THE VARIABLE PRONUNCIATIONS OF WORD-FINAL CONSONANT CLUSTERS IN A FORCE ALIGNED CORPUS OF SPOKEN FRENCH

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Abstract. This study examined both schwa insertion and simplification following word-final consonant clusters in a large corpus of spoken French and asked how do variables, such as speech style, following context, motivation for simplification and speech rate, affect the variable pronunciations of word-final consonant clusters. The results presented in this large sample corpus analysis should help to clarify the role of many phonological and stylistic factors – such as the identity of the cluster, the following context, and speaking rate – in how likely each process (simplification or schwa insertion) is to apply. The predictions of mixed-effects logistic regression models suggest that the dialectal differences between Québec and France are not as simple as “simplification in Québec, schwa insertion in France”. The differences in the effects of different factors between the dialects points towards the most interesting finding of the paper, that the two processes are related in each dialect, but in different ways. Remarkably, there seems to have been almost no previous work discussing both simplification and schwa insertion together, despite the fact that they target the same context (word-final clusters) in the same language. While the results presented here indicate that the process of simplification following a word-final consonant cluster is similar in both dialects, the process of schwa insertion is likely to be different in each dialect. In both dialects, word-final consonant cluster simplification is more frequent in a pre-consonantal context; is most likely in a spontaneous or less formal speech style and in that speech style is positively associated with higher speaking rates. Schwa insertion following a word-final consonant cluster displays much stronger dialectal differences. Schwa insertion in the dialect from France is strongly affected by following context and possibly speech style. Schwa insertion in the dialect from Québec is not affected by following context and is strongly predicted by a lack of consonant cluster simplification.

1. Introduction

This project is interested in the variable pronunciations of word-final consonant clusters in two dialects of French. In the French language, there are two well known phonological operations that target consonant clusters at word boundaries: cluster simplification and schwa insertion. Consonant cluster simplification involves, in most cases, the deletion of the final consonant of the cluster. Schwa insertion has occurred when a final schwa vowel is realized following the consonant cluster. Both are understood to alter a sequence of (phonological) consonants in order to either facilitate articulation or enhance
perception of the sequence. The variability of word-final consonant clusters in French has been investigated either from the perspective of consonant cluster simplification or from the perspective of the word-final /ɔ ~ 0/ alternation. Many of these studies have been based on data from introspection; some have used corpora of natural language; while a few more recent studies have been based on large databases of recorded speech. For word-final consonant clusters, both simplification and schwa insertion are highly variable in their application. Even when a particular motivation has been proposed for either schwa insertion or simplification, most authors have acknowledged that the application of either remains optional in most circumstances. This optionality has made a concise description of the distribution of the variable pronunciations of word-final consonant clusters elusive. Notwithstanding the long history of investigation into schwa insertion and simplification following a word-final consonant cluster, no clear and complete picture has yet emerged of exactly which variables condition the choice of pronunciation: Simplification or schwa? It has been claimed that these variable pronunciations may be sensitive to various phonological factors (e.g. perceptual needs, co-articulation, prosodic requirements). As well, the different pronunciations of word-final consonant clusters may vary according to dialect, speech style or speech rate. Additionally, variables such as position of the word in the utterance, word-length and word-frequency have all been demonstrated to have an effect on either consonant cluster simplification or the insertion of schwa at word boundaries. Sociolinguistic factors may also play a role in influencing the variable pronunciations of word-final consonant clusters. This lack of consensus may be due to the fact that most studies consider variables, and pronunciations, individually, despite the fact that they often interact or are correlated.

This research is concerned with two main questions. In the first place, how do variables such as speech style, following context, motivation for simplification and speech rate effect the probability of observing either schwa insertion or simplification following a word-final consonant cluster? In the second place, how do the strengths of these effects compare between two dialects of French, one of which seems to prefer consonant cluster simplification while the other seems to prefer schwa insertion? The answer to the first question helps to better describe the combined effects of speech style, following context, motivation for simplification and speech rate on the variable pronunciations of word-final consonant clusters in French. The answer to the second question gives a better understanding of the dialectal differences with respect to the variable pronunciations of word-final consonant clusters in French.

This paper begins with a review of the existing literature on word-final consonant clusters in French, which is divided into two areas of study. On the one hand are reports of consonant cluster simplification. The lexicon of French contains many words that terminate in a sequence of two or more consonants (a consonant cluster) and it is often the case that the final consonant of the cluster is deleted, subject to certain conditions; a process known as consonant cluster simplification. On the other hand are reports of word-final /ɔ ~ 0/ alternation. It has long been noted that, in French, a word-final consonant cluster, especially when followed by a pause or consonant-initial word, will often be pronounced with a final schwa vowel; a process known as schwa insertion. The review of these two bodies of literature will provide information about what previous authors have observed with respect to the distribution of the variable pronunciations of word-final consonant clusters in French. The literature review concludes with a brief
description of the pilot study undertaken by Milne and Côté (2009) which was an attempt at comparing both consonant cluster simplification and schwa insertion in a single corpus containing two dialects of French.

Following the literature review, the corpus used for the current study is introduced along with a description of the data set. The results on comparing the individual and combined effects of these variables between the two dialects are then presented. These results will provide evidence in favour of the conclusions that the patterns of word-final consonant cluster simplification may be more similar between the two dialects than has previously been assumed but that there may be real dialectal differences in the patterns of schwa insertion following a word-final consonant cluster.

2. Literature Review

In the French language, there are two well known phonological operations that target consonant clusters at word boundaries: cluster simplification and schwa insertion. Both are understood to alter a sequence of consonants in order to either facilitate articulation or enhance perception of the sequence. For example, word-final consonant clusters will often be either simplified, as in (1-a) and (2-a), or have schwa inserted, as in (1-b) and (2-b).

(1) "titres de gloire"
   “claims to fame”
   a. [tit dœ glwaʁ]
   b. [titʁ dœ glwaʁ]

(2) "manifestent leur colère"
   “express their anger”
   a. [manifEs lœ kɔlɛʁ]
   b. [manifestœ lœ kɔlɛʁ]

The variability of word-final consonant clusters in French has been investigated either from the perspective of consonant cluster simplification or from the perspective of the word-final /œ ∼ ə/ alternation. Many of these studies have been based on data from introspection; some have used corpora of experimentally collected language; while a few more recent studies have been based on large databases of recorded speech.

For word-final consonant clusters, both consonant cluster simplification and schwa insertion are highly variable in their application. Even when a particular motivation has been proposed for the simplified productions (cf Côté (2004a)) or for the schwa productions (cf Tranel (1987)), most authors note that the application of either remains optional in most circumstances. As well, it has been claimed that these variable pronunciations may be sensitive to various phonological conditions, whether these be perceptual needs (Côté, 2000, 2004b), the demands of co-articulation (Barnes and Kavitskaya, 2002), prosodic requirements (Eychenne, 2005), or even lexical retrieval (Pustka, 2011). Additionally, many studies have suggested that the application of both consonant cluster simplification and schwa insertion following word-final consonant clusters varies according to dialect (Milne and Côté, 2009), speech style (Armstrong, 1998, 2001) and speech rate (Hansen, 1994). Confusing the matter still further, variables such as position of the word in the utterance (Malécot, 1976), word-length (Adda-Decker et al., 2008) and...
word-frequency (Racine and Grosjean, 2002) have all been demonstrated to have an effect on either consonant cluster simplification or the insertion of schwa at word boundaries. Sociolinguistic factors may also play a role in influencing the variable pronunciations of word-final consonant clusters (Laks, 1977; Armstrong, 2001; Durand and Eychenne, 2004; Boughton, 2008).

2.1. Schwa following a word-final consonant cluster. The insertion of schwa at word-boundaries in French has been extensively studied (Grammont, 1961; Dell, 1985; Tranel, 1987; Picard, 1991; Dell, 1995; Ayres-Bennett and Carruthers, 2001; Côté, 2000, 2007; Eychenne, 2005). Noske (1993) identifies a typology of 6 contexts where French schwa alternates with zero, of which his Type D (/ə ~ ə/ alternation in the environment CC][C) is of present concern. Historically in France, the deletion process of schwa in these environments took place over the course of the 15th to the 17th centuries (Fouché, 1958). Dell (1985) suggests that in standard varieties of French, in general, word-final schwa isn’t pronounced anymore, except to break up consonant clusters.

The phonological literature has offered many contributions towards understanding and explaining the variable pronunciations of word-final consonant clusters with respect to when and why schwa is or is not realized. Notwithstanding the obviously wide range of proposals and inevitable disagreements among the authors, almost without fail, researchers agree that, following a word-final consonant cluster, the realization of schwa is optional. The oft-cited work of Grammont (1914, 1961) contains the famous “loi des trois consonnes” whereby a sequence of three consonants is a prime and usual context for the realization of word-final schwa. However, this work (along with that of Fouché (1958)), was primarily intended as a pronunciation guide, rather than a formal description of the grammar of French. Early work within the framework of generative phonology often made reference to the notion of syllable well-formedness: Schwa is required whenever the surrounding consonants could not be properly syllabified without it (Pulgram, 1961; Morin, 1974; Tranel, 1987; Noske, 1993). However, while these syllabic approaches attempted to account for cases of obligatory schwa, they either failed, or neglected to even attempt to explain, the cases of optional schwa following a word-final consonant cluster. Côté (2000), in rebutting the earlier syllabic accounts, made the case instead for a sequential account whereby, even though the realization of schwa following a word-final consonant cluster is optional, the frequency of its realization increases according to several phonological generalizations and the Sonority Sequencing Principle (SSP). The SSP is marginally inviolable at word boundaries and triggers the realization of schwa if the medial consonant in the sequence is not a permissible sonority peak. In other words, if the medial consonant is trapped between two less sonorous consonants, the realization of schwa is more likely. Côté’s phonological generalizations concern the role of adjacent vowels, the vulnerability of stop consonants, the desirability of contrast within sequences of consonants, and the effect of the adjacent prosodic boundary. In order to account for the variability of schwa following a word-final consonant cluster, she believes that these segmental factors have “a cumulative effect on the likelihood of schwa insertion and retention: the more such factors are present, the less probable schwa insertion/retention is.” (p133).

Eychenne (2005) suggests that some of the observed variability in the realization of word-final schwa could be attributed to the notion that in some dialects schwa is lexical (e.g. in the Languedoc region of Southern France), while in others it emerges to satisfy
the prosodic requirement that the head of a prosodic phrase be heavy (e.g. in the Midi-
Pyrénées region of Southern France), while in others, it is neither lexical nor prosodic
(e.g. in young Parisians’ French).

With a view to describing the variability of schwa following a word-final consonant
cluster in terms of sociolinguistic or stylistic factors, several authors have taken advantage
of the increasing availability of spoken language corpora. Using recorded speech collected
as part of the Phonologie du Français Contemporain (Durand et al., 2002, 2005, 2009),
several authors note that schwas tend to be present more often in standard than in some
regional varieties of French (e.g., Québec French) but are especially frequent in southern
French (Durand and Eychenne, 2004; Eychenne, 2006). From conversational interviews
recorded in Paris, Hansen (1994) finds that younger speakers tend to produce schwas less
often than more elderly speakers. Both Eychenne (2003) and Kemp et al. (1980), while
examining schwa at word boundaries in speakers from Québec, find that schwa at word
boundaries in the vernacular does not exist, though for a small subset of four speakers
who displayed a speaking style favoring high overall rates of cluster conservation, schwa
surfaced principally following liquids (/g, l/) and variably following stops and nasals.

Investigating the effects of speech style on the variability of word-final schwa, Adda-
Decker et al. (1999) compare the occurrence of pronunciations with and without schwa
in large corpora of orthographically transcribed speech: the BREF corpus (Lamel et al.,
1991) comprised of 120 hours of read newspaper speech and a portion of the MASK
corpus (Lamel et al., 1995) containing 35 hours of spontaneous speech collected via a
travel information dialog system. They found that in the BREF corpus, final schwas
in polysyllabic words are produced twice as often as in spontaneous speech, while in
the MASK corpus, the majority of final schwas are dropped. Using a corpus of 30 one
hour recordings of French radio interview speech, Adda-Decker et al. (2002) investigated
the variation between the number of syllables present in the citation form of a word
versus the number of syllables present in the fluent, spontaneous speech form of the
word. Their results showed that the optional schwa vowel contributes to a large amount
of pronunciation variation and that a substantial number of word-final syllables may be
completely deleted. Among the observed deletions, 40% (i.e. 9,000 occurrences out of
24,000) correspond to syllables containing a schwa. Among the large number of omitted
syllables, more than half are cross-word syllables: parts of words on word boundaries
disappear more easily. From a corpus of 13 hours of broadcast news speech, Nemoto et al.
(2010) combined time-aligned phonemic and lexical transcriptions, as well as automatic
prosodic and POS annotations to compare average $f_0$ profiles according to word classes
of given syllabic length, word-final schwa, duration and syntagms. They found that
average $f_0$ profiles tended to be raised in the presence of final schwa and interpret this
to mean that the presence of word-final schwa may reveal measurable cues contributing
to word boundary location.

Concentrating on a single style of speech, Bürki et al. (2011a) used the subset of the
ESTER corpus (24 hours of radio-broadcasted news produced by 574 speakers (Gal-
liano et al., 2005)) for which the Institut de Recherche en Informatique et Systèmes
Aléatoires (IRISA) automatic speech alignment system had produced a phonetic tran-
scription aligned with the acoustic signal at the word and phoneme levels. While they

1Syntagm: A linguistic unit consisting of a set of linguistic forms (phonemes, words, or phrases) that
are in a sequential relationship to one another
restricted themselves in their study to the “schwa-zero alternation” in word-internal position in French, their detailed examination of the variables that might condition the presence versus absence of schwa using a large corpus of radio-broadcasted speech yields important information pertinent to the present study. They note that although many studies have investigated schwa alternation in French, no clear and complete picture has yet emerged of exactly which variables condition the presence of schwa. They attribute this lack of consensus to the fact that most studies consider variables individually (with one exception (Racine and Grosjean, 2002)), despite the fact that these variables often interact or are correlated. Their findings that relate to the current study include significant main effects for speech rate and respect of the sonority sequencing principle. Schwa was more often present at lower speech rates and schwa was more often present if the sequence of consonants that would result from the absence of schwa did not obey the sonority principle according to a six-level scale, that is, a sonority scale that differentiates between fricatives and stops, as opposed to one which groups the obstruents (c.f. Côté (2009)). They also discovered large differences among speakers: The effect of the sonority principle did not affect all speakers’ behaviour equally.

2.2. **Simplification following a word-final consonant cluster.** Modern French has a large number of word-final consonant clusters, the majority of which arose from the loss of word-final schwas in the pronunciation of French in the 17th century. Consonant cluster simplification in French, like word-final schwa, has also been the beneficiary of numerous investigations. Similar to the case of word-final schwa, consonant cluster simplification, when it occurs, is optional. Word-final consonant cluster simplification also shares with accounts of word-final schwa the lack of a clear and complete understanding of exactly which variables condition the simplifications. Based on previous work using similar corpora to the one employed here, consonant cluster simplification is more common in the Québec dialect of French (Milne and Côté, 2009). In the Québec dialect, word-final consonant cluster simplification may occur freely in all contexts (pre-consonantal, pre-pausal and pre-vocalic position) (Côté, 2004a), in contrast with the French spoken in France, where deletion of the final consonant in a cluster is more constrained and is allowed only before a consonant-initial word (Dell, 1985) or is restricted to more colloquial varieties pre-vocally (de Cornulier, 1978; Tranel, 1987). In fact, in a ‘standard conversation’, de Cornulier (1978) is unsurprised that word-final consonant cluster simplification may occur before a consonant or pause, but regards simplification as stigmatized before a vowel in the absence of a pause. In so doing, he recognizes a social or stylistic component to word-final consonant cluster simplification. Several sociolinguistics studies have since shown that, although it is less common in these contexts, consonant cluster simplification (at least for clusters that end in /\k/\) can indeed occur before vowels and pauses (Armstrong, 2001; Laks, 1977; Pooley, 1996). Laks (1977), studying /\k/ deletion patterns in word-final consonant clusters in the Parisian neighbourhood of Villejuif found relatively low rates of simplification and that the more formal the conversation and the higher the speaker’s social status, the less likely the deletion of /\k/.

With respect to speech style, Armstrong (1998, 2001) found similar results. Comparing recordings from a more formal interview with recordings from a less formal conversation of school age girls in the Lorraine region of north-eastern France conducted in 1990, in formal settings, rates of /\k/ deletion before a vowel were lower than before consonants and pauses (22.1% vs 55.6%). In prevocalic environments, /\k/ deletion was limited to a
few frequently occurring lexical items. In the case of /u/ deletion, the effect of style was more important than other extra-linguistic factors, in this case gender and age. Looking at word-final consonant cluster simplification involving only clusters that terminate in /u/l/ in the casual speech recordings from the Aveyrons and Paris regions of the PFC corpus, Pustka (2011) finds that the following context plays an important role: consonant cluster simplification was more common before a consonant, but cautions that prevocalic simplification was not so infrequent as to be dismissed out of hand. It was also found that the preceding context may also play a role: deletion of /u/ or /l/ was more frequent when the first member of the cluster was a plosive than a fricative. These results from casual speech were similar to the analysis of Adda-Decker et al. (2002) who found that, for words ending in /tu/ and /du/ preceding a consonant, the pronunciations [t] and [d] are preferred, in an average ratio of 3 to 2: after the elision of the schwa in this context, consonant cluster simplification was observed in 240 occurrences, while the final consonant was maintained together with the plosive in 170 occurrences.

Côté (2004a,b) has presented an account of the simplified productions where consonant clusters that contain either a rising sonority contour, or lack crucial featural contrasts, are susceptible to deletion. While her analysis is restricted to the variety of French spoken in Québec, her proposal makes several predictions regarding what to expect in the current study. She claims two types of clusters: Clusters that simplify and clusters that are stable. She divides the clusters according to their motivation for simplification. Her proposal appeals to either perceptual salience or sonority as violable constraints. Côté’s argument for perceptual salience rests on the observations that salience is determined by the degree of contrast within the cluster and by the nature and position of each consonant. For example, /st/ and /ts/ display the same featural contrast, but simplification only affects the first one. In these cases the least salient consonants may delete. Côté’s argument for sonority rests on the definition that the “SSP is violated in all clusters whose last consonant is more sonorous than the preceding one” (Côté, 2004a, p. 159) and that clusters that violate the SSP may delete. Côté allows for some lexical effects to influence the likelihood of consonant cluster simplification. For some consonant clusters, such as the frequently occurring stop+approximant combinations, simplification may occur in any of the words in which they occur while in others, such as some fricative+stop combinations (e.g. /sk, sp/), simplification may occur in just a subset of the words in which they occur. For these lexically determined cases of simplification word frequency, register, context of usage and word length may all play a role in determining whether a particular cluster is likely to be simplified. She claims that, in general, “the more frequent and less learned a word, the more likely it is to get simplified.” (Côté, 2004a, p. 157). In all cases, when it is allowed, word-final consonant cluster simplification is always optional. Tranel (1987) and Goad (2002), noting the overt release of word-final stops in Continental French, offered a possible explanation for the lower incidence of simplification in the French spoken in Northern France.

Curiously, given the substantial amount of attention devoted to either consonant cluster simplification or schwa insertion at word boundaries, very little mention has been made of a possible relationship between these two phenomena. The literature just reviewed indicates that it is not disputed that both consonant cluster simplification and schwa insertion at word boundaries appear to share similar contexts: a sequence of consonants at a word boundary. It would also appear to be the case that the factors possibly
influencing the one are similar to the factors possibly influencing the other: A rising sonority contour, faster rates of speech, the lack of a contrast between sequences of consonants, either dialectal or regional variation, and speech style have all been positively associated with higher incidence rates of both consonant cluster simplification and schwa insertion at word boundaries. Nevertheless, in the literature reviewed, there are but two instances where both consonant cluster simplification and schwa insertion were mentioned together. Kemp et al. (1980) note that for four of their speakers who displayed a speaking style favouring high overall rates of consonant cluster conservation, schwa surfaced principally following liquids (/u, l/) and variably following stops and nasals, while Pustka (2011) wondered about the difficulty of determining a causal relationship between consonant cluster simplification and schwa insertion: “la chute du schwa entraîne-t-elle la chute de la liquide ou bien les deux variables sont-elles (presque) indépendamment corrélées aux facteurs ‘tradition’ vs ‘modernité’?” (p. 27). Neither of these two passing statements was further elaborated upon by the researchers.

Milne and Côté (2009) investigated the relationship between consonant cluster simplification and schwa insertion at word boundaries in two dialects of French: a variety spoken in and around Paris and Northern France and a variety spoken in Québec. When rates of consonant cluster simplification and schwa insertion for individual consonant clusters were calculated, the expectation that these two phonological operations pattern differently in each dialect was confirmed. For France, even as rates of consonant cluster simplification increased, rates of schwa insertion remained constant. Whereas for Québec, as rates of consonant cluster simplification increased, rates of schwa insertion also increased. A possible relationship between consonant cluster simplification and schwa insertion, at least for the Québec dialect, was proposed: In contexts where consonant cluster simplification did not occur (for whatever reason), schwa insertion was an alternative.

However, their analysis suffered from several deficits. In the first place, the conclusions were not statistically validated. While differences were observed between the two dialects of French, no statistical evidence was included to determine whether these differences were significant. Second, the data were not properly balanced between the two corpora. There was more than double the amount of data representative of France as compared to Québec, and not all clusters and lexical items were equally represented in both dialects. Third, the set of word-final consonant clusters included in the results was not very large. Of the 87 possible word-final consonant clusters attested in French (Dell, 1995), only 21 were included in the results. Finally, the results were based on different speech styles. The data from Québec, being drawn from the political debates in the Assemblée nationale du Québec, was most likely representative of a more formal speech style than the data for the France dialect, which was drawn from a less formal conversational speech style. It might have been expected that the more formal speech style would have displayed fewer occurrences of word-final consonant cluster simplification and possibly more occurrences of schwa insertion following a word-final consonant cluster than the less formal speech style. In fact, the opposite was observed. The Québec data, representative of a more formal speech style, showed higher rates of simplification and lower rates of schwa insertion following a word-final consonant cluster than the data from France, representative of a less formal style of speech. Therefore, the stylistic differences prevented measuring the real differences between the two dialects.
3. The data set and variables

The data used for the current study was obtained by combining two corpora of recorded French speech. The first corpus is the force-aligned portion of the AssNat corpus (Milne, 2016). The AssNat corpus is a corpus of political debates from the national assemblies of Québec and France that occurred in the month of May 2011. This corpus contains approximately 126 hours of audio recordings (66 hours from France and 60 hours from Québec) representing 439 different speakers (105 from Québec, 334 from France). From this, 18 hours of recordings, containing variable amounts of speech data from 148 different speakers (62 from Québec, 86 from France), has been time aligned at both the word and phoneme level. An important addition to this corpus are labels indicating whether the interval of audio was obtained while a speaker was physically reading from a text. The videos of the proceedings in the two national assemblies were watched and every audio interval was coded as either “Reading” or “Spontaneous” depending on whether or not the video indicated a speaker was reading from a text or speaking without the aid of notes. This distinction between reading and spontaneous speech was used to represent two styles of speech and mimics the distinction provided by the second corpus.

The second corpus contains the read text exercise and both recorded conversations from selected investigations in France and Québec through the PFC: Projet Phonologie du Français Contemporain (Durand et al., 2002, 2005, 2009). The PFC is an ongoing research project aimed at providing researchers interested in the French language with a database of oral data. One of the main goals is to gather data from as many varieties of French as possible, in all parts of the world, in order to investigate dialectal variation. The PFC uses a standardized interview process which includes two conversations (one free, the other guided) and a read text exercise (texte lu). The goal of the discussions is to obtain as natural a style of speech as possible while minimizing the effects of the observer’s paradox. For this reason, the free discussion preferably involves at least two participants with or without the researcher. The texte lu is a standardized text. The investigations from France were selected with a view to minimizing some of the noted geographically determined variation. Specifically, the differences in schwa realizations observed between speakers from the North of France and speakers from the South of France. For this reason, the surveys historically in the Occitan and Basque regions of France were excluded. Table 1 displays the list of investigations chosen to represent a Northern France dialect of French, as well as the list of investigations made available to represent a Québec dialect of French. The table also displays some information about the number of speakers and the amount of audio data available.²

In the table are listed a few investigations that do not conform entirely with the assumption of a uniform Québec or northern France dialect. Hawkesbury is in Ontario, not in Québec. However, the French spoken in Hawkesbury, which is on the border with Québec, is essentially the same as that spoken on the other side of the border (Nadasdy, 2005). Aveyronnais à Paris(75x) is a survey of speakers originally from the south of France, but who have been living, and were recorded while in, Paris. This mirrors a similar situation in the France portion of the AssNat corpus which surely includes some members of the national assembly who originate from the south of France, but who now spend a large amount of time in a Parisian context. As such, it might be expected that

²The survey points with a code are available online at www.projet-pfc.net. The others are not yet online but will be at some point.
both of these groups of speakers have adopted some Northern (i.e. “standard”) patterns. So both of the France corpora are mainly “Northern”, but include some Southern speakers in a Parisian context.

From the force aligned transcripts of both of these corpora (the AssNat and PFC), a data set was constructed with an entry for every occurrence of a word-final consonant cluster. Excluded from the data were a set of words that do not appear to show any variation in their pronunciations. These include the words “presque” (almost), “puisque” (since, because), “lorsque” (when) and “jusque” (up to and including, even). All of these words are pronounced almost categorically with a final schwa vowel before a consonant-initial word and are rarely simplified when occurring before a vowel-initial word.

Also excluded was the frequently occurring word “quelque(s)” (some, a few). This word is also pronounced almost categorically with a final schwa vowel before a consonant-initial word, including liaison consonants, and is rarely simplified when occurring before a vowel-initial word.

3In fact, this pattern seems to be so well established that in its pronunciation guide, the online dictionary Larousse.com explicitly lists [Zysk@] when followed by a consonant and [Zysk] when followed by a vowel!

4“quelque” may also often be pronounced [kɛrk] without the [l], in which case no schwa is realized.
Table 2. Attested word-final consonant clusters in the data set

<table>
<thead>
<tr>
<th>Type /Clusters/</th>
<th>Reading</th>
<th>Spontaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>QC</td>
<td>FR</td>
</tr>
<tr>
<td>AF /f, s, z, 3</td>
<td>225</td>
<td>273</td>
</tr>
<tr>
<td>AN /m, n</td>
<td>82</td>
<td>230</td>
</tr>
<tr>
<td>AS /d, r, t</td>
<td>71</td>
<td>115</td>
</tr>
<tr>
<td>ASA /d</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>FA /b, v</td>
<td>47</td>
<td>86</td>
</tr>
<tr>
<td>FN /m</td>
<td>46</td>
<td>35</td>
</tr>
<tr>
<td>FS /t, sk, st</td>
<td>347</td>
<td>609</td>
</tr>
<tr>
<td>FSA /s</td>
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<td>931</td>
</tr>
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<td>1400</td>
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</tr>
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</tr>
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<td>Sum</td>
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<td>4716</td>
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</tbody>
</table>

Also excluded from the data for analysis were examples of extremely fast or extremely slow speech. Speech rate is included as a variable of interest and as a normally distributed continuous variable the upper and lower tails of the distribution (at \( \alpha = 0.05 \)) could be considered extreme. The measured rates of speech centred on a mean of 13.178 phones per second and ranged from a minimum of 2.786 phones per second to a maximum of 30.770 phones per second. Using 95\% of the distribution meant the upper limit for speech rate was set at 19.67333 phones per second and the lower limit set at 7.109537 phones per second. Observations whose speech rates were either slower or faster than these limits were removed from the outset in order to avoid any outlier effects.

The resulting data set contained 28,095 observations of word-final consonant clusters comprised of 29 individual clusters grouped into 12 types collected from 351 different speakers. Table 3 displays the aggregate counts of each type of cluster according to both dialect and speech style in the final data set. In the table, A, N, F, and S stand for approximant, nasal, fricative and stop, respectively.

3.1. Variables selected for analysis. The variables included speech style, following context, motivation for simplification and speech rate. These variables were selected primarily because the body of literature on both simplification and schwa insertion following a word-final consonant cluster indicated that they were all likely to have explanatory value in any models predicting either simplification or schwa insertion.

3.1.1. Speech style. In this investigation, following the example from several previous studies (c.f. Nemoto et al. (2010); Adda-Decker et al. (2002, 1999)), a distinction was made between read and non-read speech as a way of accessing different speech styles. Defined this way, speech style is a categorical predictor with two levels. The first level, Reading, applies to clusters that occurred in a sample of speech during which the participant was actively reading from a text (either reading from prepared notes in the AssNat corpus, or the standardized text from the PFC corpus). The second level, Spontaneous, applies to clusters that occurred in a sample of speech during which the participant...
was not actively reading from a text (speaking without the use of prepared notes in the AssNat corpus, or the conversational portion of the PFC corpus).

3.1.2. **Following context.** Following context is also a categorical predictor with two levels: Consonant or Vowel. This depended on whether or not a pause was realized in the audio record. The presence or absence of a pause was determined by a purely physical measurement. Whether or not a pause was realized following the target word containing the consonant cluster was determined simply by measuring the length of the \{sp\} (‘short pause’) or \{s1\} (‘silence’) phone that follows every word in the force aligned transcription. If the length of this pause phone was exactly 0.0\text{ms}, it indicated that the two words were co-articulated. Word-final consonant clusters that were followed by a 0.0 length pause (ie, that were co-articulated with the following word) were then identified as being either pre-consonantal or pre-vocalic.

3.1.3. **Motivation for simplification.** The proposal by Côté (2004a) (which only referred to the dialect from Québec, but will be applied here also to the dialect from France), makes several predictions regarding what to expect in this data and how the variable of motivation for simplification is defined. She claims two types of clusters: Clusters that simplify and clusters that are stable. She divides the clusters according to their motivation for simplification. Her proposal appeals to either perceptual salience or sonority as violable constraints. Her complete analysis will not be duplicated here.\(^5\) In general, the word-final consonant clusters that were investigated here that are predicted to simplify were those that either violated the Sonority Sequencing Principle (SSP) or contained a final consonant, specifically a final stop-consonant, that shared some features with its neighbour. The word-final consonant clusters that are predicted to remain stable were those that either didn’t violate the SSP or whose final member, even if it was also a stop consonant, contained crucial featural contrasts with its neighbour. The generalizations to be drawn with respect to the present data are that:

1. Clusters that violate the SSP are predicted to simplify. In this data set they are \{/b\text{r}, bl, d\text{r}, gl, kl, pl, w, k\text{d}, t\text{r}, v\text{r}, f\text{r}, st\text{r}, sm/\}.
2. Clusters that respect the SSP but whose members lack crucial featural contrasts are predicted to simplify. In this data set they are \{/k\text{st}, kt, pt, sk, st/\}. Notably, all of them contain a final voiceless stop.
3. Clusters that respect the SSP and whose members contain crucial featural contrasts are predicted to remain stable. In this data set they are \{/ks, k\text{f}, km, kw, k\text{t}, kd, kw, bs, bv, k\text{z}, k\text{\textasciitilde}z/\}

The motivation for simplification, therefore, can actually be decomposed into two separate categorical predictors: One that was used only when examining word-final consonant cluster simplification and one that was used only for schwa insertion, although they both essentially refer to a similar distinction.

When examining simplification, the motivation for simplification is adapted from the proposal in Côté (2004a) and refers to the difference between SSP violating consonant clusters and stop-final consonant clusters. When applied only to those clusters that are predicted to simplify, the variable ‘SSP’ then has two levels: 0 applies to stop-final consonant clusters and 1 applies to SSP violating consonant clusters.

\(^5\)For a complete understanding of the proposal, please read carefully (Côté, 2004a)
When examining schwa insertion, the motivation for simplification refers simply to whether or not a consonant cluster also participated in simplification and has two levels: ‘Simplify’ applies to consonant clusters that did present observations of simplifications (SSP violating and perceptually deficient stop-final consonant clusters) and ‘Stable’ applies to consonant clusters that did not present observations of simplification (all /u/-initial consonant clusters as well as /ks/).

3.1.4. Speech rate. Speech rate is a continuous variable that quantifies the rate of speech, measured in terms of pronounced phones per second. This measurement was obtained from the results of forced alignment of the data. During forced alignment, an optional short pause \{sp\} or silence phone \{sl\} is inserted between words. When it is realized (that is, when the short pause or silence phone has a duration of > 0.0 ms), it indicates that the acoustic record reflects an absence of speech signals for a brief period of time and that the two words were not co-articulated. Therefore, the number of realized phones in an interval of non-interrupted speech was counted and this number was divided by the duration in seconds of the interval to give a value for speech rate measured in phones per second.

4. Mixed-effect logistic regression models

The research questions being investigated are concerned with the effects of speech style, following context, motivation for simplification and speech rate on the variable pronunciations of word-final consonant clusters in two dialects of French. Of interest is whether the direction and strength of the relationship between these variables and outcomes of either simplification or schwa insertion were different between dialects. A related question concerns whether or not schwa insertion following a word-final consonant cluster is primarily used as an avoidance of simplification for speakers of French from Québec while schwa insertion following a word-final consonant cluster is primarily used as an avoidance of any sequence of consonants for speakers of French from France. Exploring these data suggested 5 main trends that helped to inform the selection of statistical models for investigation.

First, it was expected that the frequency of occurrences of word-final consonant cluster simplification would be higher in the dialect from Québec than in the dialect from France and that the frequency of occurrences of schwa insertion following a word-final consonant cluster would be higher in the dialect from France than in the dialect from Québec. In this corpus, this was true.

Second, given the proposal in Côté (2004a) it was expected that, for the dialect from Québec, the group of word-final consonant clusters investigated in this corpus would divide into two groups: A group that would participate in simplification (SSP violating and stop-final consonant clusters), and a group that would remain stable and not participate in simplification (all /u/-initial consonant clusters, as well as /ks/). This was indeed found to be the situation for the dialect from Québec. Interestingly, it appeared to also be the case for the dialect from France.

Third, the hypothesis advanced by Milne and Côté (2009) that schwa insertion would be more frequently observed in SSP violating and stop-final consonant clusters for the dialect from Québec was apparent in this corpus. It was expected that schwa insertion following a word-final consonant cluster in the dialect from France would be regularly observed in all the clusters investigated in this corpus. While only the stop+fricative
consonant cluster /ks/ did not provide any observations of schwa insertion for this dialect, there appeared to be a difference in rates of schwa insertion according to the type of consonant cluster similar to the difference observed in the dialect from Québec.

Fourth, with respect to the role of following context, it was expected that the frequency of occurrences of both simplification and schwa insertion following a word-final consonant cluster would be higher when the consonant cluster appeared in a pre-consonantal context than when it appears in a pre-vocalic context. This has generally been understood to illustrate the supportive effects a prevocalic environment lends to both the production and perception of word-final consonants. In this corpus, a pre-consonantal context appeared to be associated with higher than expected rates of both simplification and schwa insertion following a word-final consonant cluster in both dialects.

Finally, it was observed that an effect of speech rate might only be present for the spontaneous style of speech. In both dialects, there was little or no effect of speech rate on either simplification or schwa insertion (perhaps a small effect of rate on schwa insertion for the dialect from France) for the data identified as coming from read text (reading style), while the data identified as coming from a spontaneous speech style indicated that faster rates of speech were associated with higher rates of simplification and lower rates of schwa insertion.

These observations suggest that, in agreement with much previous research on simplification or schwa insertion following a word-final consonant cluster, the variables under consideration here all play a role in both explaining and predicting the variable pronunciations of word-final consonant clusters in both dialects.

In order to test these effects, mixed-effects logistic regression models were constructed. Two models were built: One predicting an outcome of simplification, the other predicting an outcome of schwa insertion. Fixed effects in both models included terms for Dialect (a categorical predictor with 2 levels: France and Québec), Style (a categorical predictor with 2 levels: Reading and Spontaneous), Motivation for Simplification (a categorical predictor with 2 levels: Simplify and Stable for the model with an outcome of schwa insertion or SSP and Non-SSP for an outcome of simplification), Vowel (a categorical predictor with 2 levels: Consonant, and Vowel), and a continuous predictor for Speech Rate. Random effects included intercept terms for Speaker and Cluster Type, since both speakers and consonant clusters in the corpus represent only a small sample of their populations. In light of the observations made during exploration, also included were terms for interactions between Style by Rate (to estimate the effects of speech rate at each level of speech style), Dialect by Motivation for Simplification (to estimate the effects of the phonological division of clusters at each level of Dialect), and Dialect by Vowel (to estimate the effects of following context at each level of Dialect).

4.1. Results for Simplification. The coefficients from the model predicting an outcome of consonant cluster simplification are presented below in Table 3. In the model, all 2-level categorical variables were sum coded while the continuous predictor of speech rate was scaled and centred. This coding scheme allowed any collinearity between the predictors to be handled and the main effects can all be interpreted as “effect of X when all other variables are held at their mean values”.
Random effects:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Name</th>
<th>Variance</th>
<th>Std.Dev.</th>
<th>Corr</th>
</tr>
</thead>
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<td>0.4516</td>
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</tbody>
</table>

Number of obs: 28095  groups: Speaker, 351  ClusterType, 12

Fixed effects:

|               | Estimate   | Std. Error | z value | Pr(>|z|) |
|---------------|------------|------------|---------|----------|
| (Intercept)   | -0.346957  | 0.178822   | -1.940  | 0.05235  |
| Dialect.FR    | -0.936998  | 0.054115   | -17.315 | <2e-16   | ***   |
| Style.R       | -0.649269  | 0.026038   | -24.935 | <2e-16   | ***   |
| Motivation.1  | -0.107861  | 0.172872   | -0.624  | 0.53267  |
| Vowel.C       | 0.654676   | 0.021941   | 29.839  | <2e-16   | ***   |
| SpeechRate    | 0.060060   | 0.010102   | 5.945   | 2.76e-09 | ***   |
| Style.R:SpeechRate | -0.025520 | 0.009702   | -2.630  | 0.00853  | **    |
| Dialect.F:Motivation1 | -0.182231 | 0.026752   | -6.812  | 9.63e-12 | ***   |
| Dialect.F:Vowel.C | 0.018121   | 0.021390   | 0.847   | 0.39690  |

Table 3. Table of coefficients predicting a change in the log-odds for an outcome of Simplification from mixed-effects logistic regression model.

4.1.1. Main effects. The estimated parameters from this model suggest significant main effects for Dialect, Speech style, Following context, and Speech rate. No significant effect was found for Motivation for simplification.

In accordance with many anecdotal reports, simplification of word-final consonant clusters was more likely in the dialect from Québec than from France. The parameter estimate for Dialect, comparing the mean of the dependent variable Simplify between the two dialects, was $-0.937$, which is statistically significant ($p < .000$). The z-value associated with this test is $-17.315$. The odds of a word-final consonant cluster being simplified in these data from France were significantly less than the odds of simplification in these data from Québec.

In support of previous conclusions, these data suggest that simplification of consonant clusters was significantly less likely in formal, as opposed to more casual, styles of speech. The estimate for Style, which compares the predicted probability of simplification between reading and spontaneous styles of speech, was $-0.649$ with a z-value of $-24.935$ with $p < .000$.

The main effect of following context found here also provides support for much previous research suggesting that simplification (and lenition processes in general) are more common in pre-consonantal, as opposed to pre-vocalic, contexts. The estimated difference in Simplify between following contexts of consonant and vowel is positive and statistically significant ($\beta = 0.655$, $z = 29.839$, $p < .000$). The odds that simplification would occur were higher when the consonant cluster was followed by a consonant-initial word than when it was followed by a vowel-initial word.

Similarly for speech rate, which has also been demonstrated to have an effect on cluster simplification: Faster speech rates are positively associated with more simplification. The
expected difference for every one unit increase in speech rate is 0.06 and is statistically significant \( (z = 5.945, p < .000) \).

No significant effect was found for Motivation for simplification. In these data, the estimated difference between consonant clusters that violate the SSP (i.e. those clusters that end in either /w/ or /l/) compared with clusters that end in a final, voiceless stop was \(-0.108\). The \( z \)-value associated with this test was \(-0.624 \) which was not significant \( (p = 0.533) \). The odds of simplification for both SSP-violating and stop-final consonant clusters were approximately equal.

4.1.2. Interactions. The estimated parameters from this model indicate that the effect of speech rate was not the same in both styles of speech and also that the difference between SSP-violating and stop-final consonant clusters was different depending on the dialect. The effect of following context appeared to be the same in both dialects.

Comparing the effect of speech rate between each level of speech style indicated that faster rates of speech were more strongly associated with higher rates of cluster simplification in spontaneous speech than in read speech \( (\beta = -0.026, z = -2.63, p = 0.009) \).

The expected difference between SSP-violating and stop-final consonant clusters was also not the same in each dialect. The parameter estimate comparing the difference between these two types of clusters between the two dialects was \(-0.182\). The \( z \)-value associated with this test was \(-6.812 \) which was significant with \( p < .000 \). This suggests that clusters ending with a final voiceless stop are less likely to be simplified in the data from France than in the data from Québec.

Finally, the effect of following context appeared to be the same in both dialects. The odds that a word-final consonant cluster followed by a consonant-initial word would be simplified in the data from France were approximately the same as in the data from Québec \( (\beta = 0.018, z = 0.847, p = 0.397) \).

Taken together, these results can be interpreted in the following way. The effects of speaking rate, style, and following context for word-final consonant cluster simplification all seem to point to it being a classic case of reduction: More deletion at higher speaking rates, in more spontaneous speech, and in phonological contexts where a sequence of consonants can be avoided. These factors are all well understood as having cross-linguistic validity. For example, reduction of final consonant clusters occurs in many languages – deletion of word-final coronal stops in clusters in English alone has a substantial literature (Schreier (2005); Hazen (2011) give reviews), and some references for Dutch can be found in Schuppler et al. (2011, 2012)). In particular, the following context effect of more deletion before consonants than before vowels seems to hold cross-linguistically, but certain clusters being exempt from simplification (as is the case here in French) seems more unusual.

4.2. Results for Schwa insertion. The coefficients from the model predicting an outcome of schwa insertion (presented below in Table 4), indicate significant main effects of Dialect, Speech style, Motivation for simplification, Following context, and Speech rate. Additionally, the interactions between Speech style and rate, between Dialect and Motivation for simplification, as well as between Dialect and Following context were all significant.

4.2.1. Main effects. As expected, and opposite from what was determined for simplification, schwa insertion following a word-final consonant cluster was more likely in the
Random effects:

<table>
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<tr>
<th>Groups</th>
<th>Name</th>
<th>Variance</th>
<th>Std.Dev.</th>
<th>Corr</th>
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<td>0.7554</td>
<td></td>
</tr>
</tbody>
</table>

Number of obs: 28095  groups: Speaker, 351  ClusterType, 12

Fixed effects:

|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | -2.305090 | 0.251725   | -9.157  | < 2e-16  *** |
| Dialect.FR     | 0.753316 | 0.051323   | 14.678  | < 2e-16  *** |
| Style.R        | 0.552228 | 0.025888   | 21.332  | < 2e-16  *** |
| Motivation.1   | -0.563082 | 0.248198   | -2.269  | 0.0233  *  |
| Vowel.C        | 0.442779 | 0.026748   | 16.554  | < 2e-16  *** |
| SpeechRate     | -0.060024 | 0.009855   | -6.090  | 1.13e-09 *** |
| Style.R:SpeechRate | 0.045773 | 0.009515   | 4.811   | 1.51e-06 *** |
| Dialect.F:Motivation.1 | 0.167840 | 0.030725   | 5.463   | 4.69e-08 *** |
| Dialect.F:Vowel.C | 0.287971 | 0.026527   | 10.856  | < 2e-16  *** |

Table 4. Table of coefficients predicting a change in the log-odds for an outcome of Schwa insertion from mixed-effects logistic regression model.

The parameter estimate for Dialect, comparing the mean of the dependent variable Schwa between the two dialects, was 0.753, which is statistically significant ($p < .000$). The z-value associated with this test is 14.678. The odds of schwa insertion in these data from France were significantly greater than the odds in these data from Québec.

Again in the opposite direction than simplification, these data suggest that schwa insertion was significantly more likely in formal, as opposed to more casual, styles of speech. The estimate for Style, which compares the predicted probability of schwa insertion between reading and spontaneous styles of speech, was 0.552 with a z-value of 21.332 with $p < .000$.

In this model, the term that tests for differences according to Motivation for simplification compares the odds of an outcome of schwa insertion between clusters that were predicted to simplify (in these data all SSP-violating and stop-final clusters) and those predicted to remain stable (clusters beginning with /n/ and /ks/). The estimated difference between these two groups of clusters was both negative and significant ($\beta = -0.563, z = -2.269, p = 0.023$), suggesting that the odds of schwa insertion following clusters not predicted to simplify were less than for clusters that did frequently simplify.

The main effect of following context found here suggests that schwa insertion was more common in pre-consonantal, as opposed to pre-vocalic, contexts. The estimated difference in Schwa between following contexts of consonant and vowel is positive and statistically significant ($\beta = 0.443, z = 16.554, p < .000$). The odds that schwa would be inserted were higher when the consonant cluster was followed by a consonant-initial word than when it was followed by a vowel-initial word.
Similarly for speech rate, which was also in the opposite direction from that found for simplification, faster speech rates were negatively associated with schwa insertion. The expected difference for every one unit increase in speech rate is $-0.06$ and is statistically significant ($z = -6.09, p < .000$).

4.2.2. Interactions. The estimated parameters from this model indicate that the effect of speech rate was not the same in both styles of speech and also that the difference between clusters predicted to simplify or remain stable was different depending on the dialect. The effect of following context also appeared to be the different depending on the dialect.

Comparing the effect of speech rate between each level of speech style indicated that faster rates of speech were more strongly associated with lower rates of schwa insertion in spontaneous speech than in read speech ($\beta = 0.046, z = 4.811, p < .000$). This was similar to difference between speech styles found for simplification. For both simplification and schwa insertion, the effect of speech rate was more strongly observed in spontaneous than in read speech.

The expected difference between clusters that simplify and those that don’t was not the same in each dialect. The parameter estimate comparing the difference between these two types of clusters in each dialect was $0.168$. The z-value associated with this test was $5.463$ which was significant with $p < .000$. This suggests that clusters that were predicted to remain stable (i.e. clusters that infrequently simplified) were more likely to have schwa inserted in the data from France than in the data from Québec.

Finally, the effect of following context appeared to be different between the dialects. The odds that a word-final consonant cluster followed by a consonant-initial word would have schwa inserted to break up the sequence of consonants in the data from France were higher than in the data from Québec ($\beta = 0.288, z = 10.856, p < .000$).

In general, this model predicting an outcome of Schwa seems to suggest that schwa insertion should be thought of as a careful speech process and that there are real differences between these two dialects. The effects of speaking rate and speech style indicate more schwa insertion at lower speaking rates and in more formal speech. This was true of both dialects. However, in the dialect from France, schwa insertion was more likely both before a consonant-initial word and in all clusters (both simplify and stable) than in the dialect from Québec. Taken together, the interpretation is that an inserted final schwa helps to avoid sequences of consonants in the dialect from France, while in the dialect from Québec, schwa is instead inserted as a way of avoiding cluster simplification.

4.3. Discussion. The results of this corpus analysis using more than 100 hours of natural language speech, which provided more than 28,000 observations of word-final consonant clusters for investigation, should help to clarify the role of many phonological and stylistic factors – such as the identity of the cluster, the following context, and speaking rate – in how likely each process (simplification or schwa insertion) is to apply. Hypotheses from previous work are largely borne out but in interesting ways. The effects of most factors on simplification and schwa insertion are qualitatively the same in the two dialects, but sometimes differ substantially in quantitative strength. The differences in the effects of different factors between the dialects points towards the most interesting finding of the paper, that the two processes are related in each dialect, but in different ways. Remarkably, there seems to have been almost no previous work discussing both simplification and
schwa insertion together, despite the fact that they target the same context (word-final clusters) in the same language. The results presented here suggest that the two processes are motivated by avoiding sequences of consonants in the dialect from France, but are complementary options for ‘repairing’ word-final consonant clusters in the dialect from Québec. The evidence in support of this interpretation can be found by understanding the different effects each of the factors had on the variable pronunciations of word-final consonant clusters in each dialect.

In the first place, the effects of speech rate and speech style appeared to be very similar between the two outcomes (simplification and schwa insertion) in both dialects. In the model predicting cluster simplification, as speech rates increased the odds of observing simplification also increased. This effect was greater in the spontaneous style of speech. In the model predicting schwa insertion, as speech rates increased, the odds of observing schwa insertion decreased. This effect also was significantly greater in the spontaneous style of speech. In fact, comparing the coefficients that describe the main effect of speech rate for each of the two outcomes (0.06 for simplification and −0.06 for schwa) along with the those that describe the main effect of speech style (−0.65 for simplification and 0.55 for schwa), it appears that the effects are nearly the same. The different valences of the coefficients, in combination with the significant interaction between the two factors, suggest that simplification of these clusters in French should be interpreted as a cross-linguistically common process of lenition while schwa insertion is more likely an effect of careful speech.

Turning to the effects of following context on either simplification or schwa insertion, some interesting differences emerge between the two dialects. The models indicated that, in agreement with much previous research, the pre-consonantal context is a significant predictor for both simplification and schwa insertion. In both dialects, the outcomes of simplification and schwa insertion were both more likely to occur when the consonant cluster was in a pre-consonantal context than when in a pre-vocalic context. However, the strength of this relationship suggests that there are dialectal differences. In the model predicting simplification, the effect of following context was very similar between the two dialects. In the data from both Québec and France, the odds of observing simplification were significantly lower when the consonant cluster was pre-vocalic and the change in these odds was approximately the same. Contrast this with the significant difference between the two dialects in the model predicting schwa insertion. This suggests that the effect of following context, with respect to schwa insertion, is not the same in both dialects. Even though the effect of following context was statistically significant in both dialects, the phonological role it plays as a “trigger” for schwa insertion as a repair for word-final consonant clusters may be much more pronounced in the dialect from France than in the dialect from Québec.

The interpretation of this should be that, while pronunciations of schwa are characteristic of more careful speech, the phonology required to explain its appearance must be different in each dialect. In these data from France, as has long been assumed to be the case, avoiding a sequence of 3 or more consonants has strong explanatory value. In these data from Québec, on the other hand, some other factor must be at work.

A likely candidate for this other factor in the dialect from Québec is the identity of the cluster itself, as suggested by the effect of motivation for simplification. There were two interesting observations about the distributions of simplification and schwa insertion.
following a word-final consonant cluster in both dialects. On the one hand, the list of 29 individual consonant clusters examined in these data appeared to divide into two groups with respect to word-final consonant cluster simplification. In the group identified as “Simplify” were all SSP violating and stop-final consonant clusters (excluding all /v/-initial clusters). These consonant clusters all had a significant proportion of simplified consonant clusters in their observed pronunciation variants. In the group identified as “Stable” were all /v/-initial consonant clusters as well as the stop+fricative consonant cluster /ks/. These consonant clusters all had no significant proportion of simplified consonant clusters in their observed pronunciation variants. This division into “Simplify” and “Stable” consonant clusters, with respect to consonant cluster simplification, follows from the predictions described in Côté (2004a) and was similar in both dialects. On the other hand, the list of 29 individual consonant clusters examined in these data did not appear to divide into two groups with respect to schwa insertion following a word-final consonant cluster. In the dialect from France, schwa insertion regularly occurred following almost every word-final consonant cluster in these data. Only the stop+fricative cluster /ks/ was not observed to participate in schwa insertion. This contrasts with the dialect from Québec where schwa insertion following a word-final consonant cluster was observed to regularly occur in all SSP violating clusters; was observed to less frequently occur in stop-final clusters; and was only observed following /um/ and /ut/ for those consonant clusters identified as being stable with respect to simplification. The results of the main effect of this division between “Simplify” and “Stable” consonant clusters suggested that schwa insertion was significantly more likely with SSP violating and stop-final clusters (Simplify) then other clusters (Stable). However the significant interaction between this term and Dialect indicated that this effect was much stronger in the dialect from Québec than from France: schwa insertion following “Stable” clusters was more likely in the data from France than from Québec.

When combined with the fact that the strength of the relationship between following context and schwa insertion was significantly less strong in the dialect from Québec, it gives rise to the hypothesis that schwa insertion may be motivated as an avoidance of simplification in the dialect from Québec, while it is motivated by a more general principle that seeks to avoid sequences of any consonants in the dialect from France.

5. Conclusion

The results discussed above are interesting because they confirm many conclusions of previous work on these two processes, which were largely made based on introspection or laboratory experiments, and demonstrate how these earlier claims are borne out as statistically significant patterns in real world speech. The effects of speech rate, speech style and following context all suggest a cross-linguistically common pattern of reduction. The analyses conducted here conclude that simplification of word-final consonant clusters is more frequent at faster rates of speech, in less formal speaking styles, and in contexts where a sequence of consonants can be avoided. The effects of speech rate and speech style suggest that schwa insertion might be better considered as a marker of careful speech.

More interesting is what these results seem to indicate about the relationship of schwa insertion and simplification to each other within each dialect. The main hypothesis is that the relationship between these two processes is different within in each dialect. In
the dialect from France, the analyses presented here provide evidence that both schwa insertion and simplification work together to avoid sequences of consonants. In effect, in this dialect these two phenomena may be conspiring (Kisseberth, 1970) to avoid sequences of consonants. In the dialect from Québec, while simplification exists to avoid specific sequences of consonants (similar to the dialect from France), schwa insertion serves to avoid simplification.

The evidence in support of this view can be found primarily in two places. First, the fact that schwa insertion was observed to regularly occur following all but one of the investigated clusters in the dialect from France, while schwa insertion occurred almost exclusively following only those clusters that also participated in simplification in the dialect from Québec. Second, the much larger effect of following context on the outcome of schwa in the dialect from France than in the dialect from Québec, and the fact that the effect of following context was very similar for both simplification and schwa in the dialect from France. In the dialect from Québec, knowing something about a consonant cluster’s frequency of simplification helps to know whether or not schwa insertion may also occur following that consonant cluster. In the dialect from France, knowing something instead about the following context helps to know whether or not schwa insertion will occur.

In conclusion, the results presented in this large sample corpus analysis suggest that the dialectal differences between Québec and France, with respect to the variable pronunciations of word-final consonant clusters, are not as simple as “simplification in Québec, schwa insertion in France”. While the results presented here suggest that the process of simplification following a word-final consonant cluster is similar in both dialects, the process of schwa insertion is likely to be different in each dialect. Word-final consonant cluster simplification appears to be explained equally well in both dialects by the proposal presented in Côté (2004a), although the constraints protesting against a perceptually deficient final stop consonant may be less strongly observed in the dialect from France. In both dialects the direction and strength of the relationship between following context and simplification is similar: Word-final consonant cluster simplification is more likely in a pre-consonantal context. In both dialects the direction and strength of the effects of the interaction between speech style and speech rate are similar: Word-final consonant cluster simplification is more likely in a spontaneous speech style and in that speech style is positively associated with speech rate. Schwa insertion following a word-final consonant cluster displays much stronger dialectal differences. Schwa insertion in the dialect from France is more strongly affected by following context and the process of simplification has little explanatory value. Schwa insertion in the dialect from Québec is not affected by following context and the process of simplification has strong explanatory value.

References


