30E	V#wV	V#wV06	0.0568	1086.865	976.203	64.040	61.626	5.607	3.311
M30EVw#wV08	M30E	Vw#wV	Vw#wV08	0.1315	845.249	1311.603	71.303	61.425	7.576	-3.699
M30EV#wV07	M30E	V#wV	V#wV07	0.0700	1149.278	1222.646	66.585	63.200	17.255	2.394
M30EV#wV08	M30E	V#wV	V#wV08	0.0774	1157.528	1323.964	63.521	56.603	8.936	0.429
M30EVw#V15	M30E	Vw#V	Vw#V15	0.0619	2396.700	666.419	70.086	66.165	6.189	2.471
M30EV#wV09	M30E	V#wV	V#wV09	0.0469	1062.705	1238.861	64.948	65.569	12.861	9.210
F20MV#wV01	F20M	V#wV	V#wV01	0.0472	1939.575	1857.018	63.348	61.705	10.603	11.501
F20MV#wV02	F20M	V#wV	V#wV02	0.0512	1471.645	1411.271	65.524	63.572	11.461	9.539
F20MVw#wV01	F20M	Vw#wV	Vw#wV01	0.1267	1055.289	2701.333	69.808	63.140	8.376	11.254
F20MVw#wV02	F20M	Vw#wV	Vw#wV02	0.1758	1006.915	1187.324	67.585	60.987	16.094	10.010
F20MVw#V05	F20M	Vw#V	Vw#V05	0.0491	1126.208	1107.275	69.536	68.418	16.055	11.316
F20MV#wV03	F20M	V#wV	V#wV03	0.0503	1309.911	1349.644	63.091	64.015	13.020	12.626
F20MVw#wV03	F20M	Vw#wV	Vw#wV03	0.0952	1159.190	1144.369	71.272	58.209	12.665	9.588
F20MV#wV04	F20M	V#wV	V#wV04	0.0687	1222.416	1401.610	59.578	61.099	11.702	12.593
F20MVw#V12	F20M	Vw#V	Vw#V12	0.0718	1187.170	1167.476	66.347	64.717	12.344	8.894
F20MV#wV05	F20M	V#wV	V#wV05	0.0449	1408.851	1352.217	63.337	62.973	10.922	11.264
F20MV#wV06	F20M	V#wV	V#wV06	0.0822	2421.461	998.383	61.192	64.830	8.660	4.290
F20MVw#wV08	F20M	Vw#wV	Vw#wV08	0.1249	1096.490	911.967	71.528	63.386	12.588	13.813
F20MV#wV07	F20M	V#wV	V#wV07	0.0546	1578.054	1995.412	63.963	61.170	12.450	7.581
F20MV#wV08	F20M	V#wV	V#wV08	0.0725	1787.030	1920.560	61.658	58.540	12.111	3.811
F20MV#wV09	F20M	V#wV	V#wV09	0.0552	2501.719	1486.364	61.282	60.411	12.739	12.570
F29JV#wV01	F29J	V#wV	V#wV01	0.0600	1718.431	1636.167	69.185	65.033	13.536	10.543
F29JV#wV02	F29J	V#wV	V#wV02	0.0387	1294.664	1318.521	69.143	68.915	16.625	16.862
F29JVw#wV01	F29J	Vw#wV	Vw#wV01	0.1388	968.923	1237.035	70.084	63.543	12.777	14.945
F29JVw#wV02	F29J	Vw#wV	Vw#wV02	0.1307	1134.291	1359.350	67.598	63.105	10.559	19.113
F29JV#wV03	F29J	V#wV	V#wV03	0.0433	1425.432	1324.133	64.001	64.061	13.624	13.895
F29JVw#wV03	F29J	Vw#wV	Vw#wV03	0.0773	1142.915	1093.271	66.548	56.763	17.156	11.779
F29JVw#V11	F29J	Vw#V	Vw#V11	0.0532	1157.791	1051.142	67.433	64.989	17.400	5.948
F29JVw#wV04	F29J	Vw#wV	Vw#wV04	0.0835	1024.351	1271.822	71.985	63.441	14.897	6.646
F29JVw#wV05	F29J	Vw#wV	Vw#wV05	0.0916	877.807	1101.247	70.889	65.174	23.751	14.358
F29JV#wV04	F29J	V#wV	V#wV04	0.0574	1170.902	879.133	58.054	60.234	15.798	15.914

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
F29JVw#V12	F29J	Vw#V	Vw#V12	0.0759	1157.786	1161.073	68.051	65.035	19.228	19.318
F29JV#wV05	F29J	V#wV	V#wV05	0.0700	1113.701	1184.036	66.715	64.846	15.580	17.491
F29JVw#wV07	F29J	Vw#wV	Vw#wV07	0.1033	915.333	1012.486	68.969	59.270	12.053	15.772
F29JV#wV06	F29J	V#wV	V#wV06	0.0363	1234.405	1042.062	59.710	60.005	16.448	11.975
F29JVw#wV08	F29J	Vw#wV	Vw#wV08	0.0991	1040.469	971.236	71.584	65.877	16.823	11.132
F29JV#wV07	F29J	V#wV	V#wV07	0.0661	1404.940	1450.851	61.507	61.336	13.525	6.027
F29JV#wV08	F29J	V#wV	V#wV08	0.0372	1408.935	1405.259	65.073	64.447	13.754	8.835
F29JVw#V16	F29J	Vw#V	Vw#V16	0.0484	1179.813	1019.207	69.330	66.431	20.835	9.436
F29JV#wV09	F29J	V#wV	V#wV09	0.0556	1256.508	1323.175	63.734	62.057	11.213	16.314
F35CV#wV01	F35C	V#wV	V#wV01	0.0501	1222.622	1139.214	72.728	72.636	17.192	17.227
F35CV#wV02	F35C	V#wV	V#wV02	0.0521	1156.236	1090.360	69.585	71.326	9.963	13.393
F35CVw#wV01	F35C	Vw#wV	Vw#wV01	0.1237	1174.881	1218.381	76.416	69.818	26.181	18.241
F35CVw#wV02	F35C	Vw#wV	Vw#wV02	0.1346	1175.694	1220.713	75.944	69.964	18.438	18.608
F35CVw#V04	F35C	Vw#V	Vw#V04	0.0661	1318.703	1049.734	76.133	72.698	21.718	11.013
F35CV#wV03	F35C	V#wV	V#wV03	0.0512	1186.019	1133.483	71.308	70.401	11.526	13.685
F35CVw#wV03	F35C	Vw#wV	Vw#wV03	0.1146	1103.142	934.644	74.884	68.969	10.653	10.628
F35CVw#wV04	F35C	Vw#wV	Vw#wV04	0.1061	1211.232	1080.508	75.492	68.988	21.457	10.928
F35CV#wV04	F35C	V#wV	V#wV04	0.0508	1107.726	1288.067	70.663	70.274	13.772	11.593
F35CVw#V12	F35C	Vw#V	Vw#V12	0.0571	1260.405	1152.513	76.474	75.454	25.893	25.686
F35CV#wV05	F35C	V#wV	V#wV05	0.0622	1283.592	1308.985	72.113	70.960	9.825	14.902
F35CV#wV06	F35C	V#wV	V#wV06	0.0549	1055.383	1115.299	72.423	71.133	13.776	12.511
F35CVw#wV08	F35C	Vw#wV	Vw#wV08	0.1142	1113.117	907.227	76.305	70.803	17.031	12.121
F35CV#wV07	F35C	V#wV	V#wV07	0.0541	1600.229	1501.480	71.816	69.639	13.488	18.452
F35CV#wV08	F35C	V#wV	V#wV08	0.0707	1454.006	1642.718	72.367	69.813	13.659	7.275
F35CV#wV09	F35C	V#wV	V#wV09	0.0543	1251.379	1531.522	71.062	70.171	16.314	14.938
F41NV#wV01	F41N	V#wV	V#wV01	0.0576	2056.389	1704.717	66.359	57.491	14.359	5.031
F41NV#wV02	F41N	V#wV	V#wV02	0.0456	1272.520	1717.559	76.842	76.672	15.135	15.239
F41NVw#wV01	F41N	Vw#wV	Vw#wV01	0.1163	1196.111	1773.227	75.953	67.676	11.998	12.141
F41NVw#wV02	F41N	Vw#wV	Vw#wV02	0.1141	1026.700	1791.786	76.057	65.032	19.266	14.723
F41NVw#V03	F41N	Vw#V	Vw#V03	0.0619	1218.219	1084.710	79.113	76.777	16.867	9.328
F41NVw#V04	F41N	Vw#V	Vw#V04	0.0569	1330.087	985.981	79.211	77.259	13.855	7.917
F41NV#wV03	F41N	V#wV	V#wV03	0.0408	850.771	1694.726	73.855	73.396	13.319	14.105
F41NVw#wV03	F41N	Vw#wV	Vw#wV03	0.0883	1256.548	2121.088	79.586	67.392	12.564	7.235
F41NVw#wV04	F41N	Vw#wV	Vw#wV04	0.1340	1016.912	1140.132	78.465	69.194	17.047	20.079
F41NV#wV04	F41N	V#wV	V#wV04	0.0464	1052.740	1265.764	64.146	63.967	12.329	11.576
F41NVw#wV06	F41N	Vw#wV	Vw#wV06	0.1239	934.076	2008.949	78.029	66.254	15.454	13.976
F41NVw#wV07	F41N	Vw#wV	Vw#wV07	0.0733	907.268	2468.745	73.541	72.321	17.101	20.278
F41NVw#wV08	F41N	Vw#wV	Vw#wV08	0.1276	952.982	1343.656	77.539	73.372	13.555	11.714
F41NV#wV07	F41N	V#wV	V#wV07	0.0497	1821.714	1833.588	71.134	66.884	15.620	15.982
F41NV#wV08	F41N	V#wV	V#wV08	0.0501	1690.416	1706.235	70.644	68.994	12.644	13.427
F41NV#wV09	F41N	V#wV	V#wV09	0.0678	1504.593	1947.752	71.343	65.366	18.262	12.927
F27CV#wV01	F27C	V#wV	V#wV01	0.0558	1574.986	2055.287	64.499	63.352	10.135	5.079
F27CV#wV02	F27C	V#wV	V#wV02	0.0458	1534.013	1470.597	70.163	71.000	16.190	16.684
F27CVw#wV01	F27C	Vw#wV	Vw#wV01	0.1221	1112.368	1060.791	73.071	66.671	14.054	9.763
F27CVw#wV02	F27C	Vw#wV	Vw#wV02	0.1457	1125.311	1043.233	74.583	65.578	19.399	15.167
F27CV#wV03	F27C	V#wV	V#wV03	0.0483	1501.975	1435.974	65.653	65.632	13.579	13.240
F27CVw#wV03	F27C	Vw#wV	Vw#wV03	0.0967	1183.370	1048.940	70.419	61.477	13.761	7.586
F27CVw#V10	F27C	Vw#V	Vw#V10	0.0666	995.439	751.395	71.514	70.736	19.393	4.958

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
F27CV#wV04	F27C	V#wV	V#wV04	0.0401	1108.879	1394.546	63.793	65.075	4.346	6.732
F27CVw#wV08	F27C	Vw#wV	Vw#wV08	0.1110	957.600	1018.676	71.568	65.399	9.957	15.578
F27CV#wV07	F27C	V#wV	V#wV07	0.0538	2121.809	2087.603	62.732	57.905	7.889	15.323
F27CV#wV08	F27C	V#wV	V#wV08	0.0501	1440.663	2259.373	69.636	67.746	5.376	5.004
F27CV#wV09	F27C	V#wV	V#wV09	0.0528	1170.464	1342.248	69.280	68.970	15.440	11.493
F21EV#wV01	F21E	V#wV	V#wV01	0.0486	1471.074	1400.782	61.058	58.855	11.045	8.492
F21EV#wV02	F21E	V#wV	V#wV02	0.0376	1575.865	1530.578	72.620	73.214	12.504	16.251
F21EVw#wV01	F21E	Vw#wV	Vw#wV01	0.0970	1094.341	1290.252	66.561	62.332	14.651	10.459
F21EVw#wV02	F21E	Vw#wV	Vw#wV02	0.1100	1233.535	1197.237	65.683	59.546	16.983	10.137
F21EVw#V03	F21E	Vw#V	Vw#V03	0.0754	1629.046	1222.829	71.745	69.007	7.867	12.970
F21EVw#V04	F21E	Vw#V	Vw#V04	0.0497	1671.640	1121.368	65.795	65.512	10.004	4.888
F21EV#wV03	F21E	V#wV	V#wV03	0.0360	1263.872	1258.469	62.369	63.208	11.568	14.500
F21EVw#wV03	F21E	Vw#wV	Vw#wV03	0.1229	1085.838	1001.878	65.901	59.262	13.767	10.746
F21EVw#V08	F21E	Vw#V	Vw#V08	0.0757	1607.174	1273.459	71.799	67.787	18.778	9.941
F21EVw#V11	F21E	Vw#V	Vw#V11	0.0588	1876.045	1377.496	66.652	66.820	19.010	15.495
F21EVw#wV04	F21E	Vw#wV	Vw#wV04	0.1425	1239.247	1096.465	66.844	60.285	19.524	5.901
F21EVw#wV05	F21E	Vw#wV	Vw#wV05	0.1215	1263.802	1131.042	66.118	60.544	18.310	8.270
F21EV#wV04	F21E	V#wV	V#wV04	0.0582	1273.227	1352.678	60.476	59.694	22.199	21.542
F21EVw#V12	F21E	Vw#V	Vw#V12	0.0690	1318.988	1307.979	64.849	61.914	20.283	23.092
F21EVw#V13	F21E	Vw#V	Vw#V13	0.0649	1327.882	1389.589	65.336	63.607	12.335	14.387
F21EVw#wV07	F21E	Vw#wV	Vw#wV07	0.1513	1868.061	952.675	66.782	62.947	18.163	7.384
F21EV#wV06	F21E	V#wV	V#wV06	0.0591	1160.746	1007.851	66.439	65.612	11.230	10.547
F21EVw#wV08	F21E	Vw#wV	Vw#wV08	0.1066	1419.675	1001.271	69.222	63.790	14.665	7.760
F21EV#wV07	F21E	V#wV	V#wV07	0.0537	1266.981	1254.819	63.944	63.097	11.235	6.009
F21EV#wV08	F21E	V#wV	V#wV08	0.0503	1399.770	1511.858	64.757	65.089	12.626	6.642
F21EVw#V15	F21E	Vw#V	Vw#V15	0.0538	1449.042	1221.991	65.113	65.027	18.806	11.218
F21EVw#V16	F21E	Vw#V	Vw#V16	0.0817	1381.486	1287.499	63.418	62.212	12.392	21.162
F21EV#wV09	F21E	V#wV	V#wV09	0.0692	1234.184	1330.322	61.477	60.429	9.470	8.711
M22SV#wV02	M22S	V#wV	V#wV02	0.0387	1314.754	1222.791	68.753	70.062	4.216	5.821
M22SVw#wV01	M22S	Vw#wV	Vw#wV01	0.1313	1057.742	1130.761	71.401	64.006	9.394	10.807
M22SVw#wV02	M22S	Vw#wV	Vw#wV02	0.1371	1168.059	2685.173	67.194	55.069	13.469	2.178
M22SVw#V02	M22S	Vw#V	Vw#V02	0.0677	1349.994	925.166	67.985	64.407	14.181	10.703
M22SVw#V03	M22S	Vw#V	Vw#V03	0.0754	1235.212	998.907	72.567	73.608	-1.221	1.127
M22SVw#V04	M22S	Vw#V	Vw#V04	0.0567	1171.772	1074.082	69.767	69.936	10.339	1.077
M22SVw#V05	M22S	Vw#V	Vw#V05	0.0543	1356.443	1051.489	68.625	66.202	5.318	-0.162
M22SVw#V06	M22S	Vw#V	Vw#V06	0.0827	1064.803	795.725	69.494	63.780	11.604	2.941
M22SV#wV03	M22S	V#wV	V#wV03	0.0451	1277.806	1341.444	63.293	61.631	6.371	6.258
M22SVw#wV03	M22S	Vw#wV	Vw#wV03	0.0935	1125.035	891.820	69.203	63.993	10.683	6.611
M22SVw#wV04	M22S	Vw#wV	Vw#wV04	0.1315	1088.201	989.553	71.577	65.708	1.648	9.050
M22SVw#wV05	M22S	Vw#wV	Vw#wV05	0.1379	1040.674	1073.870	65.989	60.643	8.537	1.747
M22SVw#wV06	M22S	Vw#wV	Vw#wV06	0.1747	942.501	775.432	67.772	59.698	6.269	13.545
M22SVw#V12	M22S	Vw#V	Vw#V12	0.0558	1400.934	1044.388	69.452	68.492	8.821	4.900
M22SV#wV05	M22S	V#wV	V#wV05	0.0435	1306.305	1231.165	66.275	65.343	3.010	4.275
M22SVw#wV07	M22S	Vw#wV	Vw#wV07	0.1417	914.465	1196.001	69.102	58.671	14.569	12.293
M22SV#wV06	M22S	V#wV	V#wV06	0.0619	1132.414	1085.475	66.135	65.608	14.875	11.658
M22SVw#wV08	M22S	Vw#wV	Vw#wV08	0.1175	1089.941	861.059	71.151	68.821	11.281	13.529
M22SV#wV07	M22S	V#wV	V#wV07	0.0520	1597.987	1667.012	60.058	59.376	8.178	5.418
M22SV#wV08	M22S	V#wV	V#wV08	0.0509	1360.633	1492.705	63.114	62.732	8.554	5.317

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
M22SVw#V15	M22S	Vw#V	Vw#V15	0.0849	1335.357	994.360	69.365	65.651	9.016	-0.150
M22SV#wV09	M22S	V#wV	V#wV09	0.0466	1110.999	1432.293	61.243	64.290	5.100	2.959
F38TV#wV01	F38T	V#wV	V#wV01	0.0541	1423.745	1304.817	67.346	64.880	10.336	11.895
F38TV#wV02	F38T	V#wV	V#wV02	0.0392	1558.746	1569.877	70.907	71.277	9.836	14.000
F38TVw#wV01	F38T	Vw#wV	Vw#wV01	0.0980	1124.190	1166.868	74.648	70.282	21.614	12.816
F38TVw#wV02	F38T	Vw#wV	Vw#wV02	0.1455	1243.610	1032.071	73.799	67.981	17.634	18.683
F38TV#wV03	F38T	V#wV	V#wV03	0.0454	1446.712	1339.086	70.962	70.584	10.233	14.276
F38TVw#wV05	F38T	Vw#wV	Vw#wV05	0.1764	942.492	924.548	73.720	68.325	19.564	10.686
F38TV#wV04	F38T	V#wV	V#wV04	0.0431	1059.746	1246.863	64.586	64.691	11.017	8.695
F38TV#wV05	F38T	V#wV	V#wV05	0.0541	1581.689	1435.217	71.493	71.729	6.963	13.736
F38TV#wV06	F38T	V#wV	V#wV06	0.0652	1191.859	957.996	68.995	66.160	10.966	13.640
F38TVw#wV08	F38T	Vw#wV	Vw#wV08	0.2292	938.132	1002.266	77.377	68.549	15.350	8.986
F38TV#wV07	F38T	V#wV	V#wV07	0.0522	1721.337	1762.379	68.160	68.665	15.854	9.536
F38TV#wV08	F38T	V#wV	V#wV08	0.0588	1677.050	1827.395	70.828	68.853	12.098	8.788
F38TV#wV09	F38T	V#wV	V#wV09	0.0783	1198.101	1595.021	65.405	60.176	13.608	7.605
F46JV#wV01	F46J	V#wV	V#wV01	0.0489	1768.975	1711.382	68.974	70.246	11.392	7.486
F46JV#wV02	F46J	V#wV	V#wV02	0.0515	1103.966	1000.972	71.944	74.234	8.870	17.667
F46JVw#wV01	F46J	Vw#wV	Vw#wV01	0.1268	1135.716	1308.560	75.348	67.209	11.036	1.020
F46JVw#wV02	F46J	Vw#wV	Vw#wV02	0.1488	943.430	1692.598	73.807	61.078	10.561	16.005
F46JV#wV03	F46J	V#wV	V#wV03	0.0733	1281.663	1082.079	66.120	68.833	15.672	18.216
F46JVw#wV04	F46J	Vw#wV	Vw#wV04	0.1497	988.096	1093.484	72.439	67.208	19.027	4.121
F46JVw#wV05	F46J	Vw#wV	Vw#wV05	0.1023	1008.525	951.109	73.367	69.463	18.776	13.702
F46JV#wV04	F46J	V#wV	V#wV04	0.0487	928.199	1081.228	67.267	66.864	12.459	6.468
F46JVw#wV06	F46J	Vw#wV	Vw#wV06	0.0870	744.983	1604.730	70.592	67.287	11.448	11.714
F46JVw#V12	F46J	Vw#V	Vw#V12	0.0586	1226.656	1204.374	70.135	68.261	2.164	5.143
F46JV#wV05	F46J	V#wV	V#wV05	0.0566	1302.908	1086.416	71.540	70.730	8.747	12.478
F46JV#wV06	F46J	V#wV	V#wV06	0.0580	1338.026	995.990	77.874	73.488	5.884	2.036
F46JVw#wV08	F46J	Vw#wV	Vw#wV08	0.1336	1008.506	923.523	76.661	70.665	12.114	13.111
F46JV#wV07	F46J	V#wV	V#wV07	0.0504	1559.866	1456.761	65.820	63.715	8.367	10.745
F46JV#wV08	F46J	V#wV	V#wV08	0.0682	1564.096	1892.114	69.178	66.934	7.097	7.425
F46JV#wV09	F46J	V#wV	V#wV09	0.0703	991.207	1432.965	73.472	70.468	14.804	8.285
F50MV#wV01	F50M	V#wV	V#wV01	0.0588	1778.530	1549.166	64.390	64.652	12.011	8.657
F50MV#wV02	F50M	V#wV	V#wV02	0.0346	1375.484	1249.689	69.454	67.740	10.284	8.327
F50MVw#wV01	F50M	Vw#wV	Vw#wV01	0.1385	1037.650	1733.146	77.415	65.847	16.753	16.479
F50MVw#wV02	F50M	Vw#wV	Vw#wV02	0.1307	1165.733	1652.458	72.414	63.040	14.984	14.086
F50MVw#V05	F50M	Vw#V	Vw#V05	0.0607	1309.742	981.905	74.628	69.161	17.543	11.278
F50MV#wV03	F50M	V#wV	V#wV03	0.0505	1145.542	1107.360	70.303	69.563	11.631	14.354
F50MV#wV04	F50M	V#wV	V#wV04	0.0860	1156.912	1364.896	71.241	69.921	14.985	15.968
F50MVw#V12	F50M	Vw#V	Vw#V12	0.0561	1248.459	864.824	79.627	74.104	15.785	8.741
F50MVw#V14	F50M	Vw#V	Vw#V14	0.0727	1323.943	1179.127	74.652	69.318	16.836	7.790
F50MVw#wV07	F50M	Vw#wV	Vw#wV07	0.1345	841.089	1692.375	76.189	70.056	18.143	12.890
F50MV#wV06	F50M	V#wV	V#wV06	0.0502	1436.962	1307.291	68.148	70.222	12.924	15.050
F50MVw#wV08	F50M	Vw#wV	Vw#wV08	0.1229	844.472	1733.577	76.342	70.919	13.210	14.229
F50MV#wV09	F50M	V#wV	V#wV09	0.0457	1751.925	1833.510	67.132	67.530	12.207	8.114
M19MV#wV01	M19M	V#wV	V#wV01	0.0449	1634.156	1472.701	61.685	60.479	7.655	5.962
M19MV#wV02	M19M	V#wV	V#wV02	0.0467	1270.196	1161.416	72.092	77.136	4.873	11.228
M19MVw#wV01	M19M	Vw#wV	Vw#wV01	0.0951	997.126	1381.466	71.168	64.197	5.328	8.203
M19MVw#wV02	M19M	Vw#wV	Vw#wV02	0.1160	1190.179	1658.189	68.605	56.044	8.341	-2.603

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
M19MVw#V02	M19M	Vw#V	Vw#V02	0.0698	1221.394	965.731	71.596	64.191	6.905	-1.373
M19MVw#V03	M19M	Vw#V	Vw#V03	0.0553	1303.836	1197.302	78.339	76.003	7.834	9.333
M19MV#wV03	M19M	V#wV	V#wV03	0.0336	1194.121	1005.605	75.707	73.038	9.577	10.815
M19MVw#wV04	M19M	Vw#wV	Vw#wV04	0.0911	954.202	1223.662	66.581	57.481	-7.369	-0.538
M19MVw#V12	M19M	Vw#V	Vw#V12	0.0498	1256.037	1167.870	67.867	68.822	6.085	9.212
M19MV#wV05	M19M	V#wV	V#wV05	0.0406	1271.681	1218.554	66.667	67.778	0.372	1.844
M19MV#wV06	M19M	V#wV	V#wV06	0.0470	1079.661	925.647	69.226	68.134	-0.503	1.547
M19MVw#wV08	M19M	Vw#wV	Vw#wV08	0.0684	1246.736	793.762	71.466	69.908	10.885	3.544
M19MV#wV07	M19M	V#wV	V#wV07	0.0574	1424.573	1555.364	62.946	63.823	4.724	-0.182
M19MV#wV09	M19M	V#wV	V#wV09	0.0437	1516.575	1301.081	66.972	67.506	3.272	6.011
M21MV#wV01	M21M	V#wV	V#wV01	0.0445	1630.851	1505.978	68.079	68.129	3.597	8.445
M21MV#wV02	M21M	V#wV	V#wV02	0.0484	1262.616	917.679	68.594	69.676	12.425	13.317
M21MVw#V01	M21M	Vw#V	Vw#V01	0.0648	1075.796	907.914	75.007	74.369	16.770	12.373
M21MVw#wV01	M21M	Vw#wV	Vw#wV01	0.0868	1171.216	1102.690	75.181	69.790	15.520	9.698
M21MVw#wV02	M21M	Vw#wV	Vw#wV02	0.1362	1081.693	665.330	77.189	69.602	10.957	12.773
M21MVw#V02	M21M	Vw#V	Vw#V02	0.0844	1125.922	911.530	77.231	76.090	10.668	12.842
M21MVw#V04	M21M	Vw#V	Vw#V04	0.0485	1343.455	1189.216	77.120	77.071	13.217	14.693
M21MVw#V05	M21M	Vw#V	Vw#V05	0.0604	1352.858	1221.077	77.417	77.412	18.479	14.882
M21MVw#V06	M21M	Vw#V	Vw#V06	0.0588	1049.266	934.836	75.634	73.590	17.478	11.611
M21MV#wV03	M21M	V#wV	V#wV03	0.0398	1349.381	1171.092	74.178	74.975	9.798	12.866
M21MVw#wV03	M21M	Vw#wV	Vw#wV03	0.1564	991.380	798.668	76.482	66.818	21.343	15.829
M21MVw#V07	M21M	Vw#V	Vw#V07	0.0747	1065.184	852.772	76.165	72.406	16.919	9.975
M21MVw#V08	M21M	Vw#V	Vw#V08	0.0560	1468.510	1329.138	73.873	72.937	9.312	10.533
M21MVw#wV04	M21M	Vw#wV	Vw#wV04	0.0778	1354.551	1249.084	77.614	74.119	14.994	11.453
M21MVw#wV05	M21M	Vw#wV	Vw#wV05	0.0926	1285.766	1124.399	72.852	66.557	12.134	9.247
M21MVw#wV06	M21M	Vw#wV	Vw#wV06	0.1095	1055.597	979.146	75.717	75.554	19.491	20.720
M21MVw#V12	M21M	Vw#V	Vw#V12	0.0587	1300.620	1126.573	71.975	71.868	16.837	17.763
M21MV#wV05	M21M	V#wV	V#wV05	0.0615	1313.064	1183.587	68.696	67.262	10.373	10.971
M21MVw#wV07	M21M	Vw#wV	Vw#wV07	0.0678	1049.471	1072.904	76.446	75.884	13.336	14.078
M21MV#wV06	M21M	V#wV	V#wV06	0.0688	1081.026	965.747	67.971	69.362	13.400	15.536
M21MVw#wV08	M21M	Vw#wV	Vw#wV08	0.1092	1176.317	1024.290	75.944	76.691	6.996	8.457
M21MV#wV07	M21M	V#wV	V#wV07	0.0578	1477.821	1513.050	66.126	67.174	9.102	8.571
M21MVw#V15	M21M	Vw#V	Vw#V15	0.0804	1363.352	1051.930	78.165	75.974	13.692	4.480
M21MV#wV09	M21M	V#wV	V#wV09	0.0587	1280.797	1446.856	68.669	66.145	12.337	11.551
M24MV#wV01	M24M	V#wV	V#wV01	0.0674	1475.450	1303.328	72.722	66.938	9.405	6.100
M24MV#wV02	M24M	V#wV	V#wV02	0.0545	1150.591	1069.363	75.417	73.563	7.000	6.472
M24MVw#wV01	M24M	Vw#wV	Vw#wV01	0.0797	1136.880	1156.484	78.814	69.489	4.035	2.808
M24MV#wV03	M24M	V#wV	V#wV03	0.0464	1008.291	864.953	69.303	69.701	6.797	9.414
M24MVw#wV03	M24M	Vw#wV	Vw#wV03	0.1140	1079.242	913.241	71.701	65.557	8.755	10.484
M24MVw#V10	M24M	Vw#V	Vw#V10	0.0585	1164.082	911.292	73.985	73.289	1.116	1.699
M24MVw#V12	M24M	Vw#V	Vw#V12	0.0622	1251.504	1018.869	75.743	74.513	6.371	6.495
M24MV#wV06	M24M	V#wV	V#wV06	0.0755	969.422	878.333	68.897	66.075	5.871	7.967
M24MVw#wV08	M24M	Vw#wV	Vw#wV08	0.1150	986.247	1406.903	76.831	70.071	12.277	12.539
M24MV#wV07	M24M	V#wV	V#wV07	0.0559	1314.747	1608.256	65.994	67.213	7.319	4.579
M24MV#wV08	M24M	V#wV	V#wV08	0.0398	1398.744	1574.637	67.259	67.499	6.074	3.543
M24MVw#V15	M24M	Vw#V	Vw#V15	0.0642	1299.726	1070.561	72.208	71.271	5.076	2.556
M24MV#wV09	M24M	V#wV	V#wV09	0.0649	1098.095	1490.962	68.671	64.392	8.278	4.432
M26EV#wV01	M26E	V#wV	V#wV01	0.0571	1690.770	1443.191	69.480	65.000	10.350	11.021

label	speaker	type	item	dura-tion	f2 25	f2 75	intens 25	intens 75	harm 25	harm 75
M26EV#wV02	M26E	V#wV	V#wV02	0.0548	1491.562	1494.491	70.790	71.201	6.238	11.373
M26EVw#wV01	M26E	Vw#wV	Vw#wV01	0.1063	1042.043	1118.101	71.141	68.078	17.910	11.471
M26EVw#wV02	M26E	Vw#wV	Vw#wV02	0.1219	995.816	1107.854	69.415	60.450	9.110	0.340
M26EVw#V05	M26E	Vw#V	Vw#V05	0.0629	1358.177	1026.798	69.269	68.493	10.354	6.336
M26EV#wV03	M26E	V#wV	V#wV03	0.0470	1436.021	1396.373	68.520	69.546	11.244	14.801
M26EVw#V08	M26E	Vw#V	Vw#V08	0.0640	1255.554	976.662	72.293	71.092	17.445	17.488
M26EVw#V09	M26E	Vw#V	Vw#V09	0.0598	981.879	956.653	68.915	68.340	5.415	4.620
M26EVw#wV04	M26E	Vw#wV	Vw#wV04	0.1150	1019.642	953.841	71.353	68.766	18.346	3.001
M26EVw#wV05	M26E	Vw#wV	Vw#wV05	0.1492	970.648	1002.586	67.919	65.013	17.349	6.100
M26EV#wV04	M26E	V#wV	V#wV04	0.0537	1028.092	1238.278	63.144	64.327	13.014	8.892
M26EVw#wV06	M26E	Vw#wV	Vw#wV06	0.1527	878.798	1191.564	66.586	60.846	16.941	7.571
M26EVw#V12	M26E	Vw#V	Vw#V12	0.0867	1244.746	1027.239	66.723	66.256	3.282	0.062
M26EVw#wV07	M26E	Vw#wV	Vw#wV07	0.1489	1069.749	1519.038	69.645	63.339	16.910	16.731
M26EV#wV06	M26E	V#wV	V#wV06	0.0638	1353.738	1050.786	65.624	61.101	3.698	3.492
M26EVw#wV08	M26E	Vw#wV	Vw#wV08	0.1556	1014.970	1469.386	72.340	63.426	9.160	10.685
M26EV#wV07	M26E	V#wV	V#wV07	0.0770	1522.279	1669.879	64.122	67.274	6.823	10.717
M26EV#wV08	M26E	V#wV	V#wV08	0.0562	1530.625	1606.963	66.882	64.945	8.284	5.857
M26EV#wV09	M26E	V#wV	V#wV09	0.0628	1017.704	1459.695	65.477	64.790	8.536	8.330
F45MV#wV01	F45M	V#wV	V#wV01	0.0717	1713.494	2725.091	49.220	46.488	6.840	5.513
F45MV#wV02	F45M	V#wV	V#wV02	0.0516	1514.392	1339.618	64.586	61.574	6.565	2.731
F45MVw#wV01	F45M	Vw#wV	Vw#wV01	0.1807	1169.126	1940.182	69.346	55.108	8.429	11.010
F45MVw#wV02	F45M	Vw#wV	Vw#wV02	0.2002	1170.711	2522.771	67.282	49.500	13.402	10.284
F45MV#wV03	F45M	V#wV	V#wV03	0.0659	1382.208	1283.543	54.913	55.348	4.333	-1.380
F45MVw#wV04	F45M	Vw#wV	Vw#wV04	0.1317	1306.013	1404.994	67.208	56.872	6.156	9.919
F45MVw#wV06	F45M	Vw#wV	Vw#wV06	0.1705	1149.618	1663.784	72.081	59.889	13.976	17.396
F45MVw#V12	F45M	Vw#V	Vw#V12	0.0838	1317.189	1037.459	69.025	68.311	8.467	0.392
F45MV#wV05	F45M	V#wV	V#wV05	0.0649	1352.609	1560.640	61.883	58.409	8.322	9.371
F45MVw#wV08	F45M	Vw#wV	Vw#wV08	0.1218	1373.634	1036.667	70.349	65.078	12.574	6.247
F45MV#wV08	F45M	V#wV	V#wV08	0.0642	1619.267	1827.185	59.126	60.109	10.167	7.873
F45MVw#V16	F45M	Vw#V	Vw#V16	0.0538	1615.251	1581.865	66.273	62.719	2.265	6.882
F45MV#wV09	F45M	V#wV	V#wV09	0.0937	1537.350	1855.858	56.477	56.072	14.978	10.014
F29LV#wV01	F29L	V#wV	V#wV01	0.0461	1542.566	1884.496	69.008	67.128	14.416	13.998
F29LV#wV02	F29L	V#wV	V#wV02	0.0379	1504.197	1421.963	70.692	71.261	13.754	16.088
F29LVw#wV01	F29L	Vw#wV	Vw#wV01	0.2053	1084.690	1768.517	71.671	62.348	22.251	18.796
F29LVw#wV02	F29L	Vw#wV	Vw#wV02	0.1559	968.695	1653.635	71.625	63.674	16.742	20.150
F29LV#wV03	F29L	V#wV	V#wV03	0.0614	1604.817	1411.958	66.088	61.149	13.315	9.265
F29LVw#wV03	F29L	Vw#wV	Vw#wV03	0.1176	1215.046	1434.705	70.550	61.094	18.957	8.095
F29LVw#wV05	F29L	Vw#wV	Vw#wV05	0.1048	1174.881	1309.675	72.019	68.134	16.293	7.131
F29LV#wV05	F29L	V#wV	V#wV05	0.0452	1640.545	1425.849	63.828	61.556	9.231	10.523
F29LV#wV06	F29L	V#wV	V#wV06	0.0568	1258.954	1680.222	66.600	65.357	9.780	17.025
F29LVw#wV08	F29L	Vw#wV	Vw#wV08	0.1199	1145.742	1645.794	71.883	65.510	15.234	11.173
F29LV#wV07	F29L	V#wV	V#wV07	0.0425	1536.976	1808.889	66.324	63.440	14.911	5.430
F29LV#wV08	F29L	V#wV	V#wV08	0.0581	1639.846	1697.023	69.586	68.611	10.091	14.019
F29LV#wV09	F29L	V#wV	V#wV09	0.0674	1360.043	1654.059	67.361	66.312	11.367	14.180