FRENCH LIAISON AND HIATUS AVOIDANCE

BENJAMIN STORME (LEIDEN UNIVERSITY)

One key hypothesis of Optimality Theory is that phonological processes are motivated by phonotactic constraints. This hypothesis has been challenged by Morin (2005) using data from French liaison that are problematic for the analysis of liaison as motivated by an anti-hiatus phonotactic constraint. Morin proposed instead a usage-based account *à la* Bybee (1999) that does away with phonotactic constraints all together. This paper uses evidence from lexical statistics to show that hiatus avoidance does play a role in liaison alternations. The paper further shows that phonotactics is not the only motivation for liaison alternations and argues that morphophonological constraints are also at play.

Keywords: French liaison, Optimality Theory, usage-based phonology, phonotactics, hiatus avoidance, morpheme realization, paradigm uniformity

INTRODUCTION

O NE key hypothesis of Optimality Theory (OT; Prince & Smolensky 2004) is that phonological processes are product-oriented: a process happens in order to sat-

isfy a phonotactic constraint. For instance, in French, it has been proposed that the same need to avoid a vowel hiatus underlies the three processes listed under (1). Elision, liaison, and suppletion are functionally related in that they all eliminate the sequence of two vowels that would occur otherwise between the determiner and the following noun (Tranel 2000).

(1) HIATUS AVOIDANCE IN FRENCH

	PROCESS	EXAMPLE	PROCESS APPLIES (*VV SATISFIED)	PROCESS DOES NOT APPLY (*VV VIOLATED)	MEANING
a.	Elision	*l'arbre*	[laʁbʁ]	*[ləaʁbʁ]	'the tree'
b.	Liaison	*un arbre*	[ɛ̃naʁbʁ]	*[ɛ̃aʁbʁ]	'a tree'
c.	Suppletion	*cet arbre*	[sɛtaʁbʁ]	*[səaʁbʁ]	'this tree'

The French alternations in (1) can then be described in terms of a very general anti-hiatus constraint (*VV), whose effects are also visible in other languages (Casali 2011). Processes that are functionally related within a language, such as elision, liaison and suppletion in French, are called 'conspiracies' (Kisseberth 1970) and are one of the key motivations for Optimality Theory (see for example Kager 1999:55-56).

However, the hypothesis that phonological processes are product-oriented and motivated by phonotactic constraints has attracted criticism (e.g. Bybee 1999; Blevins 2004). For instance, Blevins (2004:281) writes that 'markedness constraints play no role in determining the direction of sound change. [...] Sound changes which appear to be driven by functional or structural properties of sound systems are typically either illusory, accidental, or emergent.' Instead, these authors stress the role of imperfect language transmission across generations as the main source of sound change.

In this vein, Morin (2005) argued against the role of hiatus avoidance in French, using data from liaison, and proposed instead a usage-based/evolutionary account where

phonotactic constraints play no role, both synchronically and diachronically. In his account, the synchronic distribution of liaison alternations results from the effect of lexical frequency and misperception on language transmission, without any direct bias against vowel hiatuses in speakers' productions.

The goal of this paper is to rehabilitate the role of phonotactics and hiatus avoidance in French liaison. There is a large body of OT work on French liaison that *assumes* that liaison is phonotactically motivated, either by hiatus avoidance (e.g., Steriade 1999; Tranel 2000; Storme 2024) or by an onset requirement (e.g., Tranel 1996; Eychenne 2011; Smolensky *et al.* 2020), but this assumption is rarely explicitly motivated. This paper aims to fill this gap. Note that it is beyond the scope of this paper to compare the two phonotactic approaches to French liaison (hiatus avoidance, onset requirement). They make the same predictions regarding the data discussed in this paper and would be subject to the same criticisms by Morin (2005). The paper focuses on hiatus avoidance mostly because this approach was specifically targeted by Morin (2005).[1]

Section 1 first presents Morin's argument against hiatus avoidance and introduces his alternative, usage-based analysis that does away with phonotactic constraints. Section 2 then shows that the hiatus-avoidance analysis predicts that liaison consonants should tend to be preceded by a vowel in words involved in liaison alternations. This prediction is shown to be borne out in a coherent subset of the French lexicon, namely words ending in a lexical morpheme. Morin's usage-based account does not predict this restriction, as it only predicts that liaison consonants should be *followed* by a vowel. The remainder of the paper examines liaison alternations which clearly do not to involve hiatus avoidance, in particular in grammatical morphemes. These patterns are analyzed in Sections 3 and 4 as morphological effects on pronunciation. A comprehensive account of liaison therefore requires both phonotactic and morphophonological constraints. More

---

[1]Also, one potential advantage of the hiatus-avoidance analysis is that, contrary to the onset-requirement analysis, it does not predict that liaison consonants should always be syllabified as onsets. And there is evidence that liaison consonants may pattern as codas prosodically (see Encrevé 1988; Storme 2024).

broadly, this study on French liaison and hiatus avoidance adds to a body of work suggesting that synchronic biases such as phonotactic constraints play a role in shaping phonological patterns (e.g., Martin 2007; Flemming 2017).

1 Morin (2005): Hiatus avoidance plays no role in French liaison

1.1 French liaison and hiatus avoidance

French liaison is an alternation that involves the use of a special consonant-final form for some words before vowel-initial words. For instance, the masculine singular adjective *grand* 'great' is generally realized as [gʁɑ̃], as shown in (2-a), but may be realized as [gʁɑ̃t] with a liaison consonant when followed by a vowel-initial word, as shown in (2-b)

(2)   a.   *grand monsieur* [gʁɑ̃məsjø] 'great man'
        b.   *grand ami* [gʁɑ̃tami] 'great friend'

As mentioned in the introduction, this alternation has been analyzed as motivated by a phonotactic constraint against vowel hiatuses (e.g., Steriade 1999; Tranel 2000; Storme 2024). In these analyses, there is a general preference for the form without liaison (e.g., *grand* [gʁɑ̃]). But when combining two words would create a vowel hiatus (e.g., *grand ami* pronounced as [gʁɑ̃ami]), this preference is overriden by the anti-hiatus constraint *VV and the form with liaison is then preferred, as in (2-b). This constraint against vowel hiatuses is interpreted as a linguistic bias that shapes speakers' productions.

1.2 Morin's argument against hiatus avoidance

Morin (2005) argued forcefully against phonotactic analyses of liaison, and in particular against the role of hiatus avoidance. His argument is based on the observation that vowel

hiatus is neither necessary nor sufficient to account for the full synchronic distribution of French liaison. It is not necessary because liaison consonants are not always *postvocalic*. For instance, in (3-a), the liaison consonant [z] at the end of the plural adjective *belles* 'beautiful.FEM.PL' is preceded by a *consonant* (Morin 2005:16; see also Eychenne 2011:87-88). The actual phonological generalization on liaison contexts is therefore weaker than predicted under the hiatus-avoidance analysis, according to Morin (2005): liaison consonants must be *followed* by a vowel,[2] but not necessarily *preceded* by a vowel.

(3) a. LIAISON CONSONANTS MAY BE PRECEDED BY A CONSONANT

      belles images [bɛlzimaʒ] 'beautiful pictures' (context = C_#V)

   b. LIAISON CONSONANTS DO NOT ALWAYS SURFACE IN HIATUS CONTEXTS

      grand houx [gʁɑ̃u] 'big holly'

Furthermore, an intervocalic context is not sufficient for the liaison form to be used. For instance, liaison in *grand* 'great, big' is blocked before the *h-aspiré* word *houx* [u] 'holly', despite the presence of a hiatus, as illustrated in (3-b) (Morin 2005:18). Even before vowel-initial words that are not *h-aspiré* words, liaison is not systematically realized. For instance, in this context, the preposition *chez* 'by' appears under its liaison form [ʃez] in only 80% of cases (Durand & Lyche 2016:368). In general, liaison consonants are less likely to surface in word collocations that are less frequent (Kilbourn-Ceron 2017:ch. 4). These lexical effects are unexpected under the hypothesis that French speakers avoid vowel hiatuses indiscriminately.

To summarize, the hiatus-avoidance analysis suffers from two shortcomings as a synchronic account of liaison alternations according to Morin (2005): (i) it incorrectly predicts that liaison consonants should always be preceded by a vowel and (ii) it cannot derive lexical effects on the rate of liaison.

---

[2]Morin (2005:15) cites a few marginal examples of preconsonantal liaison consonants in the speech of professional public speakers but these are likely to be orthographic effects on pronunciation. These cases are left aside from Morin's general diachronic account and will not be further discussed here.

1.3 Morin's usage-based analysis

Morin (2005) further argues that hiatus avoidance played no role in the *diachronic* development of liaison. Instead, he analyzes liaison as a residue of word-final consonants in frequent word collocations (Morin 2005:19). Word-final consonants were generally deleted in the history of French, but this deletion process was phonologically and lexically conditioned. It was less likely to happen when the final consonant was phonetically more salient and contained inside a two-word collocation that was sufficiently frequent to be stored holistically in the learner's mental lexicon (e.g., *grand ami* 'great friend'). These fossilized collocations are the locus of synchronic liaison alternations.

Morin's usage-based account explains two important features of the synchronic distribution of liaison alternations. First, it explains why liaison consonants are only found before vowels. Final consonants survived as liaison consonants only before vowels because that's the context where they were the most salient phonetically, due to the strong perceptual cues to consonant identity provided by the following vowel. Among these cues, release transitions carry particularly important information (Wright 2004). Outside of this environment, final consonants were misheard as the absence of any sound and were therefore lost. For instance, the etymological /t/ at the end of *grand* was maintained in the collocation *grand ami* but not in the collocation *grand monsieur* because it was easier to perceive by the listener in the former case, due to the presence of a following vowel.

Second, Morin's usage-based analysis also explains why liaison consonants are not always realized prevocalically. Phonetically salient final consonants only survived if they were involved in collocations that were sufficiently frequent to be stored as a lexical construction in the learner's lexicon. Over time, this resulted in the situation observed in modern day French, where liaison consonants are more likely to surface in high frequency words and collocations (Kilbourn-Ceron 2017:ch. 4). For instance, the /t/ at the end of *grand* /ɡʁɑ̃t/ was maintained over time because, due to its high frequency of use,

it occurred prevocalically in a sufficiently large number of collocations to be memorized by learners.

All in all, Morin's usage-based analysis derives both phonological and lexical conditionings on liaison alternations, but without any explicit phonotactic optimization by speakers. The role of phonotactics and hiatus avoidance in French liaison is therefore analyzed as illusory both synchronically and diachronically, in line with Blevins' (2004) claim that phonotactic constraints do not drive sound patterns. Instead the key factors that explain the distribution of liaison alternations are misperception and memory constraints.

2 LEXICAL EVIDENCE FOR THE ROLE OF HIATUS AVOIDANCE

This section reexamines the case against the role of phonotactics and hiatus avoidance in French liaison using evidence from a lexical database. It is shown that, in a coherent subset of the lexicon (i.e. in words ending in a lexical morpheme), liaison consonants strongly tend to be preceded by a vowel (Section 2.1), as predicted under the hypothesis that hiatus avoidance shapes liaison alternations (Section 2.2). This generalization, known as the *loi de Littré* in the literature (Bonami *et al.* 2005; Bonami & Boyé 2005), does not follow under Morin's usage-based account (Section 2.3).

2.1 THE *LOI DE LITTRÉ*: A MORPHEME STRUCTURE CONSTRAINT ON LIAISON LEXICAL MORPHEMES

As reviewed in Section 1.2, liaison consonants are virtually always followed by a vowel (see also Côté 2011; Bonami & Delais-Roussarie 2021:2109; Durand & Lyche 2016:365-366). But liaison consonants also tend to be *preceded* by a vowel, in particular in lexical morphemes such as adjectives. Bonami *et al.* (2005); Bonami & Boyé (2005) call this

generalization the *loi de Littré*, based on work by Plénat (1980).[3] The *loi de Littré* is a generalization about the segmental make-up of liaison words and is therefore a morpheme structure constraint in the sense of Booij (2011).

The *loi de Littré* can be illustrated with the contrast between adjectives *grand* 'big' and *fort* 'strong'. Both adjectives end in a graphic liaison consonant that could in principle be pronounced before a vowel-initial word. However only *grand* is actually attested under its liaison form [ɡʁɑ̃t]. *Fort* is only used under its non-liaison form [fɔʁ], even in liaison contexts (Bonami *et al.* 2005:94). The contrast between the two forms is illustrated in (4). The fact that the liaison consonant is pronounced at the end of *grand* in (4-a) but not at the end of *fort* in (4-b) makes sense if there is a requirement for liaison consonants to be postvocalic: the [t] in *fort* would be postconsonantal (after [ʁ]) if pronounced.

(4)   a.   *grand arbre* [ɡʁɑ̃taʁbʁ] 'big tree'   (liaison [t] may be pronounced)

        b.   *fort accent* [fɔʁaksɑ̃] 'strong accent'   (liaison [t] may not be pronounced)

Bonami *et al.* (2005:94) note that there are exceptions to the *loi de Littré*. For instance, the adverb *fort* 'strongly' (to be distinguised from the adjective *fort* discussed above) may appear under its liaison form [fɔʁt] prevocalically, despite the liaison consonant being preceded by a consonant. Also, liaison consonants that express grammatical morphemes can occur after a consonant, as in *belles images* [bɛlzimaʒ] 'beautiful pictures'. We will return to this latter type of exceptions in Section 3.

However, despite these exceptions, the *loi de Littré* appears to be a statistically robust generalization, at least among words ending in a lexical morpheme (e.g., *grand* 'great'). To establish this, a lexical database of liaison and non-liaison words was built based on Lexique 3.83 (New & Pallier 2023), an open access French lexicon with 142,694 entries. All words ending in a liaison or final stable consonant in Lexique 3.83 were annotated

---

[3]Émile Littré (1801-1881) was a French lexicographer, best known for his *Dictionnaire de la Langue Française*, commonly called the *Littré*.

automatically as to their status as liaison or non-liaison words. A liaison word is a word that has a liaison form (e.g., *grand* [ɡʁɑ̃] ∼ [ɡʁɑ̃t] 'great'). A non-liaison word is a word that ends in a stable consonant and therefore is not involved in liaison alternations (e.g., *chouette* [ʃwɛt] 'nice'). A word was identified as a liaison word based on the correspondence between its graphic form and its phonological form: a word was determined to be a liaison word if its graphic form ends in a graphic liaison consonant (*t, d, s, x, z, n, r, p, g*) but its phonological form does not end with the corresponding phonological liaison consonant ([t, z, n, ʁ, p, ɡ]).[4] For instance, this definition identifies *grand* as a liaison word because its graphic form ends with a graphic liaison consonant (*d*) but the phonological form [ɡʁɑ̃] listed in the lexicon does not end with the corresponding liaison consonant ([t]).[5] Non-liaison words were included in order to provide a baseline for comparison.

Two additional variables were recorded in order to test the *loi de Littré*: (i) the nature of the segment that precedes the liaison or final consonant in the word (vowel or consonant) and (ii) the morphological nature of the final morpheme in the word (grammatical or lexical). This second variable was added to test whether the *loi de Littré* might be stronger for lexical morphemes, as suggested in the literature.[6] Grammatical morphemes include the morphemes listed in Table 1. These morphemes can be identified using the morphological information provided in Lexique 3.83. All words that do not end in one of these grammatical morphemes end in a lexical morpheme. Table 2 shows examples of words that represent the eight categories of words obtained by crossing the three variables of interest: liaison status (yes, no), phonological shape (VC#, CC#), and

---

[4]Liaison words in which the liaison consonant and the final consonant at the end of the non-liaison form are identical (e.g. *chantent* 'sing.3PL.PRES') are not identified as liaison words by this algorithm; therefore an exception was made for those.

[5]Note that this graphic definition of liaison is quite inclusive. For instance, the adjective *fort* is treated as a liaison word in this database, even though the liaison form of this word is never used in actual speech, according to Bonami *et al.* (2005:94). See Section 2.2 for further discussion.

[6]Exceptions to the *loi de Littré* typically involve grammatical morphemes, as the plural morpheme on the adjective in *belles images* [bɛlzimaʒ] 'beautiful pictures' (see Tranel 2000; Eychenne 2011).

Morpheme	Pronunciation	Example
Plural (nominal)	$[z] \sim \emptyset$	*belle-s* 'beautiful.FEM.PLUR'
Third person	$[t] \sim \emptyset$	*vien-t* 'come.3SG'
First/Second person	$[z] \sim \emptyset$	*vien-s* 'come.1SG/2SG'
Infinitive	$[ʁ]$	*veni-r* 'come.INF'
	$[eʁ] \sim [e]$	*chant-er* 'come.INF'
Present participle	$[ɑ̃t] \sim [ɑ̃]$	*chant-ant* 'singing'

Table 1: GRAMMATICAL MORPHEMES

		PHONOLOGICAL SHAPE	
FINAL MORPHEME	LIAISON	VC#	CC#
lexical	yes	*grand* [gʁɑ̃t] 'great'	*fort* [fɔʁt] 'strongly'
	no	*chouette* [ʃwɛt] 'nice'	*abject* [abʒɛkt] 'abject'
grammatical	yes	*grand-s* [gʁɑ̃-z] 'great.PL'	*belle-s* [bɛl-z] 'beaufitul.PL'
	no	*veni-r* [vəni-ʁ] 'come.INF'	*vend-re* [vɑ̃d-ʁ] 'sell.INF'

Table 2: EXAMPLES OF WORDS ENDING IN VC# AND CC# AS A FUNCTION OF THE TWO VARIABLES OF INTEREST (FINAL MORPHEME, LIAISON STATUS).

morphological status (grammatical, lexical). The phonological shapes VC# and CC# correspond to words where the final or liaison consonant is preceded by a vowel or by a consonant, respectively.

According to the *loi de Littré*, we expect there to be a much larger number of liaison words ending in VC# (i.e. where the liaison consonant is preceded by a vowel) than in CC# (i.e. where the liaison consonant is preceded by a consonant) in the French lexicon. The results show that it is the case, in particular for liaison words ending in a lexical morpheme. Figure 1 shows the proportion of words ending in VC# and CC# in the French lexicon as a function of the liaison status of the word (yes, no) and the nature of the final morpheme in that word (grammatical, lexical). Among liaison words ending in a lexical morpheme, there is a strong asymmetry between VC# and CC# shapes: liaison consonants are much more unlikely to follow a consonant (CC#) than to follow a vowel (VC#; $\beta = -2.94 \pm 0.06, p < .001$).[7] The VC# shape represents about 95% of liaison

---

[7] β represents here the difference in logodds between liaison lexical words ending in VC# and liaison lexical words ending in CC#, as estimated using a logistic regression in R (R Core Team 2021). A negative number
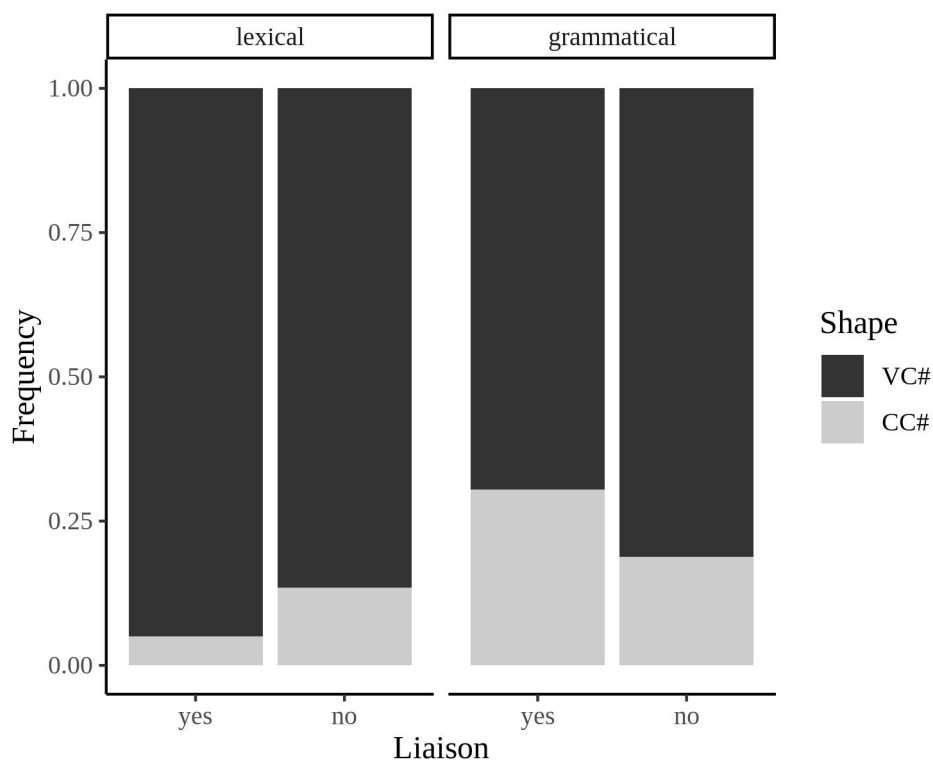
Figure 1: Phonological shape of words (VC#, CC#) as a function of their liaison status (yes, no) and their morphology (they end in a lexical or grammatical morpheme).

words ending in a lexical morpheme. This result is in line with the *loi de Littré*, i.e. it supports the hypothesis that liaison consonants strongly tend to be preceded by a vowel (at least in words ending in lexical morphemes).

The asymmetry in favor of VC# also holds for the other types of words in Figure 1, but is not as strong. CC# shapes are more frequent among *non-liaison* words ending in a lexical morpheme than among *liaison* words ending in a lexical morpheme ($\beta = 1.08 \pm 0.07, p < .001$). This result is important: it suggests that it's specifically liaison consonants that strongly tend to be posvocalic. This tendency is less strong for stable final consonants. CC# shapes are also more frequent among liaison words ending in a grammatical morpheme than among liaison words ending in a lexical morpheme ($\beta =$

represents a decrease in likelihood, i.e. here CC# shapes are less likely compared to VC# shapes.

$2.11 \pm 0.07, p < .001$). This result is in line with Bonami et al's (2005) hypothesis that the *loi de Littré* is not a general constraint. It applies under its strong version only to liaison words ending in lexical morphemes.

2.2 OT ANALYSIS: HIATUS AVOIDANCE AND PARADIGM UNIFORMITY

Under the OT analysis of liaison, the generalization that liaison consonants tend to be preceded by a vowel (= the *loi de Littré*) can be derived as an effect of the anti-hiatus constraint *VV, defined in (5-a). This section shows this by focusing on words that follow the *loi de Littré*, i.e. words ending in a lexical morphemes. The case of grammatical morphemes will be treated in Section 3.

Besides the anti-hiatus constraint *VV, an additional constraint is needed to derive a default preference for the non-liaison form. For concreteness, I use a paradigm uniformity constraint that requires similarity with the citation form of the word, following Steriade (1999) and Storme (2024). But this choice is not crucial to the analysis: any constraint that favors the non-liaison form by default would do. In citation forms, the non-liaison form (e.g., *grand* [ɡʁɑ̃] or *fort* [fɔʁ]) is preferred over the liaison form (e.g., *grand* [ɡʁɑ̃t] or *fort* [fɔʁt]) because it is phonotactically less marked: it incurs fewer violations of the constraint against coda consonants (see Storme 2024 for more details). Paradigm uniformity extends this preference beyond citation forms. The paradigm uniformity constraint is called UseCitationForm and defined in (5-b).

(5)   a.   *VV

For every sequence of two vowels in a candidate, assign one penalty.

    b.   UseCitationForm

For every morpheme in the input, assign one penalty if its output form features a segment that is not present in the corresponding citation form. (For liaison words, this constraint penalizes the liaison form.)

The full analysis is shown in Table 3. Note that, for concreteness, liaison is assumed to involve allomorphy (e.g., Gaatone 1978; Klausenburger 1984; Steriade 1999; Storme 2024) rather than allophony (e.g., Tranel 2000). But this choice is not crucial either to the analysis: the same predictions would be made if liaison was assumed to involve allophony (e.g., if liaison consonants were treated as floating segments). In the allomorphy-based theory, liaison words come with two underlyingly listed allomorphs: the non-liaison allomorph (with index 1) and the liaison allomorph (with index 2). Indices are used to indicate input-output mappings (see Mascaró 2007). For instance, the second candidate for input (a) in Table 3 corresponds to the mapping from the liaison allormoph /gʁɑ̃t/ (because the index is 2). This mapping is faithful: the output is identical to the input bearing the same index. However if the index was 1 in this candidate, the mapping would be unfaithful: a [t] would be epenthesized at the end of the non-liaison allomorph /gʁɑ̃/. Unfaithful mappings are not included here because they always involve more faithfulness violations than the corresponding faithful mappings and therefore can never win (see Storme 2024 for details).

	Input		Candidates	*VV	UseCitationForm
a.	*grand arbre* 'big tree'		[gʁɑ̃₁aʁbʁ]	1!	
	/{gʁɑ̃₁, gʁɑ̃t₂}#aʁbʁ/	☞	[gʁɑ̃t₂aʁbʁ]		1
b.	*grand pin* 'big pine tree'	☞	[gʁɑ̃₁pɛ̃]		
	/{gʁɑ̃₁, gʁɑ̃t₂}#pɛ̃/		[gʁɑ̃t₂pɛ̃]		1!
c.	*fort accent* 'strong accent'	☞	[fɔʁ₁aksɑ̃]		
	/{fɔʁ₁, fɔʁt₂}#aksɑ̃/		[fɔʁt₂aksɑ̃]		1!
d.	*fort tempérament* 'strong temperament'	☞	[fɔʁ₁tɑ̃peʁamɑ̃]		
	/{fɔʁ₁, fɔʁt₂}#tɑ̃peʁamɑ̃/		[fɔʁt₂tɑ̃peʁamɑ̃]		1!

Table 3: OT analysis of the *loi de Littré*.

The analysis assuming hiatus avoidance (*VV) successfully derives the two phonological restrictions on liaison, i.e. liaison consonants tend to be *preceded* and *followed* by a vowel.

First, let us show that the analysis explains why liaison consonants are *followed* by a vowel. The relevant contrast is between input (a) and input (b) in Table 3: in input (a), the

liaison word is followed by a vowel-initial word whereas, in input (b), it is followed by a consonant-initial word. In (a), the anti-hiatus constraint is violated when the non-liaison form is used because this results in a sequence of two adjacent vowels [ãa]. A preference for the liaison form can be derived in this context if *VV outranks USECITATIONFORM. However, in (b), there is no reason to ever use the liaison form: *VV is not violated by the candidate without liaison because the following word starts with a consonant. In this case, the winner is determined by USECITATIONFORM. This constraint favors the form without liaison. The asymmetry between prevocalic and preconsonantal contexts is therefore derived.

Second, let us show how the analysis also derives a preference for liaison consonants being *preceded* by a vowel (= the *loi de Littré*). The relevant contrast is between inputs (a) and (b) on one hand and inputs (c) and (d) on the other hand. In (a) and (b), the liaison consonant is preceded by a vowel (VC#). In (c) and (d), it is preceded by a consonant (CC#). For liaison words ending in CC#, *VV is never violated because neither the liaison allomorph nor the allomorph without liaison ends in a vowel. The only constraint relevant is the paradigm uniformity constraint USECITATIONFORM: this constraint always favors the non-liaison allomorph. In other words, the analysis where liaison is an anti-hiatus strategy predicts that only liaison words in VC# should be involved in liaison alternations, in line with the *loi de Littré*.

Note that the analysis predicts that the effects of the anti-hiatus constraint are of a different nature for the context that *follows* a liaison consonant and for the context that *precedes* it. For the context that follows, it is a restriction on the *environment* where a liaison word can occur (i.e. before a vowel-initial word). For the context that precedes, it is a restriction on the *phonological shape* of liaison words or, in other words, a morpheme structure constraint (i.e. liaison words must end in VC#). This asymmetry is due to the fact that liaison consonants belong to Word1 lexically in the analysis.

One limit of this analysis is that it derives the *loi de Littré* as a *categorical* rather than

as a *very strong* tendency in the lexicon. As mentioned above, there are exceptions to the *loi de Littré* in the French lexicon. For instance, the adverb *fort* (but not the corresponding adjective) can be used under its liaison form before a vowel-initial word, according to Bonami *et al.* (2005:94).[8] In Section 2.1, 5% of liaison words ending in a lexical morpheme were found to end in CC#, with the liaison consonant being preceded by a consonant. However this number is probably an overestimation of the actual number of exceptions. The study in Section 2.1 is based on a very inclusive view of liaison, as it is based on the graphic form of the word rather than on its actual pronunciation (see footnote 5). For instance, the adjective *fort* is analyzed as having a liaison variant, although this variant does not seem to be used in actual speech (Bonami *et al.* 2005). Future work should establish the number of exceptions to the *loi de Littré* based on the *actual* pronunciation of words in a speech corpus.

2.3 A PROBLEM FOR MORIN'S USAGE-BASED ANALYSIS

In the usage-based approach advocated by Morin (2005), it is unclear how the tendency for liaison consonants to be preceded by a vowel (= the *loi de Littré*) can be derived. Before a vowel-initial word, the final consonant of the preceding word should be robust perceptually regardless of whether this word ends in VC# or in CC#, due to the presence of release transitions in the following vowel. To illustrate, the [t] in *fort accent* 'strong accent' should be highly salient perceptually, due to the presence of a following [a]. This consonant should therefore tend to be retained as a liaison consonant over time in the same way as it was retained in words ending in VC# in the same context (e.g. *grand ami* [gʁɑ̃tami] 'great friend'). It is then unclear why, synchronically, CC# shapes are underrepresented compared to VC# shapes among liaison words.

One possibility would be to assume that, when liaison alternations arose in the 16th-

---

[8]One possibility for this particular case would be that liaison [t] is interpreted as a kind of morpheme marking the adverbial status of the word and then is morphologically rather than phonotactically motivated (see Section 3 on the role of liaison in monosegmental morphemes).

17th century (Pope 1952:223-224), final consonants in CC# words (such as *fort*) had already undergone deletion across the board whereas final consonants in VC# words were more stable (such as *grand*). However deletion is reported by Pope (1952:221-222) to have happened roughly at the same period of time in the two environments, namely in the Middle French period (mid 14th - early 17th). Pope (1952:223) also reports that, throughout the 16th century, final consonants were maintained both in VC# and CC# words before vowel-initial words in educated speech. This clearly implies that deletion had not happened across the board for CC# words at that time. Interestingly, Pope (1952:223) also notes that, in uneducated speech, VC# and CC# words were treated differently before vowel-initial words and in a way consistent with the *loi de Littré*:

> Final single consonants [note: in VC# words] appear to have been ordinarily maintained when the word was prae-vocalic, e.g. in locutions like *petit homme* [...], i.e. whenever the suppression of a final consonant would have left two oral vowels in hiatus, but among words ending in supported consonants [note: in CC# words] the forms with mute final consonants [...] were already employed freely before vowels, e.g. [...] *mor* for *mort* [...].

In other words, hiatus avoidance seems to have played a role in liaison alternations early on. However, before concluding in favor of the phonotactic analysis, one must consider whether this asymmetry could result from misperception alone. There is indeed a diachronic scenario that can explain how words ending in CC# might be reanalyzed as words ending in VC#. This scenario could in principle be used to explain a diachronic shift towards VC# shapes for liaison words without phonotactic optimization and only through misperception. It could be argued that CC# shapes have tended to be reinterpreted as VC# diachronically through the loss of the penultimate consonant (C_1). This would make sense from a usage-based/evolutionary perspective, as C_1 lacks release transitions that are available for C_2 before a vowel-initial word and is therefore perceptually

weaker and more susceptible to delete. This diachronic change is well attested, including in the history of French varieties and creoles. For instance, in Haitian Creole, a French-based creole, some medial C_1C_2 consonant clusters were simplified to C_2, e.g. fr. *portail* [pɔʁtaj] 'gate' was adapted as *pòtay* [pɔtaj] with loss of preconsonantal [ʁ]. This loss has been analyzed as due to misperception by Storme (2018).

However this analysis cannot be adopted for liaison, as it would make a wrong prediction about the consonant that got deleted diachronically. In liaison words that etymologically ended in C_1C_2#, C_2 underwent deletion but C_1 did not. For instance, the adjective *fort* is pronounced [fɔʁ] before vowels (*fort accent* [fɔʁaksɑ̃], with loss of C_2) and not [fɔt] (*fort accent* *[fɔtaksɑ̃], with loss of C_1). A usage-based account that only relies on misperception within collocations as a mechanism to explain the survival of final consonants as liaison consonants therefore has difficulties predicting the correct synchronic pronunciation for liaison words that historically ended in CC#.

By contrast, the constraint-based analysis proposed in Section 2.2 can explain why C_1 was retained in words like *fort* (from the etymon [fɔʁt]). In the citation form of the word, [fɔʁ] (with C_2 deletion) is preferred over [fɔʁt] (the etymologically faithful form) because it is phonotactically less marked (it does not feature a final CC cluster). It is also preferred over the form [fɔt] (with C_1 deletion) because it is more faithful to the etymon (it features the same VC transition as in [fɔʁt]). The form used in isolation, *fort* [fɔʁ], is then extended to prevocalic contexts (e.g., *fort accent*) through paradigm uniformity with the citation form. And the liaison form ending in [t] (e.g., *fort* pronounced as [fɔʁt]) lost ground in prevocalic contexts as it was not phonotactically optimizing (it did not help to break a vowel hiatus).

3 Ｌｉａｉｓｏｎ ａｎｄ ｍｏｒｐｈｅｍｅ ｒｅａｌｉｚａｔｉｏｎ

The OT account that analyzes French liaison as a strategy to avoid a vowel hiatus predicts that liaison consonants should tend to be preceded by a vowel. In the preceding section, we saw that this prediction was borne out for liaison words ending in a *lexical* morpheme. However it was *not* borne out for liaison words ending in a *grammatical* morpheme. The example used to illustrate this point in the introduction is repeated in (6-a). In the plural adjective *belles* 'beautiful.FEM.PL', liaison [z] appears here after [l], despite the absence of a vowel hiatus. However, the restriction on the context following the liaison consonant still holds: the liaison consonant must be prevocalic, even in words ending in a grammatical morpheme. This is shown in (6-b) and (6-c): liaison [z] cannot be used before [f] (or before any consonant).

(6)   a.   *belles images* [bɛlzimaʒ] 'beautiful pictures' (context = C#_V)

        b.   *belles photos* [bɛlfoto]/*[bɛlzfoto] 'beautiful photos' (context = C#_C)

        c.   *vraies photos* [vʁɛfoto]/*[vʁɛzfoto] 'real photos' (context = V#_C)

This section argues that liaison in examples such as (6-a) is not motivated by a phonotactic constraint, such as the anti-hiatus constraint; rather, it is motivated by a morphological constraint that requires a morpheme to be expressed by an overt exponent. What is special about these cases of liaison is that the liaison consonant constitutes the only exponent of the morpheme.

This idea was proposed informally by Tranel (2000:45, note 5) and developed further by Eychenne (2011:96-97), who argued that liaison in cases such as (6-a) is motivated by a constraint Ｍａｘ(ｐｌｕｒａｌ). This constraint requires that the plural morpheme *-s* correspond to an overt exponent in the output. Ｍａｘ(ｐｌｕｒａｌ) motivates the presence of a liaison consonant in (6-a), despite the absence of a vowel hiatus.

This section extends Eychenne's (2011) analysis of morphological liaison in two di-

rections. First, it uses the constraint RᴇᴀʟɪᴢᴇMᴏʀᴘʜᴇᴍᴇ proposed by Kurisu (2001), and defined in (7), instead of Mᴀx(ᴘʟᴜʀᴀʟ). A more general constraint is needed to derive the morphological conditioning of liaison. Liaison is observed outside of hiatus contexts for other grammatical morphemes besides the plural morpheme. It is also observed with the third person verbal marker *-t* [t] (e.g., *il court* 'he runs') and the first/second person marker *-s* [z] (e.g., *je cours* 'I run'). All three morphemes have in common to be monosegmental (see Table 1). When the liaison consonant is not realized, these morphemes are not overtly expressed. This situation is penalized by RᴇᴀʟɪᴢᴇMᴏʀᴘʜᴇᴍᴇ.

(7)   RᴇᴀʟɪᴢᴇMᴏʀᴘʜᴇᴍᴇ
         Assign one penalty for each morpheme that is not expressed overtly.

Second, Eychenne (2011) does not explain why morphological liaison is blocked preconsonantally, as in (6-b) and (6-c). In the absence of an overt plural exponent, Mᴀx(ᴘʟᴜʀᴀʟ) (or RᴇᴀʟɪᴢᴇMᴏʀᴘʜᴇᴍᴇ) should be violated in the same way whether this exponent precedes a vowel, as in (6-a), or a consonant, as in (6-b) and (6-c).

To solve this problem, I propose a morphophonological version of RᴇᴀʟɪᴢᴇMᴏʀ-ᴘʜᴇᴍᴇ that requires the exponent of a morpheme to be strong enough perceptually. Nonprevocalic liaison consonants as in (6-b) and (6-c) are problematic perceptually: due to the absence of a following vowel, they lack release transitions (Wright 2004) and therefore are less perceptible than prevocalic liaison consonants as in (6-a). The constraint that penalizes perceptually weak exponents for a morpheme is called *Pᴇʀᴄᴇᴘᴛᴜᴀʟʟʏ-WᴇᴀᴋExᴘᴏɴᴇɴᴛ and is defined in (8). This constraint can be conceived as an extension of Steriade's (1997) licensing-by-cue hypothesis to the morphological domain.

(8)   *PᴇʀᴄᴇᴘᴛᴜᴀʟʟʏWᴇᴀᴋExᴘᴏɴᴇɴᴛ
         Assign one penalty if a morpheme is expressed by a perceptually weak exponent.
         (An exponent consisting of a single consonant lacking release transitions is per-

ceptually weak.)

The full analysis is shown in Table 4. Rows (a) and (b) show how the analysis derives the phonological conditioning of liaison alternations for lexical morphemes such as *grand* (this analysis repeats rows (a) and (b) from Table 3). Neither the form with liaison nor the form without liaison violate REALIZEMORPHEME in inputs (a) and (b), as both input morphemes have overt exponents in the two output forms considered here. In general, lexical morphemes never seem to consist of a single liaison consonant,[9] contrary to grammatical morphemes (see Table 1). This explains why morpheme realization is never relevant for this type of morphemes, and only hiatus avoidance plays a role (see Section 2).

The crucial case for morpheme realization is shown in row (c) in Table 4. Input (c) involves a plural morpheme that alternates between ∅ and [z]. The null realization incurs a violation of REALIZEMORPHEME. Morphological liaison is derived if REALIZEMORPHEME outranks USECITATIONFORM. To derive the blocking of morphological liaison before consonants, *PERCERCEPTUALLYWEAKEXPONENT must outrank REALIZEMORPHEME, as shown in row (d).[10]

The analysis attributes liaison in polysegmental morphemes (e.g., lexical morphemes such as *grand* in rows a and b) and in monosegmenal morphemes (e.g., grammatical morphemes such as plural *-s* in rows c and d) to different constraints. Therefore the analysis predicts that the two types of liaison do not necessarily cooccur in a language. This prediction is borne out. In the Walloon French dialect from Liège (Belgium), the liaison form is not used for singular adjectives, as shown in (9-a), but it is used for plural adjectives built with the suffix *-s,* as shown in (9-b) (Morin 2005:17). In other words, liaison does not surface when it would be phonotactically motivated, in (9-a), but it does

---

[9]Liaison lexical morphemes can be free (as *grand* 'great') or bound (as *-eux* in *peur-eux* 'fearful'). To my knowledge, there is no clear case of bound lexical morpheme that consists of a single liaison consonant.

[10]It is assumed that a zero exponent does not violate *PERCERCEPTUALLYWEAKEXPONENT: an exponent can be weak perceptually only if it is present in the output.

	Input		Candidates	*PᴇʀᴄWᴇᴀᴋ Exᴘᴏɴᴇɴᴛ	Rᴇᴀʟɪᴢᴇ Mᴏʀᴘʜᴇᴍᴇ	*VV	UsᴇCɪᴛᴀᴛɪᴏɴ Fᴏʀᴍ
a.	*grand arbre* 'big tree'		[gʁɑ̃$_1$aʁbʁ]			1!	
	/{gʁɑ̃$_1$, gʁɑ̃t$_2$}#aʁbʁ/	☞	[gʁɑ̃t$_2$aʁbʁ]				1
b.	*grand pin* 'big pine tree'	☞	[gʁɑ̃$_1$pɛ̃]				
	/{gʁɑ̃$_1$, gʁɑ̃t$_2$}#pɛ̃/		[gʁɑ̃t$_2$pɛ̃]				1!
c.	*belles images* 'beautiful pics'		[bɛl$_1$imaʒ]		1!		
	/bɛl-{∅$_1$, z$_2$}#imaʒ/	☞	[bɛlz$_2$imaʒ]				1
d.	*vraies photos* 'real photos'	☞	[vʁɛ$_1$foto]		1		
	/vʁɛ-{∅$_1$, z$_2$}#foto/		[vʁɛz$_2$foto]	1!			1

Table 4: OT ᴀɴᴀʟʏsɪs ᴏғ ᴛʜᴇ ᴘʜᴏɴᴏʟᴏɢɪᴄᴀʟ ᴀɴᴅ ᴍᴏʀᴘʜᴏʟᴏɢɪᴄᴀʟ ᴄᴏɴᴅɪᴛɪᴏɴɪɴɢ ᴏғ ʟɪᴀɪsᴏɴ

surface when it is morphologically motivated, in (9-b).

(9)   Wᴀʟʟᴏᴏɴ ғʀᴏᴍ Lɪèɢᴇ (Mᴏʀɪɴ 2005:17)

    a.   on gros   abe [ɔ̃ː gʁo ɔːp]
       a   big.ᴍᴀsᴄ.sɢ tree
       'a big tree'

    b.   dès   gros   abes [dɛ gʁoz ɔːp]
       some big.ᴍᴀsᴄ.ᴘʟ trees
       'some big trees'

The analysis proposed in this section can account for the lack of correlation between the two types of liaison observed in Walloon. This happens if UsᴇCɪᴛᴀᴛɪᴏɴFᴏʀᴍ outranks the phonological constraint *VV but is outranked by the morphological constraints RᴇᴀʟɪᴢᴇMᴏʀᴘʜᴇᴍᴇ and *PᴇʀᴄᴇᴘᴛᴜᴀʟʟʏWᴇᴀᴋExᴘᴏɴᴇɴᴛ, as shown in Table 5. Under this constraint ranking, liaison is blocked when its only purpose would it be to break a vowel hiatus, as shown in row (a) of Table 5. But it surfaces as a way to signal the presence of a morpheme, as shown in row (b), unless this signal would be perceptually too weak due to the absence of a following vowel, as shown in row (c).

	Input		Candidates	*PERCWEAK EXPONENT	REALIZE MORPHEME	USECITATION FORM	*VV
a.	*grand arbre* 'big tree'	☞	[gʁɑ̃₁aʁbʁ]				1
	/{gʁɑ̃₁, gʁɑ̃t₂}#aʁbʁ/		[gʁɑ̃t₂aʁbʁ]			1!	
b.	*belles images* 'beautiful pics'		[bɛl₁imaʒ]		1!		
	/bɛl-{∅₁, z₂}#imaʒ/	☞	[bɛlz₂imaʒ]			1	
c.	*vraies photos* 'real photos'	☞	[vʁɛ₁foto]		1	1	
	/vʁɛ-{∅₁, z₂}#foto/		[vʁɛz₂foto]	1!		1	

Table 5: OT ANALYSIS DERIVING MORPHOLOGICAL CONDITIONING OF LIAISON WITHOUT PHONOLOGICAL CONDITIONING

4 LIAISON AND LEXICAL CONSTRAINT INDEXATION

In section 1, we saw that, besides grammatical liaison, there is another problematic case raised by Morin (2005) for an analysis in terms of hiatus avoidance: the liaison form is not always used in hiatus contexts, as illustrated in (10) (this example repeats example (3-b) from Section 1.2). In particular, liaison is lexically conditioned, with the rate of liaison depending on properties of both Word1 and Word2 in Word1-Word2 collocations.

(10)   IN HIATUS CONTEXTS, THE LIAISON FORM IS NOT ALWAYS USED

    grand houx [gʁɑ̃u] 'big holly' (context = V_#V)

Although the lexical conditioning of liaison is problematic for a pure phonological account, it can be captured through lexical constraint indexation (Pater 2007). To obtain word-specific rates of liaison, the paradigm uniformity constraint proposed in Section 2.2 can be indexed to specific lexical properties, as proposed by Zuraw & Hayes (2017) for *h-aspiré* words specifically and by Storme (2024) for liaison in general. Variability in the rate of liaison of a given word can then be obtained in a constraint-based grammar where the evaluation is probabilistic instead of categorical (e.g., Boersma & Hayes 2001; Hayes & Wilson 2008; Hayes 2017). In this section, probabilistic mappings were obtained using MaxEnt (Goldwater & Johnson 2003; Hayes & Wilson 2008) in OT-Soft (Hayes *et al.* 2013).

UseCitationForm is broken up into a family of constraints corresponding to different lexical classes. Here, to simplify, there is one constraint per word: UseCitationForm$_{word}$ penalizes the epenthesis of a segment in the output form of a specific word if that segment is not present in the corresponding citation form.

(11)   UseCitationForm$_{word}$

Assign one penalty if the output form corresponding to word features a segment that is not present in the corresponding citation form.

But, more realistically, constraints would be indexed with more general lexical properties, such as lexical frequency, as proposed by Storme (2024). These properties might affect the rate of liaison through their effects on lexical access and speech-production planning, as proposed by Kilbourn-Ceron (2017:ch. 4). In particular, words that are less frequent take longer to be accessed, according to the word frequency effect (Brysbaert *et al.* 2018). As a result, they are less likely to be planned together with adjacent words in speech production (Kilbourn-Ceron 2017:ch. 4). Because external sandhi processes such as liaison require the phonological form of adjacent words to be available for their application, these less frequent words are also less likely to be involved in external sandhi processes (Kilbourn-Ceron 2017:ch. 4). A constraint-based implementation of this psycholinguistic analysis was proposed by Storme (2024), where words that *slow down* lexical access (e.g., due to their low frequency) correspond to paradigm uniformity constraints with *higher* weights. This captures the observation that words are more likely to appear under their citation form (and therefore to resist liaison alternations) when they are less frequent.

Table 6 shows how constraint indexation can derive word-specific rates of liaison for *un* 'a' (100%), *dans* 'in' (93%) and *chez* 'by' (80%; the liaison rates come from Durand & Lyche 2016:368). As shown in Table 6, the word *chez* ends up having a lower rate of liaison than *un* and *dans* because the pressure to be uniform with the corresponding

	Input	Outputs	*VV w=8.51	UseCitation Form$_{\text{CHEZ}}$ w=7.13	UseCitation Form$_{\text{DANS}}$ w=5.93	UseCitation Form$_{\text{UN}}$ w=0	Harmony	Predicted frequency
a.	*un V* 'an V' /{ɛ̃$_1$, ɛ̃n$_2$}#V/	[ɛ̃$_1$V] [ɛ̃n$_2$V]	1			1	8.51 0	0 1
b.	*dans V* 'in V' /{dɑ̃$_1$, dɑ̃z$_2$}#V/	[dɑ̃$_1$V] [dɑ̃z$_2$V]	1		1		8.51 5.93	0.07 0.93
c.	*chez V* 'by V' /{ʃe$_1$, ʃez$_2$}#V/	[ʃe$_1$V] [ʃez$_2$V]	1	1			8.51 7.13	0.20 0.80

Table 6: DERIVING VARIABLE LIAISON IN HIATUS CONTEXTS THROUGH LEXICAL INDEXATION OF PARADIGM UNIFORMITY CONSTRAINTS

citation form is stronger (the weight of the corresponding UseCitationForm constraint is higher). This difference can in turn be attributed to lexical frequency, *chez* being less frequent than *dans* and *un* and therefore less likely to be planned together with the following word.

CONCLUSION

Morin (2005) argued against phonotactic analyses of French liaison based on hiatus avoidance, suggesting that reference to a hiatus context is neither necessary nor sufficient to account for the synchronic distribution of liaison alternations. Using evidence from lexical statistics, this paper has shown that reference to a hiatus context *is* necessary to account for liaison alternations in a coherent subset of the lexicon, namely in words ending in a lexical morpheme. In these words, liaison consonants strongly tend to be postvocalic (= *loi de Littré*), as predicted under the hiatus-avoidance analysis. Cases of postconsonantal liaison consonants are attested, but are largely limited to grammatical morphemes consisting of a single segment. Liaison in these morphemes can be analyzed as morphologically motivated: in the absence of liaison, there would be no exponent for the relevant morpheme. Finally, the fact that liaison is not always realized in hiatus contexts can be accounted for in a synchronic model where lexical properties of words affect lexical access and speech production.

By contrast, the diachronic analysis *à la* Bybee (1999) and Blevins (2004) proposed by Morin (2005) fails to derive the phonological conditioning of liaison alternations. In particular, the analysis based on misperception predicts that liaison consonants should be only prevocalic and therefore fails to derive their strong tendency to be also postvocalic. In the absence of a clear alternative diachronic mechanism to explain this latter asymmetry, the current study therefore adds to a body of work suggesting that synchronic biases such as phonotactic constraints (see Martin 2007; Flemming 2017) are necessary to account for the full range of morphophonological patterns observed in the world's languages.

REFERENCES

Blevins, Juliette (2004). *Evolutionary phonology: The emergence of sound patterns.* Cambridge: Cambridge University Press.

Boersma, Paul & Bruce Hayes (2001). Empirical Tests of the Gradual Learning Algorithm. *Linguistic Inquiry* **32**, 45–86.

Bonami, Olivier & Gilles Boyé (2005). Construire le paradigme d'un adjectif. *Recherches linguistiques de Vincennes* 77–98.

Bonami, Olivier, Gilles Boyé & Jesse Tseng (2005). Sur la grammaire des consonnes latentes. *Langages* **158**, 89–100.

Bonami, Olivier & Élizabeth Delais-Roussarie (2021). La liaison. In Anne Abeillé & Danièle Godard (eds.), *La grande grammaire du français*, 2109–2218. Arles: Actes Sud.

Booij, Geert (2011). Morpheme structure constraints. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell Companion to Phonology*, 2049–2069. Malden, MA and Oxford: Wiley Blackwell.

Brysbaert, Marc, Paweł Mandera & Emmanuel Keuleers (2018). The word frequency effect in word processing: An updated review. *Current Directions in Psychological Science* **27**, 45–50.

Bybee, Joan (1999). Usage-based phonology. In Michael Darnell, Edith Moravcsik, Frederick Newmeyer, Michael Noonan & Kathleen Wheatley (eds.), *Functionalism and Formalism in Linguistics, Vol. 1*, 211–242. Amsterdam: John Benjamins.

Casali, Roderic F. (2011). Hiatus Resolution. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell Companion to Phonology*, 1434–1460. Malden, MA and Oxford: Wiley Blackwell.

Côté, Marie-Hélène (2011). French liaison. In Marc van Oostendorp, Colin J. Ewen, Elizabeth V. Hume & Keren Rice (eds.), *The Blackwell Companion to Phonology*, 1–26. Chicester, UK: John Wiley and Sons Ltd.

Durand, Jacques & Chantal Lyche (2016). Approaching variation in PFC: The liaison level. In Sylvain Detey, Jacques Durand, Bernard Laks & Chantal Lyche (eds.), *Varieties of Spoken French*. Oxford: Oxford University Press.

Encrevé, Pierre (1988). *La liaison avec et sans enchaînement: phonologie tridimensionnelle et usages du français.* Paris: Seuil.

Eychenne, Julien (2011). La liaison en français et la théorie de l'optimalité. *Langue française* **169**, 79–101.

Flemming, Edward (2017). Dispersion Theory and Phonology. In Mark Aronoff (ed.), *Oxford Research Encyclopedia of Linguistics*. Oxford: Oxford University Press.

Gaatone, David (1978). Forme sous-jacente unique ou liste d'allomorphes? (À propos des consonnes de liaison en français). *Linguistics* **214**, 33–54.

Goldwater, Sharon & Mark Johnson (2003). Learning OT constraint rankings using a maximum entropy model. In Jennifer Spenader, Anders Eriksson & Östen Dahl (eds.), *Proceedings of the Stockholm Workshop on Variation within Optimality Theory*, 111–120. Stockholm: Stockholm University, Department of Linguistics.

Hayes, Bruce (2017). Varieties of Noisy Harmonic Grammar. In Karen Jesney, Charlie O'Hara, Caitlin Smith & Rachel Walker (eds.), *Proceedings of the 2016 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America.

Hayes, Bruce, Bruce Tesar & Kie Zuraw (2013). OTSoft 2.5.
URL `http://www.linguistics.ucla.edu/people/hayes/otsoft/`

Hayes, Bruce & Colin Wilson (2008). A Maximum Entropy Model of Phonotactics and Phonotactic Learning. *Linguistic Inquiry* **39**, 379–440.

Kager, René (1999). *Optimality theory.* Cambridge: Cambridge University Press.

Kilbourn-Ceron, Oriana (2017). *Speech production planning affects variation in external sandhi.* Ph.D. thesis, McGill University.

Kisseberth, Charles W (1970). On the functional unity of phonological rules. *Linguistic inquiry* **1**, 291–306.

Klausenburger, Jurgen (1984). *French liaison and linguistic theory.* Wiesbaden: Steiner.

Kurisu, Kazutaka (2001). *The phonology of morpheme realization.* Ph.D. thesis, UC Santa Cruz.

Martin, Andrew (2007). *The evolving lexicon.* Ph.D. thesis, UCLA.

Mascaró, Joan (2007). External allomorphy and lexical representation. *Linguistic Inquiry* **38**, 715–735.

Morin, Yves Charles (2005). La liaison relève-t-elle d'une tendance à éviter les hiatus? Réflexions sur son évolution historique. *Langages* **158**, 8–23.

New, Boris & Christophe Pallier (2023). Lexique.
URL `http://www.lexique.org/`

Pater, Joe (2007). The Locus of Exceptionality: Morpheme-Specific Phonology as Constraint Indexation. In Leah Bateman, Michael O'Keefe, Ehren Reilly & Adam Werle (eds.), *University of Massachusetts Occasional Papers in Linguistics 32: Papers in Optimality Theory III*. Amherst, MA: GLSA.

Plénat, Marc (1980). La loi de Littré. *Cahiers de grammaire* **2**, 47–135.

Pope, Mildred K. (1952). *From Latin to Modern French with Especial Consideration of Anglo-Norman.* Manchester: University of Manchester Press, 2nd edition.

Prince, Alan & Paul Smolensky (2004). *Optimality Theory: Constraint interaction in generative grammar.* Malden, MA: Blackwell. [Revision of 1993 technical report, Rutgers University Center for Cognitive Science. Available on Rutgers Optimality Archive, ROA-537].

R Core Team (2021). *R: A Language and Environment for Statistical Computing.* R Foundation for Statistical Computing, Vienna, Austria.
URL `https://www.R-project.org/`

Smolensky, Paul, Eric Rosen & Matthew Goldrick (2020). Learning a gradient grammar of French liaison. In Hyunah Baek, Chikako Takahashi & Alex Hong-Lun Yeung (eds.), *Proceedings of the 2019 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America.

Steriade, Donca (1997). Phonetics in phonology: the case of laryngeal neutralization. Manuscript.

Steriade, Donca (1999). Lexical conservatism in French adjectival liaison. In Jean-Marc Authier, Barbara E. Bullock & Lisa A. Reed (eds.), *Formal perspectives in Romance linguistics. Selected papers from the 28th linguistic symposium on Romance languages*, 243–270. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Storme, Benjamin (2018). The adaptation of French liquids in Haitian: A test of the perceptual hypothesis. *Journal of Pidgin and Creole Languages* **33**, 386–410.

Storme, Benjamin (2024). Paradigm uniformity effects on French liaison. *Natural Language and Linguistic Theory* .
URL `https://doi.org/10.1007/s11049-023-09596-z`

Tranel, Bernard (1996). French Liaison and Elision Revisited: A Unified Account within Optimality Theory. In Claudia Parodi, Carlos Quicoli, Mario Saltarelli & María Luisa Zubizarreta (eds.), *Aspects of Romance Linguistics*, 433–455. Washington, CD: Georgetown University Press.

Tranel, Bernard (2000). Aspects de la phonologie du français et la théorie de l'optimalité. *Langue française* **126**, 39–72.

Wright, Richard (2004). A review of perceptual cues and cue robustness. In Bruce Hayes, Robert Kirchner & Donca Steriade (eds.), *Phonetically Based Phonology*, 34–57. Cambridge: Cambridge University Press.

Zuraw, Kie & Bruce Hayes (2017). Intersecting constraint families: an argument for Harmonic Grammar. *Language* **93**, 497–548.