



UNIVERSITY OF AMSTERDAM

**FRENCH SCHWAS ARE WEIRD**

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## Abstract

The literature describes the alternation of schwas in French in two different ways, depending on the nature of this segment. Morpheme-internally, this alternation is shown to be caused by deletion. In contrast to this, schwas at morphological junctures, such as at word boundaries, show a strong case for an epenthesis account. However, schwas in clitics show evidence for both accounts. This means that it is not clear from the literature which of the two processes could be behind the alternation in these cases. Previous research has shown that there might be a case of incomplete phonetic neutralization with clitic reduction. This thesis builds upon that research and measured duration and F3 values on segments surrounding the reduced schwa on sentences produced by native speakers of French. This data was then compared against a minimal pair to find differences. Additionally, two control conditions were measured to be able to attribute any differences to either schwa reduction or word boundary conditions. A regression analysis showed no significant correlation between duration and condition, and F3 values and condition at the group level. This result was reflected at the individual level.

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# 1 Introduction

This thesis looks at the lexicality of schwas in French clitics through the perspective of incomplete neutralization. In standard French, schwa – henceforth transcribed as [E], following the convention of Jetchev (1999) – seems to alternate between [œ] and [Ø] (Malécot & Chollet, 1977). A debated issue in the literature has been the question of whether or not French schwas are lexical. These schwas are frequently alternated with zero and it is not clear from the literature whether it is a process of deletion or epenthesis behind this phenomenon. There seem to be cases where schwas are definitively lexical, and cases where they seem to be added to utterances through epenthesis. Distributional evidence and minimal pair analysis have been at the core of these discussions to figure out certain types of schwas, namely those word-internally. However, for the case of French clitics, these proofs do not seem convincing enough (Côté & Morrison, 2007). Fougeron & Steriade (1997) and Barnes & Kavitskaya (2002) tried to find remnants of a schwa on surrounding segments that could indicate deleted schwas. The current thesis uses these previous experiments as a stepping stone to add evidence to the discussion of this topic. The current research looks at the case of French clitics in particular and tries to answer the question of whether these schwas are lexical through the lens of incomplete phonetic neutralization. The experiment presented in the current thesis, looks at the production aspect of this phenomenon.

The current thesis first looks at both defining incomplete neutralization with regards to the current topic and give background information about incomplete neutralization and vowel epenthesis. After this, it looks at how schwas behave in French, and if this behavior can be attributed to vowel deletion or epenthesis through previous literature. Then, the topics of incomplete neutralization and reduced schwas are combined to see if a case can be made for incomplete neutralization in French. Specifically, the case is made for clitics. The current thesis argues for a deletion account in schwas, and provides a method for testing this.

## 1.1 Incomplete neutralization and epenthesis

### 1.1.1 Incomplete (phonetic) neutralization

Traditionally speaking, incomplete neutralization is a phenomenon where two segments that differ in their underlying form collapse into a single surface form, while still being distinct in their acoustic, or phonetic, forms. This distinction should be measurable in production, but not so distinct that they are perceived as separate phonemic categories. Additionally, it has been shown that this distinction is also measurable at a group level (Ernestus & Baayen, 2003). Incomplete neutralization has been found in numerous different languages regarding different phonological phenomena. A well known case of this phenomenon is the case of incomplete final devoicing seen in for example German, Dutch and Polish (Port & O’Dell, 1985; Warner et al., 2004; Slowiaczek & Dinnsen, 1985). Here two different underlying forms, e.g. in German /d/ and /t/, collapse into a single surface form [t]. This part by itself is a form of neutralization. However, it was found that a vowel preceding an underlying voiced obstruent lengthens in German (Dinnsen & Garcia-Zamor, 1971). This vowel lengthening could not be explained by the surface forms, since these would have been collapsed to [t]. Port & O’Dell (1985) found that the vowel lengthening occurred, even with phonologically neutralized segments. They conclude that final devoicing in German is an incomplete neutralization, because the vowel lengthening they observed with word-final devoiced segments could only occur if the underlying segment had voice.

However, it could be seen that incomplete neutralization might not be the main culprit of the

phenomenon seen in the case of vowel length retention in German. Another possibility could be that an underlying /d/ is also [d] in the surface form, but is devoiced at the phonetic level, due to phonetic implementation. Du & Durvasula (2022) have also remarked this: “Under the categorical view of phonological representations, phonological neutralisation entails a change from one phonological category to another phonological category, while phonetic implementation does not result in any categorical changes.” (Du & Durvasula, 2022, p. 564). They claim that in the case of final devoicing, not enough evidence is given to show that an underlying /d/ is **phonologically** changed to the surface form [t]. The devoicing of this segment could also be attributed to phonetic implementation, at the phonetic level. In this case, the vowel length distinctions would still persist phonologically, without incomplete phonological neutralization. They show that in Huai’an Mandarin, there is a case of incomplete neutralization, shown through the process of tone sandhi. In this language, tone sandhi occurs in two different conditions. These are shown in (1).

- (1) 1. Low register tone sandhi:  
 (a) Tone 3 sandhi: T3 + T3 → T2 + T3  
 2. High register tone sandhi:  
 (a) Tone 1 sandhi: T1 + T1 → T3 + T1  
 (b) Tone 4 sandhi: T4 + T4 → T3 + T4

In their study they show that an underlying T3 tone and a surface T3 tone follow the same phonological processes through a feeding order, i.e. both tones can trigger a low register tone sandhi, regardless of if it is an underlying T3 or a derived T3. This derivation occurs through a high register tone sandhi in (1). An example of this is given in (2), with derived tones shown in boldface. Here, Du & Durvasula (2022) show that a derived T3 behaves phonologically as an underlying T3. However, when measuring the pitch contours, they show that a derived T3 is still phonetically distinct.

	UR	T3	T1	T1
(2)	Tone 1 sandhi	T3	<b>T3</b>	T1
	Tone 3 sandhi	<b>T2</b>	T3	T1
	SR	T2	T3	T1

The paragraph above demonstrates the importance of use and argumentation to determine if a phenomenon is due to incomplete neutralization at the phonological level, or due to phonetic neutralization at the phonetic level. The current thesis cannot determine the difference in these two terms due to there being no mechanism in French to distinguish between the two. Because of this, no stance will be taken here on whether the phenomenon presented is phonological or not, but instead only look at the phonetic results. The current thesis will therefore look at incomplete phonetic neutralization. This term encapsulates both incomplete phonological neutralization and phonetic implementation, where no conclusion can be made on which process affects the neutralization. The only factor that will be looked at is the homophony of acoustic forms. This is because French does not have any phonological systems in place where the presence of an underlying schwa triggers a specific phenomenon. Another process that might explain the alternation of French schwas is that of vowel epenthesis.

### 1.1.2 Vowel epenthesis

Vowel epenthesis is loosely defined as adding a vowel in an utterance. Implicitly, this means that the vowel is not present in the lexical or underlying forms, but rather is applied through a phonological

process. (*Lexical* and *underlying* are considered the same term for the purposes of this study.) In most cases, this means that a vowel is epenthesized phonologically, where an illegal consonant cluster appears underlyingly (Hall, 2011). This could be word-internally, as is the case in Lebanese Arabic (Abdul-Karim, 1980 as cited in Hall, 2011, p. 1576) or between words as in French (Grammont, 1922).

Another case where vowel epenthesis could happen is the case of bringing up a word to a minimal word size. Some languages have restrictions that a lexical word has to be at least two syllables or moras long. When the word is used in compounds, however, it can be seen that these restrictions are met by the compounding. An example for this is seen in Mono, a language spoken in Congo. It can be seen in (3) that a vowel is epenthesized to an underlyingly monosyllabic word, and in (4) that when a monosyllabic word is used in a compound, no vowel needs to be added (Olson, 2003 as cited in Hall, 2011, p. 1577).

- (3)  $\begin{array}{l} /ʒ̄i/ \quad \rightarrow \quad \bar{i}ʒ̄i \\ /b\grave{e}/ \quad \rightarrow \quad \grave{e}b\grave{e} \\ /m\grave{a}/ \quad \rightarrow \quad \grave{a}m\grave{a} \\ /nd\grave{a}/ \quad \rightarrow \quad \grave{a}nd\grave{a} \end{array}$
- (4)  $/m\grave{a}+nd\grave{a}/ \quad \rightarrow \quad m\grave{a}nd\grave{a}$

Finally, vowel epenthesis can occur because of metrical structure. In Dutch, this can happen in words like ‘tulp’ (tʏlp ~ tʏlɐp) *tulip* and ‘melk’ (mɛlk ~ mɛlɔk) *milk*. Vowel epenthesis here occurs due to rhythmic context. Whenever an epenthesized vowel would create an alternation between stressed and unstressed syllables, it was more likely speakers would opt for the insertion (Kuijpers & van Donselaar, 1998).

## 1.2 Schwas in French

The processes of deletion and epenthesis could explain the behavior of alternations in the case of French schwas. Côté & Morrison (2007) give three distinct groups of schwas, depending on whether they are lexical/underlying, epenthesized or show evidence of both. They noted that schwa-Ø alternation happens in five different contexts, which can be grouped into two broader categories. These are (i) morpheme-internally, and (ii) at morphological junctures such as: at word boundaries, at clitic boundaries, at affix boundaries and in compound words. If a schwa is lexical, it must be because it serves a role in lexical contrast. So if minimal pairs can be found, where the only difference is a schwa, it can be concluded that in that context, a schwa must be underlying. For the case of morpheme-internal schwas, this seems to be undoubtedly the case. For example, *pelouse* ‘lawn’ is able to alternate its morpheme-internal schwa between [pɛluz] and [pluz]. Contrasting this, *blouse* ‘blouse’ is not able to alternate between [bluz] and \*[bɛluz]. This inconsistency shows that a schwa is underlying in *pelouse*, and can be deleted, while not being present in *blouse*. The same logic has not been able to be replicated for other positions where schwas could occur, however. Schwas in other positions exhibit different alternations and pattern which could be explained by different mechanisms.

Schwas at word boundaries seem to have the strongest case for vowel epenthesis, rather than deletion. One of these cases is followed through the Law of Three Consonants (Grammont, 1922 as cited in Bayles et al., 2016, p. 3). The law states that when a consonant cluster of three consonants appears in French, a schwa must be added through epenthesis after the second consonant. Another

argument comes in the form of French filled pauses, where speakers use the [ɛ] as a filler word (Crible et al., 2017). This may be connected to a schwa at word boundaries.

Lexical contrast does not hold for word boundaries, morpheme boundaries or clitic boundaries. Word boundaries are subject to schwa epenthesis (Côté & Morrison, 2007). Words ending in two consonants and followed by another word starting with a consonant is subject to schwa epenthesis at the word-boundary. Clitics in French are comprised of a consonant and a following schwa. This means that these schwas cannot be lexically distinct, since the only distinguishing factor between the words in this group is the consonant. However, distributional and experimental evidence shows that they might not be epenthesized after all (Fougeron & Steriade, 1997; Hansen, 1994), as Section 1.3 exemplifies.

### 1.3 Incomplete phonetic neutralization in French schwas

Fougeron & Steriade (1997) discuss whether schwa deletion in clitics leads to lexical neutralization. They examined four conditions where they compared linguopalatal contact, lingual close duration, acoustic duration and frequency of lenition. These conditions examined are as seen in Table 1. These conditions were chosen to examine two factors. Firstly, they investigated whether certain characteristic properties remained when a schwa was reduced from its full clitic form  $C_e\#C$ , into a reduced form  $C'\#C$ . Secondly, they compared the reduced clitic form  $C'\#C$  to a minimal pair  $CC$  and looked at if they became identical after the loss of the schwa. To eliminate word boundary effects, they added a fourth condition in order to be able to subtract this from their findings between the reduced clitic and minimal pair conditions.

1	<i>il n'a pas de rôle</i>	“he has no role”
2	<i>il n'a pas d'rôle</i>	“he has no role”
3	<i>il n'est pas drôle</i>	“he is not funny”
4	<i>il voit l'jade rose</i>	“he sees the pink jade”

Table 1: Example of the stimuli used in Fougeron & Steriade (1997)

Their study found that in a  $C_1\#C_2$  environment, where the schwa has been deleted from a clitic, preceding a noun starting with a consonant, the  $C_1$  has significantly longer linguopalatal contact, a longer lingual occlusion and is less subject to lenition than expected if this was a complete neutralization condition. Additionally, it appeared that the vowel succeeding  $C_2$  in the schwa deletion context was also lengthened significantly by one of the speakers. However, this was only found in the condition comparing *de rôle* ‘NDEF role’ and *drôle* ‘funny’. The study also looked at a [kl] and [k#l] condition, however, no stimuli were presented in the paper. In this condition, no incomplete neutralization was found. The study looked at the production and perception aspects of this phenomenon, and some evidence was found for production, in the case of the [dʁ]/[dʁ̥] condition. However, in the perception part of their experiment they found that there was a higher-than-chance probability of selecting the correct option in the [dʁ̥]/[dʁ] condition, but the finding was not very strong, at 58%. For this, they recruited two participants of Parisian French, one male and one female. The article concludes that the clitic condition differs from word-boundary and word-internal conditions. This indicates that there might be a case of incomplete lexical neutralization, caused by the deleted schwa.

Needless to say, the study mentioned above is problematic due to a small participant pool and

lacking in stimuli, evidenced by only having two sets of test items, a lack of mentioning all of the test items used, and only having two participants.

## 1.4 The present study

The current thesis takes from, and improves upon the limitations of the research done before by Fougeron & Steriade (1997). By doing this, the current thesis will be able to say something about the state of French schwas, whether they are lexical or not, specifically in clitics. This is done through the lens of incomplete phonetic neutralization. This could lead to interesting findings, not only in the field of French schwas in clitics, but also gain insight into phonology more generally. More specifically the processes of deletion and insertion. This thesis will be able to add to the literature of these processes and try to develop a method of detecting deletion through the lens of incomplete phonetic neutralization. If a clitic in its reduced form shows evidence of the schwa, it could be concluded that a schwa is lexical and thus deleted. The current study focuses only on production. Through production, measurements can be made on the acoustic signal of produced utterances, which could reveal traces of incompletely neutralized schwas. The hypothesis is that there will be incomplete phonetic neutralization, stemming from the fact that these schwas are, in fact, lexical, and speakers try to compensate for the deletion of this vowel through affecting the surrounding segments. More specifically, the consonant of the schwa.

## 2 Methodology

The current experiment focuses on production and employs a similar method to the one used in the aforementioned article (Fougeron & Steriade, 1997). Four different conditions are examined. The four conditions are as seen in (5). These correspond to the conditions from Table 1.

- (5)
1. full clitic
  2. reduced clitic
  3. minimal pair
  4. word-boundary condition

The first and second conditions are compared against each other to examine if there are acoustic properties carried over from the  $Ce\#C$  condition to the  $C'\#C$  condition. The second and third conditions are compared against each other to see if a  $C'\#C$  sequence remains acoustically distinct from a  $CC$  sequence after the clitic has been reduced. The fourth condition will be considered as well to examine if a word boundary could be the cause of a difference between the  $C'\#C$  and  $CC$  sequences.

### 2.1 Stimuli

Part of the stimuli were taken from Fougeron & Steriade (1997). These include the stimuli seen in Table 1. Aside from these, more stimuli were created under the conditions mentioned above in (5). These stimuli were created with guidance of a native speaker. A full list of stimuli can be seen in Appendix A. All test items were, insofar possible, put in the same location in the sentence. Where this was not possible, it was still ensured that the test items would be in the same place per block of conditions. One block of conditions constitutes one of each of the four conditions seen in (5). This



was done to avoid any interaction that prosodic patterns, or any other factors that could influence the pronunciation or rate of speech of the test items. The experiment contained 20 test items and 20 filler items, as seen in Appendix A.

There were three tested consonant pairs sets. These were [dʁ], [st] and [tʁ]. There were two sets of items for the [dʁ] and [tʁ] pairs, and one set of items for the [st] pair.

## 2.2 Participants

Eight participants from metropolitan France were recruited, three male and five female. One male and one female participant were excluded from the experiment due to poor audio quality. The participants were adults at the time of recording, were healthy and have no diagnosed medical conditions impairing their hearing, reading or speaking. All of the participants were native speakers of a variety of French spoken metropolitan France. The only recorded information was the pronunciations of the stimuli. No other personal data, such as age or location were queried. The participants were assigned a random string of digits representing their participant ID. This string was only used to distinguish participants, and contained no information that could trace back to their identities.

## 2.3 Procedure

Participants were sent a link to a questionnaire, which was taken online. First the participants would view the consent form and information brochure. If they agreed to both of these forms, they would continue to the experiment. After these prerequisites, the experiment was presented. This took around 5-15 minutes to complete, depending on the reading speed and pace of utterance of the participant. The participants were presented with sentences, one at a time in a randomized order. At the same time a sentence would appear on screen, a recording was started and participants were asked to pronounce these sentences, after which they would press a button to stop the recording and proceed to the next item. In between sentences, a fixation cross appeared on screen for 500 milliseconds. This would give participants time to prepare for the next sentence, and give the recording enough time so no words would be cut off at the beginning of pronunciation. It was asked of the participants that they pronounce these sentences colloquially, as if they were speaking to a good friend or family member. To aid with this, the stimuli were written in informal or familiar French. During the experiment, the participants were free to leave the page and stop the experiment. This would delete their previous responses and exclude them from the research. Each item was shown once during the experiment.

## 2.4 Data analysis

After collecting the data, they were analyzed based on acoustic duration of the segment preceding the deleted schwa, and their F3 values, which could indicate residual lip rounding. The F3 values of the participants were normalized using Nearey's (1978) method (Voeten, Heeringa, & Van de Velde, 2022). The acoustic durations were first log-transformed. This was done because differences in durations are relative. After this, the log-transformed durations were also standardized per participant to compensate for individual variation within the individual audio recordings. Because of the standardization, group level analyses were possible. These analyses were chosen based on the findings of Fougerson & Steriade (1997) and Barnes & Kavitskaya (2002). Individual level and group level analyses were done and compared for duration and F3 through linear regressions. Two linear regressions were made. The first one compared the dependent variable duration to the condition

Table 2: Sumcontrasts for durations.

Factor	Estimate	Std. Err.	t-value	p-value
Intercept	< 0.001	0.090	0.000	1.000
1	0.059	0.156	0.379	.706
2	-0.172	0.156	-1.100	.272
3	0.046	0.156	0.294	.770

Table 3: Sumcontrasts for F3 values.

Factor	Estimate	Std. Err.	t-value	p-value
Intercept	< 0.001	0.014	0.000	1.000
1	-0.016	0.025	-0.646	.520
2	-0.008	0.025	-0.309	.758
3	-0.011	0.025	-0.447	.656

factor. The second one was executed in the same way, but compared the dependent variable F3 to the condition factor. Out of these linear regression a response variable can be predicted through two predictors, the intercept, and the sumcoded factor Condition. It is expected that F3 lowers in conjunction with an increase in duration in the second condition of (5),  $C_1\text{-}\#C_2$ . Because of this, correlation graphs could be made comparing these two values. With this correlation, it could be seen that if a schwa is deleted, and this could be measured through duration and F3, there would be a correlation between these two variables.

The speech was word-segmented for easier data processing, using Whisper (Radford et al., 2023). Through this, word by word transcription was automatically generated for the full sentences. After that, the sentences were trimmed to keep only the test items and surrounding words, leaving out the silences at the start and end of the audio recording and any words that are not directly adjacent to the test items. This audio was then segmented further into phonetic segments through the use of the Montreal Forced Aligner (McAuliffe et al., 2017). This way, specific phonetic segments could be targeted and measured. Through testing it was found that samples with words surrounding the test items provided better accuracy during phonetic segmenting. The test items,  $C_1$  in Section 1.3, were measured for duration and average F3. The durations were first log transformed, before being standardized. This was done per participant, which meant that each participant was standardized and could be compared at the group level. The F3 values were taken from the middle of  $C_1$ , after which they were normalized.

### 3 Results

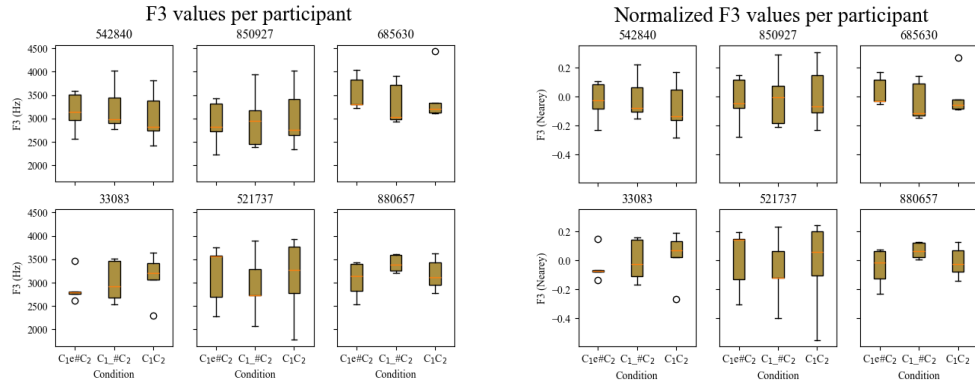
Figure 1a shows the F3 values per participant from the first three conditions of (5). The normalized F3 values per participant can be seen in Figure 1b. The F3 values varied a lot between participants and between conditions. For three of the participants, the first condition, the full clitic  $C_1e\#C_2$ , showed the lowest median F3 values, as expected through coarticulation effects with the following schwa. However, two participants did not share this effect, where their lowest F3 values were seen in the second condition, representing the  $C_1\text{-}\#C_2$  condition. The last participant had their lowest F3 value in the third condition,  $C_1C_2$ .

Figure 2 shows the durations per participant for each condition. For three of the participants, it can be seen that the item in the second condition, on average, was held for longer than in the third condition. For only one of the participants, this cannot be explained by word boundary effects. This means that the differences between the second and the third condition averages is not greater than the fourth condition averages.

Figures 1a, 1b and 2 show that there is a lot of individual variation both between participants and within participants. The biggest variation in F3 values within a participant and within a condition is seen in Figure 1. Participant 521737 in the  $C_1C_2$  condition has F3 values ranging from around 1780 to around 3900Hz for a range of around 2120Hz. In normalized terms this range is from around -0.55 to around 0.23 F3 (Nearey), for a range of 0.78. The smallest range in F3 values is seen in participant 33083 in the  $C_1e\#C_2$  condition. Excluding outliers, the F3 values range from around 2750Hz to 2800Hz for a range of around 50Hz. In normalized terms this range is from around -0.08 to around -0.07 F3 (Nearey), for a range of 0.01. For the durations, the largest variation within a participant within a condition is seen in Figure 2. This variation is seen in participant 33083 in the word boundary condition  $C_1\#C_2$ . Here the durations lie between around -2.03 and around 1.77 Log duration ( $z$ ), for a range of around 3.80. The smallest variation can be seen in participant 542840 in condition  $C_1\#C_2$ , where all of the normalized duration values lied between -0.11 and -0.12 Log duration ( $z$ ), excluding outliers.

The durations and F3 values are plotted against each other in Figure 3. In this figure, the coefficient of determination can also be seen for each participant. However, Figure 4 shows that the results depend on which  $C_1$  is selected for. In this Figure, only the data for the  $C_1 /d/$  is shown for all conditions. Here it can be seen through the line drawn by a linear regression analysis, that three of the participants exhibit a downward slope. This indicates that as the duration increases, the F3 decreases. This is in contrast to Figure 3, where none of the participants show this trend. In both Figures 3 and 4, none of the participants show a significant result.

Tables 2 and 3 show the linear regression analyses for the standardized and log-transformed durations and normalized F3 values for all participants combined. This data is also plotted in Figure 5. The duration plot shows that there is a difference between condition 2 and the intercept, albeit not a significant one ( $p = .272$ ). This means that condition 2 is not significantly different from the mean response value. The duration of condition 2 falls under the average, whereas the other three conditions fall above it. The F3 plot shows that there is no significant difference between all the conditions ( $.520 \leq p \leq .758$ ). However, the fourth condition, the word boundary condition  $C_1\#C_2$  has the highest average value. Figure 6 shows the group level data for durations and F3 values, similar to Figure 5, however, this figure shows the data before normalization and standardization, and the regression analysis.



(a) F3 values per participant.

(b) Normalized F3 values per participant.

Figure 1: F3 values and normalized F3 values per participant.

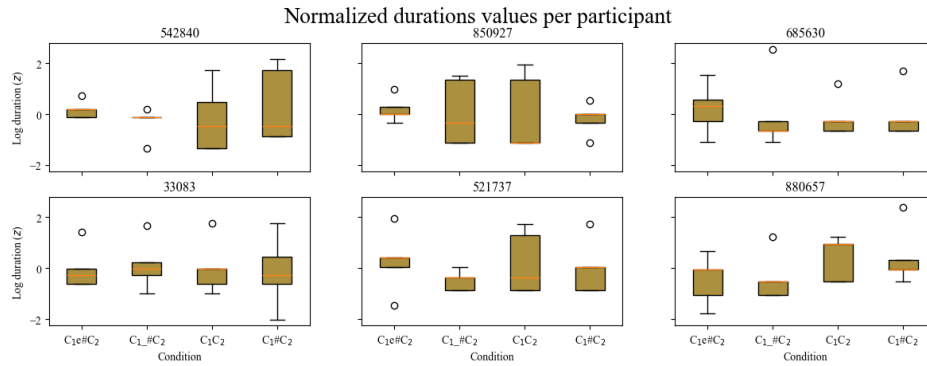


Figure 2: Standardized durations per participant.

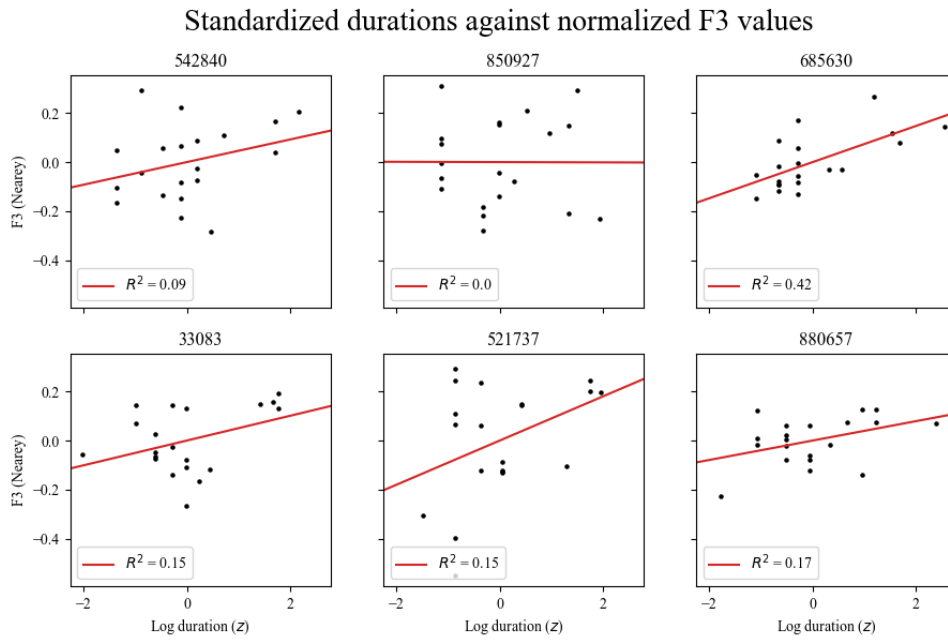


Figure 3: Standardized durations plotted against normalized F3 values with a regression line plotted in red. The coefficient of determination is given in the legend in the bottom-left.

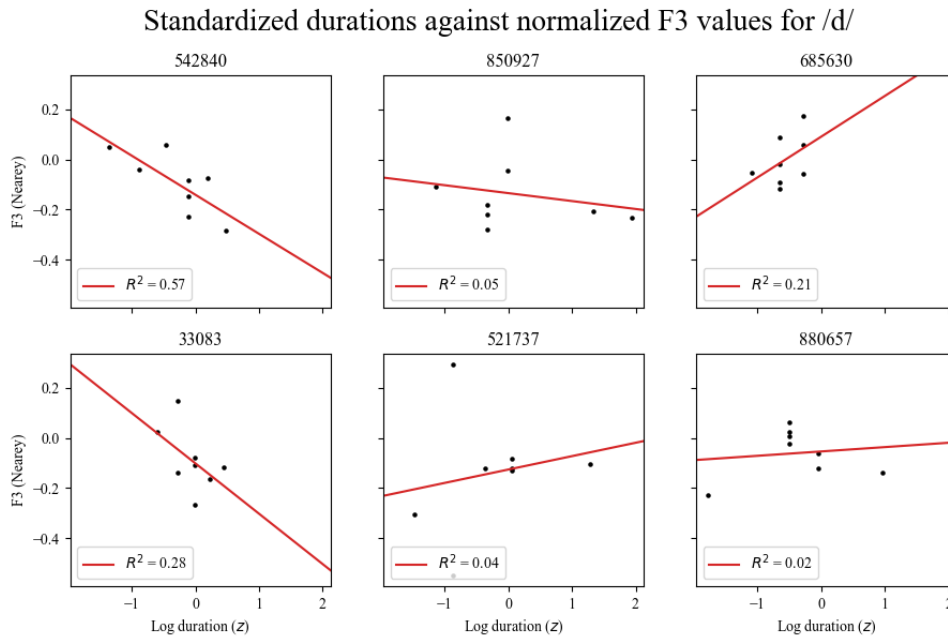


Figure 4: Standardized durations plotted against normalized F3 values including only the data with /d/ as  $C_1$  with a regression line plotted in red. The coefficient of determination is given in the legend in the bottom-left.

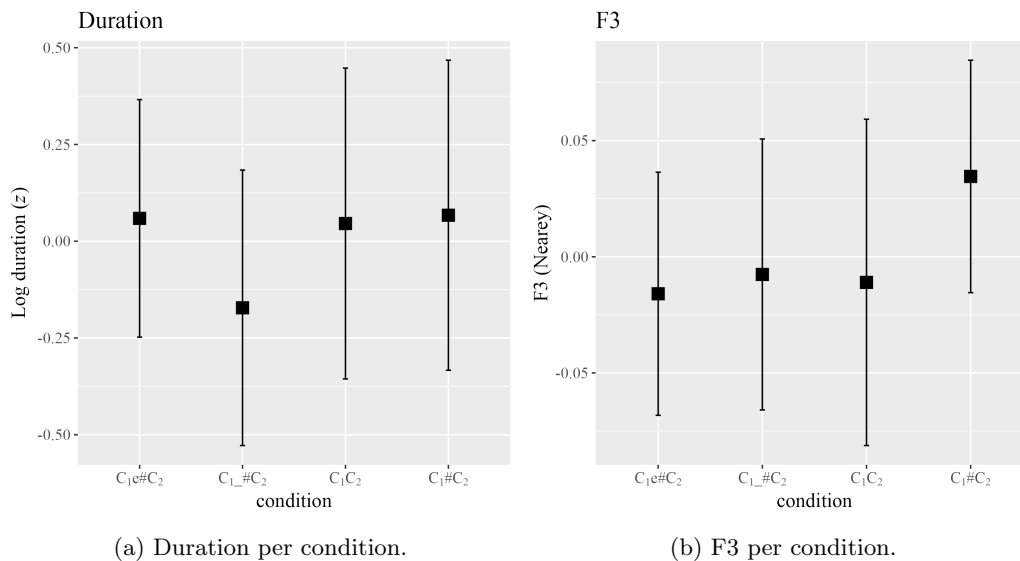


Figure 5: Linear regression analyses for duration and F3 for all participants. The points show the average values and the whiskers indicate where 95% of the data lies.

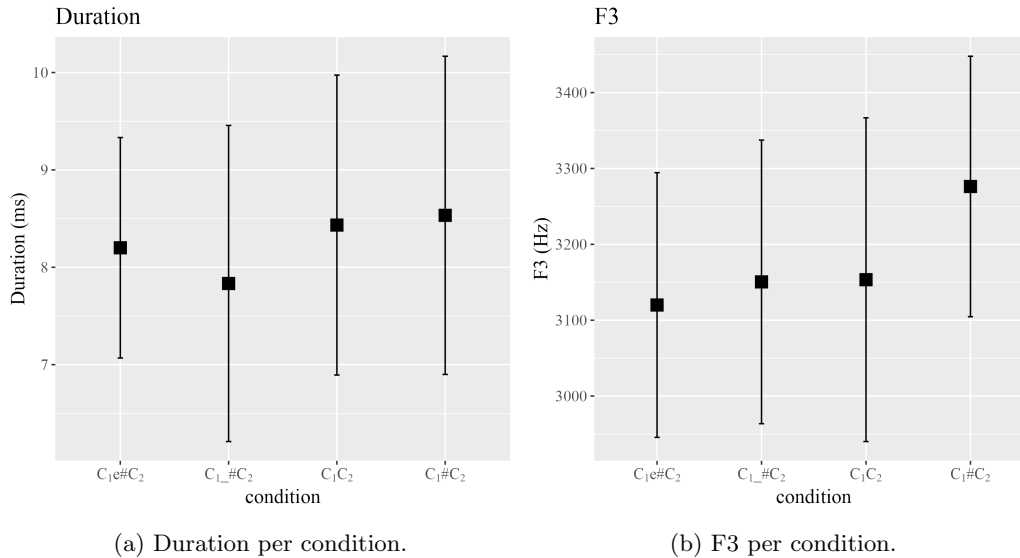


Figure 6: Group level data for duration and F3, before normalization and standardization. The points show the average values and the whiskers indicate where 95% of the data lies.

## 4 Discussion

The question that this thesis tried to answer was if schwas in French clitics are lexical. The results show inconclusive evidence for the hypothesis that they are lexical. The expectations were that the F3 would be lower and the durations would be longer for the second condition,  $C_1-\#C_2$ , but the results do not confirm this. The duration in the  $C_1-\#C_2$  condition was shorter than the other three conditions on average, however, not significantly so. Additionally, the F3 values were not significantly different between the first three conditions. This does not mean that there were no interesting findings, however.

Firstly, interesting to note is the polarity of the values seen in Figures 5 and 6. The hypothesis posited that the duration in the  $C_1-\#C_2$  condition would be greater than in the  $C_1C_2$  and than in the  $C_1\#C_2$ , indicating that the lengthening cannot be attributed to the word boundary alone, and thus had to have been influenced by the deletion of the schwa in the clitic. What is seen in the figures, however, is that the duration in the  $C_1-\#C_2$  condition is shorter than in the other three conditions. This means that even if the results had been significant, they would not have supported the hypothesis. A similar story can be told about the F3 values, where it was expected that the full schwa and reduced schwa conditions,  $C_1e\#C_2$  and  $C_1-\#C_2$ , would group together, exhibiting a lower average F3 value than the minimal pair and word boundary conditions,  $C_1C_2$  and  $C_1\#C_2$ . As with the durations, even if the results were significant, this would not support the hypothesis.

The high F3 values seen in Figures 5b and 6b in the  $C_1\#C_2$  condition are notable. This could have been caused by the selection of test items, as in this condition all of the test items were noun-adjective pairs, as opposed to the clitic-noun pairs of the first two conditions,  $C_1eC_2$  and  $C_1-\#C_2$  or the nouns in the third condition,  $C_1C_2$ . In the fourth condition,  $C_1\#C_2$ , it could be the case that a noun-adjective pair influences the word boundary differently than a clitic-noun pair, leading to

a difference in F3 values.

Secondly, another interesting finding of this thesis is found in Figure 4. Here it can be seen that only selecting for /d/ in the  $C_1$  position reveals a different picture than the overall results in Figure 3. Fougeron & Steriade (1997) found a non-significant result pointing to the lexicality of schwas in French clitics, which could be explained by the selection of the  $C_1$  context. In this study, they found that the first and second conditions,  $C_1eC_2$  and  $C_1-#C_2$ , share spatial, temporal and intergestural timing characteristics, which were not found in the third and fourth conditions,  $C_1C_2$  and  $C_1#C_2$ . These characteristics were shown by measuring linguo-palatal contact, lingual close duration, acoustic duration and frequency of lenition. They found that each pair of conditions, namely the first and second conditions, and the third and fourth conditions, paired together in their results. The first and second condition showed longer linguo-palatal contact, longer lingual occlusion and a lower frequency of lenition compared to the other two conditions. This could be explained by unknown factors influencing the duration and F3 values for this specific phoneme in this context. These findings, along with the findings shown in Figure 4 could indicate that there are factors influencing these measurements that are inherent to the [dʁ] sequence in French clitics specifically. Careful consideration of specific test items and inclusion of all different possible contexts are vital for a future experiment investigating French schwas. Additionally, future exploration on the factors influencing F3 values and duration in the context of clitics in French could lead to findings that would explain the findings in this thesis.

While the current thesis did not find any significant results, this could have been the result of limitations that were present throughout the experiment. Firstly, after reviewing the audio recordings, half of the participants seemed to not have followed the instructions. They would read the sentences out loud, as if reciting, rather than speaking to a friend. This could have influenced the results as this manner would resemble careful speech more than spontaneous speech. This lack of task adherence by half of the participants could have been a consequence of the online nature of this experiment. Both Fougeron & Steriade (1997) and Barnes & Kavitskaya (2002) performed in-person experiments, where conveying the methods would have been easier to communicate to the participants. Further research into this topic could benefit from a different approach that is more conducive for eliciting natural speech. Interviews or corpora that include natural speech could be great resources to examine this phenomenon further. Eliciting natural or spontaneous speech could come with its own problems, for example, participants could speak in unpredictable ways, making it difficult to elicit the desired test items. Additionally, spontaneous utterances vary in length and content, also making it difficult to produce or recreate desired test items. A solution for this could be in the form of interactive tasks (Ito & Speer, 2006).

Secondly, previous literature has also looked at linguo-palatal contact, lenition, lingual occlusion (Fougeron & Steriade, 1997) and lip-rounding (Barnes & Kavitskaya, 2002). This thesis attempted to approximate some of these measurements through duration and F3. These approximations might not have enough influence over the coarticulation factors that are present when a schwa is deleted. Wieling et al. (2016) show that acoustic measurements are imperfect in reconstructing articulatory movements through formant values. They show that there is no one-to-one correspondence between F1 and F2 that are measured through audio recordings, and the actual position of the tongue. They highlight that there are more factors that could influence the values of F1 and F2, such as tongue body shape and lip-rounding. The influence of other factors seen in the formant values could also extend to F3. To investigate the relation of lip-rounding and a deleted schwa, articulatory measurements could provide a better insight into the movements of the lips than audio recordings.

Future research should also look into the perception side of this question. This could help



answer if the schwas in clitics are lexical, or if this would lead to perceptual lexical neutralization with minimal pairs such as in condition 2 and 3 in Table 1. Fougeron & Steriade (1997) found non-significant evidence that the reduced clitic is perceived as distinct from a minimal pair. Their participants were able to distinguish these two conditions from each other correctly 58% of the time. This is in line with other research that has been done on incomplete neutralization, such as in Dutch (Ernestus & Baayen, 2003). A follow-up study confirming these results in the case of schwas in French clitics would increase the validity of these results.

## 5 Conclusion

The current thesis attempted to verify the lexicality of schwas in French clitics by examining duration and F3 effects surrounding a reduced schwa. Earlier research into the lexicality of schwas in French clitics showed inconclusive evidence. On one hand, Fougeron & Steriade (1997) and Barnes & Kavitskaya (2002) show evidence for surrounding segments being affected by a reduced schwa. They measured linguo-palatal contact, lenition, lingual close duration and lip rounding. Additionally, Fougeron & Steriade (1997) also tested perception and found a non-significant result supporting the hypothesis that schwas in French clitics are indeed lexical. On the other hand, there are arguments that can be made that these schwas are not actually lexical.

The methodology of the experiment was inspired by Fougeron & Steriade (1997) and contained four conditions, 1. full clitic, 2. reduced clitic, 3. minimal pair and 4. word boundary condition, seen in (5). The main comparison was done between condition 2 and condition 3, through duration and F3 measurements. Any differences that are seen in these two conditions are then compared to conditions 1 and 4 to see if these differences could have been attributed to the word boundary or full clitic. The results showed inconclusive evidence for the lexicality of clitics in French schwas. The implications of these insignificant results are that the schwas that are present in French clitics might not be lexical. Another option could be that these schwas are lexical, however no incomplete phonetic neutralization takes place. This could be the result of complete neutralization of these schwas, where they alternate with the zero morpheme. This would support the argument of lexicality, where it is posited that schwas are present in these clitics in their citation form (Tranel, 2018 as cited in Côté & Morrison, 2007, p. 165). Côté & Morrison (2007) argue that there is little evidence for the case of incomplete neutralization in prosodic-word internal schwas, exhibiting complete neutralization instead. These schwas are lexical, as they provide lexical contrast. The literature shows that there is a lot of individual variation while verifying the lexicality of schwas in French (Côté & Morrison, 2007; Rialland, 1986 as cited in Côté & Morrison, 2007, p. 182). This is corroborated in the current experiment, which could mean that the lexicality of schwas in French is an ongoing change and only lexical for some speakers. This is reflected in the large individual variation seen in the results of this thesis, which was also present after normalization and standardization of the data. If schwas are, in fact, lexical, then this thesis shows that the lexicality of these schwas cannot be measured through the methods presented. In conclusion, this thesis does not show definitive evidence for schwas in French clitics to be lexical segments that are subject to a deletion process. The presence of these schwas could not be explained through the lens of incomplete phonetic neutralization, and therefore could alternate completely with the zero morpheme or not be present in the lexical forms.

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## Appendices

### A Full list of stimuli

Condition	Sentence
1	il a pas de rôle
2	il a pas d'rôle
3	il est pas drôle
4	il voit l'jade rose
1	tu veux te raser
2	tu veux t'raser
3	tu veux le tracer
4	tu vois la tête ronde
1	ya pas de roi
2	ya pas d'roi
3	il a pas le droit
4	il approche la pyramide rouge
1	on se toque de qqch
2	on s'toque de qqch
3	on stocke qqch
4	l'once testée
1	tu te roules
2	tu t'roules
3	tu trouves
4	la lutte roumaine
fill	je fais une randonnée
fill	il a pas d'argent
fill	elle m'a abandonné
fill	ya un grand pont
fill	je me suis trompée
fill	la carte de France
fill	le ballon lourd
fill	elle a pas d'lunettes
fill	elle a pas de lunettes
fill	tu veux pas te laver
fill	tu veux pas t'laver
fill	il mange le melon
fill	elle boit d'un coup
fill	il a pas le premier
fill	il a pas l'premier
fill	le garçon principal
fill	tu me dit
fill	tu m'dit
fill	ya pas de cirque
fill	ya pas d'cirque

Table 4: All stimuli used in the experiment of this thesis. A list of conditions can be seen in (5).

## B Information brochures



UNIVERSITY OF AMSTERDAM

### Information brochure

#### B.1 Information brochure in English

Dear participant,

You will be taking part in a research project conducted by Michel van Hoof, under supervision of Cesko Voeten at the University of Amsterdam. Before the research project can begin, it is important that you read about the procedures we will be applying. Please make sure to read this brochure carefully.

##### **Purpose of the research project**

This study will look at specific sounds in French. The exact details of the purpose of the study will be shown at the end of the experiment.

##### **Who can take part in this research?**

Participants should be native speakers of French. The only other requirement is that the participants are adults, i.e. 18 years or older. I also need to make sure that you do not — to the best of your knowledge — have any language problems such as dyslexia or a specific language disorder.

##### **Instructions and procedure**

First you will be asked to read the information brochure and the consent form thoroughly. After this a sentence will appear on the screen, and an audio recording is started. It is asked of you that you pronounce this sentence as if you were talking to a friend or family member. When you are done speaking, you can press the spacebar to stop the recording and proceed to the next sentence. There will be 40 sentences in total, which you will have to pronounce. Participating will take no more than 10-15 minutes total.

##### **Voluntary participation**

You will be participating in this research project on a voluntary basis. This means you are free to stop taking part at any stage. This will not have any consequences and you will not be obliged to finish the procedures described above. You can always decide to withdraw your consent later on. If you decide to stop or withdraw your consent prior to publication of the research results, all the information gathered up until then will be permanently deleted. However, if information has been anonymised, it cannot be deleted because it is not possible to trace back the information to individual participants.

##### **Discomfort, Risks & Insurance**

The risks of participating in this research are no greater than in everyday situations at home. Previous experience in similar research has shown that no or hardly any discomfort is to be expected for participants. For all research at the University of Amsterdam, a standard liability insurance applies.

### **Confidential treatment of your details**

The information gathered over the course of this research will be used for the purpose of this research project. Your personal details will not be used in publications, and we guarantee that you will remain unidentifiable in all publications. The audio recordings will also never be shown in public.

The data gathered during the research will be encrypted and stored on the University of Amsterdam OneDrive cloud storage. These personal details and the encryption key are only accessible to Michel van Hoof and Cesko Voeten. Anonymised data will be stored for a period of 10 years.

### **Data subject rights according to the GDPR**

Participants can request more information from the researcher at any time about their rights as data subjects under the EU privacy law, the GDPR.

### **Further information**

For further information on the research project, please contact Michel van Hoof (michel.van.hoof@student.uva.nl) or Cesko Voeten (c.c.voeten@uva.nl). If you have any complaints regarding this research project, you can contact the secretary of the Ethics Committee of the Faculty of Humanities of the University of Amsterdam, commissie-ethiek-fgw@uva.nl, phone number: +31 20 - 525 3054; Kloveniersburgwal 48, 1012 CX Amsterdam.

## **B.2 Information brochure in French**



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### **Brochure informative**

Cher participant,

Vous allez participer à l'étude scientifique nommée French sounds are weird, mené par Michel van Hoof sous la direction de Cesko Voeten à l'Université d'Amsterdam. Avant de démarrer ce projet de recherche, il est important que vous vous familiarisiez avec les informations concernant les procédés que nous allons appliquer. Nous vous invitons à lire cette brochure informative attentivement.

#### **But du projet de recherche**

Cette étude se portera sur des sons spécifiques de la langue française. Les détails précis concernant le but de la recherche seront communiqués une fois l'expérience terminée.

#### **Qui peut participer ?**

Les participants doivent être des locuteurs natifs du Français. Le seul autre prérequis est que les participants doivent être adulte, c'est-à-dire avoir 18 ans ou plus. Il est également important que vous ne souffriez pas – autant que vous le sachiez- de troubles du langage, dyslexie, ou autres troubles spécifiques affectant vos capacités langagières.

#### **Instructions et procédure**

Il vous sera d'abord demandé de lire attentivement cette brochure ainsi que le formulaire de consentement. Une fois cette étape terminée, une phrase apparaîtra sur l'écran, et un enregistrement audio démarra. Il vous est demandé de prononcer cette phrase comme si vous parliez à des amis ou à des membres de votre famille. Une fois que vous avez terminé de parler, vous pouvez appuyer sur la barre d'espace pour arrêter l'enregistrement audio et passer à la phrase suivante. Il y aura 40 phrases en tout, que vous devrez toutes prononcer. Votre participation ne prendra pas plus de 10-15 minutes.

### **Participation volontaire**

Vous participerez à cette étude sur la base du volontariat. Cela signifie que vous êtes libre de vous en retirer à n'importe quel moment. Il n'y aura aucune conséquence et vous ne serez pas obligé de terminer la procédure décrite ci-dessus. Vous pouvez toujours décider de révoquer votre consentement plus tard, une fois l'expérience terminée. Si vous décidez de vous arrêter ou de révoquer votre consentement avant la publication de l'étude, toutes les informations collectées vous concernant seront définitivement supprimées. En revanche, si les informations ont déjà été anonymisées, elles ne peuvent pas être supprimées car elles ne sont plus traçables jusqu'à des participants individuels.

### **Inconfort, risques et assurance**

Les risques liés à la participation à cette étude ne sont pas plus élevés que n'importe quelle situation du quotidien. Les expériences passées pour des études similaires ont montré que l'inconfort est minime ou nul pour les participants. Pour tous les projets de recherche mené à l'Université d'Amsterdam, une assurance de responsabilité civile classique s'applique.

### **Traitement confidentiel des données personnelles**

Les informations collectées au cours de cette étude seront utilisées pour le but du projet de recherche. Vos détails personnels ne seront pas utilisés dans les publications, et nous garantissons que vous resterez non-identifiables dans toutes les publications. Les enregistrements audios ne seront jamais diffusés en public.

Les données collectées durant cette étude seront cryptées et conservées dans un lieu sécurisé. Ces détails personnels et la clé de cryptage ne seront accessibles que pour Michel van Hoof et Cesko Voeten. Les données anonymisées seront conservées pour une période de 10 ans.

### **Droit des personnes concernées selon le Règlement Général sur la Protection des Données (RGPD)**

Les participants sont à tout moment en droit de demander au chercheur plus d'information sur leurs droits en tant que personne concernée en vertu de la loi européenne sur la protection de la vie privée, le RGPD.

### **Informations complémentaires**

Pour plus d'information sur le projet de recherche, adressez vous à contact Michel van Hoof (michel.van.hoof@student.uva.nl) ou Cesko Voeten (c.c.voeten@uva.nl). Si vous avez une ou plusieurs réclamations concernant ce projet de recherche, vous pouvez contacter le secrétaire du Comité d'Éthique de la Faculté de Lettres de l'Université d'Amsterdam, commissie-ethiek-fgw@uva.nl; Binnengasthuisstraat 9, 1012 ZA Amsterdam, Pays-Bas.

## C Consent forms

### C.1 Consent form in English



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#### Informed consent form

‘I hereby declare that I have been clearly informed about the research project *French sounds are weird* at the University of Amsterdam, conducted by conducted by Michel van Hoof under supervision of Cesko Voeten as described in the information brochure. My questions have been answered to my satisfaction.

I realise that participation in this research is on an entirely voluntary basis. I retain the right to revoke this consent without having to provide any reasons for my decision. I am aware that I am entitled to discontinue the research at any time, and that I can always withdraw my consent after the research has ended. If I decide to stop or withdraw my consent, all the information gathered up until then will be permanently deleted.

If my research results are used in scientific publications or made public in any other way, they will be fully anonymised.

If I need any further information on the research, now or in the future, I can contact Michel van Hoof ([michel.van.hoof@student.uva.nl](mailto:michel.van.hoof@student.uva.nl)) or Cesko Voeten ([c.c.voeten@uva.nl](mailto:c.c.voeten@uva.nl)).

If I have any complaints regarding this research, I can contact the secretary of the Ethics Committee of the Faculty of Humanities of the University of Amsterdam; email: [commissie-ethiek-fgw@uva.nl](mailto:commissie-ethiek-fgw@uva.nl); Binnengasthuisstraat 9, 1012 ZA Amsterdam, The Netherlands.’

I consent to:

- participate in this research  yes /  no
- audio recordings being made and stored  yes /  no

Signed in duplicate:

.....      .....      .....

Name participant      Date      Signature

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‘I have explained the research in further detail. I hereby declare my willingness to answer any further questions on the research to the best of my ability.’



.....  
Name participant      Date      Signature

## C.2 Consent form in French



UNIVERSITY OF AMSTERDAM

### Formulaire de consentement éclairé

‘Je déclare par la présente avoir été clairement informé au sujet du projet de recherche *French sounds are weird* à l’Université d’Amsterdam, mené par Michel van Hoof sous la direction de Cesko Voeten, comme décrit dans la brochure informative. Mes questions ont reçu des réponses à ma satisfaction.

Je réalise que la participation à cette étude se fait uniquement sur la base du volontariat. Je conserve le droit de révoquer mon consentement sans qu’aucune raison justifiant ma décision soit requise. Je suis conscient du fait que j’ai le droit de me retirer de l’étude à tout moment, et que je peux toujours révoquer mon consentement après que l’étude soit terminée. Si je décide de me retirer de l’étude ou de révoquer mon consentement, toutes les informations collectées jusque là seront supprimées de manière permanente.

Si mes résultats sont utilisés dans des publications scientifiques ou rendus publics de quelle manière que ce soit, ils seront rendus complètement anonymes.

Si j’ai besoin de plus d’information sur l’étude, maintenant ou dans le futur, je peux m’adresser à Michel van Hoof ([michel.van.hoof@student.uva.nl](mailto:michel.van.hoof@student.uva.nl)) ou Cesko Voeten ([c.c.voeten@uva.nl](mailto:c.c.voeten@uva.nl)).

Si j’ai des réclamations concernant cette étude, je peux contacter le secrétaire du Comité d’Éthique de la Faculté de Lettres de l’Université d’Amsterdam, [commissie-ethiek-fgw@uva.nl](mailto:commissie-ethiek-fgw@uva.nl); Binnengasthuisstraat 9, 1012 ZA Amsterdam, Pays-Bas.’

Je consens à :

- participer à cette étude  oui /  non
- ce que des enregistrements audios soit collectés  oui /  non

Signé en duplicata :

.....  
Nom du participant      Date      Signature

---

‘J’ai expliqué l’étude avec plus de détails. Je déclare par la présente ma volonté de répondre à plus

de questions sur l'étude au meilleur de mes capacités.'

.....  
Nom du participant      Date      Signature