Weight and prominence in French:
An examination of corpus data from a Laurentian variety

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Abstract
Prominence is conventionally described as being assigned to the final syllable of phrases in French, but previous quantitative and qualitative work has shown that this is not always the case. Using phonetic corpus data from Laurentian French (Saguenay, Quebec), we test the hypothesis that prominence is assigned to non-final syllables to signal weight contrasts. Our results demonstrate that this is indeed the case, with both codas and long vowels attracting prominence away from final syllables, particularly when this syllable is open. In terms of phonetic realisation, we observe that the primary cues to prominence in French are higher pitch and longer durations, consistent with descriptions in the literature, with higher amplitude additionally manipulated to signal weight but not phrasal prominence. With regards to the phonological representation, we interpret these findings as indicating that the location of prominence can signal syllable weight and that this prominence is best formally expressed as a pitch accent due to its attraction to word-level properties. We propose that the phonetic and phonological evidence both converge on this analysis of the prominence system – at least for this variety of French – and can inform our interpretation of results from previous perceptual studies.

Keywords
Prominence, Prosodic domain, Weight sensitivity, Acoustic cue, French, Laurentian French.

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1. Introduction

Final syllables are conventionally characterised as bearing the main prominence in French (e.g., Delattre, 1939; Grammont, 1914; Jun & Fougeron, 1995, 2000, 2002; Martin, 1987; Pasdeloup, 1990; Selkirk, 1972). This prominence is reflected through longer durations and higher pitch peaks than are found on adjacent non-prominent syllables (e.g., Jun & Fougeron, 1995, 2000). For example, the final syllable in *patronne* /patʁɔn/ 'boss (FEM)' is the longest and has the highest pitch of the two syllables, which we indicate with the diacritic for stress: [pa'tʁɔn].[1] In contrast to languages like English with lexical stress, prominence in French is not a word-level phenomenon, but is instead assigned at the phrasal level. In a phrase with two lexical words like *la future patronne* 'the future boss (FEM)', only the final syllable is prominent in French: [la fytyʁ pa'tʁɔn].[2] In the corresponding phrase in English, however, both the adjective *future* and the noun *boss* are stressed: [ðə ˌfjuːʧəˈbɑs].

The observation that the domains of prominence in French and English are different suggests that prominence serves different functions in the two languages. In French, this cue allows interlocutors to easily and reliably recover the right edge of phrases and therefore reduce the risk of ambiguity (e.g., Mertens, 2006; Vaissière, 2010), for example, distinguishing between the one-phrase parse *la patronne responsable* [la patʁɔn ʁɛspɔ̃'sab(l)], in which the boss is a responsible person, and the two-phrase parse *la patronne responsable* [la pa'tʁɔn ʁɛspɔ̃'sab(l)], in which the boss is responsible for something in particular. However, one challenge for the view that prominence only serves to mark phrasal domains in French is that the cues to prominence do not strictly fall on the final syllable; instead, they often fall on the penult even when the final syllable does not contain a schwa (invisible to prominence assignment; e.g., Garde, 1968, Prieto et al., 2005). This has been observed across varieties of the language: Parisian French and other northern varieties (Carton et al., 1983; Goldman & Simon, 2007; Simon, 2011), Laurentian French (Thibault & Ouellet, 1996), Swiss French (Avanzi et al., 2011; Goldman & Simon, 2007), and Belgian French (Bardiaux & Mertens, 2014; Goldman & Simon, 2007; Simon, 2004, 2011). For example, in *le garçon* 'the boy', the penult can be realised with longer duration and higher pitch than the final syllable: [lə 'gaʁsɔ̃]. This *shift* in the location of prominence suggests that prominence is sensitive to considerations other than just phrasal domain edges. The goal of this paper is to investigate the factors that condition prominence shifts of this sort.

A plausible motivation for prominence shifts is that speakers are enhancing word-level properties instead of – or in addition to – phrase edges. Weight (i.e., the contrast between light and heavy syllables), whether the result of a coda or a long vowel, attracts prominence across languages (Prince, 1990) and could therefore be a relevant word-level property for French because the relative weight of syllables is computed in the domain of the word. If weight plays a role in predicting the location of prominence in French, then the penultimate syllable in *garçon* should be more likely to be prominent than the penultimate syllable in *patronne* because [gaʁ] is closed (and therefore potentially heavy) while [pa] is not. Thus far, the evidence suggesting that weight is responsible for prominence shifts is

[1] Our transcriptions reflect pronunciations in Laurentian French, the dialect under examination. For example, the French rhotic is transcribed as [ʁ] because this is the acoustic realisation that is most common in this variety (Côté & Saint-Amant Lamy, 2012).

[2] While French also has an optional phrase-initial rise (e.g., with low pitch on [la] and high pitch on [fy] in *la future patronne*), we will neither discuss nor transcribe this secondary prominence in the current analysis because we focus only on the right edge. The final high tone is the tone target that is preserved in cases where the phrase has too few syllables to realise both the initial and the final rises (Jun & Fougeron, 2002), meaning that the final high tone can successfully be isolated for study in this paper. Henceforth, we use the term *prominence* to exclusively refer to prominence assigned from the right edge.

limited to a study of naive listener judgments (Paradis & Deshaies, 1990), a study looking at the effects of long vowels on pitch contours (Thibault & Ouellet, 1996), and evidence from phonological patterns (Armstrong, 1999; Scullen, 1997).

In this paper, we test the hypothesis that prominence assignment is sensitive to differences in relative weight, consistent with how weight interacts with prominence cross-linguistically. We use mixed effects linear regression to test the effects of prosodic phrasing, of vowel weight and of coda weight on the realisation of prominence in read speech collected from the Saguenay (Quebec) survey in the Laurentian sub-corpus (Côté, 2014, 2015) of the *Phonologie du français contemporain* (PFC) corpus (Durand et al., 2002, 2009; http://www.projet-pfc.net/). Laurentian French (also referred to as Canadian French, Quebec French, and Québécois) was chosen as it presents more heavy syllables than many other varieties due to having conserved a large number of vowel contrasts from an earlier stage of the language. Furthermore, vowel length is regularly enhanced through diphthongisation (Côté, 2012; Dumas, 1974), facilitating detection of the long-short contrast. In sum, this dialect is a good test case to systematically examine and better understand the relationship between weight and the prominence shift sporadically observed in the literature. We will show that weight effects are associated with the same cues as those manipulated to mark phrase boundaries and that these weight effects provide a motivation for the variable shift in prominence observed.

2. Theoretical Context

We situate the current study within the context of previous work on prominence. The first topic, discussed in section 2.1, is cross-linguistic evidence for weight contrasts and their interaction with prominence. In this section, we additionally discuss weight in French, in order to identify the contexts in which prominence shifts are likely to occur. In section 2.2, we turn to the acoustic cues that have been shown to signal prominence, as discussed in the literature on French, in order to guide our examination of the PFC corpus data. We then proceed to a discussion of prosodic domains in section 2.3. This is crucial for the present analysis as it identifies the particular domains whose right edge is typically assumed to be marked through prominence, and departures from the baselines established for prosodic domains could indicate an interaction with weight.

2.1 Weight

Cross-linguistic comparisons have shown that weight and prominence often interact; in languages with lexical stress, for example, heavy syllables attract stress (Gordon, 2014; Prince, 1990). Using stress assignment in English verbs as an example (Halle, 1973; Hayes, 1982; Liberman & Prince, 1977), once we take into account that final consonants are extrametrical (they do not affect stress assignment), we observe that the final syllable is assigned stress if it contains a complex coda (e.g., *exíst*) or a long vowel (e.g., *eváde*); otherwise the penult is stressed (e.g., *cóvet, hárden*). Example words presented in the literature on French to illustrate prominence shift typically show a similar pattern of weight-sensitivity: prominence is word final unless the penult is heavy and the final syllable is light. We draw upon examples from the literature on French as well as cross-linguistic observations about the interaction of weight and stress to form the hypothesis in (1):

(1) Hypothesis:
French prominence assignment is sensitive to weight.

Not all phonological systems treat the same types of syllables as heavy (Hayes, 1995). The most common source of heavy syllables across languages is vowels: long vowels are heavy, and therefore can attract prominence away from syllables with short vowels. The second possible source of weight is

codas, with closed syllables patterning as heavy and therefore being able to attract prominence away from light open syllables.

If heavy syllables attract prominence in French, the question arises as to what counts as heavy: are codas weight-bearing or not, and are there phonemically long vowels in the language? We begin by discussing the status of codas, a term which we use to cover both word-medial rhymal dependents and word-final consonants. French has codas in both positions, as we can see in *marquis* [maʁ.ki] 'marquis' and *canal* [ka.nal] 'canal', so a related question concerns whether medial and final codas both pattern as heavy. Some authors have analysed word-final codas in French as the onsets of syllables with empty nuclei (Dell, 1995); consistent with this, consonants in this position have an onset profile and clusters with rising sonority are observed word-finally, as in *mettre* [mɛtʁ] 'to put', paralleling what are indisputably branching onsets in non-final position in the language (Dell, 1995).

Since onsets do not typically contribute weight[3] and empty nuclei are by definition weightless, final codas are not expected to attract prominence under this analysis, independent of the status of medial codas. In contrast to this view, we analyse final consonants as true codas (i.e., as dependents in the rhyme), based on two observations. One, vowels in final syllables are affected by following consonants in ways that are expected if these consonants are in coda position: for example, final codas are strongly associated with laxing of mid vowels, and in Laurentian French high vowels lax in closed syllables as well (Poliquin, 2007).[4] Two, impressionistic observations regarding the profile of words that have been given as examples of prominence shift in the literature lead us to expect that speakers will be less likely to shift prominence off of the final syllable in a word like *canal* that has a final coda compared to one like *marquis* where the penult is closed but the final syllable is open, which suggests that the final consonant in the former is a weight-bearing coda.

Turning to vowels, French has a relatively large vowel inventory, which is generally described as including both light (short) and heavy (long) vowels even though these contrasts are predominantly realised through quality differences in contemporary French (e.g., Walker, 1984).[5] For example, the upper mid vowel /o/[6] is described as being heavy, which can be seen in final closed syllables in a word like *côte* [koːt] 'hill' where it is realised as long; in Laurentian French this length can be reinforced by diphthongisation, as in [ko͡ʊt] (e.g., Côté, 2012; Dumas, 1974). This pattern for /o/ can be contrasted with the pattern found for the lower mid vowel /ɔ/, like in the word *cote* [kɔt] 'code', which is not realised as long or diphthongised and is therefore analysed as light. We adopt the position that vowel quality differences reflect length differences, and thus, we expect that prominence will shift inwards more often in a word like *côté* /kote/ 'side' than in a word like *coté* /kɔte/ 'coded (as)' because it is attracted to the heavy penult vowel in *côté*, but not to the light penult vowel in *coté*.

This study treats weight from any given source as binary; vowels are light or heavy; open syllables are light (when containing a short vowel) and closed syllables are heavy. While recent work shows that weight in some Romance languages is, instead, gradient (Garcia, 2017), we consider binarity a

[3] Recent work (e.g., Gordon, 2005; Ryan, 2016) has shown that in some languages onsets can contribute weight as well but these effects are small. We leave the possibility that onsets contribute to syllable weight in French for future work.

[4] For Laurentian French, closed-syllable laxing does not productively affect the mid vowels, but the lexicon shows a robust pattern for mid vowels in closed final syllables to be lax, while mid vowels in open final syllables will tend to be tense (Lamontagne, 2014).

[5] We generally use *light* and *heavy* to refer to the classification of vowels rather than *short* and *long* because the phonetic realisations of vowels in Laurentian French predominantly involve spectral differences and not durational differences (as mentioned in the text), and because we want to distinguish between the phonetic measurements of duration used in this paper and the phonological category of weight.

[6] Following typical conventions for French, we transcribe the long vowels – the upper mid vowels /e ø o/, the low back vowel /ɑ/, and the nasal vowels /ɛ̃ œ̃ ɔ̃ ɑ̃/ – without a length diacritic since, as mentioned in the text, the primary cues to the weight contrast are vowel quality and not duration.

necessary simplification for our statistical models given the number of tokens being examined, leaving the question of whether gradient weight can be motivated for French to future work. One consequence of this is that syllables with both a long vowel and a coda, for example *côte* [koːt]~[koʊ̯t] 'hill', will normally be considered alongside syllables that are heavy as a result of only having a heavy vowel or being closed, though when we need to refer to them in particular we will describe them as *superheavy syllables*. Similarly, we leave the question of whether certain codas (e.g., sonorants) contribute weight and others do not (see Zec, 1995) to future work.

As previously noted, heavy vowels show an important alternation in French. In final open syllables, underlyingly heavy vowels are typically phonetically short (like light vowels), whereas in final closed syllables, those same vowels are phonetically long (unlike light vowels) (e.g., Côté, 2012; Goad & Prévost, 2011; Montreuil, 1995; Walker, 1984). This suggests that a different behaviour is expected for vowel weight compared to coda weight in that codas always render a syllable heavy, while underlyingly heavy vowels do not.[7] We expect that final syllables will be sensitive to the *source* of weight, heavy vowel vs. coda, whereas penults will be sensitive simply to the *presence* of a heavy syllable.

We provide example words and their expected prominence patterns in Tables 1 and 2 below. Table 1 shows that we expect prominence to shift to a heavy penult only in cases when the final syllable is closed, regardless of whether the final syllable contains an underlyingly heavy vowel. Table 2 illustrates that in penults, unlike for final syllables, we expect both codas and heavy vowels to render a syllable heavy and therefore that the syllable will attract prominence. We assume that superheavy syllables will pattern similarly to the other heavy syllable shapes in Table 1 (with the exception of the particularity that final open syllables with underlyingly heavy vowels will not protect final prominence), because the presence of a coda is sufficient for a syllable to be considered heavy and therefore to attract prominence.

Table 1: Expected prominence location based on final-syllable weight.

		Underlying vowel weight	
		Heavy	Light
Coda weight	Closed	Final prominence favoured *entente* [ɑ̃.ˈtɑ̃t] 'agreement'	Final prominence favoured *antenne* [ɑ̃.ˈtɛn] 'antenna'
	Open	Prominence shift favoured *hanté* [ˈɑ̃.te] 'haunt (PTCP.M.SG)'	Prominence shift favoured *hantais* [ˈɑ̃.tɛ] 'haunt (PST.2SG)'

Table 2: Expected prominence location based on penult weight.

		Underlying vowel weight	
		Heavy	Light
Coda weight	Closed	Prominence shift favoured *conster* [ˈkɔ̃s.te] 'to establish'	Prominence shift favoured *copter* [ˈkɔp.te] 'to chime'
	Open	Prominence shift favoured *conter* [ˈkɔ̃.te] 'to recount'	Final prominence favoured *coter* [kɔ.ˈte] 'to code'

2.2 Cues

The cues manipulated to signal the right edge of prosodic domains in French have been the subject of some debate, with pitch, duration and amplitude all having been discussed as possible cues. Authors

[7] Nasal vowels may be an exception to this: nasal vowels can variably be diphthongised in final open syllables, suggesting that they may maintain their weight (as heavy). For the present paper, they have been grouped with the heavy oral vowels because they both show the pattern of being long and diphthongised in closed final syllables. We leave further examination of this issue for future work, but note that this predicts that, in our data, underlyingly heavy vowels in final open syllables may be slightly longer than light vowels on average due to nasal vowels not consistently showing the same shortening effect as other heavy vowels.

typically agree upon the role played by pitch, with high and low tones being assigned to syllables to mark phrasal boundaries (Di Cristo & Hirst, 1993a, 1996; Hirst, Di Cristo, & Espesser, 1998; Jun & Fougeron, 1995, 2000, 2002; Mertens, 1987, 1993; Post, 1993). High tones are associated with prominent syllables, both when prominence shift occurs and when it does not, leading to the frequent characterisation of pitch peaks as being a common trait of prominent syllables across varieties. Previous work has additionally suggested that pitch targets are sensitive to vowel weight in French, finding that high tones are realised on the penult more often when the penult's vowel is heavy (Thibault & Ouellet, 1996). In addition, differences in maximum pitch have been the main correlate examined in work describing prominence shifts, so we expect that pitch contours will be affected both by prosodic domains and by weight, such that heavy syllables will be realised with higher pitch maxima.

Prominent syllables are typically longer than non-prominent ones, which has led to debate about whether it is the primary cue (Delattre, 1968; Schwab & Llisterri, 2012; Walker, 1984) or simply a cue alongside pitch (Di Cristo, 1998; Jun & Fougeron, 1995, 2000, 2002; Santiago, 2011; Vaissière, 1991). We therefore expect that duration will pattern similarly to pitch in participating in prominence shifts and, given previous work showing that Laurentian French has longer penults on average compared to Parisian French (Ouellet & Tardif, 1996), we expect that duration may be robustly used as a cue in the variety under examination.

It is worth highlighting that duration is confounded with weight: having phonologically long segments (heavy vowels) or additional segments (codas) is, of course, expected to affect rhyme durations because there is more content to be pronounced independent of weight. We expect some degree of a trade-off between syllables, however, with the prominent syllable being lengthened and the non-prominent syllable being compressed. In this scenario, a coda's effect on duration would not solely be increasing the closed syllable's duration on account of the additional segmental content. The effect of weight on duration should therefore be particularly robust, so we would not conclude that there is sufficient evidence to support our hypothesis that prominence assignment is sensitive to weight if a small change in duration is the only effect of increased weight.

We additionally consider the possibility that the cues will not pattern together, for example if the pitch peak remained on a light final syllable but the heavy penult showed a large increase in duration, in which case we would have evidence that both word-level and phrase-level prominences are signalled simultaneously, albeit on different syllables.

Finally, unlike pitch and duration, amplitude is not typically reported in acoustic studies on prominence in French. Indeed, some authors have proposed that amplitude is not a possible cue to prominence in French because it is associated with word-level – and not phrasal – prominence (Féry, 2013): languages with lexical stress use amplitude to signal word-level prominence, but not to mark phrasal prominence. However, French speakers have been shown to use increased amplitude as a cue to stress in Spanish in experimental settings, with the authors describing amplitude as a cue that is also used in native French (Féry et al., 2011). Additionally, amplitude is manipulated for signalling prominence in Swiss French (Schwab & Llisterri, 2012), though this may be a feature unique to that variety. In view of most of the previous literature, we do not expect that amplitude will be associated with the marking of the right edge of prosodic domains. However, if prominence shift serves to highlight word-level properties, we expect that amplitude will pattern with pitch and duration and therefore be significantly affected by weight.

2.3 Prosodic Domains

As previously noted, the smallest domain of prominence in French is not the word, but instead, only higher phrasal domains assign pitch targets. Many terms have been used to describe the domains involved, but the smallest domain of prominence consistently groups together lexical words and their

preceding syntactic dependents (e.g., Di Cristo & Hirst, 1993a, 1993b, 1996; Jun & Fougeron, 1995, 2000).[8] We follow Jun and Fougeron (1995) in calling this domain the *accentual phrase* (AP). APs are typically characterised by rising intonation at the right edge, with the high tone target normally being associated with the final syllable (Jun & Fougeron, 1995; see Kaminskaïa, 2009, 2015 for a variety of Laurentian French).

APs are combined into larger units called *intonational phrases* (IPs), which typically correspond to a sentence (Jun & Fougeron, 1995). For clarity, we will refer to any word that is at the right edge of an IP as IP-final without indicating that it is also AP-final (IP-final words are by definition AP-final), and we will therefore refer to any word that is at the end of an AP but *not* at the end of an IP as AP-final. Different kinds of IPs are associated with different pitch contours or tone targets based on the function of the sentence.[9] For example, declarative IPs are typically associated with a final low tone, while interrogative IPs are typically realised with a final high tone (Jun & Fougeron, 1995, 2000, 2002; Kaminskaïa, 2009, 2015; Martin, 2004; Post, 2000). In this paper, we focus only on declarative IPs, given the content of the text from which the data are drawn, and we will control for the prosodic domain type when examining weight effects.[10] More specifically, we compare APs and IPs to each other in order to determine which cues are manipulated to mark prosodic domains in Laurentian French, and will include amplitude and duration in addition to pitch.

The pitch differences between APs and IPs in European varieties of French have been studied considerably. As alluded to above, for most varieties, the right edges of APs are marked with a final rise (LH*; following Jun & Fougeron, 1995). The H tone target is marked with an asterisk, which conventionally indicates a pitch accent. Following Gordon (2014), a pitch accent tone is crucially the only one in its phrasal domain, where it is associated to a syllable that is stressed or prominent rather than aligning with a morphosyntactic boundary. However, H* in French is often assumed to be assigned only to the phrase-final syllable, which suggests that it is a boundary tone rather than a pitch accent, consistent with its alignment with the phrase boundary.

The right edges of declarative IPs are typically marked with a low boundary tone (L%), which replaces the high (H*) of the AP's rise and makes the contour level or slightly falling (LL%). Here, the percent sign indicates that the tone is a boundary tone (and is therefore associated to a phrase edge). We expect that AP-final syllables are marked with a high tone – and therefore high pitch – that is preceded by a rise predominantly occurring on the final syllable. IP-final syllables have low pitch due to the IP-final low tone.

Though the pitch differences between APs and IPs have been studied extensively, it remains unclear whether duration and amplitude are also manipulated to distinguish between these prosodic domains. Previous work is divided about whether APs or IPs are realised with longer final durations, with APs being observed to have longer final syllables in some cases (Féry et al., 2010) and IPs being found to have longer final syllables in others (Michelas et al., 2010, though only for slow speech). This suggests that, if there is a significant difference in the degree of final lengthening based on type of domain, it is small and therefore small-scale studies are likely to find no result – or seemingly contradictory results – simply by chance.[11] The literature does not suggest an expected difference in

[8] A more detailed description of phrasing considerations will be provided in section 3.2.2 alongside examples.
[9] As we will be discussing both pitch as an acoustic cue (a phonetic measurement, here measured in semitones) and pitch targets (a phonological category), we will use *pitch* to refer to the acoustic measurements and *tone* to refer to the phonological target.
[10] The read passage contained an in-text question that was excluded from the analysis because we did not have enough data from questions to reliably examine the realisation of interrogative IPs. The title (which was phrased as a question) was similarly not included, though it was typically pronounced with falling intonation.
[11] It could additionally be that other factors confound the results of previous studies for duration; for example, the presence of a following pause could be associated with reducing an IP's final lengthening, since the cue is no longer needed. We will not address the availability or use of other cues in this paper.

penult durations for prosodic domains of different sizes, though it is worth noting that, in languages with lexical stress like English, the last syllable with primary stress in the phrase can be the target of final lengthening instead of the final syllable (e.g., Shattuck-Hufnagel & Turk, 1998). We expect that final syllables at the right edge of IPs are longer than those at the right edge of APs, but for this difference to be small based on mixed results in previous work.

Finally, the use of amplitude to mark different types of prosodic domains in Laurentian French, if it is manipulated at all, is not yet known. Based on work on other dialects and on typology, we expect that amplitude will not be manipulated to distinguish between APs and IPs for any syllable.

2.4 Summary

Based on the background literature, we expect that French – and Laurentian French in particular – predominantly uses pitch and duration to mark prosodic domains. The classification of French within the typology of prominence systems is at the centre of some debate (e.g., Vaissière & Michaud, 2006, who describe French as a "non-tone, non-stress language"): authors differ in whether they describe final prominence in French as a stress (e.g., Cutler, 2005; Schwab & Llisterri, 2012), as a pitch accent (e.g., Jun & Fougeron, 1995; cf. also Rossi 1980), or whether they do not formally categorise it, and there has additionally been some suggestion that the prosodic system is – or recently was – in flux (e.g., Fónagy, 1980).

We additionally expect French to exhibit weight sensitivity, with both long vowels and closed syllables being heavy and therefore attracting prominence. These heavy syllables are expected to be marked with increased rhyme durations and higher amplitudes. Furthermore, we expect the tone target (the H* in the AP's LH*) to shift inwards towards heavy penults and away from open final syllables, leading to higher pitch maxima for penults compared to final syllables. Determining the patterns found in these contexts would allow us to better situate French within the typology of prominence systems. This is important in part because it could allow us to better interpret the results provided by French speakers in perceptual studies, where participants often pattern differently than expected based on the description of French as a language with prominence strictly on the final syllable (e.g., Frost, 2011; Li et al., 2017).

Figure 1 illustrates the pitch profiles we expect by showing the idealised pitch contours at the right edge of the accentual phrase for unshifted (top row) and shifted (bottom row) cases of APs (left) and IPs (right). The values in the figure were chosen to produce curves with shapes consistent with our hypothesis in (1) that prominence assignment is sensitive to weight. In APs that are not IP-final, we predict a rising contour with the H* aligned with the final syllable if shift does not occur, but with the penult if shift does occur. In IP-final contexts, however, we expect to get no high tone if shift does not occur, since the H* in the final syllable gets replaced by the IP's L% boundary tone, assuming a declarative sentence. When shift does occur, the AP's H* tone would be expected to move inwards to the penult and therefore the phrase would end in a rise-fall because the IP's L% tone would be aligned with the boundary and would not replace the AP's H* that is assigned to the previous syllable.

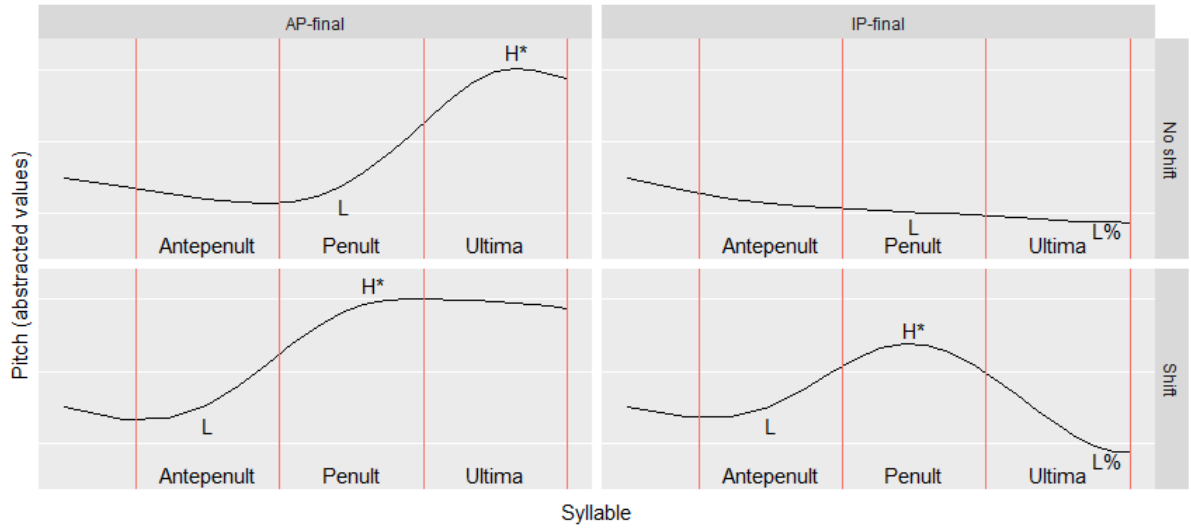

Figure 1: Predicted pitch contours at the end of APs depending on whether the AP-final word is also IP-final (right panels) or not (left panels), and whether the word undergoes prominence shift (bottom panels) or not (top panels).

The next section will address the data preparation, coding and statistical analysis that were used in order to test the patterns we predict for the realisation of prominence in the Laurentian French data under examination.

3. Methods

The goal of this study is to quantitatively test whether phonologically heavy syllables attract prominence in Laurentian French. Section 3.1 discusses the choices of corpus and of region under examination. In section 3.2, we turn to the procedure for data extraction and processing, in particular noting decisions about syllabification, the coding of prosodic boundaries, and the extraction of acoustic cues. Section 3.3 then discusses the mixed-effects logistic regression models, and how factors were coded for those models. Finally, section 3.4 presents the predictions for those factors.

3.1 Corpus and Speakers

As mentioned earlier, this study draws its data from the Laurentian sub-corpus (Côté, 2014, 2015) of the *Phonologie du français contemporain* corpus (PFC; Durand et al., 2002, 2009; http://www.projet-pfc.net/), which is a large-scale project seeking to provide corpus data from varieties of French around the world. During corpus collection, speakers from each survey location take part in four tasks: (1) reading a list of words designed to elicit regionally variable word-internal phonological phenomena in more attentive speech, (2) reading a short passage intended to examine sandhi processes and cross-word variability alongside word-internal phenomena in less attentive read speech, (3) having a semi-directed conversation lasting 20 to 30 minutes, and (4) having an informal conversation lasting 20 to 30 minutes.

In this study, we focus on the read passage (provided along with its translation into English in Appendix A). This was to ensure that the tokens across speakers are more comparable and that the phrasing is relatively fixed, since the speakers generally formed prosodic domains based on the punctuation provided in the text. Additionally, speech rate and register tend to be more consistent throughout a read passage than in spontaneous speech, which further increases comparability within and across speakers. Finally, work comparing dialect differences in French prosody has shown that read speech prosody is more similar across dialects than spontaneous speech prosody is (Simon, 2003),

which means that the results obtained in this study are more likely comparable to those that would be found for other dialects.

As previously noted, we chose to examine Laurentian French because it has conserved a large number of vowel length contrasts in comparison to other dialects, providing more opportunities for weight effects to be observed. For example, we find that the mid-vowel pairs /e-ɛ/, /ø-œ/ and /o-ɔ/, all listed with the heavy vowel first, are still robustly distinguished (e.g., Côté, 2012; Lamontagne, 2014). Examples of this phonemic contrast can be seen in pairs like *fée* /fe/ 'fairy' and *fait* /fɛ/ 'fact', and like *côte* /kot/ 'hill' and *cote* /kɔt/ 'code'. There is additionally a long counterpart to /ɛ/, transcribed as /ɛː/ and frequently realised as diphthongised (Côté, 2012), which we see contrasted in pairs like *fête* /fɛːt/ 'party' and *faite* /fɛt/ 'done (FEM)'. Furthermore, the variety has conserved a contrast in the low vowels, as seen in *pâte* /pɑt/ 'dough' and *patte* /pat/ 'paw', the former being underlyingly heavy. The presence of these additional vowel contrasts make it so that variation in vowel weight is more common in Laurentian French, and more pronounced as a result of diphthongisation, making this variety an optimal starting point for testing the prosodic effects of syllable weight in French.

More specifically, we examine the Laurentian French variety spoken in Chicoutimi, Quebec, which is located 200 km north of Quebec City. This area was selected for demographic reasons: we wanted to ensure that there would be limited contact with other languages in case this could influence the results within or across individuals. The Saguenay area, which includes Chicoutimi, is optimal for this, as census data (Statistics Canada, 2012) show: 98.3% of inhabitants report speaking French as a native language – higher than the Quebec-wide average of 78.1% –, and 98.9% speak only French at home. The frequency of French usage at home increases to 99.9% if all inhabitants who speak French at home on a regular basis are included.

The rate of bilingualism, including French-English bilingualism, is also relatively low. Inhabitants aged 20 to 44 are the most likely to be bilingual (31.8%), with those aged between 45 and 64 and those over 65 having bilingualism rates of about 17% and below 13%, respectively (Statistics Canada, 2012). These figures reflect lower bilingualism than for the province as a whole by about 20 percentage points for each age group. The Saguenay area additionally sees relatively little immigration, both from outside of the country and from elsewhere in the province or country, meaning that contact with other varieties of French and contact with other languages, including English, is unlikely to affect the results.

The data in this study come from 11 native French speakers who were born in and who grew up in Chicoutimi, with speakers spanning three generations and being relatively well-balanced for sex. The speakers' demographic factors – sex, birth year and age at time of testing – are presented in Table 3. We can see that the speakers are not perfectly balanced for these demographic factors, but previous research on French suggests that there are no gender effects with regards to the placement of prosodic tone targets (Avanzi et al., 2011). In all cases, the surveyed speakers were fluent readers.

Table 3: Speakers in the Chicoutimi survey and their demographic factors (year of birth, age)

	Sex	
Age Group	Male	Female
Young adult	fv1 (1984, 22) pl1 (1983, 23)	cl1 (1982, 24) jv1 (1979, 27) mb1 (1985, 21)
Middle-aged	db1 (1954, 52) pt1 (1965, 41)	gm1 (1958, 48) ma1 (1953, 53)
Older	rt1 (1934, 72)	gt1 (1932, 74)

3.2 Procedure

3.2.1 Alignment and Syllabification

The data were automatically processed to obtain acoustic measurements and lexical information. The PFC recordings were first forced-aligned using an aligner that was trained on Laurentian French and that uses speaker-adapted word-internal triphone models to maximise accuracy (Milne, 2014). From there, a Praat (Boersma & Weenink, 2016) script created rhyme and syllable tiers using an onset-maximisation algorithm that checked whether a consonant cluster formed an allowable onset. Word-internal /VsCV/ sequences were syllabified such that the /s/ was in coda, which reflects distributional tendencies in French: for example, /s/ does not occur in word-medial codas after a nasal vowel (historically vowel-nasal sequences) morpheme-internally, suggesting that /s/ is sensitive to constraints on coda, unlike the first consonant of a medial cluster with rising sonority. In all cases, the syllabifications used in this analysis are based on realised forms and not possible underlying ones, as coded by the forced aligner; reduced clusters and omitted schwas are not reconstructed, so that a word like *mettre* /mɛtʁ/ 'to put' was considered as having one syllable if the possible final schwa was not realised (e.g., [mɛt], [mɛtʁ]), but two if it was (e.g., [mɛtʁə]).[12]

3.2.2 Identifying Prosodic Domains

As we specifically examine prominence shift to the penult,[13] only words with at least two realised syllables were extracted. Accordingly, we also only examine the last two syllables of each target word, regardless of how many syllables are in the word. We additionally restricted the words analysed to those that are at the end of an accentual phrase given that this is the smallest prosodic domain described as assigning pitch targets (e.g., Jun & Fougeron, 1995, 2000, 2002). Since accentual phrases are always contained within intonational phrases and intonational phrases always end in an accentual phrase, this also means that all IP-final words of at least two syllables have been extracted. This was done manually based on the text – identical for all speakers – to ensure that the coding was not biased

[12] The words were also manually coded for whether the penult was the last syllable of the base, so that words like *gouvernement* 'government' and *protéger* 'to protect' were marked as having a base-final penult (cf. *gouverne* 'governs' and *protège* 'protects'). Given the limited data, we cannot speak to morphological effects directly with confidence and leave this question to future work, but we control for them through the factor and by-word random effects in the statistical model used in the current study (see further section 3.3).

[13] Jun & Fougeron (1995) found that prominence can shift to the antepenult as well. However, since it represents a small proportion of their realisations and since our data primarily consist of two-syllable words, we focus only on shifting prominence to the penult. In addition, the prominence realised on the penult in cases of shift has been shown to be distinct from emphatic stress in Laurentian French (Thibault & Ouellet, 1996), whereas this is not known for antepenultimate prominence.

by the presence or absence of cues that we would consciously associate with the right edge of a domain, which could affect the results.

The contexts included are shown in (2)-(4),[14] where we see examples of AP-final tokens that are taken directly from the text analysed (and are deemed to be AP-final, following the criteria from Jun & Fougeron, 1995). These right edge boundaries, indicated using pipes ("|") in the examples, correspond to syntactic junctures and are further supported by work that examines the prosodic domains relevant to phonological processes in French, like liaison (Hannahs, 1995). When punctuation was present, as in (3) and (4), we treated the prosodic context as being distinct from when there was no punctuation present, leaving us with three groups that were included in the statistical models: AP-final tokens not followed by punctuation, AP-final tokens followed by a comma, and IP-final tokens (AP-final tokens followed by a period). Only two of these groups are under present focus: AP-final tokens without punctuation, which, as mentioned earlier, we refer to as AP-final, and AP-final tokens followed by a period, which we refer to as IP-final.[15] In total, 1368 tokens were included, meaning that there were 2736 syllables measured.

(2) Contexts coded as AP-final without punctuation:

a. After a noun
   Ex: ... *le gouvernement* | *prend contact* | *avec la préfecture* | ...
   ... the government | makes contact | with the prefecture | ...

b. After a verb that is not an auxiliary
   Ex: ... *le gouvernement ... et s'assure* | *que ...*
   ... the government ... and ensures | that ...

c. After a post-nominal adjective
   Ex: *La côte escarpée* | ...
   The steep hill | ...

d. After a post-verbal adverb
   Ex: ... *qui tournaient toujours* | ...
   ... that always pivoted | ...

(3) Contexts coded as AP-final with punctuation:

a. After any word followed by a comma
   Ex: *Le hasard,* | *tout bêtement,* | *car le Premier Ministre,* | ...
   Happenstance, | quite frankly, | since the Prime Minister, | ...

(4) Contexts coded as IP-final:

a. After any word followed by a period
   Ex: ... *depuis les élections.* | ...
   ... since the elections. | ...

[14] The translations correspond to the senses of the words as they appear in the text, taking into account portions of the text not included in the abridged examples. Where example passages also include prosodic boundaries of types other than the one being illustrated, only the boundaries targeted for the example have been marked. Nouns followed by an adjective have been excluded because they can be realised in the same or separate APs (Post, 2003), as shown in section 1.

[15] AP-final tokens followed by a comma were excluded from the analysis for reasons of space. In previous work (Anonymous, 2017), we discuss the results for this domain and their implications for the assignment of domain-marking tones.

3.2.3 Acoustic Measurements

For each syllable that was included in the analysis, a Praat script extracted the rhyme durations,[16] as well as the syllable's maximum pitch and its maximum amplitude, based on the cues discussed by Gordon (2014) in his typological work and those examined for French by Jun & Fougeron (1995, 2000, 2002).[17] We focus our analysis on maximum pitch (discussed further in section 3.4.1) because it corresponds to the phrase-final high tone that is interpreted to be the acoustic target for AP prominence (e.g., Jun & Fougeron, 1995, 2000, 2002). Figure 2 illustrates an example of a token without shifted prominence (speaker cqbcl1), while Figure 3 shows a token with prominence shift (speaker cqbfv1). In these tokens we can see the pitch maximum is highest in the final syllable and in the penult, respectively. In both cases, the token was AP-final and was followed by segments with lower pitch at the beginning of the next AP within the same IP.

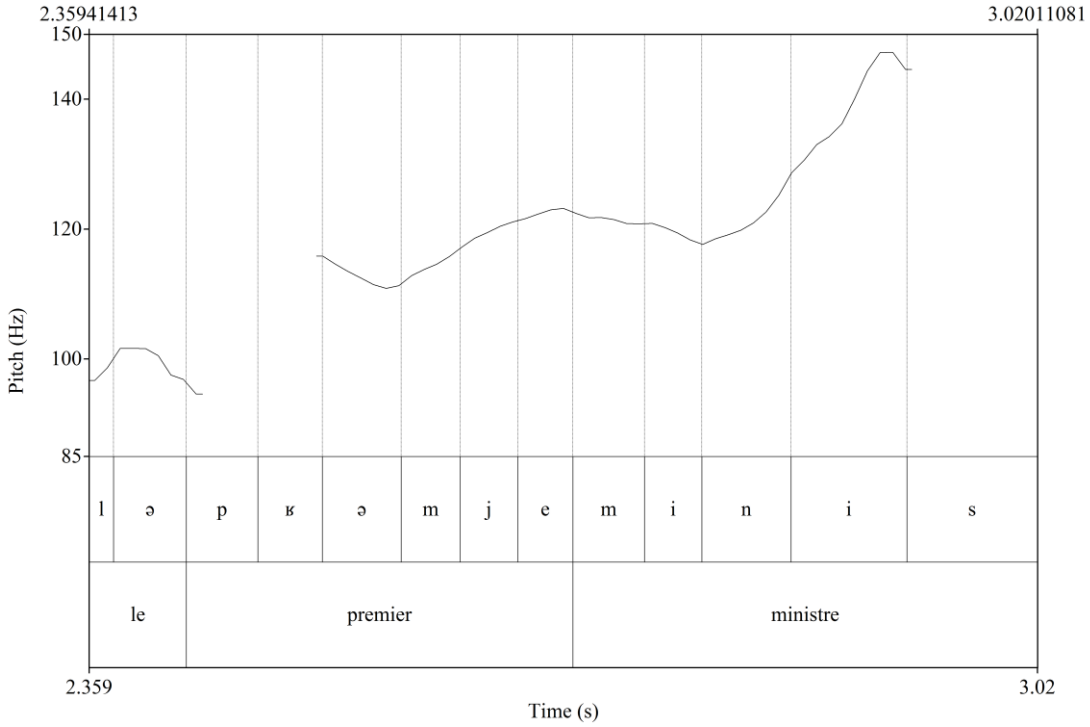

Figure 2: *Le premier ministre* 'the prime minister' produced by cqbcl1, in which prominence shift did not occur. The final cluster was reduced such that [s] was the end of *ministre*, with the alignment otherwise showing the phonemic transcription for each phoneme.

[16] We additionally extracted vowel durations to examine which part of the rhyme is particularly affected by lengthening because in discussion of length alternations in French, it is specifically the vowel that is said to lengthen (Walker, 1984). However, we will not report on the vowel duration data as the patterns under present focus for the rhyme and vowel were the same.

[17] Earlier analyses, such as those presented in Anonymous (2018), included results for pitch range. However, as those results closely mirror the ones found for maximum pitch and less directly reflect the high-tone target of the AP, we have not included them in the current paper for conciseness.

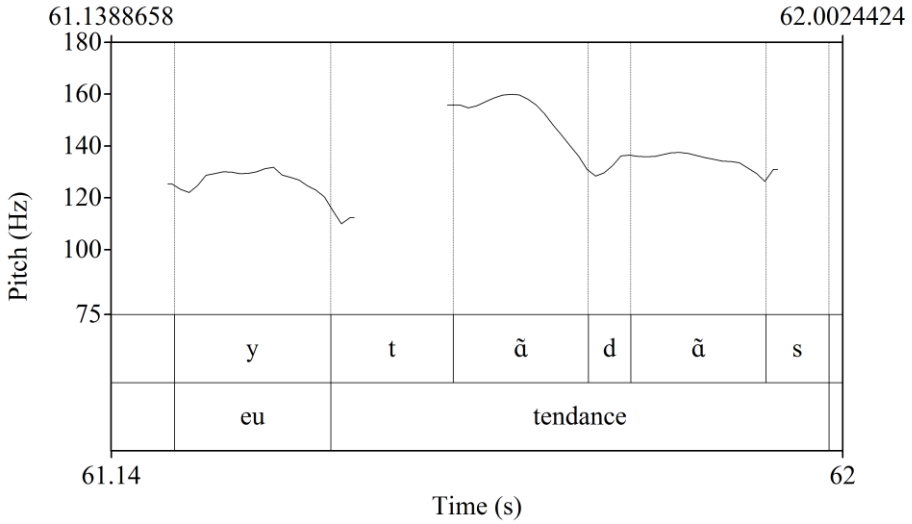

Figure 3: *(Ont) eu tendance* '(had) a tendency' produced by cqbfv1, in which the pitch maximum was realised on the penult.

It is worth noting that with this method we do not directly know whether a contour is rising or falling, but the height of the maximum pitches for the two syllables is suggestive of the contours present and directly reflects the component of prominence that interests us with respect to pitch (the tone target). In Figures 2 and 3, for instance, the syllable with the highest maximum pitch shows a pitch rise leading up to that maximum pitch. In a case where the token is also IP-final, a fall or low plateau is present, and therefore the contour can be inferred effectively from the values.

Maximum amplitude was preferred over mean amplitude because the mean is more likely to be affected by the segments present in a given syllable and because a shorter vowel would be expected to be at its maximum amplitude for a shorter period of time, thereby reducing the mean value without necessarily reflecting a lower amplitude target. Using maximum amplitude also meant that we could reliably measure through the rhyme instead of limiting ourselves to measuring the vowel, which could have resulted in not including the point with the greatest amplitude if, for example, there was a sonorant consonant in the coda that was higher in amplitude than the immediately preceding vowel.

3.3 Models

The acoustic cue realisations of the 2736 targeted syllables were analysed using the lme4 package (Bates et al., 2015) in R (R Development Core Team, 2015) to compute mixed-effects linear regressions with speaker and word as random intercepts and with by-speaker random slopes for all fixed-effect factors and interactions. No by-word random slopes were included because the predictors only varied by speaker. We discuss the results of three models, one for each acoustic cue (maximum pitch, rhyme duration, and maximum rhyme amplitude). We plotted the residuals and found them to be approximately normally distributed, and we verified the correlation matrices to ensure the assumption of multicollinearity was not violated.[18]

[18] While the factors are not too confounded for testing, there are distributional asymmetries that mean the dataare skewed towards having certain phonemic content in some contexts. For instance, while /e/ is common word-finally, it does not occur in closed final syllables. As a result, while we have numerous tokens of heavy vowels in closed final syllables, the heavy vowels are only a subset of those found elsewhere (e.g. /o/ and nasal vowels still occur in this context). Similarly, /ɔ/ is absent word-finally, meaning that it is amongst the light vowels in closed final syllables, but it is not included in the light vowels found in final open syllables (which include /ɛ/, for example).

The models take as their dependent variables not the raw acoustic measurements, but instead, the difference between the last two syllables' values, which yields a relative value to provide some normalisation for the context, with the use of random slopes and random intercepts simulating normalisation procedures to remove inter-speaker differences (Drager & Hay, 2012). For clarity, we will refer to the relative value as *RV* throughout the rest of this analysis. The formula for the RV, presented for each cue in (3), involves subtracting the final syllable's value from the penultimate syllable's value. This transformation was chosen because it provides an interpretable value: an RV greater than 0 indicates that the penult has a higher cue measurement, while an RV below 0 indicates that the final syllable has a higher value. The further from 0 that the RV is, the larger the difference between the two syllables is.

We use subtraction instead of division when calculating the RV for two reasons. First, the cues were already log-transformed either as a preliminary step (for duration) or as a result of their units (decibels for amplitude and semitones for pitch), meaning that subtraction is equivalent to dividing the cue values, following the laws of logarithms. Second, this allows for a more intuitive interpretation of the RVs: not only does the RV's sign indicate which syllable has a greater cue measurement, but the RV can be directly interpreted as being the size of the effect – an RV of 1 for the pitch maximum means that the penult's pitch maximum is one semitone higher than the one for the final syllable, for example. Because our models look at RVs, the model considered 1368 data points (one per word rather than one per syllable). Four tokens were excluded from the maximum pitch and maximum amplitude models due to excessive devoicing of a high vowel making those measurements unreliable.

(3) Formula for calculating RVs:

$$RV_{cue} = measurement_{penult,cue} - measurement_{final,cue}$$

Figure 4 illustrates how RVs relate to the cue measurements using hypothetical values generated through the *rnorm* function in R.[19] In the panel on the left, we provide an example of what the hypothetical results for penult weight could be – penults having a higher value when heavy compared to when light. In the panel on the right, we see the RVs based on the hypothetical measurements: the RV is positive when the penult vowel is heavy because the penult's value is larger than the final syllable's value; the RV is negative when the penult vowel is light because the final syllable's value is larger than the penult's value.[20] In the statistical analysis, the model coefficients would reflect the

[19] 500 tokens were generated for each combination of the penult and final syllables being light or heavy. Prominent syllables were given a mean of 25, while non-prominent syllables were given a mean of 15. If a final syllable was heavy (ie. the final syllable is expected to preserve prominence) or the penult was light (ie. the penult is expected to attract prominence), the final syllable was treated as prominent and the penult was treated as non-prominent. To reflect the hypothesis that heavy penults will optionally attract prominence from light final vowels, the penult was treated as prominent (mean value of 25) in half of the cases where the penult syllable was heavy, with the final syllable therefore not being treated as prominent (mean value of 15). In all other cases, the penults were treated as non-prominent (mean value of 15), with the final syllable instead being prominent (mean value of 25). If the two syllables had equal weight and therefore more variation in prominence may occur, the standard deviation for both syllables was set to 7, while it was set to 3 if the syllables differed in weight. While we do not believe the differences in means and variation are this straightforward in reality, it provides a straightforward set of values for visual inspection of potential patterns and illustrates that even a relatively clear effect is not as evident in plots. Figure 4 and the associated discussion only include the tokens that were generated to include prominence shift (ie. penults always attract prominence when the penult is heavy and the final syllable is light), but Figure 5 and the associated discussion in section 3.4.5 introduce the additional tokens.

[20] For maximum pitch, the RV will often be near 0 in the case of tone targets retracted to the penult because the final syllable will not have a separate tone target, as shown in Figure 1, and therefore the final syllable's pitch will be similar to the penult's pitch.

penult attracting prominence by being a positive value proportional to the difference in RVs between the light-vowel context and the heavy-vowel context.

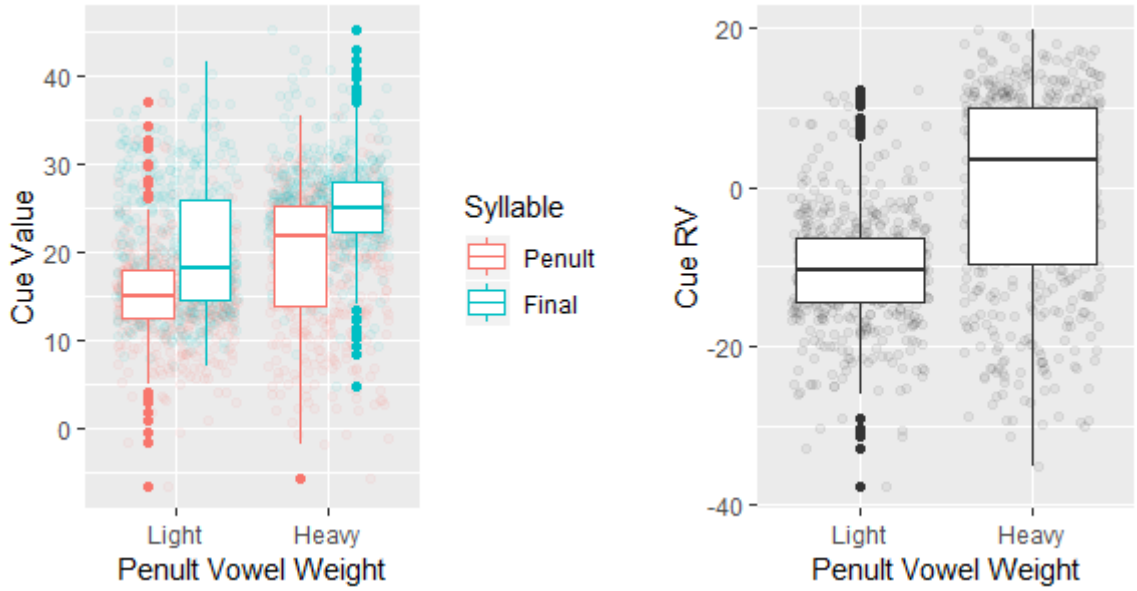

Figure 4: Syllable weight values and their associated RVs using hypothetical data.

Returning to the statistical analysis, the models all include the same fixed and random effects to ensure that they are maximally comparable. With the exception of the prosodic domain, all factors are binary and were therefore rescaled by two standard deviations and centred for better comparability with other analyses. The prosodic domain is a ternary factor (AP with no punctuation vs. AP with comma vs. IP) and was Helmert-coded so that the first prosodic domain factor in the model provides the difference between APs with no punctuation and IPs, as this is the domain comparison we focus on in the analysis. In all cases, except when specifically discussing intonational pitch targets, the following directions of effect are interpreted as an increase in prominence: higher pitch and amplitude maxima and longer durations. The coefficients in the model can be interpreted as the size of the change in acoustic cue measurements.

We included one additional factor in the model that does not directly relate to the predictions within the scope of this paper: the morphological structure. A larger – and more morphologically diverse – dataset would be required to test the effects of morphological structure in detail since many properties of individual morphemes could play a role (e.g., syllable shape, phonological size, status as derivational or inflectional). However, preliminary data exploration suggested that we would need to control for morphological structure in our models, so a manually coded factor that identified whether the penult was base-final or not was included. We will point out where this factor was crucial in our description of the results, but not treat it as a focus given the limitations of the dataset.

3.4 Predictions

In this section, we discuss predictions that stem from our hypothesis that French prominence is sensitive to weight. Anticipating the order of presentation in the results section, we begin by providing our predictions relating to prosodic domains in section 3.4.1. We then turn to coda weight and vowel weight, in sections 3.4.2 and 3.4.3 respectively. In section 3.4.3, we also provide our predictions for

how vowel weight and coda weight interact in the final syllable. Finally, in section 3.4.4, we discuss how our predictions differ slightly between penultimate and final syllables.

3.4.1 Prosodic Domains

AP-final syllables are generally expected to be marked with an LH* sequence, which means that the penult will have a lower maximum pitch (marked with a low tone) than the final syllable (marked with a high tone), yielding a negative RV for maximum pitch. We also expect IP-final syllables to be marked with an LL% or H*L% contour, which means that the RV will be near or above 0 since the final syllable will be marked with a low tone. These expectations lead to the prediction that the maximum pitch RVs will be significantly higher in IPs (where the final syllable has a low tone) compared to in APs (where the final syllable has a high tone).

Given the results of previous studies for final lengthening in different domains, we expect that the duration RV will be higher in APs than in IPs because the final syllable of IPs will be subject to greater phrase-final lengthening. However, this difference is likely to be small based on the mixed results in the literature, and this study will not have the statistical power required to confidently refute that a small effect exists and therefore will need to be compared alongside other work in meta-analyses. These expectations lead to the prediction that we will find any difference in duration resulting from the type of prosodic domain.

Finally, we do not expect that there will be a significant difference between APs and IPs with respect to amplitude RV because amplitude is not expected to be used as a cue to phrasal prominence, though again we will not be able to refute the presence of a small effect if no statistically significant effect is found. We therefore do not predict any difference in amplitude resulting from the type of prosodic domain present.

We summarise our predictions for the marking of prosodic domains as Prediction 1 in (5):

> (5) **Prediction 1**: We predict that IPs will have lower-pitched final-syllable rhymes than APs will, but we do not predict that there will be a significant difference in duration or amplitude between APs and IPs.

3.4.2 Coda Weight

The first possible source of weight that we discuss is codas, where closed syllables are heavy and open syllables (with short vowels) are light. We expect that syllables with codas will have greater prominence compared to those without.[21] As a result, our expectations for coda weight are straightforward: closed penults will attract prominence, while final closed syllables will preserve prominence. These expectations lead to the prediction that closed syllables will have higher maximum pitch RVs, longer rhyme duration RVs, and higher maximum amplitude RVs. The RVs will therefore be higher if the penult is closed rather than open, and lower if the final syllable is closed rather than open.

We summarise this second prediction in (6):

[21] French has a process whereby the vowel in a final syllable is longer when the syllable is closed by /v z ʒ ʁ vʁ/ than when the syllable is either closed by another consonant or open (e.g., Côté, 2012; Walker, 1984). This length difference is particularly evident in high vowels in Laurentian French since laxing and lengthening, both of which occur in closed syllables, are mutually exclusive: compare *vite* [vɪt] ‘quick’ and *vivent* [vi:v] ‘live (3PL)’ (also *vie* [vi] ‘life’). Because this lengthening process was shown not to have an effect on the realisation of prominence in earlier statistical models (see Anonymous, 2017), this factor was not included in the models discussed here.

(6) **Prediction 2**: We predict that closed syllables will have significantly higher values compared to open ones for all acoustic cues signalling prominence (maximum pitch, duration, and amplitude).

3.4.3 Vowel Weight

Before turning to our predictions for vowel weight, we discuss how we partitioned the French vowel space into length classes. As previously noted, we modelled vowel weight as binary. Following Walker (1984) and Côté (2012), we classified vowels into the two categories in Table 4, which we label as light and heavy. Vowels that are classified as heavy are those that surface as long in closed final syllables, thereby revealing their underlying weight. Although one vowel in this category, /e/, does not occur in this context in native French words, it was classed as heavy based on its phonological similarity to /ø o/, on its phonological opposition to the unambiguously short /ɛ/, and on how it surfaces as long – and often diphthongised – in integrated borrowings from English like *break* or *tape* (Côté, 2012; Lamontagne, 2014). For both syllables under analysis, the binary factor for vowel weight (light, heavy) was centred and rescaled by two standard deviations.

Table 4: Vowels in Laurentian French and their inherent weights.

Light vowels				Heavy oral vowels			Heavy nasal vowels		
i	y		u						
				e	ø	o			
ɛ	œ	ə	ɔ	ɛː			ɛ̃	œ̃	ɔ̃
a						ɑ			ɑ̃

We expect that heavy vowels will attract prominence and therefore that (a) the final high tone will be attracted to heavy vowels, (b) that heavy vowels will have significantly longer duration, and (c) that heavy vowels will be marked with increased amplitude. Combining our expectations that final syllables must be closed to count as heavy and that vowel weight contributes to weight in final closed syllables, we expect that final syllables that both are closed and have a heavy vowel will preserve prominence, but that final open syllables will pattern as light even if they contain an underlyingly heavy vowel. These expectations lead to the prediction that heavy penult vowels will be associated with higher maximum pitch RVs, higher duration RVs, and higher maximum amplitude RVs, but we do not predict that an effect will be found in final open syllables.

This prediction is summarised in (7):

(7) **Prediction 3**: We predict that syllables containing a heavy vowel will have significantly higher values for all acoustic cues (maximum pitch, duration, and maximum amplitude) compared to syllables containing a light vowel, except in the case of final open syllables where we do not predict that a significant effect will be found.

3.4.5 Differences between Syllables

In the discussion thus far, we have treated the two syllables under focus as equally capable of hosting prominence. This, though, is not consistent with the literature where final syllables are standardly considered to be the default position for prominence assignment in French. In view of this, we must modulate our predictions to ensure that the prominence-retaining properties of final syllables will have a greater effect than the prominence-attracting properties of penult syllables. This may manifest itself not only in the relative sizes of the predicted coefficients (larger for factors relating to final syllables than for those relating to penults), but also in the distributions themselves.

Consider again Figure 4, where we presented hypothetical results for weight effects to illustrate how the RVs relate to the acoustic values. Examining the predicted role of penult vowel weight, we

see that the hypothetical distributions are entirely separate – as though the profiles of the final syllables do not have any effect. If we revise the simulated data to better match the hypothetical patterns in Table 2, this would more closely match the distributions in Figure 4. For this figure, we treated the penult as prominent when the penult was heavy and the final syllable was light, but the final syllable as prominent when this was not the case (i.e., heavy final syllables retain prominence, and light penults do not attract it).

We can see from a comparison of Figures 4 and 5 that this has a fairly marked effect on the appearance of the distributions in plots: now even when the penult is heavy, the distribution suggests frequent final-syllable prominence because it is centred closer to zero, and often has a mean below zero. The plots in the results section present the acoustic measurements in the same format as in the left panels of Figures 4 and 5 (with the syllable values rather than RVs) to make the patterns easier to interpret visually, but the models take as input the RVs (like what is shown in the right panels of Figures 4 and 5). With these hypothetical data, a fixed-effects linear regression model that includes the weight of both syllables and the interaction between those weights gives a coefficient for weight of 2.425 (positive), after centring and rescaling the vowel weight factor. This means that heavy penults increase the mean difference in cue values by about that number relative to the estimated mean (and therefore by twice that number relative to the being light, since the mean is centered between the two values).

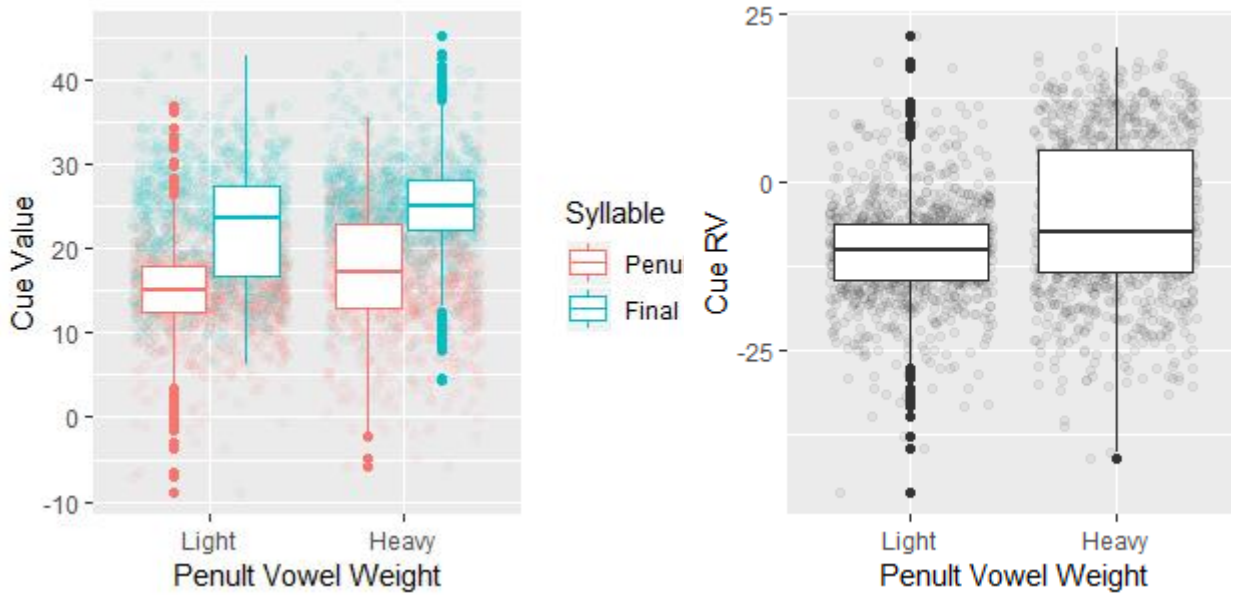

Figure 5: Hypothetical results and their associated RVs.

4. Results

In this section, we discuss the results of the statistical models. We present the findings thematically – based on the main factors of interest – to directly compare the effect of each factor on the acoustic cues. We begin with the results for prosodic domains in section 4.1, discussing how the marking of the right edge of IPs compares to the marking of the right edge of other APs. We continue in sections 4.2 and 4.3 with the results for coda weight and vowel weight, respectively. Section 4.4 then examines the interaction between coda and vowel weight in the final syllable – in other words, it allows for a comparison of final syllables that are underlyingly light (open with light vowel), heavy (open with heavy vowel or closed with light vowel) and superheavy (closed with heavy vowel). The model results themselves are provided in Appendices B through E, and for ease of reference all figures

in this section will follow the same layout, where panel A shows maximum pitch, panel B shows rhyme duration, and panel C shows maximum amplitude.

4.1 Prosodic Domains

Prediction 1 stated that IPs would have higher pitch maximum RVs than APs because the IP-final syllable receives a low tone. We find that IPs have considerably higher values (β=1.1817, p<0.0001), which is consistent with IPs having a low tone rather than a high tone in the final syllable. We see this in panel A of Figure 6, where we additionally note that this difference mainly appears to be a result of the final syllable's pitch changing, consistent with these phrase types having different final-syllable targets, but not different tone targets for the penult.

Regarding duration RVs, we predicted lower values in IPs than in APs because we expected to find more final lengthening in IPs than in APs. Consistent with this prediction and as shown in panel B of Figure 6, we find a small but significant difference whereby IP-final syllables are proportionally longer than AP-final ones (β=-0.1068, p=0.0480). However, this result should be tested in future work, as the effect is small and only barely reaches the threshold for significance. Additionally, we note that the effect is too small to counteract the intercept (β=-0.6097, p<0.0001), meaning that overall final syllables are longer than penults unless other factors (such as weight, to be discussed below) lengthen the penult or shorten the final syllable.

As for amplitude, we predicted that no significant difference between APs and IPs would be found because amplitude is not expected to be manipulated to signal boundaries. Contrary to this prediction, however, we find that IPs have significantly higher RVs for maximum amplitude (β=1.9705, p=0.0011), which indicates that IP-final syllables have much lower amplitude than AP-final ones. Panel C of Figure 6 illustrates this interpretation, where we see that both the penult and final syllables have lower amplitude in IPs than in APs, with final syllables showing the largest decrease.

Overall, these results are consistent with (a) APs being marked with a rising pitch contour and (b) IPs being marked with low final pitch. We additionally find evidence that IP-final syllables are longer than AP-final ones and that IPs have lower final amplitude. These results suggest that Laurentian French patterns like other French varieties in terms of the tone targets used to mark phrasal domains. With the tone for APs established, we turn to the results for weight factors.

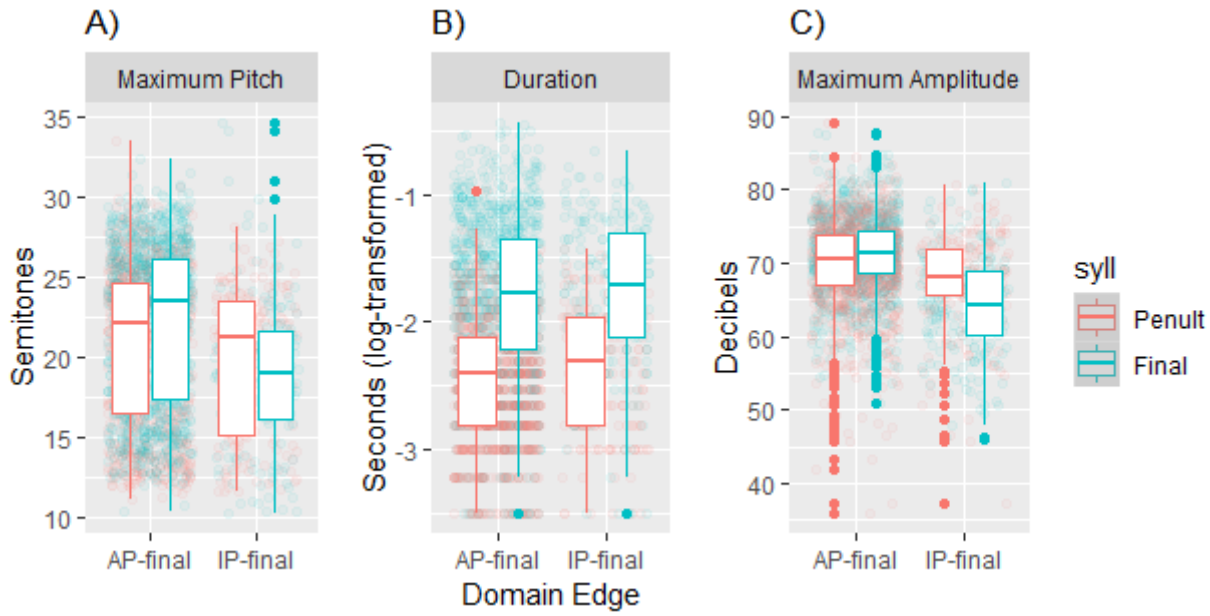

Figure 6: Results for domain type.

4.2 Coda Weight

Prediction 2 stated that the RV for all acoustic cues would be higher in closed syllables, following from our hypothesis that closed syllables will attract prominence. We begin by presenting our results for penult coda weight in section 4.2.1, and then continue to final-syllable coda weight in section 4.2.2.

4.2.1 Penult Coda Weight

We predicted that closed penults would have higher pitch maxima because heavy penults attract the H* tone from the final syllable. Our models support this prediction (β=1.1533, p<0.0001), but an examination of panel A in Figure 7 suggests otherwise. Based on model comparisons, the prediction of greater penult pitch maxima is borne out so long as we control for morphological structure. However, based on additional data inspection and model comparisons, this result appears to be consistent whether the penult is base-final or not, but skewed data proportions mask this result in the figure because the morphological structure had additional effects on the realised pitch contours.

We predicted that closed penults would have significantly longer rhymes not only because of the additional segment, but because the penult optimally attracts prominence. Closed penults have significantly longer rhymes (β=0.6992, p<0.0001), and panel B of Figure 7 shows the expected trade-off between syllables, such that the penult being heavy not only increases the penult's rhyme duration, but also appears to decrease the final syllable's rhyme duration. This relationship between the durations of the two final syllables allows us to infer that the increase in relative duration is not simply the result of there being an additional segment in the penult rhyme with no influence on prominence assignment. Finally, as shown in panel C of Figure 7, we also find that closed penults have higher amplitude RVs (β=2.0582, p<0.0084).

In short, these results show that words with closed penults, like /mɛrsi/ *merci* 'mercy', more often have higher pitch, higher amplitude and longer duration in the penult than words with open penults, like /mɛsi/ *messie* 'saviour', consistent with Prediction 2. Based on our hypothesis that French prominence exhibits weight sensitivity, we expect that closed final syllables will similarly have higher values for these acoustic cues. The next section provides the results for this prediction.

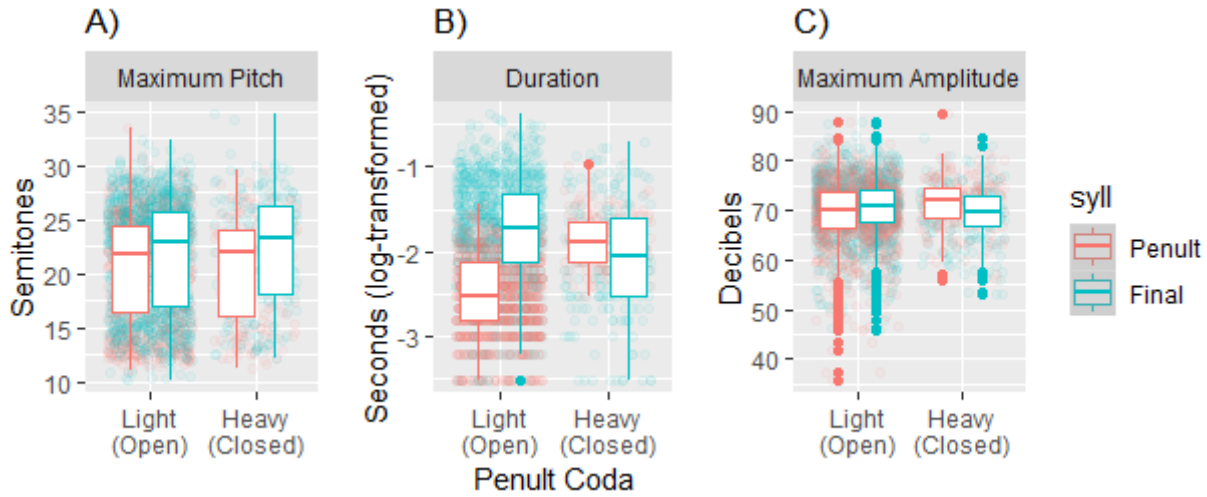

Figure 7: Results for penult coda weight.

4.2.2 Final Syllable Coda Weight

Turning to coda weight in final syllables, we predicted that the final syllable being closed would be associated with that syllable being highly likely to preserve prominence and therefore to be realised with a high tone. We see from panel A of Figure 8 that this does have an effect (β=-0.1440, p=0.0139).

Also in line with our prediction that closed syllables are heavy and therefore should be longer, closed syllables have significantly longer relative rhyme durations. While the increase in relative duration for the penult is quite large, we find an even larger effect for final syllables (β=-0.9202, p<0.0001), as shown in panel B of Figure 8, suggesting that this effect is not solely the result of adding segments.

Finally, we find much lower RVs for amplitude when the final syllable is heavy (β=-3.1101, p<0.0001), as illustrated in panel C of Figure 8. This is consistent with our prediction that a heavy final syllable would have increased amplitude because weight is a word-level property and therefore amplitude is available as a cue.

In summation, we find that closed final syllables, like in /navɛt/ *navette* 'shuttle', typically have higher pitch, amplitude and duration than open final syllables, like in /navɛ/ *navet* 'turnip', consistent with Prediction 2. In the next section, we examine the results for vowel weight to determine whether weight effects are also found for vowels.

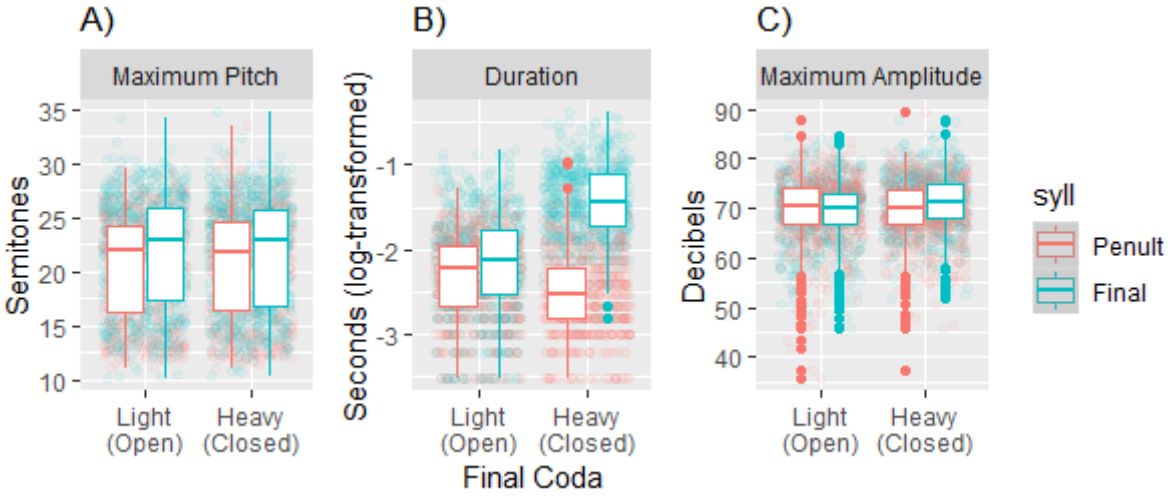

Figure 8: Results for final coda weight.

4.3 Vowel Weight

Prediction 3 stated that heavy vowels should attract prominence in penults, but that final open syllables should pattern as light and therefore vowel weight should not have a significant effect in this position. We predicted that RVs would be higher for heavy penults, but unaffected by heavy final-syllable vowels unless the final syllable is also closed, in which case the vowel would be more likely to attract prominence. Since we are discussing main effects here, we predicted that heavy penult vowels would attract prominence (leading to positive RVs), but we did not predict that heavy final-syllable vowels would be significantly different from light ones. We again begin by presenting the results for penults first (section 4.3.1) and then turn to final syllables (section 4.3.2).

4.3.1 Penult Vowel Weight

We predicted that heavy final syllables would be associated with higher RVs for pitch maxima, but the results are marginal (β=0.2493, p=0.0720). We illustrate these cues in panel A of Figure 9. Once again, asymmetries in the morphological and phonological profiles of the words in the data largely obscure the statistical trends visually. We find the predicted increase in duration RVs when the penult

vowel is heavy (β=0.1881, p=0.0024), shown in panel B of Figure 9, but find no significant effect of penult vowel weight on amplitude RVs, which may reflect our expectation that a small difference in duration may be present without signifying a difference in weight. As shown in panel C of Figure 9, the amplitude differences are small with a possible trade-off between syllables and therefore this statistical trend should be explored further in future work. In other words, a penultimate heavy vowel, as in /gɑto/ *gâteau* 'cake', is likely to have longer duration than the penultimate light vowel in a word like /bato/ *bateau* 'boat' and is likely to have a higher pitch maximum, but may not have higher amplitude, overall in line with Prediction 3.

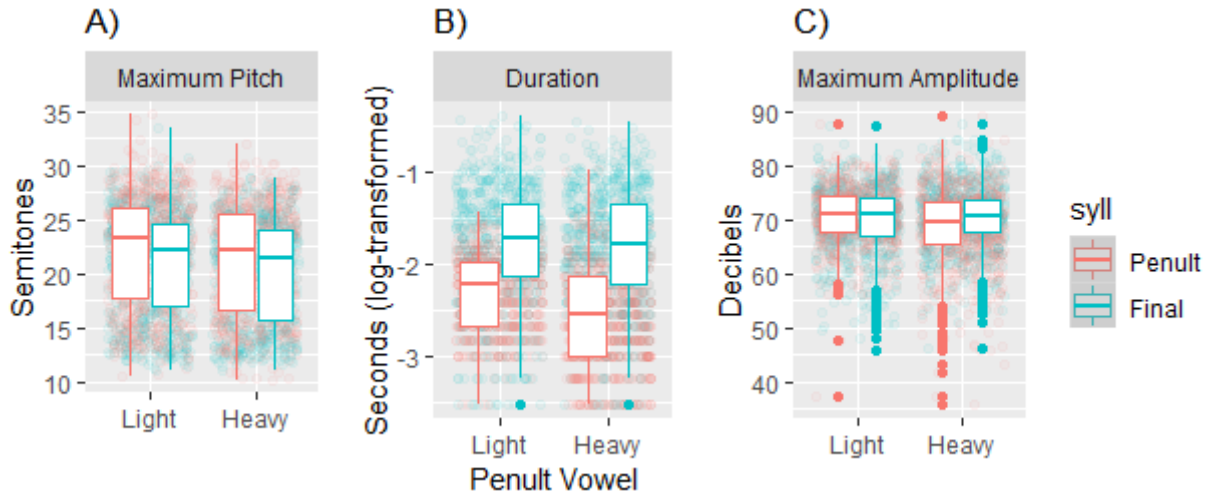

Figure 9: Results for penult vowel weight.

4.3.2 Final Syllable Vowel Weight

For final syllable vowel weight, we predicted no main effects with the possible exception of a small increase in final rhyme duration. In this case, pitch maxima (panel A of Figure 10) and amplitude (panel C) show no noteworthy effect that does not result from other factors, primarily from the presence of a coda in the penult. Our models reveal no significant effects for these factors (though for the maximum pitch and amplitude there may be a small effect, which future work should test with a larger dataset). For duration, however, we do find that the RV is significantly lower when the final syllable is heavy, consistent with the small predicted effect (β=-0.2662, p=0.0184). Overall, this means that the final syllables in words like /ami/ *ami* 'friend' (light final vowel) and /ane/ *année* 'year' (underlyingly heavy final vowel) may show no difference in pitch, duration or amplitude, consistent with Prediction 3.

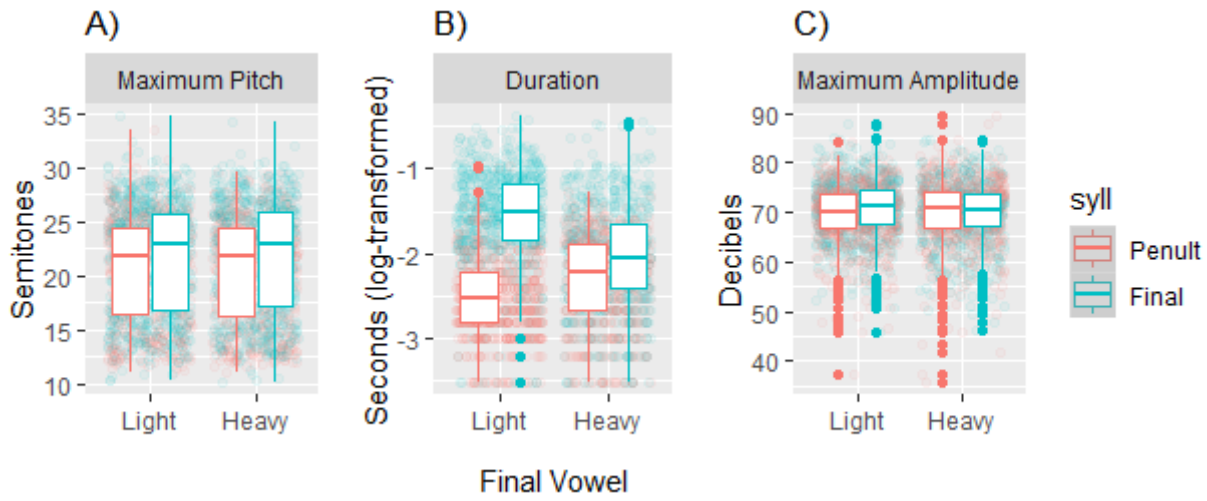

Figure 10: Results for final vowel weight.

4.4 Superheavy Final Syllables

Prediction 3 stated that the final syllable's vowel weight effects would primarily be found in superheavy syllables because vowel length is retained in final closed syllables in French but not in final open syllables. We find no significant interaction, as shown in panel A of Figure 11. However, the figure suggests that future analyses should revisit this comparison, since closed final syllables with light vowels (leftmost in panel A) seem to show much smaller differences in cue values compared to those found in the other panels.

Turning to duration, shown in panel B of Figure 11, we find a significant interaction (β=0.4866, p=0.0006). However, while it seems that superheavy syllables are longer than regular closed syllables, the interaction predominantly reflects that the final syllable's weight is instead affecting duration in the penult.

As for amplitude RVs, we find a large and significant interaction (β=4.8909, p=0.0007) that, as shown in panel C of Figure 11, reveals that light syllables (i.e., those that are open and have a light vowel) pattern differently than heavy syllables because the final syllable has lower amplitude than the penult when the final syllable has neither a coda nor a heavy vowel. In final open syllables that have a heavy vowel, the two final syllables have roughly equal amplitude on average, while closed final syllables on average have higher amplitude than the penult that precedes them.

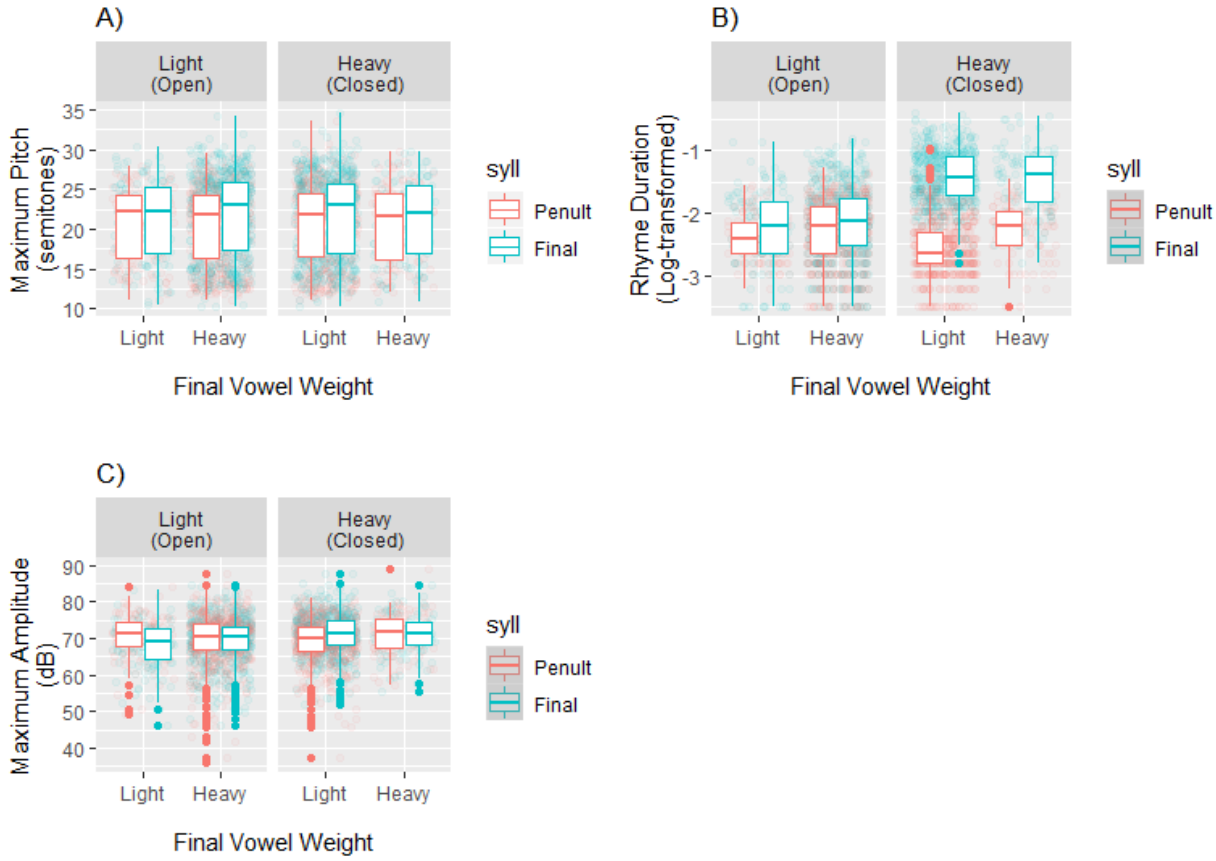

Figure 11: Results for the interaction between coda weight (x-axis) and vowel weight (facets).

4.5 Summary of Results

In summation, we find that all acoustic cues are affected by the prosodic context and by weight. Regarding marking domains, our results are consistent with what was predicted, and therefore suggest that the basic patterns for marking prosodic domains in Laurentian French match the patterns for other dialects. Crucially, our predictions hold for weight: heavy syllables are associated with greater prominence than light syllables in all cases where weight is significant. In the following section, we discuss the implications of these results.

5. Discussion

Overall, we found the effects we predicted, with significant results both for prosodic domains and for weight, suggesting that both play a role in determining the realisation of prominence cues. We will begin the discussion of the results with the marking of prosodic domains in section 5.1. Following this, we will examine how prominence and its assignment signal weight in section 5.2. Finally, in section 5.3, we will discuss what these results suggest for classifying French typologically, as well as for the interpretation of results from previous studies.

5.1 Marking Prosodic Domains

In this section, we discuss what our results for prosodic domains suggest for marking domains, focusing both on the cues a speaker would intentionally manipulate and on possible perceptual cues (even if they are not intentionally manipulated for this purpose). We begin by discussing pitch in section 5.1.1, where we examine how the pitch maximum results reflect the pitch contours realised by speakers. In section 5.1.2, we turn to the relationship between lengthening and prosodic domains, focusing on phrase-final lengthening. Finally, in section 5.1.3, we discuss how our results for

amplitude suggest that this acoustic cue may be used in perception, even though we do not find strong evidence of intentional manipulation of it to mark prosodic domains. Our results for pitch maxima largely coincide with both our predictions and the literature, but our results for duration and amplitude at first glance seem surprising. Overall, we will propose that the Laurentian French prosodic system for marking domains is like the one found in other dialects, as observed by Kaminskaïa (2009, 2015).

5.1.1 Pitch

We find that the IP's final syllable has significantly lower maximum pitch than the AP's final syllable does, which is consistent with Laurentian French speakers marking APs with a rising (LH*) bitonal unit and with IPs being assigned an additional low boundary tone (L%) that replaces any tone assigned to the AP-final syllable. This result suggests that, at least with respect to the general pitch contours, Laurentian French follows the same system as other dialects studied in the literature (with the exception of Parisian French where rising tones may be used to mark IPs instead of only APs; Post & Delais-Roussarie, 2006). These results are also consistent with Prediction 1 that the right edges of prosodic domains are marked using pitch contours.

5.1.2 Duration

We found only a very small and barely significant rhyme duration difference between APs and IPs, with IPs tending to have longer final syllables compared to APs. That we did not find a robust result is consistent with the mixed results found in the literature for other dialects; the durational difference between APs and IPs may be very small, highly variable or non-existent, which leads to certain studies finding that final syllables get compressed in IPs, others finding that final syllables are further lengthened in IPs, and some studies not being able to conclude either way (cf. Demers, 2003; Jun & Fougeron, 2000; Michelas et al., 2010; Post & Delais-Roussarie, 2006; Simon, 2011). Given that the results across studies are so mixed, and based on our relatively marginal result, the prediction that higher domains will show greater degrees of lengthening cannot be confidently confirmed.

We conjecture, however, that the presence of mixed results across studies may be a consequence of the type of data analysed. If greater lengthening in IP-final tokens reflects planning limitations (with lengthening being a method to gain more time to plan upcoming words) or conversational cues (for example, signalling that the speaker is not ceding the floor), then perhaps it should be expected that IP-final lengthening will pattern differently across contexts. In the present study, which analysed read speech, the speakers do not need to plan the content of upcoming phrases (they need to retrieve lexical entries, but do not need to plan what the words themselves will be), meaning that there may be less need to slow down at the end of an IP to facilitate planning the next prosodic domain.

Future work on this corpus can test the proposal that lengthening is an effect of planning limitations, as the speakers provided both read speech and conversational speech. If this proposal is supported, it would suggest that the difference between domains is not a consequence of marking the right edges of domain types differently, and especially not of lengthening being proportional to domain size. Domain-final lengthening may nonetheless be used by listeners to chunk strings into prosodic phrases in regular conversation.

5.1.3 Amplitude

Lastly, we found that IPs have lower relative amplitude than APs do, seemingly contrary to our prediction that amplitude would not be used as a cue to phrasal prominence. While this may suggest that amplitude could be directly manipulated by speakers as a cue because a gradual decrease in amplitude could signal that the right edge of the current IP has not yet been reached, cross-linguistic evidence leads us to believe that amplitude is not intentionally used by speakers to mark the right edge of prosodic domains.

Based on findings from German (Poschmann & Wagner, 2015) and from Vietnamese (Brunelle, 2016) in addition to a similar proposal for French (see below), we suggest that the results obtained reflect purely aerodynamic and physiological effects. In particular, the articulatory force will be lowest IP-finally, leading to a decrease in amplitude unless the speaker intentionally counters these effects (e.g., to hold the floor). If the syllable that is assigned default prominence (signalled through higher pitch and longer duration) has lower amplitude and it is the result of a gradual decrease throughout the phrase, then it seems unlikely that amplitude is being intentionally manipulated to signal phrasal prominence, and that this reduction may instead be aerodynamic in nature.

Even if amplitude is not consciously manipulated by speakers, it may still be used as a perceptual cue by listeners. This proposal is not only consistent with the cross-linguistic acoustic work just mentioned, but we believe it is also supported by the results of a previous perceptual study on French speakers. Although Féry (2011) contends that amplitude is not a possible cue to prominence in French, and amplitude is typically not tested in perception studies of French prominence, Schwab & Llisterri (2013) found that French speakers learning Spanish readily attended to amplitude to identify stressed syllables in Spanish. It may be that the usefulness of amplitude for parsing phrases in French makes it a possible candidate for transfer: French speakers could repurpose a cue for identifying IP boundaries in French to locate stress in Spanish. However, as we will discuss in the next section, it may be that the relationship that amplitude has with weight – rather than its correlation with phrasal boundaries – is what makes it a good candidate for locating word-level stress in Spanish.

5.2 Signalling Weight

Our results provide support for the hypothesis in (1) that prominence assignment in French is sensitive to weight. Only two studies to our knowledge have quantitatively examined relationships between weight and prominence in French. The first (Paradis & Deshaies, 1990) is a perceptual study on Laurentian French that found that listeners were more likely to categorise a syllable as prominent if it is closed. The second (Thibault & Ouellet, 1996) demonstrates that the pitch contours that result from prominence shifting to the penult (using heavy vowels in their study to elicit these tokens) are distinct from those that arise under focus in Laurentian French, and therefore that penultimate prominence cannot be explained by focus. The current study, we believe, is the first to examine both vowel and coda weight when probing prominence assignment, as well as the first to test weight effects in speech directly. The results align with earlier work motivating the existence of weight contrasts based on segmental processes in French (e.g., Armstrong, 1999; Scullen, 1997).

Beginning with coda weight, which was expected to significantly attract prominence based on our second prediction, we observe that the presence of a final coda increases the relative prominence of the final syllable, affecting pitch, amplitude, and duration. Similarly, closed penults show an increase in relative value for these same cues. Our results suggest not only that these cues signal weight,[22] but additionally, that only one syllable is targeted by these effects, and the other may even show *decreased* values for the cues. These results are consistent with a phonological representation of weight, like the mora (Hayes, 1989; Hyman, 1985); relative durations are computed by comparing the weights of the final two syllables. In Section 2.1, we noted that there is debate in the literature on French about whether word-final consonants are truly codas or whether they are onsets of empty-headed syllables. Given that word-final consonants in the data we examined bear weight, we conjecture that they are best analysed as codas, but we leave further testing of alternative analyses (e.g., that some word-final consonants may pattern as onsets) for future work. We also leave for future work the question of

[22] With the exception of cases where the intonational contour requires a different tone target, like in the case of heavy IP-final syllables, which have low pitch because of the IP's boundary tone.

whether lengthening processes (like those discussed in footnote 19) and the shortening of underlyingly heavy vowels in final open syllables reflect adding and losing morae, respectively.

There are trends for heavy penult vowels to attract prominence, but underlying vowel weight in the final syllable is not sufficient to preserve prominence on that syllable. These results suggest that vowel weight (when not in a final open syllable) contributes to syllable weight. Final heavy vowels slightly enhance the effects of being closed – that is, either making that syllable even more prominent or further decreasing the likelihood that prominence shifts to the penult, which suggests that those syllables may be phonologically heavier than other closed syllables and, thus, that the label superheavy may be appropriate. This result is particularly noteworthy because it confirms that underlyingly heavy vowels in final open syllables pattern as short for prominence assignment, which accords with the inability to diphthongise oral vowels in those syllables; only heavy oral vowels in final closed syllables lengthen and can diphthongise.

Returning to Table 4 where we had classified vowels as light or heavy, we included schwa as a light vowel. We did not analyse rhymes with schwa, however, as none were present in the positions targeted in the data. In the literature, schwa is not assigned prominence (Garde, 1968; Pasdeloup, 1990; Prieto et al., 2005), rather than simply being disfavoured in prominence assignment like the light vowels in our data. This is consistent with schwa having no mora (e.g., Hyman, 1985; Tranel, 1984; but cf. Eychennes, 2006). Turning to the heavy vowels in Table 4, we included nasal vowels in the set of heavy vowels, though nasal vowels differ from oral ones because they appear to preserve their long duration and can undergo diphthongisation in final open syllables (see footnote 7). Since historically nasal vowels were derived from a nasal consonant, we leave for future work whether syllables containing nasal vowels conserve their weight like closed syllables.

In summation, we have found evidence of weight effects for vowels as well as codas for all three acoustic cues, consistent with our predictions, but we observe that these effects are not identical. Heavy vowels only pattern as heavy (i.e., attract prominence) when they are not word-final, while codas show the same prominence-attracting property in both penultimate and final syllables. As such, while prominence assignment is probabilistic, it is not arbitrary when prominence shift is most likely to occur.

5.3 Implications for the Prominence System

Our results demonstrate that the marking of prosodic domains matches what has been found for other dialects of French. The cues used to mark prosodic domains also signal weight, which means that these factors interact to produce the prominence patterns we observe in French, or at least in Laurentian French.[23] Heavy syllables attracting prominence therefore has important repercussions for our understanding of the prominence system itself in (this variety of) French.

At the very least, prominence – including the assignment of the AP's H* tone – appears to play a different role in the grammar of French than conventionally proposed; *word*-level factors (i.e., weight) influence the prosody of a *phrase*, while previously it was generally assumed that only phrase-level information was relevant (barring the inability to assign prominence to a phrase-final schwa). This may account for speakers' judgments in perceptual studies being variable and difficult to interpret (e.g., Frost, 2011; Paradis & Deshaies, 1990) and may have led to the characterisation of French speakers as "stress deaf" (e.g., Dupoux et al., 1997; Peperkamp & Dupoux, 2002). If only the location of phrasal domain edges is presumed to be relevant for prominence assignment and stimuli are resynthesised without taking word-level factors into account, then we might expect speakers, faced

[23] The current study does not have sufficient speakers to confidently test inter-speaker variability, but the consistency within our speaker sample suggests the weight effects are found across speakers.

with conflicting acoustic information and uncertainty as to which aspect of prominence they are asked to identify, to provide inconsistent responses in experimental settings.

The role of word-level factors may also explain previous findings like those of Frost (2011), which showed that French speakers' perception of prominence was affected not only by the pitch contour of the stimuli, but also by the specific word – a result that we expect when taking into account that the stimuli differed in vowel weight. Additionally, the fact that amplitude is manipulated as a cue – even though this is for signalling weight rather than for marking domains – could also help explain why French speakers listening to Spanish readily use amplitude as a cue to locate Spanish stress (Schwab & Llisterri, 2012).

Signalling word-level factors (weight) using the same cues as those used to mark prosodic domains has greater implications than simply explaining otherwise surprising results in perceptual studies. In particular, it helps shed light on the type of prominence system that French employs. In section 2.3, we mentioned that APs are marked with an LH* tone, described as a pitch accent, but we did not elaborate on the matter. In the literature, there is little discussion about why it is referred to as a pitch accent: it is assumed to fall on the last non-schwa vowel in the AP like a boundary tone. It may be that the pitch accent notation is used because the tone is assigned by the domain that cross-linguistically assigns pitch accents (as per Gordon, 2014). In other words, the pitch accent notation in French reflects the *domain* of assignment but may not be meant to indicate that the tone is *formally* a pitch accent: pitch is used to cue a single lexically prominent syllable, with the phonological assignment occurring in the phrasal domain.

As previously noted, the formal description of obligatory final prominence in French is debated, and often is not clarified. On one hand, many studies refer to the prominence in French as being stress (e.g., Cutler, 2005; Schwab & Llisterri, 2012), which then should be assigned at the level of the word (as has been proposed for Midi French; Sichel-Bazin, 2016) and therefore its location would be expected to be sensitive to word-level properties, notably weight. On the other hand, French prominence is often described as phrasal or post-lexical, and thus not sensitive to word-level properties (e.g., Féry, 2013; Jun & Fougeron, 1995). In this paper, however, we have shown that the H* tone patterns like a pitch accent: the H* in the AP's LH* tone is attracted to the rightmost heavy syllable within a limited window, which leads to the pitch peak being on heavy penults when the final syllable is light.[24] This is consistent with what we observe in pitch accent systems cross-linguistically (Gordon, 2014). We therefore propose based on this and on the acoustic cues manipulated (notably amplitude) that French may be best categorised as a pitch accent language.

6. Conclusion

The results of this study confirm that prominence shifts do occur in French, with the acoustic cues associated with prominence being realised on the penult. In this analysis, we show that, although this phenomenon is probabilistic such that the location of prominence cannot consistently be predicted for any given token, it is not arbitrary once we examine the broader patterns. In particular, weight effects predict the prominence assignment patterns we observe and may also explain the prominence shift noted in previous studies that examined data from as long as a century ago (Martin, 2011).

One question of considerable debate has been how to formally categorise the prosodic system in French. The system may itself be in flux (as suggested by Fónagy, 1980), leading to the variation in prosodic realisations found within and across dialects, and we aim to determine what structure

[24] As Jun and Fougeron (1995) found that a small proportion of their tokens showed antepenultimate prominence, we expect that a window of two or three syllables from the right edge is considered when assigning prominence. We leave this question for future research, since to our knowledge the contexts allowing antepenultimate prominence are not known and it may be that another factor – like morphological structure – allows the prominence to surface earlier in the AP-final word than might otherwise be expected.

underlies or constrains this variation. We expect that weight effects are not confined to Laurentian varieties of French, but instead that weight sensitivity contributes to prominence shifts across varieties and should be robustly found across speakers. It could be, for example, that the rate of prominence shift is markedly different in dialects like Parisian French where many vowel contrasts have been or are being lost (e.g., Berit Hansen, 2012). Given that different dialects have different phonological contrasts, future work on other varieties may additionally (a) test for weight sensitivity, (b) compare dialects' vowel inventories with their prominence shift patterns, and (c) verify whether (word-final) codas contribute to weight.

We may infer that there is a trade-off whereby word-level factors are signalled at the expense of marking prosodic domains, but we expect that this is not the case. The word containing the phrasal prominence is still on the right edge of the domain and locating the pitch accent near this edge allows listeners to interpret both the word's phonological profile and the word's position in the phrase. Signalling word-level prominence may therefore not interfere with marking phrase-level prominence because the availability of prominence shift is largely predictable to listeners. Listeners should still be able to parse the word and phrase boundaries successfully because they – like speakers – can compute whether prominence shift could occur.

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Appendix A

Original French:

Le village de Beaulieu est en grand émoi. Le Premier Ministre a en effet décidé de faire étape dans cette commune au cours de sa tournée de la région en fin d'année. Jusqu'ici les seuls titres de gloire de Beaulieu étaient son vin blanc sec, ses chemises en soie, un champion local de course à pied (Louis Garret), quatrième aux jeux olympiques de Berlin en 1936, et plus récemment, son usine de pâtes italiennes. Qu'est-ce qui a donc valu à Beaulieu ce grand honneur? Le hasard, tout bêtement, car le Premier Ministre, lassé des circuits habituels qui tournaient toujours autour des mêmes villes, veut découvrir ce qu'il appelle « la campagne profonde ».

Le maire de Beaulieu - Marc Blanc - est en revanche très inquiet. La cote du Premier Ministre ne cesse de baisser depuis les élections. Comment, en plus, éviter les manifestations qui ont eu tendance à se multiplier lors des visites officielles ? La côte escarpée du Mont Saint-Pierre qui mène au village connaît des barrages chaque fois que les opposants de tous les bords manifestent leur colère. D'un autre côté, à chaque voyage du Premier Ministre, le gouvernement prend contact avec la préfecture la plus proche et s'assure que tout est fait pour le protéger. Or, un gros détachement de police, comme on en a vu à Jonquière, et des vérifications d'identité risquent de provoquer une explosion. Un jeune membre de l'opposition aurait déclaré: « Dans le coin, on est jaloux de notre liberté. S'il faut montrer patte blanche pour circuler, nous ne répondons pas de la réaction des gens du pays. Nous avons le soutien du village entier. » De plus, quelques articles parus dans La Dépêche du Centre, L'Express, Ouest Liberté et Le Nouvel Observateur indiqueraient que des activistes des communes voisines préparent une journée chaude au Premier Ministre. Quelques fanatiques auraient même entamé un jeûne prolongé dans l'église de Saint Martinville.

Le sympathique maire de Beaulieu ne sait plus à quel saint se vouer. Il a le sentiment de se trouver dans une impasse stupide. Il s'est, en désespoir de cause, décidé à écrire au Premier Ministre pour vérifier si son village était vraiment une étape nécessaire dans la tournée prévue. Beaulieu préfère être inconnue et tranquille plutôt que de se trouver au centre d'une bataille politique dont, par la télévision, seraient témoins des millions d'électeurs.

English translation:

The village of Beaulieu is full of commotion. The Prime Minister has indeed decided to stop in this community during his tour of the region at the end of the year. Until now, Beaulieu's only claims to fame were its dry white wine, its silk shirts, one champion in footraces (Louis Garret), fourth place in the 1936 Olympics in Berlin, and, more recently, its Italian pasta factory. What earned Beaulieu this great honour? Happenstance, quite frankly, because the Prime Minister, tired of his usual routes that always pivoted around the same cities, wanted to discover what he calls "the deep country".

Beaulieu's mayor – Marc Blanc – is very worried, however. The Prime Minister's ratings haven't stopped falling since the elections. What's more, how can the protests that have a tendency to multiply during official visits be avoided? The steep cliff of Mont Saint-Pierre that leads to the village is blockaded each time the opponents on any side show their anger. On the other hand, during each of the Prime Minister's visits, the government gets into contact with the nearest prefecture and ensures that everything is done to protect him. However, a large police detachment, as we saw in Jonquière, and identity checks threaten to cause an explosion. A young member of the opposition said: "In the area, people are jealous of our freedom. If people have to show their credentials to circulate, we do not respond to the reaction of the country's people. We have the support of the entire village." Additionally, articles that appeared in La Dépêche du Centre, L'Express, Ouest Liberté and Le Nouvel

Observateur suggest that activists in nearby villages intend to make the Prime Minister's day difficult. Some fanatics are even said to have undertaken a prolonged fast in the church in Saint Martinville.

The sympathetic mayor of Beaulieu does not know where to turn. He has the feeling that he finds himself in a stupid impasse. He has decided to write to the Prime Minister out of desperation to see if his village is truly a necessary stop in the planned trip. Beaulieu would rather be unknown and quiet instead of finding itself in the middle of a political battle that, through television, would be witnessed by millions of voters.

Appendix B

Model outputs for maximum pitch. P-values were calculated using the Satterthwaite approximation.

	Estimate	Std. Error	df	t-value	p-value	
(Intercept)	-1.1343	0.2724	111.4	-4.164	0.0001	***
AP vs. IP	1.1817	0.2105	99.7	5.612	<0.0001	***
AP&IP vs. Comma	-0.8607	0.1746	93.0	-4.929	<0.0001	***
Base-final penult	0.3047	0.1677	109.4	2.04	0.0464	*
Closed final syllable	0.1440	0.3668	196.6	2.631	0.0139	*
Closed penult	-1.1533	0.1812	137.3	-7.215	<0.0001	***
Heavy final vowel	-0.1859	0.3606	200.8	0.515	0.6070	
Heavy penult vowel	0.2493	0.2749	91.5	1.817	0.0720	.
Superheavy final syllable	0.1119	0.6721	209.6	-0.366	0.7146	

Appendix D

Model outputs for maximum amplitude. P-values were calculated using the Satterthwaite approximation.

	Estimate	Std. Error	df	t-value	p-value	
(Intercept)	1.3877	0.6574	111.4	2.111	0.0370	*
AP vs. IP	1.9705	0.5863	99.7	3.361	0.0011	**
AP&IP vs. Comma	-0.3995	0.4927	93.0	-0.811	0.4196	
Base-final penult	0.4822	0.4533	109.4	1.064	0.2900	
Closed final syllable	-3.1101	0.4576	196.6	-7.31	<0.0001	***
Closed penult	2.0582	0.7670	137.3	2.683	0.0084	**
Heavy final vowel	-0.3573	0.8689	200.8	-0.411	0.6813	
Heavy penult vowel	0.9189	0.6288	91.5	1.461	0.1483	
Superheavy final syllable	4.8909	1.4404	209.6	3.396	0.0007	***

Appendix E

Model outputs for rhyme duration. P-values were calculated using the Satterthwaite approximation.

	Estimate	Std. Error	df	t-value	p-value	
(Intercept)	-0.6097	0.0696	111.8	-8.763	<0.0001	***
AP vs. IP	-0.1068	0.0570	100.0	-1.873	0.0480	*
AP&IP vs. Comma	-0.0387	0.0479	93.3	-0.808	0.4215	
Base-final penult	-0.2454	0.0438	109.7	-3.317	0.0012	**
Closed final syllable	-0.9202	0.0911	197.2	-10.101	<0.0001	***
Closed penult	0.6992	0.0710	137.7	9.845	<0.0001	***
Heavy final vowel	-0.2662	0.0864	201.4	-2.376	0.0184	*
Heavy penult vowel	0.1881	0.0602	91.8	3.126	0.0024	**
Superheavy final syllable	0.4866	0.1412	210.2	3.447	0.0006	***