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REDUCTION OF OBSTRUENT-LIQUID-SCHWA CLUSTERS IN CASUAL FRENCH

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ABSTRACT

This study investigated pronunciation variants of word-final obstruent-liquid-schwa (OLS) clusters in casual French and the variables predicting the absence of the phonemes in these clusters. In a dataset of 291 noun tokens extracted from a corpus of casual conversations, we observed that in 80.7% of the tokens, at least one phoneme was absent and that in no less than 15.5% the whole cluster was absent (e.g., /mis/ for *ministre*). Importantly, the probability of a phoneme being absent was higher if the following phoneme was absent as well. These data show that reduction can affect several phonemes at once and is not restricted to just a handful of (function) words. Moreover, our results demonstrate that the absence of each single phoneme is affected by the speaker's tendency to increase ease of articulation and to adapt a word's pronunciation variant to the time available.

Keywords: pronunciation variation, casual speech, word-final clusters, nouns, French.

1. INTRODUCTION

Acoustic reduction is a frequent phenomenon in casual speech whereby words are produced with fewer or lenited phonemes compared to their citation forms. In American English, the word *yesterday* /jɛstədəɪ/, for instance, may be pronounced as something like /jɛʃeɪ/. Previous research [16] showed that 25% of the content words in American English lack at least a single sound. Reduction is also highly frequent in other languages (for an overview, see [8]), including French (e.g., [1]).

This study investigates reduction in European French, focussing on obstruent-liquid-schwa (OLS) clusters at the end of nouns, like /trə/ in *ministre*. We report possible pronunciation variants of these clusters, their frequencies, and the factors favouring these pronunciation variants. In this way, we contribute to documenting the enormous variation present in everyday speech.

We are not the first to study phoneme reduction in French (e.g., [1, 4, 5, 7, 14, 18, 21]). Previous research showed that word-final schwas are absent in 90% of the polysyllabic and in 35% of the

monosyllabic words [1], and that word-final liquids are missing in 58% of all word tokens (mono- and polysyllabic) [21]. In contrast, the absence of obstruents in word-final OLS clusters has never been studied before, which suggests that these obstruents are generally assumed to be always present.

Importantly, we will also investigate the dependencies between the three phonemes in these clusters, which, to our knowledge, have never been studied before. These dependencies may shed light on the mechanisms underlying speech production and reduction.

We will first present the variety of OLS cluster pronunciations that we observed in nouns in the Nijmegen Corpus of Casual French (NCCFr) [20]. We will then determine the variables that increase the likelihoods that the phonemes in these clusters are absent. In both parts, we study the correlations between the phonemes being absent.

2. PRONUNCIATION VARIANTS

2.1. Methods

2.1.1. Materials

All tokens were extracted from the NCCFr, which contains 35 hours of casual conversations between friends of the same sex. We selected 291 noun tokens (212 singulars and 79 plurals, 41 lemmas) ending in an OLS cluster, including one token of /flə/, seven of /frə/, 66 of /klə/, one of /krə/, 55 of /plə/, and 161 of /trə/. These noun tokens, of which 147 are monosyllabic and 144 are bisyllabic, were produced by 43 different speakers (21 females, 22 males), aged between 18 and 50 years (mean age = 22.7). We did not analyse tokens which occurred in phrases containing laughter or overlapping speech.

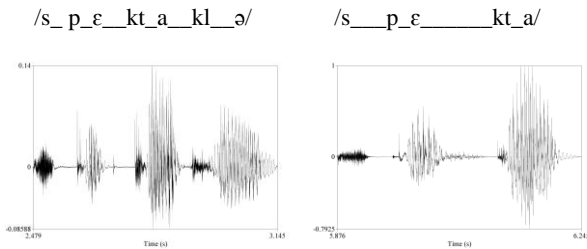
2.1.2. Transcriptions

The first author phonetically transcribed the OLS clusters of the 291 word tokens in Praat [3]. One hundred randomly selected tokens were also annotated by a second transcriber. No major disagreements were found between the two annotators (95% agreement in presence of the obstruent and the schwa, 96% agreement in presence of the liquid).

2.2. Results

We observed a wide range of pronunciation variants for the OLS cluster. Figure 1 presents two pronunciation variants of the same word: one with and one without the OLS cluster being present.

Figure 1: Examples of an unreduced and a maximally reduced pronunciation of the OLS cluster in *spectacle* 'show'.



The majority of the casually produced word-final OLS clusters (80.7%) lack at least one phoneme. Table 1 shows the relative frequencies of the six variants of the OLS clusters in our dataset. Each one occurs at least twice.

Table 1: Relative frequencies (percentages of occurrence) of the OLS pronunciation variants, illustrated with the word *ministre* 'minister'.

obstruent	liquid	schwa	example	relative frequency
present	present	absent	/ministr/	35.7
present	absent	absent	/minist/	27.1
present	present	present	/ministrə/	19.2
absent	absent	absent	/minis/	15.5
absent	present	present	/minisrə/	1.4
absent	present	absent	/minisr/	1.0

We can distinguish four main pronunciation variants for the OLS cluster: variants in which (1) all three phonemes are present, (2) obstruent and liquid are present, (3) only the obstruent is present and (4) none of the three phonemes is present. All 43 speakers produced at least one token of each of these four main variants. The variant without schwa is the most frequent (35.7%), followed by the variant in which only the obstruent is left (27.1%). The full variant, with all phonemes present, is the third most frequent pronunciation (19.2%). Strikingly, the variant in which the whole cluster is absent also occurs quite often (15.5%).

A phoneme was more likely to be absent if the following phoneme was also absent. This pattern also emerges from two logistic mixed-effects models [9] (with word and speaker as random variables) in which the absence of the obstruent and the absence of the liquid were predicted as a function of the absence of the following phoneme, ($\beta = 2.69$, $z = 5.36$, $p < .001$; $\beta = 4.50$, $z = 4.31$, $p < .001$, respectively).

Figure 2 shows the percentages of the presence of the obstruent, the liquid and the schwa in different OLS clusters. Since we obtained only one token of /flə/ and of /krə/, we did not incorporate these clusters.

Figure 2: The likelihoods of obstruents, liquids and schwas being present in different OLS clusters.

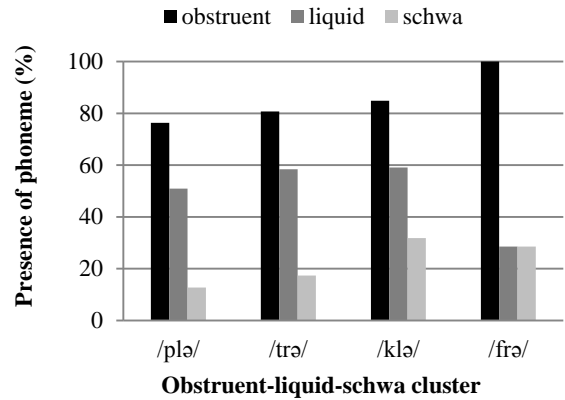


Figure 2 shows, like Table 1, that in all OLS clusters, schwa is absent most of the time. Schwa is most often present in the /klə/ cluster (difference with /plə/, $p < .05$; difference with /trə/, $p < .05$). Further, in all clusters, except /frə/ (please note that this cluster is only represented by seven tokens), the liquid surfaces more often than the schwa. Finally, Figure 2 demonstrates that French speakers tend to maintain /f/ out of all obstruents most often: both /p/ ($p < .001$), /t/ ($p < .001$) and /k/ ($p < .01$) were significantly more often absent than /f/.

The tokens without the OLS cluster often lack other phonemes too. For instance, *ministre(s)* 'minister' is realised as /mis/ in 52.9% of the tokens and *fenêtre* 'window' is pronounced as /fnɛn/ in 8.3% of the tokens. The latter token shows that there are additional pronunciation variants for each cluster, next to the variants in which phonemes are absent: in /fnɛn/, the /t/ sounds like /n/. Other pronunciation variants are those in which the voiceless obstruent is voiced. For instance, word-final /k/ resulting from /klə/ (e.g., in *spectacle* 'show') and word-final /t/ resulting from /trə/ (e.g., in *théâtre* 'theatre') are voiced in 6.06% and 3.73% of the tokens, respectively. In these tokens, the velar plosive is always followed by a voiced word-initial phoneme.

We do not find substantial differences between word-final schwa reduction in monosyllabic and polysyllabic words (78.9% vs. 79.9%). The two other cluster phonemes, in contrast, seem to be affected by the number of syllables. Obstruents and liquids are more often absent in polysyllabic words than in monosyllabic words (26.4% vs. 9.5%; 49.3% vs. 36.0%).

3. PREDICTORS OF REDUCTION

3.1. Methods

We annotated every word token for variables that proved to be significant predictors of the absence of phonemes in previous studies [2, 11, 17].

First, we annotated which phoneme preceded and which phoneme followed the OLS cluster. We specified their voicing, manner and place of articulation. We also identified the words that preceded and followed each word token.

Second, we added word frequencies based on the NCCFr corpus to our dataset. We also incorporated bigram frequencies of the word with the following word and with the preceding word from the NCCFr corpus. All probabilistic variables were logarithmically transformed.

Third, we took five possible word positions into account: phrase-initial (IP), phrase-medial (MP), phrase-final (FP), postpausal (POP) and prepausal (PREP) position. Silences were considered pauses, which can be filled (e.g., by *eah*) or unfilled, if their duration was minimally 200 ms, because this appears to be the standard threshold for perception [10, 13, 22].

Fourth, we defined speech rate as the number of syllables, and thus the number of vowels realised in the utterance, divided by the duration of the utterance. If the utterance contained a pause, this part of the utterance was not taken into account.

Finally, we included the number of syllables of the word in its citation form.

Comparisons of the annotations provided by the two transcribers for the hundred tokens (see above) showed an agreement of 96% for the type of phoneme following the word. The agreements for the phoneme preceding the cluster and for phrasal position were both 87%.

3.2. Results

We used generalised mixed-effects regression models with the binomial link function, with word and speaker as crossed random effects and the predictors mentioned in the preceding section as potential fixed predictors. Random slopes were tested for all fixed predictors. Since we found correlations between the clusters' phonemes being present or not (see section 2), we incorporated the absence of the liquid and the absence of the schwa as predictor of obstruent and liquid absence respectively. The word tokens were not equally distributed among the defined word positions. Therefore, we also tested binary variables for word position (e.g., POP: yes/no). We only retained those predictors in the model that were statistically

significant or figured in statistically significant interactions.

Table 2: Summary of the linear mixed-effects model fitted on the absence of the obstruent.

Fixed effects	β	$z^{(p)}$
Liquid absent	27.60	18079***
Following stop	14.42	9442***
After pause	-15.44	-10111***
Random effects		<i>SD</i>
Word	intercept	99.89
Speaker	intercept	11.43

Note. *** $p < .001$, ** $p < .01$, * $p < .05$

Table 2 shows that the obstruent was more often absent when the liquid was also absent and when it was followed by a stop. In contrast, the obstruent was more often present when the word token was preceded by a pause.

Table 3: Summary of the linear mixed-effects model fitted on the absence of the liquid.

Fixed effects	β	$z^{(p)}$
Schwa absent	4.74	4.43***
Speech rate	0.41	2.52*
Following bigram frequency	0.80	2.18*
Following vowel	-2.16	-3.45***
Random effects		<i>SD</i>
Word	intercept	0.43
Speaker	intercept	0.41
	following vowel	1.45

Note. *** $p < .001$, ** $p < .01$, * $p < .05$

From Table 3 we can conclude that the liquid was more often absent when the schwa was absent and when speech rate was higher. Moreover, the liquid was more often absent when the following word was more predictable in the NCCFr corpus and when that next word started with a consonant. The latter effect was larger for some speakers than for others, as shown by the significant random slope of following vowel for speaker.

Table 4: Summary of the linear mixed-effects model fitted on the absence of the schwa.

Fixed effects	β	$z^{(p)}$
Following consonant	-1.59	-3.41***
Preceding consonant unvoiced	-2.00	-3.04**
Final position	1.25	2.37*
Word frequency	0.40	2.38*
Speech rate	0.54	2.94**
Random effects		<i>SD</i>
Word	intercept	0.00047
Speaker	intercept	1.05

Note. *** $p < .001$, ** $p < .01$, * $p < .05$

Table 4 demonstrates that schwa is more often present when it is followed by a consonant and when the cluster in which schwa occurs is preceded by an unvoiced consonant. Schwa is less often present when the word token occurs in phrase-final position, when it is more frequent in the NCCFr corpus and when speech rate is higher.

4. DISCUSSION AND CONCLUSION

This study documented the pronunciation variants of word-final obstruent-liquid-schwa (OLS) clusters in 291 noun tokens uttered in French casual conversations. The data show a wide range of variation. When we only focus on the absence vs. presence of the three phonemes, we can distinguish six pronunciation variants, of which four variants frequently occur. In addition, the data demonstrate that OLS clusters may also be reduced by pronouncing voiceless obstruents in a voiced way.

The citation form of the OLS cluster only occurs in 19.2% of the tokens. This is in line with previous research (e.g., [1]) which shows that word-final schwa is often absent in French. The variant in which schwa is absent may therefore be considered as the canonical variant. However, this variant only occurs in 35.7% of the cases. In the remaining 45% of the tokens at least the obstruent (15.5%) or the liquid (27.1%) is absent. These results show that there are multiple pronunciation variants for the OLS cluster, of which none is clearly dominant and thus canonical.

Previous research showed that the liquid had an absence rate of 58% [21]. In our study, the liquid was absent in 42.6% of the tokens. Possibly, [21] observed a higher absence rate because in addition to nouns, they also examined other grammatical categories, including verbs (e.g., *être*) and adverbs (e.g., *par exemple*) which are known to have particularly high rates of reduction.

Our study is the first to document the absence of obstruents in OLS clusters. In 17.9% of the tokens, the obstruent was absent. When the obstruent was absent, the whole cluster was usually missing. In those cases, other phonemes in the word also often showed reduction. This resulted in variants like /mis/ for *ministre* 'minister'.

The liquid was especially absent, when the schwa was missing, and, as mentioned above, the obstruent was especially absent when the liquid was missing. This demonstrates that a cluster's phoneme is more likely to be absent if the following phoneme is also absent. One possible explanation for this pattern is that phonemes may be more likely to disappear if they are not followed by other phonemes in the word. Alternatively, the pattern may arise just because schwas are more likely to disappear than liquids and because liquids are more likely to disappear than obstruents. Possibly, both tendencies contribute to the emergence of the pattern.

Our findings are in line with the growing body of literature on the enormous pronunciation variation that is inherent to casual speech. Our study adds to this literature by describing a reduction phenomenon

that can affect several phonemes at once, that affects content words, and is not restricted to just a handful of content words. Our results therefore illustrate the challenges that listeners have to cope with when listening to casual conversations and that models of human speech comprehension have to account for. Moreover, our results explain why automatic speech recognisers, which typically only have information about the full pronunciation variants of words, have high error rates for informal speech [15].

Our analyses further show that several other variables favour the absence of the phonemes from the OLS cluster: speech rate, word token position in the utterance, and the probability of the word and of the following word given the target word. In line with previous research (e.g., [2, 5, 19]), we assume that these variables indicate that phonemes are less likely to be present when speakers take or need less time to produce or plan the word or the next word.

Moreover, the types of the phonemes surrounding the OLS cluster are relevant. Possibly, phonemes are more likely to be absent if the resulting phoneme sequence can be more easily articulated. This sequence preferably obeys the sonority principle according to which phonemes' sonorities increase from syllable onsets towards nuclei, but decrease from nuclei towards syllable codas [6]. In addition, the sequence also preferably obeys the *loi des trois consonnes* [12], which states that schwa can be absent if this does not result in a succession of three consonants.

We also investigated whether there were differences between the monosyllabic and the bisyllabic words. We found these differences only when we did not take into account the variables mentioned above. In this respect, our results contrast with those reported in [1], probably because [1] analysed schwa also in other sequences than OLS clusters, because [1] studied nouns as well as other word categories like adverbs and verbs, and because [1] did not study the influences of the variables mentioned above.

In general, our results are in line with previous results in that they show that the absence of phonemes is mainly driven by the speaker's tendencies to increase ease of articulation and to adapt a word's pronunciation variant to the time available. On top of this, our data demonstrate that these tendencies even affect phonemes whose reduction is predominantly determined by the reduction of the next phonemes.

In conclusion, this study has shown that French word-final obstruent-liquid-schwa clusters are often reduced and occur in many pronunciation variants. Phonemes tend to be more often absent if the following ones are absent as well.

5. ACKNOWLEDGEMENTS

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