How phonology and morphology interact: The case of French liaison

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NELS 2024 - MIT

French liaison: the basics

- French liaison: an alternation involving certain words before vowel-initial words

(1)

		Word1	Word2		Context
a.	*grand*	[gʁɑ̃]	(none)	'great'	(citation form)
b.	*grand monsieur*	[gʁɑ̃]	[məsjø]	'great man'	(before C-initial words)
c.	*grand ami*	[gʁɑ̃t]	[ami]	'great friend'	(before V-initial words)

- Complex conditioning:
  - phonological factors
  - morphological/lexical factors
  - register

(e.g., Bonami and Delais-Roussarie 2021; Côté 2011; Côté 2017)

Two questions about the role of phonology and morphology in French liaison

- Despite decades of work on French liaison, some basic issues are still unresolved.

1. What kind of alternation is French liaison? (representation)
   - **allophony**: /$t_{liaison}$/: $\emptyset \sim$ [t]
     (Dell 1973 a.o., revived by Smolensky and Goldrick 2016)
   - **allomorphy**: *grand*: /gʁɑ̃, gʁɑ̃t/
     (Klausenburger 1984; Steriade 1999 a.o.)
2. Is French liaison phonologically optimizing? (computation)
   - **yes**: liaison as hiatus avoidance
     (cf. Tranel's 2000 OT account)
   - **no**: liaison as phonologically conditioned allomorphy but without phonological optimization
     (cf. Morin's 2005 usage-based account)

Broader implications

- Methodological question: how to diagnose allophony/allomorphy?
- Theoretical question: constraint-based phonology (Prince and Smolensky, 2004) or usage-based/evolutionary phonology (Blevins, 2004; Bybee, 1999)?

Blevins 2004: 281 on markedness constraints

'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.'

This talk

- French liaison is a pattern of allomorphy...
- that is phonologically optimizing...
- but also morphologically optimizing
  - paradigm uniformity/output-output correspondence
  - morpheme realization
- Evidence mainly from lexical statistics, based on a lexical database of liaison words (Storme, 2023)

Part 1: Is French liaison allophony or allomorphy?

Research question: what type of alternation is liaison?

- **Phonological analysis: liaison = allophony**
  (liaison as a special type of *phoneme*)

(2)

	Phoneme	Allophones
Liaison consonant	/$t_{liaison}$/	∅, [t]
Non-liaison consonant	/t/	[t]

- **Morphological: liaison = allomorphy**
  (liaison as a special type of *morpheme*)

(3)

	Morpheme	Allomorphs
Liaison word	*grand* 'great'	/gʁɑ̃/, /gʁɑ̃t/
Non-liaison word	*chouette* 'nice'	/ʃwɛt/

Remark

These these theories come in different versions.

1. Liaison as allophony

- Liaison as *contextually* special phonemes (Dell, 1985; Schane, 1968)

(4)

		Underlying representation
Liaison word	*grand* 'great'	/gʁɑ̃t/
Non-liaison word	*chouette* 'nice'	/ʃwɛtə/

- Liaison as *inherently* special phonemes
  - floating consonant (Encrevé, 1988; Tranel, 1990, 1995)
  - latent phoneme (Bonami, Boyé, and Tseng, 2005; Eychenne, 2011)
  - gradient symbolic representation (Smolensky and Goldrick, 2016; Smolensky, Rosen, and Goldrick, 2020; Tessier and Jesney, 2021)

(5)

		Underlying representation
Liaison word	*grand* 'great'	/gʁɑ̃$\mathbf{t}_{\mathbf{liaison}}$/
Non-liaison word	*chouette* 'nice'	/ʃwɛt/

What is common to these analyses

Liaison analyzed as (blocking of) elision.

1. Liaison as allophony

The analysis of liaison as epenthesis

- Treats ∅ as the phoneme and the consonant as the allophone (Tranel 1981, p. 251; Morin 1983).
- Problem: the epenthetic consonant is not predictable
  - Liaison depends on Word 1: *gran*[t] vs. *gro*[z]
  - Some words lack a liaison form: *vrai*.
- The epenthesis rule must be lexically conditioned ⇒ notational variant of the morphological analysis (Klausenburger, 1984, p. 27).

2. Liaison as allomorphy

- **Allomorphy involving Word 1** (liaison = final consonant), with (partly) phonological conditioning (e.g. Bonami 2011; Bonami and Boyé 2005; Bürki, Frauenfelder, and Alario 2015; Gaatone 1978; Klausenburger 1984; Steriade 1999; Storme in press(a))

(6)

	Morpheme	Allomorphs
Liaison word	*grand* 'great'	/gʁɑ̃/, /gʁɑ̃t/
Non-liaison word	*chouette* 'nice'	/ʃwɛt/

- **Allomorphy involving Word 2** (liaison = initial C), with lexical conditioning (Chevrot, Dugua, and Fayol, 2009; Smolensky and Goldrick, 2016)

(7)

	Morpheme	Allomorphs
Vowel-initial word	*ami*	/ami/, /tami/, /nami/, etc.
H-aspiré word	*héros*	/eʁo/

- **Allomorphy involving a two-word construction** (Bybee, 2001)

(8)

	Morpheme	Allomorphs
Liaison construction	*grand*	/gʁɑ̃/, /gʁɑ̃ t X/

This presentation focuses on the analysis with allomorphy involving Word 1

Why?

- **Methodological reasons**: allows for a minimal comparison with the phonological analysis (both analyses treat liaison consonants as word-final consonants)
- **Theoretical reasons**: effects of Word 2 on liaison can be largely derived without assuming a *lexical* attachment to Word 2:
  - paradigm uniformity (Storme, in press[a])
  - effect of lexical access on speech-production planning (Kilbourn-Ceron, 2017)

Earlier arguments and data

Theoretical arguments

- Phonological analysis:
  - +: smaller lexicon
  - −: larger phoneme inventory
- Morphological analysis:
  - +: smaller phoneme inventory + unified treatment of liaison with suppletive liaison (Gaatone, 1978, p. 49)

(9) Clearly suppletive liaison

		Word1	Word2		Context
a.	*vieux*	[vjø]	(none)	'old'	(citation form)
b.	*vieux monsieur*	[vjø]	[məsjø]	'great man'	(before C-initial words)
c.	*vieil ami*	[vjɛj]	[ami]	'old friend'	(before V-initial words)

  - −: larger lexicon

Summary

- No clear advantage for either analysis

This presentation: an empirical argument

- Lexical-frequency effects on the rate of liaison $\Rightarrow$ argument against the phonological theory
- Argument based on well-known data, but these data have not been used in the debates on the underlying representation of liaison

Lexical frequency and deletion

- More frequent words tend to be more reduced (Bell et al., 2009; Jurafsky et al., 2001)
- E.g. deletion of final C is positively correlated with lexical frequency:
  - English /t, d/ (Bybee 2007, chapter 9; Coetzee and Kawahara 2013)

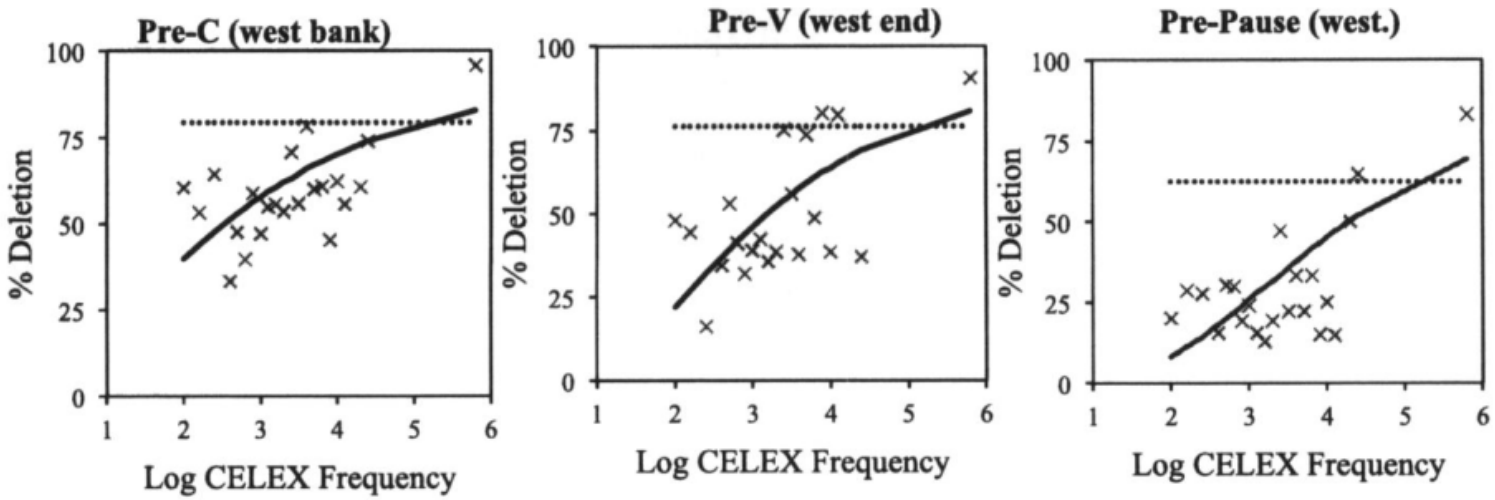

Fig. 4 Observed and predicted *t/d*-deletion rates in Columbus English. The *broken line* indicates the predictions based on the baseline, unscaled HG. The *solid line* shows the predictions based on the frequency weighted HG with a ρ-value of 5

  - Dutch /t/ (Goeman, 1999, pp. 179–184)
  - Spanish /s/ (File-Muriel, 2010)

Predictions about liaison

- In the phonological analysis of liaison, liaison is (blocking of) deletion: /gʁɑ̃t/ → [gʁɑ̃]
- **Prediction**: **positive** correlation between lexical frequency and frequency of use of the short form (without liaison)

Results

- Before V: **negative** correlation between lexical frequency and frequency of the short form (without liaison) (Fougeron et al., 2001; Kilbourn-Ceron, 2017)
- Before C and pause: categorical use of the short form (without liaison)

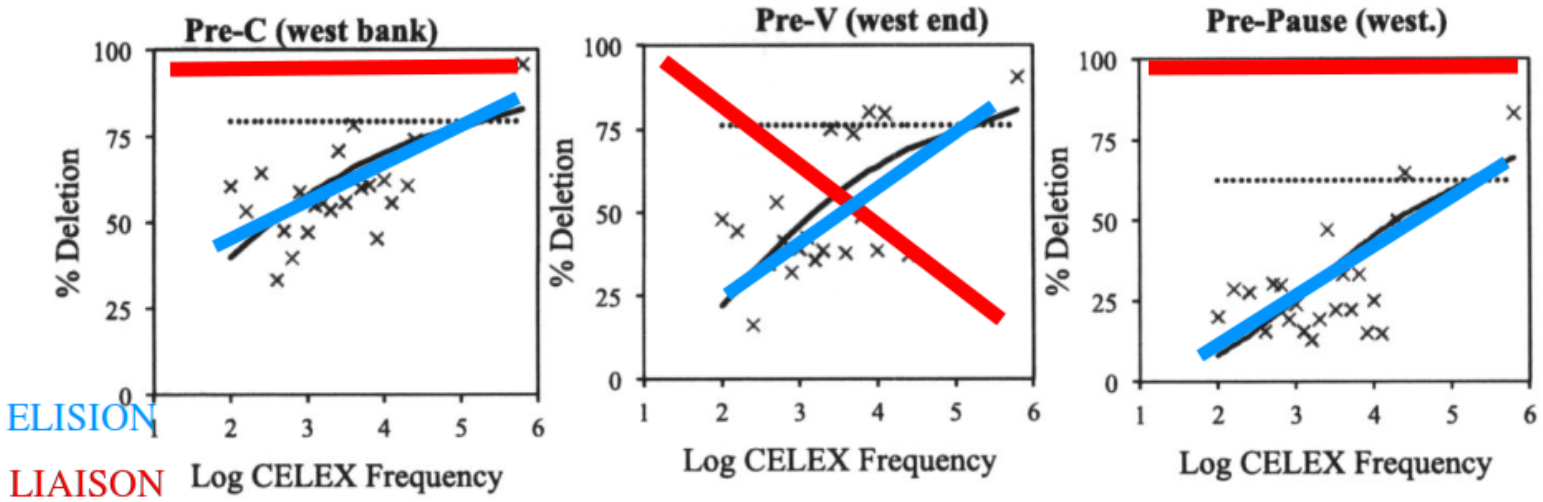

Fig. 4 Observed and predicted *t/d*-deletion rates in Columbus English. The *broken line* indicates the predictions based on the baseline, unscaled HG. The *solid line* shows the predictions based on the frequency weighted HG with a ρ-value of 5

Summary

- French liaison does not behave like a regular reduction process
- Empirical argument against phonological theory of liaison as blocking of deletion

$\Rightarrow$ Liaison involves neither epenthesis nor deletion

Testing the morphological theory of liaison

Is French liaison allomorphy?

- Allomorphy has a specific lexical signature: implies a small number of frequent words (see irregular verbs)

  (Bybee 1985, Chapter 5; Berg 2011)

  Prediction

  Liaison words have *lower* **type frequency** but *higher* **token frequency** than non-liaison words.

  type frequency: nb of words in the lexicon

  token frequency: nb of words in a corpus

- Goal: testing this prediction using Lexique 3.83 (New and Pallier, 2023) while controlling for phonotactics and
  - inflectional morphology (Study 1)
  - derivational morphology (Study 2)

Study 1

Methods: database

- We need 2 types of information:
  - a list of liaison and non-liaison words
  - with number of tokens in a corpus (ideally oral)
- I chose Lexique 3.83 (New and Pallier, 2023; New et al., 2004)
  - +: data on token frequency (subtitles) + grammatical information
  - −: no information about the liaison/non-liaison status of words

Methods: identification of liaison/non-liaison status

- In general, a liaison is characterized by:
  - a graphic form ending in a graphic liaison C (*n, r, t, d, s, p, g, x,* or *z*) and
  - a phonological form whose citation form does not end with the corresponding phonological liaison C [n, ʁ, t, z, p, g].

    Remark: Lexique 3.83 provides the citation form of words
- Application: *grand* is identified as a liaison word, but not *chouette*.
- Some exceptions: liaison words with a liaison consonant that is identical to the stem-final consonant
  - *chantent* [ʃɑ̃t] ∼ [ʃɑ̃tət] 'they sing'
  - *ronces* [ʁɔ̃s] ∼ [ʁɔ̃səz] 'thorns' (plur)

Methods: identification of liaison/non-liaison status

Remark

- Very inclusive definition of liaison
- For instance, *chantent* is treated as a liaison word, but this word behaves as a liaison only in a very specific register

⇒ This imposes a stricter criterion for morphological analysis, as this inflates the number of liaison words.

- One restriction was considered: singular nouns are removed from the corpus because they are not involved in liaison alternations (Côté, 2011)

Methods: controling for phonotactic effects on lexical frequency

- Consonants vary in their lexical frequency (Malécot, 1974).

Table II. Distribution of phonemes (word-final position)

Rank	Phoneme	Occurrences	Rank	Phoneme	Occurrences
1	/ə/	8,334	19	/o/, /ɔ/	506
2	/e/, /ɛ/	7,413	20	/d/	340
3	/r/	4,559	21	/j/	250
4	/a/, /ɑ/	4,540	22	/v/	234
5	/i/	3,381	23	/ʒ/	223
6	/z/	3,120	24	/ʃ/	120
7	/l/	2,709	25	/f/	114
8	/t/	2,660	26	/p/	110
9	/ɑ̃/	2,550	27	/g/	89
10	/n/	2,116	28	/ɲ/	51
11	/ɔ̃/	1,759	29	/œ̃/[1]	28
12	/ɛ̃/	1,602	30	/ŋ/	23
13	/u/	1,515	31	/b/	16
14	/s/	1,096	32	/w/	0
15	/y/	1,017	33	/ɥ/	0
16	/m/	968	34	/ɔ/	(incl. in /o/)
17	/k/	818	35	/œ/	(incl. in /ø/)
18	/ø/, /œ/	703	36	/ɛ/	(incl. in /e/)

[1] Nasal vowel spelled *un*.

⇒ The control group (non-liaison words) only includes words ending in [n, ʁ, t, z, p, g].

Methods: controlling for the effect of inflectional morphology on lexical frequency

- Many words share the same suffix, and therefore cannot be treated as independent:
  - *fruits* 'fruits' - *voitures* 'cars' plural *-s*
  - *glorieux* 'glorious' - *chanceux* 'lucky' *-eux*
- Study 1 controls for the effect of inflectional suffixes like *-s*.
  - Practical reason: information available in Lexique 3.83
  - Theoretical reason: inflectional suffixes are more likely to be stored independently from stems in the lexicon (productivity, semantic transparency)

$\Rightarrow$ Words ending with the same inflectional morpheme are counted as 1 in the analysis

Methods: controlling for inflectional morphology

(10) Plural suffix

	Word1	Word2	
fruits frais	[fʁɥi]	[fʁɛ]	'fresh fruits'
fruits exotiques	[fʁɥi-z]	[ɛgzotik]	'tropical fruits'

(11) 3sg/3pl ∅ ∼ [t]

	Word1	Word2	
Il veut deux cafés.	[vø]	[dø]	'He wants two coffees.'
Il veut un café.	[vø-t]	[ɛ̃]	'He wants a coffee.'

(12) 1/2sg/pl ∅ ∼ [z]

	Word1	Word2	
Je veux deux cafés.	[vø]	[dø]	'I want two coffees.'
Je veux un café.	[vø-z]	[ɛ̃]	'I want a coffee.'

(13) Present participle [ɑ̃] ∼ [ɑ̃t]

	Word1	Word2	
voulant deux cafés.	[vulɑ̃]	[dø]	'wanting two coffees.'
voulant un café.	[vulɑ̃t]	[ɛ̃]	'wanting a coffee.'

(14) Infinitive [e] ∼ [eʁ] (first conjugation group)

	Word1	Word2	
acheter deux cafés	[aʃəte]	[dø]	'to buy two coffees'
acheter un café	[aʃəte-ʁ]	[ɛ̃]	'to buy a coffee'

(15) Infinitive [ʁ] (second and third conjugation groups)

	Word1	Word2	
boire deux cafés	[bwa-ʁ]	[dø]	'to drink two coffees'
boire un café	[bwa-ʁ]	[ɛ̃]	'to drink a coffee'

Methods: statistical analyses

- Poisson regression (Winter and Bürkner, 2021) to model word counts
- Poisson distribution characterized by a single parameter λ (describes the mean number of occurrences of an event)
- Why Poisson distribution? Discrete distribution (takes integers as values)

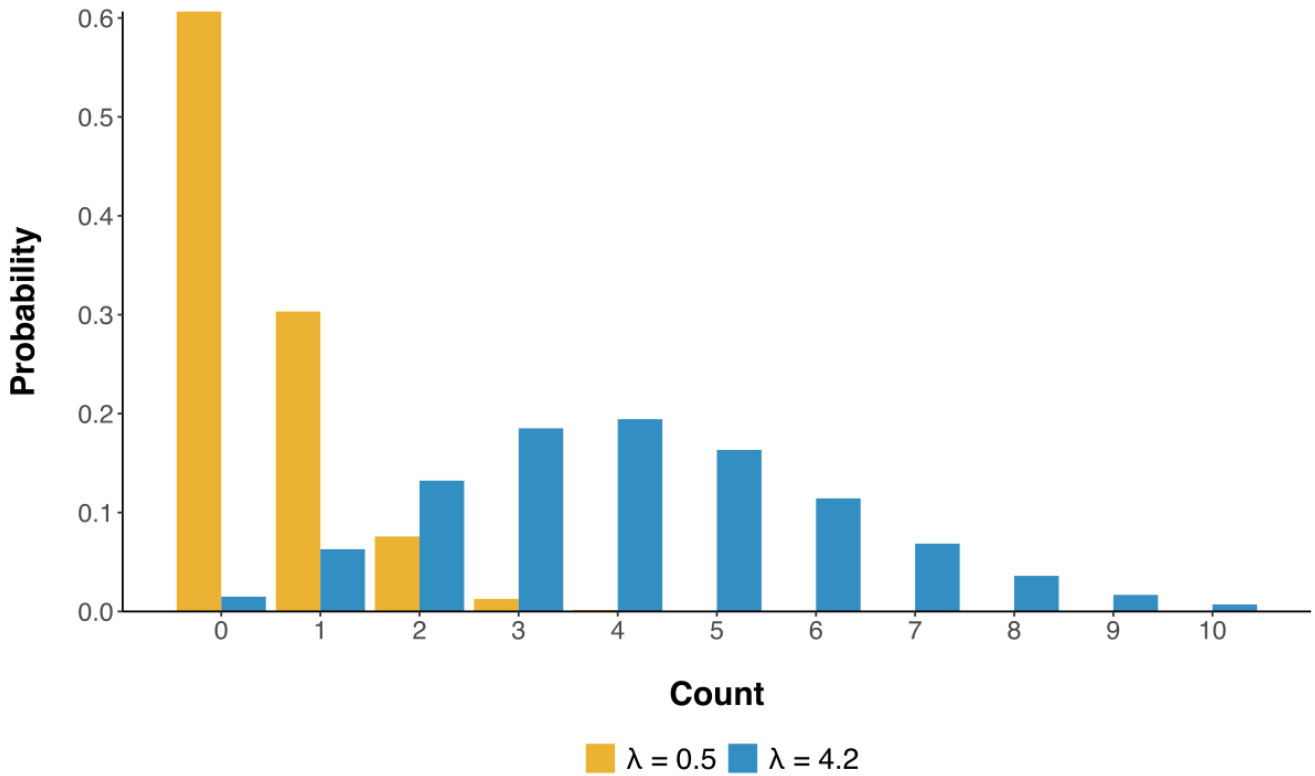

FIGURE 1 Counts with their associated probabilities expected under the Poisson distribution for two different values of lambda; yellow: $\lambda = 0.5$; blue: $\lambda = 4.2$

Methods: statistical analyses

Predictions of the allomorphic analysis

- ☐ Type frequency: $\lambda_{\text{liaison}} < \lambda_{\text{non-liaison}}$ (lexicon)
- ☐ Token frequency: $\lambda_{\text{liaison}} > \lambda_{\text{non-liaison}}$ (corpus)

- ☐ Predictions tested using brms (Bürkner, 2017) in R
- ☐ Controlling for phonotactics and morphological inflection

Results: analysis of type frequency (descriptive statistics)

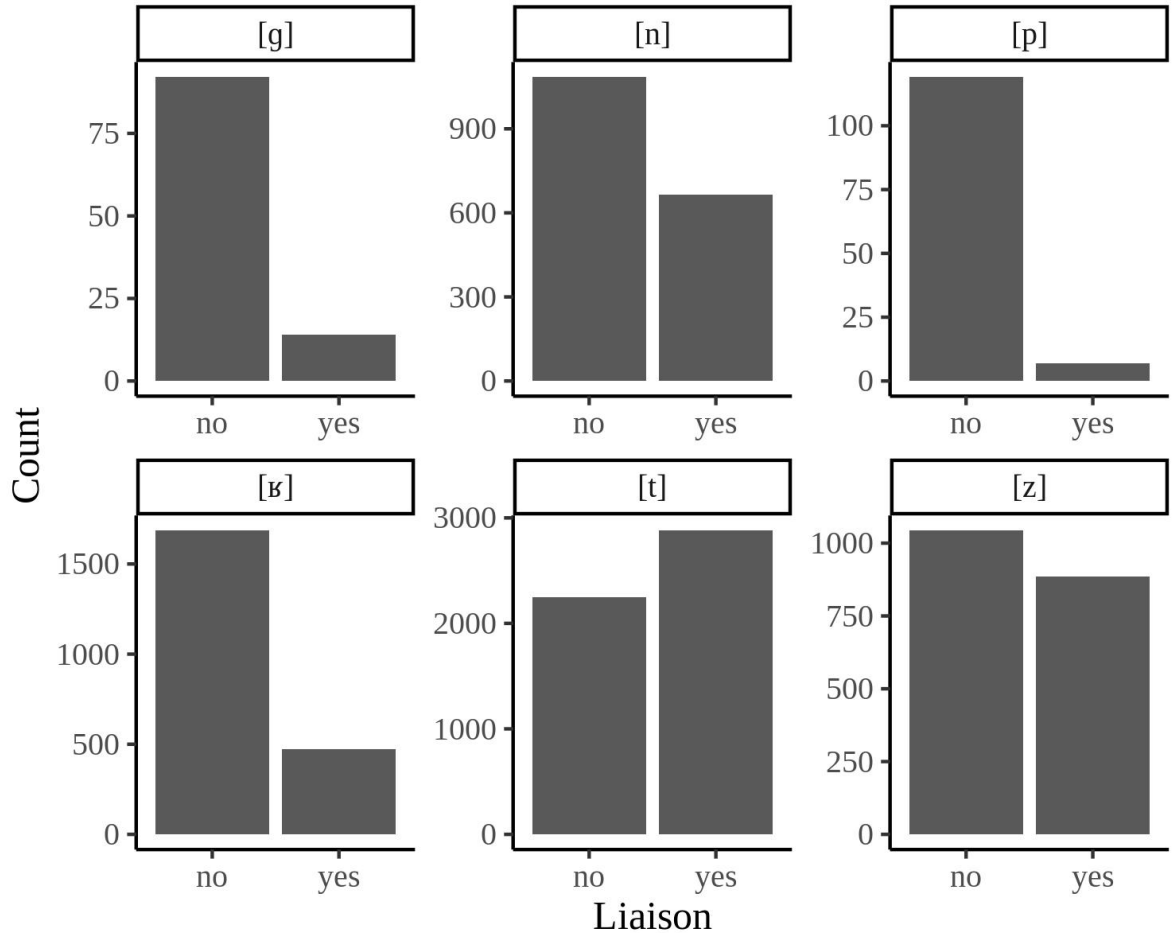

Figure: Descriptive statistics for the type-frequency analysis: count of liaison and non-liaison words in Lexique 3.83 as a function of the identity of the word-final consonant. Word count is determined after the segmentation of inflectional suffixes, with words sharing an inflectional suffix counting as one.

Results: analysis of type frequency (inferential statistics)

Hypothesis	Estimate	Est.Error	CI.Lower	CI.Upper	Post.Prob
$\lambda_{\text{liaison, [g]}} - \lambda_{\text{non-liaison, [g]}} < 0$	-1.92	0.30	-2.43	-1.45	1
$\lambda_{\text{liaison, [n]}} - \lambda_{\text{non-liaison, [n]}} < 0$	-0.49	0.05	-0.57	-0.40	1
$\lambda_{\text{liaison, [t]}} - \lambda_{\text{non-liaison, [t]}} < 0$	0.25	0.03	0.20	0.29	0
$\lambda_{\text{liaison, [ʁ]}} - \lambda_{\text{non-liaison, [ʁ]}} < 0$	-1.27	0.05	-1.36	-1.18	1
$\lambda_{\text{liaison, [z]}} - \lambda_{\text{non-liaison, [z]}} < 0$	-0.16	0.05	-0.24	-0.09	1
$\lambda_{\text{liaison, [p]}} - \lambda_{\text{non-liaison, [p]}} < 0$	-2.90	0.40	-3.60	-2.27	1

Table: Inferential statistics for the type-frequency analysis: difference between the λ parameters for liaison and non-liaison words for each consonant (estimate, estimated error and 95 % Credibility Interval) and posterior probability that this difference is negative.

Results: analysis of token frequency (descriptive statistics)

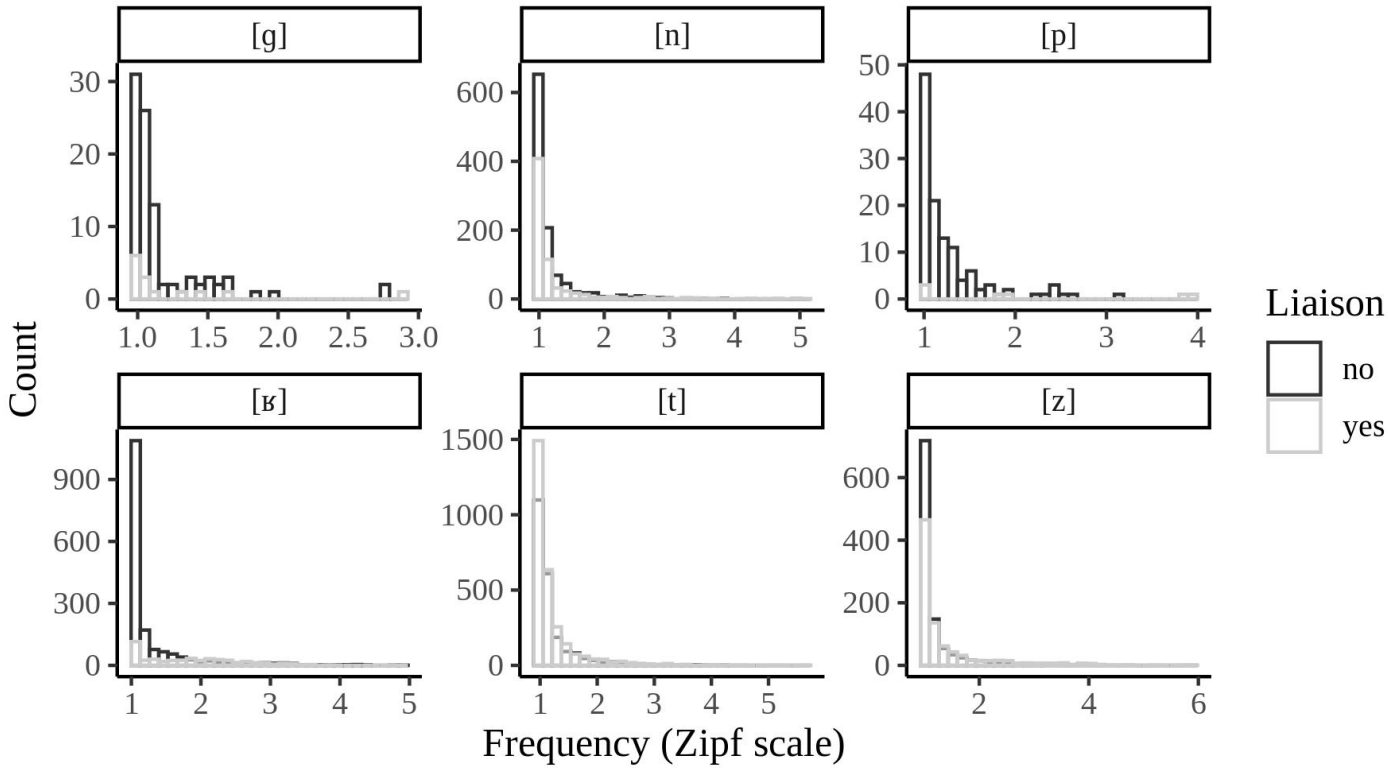

Figure: Descriptive statistics for the token-frequency analysis: distribution of token frequencies (in Zipf) for liaison and non-liaison words in the corpus of movie subtitles from Lexique 3.83 as a function of the identity of the word-final consonant. The frequency values on the x-axis were binned into 30 intervals. Word count is determined after the segmentation of inflectional suffixes, with words sharing an inflectional suffix counting as one.

Results: analysis of token frequency (inferential statistics)

Hypothesis	Estimate	Est.Error	CI.Lower	CI.Upper	Post.Prob
$\lambda_{\text{liaison, [g]}} - \lambda_{\text{non-liaison, [g]}} > 0$	1.25	0.01	1.22	1.27	1
$\lambda_{\text{liaison, [n]}} - \lambda_{\text{non-liaison, [n]}} > 0$	2.00	0.00	2.00	2.00	1
$\lambda_{\text{liaison, [t]}} - \lambda_{\text{non-liaison, [t]}} > 0$	1.89	0.00	1.89	1.89	1
$\lambda_{\text{liaison, [ʁ]}} - \lambda_{\text{non-liaison, [ʁ]}} > 0$	0.44	0.00	0.44	0.44	1
$\lambda_{\text{liaison, [z]}} - \lambda_{\text{non-liaison, [z]}} > 0$	4.88	0.00	4.88	4.89	1
$\lambda_{\text{liaison, [p]}} - \lambda_{\text{non-liaison, [p]}} > 0$	4.12	0.01	4.11	4.13	1

Table: Inferential statistics for the token-frequency analysis: difference between the λ parameters for liaison and non-liaison words for each consonant (estimate, estimated error and 95 % Credibility Interval) and posterior probability that this difference is positive.

Discussion

- Results are generally compatible with the morphological theory.
- Liaison words/morphemes are fewer in the lexicon but more frequent in a corpus than similar non-liaison words.
- One problem: [t].

Reminder

- This result is obtained with a very inclusive view of liaison.
- There are probably fewer liaison words in actual speech than what was included in the analysis.

Discussion

- Potential explanation for [t]: insufficient control of *derivational* morphology
- Words sharing a derivational suffix were treated as independent in Study 1 (e.g., *appétiss-ant* 'appetizing' et *odor-ant* 'fragrant').
- If liaison suffixes like *-ant* are few but very productive, then this will increase the type frequency of liaison words.

Discussion

- Result when flectional morphology is not controlled for!
- The 3 liaison consonants involved in inflectional suffixes suddenly have a very high type frequency

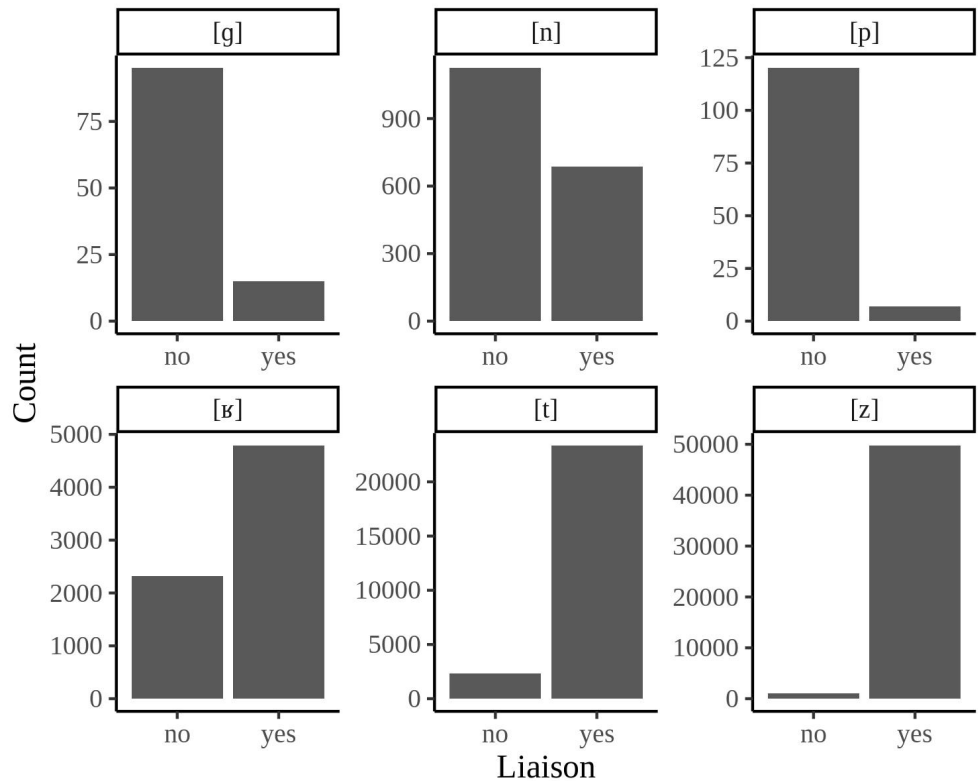

Figure: Count of liaison and non-liaison words in Lexique 3.83 as a function of the identity of the word-final consonant when grammatical morphology is not controlled for.

Study 2

Research question

- Study 2 almost identical to Study 1, but focusing on adjectival liaison

(16) Free adjectival morphemes

	Word1	Word2	
grand monsieur	[gʁɑ̃]	[məsjø]	'great man'
grand ami	[gʁɑ̃t]	[ami]	'great friend'

(17) Bound adjectival morphemes

	Word1	Word2	
heureux mariage	[øʁ-ø]	[maʁjaʒ]	'happy wedding'
heureux événement	[øʁ-øz]	[evɛnəmɑ̃]	'happy event'

Predictions

Adjectival liaison morphemes (*grand*) have lower type frequency but higher token frequency than adjectival non-liaison morphemes (*chouette*).

Remarks

- Bybee (2001, pp. 179–180): adjectival liaison limited to a very small number of adjectives (6 adjectives listed by Bybee)
- But Morin (2005, pp. 11–12) says that liaison is available for many more adjectives, in particular in the formal register (see also Côté 2011, Section 2.1.1).

Remark

As in Study 1, I adopt in Study 2 a very inclusive view of adjectival liaison

Methods: database

- A subset of the database from Study 1 was used to focus on adjectival liaison (masculin singular adjectives).
- Among adjectives, I excluded:
  - clearly feminine adj (*heureuse* [øʁøz])
  - clearly plural adj (*grands* [gʁɑ̃] ∼ [gʁɑ̃z])
  - adjectives that are ambiguous for both number and gender because typicaly derived from singular nouns by conversion (*marron* 'brown')
- Inclusion of:
  - adj ambiguous for number only (*heureux* 'happy')
  - adj ambiguous for gender only (*chouette* 'nice')
- These adjectives were included to have a large corpus, but this makes data on token frequency more difficult to interpret:
  - inflates token frequency (but inflation for both liaison and non-liaison adjectives)

Methods: morphological segmentation

- Suffixes were identified manually using a distribution (rather than semantic) criterion
  - Suffixed words are based on a stem containing at least one syllable (with a few exceptions: *boueux* 'muddy' [bwø])
  - Suffix as recurring unit, even if no clear compositional meaning (*belliqu-eux* 'aggressive, warlike') (with a few exceptions, as *anti-calcaire*, where there is no adjectival suffixe but derivation based on the noun *calcaire*).

Methods: statistical analyses

- Same analyses as in Study 1: Poisson regression on lexical data (type frequency) and corpus data (token frequency)

Methods: statistical analyses

Predictions of the allomorphic analysis

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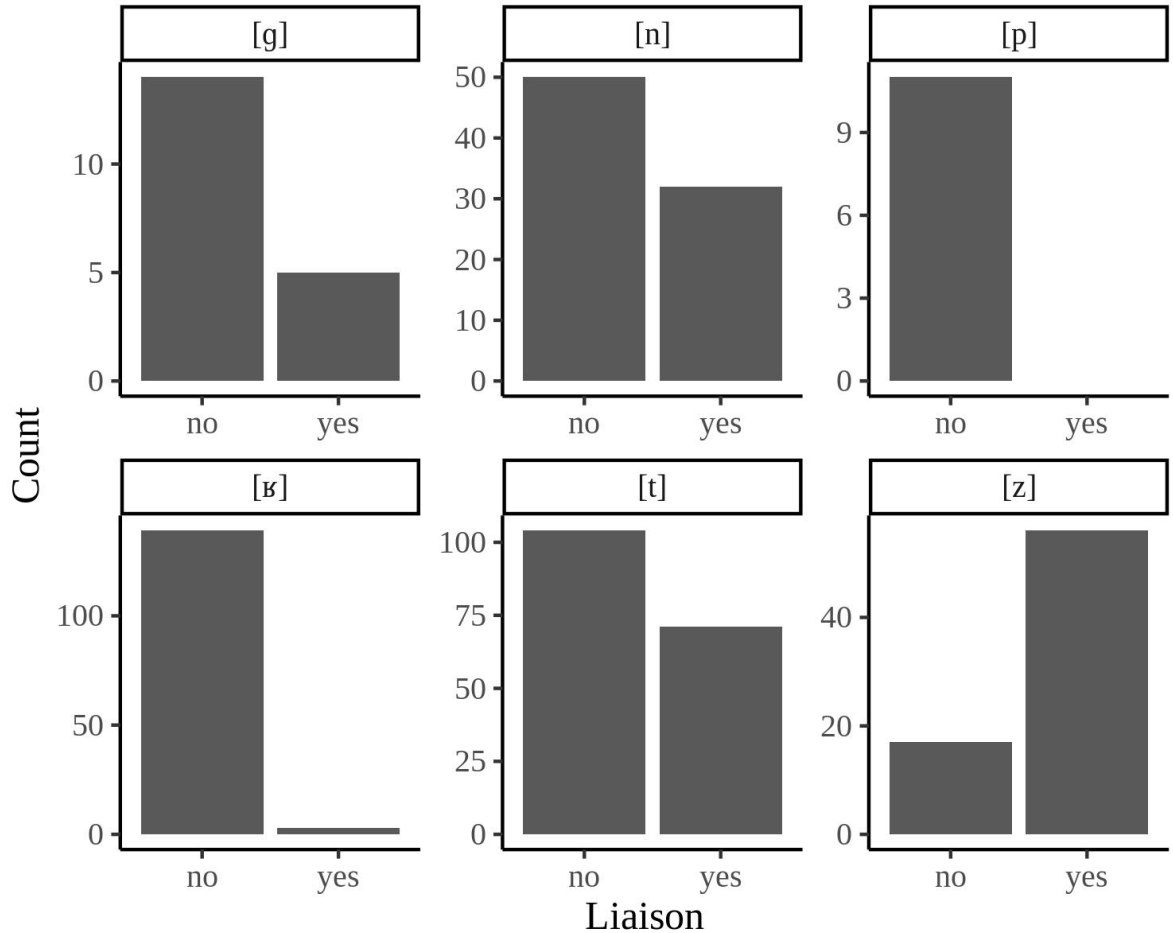

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$\lambda_{\text{liaison, [n]}} - \lambda_{\text{non-liaison, [n]}} < 0$	-0.45	0.23	-0.83	-0.06	0.97
$\lambda_{\text{liaison, [t]}} - \lambda_{\text{non-liaison, [t]}} < 0$	-0.38	0.15	-0.63	-0.13	0.99
$\lambda_{\text{liaison, [ʁ]}} - \lambda_{\text{non-liaison, [ʁ]}} < 0$	-3.98	0.62	-5.10	-3.09	1.00
$\lambda_{\text{liaison, [z]}} - \lambda_{\text{non-liaison, [z]}} < 0$	1.22	0.29	0.75	1.70	0.00
$\lambda_{\text{liaison, [p]}} - \lambda_{\text{non-liaison, [p]}} < 0$	-34.00	30.66	-94.68	-4.90	1.00

Table: Inferential statistics for the type-frequency analysis: difference between the λ parameters for liaison and non-liaison adjectives for each consonant (estimate, estimated error and 95 % Credibility Interval) and posterior probability that this difference is negative.

Results: analysis of token frequency (descriptive statistics)

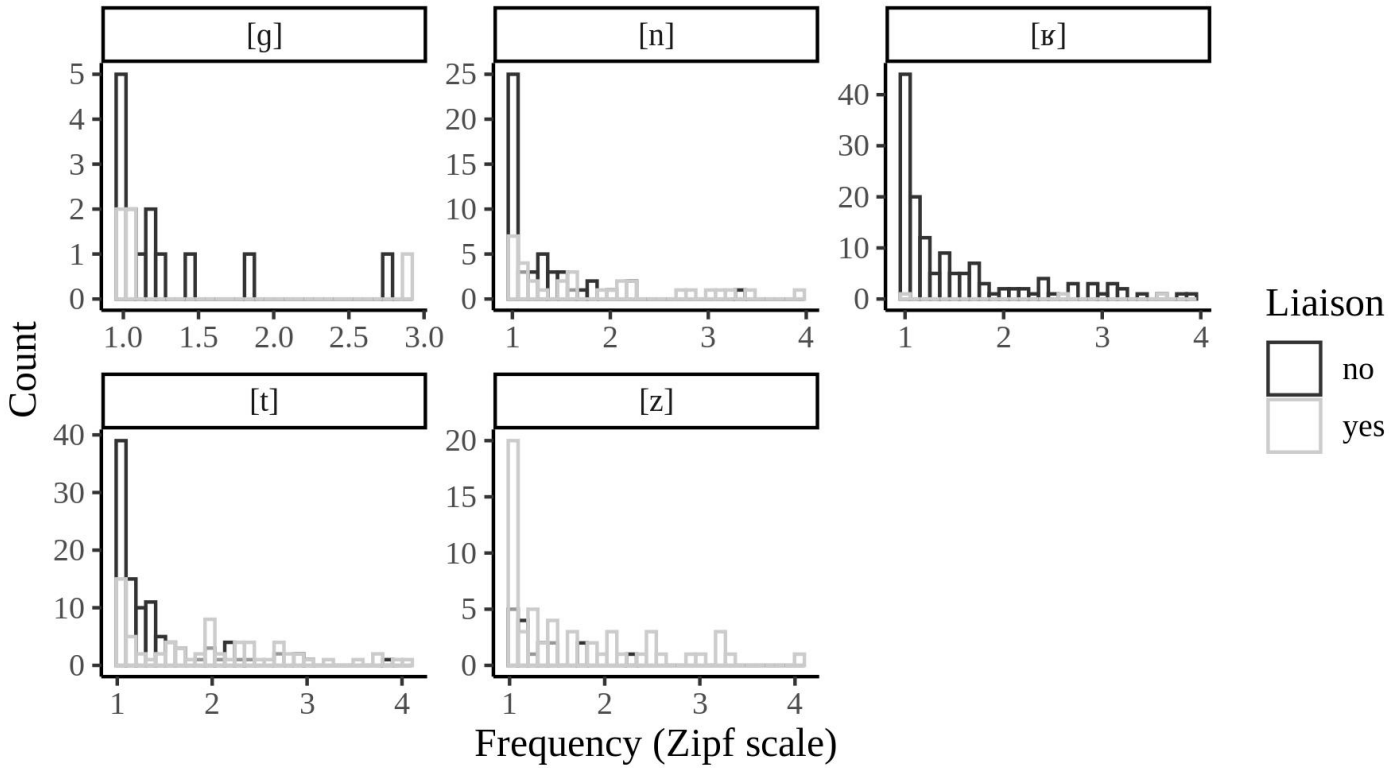


Figure: Descriptive statistics for the token-frequency analysis: distribution of token frequencies (in Zipf) for liaison and non-liaison adjectives in the corpus of movie subtitles from Lexique 3.83 as a function of the identity of the word-final consonant. The frequency values on the x-axis were binned into 30 intervals. Word count is determined after the segmentation of adjectival suffixes, with words sharing an adjectival suffix counting as one.

Results: analysis of token frequency (inferential statistics)

Hypothesis	Estimate	Est.Error	CI.Lower	CI.Upper	Post.Prob
$\lambda_{\text{liaison, [g]}} - \lambda_{\text{non-liaison, [g]}} > 0$	1.25	0.02	1.22	1.27	1.00
$\lambda_{\text{liaison, [n]}} - \lambda_{\text{non-liaison, [n]}} > 0$	2.13	0.01	2.12	2.14	1.00
$\lambda_{\text{liaison, [t]}} - \lambda_{\text{non-liaison, [t]}} > 0$	1.67	0	1.66	1.67	1.00
$\lambda_{\text{liaison, [ʁ]}} - \lambda_{\text{non-liaison, [ʁ]}} > 0$	1.78	0	1.77	1.78	1.00
$\lambda_{\text{liaison, [z]}} - \lambda_{\text{non-liaison, [z]}} > 0$	2.91	0.02	2.88	2.93	1.00

Table: Inferential statistics for the token-frequency analysis: difference between the λ parameters for liaison and non-liaison adjectives for each consonant (estimate, estimated error and 95 % Credibility Interval) and posterior probability that this difference is positive.

Discussion

- Results generally compatible with allomorphic hypothesis
- Liaison adjectives are fewer in the lexicon but more frequent in a corpus than non-liaison adjectives (except for [t]).
- Problem: [z].

Reminder

- This result is obtained with a very inclusive view of liaison.
- There are probably fewer liaison words in actual speech than what was included in the analysis.

Discussion: problem with [z]

- Potential explanation: phonotactic difference between final [z] and prevocalic [z]
- Final [z] is phonotactically marked across languages (Gordon, 2016, chapter 2), and in French (Jatteau et al., 2019).

⇒ Diachronically this should make the number of words ending in [z] smaller.

- [s] is phonotactically marked between vowels across languages (Gordon, 2016, p. 151), and in the history of French (see intervocalic voicing).

⇒ Diachronically this should make the number of words with intervocalic [s] smaller, and also the number of liaison words ending in [s].

- No effect with other consonants? Maybe because no such phonotactic asymmetry

Interim conclusion

Question

Is French liaison allophony or allomorphy?

- The following results favor the allomorphic theory:
  - liaison does not behave like a typical deletion process
  - liaison behaves like a typical pattern of allomorphy
- Reminder: results obtained under a very inclusive view of liaison

Remark

The methods proposed here could be applied to other debated alternations, e.g., French [ə]-[ɛ] (*appeler-appelle*).

Why has the allophonic theory been so popular?

- Probably because liaison consonants also have a special *prosodic and segmental realization*.

  (18) Liaison has a realization that is intermediate between a word-final and word-initial consonant

  a. *gran*[t]... *ami* 'great friend'

  b. *gran*... [t]*ami* 'great friend'

- Motivation for the idea that liaison consonants are special segments *underlyingly*.
- But this can be derived as a paradigm uniformity effect under the allomorphic theory (Steriade, 1999; Storme, in press[b]).

Part 2: Is French liaison phonologically optimizing?

Liaison and hiatus avoidance

- Classical OT analysis of liaison as hiatus avoidance (*VV) (Tranel, 2000)

  (19) *un arbre* ‘a tree’
  [ɛ̃n#aʁbʁ]/*[**ɛ̃#a**ʁbʁ]

- *VV also motivated by other processes:

	Process	Example	Process applies (*VV satisfied)	Process does not apply (*VV violated)	
a.	Liaison	*un arbre*	[ɛ̃n#aʁbʁ]	*[**ɛ̃#a**ʁbʁ]	‘a tree’
b.	Elision	*l’arbre*	[l#aʁbʁ]	*[lə**#a**ʁbʁ]	‘the tree’
c.	Suppletion	*cet arbre*	[sɛt#aʁbʁ]	*[sə**#a**ʁbʁ]	‘this tree’
d.	Epenthesis-blocking	*chaque arbre*	[ʃak#aʁbʁ]	*[ʃakə**#a**ʁbʁ]	‘every tree’

⇒ Classical case of conspiracy

- **Liaison = phonologically optimizing allomorphy**
  Cf Inkelas (2014)

Morin's argument against the role of hiatus avoidance

- Morin (2005) argued against this analysis.

1. A hiatus context (V_V) is not necessary for liaison:

(20) C_#V
magnifiques arbres 'magnificent trees'
[maɲifi**k**z̲#**a**ʁbʁ]

(21) V_#C (limited to professional public speakers)
c'est possible 'it's possible'
[s**ɛ**t̲#**p**osibl]

2. A hiatus context is not sufficient for liaison:

(22) V_#V (variability with some liaison words)
dans une heure 'in one hour'
[d**ɑ̃**z̲#**y**nœʁ]/[d**ɑ̃**#**y**nœʁ]

(23) V_#V (h-aspiré word)
grand houx 'big holly'
[gʁ**ɑ̃**#**u**]

Morin's proposal

- Liaison consonants are part of lexical constructions (see Bybee 1999; Bybee 2001)

(24)

	Morpheme	Allomorphs
Liaison construction	*grand*	/gʁɑ̃/, /gʁɑ̃ t X/

(where X is a noun)

- More frequent words are more likely to be stored in a lexical construction.
  - This explains lexical frequency effects on liaison (higher rate of liaison with more frequent Word1 and Word2).
- Phonological conditioning due to 'innocent misperception' in a diachronic account (cf. Ohala 1981, Blevins 2004):
  - loss of final consonants, except before vowels due to better perceptibility in this context
- But no phonological optimization: no *VV constraint

Argument against OT

Blevins 2004: 281 on markedness constraints

‘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.’

Argument for the role of hiatus avoidance

1. Liaison consonants are mostly prevocalic
2. Liaison consonants are mostly postvocalic

Implications

Restriction 2 follows under Tranel's (2000) OT analysis, but not under Morin's (2005) usage-based account.

Liaison consonants are mostly prevocalic

- Examples of preconsonantal liaison are extremely limited and can be explained as effects of the graphic form on pronunciation (see later)

(25) V_#C (limited to professional public speakers)
c'est possible [sɛt̪posibl] 'it's possible'

- Outside of these limited contexts, liaison is prevocalic.
- For instance, PFC project only codes prevocalic contexts as potential liaison contexts: 'By potential liaison site, we understand all final orthographic consonants followed by a vowel initial word.' (Durand and Lyche, 2016, pp. 365–366)

Implication

- This restriction is derived under both approaches.
- OT because of *VV
- Morin (2005) because of prevocalic contexts providing better perceptual cues to C identity

Liaison consonants are mostly postvocalic

- Liaison consonants tend to be preceded by vowels, in particular in lexical morphemes such as adjectives.

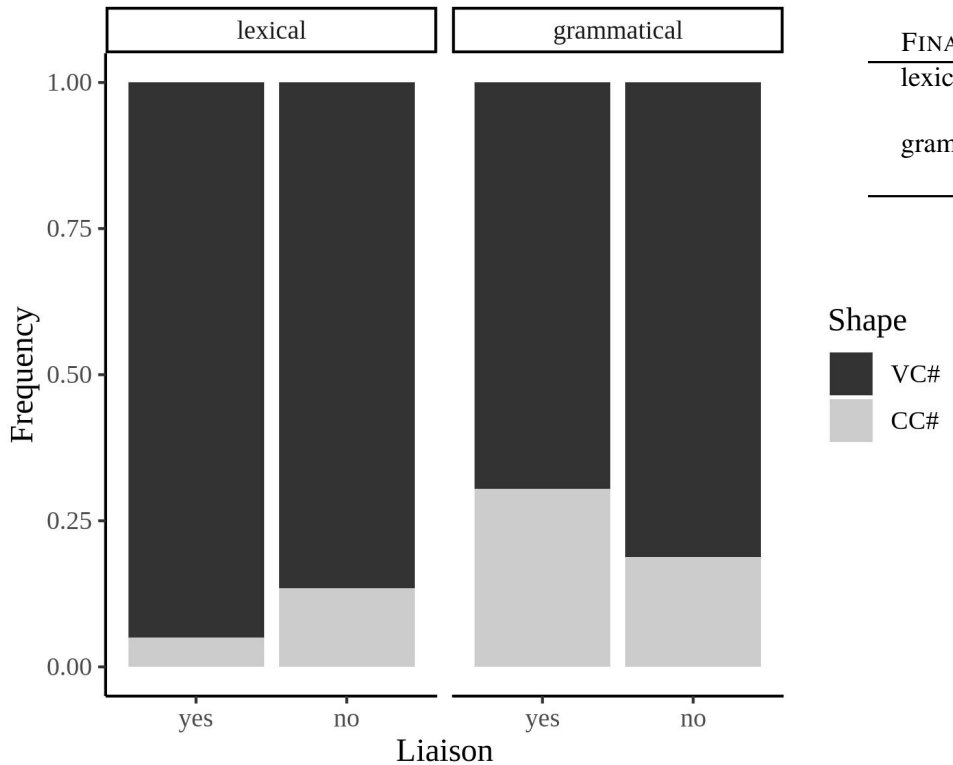
  (26) *grand arbre* 'big tree'
  [gʁɑ̃taʁbʁ] (liaison [t] may be pronounced)

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

- Generalization known as *loi de Littré* (Bonami and Boyé, 2005; Bonami, Boyé, and Tseng, 2005)
- *loi de Littré* = a morpheme structure constraint in the sense of Booij (2011).
- A few exceptions: adverbs *toujours, fort*

Liaison consonants are mostly postvocalic

- This generalization is statistically robust, and applies in its strongest version only to *lexical morphemes*.



Final morpheme	Liaison	Phonological shape: VC#	Phonological shape: CC#
lexical	yes	*grand* 'great'	*toujours* 'always'
	no	*chouette* 'nice'	*abject* 'abject'
grammatical	yes	*vélos* 'bikes'	*voitures* 'cars'
	no	*venir* 'to come'	*vendre* 'to sell'

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).

Deriving the *loi de Littré* in OT

- Constraints:

(28) *VV
For every sequence of two vowels in a candidate, assign one penalty.

(29) 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.)

- Analysis (following Mascaró 2007 for listed allomorphs)

	Input		Candidates	*VV	USECITATION FORM
a.	*grand arbre* 'big tree' /{gʁɑ̃$_1$, gʁɑ̃t$_2$}#aʁbʁ/		[gʁɑ̃$_1$aʁbʁ] [gʁɑ̃t$_2$aʁbʁ]	1!	 1
b.	*grand chêne* 'big oak' /{gʁɑ̃$_1$, gʁɑ̃t$_2$}#ʃɛn/	☞	[gʁɑ̃$_1$ʃɛn] [gʁɑ̃t$_2$ʃɛn]		 1!
c.	*fort accent* 'strong accent' /{fɔʁ$_1$, fɔʁt$_2$}#aksɑ̃/	☞	[fɔʁ$_1$aksɑ̃] [fɔʁt$_2$aksɑ̃]		 1!
d.	*fort tempérament* 'strong temperament' /{fɔʁ$_1$, fɔʁt$_2$}#tɑ̃peʁamɑ̃/	☞	[fɔʁ$_1$tɑ̃peʁamɑ̃] [fɔʁt$_2$tɑ̃peʁamɑ̃]		 1!

Table: OT ANALYSIS OF THE *loi de Littré*.

The *loi de Littré* is problematic for Morin (2005)

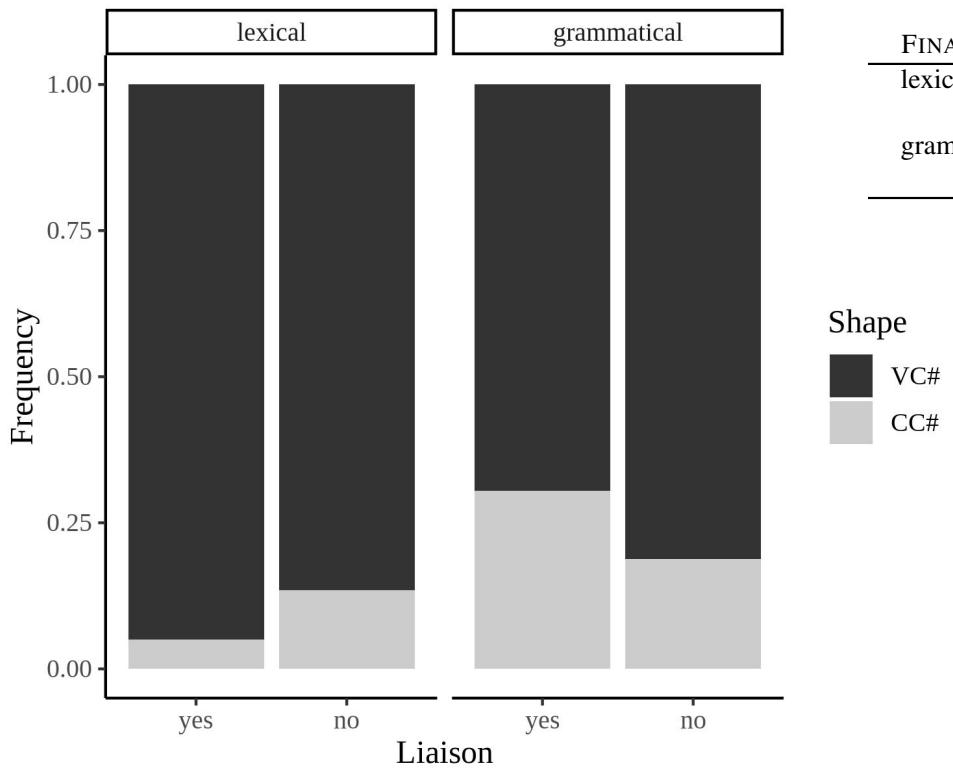
- Availability of perceptual cues for the final C for both VC#V and CC#V words.

⇒ Not clear why VC# should be overrepresented as compared to CC# in liaison words.

- Innocent misperception would predict $VC_1C_2\#V \rightarrow VC_2\#V$
  - C_1 lacks important perceptual cues that are available for C_1 (release transitions)
- But it makes the wrong prediction about the consonant that underwent deletion in CC# words historically.
- C_2 and not C_1 was deleted: *fort* [fɔʁt] changed to [fɔʁ] and not to [fɔt]

The *loi de Littré* does not apply to grammatical morphemes: why?

(30) C_#V
magnifiques arbres 'magnificent trees'
[maɲifi**k**z̲#**a**ʁbʁ]



Final morpheme	Liaison	Phonological shape: VC#	Phonological shape: CC#
lexical	yes	*grand* 'great'	*toujours* 'always'
	no	*chouette* 'nice'	*abject* 'abject'
grammatical	yes	*vélos* 'bikes'	***voitures* 'cars'**
	no	*venir* 'to come'	*vendre* 'to sell'

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).

Proposal: liaison is morphologically motivated in this case

- Proposal building on Tranel (2000) and Eychenne (2011)
- CC# liaison words ending in a grammatical morpheme involve *monosegmental* morphemes:
  - plural [-z]
  - 1st/2d person [-z]
  - 3d person [-t]
- In the absence of liaison, there is no overt exponent for these morphemes.

(31) C_#V
magnifiques arbres 'magnificent trees'
[maɲifi**k**z̲#**a**ʁbʁ]

- Liaison motivated by REALIZEMORPHEME (Kurisu, 2001)

(32) REALIZEMORPHEME
Assign one penalty for each morpheme that is not expressed overtly.

Proposal: liaison is morphologically motivated in this case

- However REALIZEMORPHEME is not sufficient.
- Morphological liaison is not possible before a consonant:

  (33) C#_C *magnifiques chênes* 'magnificent oaks'
  [maɲifik#ʃɛn]/*[maɲifikz̲#ʃɛn]

- Blocking of liaison in this case is motivated by AUDIBLEMORPHEME (a morphological version of Steriade's Licensing by cue):

  (34) AUDIBLEMORPHEME
  Assign one penalty if a morpheme is expressed overtly but is perceptually weak.
  (A consonant lacking release transitions is perceptually weak.)

Note

- Similar to the Morin's usage-based analysis of prevocalic liaison, but with a morphological interpretation.

OT analysis

- Constraints:

(35) REALIZEMORPHEME (Kurisu, 2001)
Assign one penalty for each morpheme that is not expressed overtly.

(36) AUDIBLEMORPHEME
Assign one penalty if a morpheme is expressed overtly but is perceptually weak.
(A consonant lacking release transitions is perceptually weak.)

- OT analysis:

	Input		Candidates	AUDIBLE MORPHEME	REALIZE MORPHEME	*VV	USECITA-TIONFORM
a.	*grand arbre* 'big tree'		[gʁɑ̃$_1$aʁbʁ]			1!	
	/{gʁɑ̃$_1$, gʁɑ̃t$_2$}#aʁbʁ/	☞	[gʁɑ̃t$_2$aʁbʁ]				1
b.	*grand chêne* 'big oak'	☞	[gʁɑ̃$_1$ʃɛn]				
	/{gʁɑ̃$_1$, gʁɑ̃t$_2$}#ʃɛn/		[gʁɑ̃t$_2$ʃɛn]				1!
c.	*magnifiques arbres* (plur)		[maɲifik$_1$aʁbʁ]		1!		
	/maɲifik-{∅$_1$, z$_2$}#aʁbʁ/	☞	[maɲifikz$_2$aʁbʁ]				1
d.	*beaux chênes* (plur)	☞	[bo$_1$ʃɛn]		1		
	/bo-{∅$_1$, z$_2$}#ʃɛn/		[boz$_2$ʃɛn]	1!			1

Table: OT ANALYSIS OF THE PHONOLOGICAL AND MORPHOLOGICAL CONDITIONING OF LIAISON

A welcome prediction

- In some dialects, liaison is *only* morphologically motivated, e.g. Walloon from Liège (Morin, 2005, p. 17)

  (37) Morphologically motivated liaison (plural)
  dès gros abes 'some big trees'
  [gʁoz#ɔːp]

  (38) No phonologically motivated liaison (hiatus permitted)
  on gros abe 'a big tree'
  [gʁo#ɔːp]

- This pattern can be derived through constraint reranking:

	Input		Candidates	AUDIBLE MORPHEME	REALIZE MORPHEME	USECITA -TIONFORM	*VV
a.	*grand arbre* 'big tree' /{gʁɑ̃$_1$, gʁɑ̃t$_2$}#aʁbʁ/	☞	[gʁɑ̃$_1$aʁbʁ] [gʁɑ̃t$_2$aʁbʁ]			 1!	1
b.	*magnifiques arbres* (plur) /maɲifik-{∅$_1$, z$_2$}#aʁbʁ/	 ☞	[maɲifik$_1$aʁbʁ] [maɲifikz$_2$aʁbʁ]		1!	 1	
c.	*beaux chênes* (plur) /bo-{∅$_1$, z$_2$}#ʃɛn/	☞	[bo$_1$ʃɛn] [boz$_2$ʃɛn]	 1!	1	 1	

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

Liaison and paradigm uniformity

- Two other problematic cases raised by Morin for liaison as hiatus avoidance:

  (39) V_#V (variability with some liaison words)
  dans une heure 'in one hour'
  [dɑ̃z#ynœʁ]/[dɑ̃#ynœʁ]

  (40) V_#C (limited to professional public speakers)
  c'est possible 'it's possible'
  [sɛt#posibl]

- I propose that these cases can be understood as paradigm uniformity (or output-output correspondence) effects in a probabilistic grammar:
  - uniformity with *citation form* for blocking of liaison in hiatus contexts
  - uniformity with *graphic form* for preconsonantal liaison

Uniformity with the citation form

- To get lexically specific blocking of liaison, I propose:
  - lexically indexed paradigm uniformity constraints (see also Zuraw and Hayes 2017)
  - in a probabilistic grammar
- Lexical frequency effects on the rate of liaison can be derived if PU constraints referring to less frequent words have higher weights (Storme, in press[b])
  - $w(\text{USECITATIONFORM}_{\text{DANS}}) > w(\text{USECITATIONFORM}_{\text{UN}})$
- MaxEnt analysis:

	Input	Outputs	*VV w=8.51	USECIT FORM$_{\text{CHEZ}}$ w=7.13	USECIT FORM$_{\text{DANS}}$ w=5.93	USECIT FORM$_{\text{UN}}$ w=0	Harmony	Predicted frequency
a.	*un V* 'an V' /{$\tilde{\varepsilon}_1$, $\tilde{\varepsilon}n_2$}#V/	[$\tilde{\varepsilon}_1$ V] [$\tilde{\varepsilon}n_2$ V]	1			 1	8.51 0	0 1
b.	*dans V* 'in V' /{$d\tilde{a}_1$, $d\tilde{a}z_2$}#V/	[$d\tilde{a}_1$ V] [$d\tilde{a}z_2$ V]	1		 1		8.51 5.93	0.07 0.93
c.	*chez V* 'by V' /{$\int e_1$, $\int ez_2$}#V/	[$\int e_1$ V] [$\int ez_2$ V]	1	 1			8.51 7.13	0.20 0.80

Table: Deriving variable liaison in hiatus contexts through lexical indexation of paradigm uniformity constraints

Uniformity with the graphic form

- Rate of liaison is known to be higher in read speech than in conversational speech (59.4% vs 43.4%; Durand and Lyche 2016, pp. 373–374)
- This has been attributed to an effect of the graphic form of the word on its pronunciation (ibid., pp. 373–374)
  - The liaison consonant is present in the graphic form.
- This effect can be modeled with a paradigm uniformity constraint where the graphic form is the base.

(41) USEGRAPHICFORM
For every word, assign one penalty if its output form does not feature a segment that is present in the corresponding graphic form.

Uniformity with the graphic form

- This analysis predicts two effects:
  - higher rate of liaison in hiatus contexts in read speech than in conversational speech
  - non-phonologically motivated liaison consonants in read speech
- Conversation

	Input	Outputs	*VV w=8.32	USECITATIONFORM w=8.51	USEGRAPH-ICFORM w=0	H	Predicted frequency
a.	*est V* 'is V' /{e_1, et_2}#V/	[e_1V] [et_2V]	1	 1	1	8.32 8.51	0.57 0.43
b.	*est C* 'is C' /{e_1, et_2}#C/	[e_1C] [et_2C]		 1	1	0 8.51	1 0

- Read speech

	Input	Outputs	*VV w=2.56	USECITATIONFORM w=2.34	USEGRAPH-ICFORM w=0.14	H	Predicted frequency
a.	*est V* 'is V' /{e_1, et_2}#V/	[e_1V] [et_2V]	1	 1	1	2.56 2.34	0.41 0.59
b.	*est C* 'is C' /{e_1, et_2}#C/	[e_1C] [et_2C]		 1	1	0.14 2.34	0.9 0.1

General conclusion

- French liaison as a ‘regular’ pattern of suppletive allomorphy, with:
  - phonological optimization (hiatus avoidance)
  - morphological optimization (morpheme realization, paradigm uniformity)
- Debate OT vs. usage-based phonology:
  - unclear how to derive the morpheme structure on liason words under Morin’s usage-based account

*T*hank you!

This work is funded by the Leiden University Fund and by an NWO Open Competition XS grant.

Experimental evidence for the role of paradigm uniformity in the variable realization of liaison

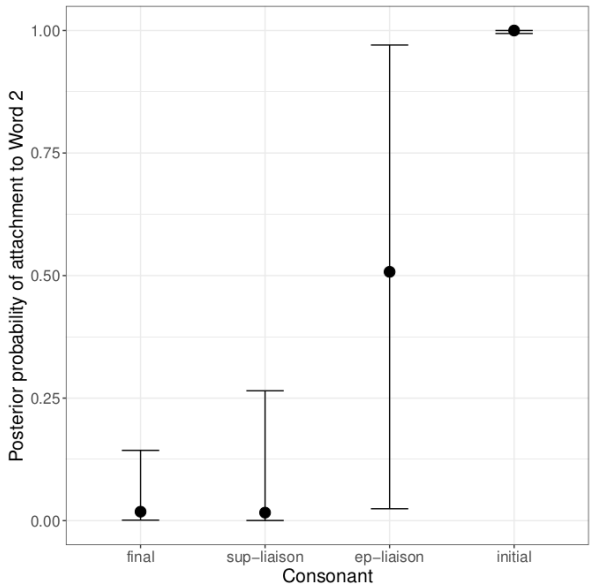


Figure 2: Posterior probability of attachment to Word2 as a function of consonant type (mean and 95% CI)

	Masculine form	Feminine form
'epenthetic' liaison	/gʁɑ̃, gʁɑ̃t/	/gʁɑ̃d/
	/pəti, pətit/	/pətit/
'suppletive' liaison	/bo, bɛl/	/bɛl/

Underlined: form that serves as the base for paradigm uniformity

For suppletive liaison, you prefer to take the feminine form as the base because using the masculine form involves two phonological faithfulness violations: vowel quality + C epenthesis

[

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