THE PHONETICS AND PHONOLOGY OF LIAISON CONSONANTS IN MONTREAL FRENCH

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ABSTRACT

This thesis investigates the behaviour of liaison consonants (LCs) in Montreal French from both a phonetic and a phonological perspective. LCs are consonants that surface between two words only if certain phonological, syntactic, lexical, and socio-indexical factors are met. The main question addressed here pertains to the syllabic affiliation of these consonants.

Based on previous research on acoustic and articulatory cues of syllable affiliation, I designed and conducted two experiments comparing the acoustic and kinematic behaviour of LCs with the behaviour of non-alternating codas and onsets. The results are presented and then discussed through the lense of two phonological frameworks: Articulatory Phonology (AP) and Selection & Coordination Theory (SCT). I conclude that LCs in Montreal French syllabify as non-canonical codas.

BIOGRAPHICAL SKETCH

Marie-Josée L'Espérance was born in Montréal (Québec). She completed an undergraduate diploma in archive management from Université de Montréal in 2008, before going on to complete a B.A. in linguistics from Concordia University in 2011.

She started the PhD program in linguistics at Cornell University in the fall of 2011, and graduated with a masters in August 2015. Upon graduation, she returned to Montréal, where she is hoping to find a teaching position in one of the local CÉGEP as a second language instructor.

To Pascal, for everything.

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CHAPTER 1

INTRODUCTION

1.1 Overview of the Thesis

This thesis looks at liaison as a phonological phenomenon in the Montreal dialect of Canadian French[1] by investigating and comparing the acoustic and kinematic properties of segments at word edges. Liaison consonants (henceforth LCs) are traditionally defined as word-final segments realized in prevocalic contexts, but unrealized in other contexts. While the traditional definition presents LCs as "word-final consonants", the phonological status of LCs is still very much an object of debate in contemporary phonological literature. The main goal of this thesis is to contribute to this debate by investigating the phonetic properties of LCs in the Montreal dialect and discuss how these properties can inform the understanding of the phonological structure of LCs.

Research on the phonetics and phonology of word-boundaries has shown that segments that syllabify as codas behave differently than segments that syllabify as onsets. Therefore, the main hypothesis is that comparing the behavior of LCs with that of non-alternating (canonical) codas and onsets will provide insight into their underlying syllabification. I argue that the traditional dichotomy of coda and onset is not satisfactory to account for the experimental data presented here and in previous experimental studies. I introduce two frameworks that allow us to explore a more

[1] For clarification on dialect names, see section 1.3.

non-binary conception of syllabification, namely Articulatory Phonology (AP) and Selection & Coordination Theory (SCT). I conclude that both LCs and non-alternating codas syllabify as word-final consonants; the difference between the two resides in how the consonantal gestures are selected and coordinated with the nucleus gestures.

The structure of this thesis is as follows: in this chapter I introduce basic data concerning liaison and the dialect used in this study, as well as our motivation for using this particular variety of French. In Chapter 2, I provide an overview of the theoretical and experimental work conducted on liaison since the sixties, focusing on the main analyses proposed for the syllabification of LCs. In Chapter 3, I provide a detailed discussion of possible acoustic cues for the syllabification consonants in coda and onset position, and how these cues can serve as evidence for the syllabification of LCs. In Chapter 4, I present the results of a phonetic and compare these results with the previous experimental results presented in Chapter 3. In Chapter 5, I present an analysis of LCs within the frameworks of Articulatory Phonology (AP) and Selection & Coordination Theory (SCT). In the conclusion, I provide a summary of the thesis and potential directions for future work.

1.2 Liaison: Data and Definition

LCs are consonants that surface between two words, traditionally referred to as Word1 and Word2, if Word2 is vowel-initial. Therefore, the main factor influencing the realization of LCs is phonological. In (2) we see a token of liaison in

[z] with the numeral adjective *trois*, while examples (1) and (3) show the same word in isolation, and before a consonant-initial word, where the LC does not surface.

(1) trois	[tʁwa]	→ no liaison	'three'
(2) trois amis	[tʁwa**z**ami]	→ **liaison**	'three friends'
(3) trois copains	[tʁwakopɛ̃]	→ no liaison	'three friends'

As mentioned above, in the traditional literature LCs are typically analyzed as codas. However, since the object of this thesis is precisely to question that assumption, I will use a neutral definition, as found in Côté (2008: 64): "Liaison corresponds to the pronunciation of a consonant between two words in certain liaison-triggering contexts." The discussion below reviews in details the interactions between the phonological context and the liaison-trigerring contexts mentioned in Côté's definition.

The examples from (4)-(7) illustrate that liaison is not, as might appear at first sight, a repair mechanism to avoid vowel hiatus; indeed French tolerates vowel hiatus reasonably well (see Appendix 1, section 1.2 for more details).

(4) petit ami	[pt^{s}i**t**ami]	'boyfriend'
(5) joli ami	[ʒoliami]	'good-looking friend'
(6) des huîtres	[de**z**ɥɪt]	'some oysters'
(7) des huit	[deɥɪt]	'eight (pl.)'

The pairs in (4)-(5) and (6)-(7) illustrate that liaison must be at least partially lexicalized: in the same context, some words trigger liaison and others do not. For the pair in (4)-(5), the presence (or absence) of the LC is determined by Word1. Historically, we can easily explain why *petit* triggers liaison while *joli* does not, but this information needs to be stored, rather than derived, for modern-day speakers. For the pair in (6)-(7), Word2 determines whether the [z] LC is pronounced or not. Since the surface form of *huîtres* and *huit* is the same (in this particular dialect), the presence (or absence) of LCs cannot be predicted solely by the phonological context, which again shows that at least part of the information pertaining to liaison needs to be stored.

Liaison is not only sensitive to the phonological and lexical contexts, but also to the syntactic structure.

(8) marchand de *draps anglais*	[dʁa**z**ɑ̃glɛ]	'merchant of english sheets'
(9) marchand de *draps anglais*	[dʁaɑ̃glɛ]	'English merchant of sheets'

In examples (8)-(9), the structural difference between the two strings is reflected in the difference in liaison: only in the case where *anglais* modifies *draps* does the LC appear. The syntactic conditions on liaison are ill-defined in the literature, but it is generally agreed that for a LC to surface, Word1 and Word2 need to be in a 'close syntactic relationship'.

Liaison is further divided into two categories: obligatory liaison, in which the LC **must** be realized for the string to be grammatical, and optional liaison, where the string is grammatical whether the LC is realized or not.

(10) les hommes heureux [le**z**ɔm(**z**)œʁœ] ‘the happy men’

This is illustrated in example (10), where the first liaison in [z] between the determiner *les* and the plural noun *hommes* must be realized, while the realization of the second liaison in [z] between the plural noun *hommes* and the adjective *heureux* is conditioned by sociolinguistic factors.

1.3 Using data from “non-standard” dialects: Canadian French

Work on French, especially work on liaison, mostly relied on Standard French (SF) as its primary source of evidence until about a decade ago. There has been, however, a certain lack of consensus on what constitutes SF. To quote Durand & Lyche (2008: 35):

> Even if many specialists agree on restricting SF to a geographical area (Paris) and to a social norm, that of educated speakers, the circumscription of French remains hard. This circumscription has been made worse by the fact that descriptions of French have regularly been extended in a variety of often conflicting directions.

Adding to this ill-defined concept is the fact that a lot of the early accounts of liaison are based on normative treatises, written for teaching or corrective purposes[2].

[2] Selkirk (1974) used Fouché's (1959) reference book aimed primarily at foreign students and teachers as her main source (Durand & Lyche 2008, p.35).

This thesis is part of an effort to reverse this trend and expand linguistic inquiry to other dialects (see most notably the Projet de Français Contemporain, Durand, Laks & Lyche, 2002, 2009 <www.projet-pfc.net> and associated articles). To a large extent liaison is tied to orthography, education, and prescriptive pronounciation rules dictated by normative bodies such as the *Académie de la Langue Française*. Using a dialect that is one ocean removed from part of that pressure might allow us to observe a more natural behavior from speakers. Encrevé (1988:112) noted that scholars working on Canadian French had a greater propensity to rely on data from the community than to use the classical sources: "[…] travailler sur le français au Canada, où l'écoute quotidienne rend extrêmement sensible le caractère limité des sources «classiques», conduit assez naturellement à une conception variationniste de la langue." ([…] working on French in Canada, where daily listening makes the limited nature of the 'classical' sources extremely obvious, leads quite naturally to a variationist conception of the language.) In addition, Canadian French displays two phonological processes sensitive to syllable and word boundaries, key phonological contexts in a discussion of syllabification. These processes are absent from the standard variety (see Chapter 3 for details).

A technical sidenote is required before we go any further. The nomenclature of French varieties in North America is a deeply political issue. My wish is to remain as apolitical as possible, and I am therefore making an effort to choose neutral terms. Canadian French is a general term that covers two very distinct dialect families of French spoken in Canada: Acadian French and Laurentian French. This thesis focuses on the French spoken in Montreal and its surrounding suburbs, which is a sub-variety of Laurentian French. Throughout the rest of this thesis, I will use the term Montreal French to designate the dialect I am primarily concerned with. I am aware that some features that will be discussed here are absent in other sub-varieties, and vice-versa, and I made an effort to mention these differences to the best of my knowledge.

CHAPTER 2

LIAISON IN THE LITERATURE

2.1 Liaison within the Generative Framework (and beyond)

> Il peut paraître surprenant que des décennies de recherche sur la liaison n'aient pas fourni de réponses plus claires à la question du status lexical des CL. Le maintien de l'incertitude s'explique en partie par la nature du débat, qui s'est largement concentré sur des arguments formels plutôt qu'empiriques, et par l'éventail plutôt limité des données généralement considérées. (Côté 2005:66)

> It may seem surprising that decades of research on liaison did not provide a clearer answer to the question of the lexical affiliation of LCs. The incertitude is explained in part by the nature of the debate, which has largely used formal arguments rather than empirical ones, and by the limited body of evidence generally taken into account.

Morrison (1969) cited in Morin (2011:385) listed some 200 studies at least partly concerned with liaison between the year 1800 and 1968. Adding to that number all the work from Schane (1968) to today's latest experiment, and the surprised expressed in the quote above is easily understandable. It is beyond the scope of this thesis to provide an account of all the theories and conceptualizations of liaison through the ages. This section, therefore, will focus specifically on the various representations of LCs and leave aside the derivational aspect. I will focus particularly on three different representations: codas of Word1, independent segments, and onsets of Word2. For more comprehensive background, see Encrevé (1988), Davis (2000), and Mallet (2008).

In Côté's extensive work on the phonological affiliation of LCs (2005, 2008, 2010, 2011, 2012, 2014), she noted that the variability in the different analyses of LCs was such that it covered all the possibilities, from codas of Word1 to onsets of Word2. The table below provides a summary of the analyses that will be presented here, and is adapted from Côté (2010: 1280).

Lexical representation	Type of analysis	Example
Codas of Word1	Truncation	/tʁwa**z**/ /ami/
	Autosegmental	/tʁwa(**z**)/ /ami/
Independant	Epenthesis	/tʁwa/ /ami/
	Constructionnism	/tʁwa **z** ami/
Onset of Word2	Suppletion	/tʁwa/ /**z**ami/

Table 1: Lexical affiliation of LCs and types of analyses presented in the literature.

In addition to the three options presented here, morphological analyses have also been proposed, where LCs are either seen as a suffix of Word1 or a prefix of Word2. These analyses are marginal and usually restricted to a subset of cases, and therefore will not be included in this review. See Côté (2011) and references therein for more information.

2.1.1 LCs as codas of Word1

The main appeal of the coda analysis is that it follows naturally from the historical development of liaison, which came to be due to the gradual loss of final consonant before consonant-initial words and pauses (Côté 2011:2685). The coda analysis has the added benefit of following the orthography, which was an influential factor in the early work on liaison, as most analyses relied on written and standardized corpora. This analysis is found in the vast majority of liaison studies, especially in the early generative phonology period. It has been implemented in a number of different ways, two of which stand out: the truncation analysis and the autosegmental analysis. The following subsections review the basic ideas conveyed in each.

2.1.1.1 Truncation analysis

Schane (1965, 1968) was a pioneer of proposing the famous French Truncation Rule, by which a word-final coda consonant would be deleted if the following word was consonant-initial. In his view, there was no underlying difference in syllabification between LCs and other non-alternating final consonants. To preserve non-alternating final consonant from deleting in the truncation environment, he relied on a protective schwa that would delete later in the derivation, yielding the following representations for non-alternating codas and LCs:

(11) (a) Final non-alternating consonant	(b) Liaison consonant
/# … C V C ə #/	/# … C V C #/

By formulating his rule the way he did, Schane managed to encompass both liaison and elision, which was seen as an important advantage of the analysis, given the similarities between the two phenomena. However, to do so he had to limit himself to cases of non-liaison, that is cases in which LCs **did not** surface. By doing this, he missed the most crucial aspect of liaison: its variability (Encrevé 1988:90). However, Schane's analysis was so welcomed by phonologists that the essence of his Truncation Rule survived for more than a decade, even after the author himself repudiated the idea.

2.1.1.2 Autosegmental analysis

Non-linear phonology introduces the concept of latent segments, that is segments that are deficient at some level of representation. The specific level at which the deficiency is attributed varies according to different framework, but the main propositions are deficiency at the skeletal tier, at the syllabic tier, or at both (Encrevé 1988; see Tranel 1995 for further discussion). The following example provides an agnostic representation of the latency of LCs, as opposed to parsed (i.e.: non-alternating) consonants:

(12) (a) Final non-alternating consonant

```
XXXXX
| | | | |
CVCVC
```

(b) Liaison consonant

```
XXXX
| | | |
CVCVC
```

In the example (12) above, the final consonant in (a) is parsed into the prosodic structure (i.e.: it is linked to a tier), while the final consonant in (b) is not parsed into the prosodic structure (i.e.: there is no link between the melodic tier and a skeletal or syllabic tier). In these analyses, LCs are underlyingly associated with Word1, as floating codas, but they are realized as onsets of the following word if there is an empty position into which the latent consonant can be parsed (in the majority of cases, see Encrevé 1988 for cases of *liaison sans enchaînement*).

(13) (a) Latent consonant (no liaison)   (b) Latent consonant (liaison)

```
XXXX    XXXXX          XXXX     XXXXX
| | | |    | | | | |          | | | |       | | | |
CVCVC   CVCVC          CVCVC    VCVC
```

The examples in (13) illustrate a necessary assumption within the non-linear framework, namely that vowel-initial words have an available, empty slot into which a latent consonant can be parsed. Tranel (1995: 146) states that, “when these consonants [LCs] are phonetically realized, they syllabify unexceptionally”. We will see in Chapter 5 that this assumption (and the binarity of syllabification that underlies it) is challenged by the more recent experimental work.

2.1.1.3 Optimality Theory

Tranel (1996) sees liaison as an output-driven phenomenon, a way to “yield a better output in terms of syllable structure, specifically with respect to ONSET satisfaction” (1996:433). While OT is known to move the debate away from the question of representation, Tranel, and later Davis (2000), assume the same basic notion of latent final consonant that was present in autosegmental analyses. They also assume that LCs fully resyllabify as onsets of the following word to satisfy the ONSET constraint. Again, the problem that this binary conception of syllabification poses will be discussed in Chapter 5.

2.1.2 LCs as independent segments

This type of analysis typically eschew the question of lexical affiliation by positing that LCs are independent from either Word1 or Word2. I review two ways in which LCs are analyzed as independent: the epenthetic analysis and the constructionist analysis.

2.1.2.1 Epenthesis

Epenthesis analyses are, in a way, the opposite of the truncation analyses presented in section 2.1.1.1. Where truncation viewed LCs as final segments syllabifying as codas of Word1 and deleting in the proper environment, epenthesis analyses view LCs are affiliated with neither Word1 nor Word2, but as segments inserted via a grammatical process (Klausenburger 1974; Tranel 1981; Côté 2005, 2008). Of Klausenburger, Encrevé argues that, "[il] ne précise jamais par quel méchanisme formel la grammaire sélectionne pour chaque mot la CL particulière à épenthétiser […] ([he] never specifies the formal mechanism by which the grammar selects the appropriate LC for each word […]) (1988: 105).

In his analysis of prenominal adjectives, Tranel (1981:237-238) addresses this issue by postulating a rule that inserts a consonant between all masculine singular adjectives and a following noun, the nature of which is lexically specified. Adjectives for which there is no specification (that is, adjectives like *joli* that do not trigger liaison) receive a null phonetic realization. This analysis distinguishes itself from the truncation analyses in two major ways: on the one hand, the mechanism to derive liaison forms is one of insertion rather than deletion; on the other hand, Tranel considers LCs to be, "idiosyncratic phonological markings which are simply part of the lexical entries", rather than, "part of the phonological representations" (1981:238), which was the standard assumption in the previous section. Tranel remains vague about how his distinction is implemented, leaving the reader to ponder the difference between the two.

Côté (2005) uses acquisition data to argue that epenthesis is actually the final stage of liaison acquisition. She uses the notion of lexical economy to motivate that last step: once the child learns the appropriate liaison forms and contexts, the correct LC becomes predictable by the environment (i.e.: the phonological and syntactic contexts). Thus, encoding LCs as either codas of Word1 or onsets of Word2 becomes redundant information since their realization is predictable from the context (2005: 69). She is careful not to generalize this analysis to all kinds of liaison, but only to a subset, like liaison occurring between a prenominal adjective and a noun.

2.1.2.2 Constructionnist approaches

According to Bybee (2001, 2005), the fact that liaison, as opposed to a phenomenon like English flapping, requires more than the appropriate phonetic environment to be applicable is evidence that phrases and constructions are stored in the lexicon, just like words. In her analysis, she does not distinguish between a word-medial consonant and a liaison consonant: both are embedded within a lexically-stored chunk.

Bybee proposes a distinction between **phrases**, which encompass such lexicalized expresssions as *c'est-à-dire* ('that is to say'), and **constructions**, which include only sequences that have open slots for grammatical material. For example, for the plural liaison between a noun and an adjective, she proposes the following constructions:

(14) [DET (PL) NOUN ADJECTIVE]$_{\text{PLURAL}}$

(15) [DET (PL) NOUN -Z- [vowel]-ADJECTIVE]$_{\text{PLURAL}}$

The first construction in (14) represents adjectives that are consonant-initial, and therefore do not trigger liaison, while the second is used for vowel-initial adjectives. Bybee's analysis is reliant on frequency of use, and therefore it captures one of the crucial aspect of liaison that few other type of analysis do: its variable nature. She argues that since the construction in (14) is more general, and therefore more frequently used than the construction in (15), it might be selected in contexts where (15) would have been appropriate, leading to an apparent levelling out, or loss of liaison-triggering contexts. The tendency for optional liaison to disappear in many contexts was observed prior to Bybee's work, most notably in Ågren (1973). It was also Ågren (1973) who noted that higher frequency of use seemed to equate higher frequency of realized liaison (in cases of optional liaison). To account for this, Bybee proposes more specific constructions for very frequent words or combinations of words, such as seen in (16):

(16) [DET (PL)   NOUN   -Z-   anglais]$_{\text{PLURAL}}$

The distinction proposed between fixed phrases, which are listed in the lexicon, and productive liaisons, which are derived, is a necessary distinction that must be incorporated into any adequate theory of liaison. However, one of the main problems with the constructionnist model as envisioned by Bybee is that it leaves little to no place for abstraction and derivation. While it recognizes the importance of morphological and lexical factors, it obscures the fact that liaison remains, at its core, a phonological phenomenon.

2.1.3 LCs as onsets of Word2

This type of analysis is significantly more marginal than the first two (see Côté 2011 for discussion). It is typically reserved for imperative constructions and third person subject inversion (Côté 2005, 2008), as in the examples below:

(17) vas-y [vazi] ‘go there (3rd sg, imp.)’

(18) dit-elle [d^{z}itɛl] ‘she says’

It is assumed that the examples in (17) and (18) are lexicalized as [zi] and [tɛl] respectively (Côté 2011: 20). This analysis is mainly motivated by familiar forms such as (19), as opposed to the standard form given in (20):

(19) donne-moi-en [dɔnmwa**z**ã] ‘give me some’

(20) donne-m'en [dɔnmã] ‘give me some’

To my knowledge, only Ternes (1977, cited in Côté 2011) proposed a more general onset analysis for LCs, an analysis similar to that of Celtic mutation consonants (see Côté 2011 for a brief discussion).

2.2 Experimental approaches

There was in shift, in the early 2000s, to move the debate around liaison from the classical, prescriptive sources to more empirical and descriptive data sources. This section summarizes the findings of the key papers that shaped the current study.

An important focus of investigation in recent experimental work has been the mismatch between syllable and word boundaries. The term *enchaînement* is defined as the resyllabification of coda consonants at the onset of the following syllable even across word boundaries. This process, which affects both non-alternating codas and

LCs, creates a misalignment between the syllable the final consonant occupies and the word it is assumed to be affiliated with (Word1), as seen in examples (21)-(22) below:

(21) petite amie	[ptˢɪ.t#a.mi.]	‘girlfriend’
(22) petit ami	[ptˢi.t#a.mi.]	‘boyfriend’

The hypothesis that this mismatch would impede or slow word recognition was tested in several studies (see most notable Gaskell et al. 2002; Spinelli et al. 2003), none of which found evidence of any processing cost in accurately perceiving and recognizing strings of words containing LCs. Gaskell et al. (2002:803) concluded that “[…] if resyllabification does impede the recognition of the following word, the effect is swiftly offset by the segmental information in the speech stream”. They entertained the idea that resyllabification might be partial, and therefore that LCs might present different acoustic markings than non-alternating onset consonants (or non-alternating coda consonants). These differences in the acoustic signal, “could be used to counter the negative effects of word boundary misalignment or, possibly, even facilitate processing” (2002:800).

Nguyen et al. (2007) reported on two experiments on the perceptual status of LCs: their own, and the unpublished dissertation of Wauquier-Gravelines (1996). Both experiments consisted of an explicit phoneme-detection task, where listeners where asked to identify prespecified phonemes ([n] and [t] in Wauquier-Gravelines (1996), [n] and [z] in the original Nguyen et al. (2007) study). Both data sets showed that, "listeners experienced greater difficulties in detecting the liaison than the word-initial consonants" (2007:20). If we look in more detail at the experiment conducted by the authors, we can establish the detection rate seen in Figure 1.

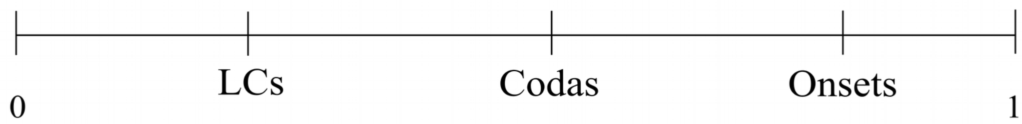

Figure 1: Detection rate in a phoneme-detection task according to consonant type. Adapted from data from Nguyen et al. (2007).

From the experiments described above, we can draw two seemingly opposing conclusions: a) that listeners are sensitive to the presence of LCs in the signal, and b) that the same listeners will have a lower detection rate for LCs than for any other type of consonants. This is a fact that Nguyen et al. (2007:19) highlight, and they attribute it to the, "specific status liaison consonants have in French phonology". The authors elaborate that this "specific status" makes LCs facilitative markers in word recognition and identification, but also, "harder to map onto 'ordinary' phonemic categories" (2007:19).

2.3 Conclusion

In the first part of this chapter, I presented the main analyses that have been proposed for LCs since the sixties. We can roughly divide these analyses into three categories: analyses that assume that LCs are syllabified as the coda of Word1, analyses that assume that LCs are syllabified as the onset of Word2, and analyses which assume the phonological independence of LCs.

The main issue with the first two kinds of analyses is that they rely on a strictly binary conception of syllabification. In other words, syllabification is assumed to be a categorical process where consonants can syllabify in one of two positions: coda or onset. However, in the second part of this chapter, we presented studies that illustrate the inadequacy of this vision. LCs are found to be inherently different than non-alternating onsets and codas, hinting that syllabification might either require more categories than the traditional binary conception allows, or be a more gradient phenomenon than previously expected. This issue will be discussed further in Chapter 5.

The second kind of analysis is more variable in its deficiencies. The epenthetic analyses eschew the syllabification problem pointed out above, but in our view they fail to adequately address how the appropriate epenthetic material is selected. This echoes Encrevé's (1988) critique of Klausenburger (1974), but extends beyond that: Tranel (1981) outlined with the most detail the process through which epenthetic LCs are selected, and yet he had to resort to include LCs as part of the lexical entries of each adjective[3]. Bybee's (2001, 2005) constructionnist approach had the advantage of capturing the variability and the tendency towards levelling shown in optional liaison. However, because LCs are treated like any other word-medial consonant, it fails to account for what Nguyen et al. (2007) called LCs' special status.

[3]As I already discussed, he makes a crucial distinction between the epenthetic LCs, which he calls "idiosyncratic phonological markings part of the lexical entries", and other phonological content more traditionally "part of the phonological representations" (1981:238). However, I feel that this distinction is rather hard to uphold outside of this particular context.

Treating LCs like any other consonant fails to highlight the fact that LCs are interesting precisely because they do not behave like any other consonant in the language.

The second part of this chapter presented more recent, experimental studies on liaison. Perceptually, LCs seem to be weaker than other consonant types, being missed in the speech signal more than codas and onsets. However, word-recognition studies showed that LCs leave their own particular acoustic markings in the speech stream, making it easier to recognize them as such. In the next section, we will look in more detail at these potential acoustic markers, and how they vary across consonant types.

CHAPTER 3

EVIDENCE FOR SYLLABIFICATION

3.1 Acoustic Correlates of Syllabification

Previous research has shown that consonants syllabifying as codas exhibit different acoustic and articulatory properties than consonants syllabifying as onsets. This section examines the possible phonetic correlates of syllabification as found in various experimental studies on French. While there is a lack of consensus, this section aims to present the key experimental findings and how they relate to the experimental design of the work presented here.

In the examples below, we can observe a difference in underlying grouping between (23), where the second [t] is a coda, and (24), where the second [t] is an onset, and (25), where the affiliation of the second [t] is uncertain.

(23) petite amie	/pə.tit.a.mi/	‘girlfriend’
(24) petit tamis	/pə.ti.ta.mi/	‘small sieve’
(25) petit ami	/pə.ti <t> a.mi/	‘boyfriend’

On the surface, however, due the *enchaînement*, the same three pairs of adjective+noun in (26)-(28) are expected to be completely homophonous, with the expected pronunciation and syllabification for Standard French:

(26) petite amie	[pə.ti.ta.mi]	‘girlfriend’

(27) petit tamis [pə.ti.ta.mi] ‘small sieve’

(28) petit ami [pə.ti.ta.mi] ‘boyfriend’

As a result of *enchaînement,* all three pairs exhibit the same surface syllabification. Due to the resulting homophony, we might expect a processing cost for the vowel initial word *ami/amie*, where there is a mismatch between word boundary and syllable boundary. However several perceptual studies (Gaskell et al. 2002; Spinelli et al. 2003) found no evidence of processing cost when comparing strings of the type *petit ami* with strings of the type *petit tamis*. On the contrary, both studies cited above found that liaison and *enchaînement* contexts favoured the activation of vowel-initial words, effectively creating a positive bias rather than a processing cost.

The main acoustic cue that is usually considered is duration, especially the target consonant duration, but also the preceding vowel duration . Montreal French provides two additional acoustic cues, namely vowel laxing and affrication of alveolar stops.

3.1.1 Segment duration

A variety of durational cues have been collected throughout various phonetic and psycholinguistic experiments, but only two specific cues are considered here: target consonant duration, and preceding vowel duration. In general, LCs have been found to be significantly shorter than underlying onset consonants (Gaskell et al. 2002; Spinelli et al. 2003). Spinelli et al. (2003) reported measurements for [p, r, t, n, g] in liaison position (64 ms) and onset position (71 ms), a statistically significant difference. For a different set of consonants ([t, r, z]), Gaskell et al. (2002) reported a measure of 73 ms and 74 ms for consonants in liaison and coda position respectively, and a measure of 88 ms for the same consonants in onset position, a significantly significant difference ($t(47)=2.2$, $p<.005$). In their 2007 paper, Nguyen et al. found that [z] was significantly longer in onset position than in coda position, but found no significant difference between consonants in liaison position and consonants in either onset or coda position. Yersin-Bersin & Grosjean (1996, cited in Gaskell et al. 2002, p.804-805) compared pairs of consonants in liaison and onset position, and found that LCs were 10% shorter in duration than consonant in onset position, a number that is corroborated by Spinelli et al. (2003).

Nguyen et al. (2007) also investigated the duration of the preceding vowel. They found that the vowel preceding [z] or [n] in coda position was significantly longer than a vowel preceding the same two consonants in either liaison or onset position. The vowel was also significantly longer when the syllable was closed by [z], as vowels surface as long before a voiced fricative. Spinelli et al. (2003:239) reported a marginally significant difference between vowels preceding a LC and vowels preceding an onset. Similarly Martin (2002), reporting on the vowel system of native Quebec French speakers, concluded that vowels are longer in closed syllables. On the other hand, Poliquin (2006:29) found that most speakers exhibited a tendency to have longer vowels in open syllables than in closed syllables. However, it is important to notice that Poliquin was reporting strictly on [high] vowels, which show an allophonic variation between tense and lax vowel that is directly related to syllable structure (see section 3.1.2 below for more details). Figure 2 presents a schema of relative duration of both vowels and consonants according to the studies cited in this section[4].

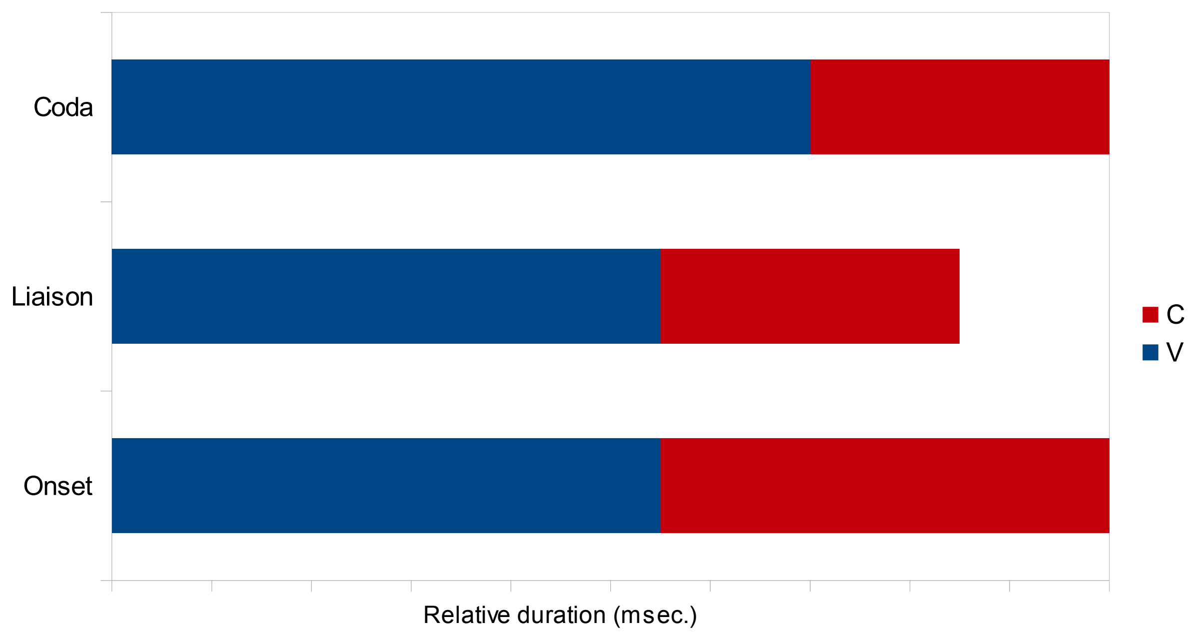

Figure 2: Schematic relative duration of vowels (V) and consonants (C) across all three consonantal contexts.

3.1.2 Vowel laxing

Table 2 gives the surface inventory of non-nasal vowels of Montreal French. We can see that, while the tense/lax distinction is phonemic for mid vowels, it is considered allophonic for high vowels.

4 I have excluded the results reported in Poliquin (2006) due to the nature of his data.

		front		back	
		unround	**round**	**unround**	**round**
high	**tense**	i	y	–	u
	lax	(ɪ)	(ʏ)	–	(ʊ)
mid	**tense**	e	ø	–	o
	lax	ɛ	œ	–	ɔ
low	**tense**	–	–	–	–
	lax	a	–	ɑ	–

Table 2: Surface inventory of vowels in Montreal French. Lax allophones are given in parentheses. Adapted from Poliquin (2006:5-6).

High vowel laxing is a characteristic feature of Montréal French[5] that is heavily dependant on syllable structure and position. Côté (2010) describes the phenomenon as categorical within closed, final syllables[6], and variable in non-final syllables. In non-final position, laxing can be triggered by vowel harmony (see Poliquin 2006 for details) if the syllable is open, or depends on the nature of the consonant in coda position if the syllable is closed (see Côté 2008 for details). The examples below illustrate vowel laxing in various environments, with the SF pronunciation given to the right:

(29) fille	[fɪj]/[fij]	‘girl, daugther’
(30) pillule	[pɪ.lʏl]/[pi.lyl]	‘pill’
(31) dégoutte	[de.gʊt]/[de.gut]	‘to drip (pres. tense)’

5 It is worth noting that this phenomenon tends to disappear as one travels eastward along the St-Lawrence River. Speakers native to the area of Gaspésie naturally produce words like example (27), fille, as [fij].

6 Unless the syllable is closed by a voiced fricative, in which case the vowel surfaces as tense (and long).

(32) tigre [t^{s}ɪg]/[t^{s}igʁ] ‘tiger’

(33) lune [lʏn]/[lyn] ‘moon’

The phenomenon is especially salient if we compare the words in (32) and (33) with similar words in the same family that have a different syllable structure, as in examples (34) and (35):

(34) tigresse [t^{s}i.gʁɛs] ‘tiger (fem.)’

(35) lunaire [ly.nɛʁ] ‘lunar’

Because vowel laxing is so dependant on syllable structure and syllable position, it provides another diagnostic cue for the syllabification of LCs. In her 2010 paper, Côté looked at the behaviour of vowels preceding a consonant in four different positions: non-alternating (stable) coda, liaison, pro-clitic, and non-alternating (stable) onset. She provided the following examples, along with native speakers' judgement of whether laxing was acceptable or not[7]:

(36) Coda:	maudite amie	[mod^{z}ɪtami]	‘damned friend (fem.)’
(37) Liaison:	maudit ami	*[mod^{z}ɪtami]	‘damned friend (masc.)’
(38) Proclitic:	Jordi t'amuse	*[ʒɔrdɪtamyz]	‘Jordi is amusing you’
(39) Onset:	maudit tamis	*[mod^{z}ɪtami]	‘damned sieve’

7 It is important to remember that for Côté, the difference between (34), (35) and (37) is a difference in underlying structure, since on the surface, all three Word1 have an open final syllable due to *enchaînement*.

The judgement given in example (39) reflects what we expect of the phenomenon, since the final syllable is open, a structure that does not trigger laxing. The fact that the pro-clitic consonant (38) does not trigger laxing is also expected, since in most analyses, these consonants are considered phonologically closer to Word2, and are therefore expect to behave as onset consonants. The main point of interest in Côté's data, however, comes from the judgements she gets for the vowels preceding a consonant in liaison position (37), where vowel laxing is categorically excluded by native speakers. She concludes that this behaviour suggests one of the two following options: LCs are not syllabified in the coda of Word1, but in the onset of Word2 like pro-clitic and non-alternating onset consonants; or vowel laxing is sensitive to the lexical structure rather than the syllabic structure. Côté tends to favour the second hypothesis (see Côté 2010 for more details), but concludes that either way, these results indicate that LCs do not behave like non-alternating coda consonants, but rather like non-alternating onset consonants. From our perspective, there is at least one more possibility to consider. Vowel laxing could be a post-lexical process that is active once the enchainement has taken place. Under this hypothesis, the difference between codas and LCs is in the timing of the vowel laxing process with respect to *enchaînement*. I posit that vowel laxing happens before *enchaînement* in the case of non-alternating codas, and after *enchaînement* in the case of LCs. In an acoustic study performed by Fougeron et al (2003), they found that the resyllabification of coda consonants from *enchaînement* is not as complete as previous literature supposed. This suggests that *enchaînement* might be a gradient phenomenon, which would allow various consonant types to behave differently from each other.

3.1.3 Affrication

In the same (2010) article, Côté also investigated the affrication of alveolar [t, d] in front of front, high vowels [i, y] and their glide counterparts, as illustrated in the examples below:

(40) tu	[tˢy]	'you'
(41) petit	[ptˢi]	'short'
(42) durée	[dᶻyʁe]	'duration'
(43) dimanche	[dᶻimɑ̃ʃ]	'Sunday'

She describes affrication as one of the, "most stable processes, generalized to all social strata and stylistic forms" (p.1281). Since affrication is thought to be categorical within a word, but variable across word boundary, it lends itself to further investigation concerning the behaviour of LCs. Côté (2010) looked at alveolar stops in the same four positions described above, and found that for consonants in coda position (44), pro-clitic position (45) and liaison position (46), speakers accepted both the affricated [tˢ, dᶻ] and the non-affricated [t, d], as seen in the examples below (Côté 2010:1284):

(44) trente idées	[trɑ̃tide]/[trɑ̃tˢide]	'thrity ideas'
(45) Jean t'imite	[ʒɑ̃timɪt]/[ʒɑ̃tˢimɪt]	'Jean impersonates you'
(46) grand iguane	[grɑ̃tigwan]/[grɑ̃tˢigwan]	'big iguana'

She further found that speakers perceived the non-affricated pronounciation to vary in markedness depending on the type of consonant, pro-clitic consonants being the most marked, and liaison and coda consonant the least marked (p.1284). She concluded that, in the case of affrication, LCs behave more like coda consonants than onset consonants.

In a later corpus study, Côté (2014) used data from 56 speakers of Laurentian French recorded in eight different towns. She looked at the affrication of non-alternating final consonants (see example (44) above), LCs (example (46) above) and proclitic consonants (example (45) above). She found the following percentage of affrication for each:

	Affrication	**No Affrication**
Non-alternating final Cs	36.5%	63.5%
LCs	66%	35%
Proclitic Cs	100%	–

Table 3: Percentage of affricated and non-affricated consonant by context. Adapted from Côté (2014: 20).

The current experiment investigates the behaviour of [t] in coda, liaison, and onset position. Based on the results from Côté (2010, 2014), I expect [t] to be consistently produced with affrication when situated in onset position, and to be produced only variably with affrication in coda and liaison positions. Furthermore, based on the results in Table 3, I expect tokens containing LCs to affricate more frequently than tokens containing non-alternating codas.

3.2 Hypothesis and predictions

Based on the information presented in Chapter 2 and the previous sections of Chapter 3, I entertain three hypotheses for the syllabification of LCs: (a) they syllabify as non-alternating codas, (b) they syllabify as non-alternating onsets, (c) they are ambisyllabic segments, either exhibiting characteristics of both codas and onset, or adversely exhibiting characteristics proper to neither and therefore warranting a third category of syllabification.

The first two hypotheses are fairly straightforward; if LCs syllabify as either codas or onsets, we predict that they will exhibit predominantly phonetic characteristics of the category to which they belong. While the relationship between phonetics behaviour and phonological categories is not always a simple one-to-one mapping, I follow Turk's (1993:13-14) lead:

> […] for a given correlate of a phonological feature/structure, members of one category will be more similar to members of the same category than to members of a different category. Furthermore, if there is a significant difference between members of one phonological category and tokens whose phonological representation is unknown, I consider this evidence that the tokens of the unknown category should have a different phonological representation.

Therefore, I assume that the phonetic correlates presented above are representative of differences in phonological structure and therefore can serve as valid diagnostic tools for a class of segments (LCs) whose syllable affiliation is unknown.

The third hypothesis requires a little more elaboration. There are three ways in which a consonant can be attributed the epithet ‘ambisyllabic’, which I outlined above. In the first one, introduced by Kahn (1976), the target segment exhibits characteristic behaviour of both codas and onsets. In other words, it is, “simultaneoulsy syllable-initial and syllable-final” (Turk 1993:4). In the second type of ambisyllabicity, the target segment is distinct from both codas and onsets and requires its own non-canonical syllabification. This type of ambisyllabicity was proposed in Turk's (1993) dissertation as one possible syllabification for intervocalic stops in English. The way this is realized phonetically can vary. Measurements of the target segments can be entirely different from measurements of both codas and onset. Alternatively, the measurements can intermediate, located in the middle of a continuum between non-alternating codas and non-alternating onsets (Scobbie & Pouplier 2010).

As this short discussion illustrates, ambisyllabicity is an ambiguous term that is used in the literature to refer to more than one abstract concept. For this reason, I try to avoid it throughout the rest of this thesis, preferring the term ‘non-canonical syllabification’ whenever possible. Table 4 summarizes the three hypotheses entertained, and the predictions affiliated with each hypothesis.

Hypothesis	**Predictions**
LCs are codas	• Duration of LCs and preceding vowels are similar to the duration of other non-altnerating codas; • Vowels preceding LCs are lax.
LCs are onsets	• Duration of LCs and preceding vowels are similar to the duration of other non-alternating onsets;

	• Vowels preceding LCs are tense.
LCs are ambisyllabic	• Some measurements are more coda-like, while others are more onset-like.
	• Measurements are completely different from both codas and onsets.
	• Measurements are intermediate in nature.

Table 4: Hypotheses and predictions regarding the syllabification of LCs.

3.3 Conclusion

Table 5 presents a succint summary of the results from the studies presented above.

	Coda	**LC**	**Onset**
Consonant duration	short	short	long
Preceding vowel duration	short	long	long
Preceding vowel laxing	yes	no	no
Affrication	variable	variable	systematic

Table 5: Expected phonetic behavior of target segments according to environment.

During the experimental design, a pilot study was conducted and results showed that, contra Côté (2008, 2014), affrication was systematic across all three contexts in a triad of adjective+noun pairs like the following: *petit tigre* ([pt^{s}it^{s}ɪg], ‘small tiger’) ~ *petit iguane* ([pt^{s}it^{s}igwan], ‘small iguana’) ~ *petite idée* ([pt^{s}ɪt^{s}ide], ‘small idea’). I therefore discarded affrication as a potential syllabification cue. According to Côté (2008), systematic affrication was expected only in the first adjective+noun pairing, and variable in the two others. In her investigation of part of the PFC corpus, Côté (2014:22) gives the following percentages: only 36.5% of coda consonants are affricated, versus 66% of LCs, and 100% of onset consonants. However, my own results indicate that even for codas and LCs, affrication is systematic. Further measurement of duration and intensity of affrication did not vary in any significant way. Therefore, I concluded that for the participants of this experiment, affrication was not a reliable correlate of syllabification. I suggest that the discrepancy between the results presented here and the results presented in Côté (2008, 2014) is due to register difference. The lack of affrication across word boundary is a marker of a higher register of speech, which may be readily available to a listener making a grammaticality judgement, but less available to a speaker asked to produce casual speech.

CHAPTER 4

ACOUSTIC EXPERIMENT

4.1 Prenominal Adjectives

I distinguished in Chapter 1 between two types of liaison: (a) obligatory liaison, without which the grammaticality of an utterance is degraded, and (b) optional liaison, the realization of which depends heavily on sociolinguistic factors. This thesis is concerned exclusively with category (a), obligatory liaison. More specifically, the focus of the present experiment is on obligatory liaison in prenominal adjective + noun pairings.

The majority of adjectives in Montreal French and most varities of French are post-nominal. There exists however a small class of prenominal adjectives, usually pertaining to size, appearance and age, such as *petit* ('small'), *gros* ('big'), *jeune* ('young') and *beau* ('good-looking'). These adjectives are fairly common in the spoken language and are thought to have the property of consistently triggering liaison, if the adjective is consonant final[8] and the following noun is vowel initial. Due to these two characteristics, prenominal adjectives have been predominantly used in experimental studies on liaison, and are used in this study as well.

Côté objected to the traditional view that prenominal adjectives always trigger liaison, stating that, "[...] corpus studies have established the variability of liaison in this context." (2012, p.263) However, she does not cite any particular corpus studies,

8 Some prenominal adjectives that ends in a vocalic sounds have an alterning allomorph used if the following noun is vowel-initial. Therefore, one sees the following alternation: un bel homme ([bɛlɔm], 'a pretty man') vs. un beau garçon ([bogaʁsõ], 'a pretty boy').

and in the section of the PFC corpus that she used for her 2012 paper, she found that, “liaison [in the contexte of prenominal adjective + noun] is systematic [...]” (2012:263). If liaison in prenominal adjectives was truly “quasi-categorical”, as Côté dubbed them, we would expect to find a relatively higher number of unrealized liaison consonants in this context in any given corpus. Therefore, I still expect liaison consonants to surface between prenominal adjectives and the following nouns in the present experiment.

4.2 Methodology

4.2.1 Participants

Participants were recruited in Montreal and the surrounding suburbs, and divided in two groups according to age: group A included participants between 18 and 25 years old, and group B included participants between 55 and 59 years old. The following two tables provide demographic information about each participant.

	S01	**S02**	**S03**	**S04**	**S05**
gender	F	M	F	F	M
age	25	22	18	20	23
occupation	student	youth program coordinator	student	retail worker	student
education[9]	B.A.	high school	high school	CÉGEP[10]	B.S.

Table 6: Demographic information by participant; Group A.

9 Highest level of education achieved at the time the experiment was conducted.

10 CÉGEP is an institution typical to Québec, where programs span 2 or 3 years between high school and university.

	S06	S07	S08	S09	S10
gender	M	F	M	M	F
age	59	55	57	59	56
occupation	retail buyer	administrative assistant	policeman	--	IT technician
education	high school	CÉGEP	B.A.	B.S.	CÉGEP

Table 7: Demographic information by participant; Group B.

4.2.2 Stimuli and procedure

In a soundproof recording booth, I used the E Prime 2.0 Pro software to present the stimuli and collect the output data. Participants were presented with combinations of adjective+noun in the form of images, in order to limit the influence of orthography as much as possible.

Adjectives (masc./fem.)	Nouns	
joli/jolie ('good-looking')	abeille ('bee', fem.)	sac ('bag', masc.)
petit/petite ('short')	abricot ('apricot', masc.)	savon ('soap', masc.)
gros/grosse ('big')	assiette ('plate', fem.)	tatou ('armadillo', masc.)
maudit/maudite ('damned')	avion ('airplane'', masc.)	tapis ('rug', masc.)

Table 8: Target words with gloss and gender.

For the adjectives, the masculine form is the form potentially triggering liaison, while the feminine form is produced with a non-alternating final consonant. The eight target nouns were selected based on the following criteria: their phonetic shape, their frequency and the ease with which they could be represented with simple images. I chose words with the shape [a-] and [Ca-], where [C] was either [t] or [s] to mimic the set of coda consonants from the adjectives. I selected words that were frequent enough to be unmarked and easy to remember, avoiding words that were too frequent, or that were involved in lexicalized expressions. Finally, I needed words that would be easy to depict with simple images, as to not tax the memory of the participants by requiring that they memorize random word/image associations.

Participants each performed 5 block of 25 trials. Every stimulus combination was presented once in each block in random order, for a total of 125 tokens per participant. A break of a duration determined by each participant was introduced between block 3 and block 4. I excluded 97 tokens (8%) due to misidentitication of target words, stuttering or other disruptions in the acoustic signal. All tokens from S08 were discarded because he produced all the words in their isolation form (i.e.: no LC, and final consonants *non-enchaînées*). I labeled the remaining tokens in Praat, identifying the preceding vowel, consonant closure, and consonant release (if any) of each target sequences. Onset and offset of voiced (or partially voiced, when possible) vowels were determined by the onset and offset of voicing and vibration in the waveform, as well as the presence of formants in the spectogram. Voiceless vowels were identified from the beginning of the fricative part of the affricate to the end of the frication in the spectrum. The consonant closure was identified from the offset of the previous vowel to the onset of the release (when applicable) or the onset of the following vowel.

Vowel formants were measured using a robust LPC algorithm implemented in Matlab (Yao et al., 2010); measures from consonant and preceding vowel duration were also extracted via a Matlab script.

4.2.3 Articulatory investigation

Ultimately, the goal is to collect articulatory data. However, using the technology to collect such data puts severe physical constraint of where the data can be collected and who can participate in the study. Acoustic investigation, on the other hand, can be conduct virtually anywhere. In order to look a at large enough pool of participants, it was in my best interest to collect acoustic data rather than articulatory data. I did however conducted a follow-up study using the electromagnetic articulometer technology. Analyzing the data from this experiment, and comparing it with the acoustic results showed that, at the level of detail focused on here, acoustic results are as reliable as articulatlory results. The results from the pilot articulatlory study in themselves are of some interest, and are presented in Appendix 2.

4.3 Results

For each of the three consonantal contexts (coda, LC, onset), I analyzed the following four variables: consonant duration, preceding vowel duration, preceding vowel F1 and F2 values, and pecentage of devoiced [i]. A summary of the results for all participants can be found in Table 9.

	Coda	**LC**	**Onset**
Consonant duration	short	short	long
Preceding vowel duration	short	short	long

Preceding vowel laxing	yes	intermediate	no
Percentage devoiced [i]	high	high	low

Table 9: Sumary of the four acoustic measurement for all nine participants.

The overall results suggest that LCs syllabify for the most part like non-alternating codas, except for vowel laxing, for which LCs seem to syllabify neither as codas nor onsets.

Originally, participants were divided into two groups according to age, because I expected to see differences between younger and older participants. However, data analysis revealed nothing but minor differences between group A and group B. Therefore, the results presented below are for all participants together, unless otherwise specified. More information on individual results can be found in Appendix 1.

4.3.1 Duration

The duration measurements for both preceding vowels and target consonants are presented in Table 10. The general tendency that we can draw from the values shown below is that LCs are statistically different than onsets, but not significantly different than codas in the majority of the cases.

Vowel Duration				**Consonant Duration**			
	Coda	*LC*	*Onset*		*Coda*	*LC*	*Onset*
[o]	109 ms.	94 ms.*†	104 ms.	*[s]*	89 ms.	62 ms.*†	117 ms.

[i]	55 ms.	50 ms.†	76 ms.	*[t] (clo.)*	59 ms.	60 ms.†	72 ms.
[i̥]	56 ms.	56 ms.	60 ms.	*[t] (rel.)*	20 ms.	21 ms.	21 ms.

Table 10: Mean vowel and consonant duration for all speakers. The asterisk means that the LC value is statistically different from the coda value, and the cross means that the LC value is statistically different from the onset value.

The consonant duration measure was taken from the offset of the previous vowel to the onset of the following vowel. For [t], I distinguished between closure and release when there was a period of aspiration extending beyond the release burst. We can see in the table above that this period of aspiration was almost identical across all three contexts, around 20 ms. Figure 3 below shows the mean duration measurement for [t] and [s], distinguishing the duration with and without the closure for [t]. Both [t] and [s] in LC position were significantly shorter than their counterpart in onset position. Furthermore, [s] in LC position was also significantly shorter than when in coda position, which is not the case for [t].

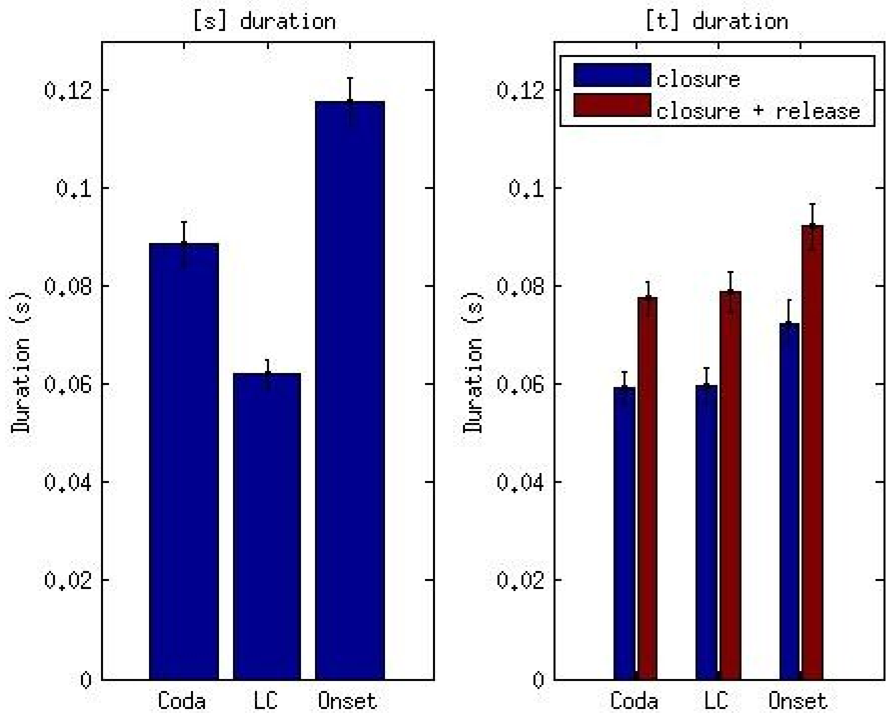

Figure 3: Mean duration of [s] and [t] without release on the left and with release on the right.

The vowel duration was calculated from the onset of voicing and fomants to the onset of the following consonant. For [i], in cases of partial or complete devoicing (highlighted in Table 8 above as [i̥]), the duration was calculated from the onset of frication to the offset of frication. Figure 4 below shows the mean duration of both voiced [i] and [o] across all three contexts. The vowel [i] is shorter when preceding both a coda and a LC ($t(126) = -1.96$, $p<0.03$; $t(145) = -2.86$, $p =0.004$) compared to the same vowel in onset position. In all the figures in this section, the error bar represents the standard error from the mean multiplied by two. The variation is mostly driven by a between-speaker effect than an within-speaker effect.

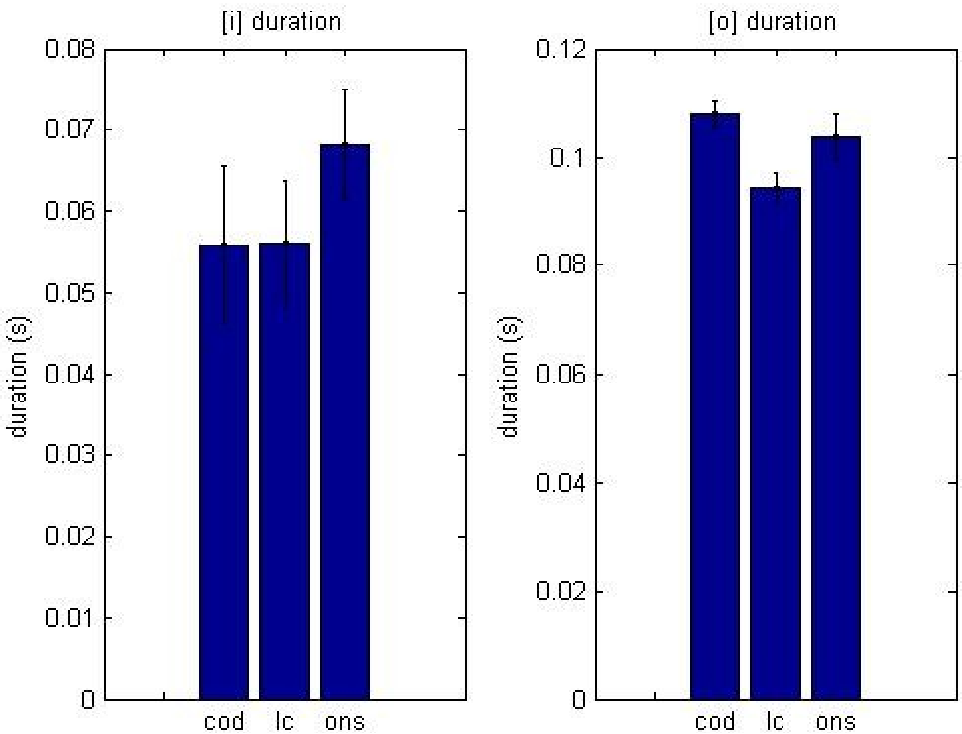

Figure 4: Mean duration for [o] and [i].

For [o], duration is shorter when the vowel is preceding a LC compared to [o] preceding both a coda and an onset ($t(161) = 2.16$, $p = 0.03$; $t(162) = -1.84$, $p = 0.06$). This behaviour is odd if we consider the behaviour of vowels (and more notably of [o]) in closed, final sylable in French. In this environment, a vowel will generally surface as long in the following two contexts: if the coda is comprised of [r, v, z, ʒ], or if the vowel is [ø, o, ɑ, ɛ̃, œ̃, ɔ̃, ɑ̃] (Côté 2010:49). In our particular case, [o] is followed by [z] when the next consonant is a LC. If the LC was syllabifying as a coda, we would expect the mean value of [o] not to be significantly shorter than before a coda, but we observe the opposite. At face value, then, measurements for [o] seem to contradict the general trend emerging from other duration measurements, which point towards a coda-like syllabification for LCs. Similar to the earlier discussion of vowel laxing, one hypothesis to entertain is the relative timing of the vowel lengthening with respect to resyllabification. If *enchaînement* is triggered before vowel lengthening, then in the present case the conditions for lenghtening are not met, since the LC is resyllabified as the onset of the following word.

4.3.2 Vowel laxing

Figure 5 shows a scatterplot of the average F1/F2 values for all speakers across all three consonantal contexts. We can see a marginal laxing effect for [i] when preceding a LC, and no laxing effect for [o] when preceding LCs.

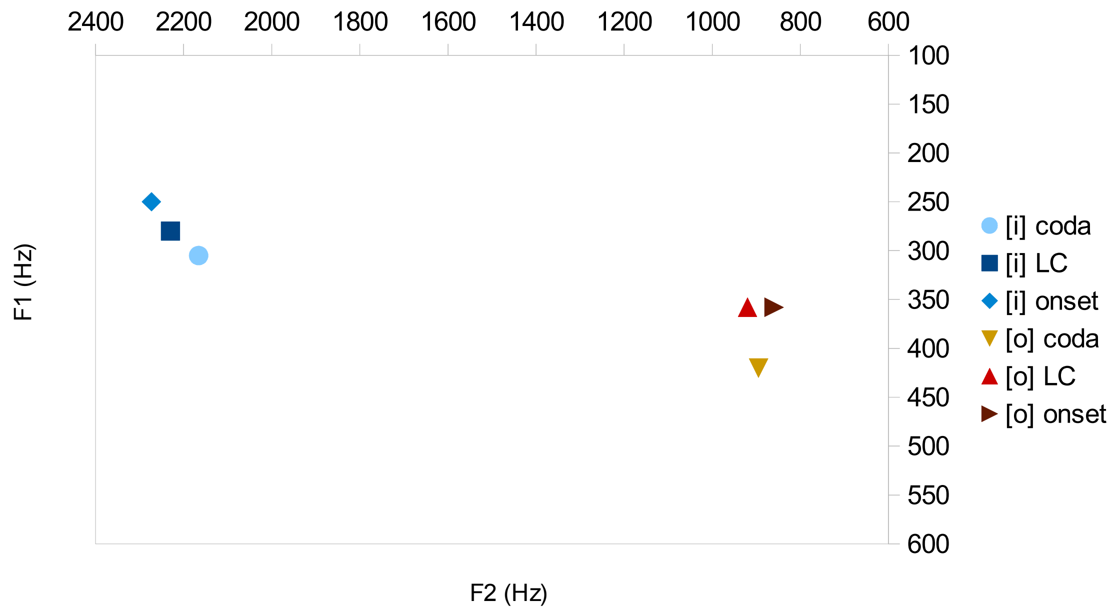

Figure 5: Formants distribution for [i] and [o].

A closer look at formant values for [o], especially F1, reveals a difference between the three consonantal contexts. Before a non-alternating coda, we can see a higher F1, which indicates laxing. Before either a LC or an onset, we can see a lower F1, which indicates no laxing. This difference between codas, and LC and onsets is significant ($t(157) = 5.70$, $p<0.001$; $t(168) = -6.05$, $p<0.001$). The formant values for F2, however, show some marginal effect of centralization (a higher value for back vowels) preceding both codas and LCs, compared to vowels preceding onsets ($t(159) = -2.35$, $p = 0.08$; $t(168) = -1.74$, $p = 0.01$).

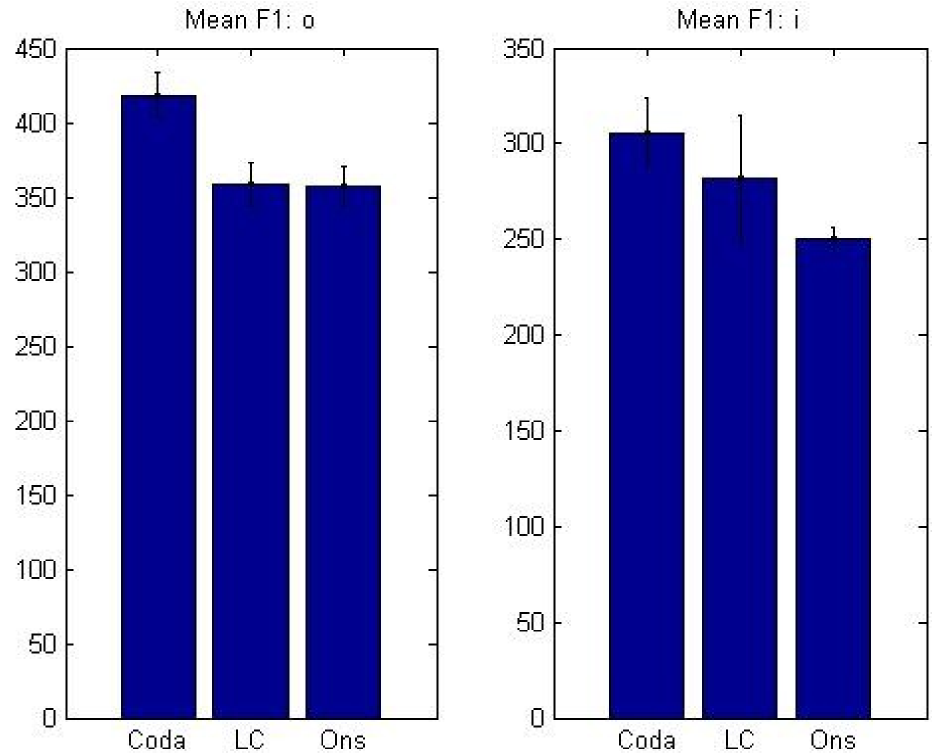

Figure 6: Mean F1 value for [o] and [i].

The story for [i] is slightly different. While there is a significant difference between the F1 values preceding a coda and an onset ($t(192) = -6.53$, $p<0.001$), the value in the environment of a LC seems to be intermediate. It is higher than the same vowel preceding an onset consonant, but lower than when preceding a coda consonant.

For F2 values, we see a difference between group A and group B. Participants from group A showed the same intermediate value for vowels preceding LCs. For these speakers, F2 values for these vowels were maginally different from vowels preceding both codas and onsets ($t(6) = -2.30$, $p = 0.06$; $t(99) = 1.71$, $p = 0.08$).

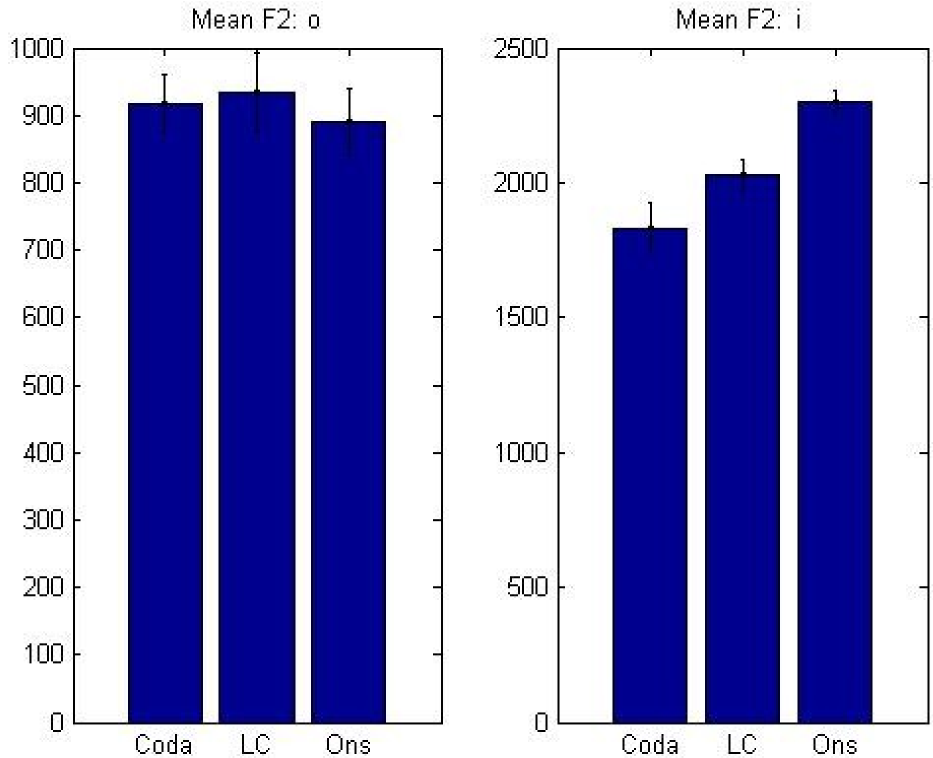

Figure 7: Mean F2 duration for [o] and [i] for all four speakers of group A.

Speakers of group B showed no difference in F2 across all three consonantal contexts.

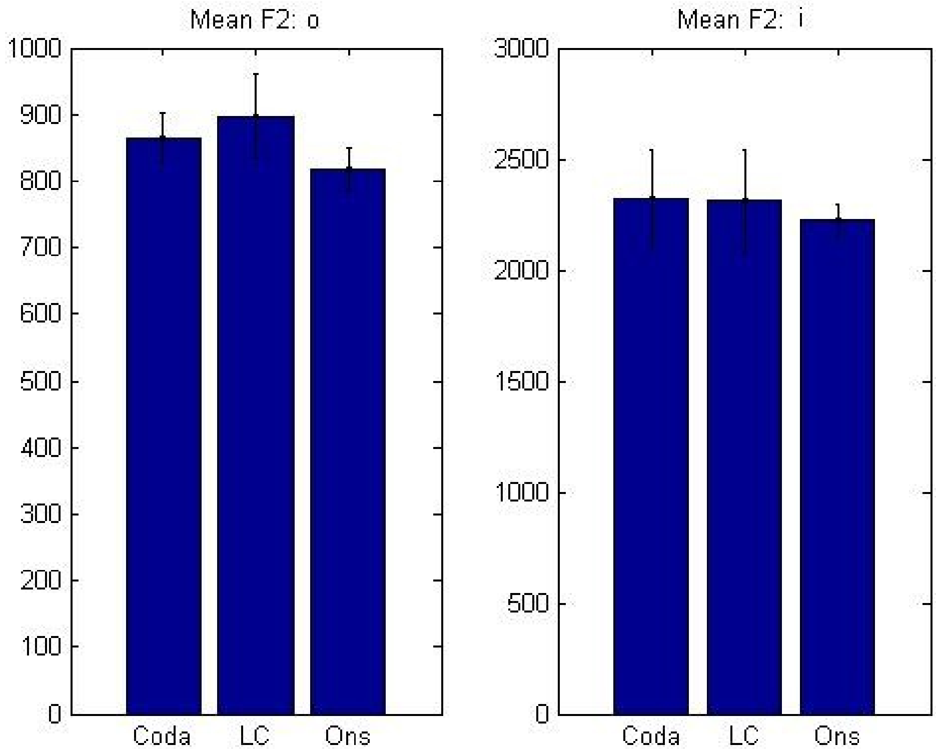

Figure 8: Mean F2 duration for [o] and [i] for all four speakers of group B.

The tendency for vowels preceding a LC to show an intermediate quality is particularly interesting in light of Scobbie & Pouplier's (2010:242, emphasis mine) view on ambisyllabic consonants: “Phonetically, an ambisyllabic consonant may be expected to be **intermediate in behaviour between onset and coda**, or to vacillate between the two”. This intermediate quality could be the sign of a non-canonical, or in other words non-categorical, syllabification. I will come back to this issue in Chapter 5.

Poliquin (2006:24) cited Dumas (1981) on the tendency of certain vowels to elide completely in a given environment: “in fact, in an unstressed position, if a [+high] vowel is flanked by two voiceless consonants, the vowel can be completely elided [...]”. During the hand-segmentation phase, I found this to be the case for many of [i] tokens found in the word *petit* and *maudit*. However, I also noticed that the syllabification of the coda consonant had an effect on whether or not the vowel was completely elided: some tokens were partially devoiced, in which case I could still identify formants, and other were fully voiced. I distinguised the completely devoiced (elided) tokens from the partially or completely voiced tokens, and I calculated the percentage of tokens that fell in the first category across all three consonant types. When [i] preceded a consonant in coda or LC position, the percentage of devoiced tokens was high (80% and 92% respectively), but much lower if the vowel is preceding an onset (41%). Like consonant and vowel duration, this measurement seems to indicate a more coda-like syllabification.

4.4 Comparison with Previous Studies

In this section I compare our results with results from the previous studies presented in Chapter 3.

Concerning duration, there are two opposite results that are possible. On the one hand, studies like Gaskell et al. (2002) and Spinelli et al. (2003) found that LCs were significantly shorter than consonants in onset position, and Gaskell et al. found no difference between codas and LCs. On the other hand, Nguyen et al. (2007) found that both the consonant in coda position and the vowel preceding it were significantly longer than a vowel preceding either an onset or a LC. Our own results align better with the former than the latter, bearing in mind minor differences that will be discussed further in a moment.

The major differences between the two categories of results might be attributed to the subset of consonants involved; none of the studies mentioned above, ours included, investigate the same consonants. Gaskell et al. (2002) studies collated results for [t], [r], and [z] indescriminately, and Spinelli et al. (2003) only reported results for [r]. Nguyen et al. (2007) looked at both [z] and [n], and did not specify which vowels they were including, although from their brief description of their stimuli, their subset seemed to be larger than the set under consideration in this study. When I looked at duration, I found that the nature of the consonant mattered. Specifically, [t] and [s] did not behave the same way, and collapsing the results for both would have obscured that fact. I hypothesize that this account for the difference betweent eh current results and Gaskell et al. (2002), especially concerning [s].

Another aspect that could be a factor is the morphological make-up of the material, especially in Nguyen et al. (2007). Their study used the following contexts: determinant+noun, adjective+noun, monosyllabic adverb+complement, and preposition+complement. While all of these are contexts where liaison is obligatory, they are different enough that assuming that they all represent the same phenomenon might be problematic. It is especially true for the liaison in [n], which in some contexts has been analyzed as arising from suppletive forms rather than from a productive phonological phenomenon, or as having a different underlying representation than other prenominal adjectives (Tranel 1990; Coté 2005, Côté 2010). The main point is that not all liaison contexts are created equal, and we should be careful to distinguish between different contexts, both phonological and morphological.

Based on perceptual judgements, Côté (2010:1283) stated that vowel laxing was obligatory for the vowel preceding a consonant in coda position, but completely excluded for vowels preceding LCs, and consonants in onset and proclitic positions. However, our results suggest a less categorical division. It is especially salient for [i], where the vowel when preceding a LC seems to be taking an intermediate position between tense and lax. In section 4.4.1.2 I cited Scobbie & Pouplier's (2010) expectation for how an ambisyllabic segment should behave. I argue that what our results for vowels preceding a LC show is the acoustic manifestation of that non-canonical syllabification. I hypothesize that non-canonical codas could trigger a phonetic laxing, which surfaces as this intermediate value, as opposed to the phonological laxing induced by canonical codas.

In the next chapter, I will expand on this idea of non-canonical syllabification, its implementation and its implication for liaison.

CHAPTER 5

LIAISON IN THE SELECTION-COORDINATION THEORY

5.1 Introduction

The general conclusion that can be reached from looking at the data presented in the previous chapters is that the typical models of syllabification used so far seem to be unable to account for liaison. We have seen that while presenting mostly coda-like behaviour, LCs seem to form a class of their own in many respects. I have been reluctant to call this phenomenon 'ambisyllabicity', mostly because it is a term that has been overused in the literature, and that does not fully resolve the issue at hand as LCs do behave overwhelmingly like codas, with some exceptions. The account presented in this chapter strives to develop a framework that allows for a non-canonical conception of syllabification. I introduce two related theories, Articulatory Phonology (AP), developed by Browman & Goldstein (1986, 1992) and Selection and Coordination Theory (SCT), developed by Tilsen (2013, 2014) to account for the syllabification of LCs.

5.2 Theoretical frameworks

Rather than positing segments or features as primitives, AP uses gestures. Citing Browman & Goldstein (1992:23), "From our perspective, phonology is a set of relations among physically real events, a characterization of the systems and patterns that these event, the gestures, enter into". The gestures can further be arranged into gestural scores or gestural constellations. The reason I turn to AP over other framework is for its insight on the asymmetry of syllable structure. Within the constellations, gestures are coordinated with each other in two ways: in-phase or anti-phase. This form of coordination arises from task dynamic models found in motor control and extended to speech. The model holds that onsets are coordinated in-phase with (completely or almost completely overlapping with) the nucleus, while codas are coordinated anti-phase with (partially overlapping with) the syllable nucleus[11]. Furthermore, the former is considered a much more stable (or stronger) coupling relation that the latter (Tilsen 2014:7).

AP provides us with new vocabulary to talk about syllable structure, but still only presents two ways to organize basic units among themselves. The dichotomy between in-phase and anti-phase coordination can be seen as inadequate for the current purposes as the traditional dichotomy between onsets and codas. My results show that we need more to account for the liaison data presented here. This is where SCT comes into play. As a phonological theory, it allows for segments to syllabify in more than one way in any given syllabic position. For this reason, I find it particularly well-suited to capture the data presented in this thesis.

SCT relies on two distinct cognitive mechanisms involved in speech control: selection and coordination (Tilsen 2014:1). Selection refers to the way gestures (or constellations of gestures, to be more accurate) are selected in selection sets; it can be either competitive or coordinative. Coordination refers to the fine-grained gestural

[11] The coordination mechanisms can be more complex in cases of complex onsets/codas, but for the purpose of this chapter, I will focus only on CVC syllables.

coordination between gestural constellations within a given selection set. An illustration of those concepts is given in Figure 9 below.

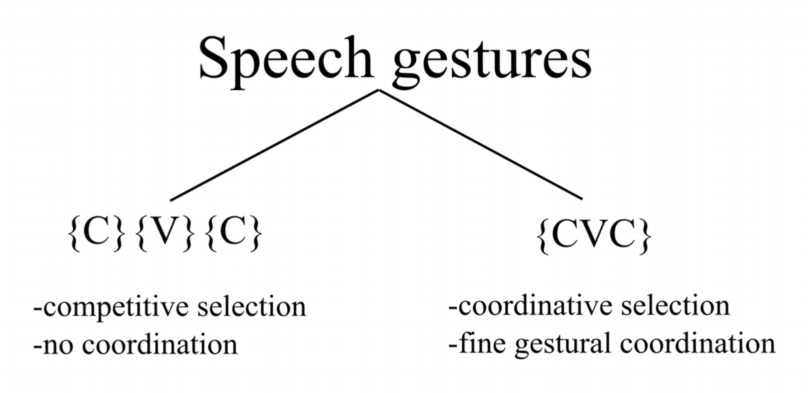

Figure 9: Differences in selection and coordination between competitively selected sets (on the left) and coordinatively selected sets (on the right).

For any given CVC syllable, Tilsen (2014:11) proposes three possible models of control:

(47) (a) {C}{V}{C} (b) {CVC} (c) {CV}{C}

Model (a) is the purely competitive one: constellations of gestures forming the onset, the nucleus, and the coda, are selected sequencially. Model (b) is the purely coordinative one: constellations of gestures forming the onset, the nucleus and the coda are co-selected. Model (c) is a mix between the two: the constellations of gestures for the onset and the nucleus are co-selected, while the constellation of gestures for the coda is competitively selected. It is important to note that in both model (b) and model (c), the phasing of the gestures is the same: the gestures for the onset and the nucleus are in-phase coordinated and the coda gestures are anti-phase coordinated with the vowel.

Tilsen (2014) hypothesizes that both competitive and coordinative control are available to adult speakers. We can therefore posit that for any given adult speaker, both model (b) and model (c) can coexist in the grammar. Given this, a consonant in coda position, while always anti-phase coordinated with the nucleus, can be either co-selected (that is, part of the same selection set as the rest of the syllable) or competitively selected. In other words, Tilsen's SCT presents a model that can accommodate more than one way to syllabify in a given position. The way the coda constellation of gestures is phased and selected can account for the strength and stability of the bond between the coda consonant and the syllable it is affiliated with. In section 5.3 we will see how this model can be applied to adjectival LCs.

5.3 Liaison Consonants in Adjectives+Nouns pairs

I will consider two types of pressures influencing the representation of LCs: organizational pressure and lexical pressure. These will be explained and explored in the following sections.

5.3.1 Organizational pressure

The first type of control available to a speaker is the competitive one (model (47a) from above), which yields something like {p}{ə}{t}{i}{t}{a}{m}{i} for the string *petit ami* ([pətsi<t>ami]). I assume that each curly bracket represents a selection set, which is composed of one or more gestural constellation. Each consonantal and vocalic gestural constellation is sequentially selected and there is no coordination. During the acquisition phse, a speaker develops the ability to exercise coordinative control through the internalization of feedback. An adult speaker will be pressured into adopting one of the following representation :

(48) (a) {pə}.{ti}.{ta}.{mi}.

(b) {pə}.{tit}.{a}.{mi}.

(c) {pə}.{ti}{t}.{a}.{mi}.

The example in (a) contains four selection sets of CV syllables, which according to AP and SCT exhibit the stronger, most stable coupling relationship. The example in (b) also contains four selection sets, with the second set being a CVC syllable, and the third being a simple V set. In terms of coupling relationships, the second [t] in the string *petit ami* is more weakly coupled to its syllable nucleus than in the previous example due to its anti-phase coordination. Finally, the example in (c) has five sets, the third of which is a single coda consonant competitevely selected with respected to the previous CV co-selected set. Assuming that speakers are going to favour cohesion and stability, this example has the weakest possible representation. In purely organizational terms, therefore, the first example is ranked higher than the second example, which is then ranked higher than the third one.

5.3.2 Lexical pressures

I am calling "lexical" pressure any influences that come from the linguistic content, to distinguish these influences from the previous type. I consider two opposing lexical pressures: a morphological one and a phonological one.

The morphological pressure comes from morphologically related words. The word *petit* in its isolated form is pronounced [pətˢi] without a final consonant. However, other morphologically related words such as *petite* ([pətˢɪt]), *petitesse* ([pətˢitɛs], 'shortness') surface with a [t]. The idea behind the morphological pressure is that all the forms of a lexeme should be represented by a single lemma. In the case of *petit* and all derived words, that means storing [pətˢit] as a lemma, even though the word *petit* itself sometimes surfaces without the final [t] (in isolation, and when preceding a consonant-initial word). Moreover, if we take a string like the one in examples (48a)-(48c) above, there is additional pressure to associate the liaison [t] with *petit* rather than with *ami* since children do not hear [tami] to mean 'friend' in contexts other than after *petit*[12].

The phonological pressure, on the other hand, works in the opposite direction. Due to the differences both in underlying behaviour and surface characteristics between a word like *petite* (with a non-altnernating final consonant) and *petit* (with an alternating final consonant), there is a need to posit a different underlying form to capture these differences. Since the final [t] in *petite* always syllabifies as a coda, we need a different syllabification for the final [t] in *petit*. Autosegmental Theory

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[12] Or other prenominal adjectives that trigger liaison in [t], such as *grand.*

introduced the idea of deficient (latent) segments to account for this difference: in autosegmental terms, LCs are structurally deficient codas, which explains their alternating nature. In SCT, this notion of deficiency is redefined in terms of coupling relationships and syllabic cohesion. Or, in the words of Scobbie & Pouplier, “if lexical representations are not symbolic segments, but articulatory scores comprising gestures which cohere into greater molecular structures through coupling relations, syllable affiliation itself becomes a gradient phenomenon” (2010:252). Whether we want to posit true gradience as opposed to finer-grained categories is an issue I will address in section 5.4.

A further area of lexical effect is suggested by the pilot articulatory study where subtle differences were found in the articulatory patterns of different adjectives. These effects are likely to be due to gradient degrees of lexicalization of adjective-noun pairs. For more information, see section A2.4 of Appendix 2.

5.3.3 Interaction between organizational and lexical pressures

As described in section 4.2, a coda consonant can be either competitively selected or co-selected and coordinated with the previous vocalic gestures. I argue that the final consonant in *petite* ([pət^{s}it]) is co-selected with the vowel, while the final consonant in *petit* ([pət^{s}i<t>]) is competitively selected.

Looking again at examples (48a)-(48c), repeated in here in (49a)-(49c), I posit that the representation of LCs for any given speaker of Montreal French is that given in example (c), the representation that was the least favoured by the organizational pressure.

(49) (a) {pe}.{ti}.{ta}.{mi}.

(b) {pe}.{tit}.{a}.{mi}.

(c) {pe}.{ti}{t}.{a}.{mi}.

This can be explained by the interaction between the organizational pressure and the lexical pressures. Given limited to no exposure to the language, I hypothesize that the grammar should privilege the representation in (49a) over the others. However, exposition to other words related to *petit*, and to other instances of the word *ami* will contribute to rule out this representation. In other words, morphological pressure will rule out anything but a coda syllabification. I further hypothesize that as the speaker continues to be exposed to the language, he or she will latch on to the underlying and surface differences between LCs and non-alternating codas, and the phonological pressure will force a representational difference between the two. Therefore, the combination of the morphological and the phonological pressures will bring speakers of the Montreal dialect to converge on representations like that of (49c) for words containing a LC.

Compared to onsets, a coda is always in a less stable coupling relationship. If we go back to models (47b) and (47c) from above, we can make a further distinction based on the selectional properties of codas. A coda consonant part of a co-selection set (model (b)) will be more cohesively bound to the set it is underlyingly affiliated to than a consonant that is competitively selected (model (c)). Based on the following quote from Scobbie and Pouplier (2010:252), “[…] the local coordination of word-final codas makes them less tightly bound at an articulatory level to the preceding vowel, and more able to be bound to a following one should it be present”, I hypothesize that the weak cohesion and unstable coupling relation of LCs with respect to their syllable make their realization dependant on the nature of the following set.

If we take a look at the examples below, we can illustrate the difference in grouping between the triad *petite amie* ~ *petit ami* ~ *petit tamis* in the following way:

(50) petite amie	[pət^sɪtami]	{pə}{t^sɪt}{a}{mi}	‘girlfriend’
(51) petit ami	[pət^sitami]	{pə}{t^si}{t}{a}{mi}	‘boyfriend’
(52) petit tamis	[pət^sitami]	{pə}{t^si}{ta}{mi}	‘small sieve’

The [t] in *tamis* (52) is in an onset position of a co-selection set; it has the strongest coupling relationship, and is the most tightly bound to its nucleus. As such, it is the least likely to be attracted to a different set. The [t] is both *petit* (51) and *petite* (50) are codas; they have the weakest coupling relationship. However, the [t] in *petit* (51) is its own competitively selected set, which makes more likely to be attracted to a different set than the [t] in *petite* (50), which is part of a co-selection set.

5.4 Selection of LCs

Lexical entries in SCT not only comprise constellations of gestures and selection sets but also relative activation levels. The activation levels are the degree to which a given set is initially activated.. Coupled to a gating mechanism, they ensure that sets are sequentially produced: sets are going to reach the gate according to their relative activation levels. I argue that LCs have a much lower relative activation level than other coda consonants, making them less likely to reach the activation gate.

Low relative activation, in addition to unstable coupling relation and weaker syllabic cohesion means that, from the three consonant types (codas, LCs, onsets) discussed here, LCs are the least likely type to surface. And indeed, in a lot of contexts (in isolation, before most pauses, before consonant-initial words, etc) they do not surface. However, when the following word is vowel-initial, LCs do surface. This is because the appropriate context for LCs to enter into a co-selection is available. Because constellations of gestures that are part of the same co-selection set are overlapping, they are activated as one unit. In other words, by being bound in a new selection set, LCs are effectively raised to the level of activation of the new set.

Associating with a new selection set might explain the difference in resyllabification that were discussed in Chapter 3. While non-alternating codas are more strongly bound to their own syllable, and only partially resyllabify at the onset of the following vowel-initial word, at the activation gate LCs form new bond with a new selection set, effectively surface as non-alternating onsets.

5.5 Gradient vs. categorical

Categorical phenomena can be defined in terms of discreet categories, while gradient phenomena typically fall on a continuum. In linguistics, categorical is usually used to described the core phonological phenomena, while gradient is usually assigned to phonetic phenomena. Syllabification, therefore, as a core component of phonology, has mostly been described as a categorical phenomenon.

I have been careful to use the term non-canonical when describing the syllabification of LCs, but at this point of the discussion, we can wonder what that means in terms of the gradient/categorical distinction. In Chapter 2, the previous analyses of LCs mostly assumed that consonants syllabify either a coda or as onset. I have highlighted the fact that not only did these analyses viewed syllabification as a categorical process, but they assumed only two possible categories. On the other hand, Scobbie and Pouplier (2010) have characterized syllabification in AP as a gradient phenomenon.

The results presented here do not seem to support a gradient analysis so much as a categorical analysis that includes finer-grained categories. In other words, syllabification does not seem to fall on a continuum, but seems to be more adequately represented by discreet categories. The difference between the traditional analyses of LC, and indeed of syllabfication in general, and the analysis presented here is in the number of bins available. While the typical classification of codas and onsets was not sufficient to account for the liaison facts, the proposed classification incorporates both the coordinative aspect (in-phase or anti-phase) and the selectional aspect (competitevely or co-selected), allowing for a non-binary classification of syllabification and accounting for the data presented in this thesis.

5.6 Conclusion

In this chapter I have introduced two frameworks, Articulatory Phonology and Selection and Coordination Theory, and used the mechanisms provided by these frameworks to account for the non-canonical syllabification of LCs. Such an analysis accounts for the fact that LCs mostly behave like non-alternating codas, while also accounting for the differences in acoustic characteristics between the two types of codas highlighted by the experimental data. It also provides an account for the differences noticed in phoneme-detection and word-identification tasks as outlined in Chapter 2. While the presence of LCs contributed particular acoustic markers that helped word-identification, hearers had more difficulty detecting LCs in the speech stream than other consonant types. I argue that since LCs do not syllabify either as non-alternating codas nor onsets, that non-canonical syllabification is what is responsible for the acoustic markers allegedly facilitating word recognition. On the other hand, since the syllabification of LCs is also the less stable and the weaker, it makes LCs less perceptually salient, and therefore harder to pick out from the speech stream.

CHAPTER 6

CONCLUSION

In this thesis, I have looked mainly at the acoustic, but also at the articulatory, behaviour of liaison consonants. The main goal was to investigate the syllabification and lexical affiliation of LCs using experimental data from the understudied dialect spoken in and around Montreal. I have proposed an analysis that relies on the cohesion of the selection and coordination of speech gestures to account for the differences in behaviour between non-alternating codas, LCs, and non-alternating onsets.

Reviewing more than sixty years of work on liaison in Chapter 2, I concluded that the traditional models of syllabification were unable to account for the experimental data presented in this thesis and in other previous studies. Specifically, I claimed that the binary distinction between codas and onsets is too narrow and does not allow for non-canonical, gradient conceptions of syllable affiliation. In Chapter 3 I examined the traditional acoustic cues associated with non-alternating codas and onsets, and how they could be used as diagnostic tools for the syllabification of LCs. Based on these acoustic characteristics, I conducted an acoustic experiment and an articulatory follow-up experiment, the details and results of which are presented in Chapter 4 and Appendix 2 respectively. Based on our analysis of these results, I proposed an analysis of LCs that relies on the selection and coordination principles of Articulatory Phonology and Selection & Coordination Theory. These two frameworks allow us to make a distinction between non-alternating codas and LCs while having both types of consonants retain their affiliation to Word1.

Future work should consider different sources of empirical and experimental evidence. On an experimental level, the general discussion on liaison would greatly benefit from work expanding beyond the context of prenominal adjectives + nouns. Most studies on this topic, this thesis included, are restricted to this particular context. The reason for this focus is quite simple: it provides a context in which we expect little to no variation in the production of LCs. However, I strongly believe that not all liaison contexts are created equal, and that further research on other contexts will help provide a more complete understanding of the phenomenon. Moreover, AP and SCT provide interesting theoretical frameworks to continue investigating particularly thorny questions, such as the development and acquisition of liaison by children and second language learners. As this thesis shows, despite the extensive number of studies and analyses of liaison, there are still many questions left unanswered.

APPENDIX 1

FURTHER RESULTS

A1.1 Individual results

I extracted measurements and statistical significance for each individual speaker in order to see if there was any anomalies.

Speaker	**Vowel Duration**				**Consonant Duration**			
01		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	80 ms.	91 ms.	91 ms.	*[s]*	82 ms.	53 ms.*†	113 ms.
	[i]	76 ms.	–	79 ms.	*[t] (clo.)*	49 ms.	48 ms.	47 ms.
	[i̥]	54 ms.	52 ms.	63 ms.	*[t] (rel.)*	18 ms.	17 ms.†	20 ms.
02		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	93 ms.	80 ms.	87 ms.	*[s]*	82 ms.	49 ms.*†	105 ms.
	[i]	45 ms.	37 ms.	60 ms.	*[t] (clo.)*	45 ms.	46 ms.	58 ms.
	[i̥]	45 ms.	52 ms.	61 ms.	*[t] (rel.)*	18 ms.	22 ms.*	20 ms.
03		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	87 ms.	82 ms.	87 ms.	*[s]*	86 ms.	66 ms.*†	104 ms.
	[i]	–	–	76 ms	*[t] (clo.)*	49 ms.	46 ms.†	58 ms.
	[i̥]	52 ms.	56 ms.	59 ms.	*[t] (rel.)*	19 ms.	23 ms.*†	19 ms.
04		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	85 ms.	78 ms.	89 ms.	*[s]*	67 ms.	69 ms.†	96 ms.
	[i]	50 ms.	–	71 ms.	*[t] (clo.)*	43 ms.	52 ms.	61 ms.
	[i̥]	52 ms.	53 ms.	51 ms.	*[t] (rel.)*	21 ms.	18 ms.†	22 ms.
05		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	88 ms.	94 ms.	97 ms.	*[s]*	94 ms.	58 ms.*†	123 ms.
	[i]	52 ms.	70 ms.	91 ms.	*[t] (clo.)*	49 ms.	59 ms.	80 ms.
	[i̥]	72 ms.	69 ms.	68 ms.	*[t] (rel.)*	25 ms.	25 ms.	23 ms.
06		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	117 ms.	90 ms.	114 ms.	*[s]*	85 ms.	60 ms.	136 ms.
	[i]	63 ms.	39 ms.	75 ms.	*[t] (clo.)*	71 ms.	76 ms.	90 ms.

Speaker	Vowel Duration				Consonant Duration			
	[i̥]	48 ms.	52 ms.	58 ms.	*[t] (rel.)*	18 ms.	20 ms.	18 ms.
07		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	107 ms.	93 ms.	106 ms.	*[s]*	103 ms.	66 ms.	109 ms.
	[i]	–	–	77 ms.	*[t] (clo.)*	62 ms.	54 ms.	73 ms.
	[i̥]	64 ms.	54 ms.	61 ms.	*[t] (rel.)*	22 ms.	22 ms.	23 ms.
09		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	196 ms.	137 ms.	136 ms.	*[s]*	111 ms.	70 ms.	150 ms.
	[i]	60 ms.	54 ms.	82 ms.	*[t] (clo.)*	86 ms.	80 ms.	101 ms.
	[i̥]	69 ms.	63 ms.	66 ms.	*[t] (rel.)*	25 ms.	22 ms.	21 ms.
10		*Coda*	*LC*	*Onset*		*Coda*	*LC*	*Onset*
	[o]	122 ms.	97 ms.	122 ms.	*[s]*	80 ms.	70 ms.	129 ms.
	[i]	57 ms.	50 ms.	76 ms.	*[t] (clo.)*	69 ms.	70 ms.	84 ms.
	[i̥]	55 ms.	62 ms.	61 ms.	*[t] (rel.)*	19 ms.	21 ms.	22 ms.

Table 11: Mean vowel and consonant duration for each individual speaker. The asterisk means that the LC value is statistically different from the coda value, and the cross means that the LC value is statistically different from the onset value.

One measurement stands out in this table. For quite a few speakers of group A (S01, S03, S04) and one speaker of group B (S07), I was unable to identify fully voiced [i] tokens preceding LCs (and preceding codas for S03). In general, this was a qualitative trend that I noticed during the hand-segmentation: older speakers (group B) produced more voiced [i] tokens (across all three consonant contexts) than younger speakers (group A).

A1.2 Vowel hiatus

One particular trend that I noticed when conducting the experiment was that speakers had a tendency to try to avoid vowel hiatus in the context of *joli* + vowel-initial noun. In order to do so, they substituted *beau* for *joli*, which in front of a vowel-initial word surfaces as bel ([bɛl]). This is quite an unremarkable substitution to make, since both adjectives have a very similar (if not identical) meaning. After the experiment, a few speakers commented that while they could produce a string like *joli* + vowel-initial noun, they felt that *beau* + vowel-initial noun was more natural. When prompted for a similar preference for *beau* + consonant-initial noun, all but one speakers indicated that they would not have that bias in this case. I also noticed that the substitution happened more frequently with older speakers (from group B) than with younger speakers. Older speakers were noticeably less confident in the laboratory setting than younger speaker, and I hypothesize that this discomfort might play a role in explaining the substitution rate.

APPENDIX 2

THE ARTICULATION OF LCs: A PILOT EXPERIMENT

A2.1 Introduction

In Chapter 5, I outlined the basic concepts of Articulatory Phonology (AP). This framework uses gestures and vocal tract variables formed by one or more articulators (upper lip, lower lip, tongue tip, etc.) as the basic unit. The syllable structure emerges from the coupling relationships between scores (constellations) of gestures: in-phase coupling for the gestures of the onset and the nucleus, and anti-phase coupling for the gestures of the nucleus and the coda. According to previous research (e.g. Marin & Pouplier 2010), these differences in theoretical coupling relationships translate into observable kinematic (articulatory) differences in behaviour between onsets and codas.

The goal of this pilot experiment was twofold: first, to collect what is, to our knowledge, the first kinematic data on Montréal French, and to use this data to compare the behaviour of LCs with respect to the behaviour of non-alternating codas and non-alternating onsets. Second, to validate the acoustic measurements collected in the earlier part of this project. Ideally, I would have collected kinematic data from more participants. However, the electromagnetic articulometer is physically limiting, since it cannot be taken out of the laboratory. Acoustic data collection, on the other hand, requires less sophisticated equipment, which can be taken out in the field.

Therefore, by verifying the early acoustic measurements with articulatory data, it validates the usage of acoustic data in lieu of articulatory data.

A2.2 Methodology

A female native speaker of Montreal French (age 25) and a male speaker of the same dialect (age 24) participated in this second experiment, in which articulatory data was collected. The design was identical to the first experiment, except for the word list, which was shorter and included different words (see Table 12).

Articulatory data and synchronized audio were collected using an NDI Wave electromagnetic articulometer (Berry, 2011) and a shotgun microphone positioned approximately 0.75 meters from the mouth of the speaker. Reference sensors were placed in the nasion and left/right mastoid processes. Articulator sensors were located in the midsaggital plane on the following: upper lip (UL), lower lip (LL), on the tongue blade approximately 2 cm from the tip (TT), on the body of the tongue approximately 5 cm from the tip (TB), and externally on the jaw (JAW).

In the first phase, each participant was familiarized with the eight word/image combinations seen in Table 12. In the second phase, the speaker performed 21 blocks of 12 trials, where every stimulus combination was presented once in each block in random order. Prior to the data collection phase, a bite plate was used to measure the orientation of the occlusal plane relative to the reference sensors.

Adjectives	Nouns
joli/jolie ('good-looking')	abeille ('bee', fem.)

petit/petite ('short')	abri ('shelter', masc.)
gros/grosse ('big')	sabot ('hoof', masc.)
maudit/maudite ('damned')	tableau ('blackboard', masc.)

Table 12: Target words with gloss and gender for the articulatory experiment.

In choosing the four target nouns, I refined the phonetic shape critera to select only words of the shape [ab-] or [Cab], where the consonant is either [t] or [s] to reflect the consonants found in the coda of the adjectives. The choice of phonetic shape was driven by the desire to maximize variation in height in the jaw, lips and tongue, facilitating the identification of gestural landmarks.

A2.3 Results

The results show great variability that depends on the prenominal adjective, the speaker, and the part of the gesture (onset/offset of gesture). Overall, the LC in the adjective *gros* seems to syllabify as a coda, the one in *petit* as an onset, while the one in *maudit* presents characteristics of both syllabification. The sections below provide more details.

A2.3.1 Gros

The general tendency that emerges from the data collected for the adjective *gros* suggests that LCs pattern more like codas than onsets. This behaviour was particularly robust in measurements of the release of the TT gesture, while the measurements of the onset of TT gesture showed greater variability.

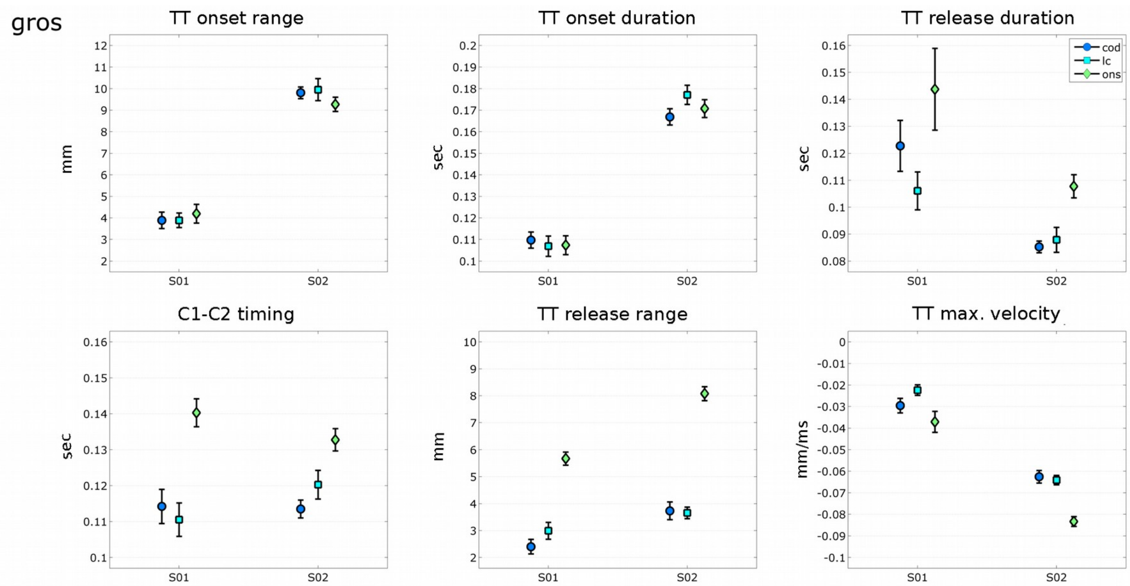

Figure 10: Articulatory results for the adjective *gros*, for the TT gesture. Top row, left to right: [1] change in height from onset to peak; [2] duration from onset to peak; [3] duration from peak to offset. Bottow row: [4] duration from peak of C1 to onset of C2; [5] change in height from peak to offset; [6] point of maximal velocity in the release.

Participant S01 showed greater variation in her measurements, especially for the release duration. Post-hoc Tukey tests showed that LCs and codas have significantly shorter peak-to-onset durations and smaller ranges than consonants in onset position. LCs were also produced with a significantly slower maximal velocity than both codas and onsets.

Articulatory measurements	**ANOVA results**	**Post-hoc T-test results**
TT onset range	n.s.	--
TT onset duration	n.s.	--
TT release duration	n.s.	--
C1-C2 timing	$F(2, 53)=12.95$, $p=0.000$	LC, coda < onset
TT release range	$F(2, 59)=39.56$, $p=0.000$	LC, coda < onset

TT max. velocity	F(2, 58)=4.04, p=0.023	LC < coda, onset

Table 13: Statistical results of ANOVA and post-hoc T-tests for S01 for the adjective *gros*.

Participant S02 showed similar results, with less amount of variation. Post-hoc Tukey tests showed that LCs and codas exhibited a shorter release, a smaller release range and a slower velocity than consonants in onset position.

Articulatory measurements	ANOVA results	Post-hoc T-test results
TT onset range	n.s.	
TT onset duration	n.s.	
TT release duration	F(2, 56)=10.42, p=0.000	LC, coda < onset
C1-C2 timing	F(2, 56)=9.28, p=0.000	LC, coda < onset
TT release range	F(2, 59)=84.74, p=0.000	LC, coda < onset
TT max. velocity	F(2, 54)=21.13, p=0.000	LC, coda < onset

Table 14: Statistical results of ANOVA and post-hoc tests for S02 for the adjective *gros*.

A2.3.2 Maudit

For the adjective *maudit*, the results show little variation across all three positions, where we would expect a minimal difference between onset and coda positions. For the measurements that do show variation, LCs tend to pattern more like codas than onsets.

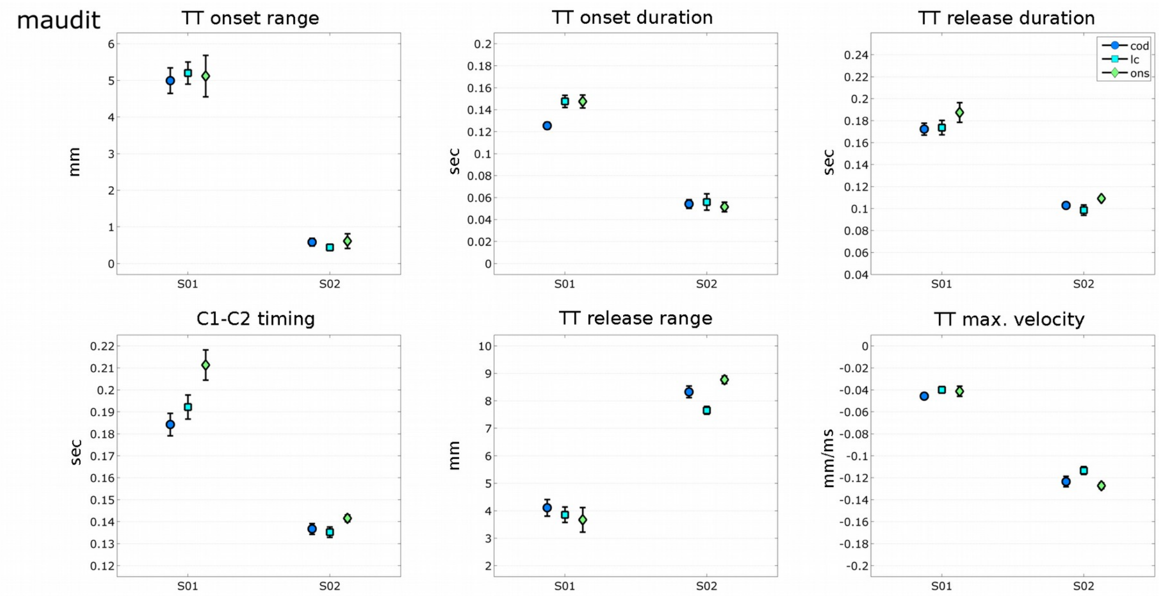

Figure 11: Articulatory results for the adjective *maudit*, for the TT gesture. Top row, left to right: [1] change in height from onset to peak; [2] duration from onset to peak; [3] duration from peak to offset. Bottow row: [4] duration from peak of C1 to onset of C2; [5] change in height from peak to offset; [6] point of maximal velocity in the release.

For the participant S01, only TT onset duation and C1-C2 timing were statistically different. Post-hoc tests revealed that for TT onset duration, both LCs and consonants in onset position were significantly longer than consonants in coda position. For C1-C2 timing, LCs and codas exhibited a shorter peak-to-onset duration than consonants in onset position.

Articulatory measurements	ANOVA results	Post-hoc T-test results
TT onset range	n.s.	--
TT onset duration	$F(2,52)=7.24$, $p=0.002$	LC, onset > coda
TT release duration	n.s.	--
C1-C2 timing	$F(2, 52)=5.36$, $p=0.008$	LC, coda < onset
TT release range	n.s.	--

TT max. velocity	n.s.	--

Table 15: Statistical results of ANOVA and post-hoc tests for S01 for the adjective *maudit*.

For the participant S02, only the release range and the maximal velocity showed statistical difference. Post-hoc tests showed that in both cases, LCs were significantly different from consonants in both onset and coda position, either by exhibiting a smaller release range, or by having a slower maximal velocity.

Articulatory measurements	**ANOVA results**	**Post-hoc T-test results**
TT onset range	n.s.	--
TT onset duration	n.s.	--
TT release duration	n.s.	--
C1-C2 timing	n.s.	--
TT release range	F(2, 54)=11.92, p=0.000	LC < coda, onset
TT max. velocity	F(2, 54)=3.60, p=0.034	LC < coda, onset

Table 16: Statistical results of ANOVA and post-hoc tests for S02 for the adjective *maudit*.

A2.3.3 Petit

The LC in the adjective *petit* behaved more like an onset than a coda, which is contrary to the majority of the results presented here.

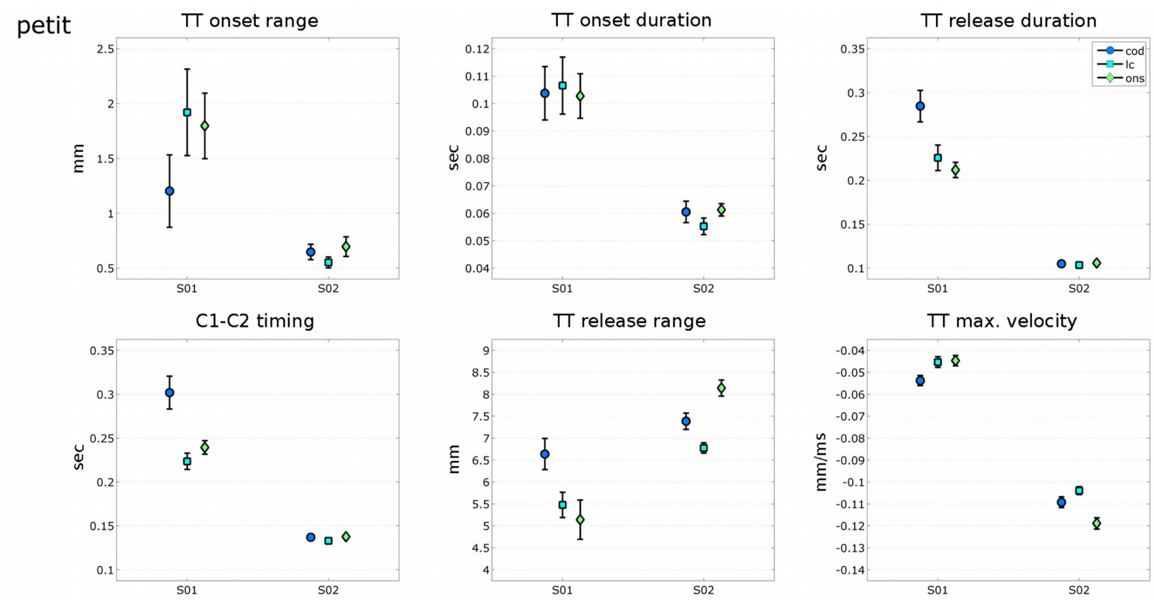

Figure 12: Articulatory results for the adjective *petit*, for the TT gesture. Top row, left to right: [1] change in height from onset to peak; [2] duration from onset to peak; [3] duration from peak to offset. Bottow row: [4] duration from peak of C1 to onset of C2; [5] change in height from peak to offset; [6] point of maximal velocity in the release.

For the participant S01, results were significant for release duration, C1-C2 timing, release range, and maximal velocity. Post-hoc tests showed that in all cases, LCs and consonants in onset position were significantly different from consonants in coda position.

Articulatory measurements	ANOVA results	Post-hoc T-test results
TT onset range	n.s.	--
TT onset duration	n.s.	--
TT release duration	F(2, 50)=7.30, p.=0.002	LC, onset < coda
C1-C2 timing	F(2, 49)=11.27, p=0.000	LC, onset < coda
TT release range	F(2, 53)=4.23, p=0.020	LC, onset < coda
TT max. velocity	F(2, 52)=4.43, p=0.017	LC, onset > coda

Table 17: Statistical results of ANOVA and post-hoc tests for S01 for the adjective *petit*.

For the participant S02, the results were significant for only two measurements, namely release range and maximal velocity. Post-hoc tests revealed that there was a significant difference in the release range across all three position, with LCs having the smallest range and onset having the largest range. Addtionally, LCs exhibited a slower maximal velocity than consonants in both onset and coda position.

Articulatory measurements	**ANOVA results**	**Post-hoc T-test results**
TT onset range	n.s.	--
TT onset duration	n.s.	--
TT release duration	n.s.	--
C1-C2 timing	n.s.	--
TT release range	F(2, 58)=17.47, p=0.000	LC, onset < coda
TT max. velocity	F(2, 56)=11.31, p=0.000	LC, onset > coda

Table 18: Statistical results of ANOVA and post-hoc tests for S02 for the adjective *petit*.

A2.4 Discussion

The general pattern that emerges from the data presented in this appendix is that LCs tend to exhibit principally the articulatory characteristics of consonants in coda position, except for the adjective *petit*, where LCs' behavior is similar to consonants in onset position. The adjective *maudit* presents ambiguous results, with some measurements showing a more coda-like behavior, and others showing a more onset-like behavior. This difference between the three adjectives might be attributed to the landmarking process, since it was harder to accurately identify landmarks for the words *maudit* and *petit*. This could be due to the affrication of the consonant, which causes vowel gestures to be reduced or completely absent, and to the reducted production of the word *petit* as [ptˢi̥], or even [tˢi̥] in its most reducted form. To support our current conclusion, therefore, I would need to collect more data from non-reduced, non-affricated forms.

It is also worth noting that the adjective *petit* is extremely common and forms a number of lexicalized expressions, such as *petit déjeûner* ('breakfast') and *petit ami* ('boyfriend'). While I avoided those constructions in the wordlist, it is possible that all sequences of the type *petit* + noun have a more lexicalized nature than most sequences of adjective + noun.

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