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An experimental study of Catalan consonant alternations

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BACKGROUND AND GOALS

(1) The Catalan consonant alternations

- They occur at the right edge of stems.
- Often, the feminine form of a stem, with [-ə], preserves the UR intact, with phonological changes in (unsuffixed) masculine.
- We examine four alternations:

Deletion of /n/	[sa**n**-ə] ~ [sa]	‘healthy fem./masc.’
Deletion of /r/	[du**r**-ə] ~ [du]	‘hard fem./masc.’
Simplification of /nt/	[sa**nt**-ə] ~ [sa**n**]	‘holy fem./masc’
Affrication of /ʒ/	[bɔ**ʒ**-ə] ~ [bɔ**tʃ**]	‘crazy fem.masc.’

(2) Rationale for this work

- Catalan phonology has played an important role in phonological theory, in computational linguistics, and in pedagogy.
- But little work has been done assessing the *productivity* of the various processes.[1]
- By studying this productivity experimentally, we can shed light on a variety of current issues in theoretical phonology.

(3) Roadmap

- Description of the phenomena and their theoretical relevance
- Describe our experiments
- Results, with discussion
- Conclusions and directions for further work

[1] We know only of Jovanovich-Trakál (2021), who, in studying 7-and 8-year-olds, found modest productivity for /n/ deletion in alternations like [klaˈfons] ~ [klaˈfo(n)] ‘wug-pl./sg.’

PHENOMENA

(4) /n/-deletion and /r/-deletion

- /n/ and /r/ are deleted in final position, following very similar patterns.
  - (Not *quite* identical: /r/ deletion also applies before plural [-s] ([du-s] 'hard-masc.pl.')
- Both processes are *lexically specific*: applicability to individual items must be memorized, in some way.
- But the exceptionality is *patterned* (Zuraw 2000): various factors influence deletion rates across the lexicon.
- The patterning is essentially the same for both /n/-deletion and /r/-deletion.
- Here are the aspects of patterning we study:
  - **Penultimately-stressed stems** virtually never undergo deletion (e.g., [əwˈtɔk.tu.**n**ə] ~ [əwˈtɔk.tu**n**] 'autochthonous-fem./masc'; [ˈprɔs.pə.**r**ə] ~ [ˈprɔs.pə**r**] 'prosperous').
  - **Monosyllabic stems**: deletion is more frequent, about half the time ([ˈsa.**n**ə] ~ [ˈsa] 'healthy', but [ˈnɛ.**n**ə] ~ [ˈnɛ**n**] 'child'; [ˈkla.**r**ə] ~ [ˈkla] 'clear', but [ˈpu.**r**ə] ~ [ˈpu**r**] 'pure').
  - **Frequent suffixes**: deletion is exceptionless with *-i(**n**a)* 'related to' and *-do**r**(a)* 'agentive' ([ər.ʒənˈti.**n**ə] ~ [ər.ʒənˈti] 'Argentine', [əd.mi.nis.trəˈdo.**r**ə] ~ [əd.mi.nis.trəˈdo] 'administrator').
  - In all **other cases**, it is *near*-exceptionless ([kə.təˈla.**n**ə] ~ [kə.təˈla] 'Catalan', [sə.ˈgu.**r**ə] ~ [sə.ˈgu] 'safe').

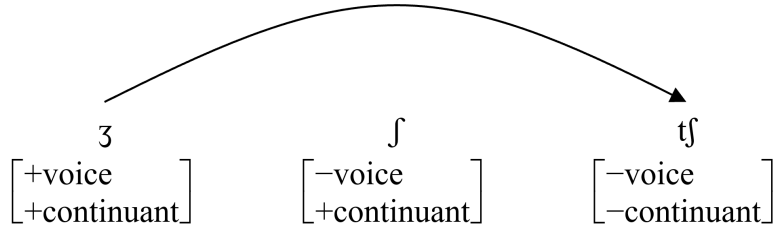
(5) /nt/ cluster simplification

- /t/ is deleted finally after /n/, as in [ˈsan.**t**ə] ~ [ˈsan] 'saint'
- Note that /nt/ cluster simplification and /n/-deletion show *counterfeeding opacity*:
  - Word-final [n] resulting from cluster simplification is never deleted (no cases like [sa**nt**-ə] ~ *[sa])
- Here is an illustration using (for brevity) classical rule-based phonology:

'holy-m.'	'holy-f.'	'healthy-m.'	'healthy-f.'	
/sant/	/sant-ə/	/san/	/san-ə/	URs
—	—	sa	—	*Final /n/ Deletion*: n → ∅ / ___]$_{word}$
san	—	—	—	*Cluster Simplification*: t → ∅ / n ___]$_{word}$
[san]	[santə]	[sa]	[sanə]	SRs

(6) **[ʒ] ~ [tʃ] alternation**

- This is a **saltatory** alternation, in the sense of Hayes and White (2015)
  - All voiced obstruents undergo devoicing in final position.
  - But [ʒ] devoices not to the expected [ʃ] but [tʃ], as in [ˈbɔ.ʒə] ~ [ˈbɔ**t͡ʃ**] 'crazy'.
  - Thus [ʒ] "saltates," jumping over intermediate [ʃ] in arriving at surface [tʃ]:



  - (We can't simply turn final [ʃ] into [tʃ]: final [ʃ] is well-formed, e.g. [ba**ʃ**] 'short').

(7) **The productivity of saltation**

- Hayes and White (2015) consider saltation to be marked, and document cases of diachronic breakdown.
- White's experimental and modeling work (artificial grammar learning) suggests a learning bias against saltation (White, 2014 in adult English-speakers; White & Sundara, 2014 in 12-month-old infants).

(8) **Three research questions**

a) What productive generalizations do learners make from exceptionful data?

- Current work suggest a two-part answer:
  - As a rough approximation (Zuraw 2000 et seq.): when using their grammar productively, language learners *frequency-match the lexicon.*
  - But they *deviate* from frequency-matching due to UG biases. (Becker et al., 2011 in Turkish; Becker et al., 2012 in English; Ernestus & Baayen, 2003 in Dutch; Hayes et al. 2009 in Hungarian)
- Catalan /n/-deletion and /r/-deletion are a good area to study, because they show clear patterns of structured exceptionality.
- How do Catalan speakers' responses differ from the lexical pattern, and why?

b) Can an opaque alternation be productive?

- As shown above in (5), /nt/ cluster simplification interacts opaquely with /n/-deletion.
- Sanders (2003) argues that Polish counterbleeding opacity is not productive and is instead dealt with by memorization.
- What of the opaque pattern in Catalan?

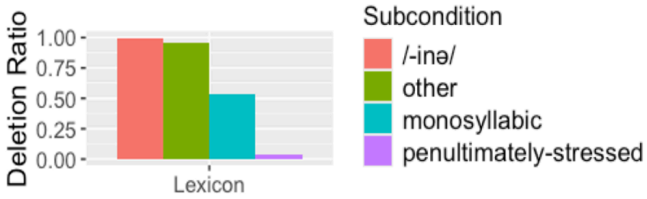
c) *Is the saltatory* [ʒ] ~ [t͡ʃ] *alternation of Catalan productive*?

- Do some speakers commit "saltation repair?"
  - Example: [səˈlɔʃ], instead of [səˈlɔt͡ʃ], for [səˈlɔʒ-ə]

(9) **Evaluating the lexical generalizations quantitatively: our database**

- The above generalizations are carefully covered in the analytical literature, notably Mascaró (1976) and Wheeler (2005).
- We reconfirmed the patterns and assessed them quantitatively by constructing and counting a corpus of 5,761 nominal and adjectival paradigms, compiled from Wiktionary.

Graph: rates of /n/ Deletion for the four environments given above in the lexicon.



- These data will appear in the graphs below as we compare the patterns seen in the wug test with the patterns of the lexicon.

OUR WUG-TEST EXPERIMENT

(10) Strategy

- A classical wug test (Berko, 1958)
- We gave the participants feminine forms, and designed the task to require them to construct the corresponding masculine, thus testing the productivity of the target phonological process.
  - **Experiment 1** (production task): given a feminine form, participants recorded themselves saying aloud the appropriate masculine form.
  - **Experiment 2** (rating task): participants rated the acceptability of two or three potential masculine forms on a scale from 1 to 7. Choices were as in table (13) below.
  - Example: asking for the masculine of [ˈfrun-ə] tests the productivity of /n/-deletion in monosyllables – will they respond with (Expt. 1) or prefer (Expt. 2) [ˈfru] or [ˈfrun]?

(11) Participants

- Adult, native speakers of Central Catalan who spoke Catalan at home and attended elementary school in Catalan.
- Participants who failed the pre-experiment training trials or control trials with real words were excluded.
- They participated remotely and they were compensated with a $15 electronic gift card.
- Participant count:
  - Experiment 1 (production task): **37** (+ 6 exclusions)
  - Experiment 2 (rating task): **37** (+14 exclusions)

(12) Materials

- We employed 100 different feminine wug forms, such as [səˈða.n-ə], for this study; any one participant saw a balanced selection of 20.
- In designing the wug forms we sought to achieve:
  - **Phonotactic acceptability** (wugs sound natural to a native speaker)
  - **Novelty** (wugs and their inflected forms were not real words of Catalan)
  - **Variegation:** they contained a wide range of distinct consonants and vowels.

(13) Sample wug forms

- There were 4 conditions and 10 subconditions as exemplified in the table below.
- The table entries correspond directly to the phonological phenomena and environments described earlier.
- Comment on possible outcomes for the masculine form:
  - First outcome: process applies
  - Second outcome: process does not apply

Condition	*Subcondition*	*Feminine form (presented to participants)*	*Anticipated masculine responses*
/n/-deletion	frequent affix /-inə/	[bəlunˈtrin-ə]	[bəlunˈtri], [bəlunˈtrin]
	monosyllabic	[ˈfrun-ə]	[ˈfru], [ˈfrun]
	penultimately-stressed	[ˈdɔstun-ə]	[ˈdɔstu], [ˈdɔstun]
	other	[gəˈmɛn-ə]	[gəˈmɛ], [gəˈmɛn]
/r/-deletion	frequent affix /-dorə/	[gruəˈdor-ə]	[gruəˈdo], [gruəˈdor]
	monosyllabic	[ˈlɛr-ə]	[ˈlɛ], [ˈlɛr]
	penultimately-stressed	[ˈsɔlir-ə]	[ˈsɔli], [ˈsɔlir]
	other	[kəˈnar-ə]	[kəˈna], [kəˈnar]
/nt/ final cluster reduction (opacity)	—	[mirbunt-ə]	[mirbun], [mirbunt], [mirbu] (feeding order)
/ʒ/ final obstruent devoicing (saltation)	—	[səˈlɔʒ-ə]	[səˈlɔt͡ʃ], [səˈlɔʃ] (final devoicing only)

(14) Frame paragraphs

- The feminine wug items were first presented once in isolation, and then embedded in frame paragraphs read by a female native speaker.
- Sample paragraph:

  WUG-fem.

  Una obra __WUG-fem__ era una peça d'art on s'havien aplicat tècniques mixtes amb ornaments de metalls i pedres precioses. Al segle XV, un artista català va crear la primera escultura ____, feta de marbre, pedres precioses, i or. El primer quadre ___ no es va crear a Espanya fins al segle XVII.

  'A ____ work was a work of art where they applied mixed media with precious metals and stone ornaments. In the 15th century, a Catalan artist created the first ___ sculpture, made of marble, precious stones and gold. The first ___ painting was not created in Spain until the 17th century.'

- The frame paragraphs were constructed with the goal of encouraging participants to interpret the stimuli as authentic Catalan words.
- The grammatical context was always one which would force the use of a masculine form of the wug word to fill the pause.

- The paragraphs were recorded such that there was a pause where a response was requested.
- The frames were presented both in spoken form and as text. However, the wugs never appeared in written form.

KEY RESULTS AND THEORETICAL INFERENCES

(15) How we report the findings

- Expt. 1 and Expt 2 yielded very similar results, so we report them together.
- We are not reporting statistical testing in this talk; generally, differences we report here test as significant; please ask us for the written paper to see full details.

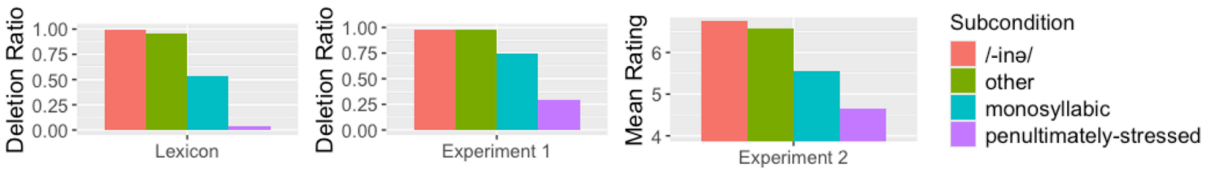
(16) General findings

- All of the processes we investigated were productive at least to some degree.
- In detail, the findings shed light on various theoretical questions.

(17) Frequency-matching in /n/-deletion

- We obtained clear evidence of frequency-matching (Zuraw 2000, Ernestus & Baayen 2003) for both experiments:

Graph: /n/-deletion in the lexicon, Experiment 1 (production), and Experiment 2 (ratings)

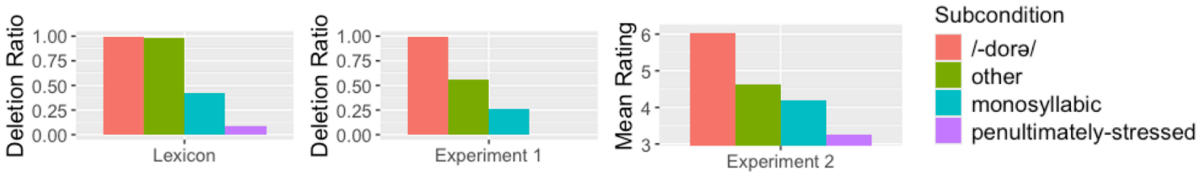


  - Experiment 1: Across four environments, the environments where /n/-deletion applies most often in the lexicon match the environments where speakers most often applied /n/-deletion: *frequent affix* > *other* > *monosyllabic stems* > *penultimately-stressed stems*
  - Experiment 2 (ratings): Same pattern (most to least acceptable)
  - *Not* "dialect mix": although there were participants who consistently deleted and others who consistently produced /n/ or /r/, most participants provided both types of answers (ditto for all other phenomena).

(18) Participants also frequency-matched for /r/-deletion

- The four contexts for /r/-deletion have similar *relative* frequencies in the lexicon and experiments.

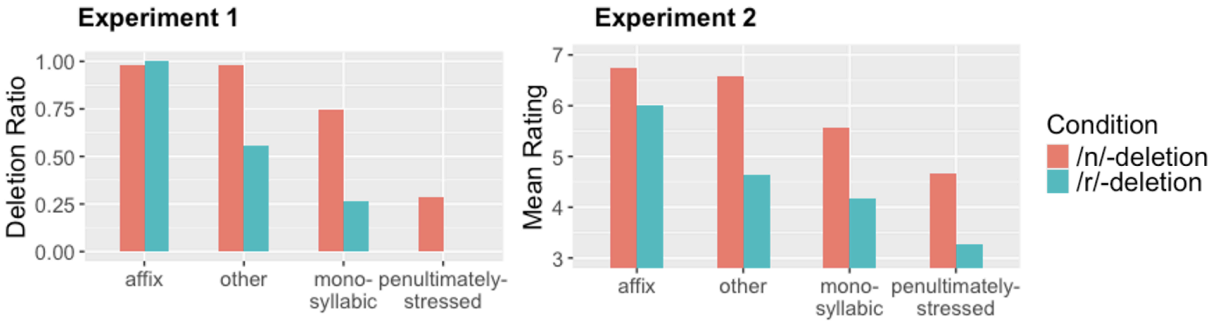
Graph: /r/-deletion in the lexicon, Experiment 1 (production), and Experiment 2 (ratings)



(19) A frequency-matching puzzle: why does /n/ delete far more often than /r/?

- [n]-deletion closely matched the lexical frequencies.
- But [r]-deletion matched only in *relative* terms:
  - Speakers consistently disfavored [r] deletion, relative to the lexical pattern

Graph: /n/- and /r/-deletion in Experiment 1 (production) and Experiment 2 (ratings)



(20) Why the /n/ - /r/ difference? Hypothesis I: dialect variation

- Speakers of Central Catalan encounter speakers of another major dialect, Valencian, which lacks /r/-deletion.
- /n/-deletion is pan-dialectal.
- For dialectology, see Wheeler (2005).

(21) Why the /n/ - /r/ difference? Hypothesis II: orthographic influence

- Previous work argues that phonological intuitions are often influenced by orthography (see Kawahara, 2018; Daland, Oh & Kim, 2015).
- In Catalan orthography, /n/-deletion is spelled out:
  - [ˈsan-ə] ~ [ˈsa] is spelled *sana* ~ *sa*
- /r/-deletion is not spelled out:

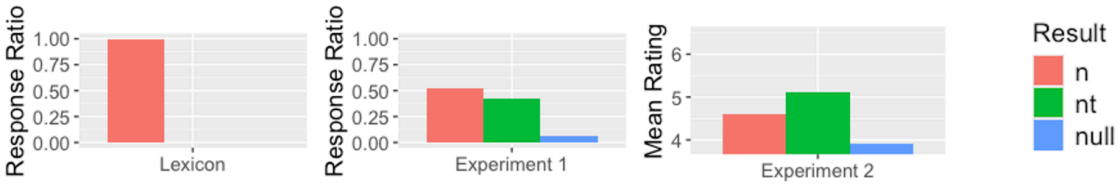
- [ˈklar-ə] ~ [ˈkla] is spelled *clara* ~ *clar*

- Rough idea: Our participants may have been constructing appropriate orthographic representations for what they heard, preferring to pronounce these representations faithfully.
- We are exploring models that could express and incorporate this influence on participant responses.

(22) /nt/ Cluster Simplification

- Despite this process being exceptionless in the lexicon, 42% of the responses in Experiment 1 had final [nt].
- Such forms were also rated higher than expected, better than forms undergoing cluster simplification.

Graph: /nt/ cluster simplification in the lexicon, Expt. 1 (production), and Expt. 2 (ratings)



- We conjecture three possibilities:
  - Exposure to other languages or other dialects of Catalan that allow final [nt] (e.g., Wheeler, 2005:221) weakens the native-language phonotactic constraint banning final [nt].
  - Orthographic influence, as above: /nt/ cluster simplification is *not* spelled out, e.g. [san] 'saint-masc.' is spelled *sant*.
  - Opacity repair: see immediately below.

(23) Results for opacity (/nt/ cluster simplification and /n/ deletion)

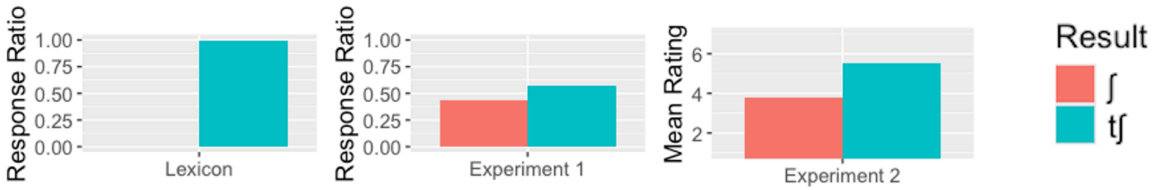
- We examined a subset of the data, in which usable responses were given for both /nt/ cluster simplification and /n/-deletion.
- This examination suggests that *counterfeeding opacity can be quite productive*: two thirds of the response patterns[2] are like [gəˈmɛn-ə] → [gəˈmɛ], [mirbuntə] → [mirbun].
- Of the remaining third, virtually all were of the type [gəˈmɛn-ə] → [gəˈmɛ], [mirbuntə] → [mirbunt]

[2] Participants received two wug words for each subcondition; where their responses treated both pairs identically, we counted the data as two response patterns.

- Opacity-related? – if you don't apply /nt/ deletion, the resulting output keeps /n/-deletion transparent.

(24) The saltatory [ʒ] ~ [tʃ] alternation

Graph: [ʒ] ~ [tʃ] *alternation in the lexicon, Expt. 1 (production), and Expt. 2 (ratings)*



- Many speakers produced forms that repaired saltation (e.g., [ʎudaʒə] → [ʎudaʃ]) and rated such forms highly.
- These saltation repairs have [ʃ], not [ʒ], because Final Devoicing remains a powerful phonotactic principle.
- Lexical basis: Forms with [ʒ] ~ [ʃ] are *not attested* in the lexicon, nor in any other dialect of Catalan.
- White (2014) and Hayes & White (2015) argue that saltation is a form of "unnatural phonology," liable to repair – we may be seeing such a case here.

SUMMARY OF FINDINGS

(25) Tentative answers to our research questions (8a-c)

- Catalan speakers generally:
  - **frequency-match the lexicon**, with deviations resulting perhaps from orthography or dialect difference
  - **can manage opacity**: Many participants gave the /nt/ → [n], /n/ → ∅ pattern.
  - **tend to repair saltation**

Moltes gràcies!

(26) Thanks to …

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References

Becker, M., Ketrez, N., & Nevins, A. (2011). The surfeit of the stimulus: Analytic biases filter lexical statistics in Turkish laryngeal alternations. *Language*, 84-125.

Becker, M., Nevins, A., & Levine, J. (2012). Asymmetries in generalizing alternations to and from initial syllables. *Language, 88*(2), 231–268.

Berko, J. (1958). The child's learning of English morphology. *Word, 14*(2-3), 150-177.

Daland, R., Oh, M., & Kim, S. (2015). When in doubt, read the instructions: Orthographic effects in loanword adaptation. *Lingua, 159*, 70-92.

Do, Y. (2018). Paradigm uniformity bias in the learning of Korean verbal inflections. *Phonology, 35*(4), 547–575.

Ernestus, M., & Baayen, R. H. (2003). Predicting the Unpredictable: Interpreting Neutralized Segments in Dutch. *Language, 79*(1), 5–38.

Hayes, Bruce, Kie Zuraw, Peter Siptar, and Zsuzsa Londe (2009). Natural and unnatural constraints in Hungarian vowel harmony. *Language* 85: 822-863.

Hayes, B., & White, J. (2015). Saltation and the P-map. *Phonology, 32*(2), 267–302.

Kawahara, S. (2018). Phonology and orthography: The orthographic characterization of rendaku and Lyman's Law. *Glossa, 3*(1).

Kiparsky, Paul (1971). Historical linguistics. In Dingwall, William O. (ed.), *A Survey of Linguistic Science*. College Park: University of Maryland, 576-649.

Mascaró, J. (1976). *Catalan phonology and the phonological cycle*. [Doctoral dissertation, Massachusetts Institute of Technology].

Sanders, N. (2003). *Opacity and sound change in the Polish lexicon*. [Doctoral dissertation, University of California, Santa Cruz].

Wheeler, M. W. (2005). *The phonology of Catalan*. Oxford University Press.

White, J. (2014). Evidence for a learning bias against saltatory phonological alternations. *Cognition, 130*(1), 96–115.

White, J., & Sundara, M. (2014). Biased generalization of newly learned phonological alternations by 12-month-old infants. *Cognition, 133*(1), 85–90.

Zuraw, K. R. (2000). *Patterned exceptions in phonology*. [Doctoral dissertation, University of California, Los Angeles].