On the role of morphology, syllable structure, frequency and spelling in English vowel reduction

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Background

VOWEL REDUCTION IN ENGLISH

In English, many vowels reduce when unstressed:

atom /ˈætəm/ vs. *atomic* /əˈtɒmɪk/

fatal /ˈfeɪtəl/ vs. *fatality* /fəˈtælɪti/

eponymous /ɪˈpɒnɪməs/ (cf. *eponym* /ˈepənɪm/)

We take reduced vowels (/ə/, /i/, /ɪ/, /ʊ/ or /u/) to be defined as in Cruttenden (2014 : 158): "these are the short vowels with a central or centralised quality (apart from final /i/) and are the least prominent syllables."

However, reduction is not systematic: some words have full vowels in unstressed positions:

relaxation /ˌriːlækˈseɪʃən/ *dynamic* /daɪˈnæmɪk/

A number of different factors have been claimed to influence vowel reduction.

POTENTIAL FACTORS

- **Syllable structure:** vowels in open syllables are more likely to reduce than vowels in closed syllables (Burzio 1994: 113; Fudge 1984; Halle & Keyser 1971)
- **Nature of the coda:** vowels in syllables closed by obstruents are less likely to reduce than vowels closed by sonorants (Pater 2000) & vowels in syllables closed by non-coronals are less likely to reduce than vowels closed by coronals (Burzio 1994; Dahak 2011; Fudge 1984; Ross 1972).
- **Prefixation:** initial pretonic closed syllables normally do not reduce except if that syllable is a semantically opaque prefix (Chomsky & Halle 1968: 118; Guierre 1979: 253; Libermann & Prince 1977; Pater 2000; Selkirk 1980).
- **Spelling:** vowels spelled with a digraph reduce less than monographs, especially in the initial pretonic position (Dahak 2011; Deschamps et al. 2004: 217).
- **Word frequency:** More frequent words show more reduction than less frequent words (Fidelholtz 1975).
- **Existence of a base:** the existence of a morphological base in which the vowel is stressed can diminish its chances to reduce (Chomsky & Halle 1968: 112, e.g. *relax → rèlaxation*, *expréss → èxpressívity*), even more so if that base is more frequent than the derivative (Bermúdez-Otero 2012: 32, after Krazka-Szlenk 2007: § 8.1.2).

PROBLEM

No large-scale empirical evaluation of these factors and their interactions has been conducted.

AIMS

- Conduct a large-scale investigation of these factors using dictionary data, which may then be used as a reference point for later studies using speech data.
- Two positions are considered:
  - Initial pretonic (e.g. *arríve*)
  - intertonic (e.g. *rèlaxátion*)
- Draw some of the theoretical consequences of the results.

Methodology

THE DATA

Two datasets have been used:

- **Initial pretonic position:** Data from Jones (2006). Extraction of all words with no stress on their first syllable. Once proper names have been excluded, the full dataset contains 9432 words.
- **Intertonic position:** data from Wells (2008), taken from the datasets of Dabouis (2016). Two datasets were used: monomorphemic words & bound roots + suffix, and derived words with a base stressed on its second syllable.

Our study focuses on monomorphemic words & bound roots + suffix and stress-shifted derivatives for both datasets AND prefixed words for the initial pretonic position.

Only British pronunciations are considered.

Not included in the analyses:

- Words with uninterpretable vowels: <i> realized /ɪ/, <u> realized /ʊ/. /ə(ʊ)/ is treated as Full ~ Reduced.
- Intertonic position: words whose second syllable is part of a historical prefix (e.g. *recollect, supersede*)
- Derivational pairs with a different spelling of the vowel (e.g. *revéal → revélation*)
- Neoclassical roots

Vowels followed by <rC> are treated separately because it is not clear whether they should be analysed as representing underlying /Vː/ or /Vr/.

CODING

Based on the proposals found in the literature, the following variables were coded:

- **SYLLSTRUCTURE**: syllables are coded as OPEN, CLOSED or S (when the vowel is followed by /sC/).
- **CODA-PLACE**: Codas were coded as CORONAL or NON-CORONAL.
- **CODA-MANNER**: Codas were coded as OBSTRUENT or SONORANT.
- **LOGFREQUENCY**: token frequency taken from SUBTLEX-UK (Van Heuven et al. 2014), which was log-transformed so as to resemble the way "humans process frequency information" (Hay & Baayen 2002).
- **SPELLING**: vowels were coded as MONOGRAPH or DIGRAPH.
- **MORPHOLOGY**: presence of a semantically opaque prefix (PREFIXED vs. NONPREFIXED)
- **SEMANTICTRANSPARENCY**: Items for which the base appears explicitly in the definition of the derivative in a general dictionary (Dictionary.com) were coded as TRANSPARENT. Others were coded as OPAQUE – Derivatives only.

The dependent variable is **VOWELREDUCTION**, coded using a four-point scale (Full, Full ~ Reduced, Reduced ~ Full, Reduced).

Results: Monorphemic words and bound roots + suffix (n = 1120 & 454)

Global results

Logistic regression was conducted and three parameters were found to have a significant effect on reduction.

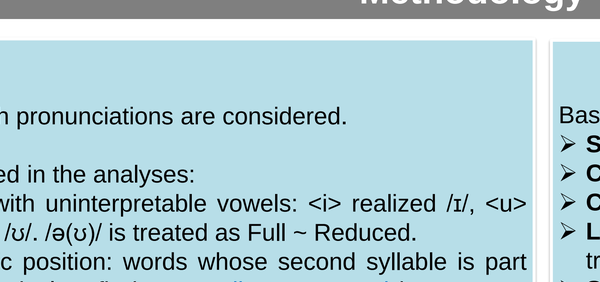
Reduction is more likely if:

- The vowel is spelled with a monograph (e.g. *ácademy, àvocádo*)
- The syllable is open (e.g. *fiáncee, kàngaróo*)
- The word has a high frequency.

	Initial pretonic				Intertonic			
	95% C.I.			p-value	95% C.I.			p-value
	Lower	OR	Higher		Lower	OR	Higher	
SPELLING-MONO	3.41	4.59	6.19	<2 e-16	1.48	2.00	2.70	9.18 e-06
SYLLSTR-OPEN	4.76	5.74	6.93	< 2 e-16	1.79	2.30	2.94	1.21 e-10
SYLLSTR-SC	1.83	2.59	3.67	1.14 e-08	1.05	1.74	2.87	0.031728
LOGFQ	1.06	1.08	1.11	1.69 e-09	1.02	1.05	1.08	0.000892

Spelling

The effect of spelling can be observed in both positions, even though reduction is a lot more common in the intertonic position.



Examples:

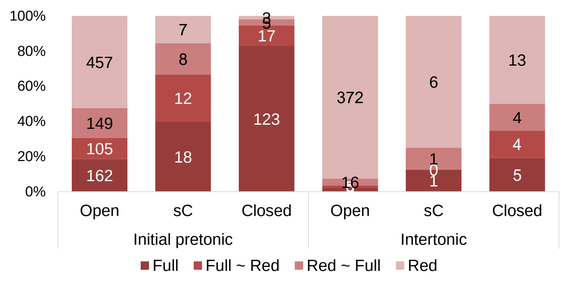
Monographs: *àborígine, legítimize, umbrélla*

Digraphs: *àmaurósis, authéntic, limousíne*

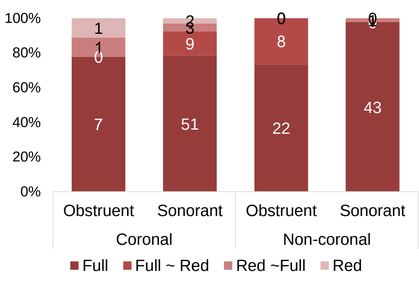
Syllable structure

In both positions, there is a clear effect of syllable structure.

Vowels followed by /sC/ (e.g. *estáte, bàlustráde*) constitute an intermediate class, probably due to the problematic syllabification of /s/.



The effect of the nature of the coda is weakly significant in the initial pretonic position only.



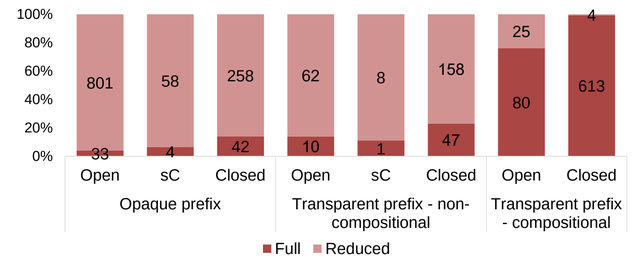
Results: Prefixed words and stress-shifted derivatives

Prefixation (n = 2204)

In words that are not suffixal derivatives, we distinguished three categories of prefixed words:

- Opaque (e.g. *accede, betray, collect, promote, receive*)
- Transparent prefix – non-compositional (e.g. *cohabit, deflate, enable, exterior, revive*)
- Transparent prefix – compositional (e.g. *abnormal, co-author, decentralize, reactivate*)

Only the main pronunciation is considered here.



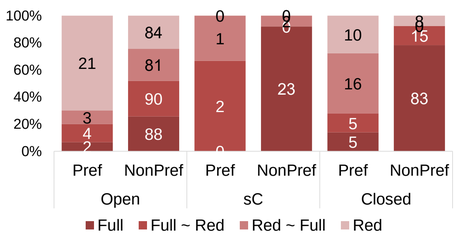
Clear difference between compositional and non-compositional structures.

Stress-shifted derivatives (n = 565 & 179)

Logistic regression revealed significant effects for the following variables:

	Initial pretonic				Intertonic			
	95% C.I.			p-value	95% C.I.			p-value
	Lower	OR	Higher		Lower	OR	Higher	
SPELLING-MONO	1.80	2.70	4.06	2.29 e-06	1.21	2.65	5.77	0.01545
SYLLABLE-OPEN	2.23	2.73	3.33	< 2 e-16	2.75	3.75	5.11	1.8 e-14
SYLLABLE-SC	0.56	0.84	1.25	0.386	0.44	0.80	1.46	0.47611
LOGFQ_DERIVATIVE	1.04	1.08	1.11	< 2 e-16	1.03	1.08	1.14	0.00331
MORPH-PREF	2.58	3.35	4.36	2.89 e-06				

As could be expected, prefixed derivatives display more reduction (only monographs are shown below):



Compare:

rémedy → r/ə/médial

áspect → /ə ~ æ/spéctual

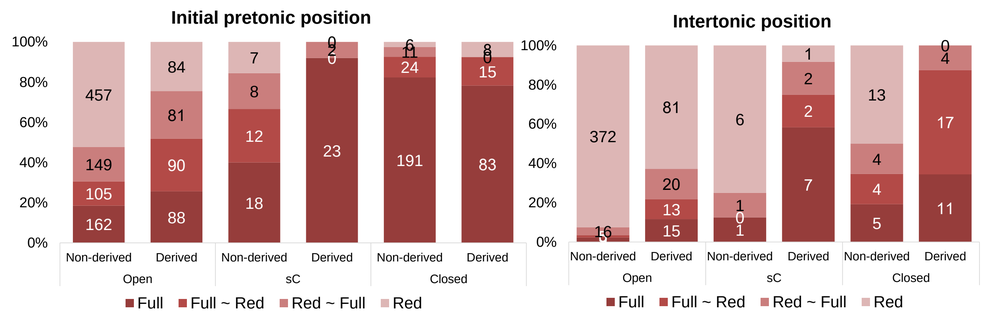
cóncept → c/ə/ncéptual

vítal → v/aɪ/tálity

hóstile → h/ɒ/stílity

táctic → t/æ/ctícian

Reduction in derived and non-derived items (non-prefixed, monographs only)

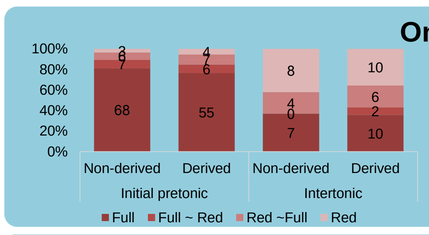


The difference between derived and non-derived words is clear in all configurations except in closed initial pretonic syllables, where the vast majority of vowels do not reduce.

Interestingly enough, vowels followed by /sC/ behave in a way that is comparable to that of vowels in closed syllables in derivatives, but not in non-derived words.

Discussion

On monographs followed by <rC>



In non-derived words, the behaviour of vowels followed by <rC> resembles that of vowels in closed syllables and/or that of digraphs.

In derivatives, there is more reduction in the intertonic than for vowels in closed syllables.

On semantically opaque prefixes

The results confirm the long-standing assumption that such prefixes have a distinct behaviour and supports analyses that refuse to see words that contain them as morphological simplexes.

On preservation effects

The importance of morphological relationships is found to extend to reduction, although no effects of segmentability (through relative frequency and semantic transparency) can clearly be confirmed.

So, what determines vowel reduction in English?

The results confirm the importance of position, syllable structure, spelling, morphology and absolute frequency.

However, there is only weak evidence for segmentability factors and the nature of coda consonants.

Other factors may still need to be considered ("Arab Rule" weight interactions, foreignness, vowel-specific behaviours, etc.) to reach a comprehensive understanding of English vowel reduction.

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