The pronunciation of vowels with secondary stress in English

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RESUME

Peu d'études se sont concentrées sur la prononciation des voyelles sous accent secondaire en anglais. Dans le cadre de l'approche introduite par Guierre (1979), cet article propose une étude empirique large de ces voyelles et se concentre sur trois catégories clés de mots : les mots non-dérivés, les constructions contenant un préfixe sémantiquement transparent et les dérivés suffixaux. Dans leur ensemble, les analyses précédentes fondées sur le rang, les domaines phonologiques et l'isomorphisme dérivationnel sont confirmées mais certains phénomènes mis à jour par cette étude rendent nécessaires quelques révisions des modèles existants. Plusieurs possibilités de formalisations sont proposées pour ces révisions, dont la plus prometteuse semble être l'analyse (ici de nature exploratoire) ayant recours aux pieds car celle-ci permettrait d'élargir considérablement la couverture empirique de la théorie.

ABSTRACT

There are few studies which have focused on the pronunciation of vowels with secondary stress in English. Within the framework introduced by Guierre (1979), this paper offers a large empirical study of these vowels and focuses on three key categories of words: non-derived words, constructions containing a semantically transparent prefix and suffixal derivatives. Overall, previous analyses based on rank, phonological domains and derivational isomorphism are confirmed but certain phenomena unveiled by this study require a few revisions of existing models. Several possible formalisation options are proposed to implement these revisions. The most promising seems to be the (here, exploratory) analysis using feet because it could considerably broaden the empirical coverage of the theory.

Key words: English, secondary stress, phonology, reading grammar, graphophonology

1. Introduction

Research on the pronunciation of vowels has often focused on vowels with primary stress. Vowels with secondary stress have rarely been the object of specific studies. After introducing the general framework adopted here and the proposals that have been put forward in the literature (§2), I will establish the aims of this paper (§3). Then, I will present the methodology used for the study of vowels with secondary stress here (§4) before detailing the results and their interpretation (§5).

2. Theoretical background

2.1. General framework

The framework adopted here is that introduced by Guierre (1979) and later developed, among others, by Fournier (1998, 2007, 2010), Deschamps (1994), Duchet (2018) and Trevian (2003). This approach aims to account for two main phenomena: stress placement and spelling-to-sound rules. Here, I shall be interested in the latter. The approach can be characterised by several theoretical assumptions: the fact that spelling (Dabouis in preparation) or certain types of morphological structures (Dabouis 2017a; Fournier 1996) can be relevant to phonology, or the fact that there are more than a single phonology in English (Dabouis 2016: §3.5; Fournier 2007). It is also characterised by the methodology used to study the (grapho)phonological system in English. Where most generative works in phonology are based on samples whose origin or representativeness are seldom discussed, works conducted in the Guierrian tradition have always used large corpora, most often taken from pronunciation dictionaries.

Following the British tradition, three levels of stress are acknowledged. They are listed in (1) along with the way they will be represented throughout this paper.

[Tapez ici]

(1)   Primary stress   /1/,   σ́   or   [']
       Secondary stress   /2/,   σ̀   or   [ˌ]
       No stress   /0/,   σ   or   []

The next section introduces the system of correspondences between the orthographic form and the phonological form developed in that framework.

2.2. Vowel values

When we analyse the spelling-to-sound correspondences for vowels, we observe that stressed vowels can usually have four different "values". For example, <a> can be realised as [æ] (e.g. *fat*), [eɪ] (*fate*), [ɑː] (*far*) or [eə] (*fare*). The whole table of correspondences is shown in Table 1.

V̆ʳ	V̆	**Monographs**	V̄	V̄ʳ	**Digraphs**
r vowel	checked vowel	**<V>**	free vowel	r-coloured free vowel	**<V̄V̄>**
[ɑː]	[æ]	<a>	[eɪ]	[eə]	<ai, ay / ei, ey>
[ɜː]	[e]	<e>	[iː]	[ɪə]	<ea, ee / ie**>
[ɜː]	[ɪ]	<i>	[aɪ]	[aɪə]	<ie*, ye>
[ɔː]	[ɒ]	<o>	[əʊ]	[ɔː]	<oa**, oe*>
[ɜː]	[ʌ (ʊ)]	<u>	[(j)uː]	[(j)ʊə]	<e(a)u, ew/ ue*>
			[ɔː]	[ɔː]	<au, aw>
			[uː]	[ɔː]	<oo>
			[ɔɪ]		<oi, oy>
			[aʊ]	[ɔː (aʊə)]	<ou, ow>

*: final **: non-final

Table 1. Table of correspondences for vowels (taken from Fournier (2010: 98))

This table actually contains two tables: one for monographs and one for digraphs. Monographs normally have four different values: r, checked, free and r-coloured free, while digraphs only have two: free and r-coloured free. Some of the vowels being shared between monographs and digraphs, both tables can be represented together by merging the overlapping parts of each table.

Note that these correspondences may not hold in the case of foreign words, where the principle of articulatory proximity with the vowels of the source languages sometimes overrides that of graphic analogy (Tournier 1993: 149). The main three foreign free vowels (represented as V̄ᵉ) are shown in Table 2.[1] Note that <o> and <u> are not realized differently in foreign vocabulary. However, a few words with <o> are realised as V̄s in contexts where V̆s are expected, which could be explained by the fact that they are foreign words (see §5.1.3 below).

V̄ᵉ	
<a>	[ɑː]
<e>	[eɪ]
<i>	[iː]

Table 2. The main foreign free vowels

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[1] Other foreign vowels include:
  ➤ French: <ou> → [uː/ʊə]: *bijou, courgette;* <eu> → [ɜː]: *danseur/danseuse;* <(e)au> → [əʊ]: *auberge, chateau;* <oi, oy> → [wɑː]: *boudoir;* <é(e), ê, è> → [eɪ/eə]: *negligée, déjà vu.*
  ➤ "Classical": <ae, oe> → [iː]: *Caesar, foetus;* <aa> → [ɑː]: *bazaar.*

A number of rules can be used in order to determine which value should be used for a given stressed vowel. First, I will introduce the rules which have been proposed for vowels with primary stress before turning to those with secondary stress in the next section. These rules refer mainly to the spelling of the stressed vowel, to its right-hand context and to its rank. The presentation given here follows that of Fournier (1997, 2010). In this approach, the rules are hierarchically ordered, and the general organisation of these rules represents the hierarchy of the parameters which determine vowel values. The first of these rules deals with vowel digraphs (represented as $\overline{VV}$) and it states that if the vowel is a digraph, then it should be a free vowel. The fact that it is the first rule means that the value "digraph" for the parameter "nature of the vowel" dominates all the other parameter. The vowel will normally be free, even in contexts in which monographs are normally checked. This also means that, at this point, all the words in the lexicon with a digraph have been accounted for (apart from the few exceptions; e.g. *head, look, cough*) and that all the remaining words have a monograph. Therefore, the value "monograph" for the parameter "nature of the vowel" is neutral in the sense that it is not associated to a fixed vowel value and that it is necessary to use other parameters to determine which vowel value should be used.

The hierarchical organisation of rules is determined through the analysis of relevant cases, i.e. words which fit the structural conditions for the application of two contradictory rules. For example, one of the later rule is the "C_2"[2] rule, which holds that a vowel followed by two consonants should be checked (e.g. *nest, custom, mystery*). Digraphs followed by two consonants (e.g. *augment, feast, boost*) are therefore relevant cases to determine the hierarchy between the rule $\overline{VV} \rightarrow \overline{V}$ and the rule $C_2 \rightarrow \breve{V}$. The fact that these words all have free vowels shows that the former dominates the latter. Sometimes, such an analysis cannot be conducted because the rules are not contradictory, i.e. they predict the same value. For examples, it would be difficult to say whether words such as *agnóstic, eccéntric, sadístic* obey the $C_2 \rightarrow \breve{V}$ or the -ic(s)# $\rightarrow \breve{V}$ rule[3], as both yield checked vowels. The answer lies in transitivity, i.e. if A>B and B>C, then A>C. It can be shown that the rule u $\rightarrow \overline{V}$ is dominated by $C_2 \rightarrow \breve{V}$, as words with <u> followed by C_2 have checked vowels (e.g. *butter, function, mustard*) but that this rule dominates -ic(s)# $\rightarrow \breve{V}$, as words in <-uCic(s)#> have free vowels (e.g. *cubic, mercuric, music*). Therefore, through transitivity, we can assert that $C_2 \rightarrow \breve{V}$ dominates -ic(s)# $\rightarrow \breve{V}$.[4]

The rules are divided into two groups. The first group of rules deals with the stressed syllable and is shown in (2).

(2) $\overline{VV} \rightarrow \overline{V}$ e.g. *óut, wáy, néed, hóuse, méan, fóod…*
  $C^0 \rightarrow \overline{V}$ e.g. *bé, mé, só, whý, scíence, muséum…*
  rC/r# $\rightarrow \overset{r}{\breve{V}}$ e.g. *párt, túrn, pérson / fár, prefér, guitár…*
  C_2/C# $\rightarrow \breve{V}$ e.g. *thínk, néxt, stíll, sórry / lót, mán, untíl…*

The second group of rules deals with the broader context of the stressed syllable (́VCV) and is shown in (3).[5]

(3) u $\rightarrow \overline{V}$ e.g. *úse, Júlia, dúring, húman…*
  -V# $\rightarrow \overline{V}$ e.g. *hére, táke, quíte, níce, hálo, dáta…*
  -ic(s)# $\rightarrow \breve{V}$ e.g. *mágic, specífic, histíric, económic…*

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[2] "C" refers to any consonant, a subscript figure means "at least" and a superscript figure means "at the most". Therefore, C_2 means "at least two consonants" (= two or more consonants) and C^0 means "at the most zero consonants" (= no consonants).
[3] # refers to a word boundary.
[4] Fournier (2010: 141) represents the hierarchical organisation of rules using a form of decision tree.
[5] There are also a few minor rules which have to do with disyllables only which are irrelevant here and therefore will not be discussed (but see Deschamps (1994: Ch. 10)).

-{i,e}+C(C$_0$(e))# if 'V ≠ <i,y> ("CiV Tensing"[6]) → V̄   e.g. *média, Victória, périod…*
At least antepenultimate ("Luick's rule"[7]) → V̆   e.g. *fámily, évidence, América…*
Penultimate → V̄   e.g. *Octóber, mediéval, volcáno…*

After all these rules have applied, there is a "second step" rule which turns V̄s into V̄ʳs whenever they are followed by <r>. Let us now turn to the proposals which have been made for vowels with secondary stress.

2.3. Vowels with secondary stress

In this section, I will review the claims that have been made for the pronunciation of vowels with secondary stress and I will focus on three types of morphological structures:

➢ Words with no morphological structure or made up of a bound root and (an) affix(es), which I will call "non-derived" words for simplicity (§2.3.1);
➢ Words with semantically transparent prefixes (§2.3.2);
➢ Words made up of a free stem and a stress-shifting suffix (§2.3.3).

2.3.1. Non-derived words

Guierre (1979) and Fournier (1994) propose slightly different analyses of the rules regulating the value of vowels with secondary stress. Both acknowledge that the first group of rules and the rule u → V̄ applies to vowels with secondary stress as it does for those with primary stress, except -r#, -C# and -ic(s)# which crucially refer to the end of the word and are therefore inapplicable. However, their analyses differ when it comes to the remaining rules.

Guierre claims that the pretonic sequence (i.e. all that precedes primary stress) behaves like the end of the word. In other words, the syllable with primary stress would be for the vowel with secondary stress what the end of the word is to the vowel with primary stress. The analyses therefore predict different applications of the rules that refer to the rank of the stressed vowel. For instance, Luick's rule applies to a vowel that is at least antepenultimate. If one considers only the pretonic sequence, that means that Luick's rule should apply only with the /200(-)/[8] pattern, whereas if one counts from the end, it could apply with the /(-)201(-)/ pattern. As Fournier applies the rules to vowels with secondary stress in a similar fashion as to vowels with primary stress, that means that the rule of the penultimate cannot apply, as vowels with secondary stress are not normally found in the penultimate syllable. As a consequence, his analysis predicts that Luick's rule will apply to vowels with secondary stress in /#0201(-)/. Finally, Fournier predicts that the CiV rule will apply to words in which the vowel following <i> or <e> is the last of the word (e.g. *comèdiénne*) and that, otherwise, Luick's rule will apply. Guierre predicts the CiV rule will apply regardless of what may follow the sequence of two vowels. The different predictions made by these two analyses are summed up in Table 3.

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[6] The name "CiV Tensing" (or sometimes "CiV Lengthening") is often used in the generative literature and will be used here for convenience because of the complexity of the formulation of the rule.
[7] After Luick (1898), who first described it. This rule is often called Trisyllabic Shortening or Laxing in the generative literature.
[8] (-) refers to optional syllables.

Structure	Guierre (1979)	Fournier (1994)
#201(-)	?	$\breve{V}$ (Luick)
#2001(-)	$\breve{V}$ (Luick)	
#0201(-)	$\overline{V}$ (penultimate)	
(-)σ́{i,e}VC$_0$-	$\overline{V}$ (CiV)	
(-)σ́{i,e}VC$_0$#		$\overline{V}$ (CiV)

Table 3. Values predicted by Guierre (1979) and Fournier (1994) for vowels with secondary stress

2.3.2. Semantically transparent prefixes

This type of prefixes is the one found in compositional prefixed constructions (e.g. *deactivate, ex-actor, redo, subdomain*) but also in a few constructions with bound bases (e.g. *acephalous, decelerate, export*). There is converging evidence that these prefixes have their own phonological domain, unlike semantically opaque prefixes.[9]

First, they can carry secondary stress, regardless of the stress pattern of their base. This can generate stress clashes, which are normally banned domain-internally (e.g. *còáuthor, èxbóyfriend, rèdó*) (J.-M. Fournier 2010: Ch. 1; Guierre 1979: 317; Trevian 2003: 160). Second, they can generate gemination when their final consonant is the same as the first consonant of their base (e.g. *di*[sː]*imilation, i*[lː]*ogical, u*[nː]*atural*) (Ben Hedia & Plag 2017; Cruttenden 2014: 248; Fudge 1984:§6.1; Guierre 1979: 276; Kaye 2005; Oh & Redford 2012; Videau 2013). Third, the position of stress can be different, especially for prefixed constructions of more than two syllables in *-ate*, such as the examples in (4), which are taken from Raffelsiefen (1993: 119).

(4)   *récreate*   "to impart fresh life to"   *rè-creáte*   "to create again"

This difference is significant because verbs in *-ate* have final primary stress if they are disyllabic and antepenultimate stress if they are longer. Therefore, *rè-creáte* really behaves as if *re-* and *create* were independent. Finally, and crucially for this paper, monosyllabic prefixes which end with a vowel usually have a $\overline{V}$. This diverges from the behaviour of vowels in semantically opaque prefixes which normally follow general rules, such as Luick's rule, as will be seen in the next section. The difference between opaque and transparent prefixes can be seen in the examples in (5), which are taken from Raffelsiefen (1993: 118).[10]

(5)   a. *r*[è]*presént* "to serven express or stand for"   b. *r*[iː]*present* "to present again"
            r[è]*colléct* "to recall to mind"   *r*[iː]*colléct* "to collect again"

In the system of rules presented in §2.2, assuming that prefixes have their own phonological domain means that the rule applying in (5b) is $C^0 \rightarrow \overline{V}$, just as it does to word-final vowels (e.g. *so, why, me*).

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[9] In Prosodic Phonology, this domain is called the phonological (or prosodic) word (represented by ω; see Booij & Rubach, 1984 ; Raffelsiefen, 1993, 1999, 2007 ; Szpyra, 1989). Constructions with semantically transparent prefixes can be represented as (co)ω(habit)ω, (pre)ω(cook)ω or (re)ω(align)ω.

[10] Raffelsiefen (1993: 109-111) claims that two other phenomena indicate that prefixes can have their own domain. First, she claims that [h] can only appear in the intertonic position preceding a schwa if the first syllable is a prefix with its own phonological word: cp. *re*[Øə]*bilitate* ('restore to a former state') ~ *re*[hə]*bilitate* ('habilitate again'). However, the facts are not as clear as she claims. As shown by Dabouis (2016: 511-513), the presence of [h] in the rare words with the relevant structure could be attributed to derivational identity with a base (e.g. *in*[hɪ ~ ɪ ~ ə]*bition* ← *in*[hí]*bit*) or to spelling pronunciations (as suggested by Raffelsiefen herself).

Second, she claims that the absence of vowel reduction in the second syllable of words stressed /201(-)/ would indicate that an initial monosyllabic prefix has its own phonological word: cp. *ref*[ə]*mation* ('restoration') ~ *re-f*[ɔː]*mation* ('action of forming again'). However, vowel reduction has not been the object of many empirical studies (but see Dabouis *et al.* 2018; Dahak 2011 and §5.3.3 below) and it seems premature to make this sorts of claim before the roles of segmental structure, word frequency, derivational relationships and prosodic structure have clearly been established empirically.

2.3.3. Suffixed words

According to Fournier (1994), there are two options for words suffixed with stress-shifting suffixes. The value will be identical to that found in the base if the secondary stress in the derivative is on a syllable that is stressed in the base (e.g. *nótable* $\overline{V} \rightarrow$ *nòtabílity* $\overline{V}$). If the base has primary stress on its second syllable and the suffix shifts it to the third syllable, then stress preservation cannot occur.[11] Secondary stress is then placed on the first syllable and the vowel with secondary stress should obey the same rules as non-derived words.

3. Aims

None of the works discussed in the previous sections is based on a large corpus study focused on vowels with secondary stress. Therefore, the main aim of this paper is to evaluate how efficient the different generalisations are in a large corpus. In doing so, I will seek to determine which of Fournier's or Guierre's analyses should be preferred or whether a new one should be proposed.

I will focus on the structures that correspond to the rules which are inferior to the rule $u \rightarrow \overline{V}$, i.e. vowels with secondary stress which are
  ➢ monographs
  ➢ not <u>
  ➢ followed by a single consonant, except in the case of transparent prefixes, for which cases with a following C_2 will be preserved because such words will constitute relevant cases to establish the phonological autonomy of prefixes.

Vowels with these properties should be free from the influence of orthography and will be relevant to test the role of rank and of the right-hand context.

4. Methodology

The main[12] data used for this study is a subset of the dataset used in Dabouis (2016), which contains 5829 words with a secondary stress. The pronunciations are taken from Wells (2008). Only the British pronunciation is considered. For full details on the constitution of this dataset and the choices that have motivated its structure, the reader is advised to see Dabouis (2016: §6). For the purposes of this paper, let us simply say that certain categories that were problematic were left aside: proper names, compounds and words containing neoclassical roots. The online *Oxford English Dictionary* (henceforth OED) was used to check contemporaneity and "Britishness": all the words which were marked as rare, obsolete, as belonging to another variety of English or which had no entry were excluded.

Three categories of words have been extracted from this larger dataset, corresponding to the categories discussed in the previous sections:
  ➢ Words with no morphological structure or formed with bound roots ("non-derived words"; n=373).
  ➢ Words containing a semantically transparent prefix (n=388). This category includes both compositional constructions with a free base (e.g. *co-driver, de-ice, pre-flight, redecorate*) and non-compositional constructions or constructions with a bound base and for which the meaning of the prefix appeared to be potentially transparent at least for some speakers (e.g. *decrease, export, premature, recycle, reflate*). This last category is voluntarily broad so as to be able to capture all the cases for which the prefix is clearly not opaque and may be made prominent phonologically. However, this means that it is not a completely homogeneous category.

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[11] Although it exceptionally does in words such as *departmental* /2010/ ~ /0210/ (← *depártment*), *collectivity* /20100/ ~ /02100/ (← *colléctive*) (see Dabouis (2017b)).
[12] That is, excluding the datasets used in §5.3.3, which will be presented later in the paper.

[Tapez ici]

> ➢ Stress-shifted suffixal derivatives (n=1292). A word was treated as derived if a semantically related base existed in the OED, except if that base is marked as rare, obsolete or as belonging to another variety of English. The existence of a semantic relationship was established using the definitions in the OED. Rare cases for which a formal and historical relationship exists but the semantic relationship has been lost (e.g. *appellation, hospitality, macaronic*) have been left aside.

The results are discussed and interpreted in the following sections.

5. Results and interpretation

5.1. Non-derived words

Non-derived words will be analysed in three steps. First, I will discuss a configuration which was not discussed in the literature and occurs marginally in the dataset: words stressed /21(-)/ (§5.1.1). Indeed, this stress pattern should normally not occur because of the restriction against stress clashes. I will then analyse words which might obey the CiV rule (§5.1.2) before turning to words which have more than one pretonic syllable (§5.1.3). Finally, I will propose an interpretation of these results in §5.1.4.

5.1.1. The initial pretonic position (n=38)

Although there are few words with that structure, their behaviour is relatively uniform: most of them have a $\overline{V}$, as shown in Table 4.

$\overline{V}$ (including $\overline{V}^e$)	$\breve{V}$	$\breve{V} \sim \overline{V}$
35 (92%) *betise, bravo, cave, covert, debar, debouch, decant, decussate* (adj), *decussate* (vb), *demarche, dementia, detour, dilute, direct, divan, divers, donee, elite, harem, hotel, idea, kotow, lichee, migrate, milieu, motif, nonet, petanque, prolix, retail, scalene, tirade, tycoon, typhoon*	**2 (5%)** *amour, taboo*	**1 (3%)** *menage*

Table 4. Vowel values in the initial pretonic position

Two words in the corpus display alternations which suggest that there is indeed something special with the initial pretonic position, as shown in (6).

(6)   *decussate* (vb)   [ˌdiːˈkʌseɪt] ~ [ˈdekəseɪt]
       pineal   [ˈpɪn i‿əl] ~ [(ˌ)paɪˈniː‿əl][13]

These words have a $\overline{V}$ when the first vowel is in the initial pretonic position and a $\breve{V}$ when they have antepenultimate primary stress (as predicted by Luick's rule). This suggests that the difference in vowel values can be attributed to the difference in stress patterns.

These results show that there is a rule applying in this environment. Let us call this rule, the « Rule of the Initial Pretonic ». It can be formulated as (7).

(7) V → $\overline{V}$ / #C$_0$__CV$_{acc}$

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[13] The $\overline{V}$ in *pinéal* could also be attributed to vowel preservation from *pine* (see §5.3.1.1).

5.1.2. The CiV rule (n=20)

The CiV rule applies very efficiently to primary stressed vowels in thousands of words (e.g. *création, média, negótiate*).[14] However, as detailed below, this does not extend to vowels with secondary stress.

Let us first evaluate Fournier's (1994) proposal that this rule applies to words with the structure $(\text{-})\acute{\sigma}\{i,e\}VC_0\#$, i.e. for which the hiatus is made of the last two vowels of the word. There are very few words with that structure and some of them have been left aside because they could be related to words in which the vowel carries primary stress and that, as a consequence, the value could be preserved from these other words, as in (8).

(8)   *comèdiénne*   ←? *comédian*
        matèriél   ←? *material*

Although the words on the right in (8) are not exactly bases in the traditional sense, it seems that, due to their high semantic and phonological relatedness, we cannot exclude the possibility that this relatedness will influence the pronunciation of words on the left in (8).

Once these two words have been left aside, we are left with two words, which do not behave uniformly: *procreate* has a $\overline{V}$ while *cabriole* has a $\breve{V}$. As a consequence, there is not enough data to confirm or disconfirm Fournier's proposal.

When we extend our analysis to words which have the structure $(\text{-})\grave{\sigma}\{i,e\}VC_0(\text{-})$, i.e. for which the vowel with secondary stress is followed by the hiatus, regardless of the position of the end of the word, there is no evidence of a rule or even a trend towards $\overline{V}$s, as shown by the results in Table 5.

$\overline{V}$	$\breve{V}$	$\breve{V} \sim \overline{V}$
2 (10%) *aviation,* *procreate*	**15 (75%)** *arietta, cabriole, cabriolet;* *carioca, caryatid, coriander,* *gladiolus, hacienda, kwashiorkor,* *lavaliere, mariachi, ratiocinate,* *ravioli, seriema, tapioca*	**3 (15%)** *aleatoric,* *olearia,* *retiarius*

Table 5. Vowel values in the structure $(\text{-})\grave{\sigma}\{i,e\}VC_0(\text{-})$

Therefore, it appears that no special treatment is required for words with this structure as most of them have $\breve{V}$s, as predicted by Luick's rule and Fournier's analysis. As a consequence, these words will be integrated among the words analysed in the next section.

5.1.3. Words with more than one pretonic syllable (n=335)

The words in this category generally follow Luick's rule, as shown in Table 6.[15]

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[14] Fournier (2010: 133) asserts that this rule applies to close to 2000 words.
[15] When a word has a stress variant, both instances are included in the relevant columns, e.g. *egalitarian* [iˌɡælɪˈteəriən] ~ [ˌiːɡælɪˈteəriən] was counted among words having a $\breve{V}$ and the stress pattern /0201(-)/ and among the words having a $\overline{V}$ and the stress pattern /2001(-)/.

	/201(-)/	/200(-)/	/0201(-)/	/0200(-)/	Total
V̆	266	21	8		295
V̆ ~ V̄	13	1			14
V̄ ~ V̆	6				6
V̄	16	2	1	1	20
Efficiency of Luick's rule (main pron. only)	93%	92%	89%	0%	92%
Examples	*còriánder ànimósity rèconcíle*	*àbracadábra càricatúre ègalitárian*	*apèritíf amànuénsis repètitéur*	*taràmasaláta*	

Table 6. Vowel values for words having more than one pretonic syllable per stress pattern

Here, regardless of the stress pattern, a large majority of the words have a V̆. The efficiency of Luick's rule was calculated by counting only the words which have a V̆ as their main pronunciation (the first two lines in Table 6). This yields an efficiency of 92% overall. If we count as "regular" all the words which *can* be pronounced with a V̆ (the first three lines in Table 6), that figure goes up to 94%. The only word stressed /0200(-)/, *taràmasaláta*, has a V̄^{e}. However, it would be far-fetched to make any conclusions on that stress configuration based on a single word, especially considering that some might want to not consider it as morphologically simple.[16]

Overall, the results favour Fournier's analysis rather than Guierre's. First, Luick's rule does seem to apply in words stressed /201(-)/. If the pretonic sequence were to behave in a similar fashion as the end of the word, we would not expect Luick's rule to apply here but the rules that apply to disyllables. Second, the rule of the penultimate does need appear to apply in words stressed /0201(-)/: although there are few words with that stressed pattern, most of them have a V̆ and not a V̄.

Let us now briefly go through the 40 exceptions (i.e. words which can be pronounced with a V̄), which are listed in (9).

(9) a. 23 V̄^{e}: *bahuvrihi, bechamel, chiaroscuro, guacamole, maharaja, taràmasaláta…*
     b.   9 words with <o> realised as [əʊ]: *coterie, olearia, oloroso, omerta, origami, provolone, pococurante, potoroo, rodomontade*
     c. 8 other exceptions: *aleatoric, aviation, deleterious, ègalitárian, ipomoea, procreate, proletariat, retiarius*

First, 23 words have a V̄^{e} (9a), which means that more than half of the exceptions could be attributed to the foreign character of these words. Second, nine words have <o> realised as [əʊ], which could be analysed as a V̄^{e} (9b). The reason for doing so is the foreignness of these words, which can be identified through etymology and through structural characteristics: penultimate or final stress, the endings <-ie, -a, -o, -i, (non-mute) -e, -oo, -ade>, foreign vowels for the vowel with primary stress in *coterie, omerta, origami* and *rodomontade*. Remember that <o> has no distinct foreign pronunciation, unlike <a, i, e>. Considering that more than half of the exceptions are clearly identifiable foreign vowels, then it seems reasonable to assume that the exceptional pronunciation of words with <o> in (9b) is in fact a V̄^{e}. Finally, there are eight remaining exceptions which I cannot account for (9c).[17] To conclude, it turns out that three quarters of the exceptions can be attributed to their foreign character.

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[16] Bermúdez-Otero (personal communication) calls it a "crypto-compound".
[17] For two of those words, the free vowel could be attributed to a related word: *equal* for *egalitarian* and (less convincingly) *avian* for *aviation*.

[Tapez ici]

5.1.4. Interpretation

First, let us sum up the results. It has been shown that vowels in the initial pretonic position generally have a $\overline{V}$. I have analysed this as a new rule: the Rule of the Initial Pretonic. This rule cannot be argued to be specific to vowels with secondary stress. Indeed, the primary stressed vowel of words stressed /12(-)/ would have to be studied. If one excludes compounds or transparent prefixed constructions, it might be that relevant cases will be very hard to find. We have also seen that there is no evidence for the CiV rule for vowels with secondary stress. Finally, in words with more than one pretonic syllable, we have seen that the vast majority of words seems to obey Luick's rule and therefore have $\breve{V}$s. Most of the exceptions to Luick's rule have been shown to be foreign words. Overall, the evidence contradicts Guierre's proposal that the pretonic sequence behaves like the end of the word.

Fournier's analysis makes better predictions for most configurations but is faced with a problem when it comes to the new Rule of the Initial Pretonic. Indeed, some words, such as those in (10), have a stressed initial pretonic vowel which is also at least antepenultimate.

(10)   *decussate* (adj), *decussate* (vb), *dementia, idea*[18]

If there was no Rule of the Initial Pretonic we would expect these words to have $\breve{V}$s according to Luick's rule. None of them does. Let us go through three possible reasons why.

First, we can assume that this rule simply dominates Luick's rule, as suggested in Dabouis (2016). In the hierarchy presented in §2.2, it would be the first referring to rank, meaning it would immediately precede Luick's rule.

Second, as suggested by Fournier (personal communication), the fact that the initial vowel is followed by a stressed syllable means that the single consonant that follows it unambiguously belongs to the second syllable, as opposed to most $\acute{V}$CV configurations, in which it is difficult to decide which syllable the medial consonant should belong to. If this is true, then the first syllable is clearly an open syllable and should follow the C^0 rule, which correctly predicts that the vowel should be a $\overline{V}$.

Third, it could be that the formulation of Luick's rule should be revised. Defending this proposal requires to use a theoretical tool which is not usually used in the Guierrian approach: the foot. Feet are prosodic units that contain one or more syllables; they have been widely used by phonologists since the 1970s in Metrical Phonology (Hayes 1980; Liberman & Prince 1977) and Prosodic Phonology (Nespor & Vogel 1986; Selkirk 1980, 1981), where feet are part of a hierarchy of prosodic constituents (e.g. the syllable, the prosodic word, the intonational phrase, etc.). As pointed out by Scheer (2011: 303), "prosodic categories have ceased to engage phonologists theoretically: the prosodic word and its peers have become descriptive categories, much in the way syllabic vocabulary such as onset and coda is used when informally talking about languages". In English, feet have been used to tie together a number of phenomena: stress, vocalic patterns, expletive infixation (Davis & Cho 2003; Hammond 1999: §5.4.3; McCarthy 1982), flapping, the obligatory assimilation of /n/ to a following stop, the mutual assimilation of /k/ and /r/, the devoicing of /l/ after a voiceless consonant (Kiparsky 1979), the aspiration of voiceless stops, the distribution of [h] and of [r] in certain American dialects (Bermúdez-Otero 2012; Davis & Cho 2003; Harris 2013) and word-internal schwa syncope (Hammond 1999: §5.4.4).

Most works on English assume that, in this language, feet are normally bimoraic trochees (see Bermúdez-Otero & McMahon (2006) and Pater (2000)). This means that they should contain at least

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[18] Although *idea* is generally pronounced as a disyllable in British English because of historical smoothing, I am assuming it is still trisyllabic based on its derivatives, *ideate* [ˈaɪdɪeɪt] and *ideation* [ˌaɪdiˈeɪʃən], in which it can be seen that the second and third syllable can still be distinct.

two morae, assuming that a short vowel has one mora, a long vowel has two morae and coda consonants have one mora. Trochaicity means that, if the foot is disyllabic, then its head should be the leftmost syllable. Stress patterns are usually seen as manifestations of foot structure. Foot-heads and stresses are in a one-to-one relationship: wherever there is a foot-head, there should be a stress and wherever there is a stress, there should be a foot-head. Most theories also assume that vowels are lexically present and that syllable structure and foot structure are projected from the segmental structure. After Hayes (1982), most works also assume that the final syllable of nouns, the last consonant of verbs and certain suffixes are extrametrical, i.e. they are invisible to the stress-assigning algorithm.

Within the framework of a reading grammar, which is what is usually studied in the Guierrian approach, one of these assumptions cannot be adopted. Indeed, in a reading grammar, vowel values need to be accounted for and therefore cannot be assumed to be lexical. Moreover, the rules given in §2.2 are highly efficient if spelling is taken into consideration but less so if it is not. As a consequence, feet may not be derived from segmental structure, or at least may not be determined by vowel length.[19] Here, I am going to assume that stress is assigned with the rules proposed by Fournier (2007, 2010), which do not require any reference to vowel length or fullness. Additionally, I am not going to assume that there exists a one-to-one relationship between feet and stress. I will assume that a stressed vowel is the head of a foot but not that the head of a foot is necessarily stressed. This is in line with proposals such as Gussenhoven (1991), who claims that there are two kinds of prominence in English: foot structure, which "captures the distinction between reduced and unreduced syllables", and what he calls "accent", which he defines as "a place marker in the phonological structure where tones are to be inserted" (Gussenhoven 2011). I will keep using the word "stress" to refer to the second kind of prominence.[20]

Once we have made these assumptions, it should be possible to derive vowel values through foot structure. Note that this proposal is exploratory and that many of the aspects of the analysis developed below are still to be refined. I am going to focus on words which normally obey the rules of vowel value that refer to rank. Let us take the two possible pronunciations of the word *coronal* and assume, in line with most works on English phonology, that the adjectival suffix *-al* is extrametrical. If stress is on the antepenultimate, the foot can be disyllabic and, to be bimoraic, requires the first syllable to be short (11a). If stress is on the penultimate, the foot cannot include the final syllable because it is extrametrical. As a consequence, the vowel has to be long to satisfy bimoraicity (11b).[21] [22]
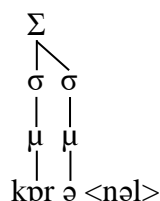
(11)   a. *córonal*   b. *corónal*
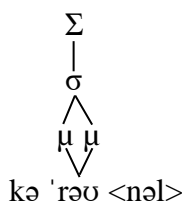
Assuming that the last syllable is extrametrical also means that Luick's rule in fact refers to a sequence of two syllables and not three syllables. In the generative literature, it has been reanalysed as

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[19] Carr (2000) argues that the same could be true for phonological analyses of English stress because Standard Scottish English has the exact same stress system and yet has no vowel length.

[20] For further discussion on the issue of "stress" and "accent", see Dabouis(2016: §3.1, 2017b; Fox 2000: §3.1.1; Schane 2007; van der Hulst 2012, 2014).

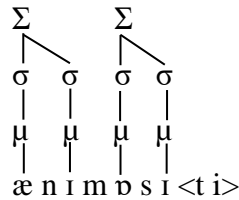[21] I will not represent the prosodic structure for initial unstressed syllables because it is not relevant here. In line with Davis & Cho (2003) and Jensen (2000), it could be assumed that such syllables are adjoined to a higher foot projection to their right, which is also necessary word-internally to account for the aspiration and absence of flapping in American English in the third syllable of words such as *Mèditerránean*.

[22] Note that this analysis cannot completely account for the vowel value of disyllables with initial stress. As pointed out by Deschamps (1994: 230), these words generally have V̄s, as predicted by the present analysis, but there are many subclasses which do not.
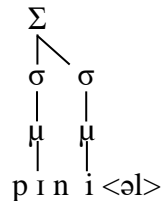
"Trochaic Shortening" (Prince 1991). This analysis predicts that there will be a difference between vowels with secondary stress which are followed by an unstressed vowel and those followed by another stressed vowel. Those followed by an unstressed vowel should obey Luick's rule, because the foot can be disyllabic, as in (12).

(12)   *ànimósity*

```
        Σ         Σ
       /\        /\
      σ   σ     σ   σ
      |   |     |   |
      μ   μ     μ   μ
      |   |     |   |
      æ n ɪ m ɒ s ɪ <t i>
```
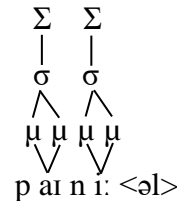
In the initial pretonic position, this analysis predicts the effects of the Rule of the Initial Pretonic: the vowel should be long because the foot can only be monosyllabic, just as in (13b). The two pronunciations of *pineal* can therefore be represented as in (13).
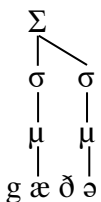
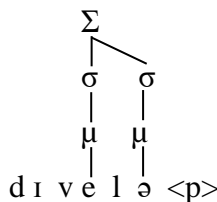(13)   a. *píneal*   b. *pìnéal*

```
        Σ                              Σ    Σ
       /\                              |    |
      σ   σ                            σ    σ
      |   |                           /\   /\
      μ   μ                          μ μ  μ μ
      |   |                           \/   \/
      p ɪ n  i <əl>                   p aɪ n iː <əl>
```

If we also adopt the assumption that, in verbs, only the last consonant is extrametrical, then we should expect Luick's rule to apply to verbs with penultimate stress. Indeed, the last syllable can be part of the foot and the stressed vowel should then be short, as in (14).

(14)   a. *gáther*   b. *devélop*

```
        Σ                              Σ
       /\                             /\
      σ   σ                          σ   σ
      |   |                          |   |
      μ   μ                          μ   μ
      |   |                          |   |
      g æ ð ə                        d ɪ v e l ə <p>
```

I tested this prediction on the dataset used in Dabouis & Fournier (in preparation), which is a dataset of over 5000 verbs listed in Jones (2006). I extracted all the verbs which are not suffixed, do not contain a transparent prefix, are not compounds and which have the proper environment for Luick's rule (i.e. a monograph stressed vowel that is not <u> and is followed by a single consonant). The results are shown in Table 7.

	$\breve{V}$	$\overline{V}$
Disyllables	*blather, bury, bother, copy, cover, covet, cozen, dither, drivel, fathom, foray, gather, govern, grovel, harass, herald, hover, kibitz, quiver, ravel, raven, scavenge, shiver, shrivel, slaver, slither, smother, snivel, smother, travail, travel, wither, wizen*	*blazon, caper, cater, open, peter*
Trisyllables	*consider, continue, deliver, develop, dishevel, disparage, envelop, examine, imagine, recover*	*bedizen, environ*
	43 (86%)	7 (14%)

Table 7. Vowel values in verbs with penultimate stress

These results confirm the predictions made by the analysis using feet and extrametricality. They are also interesting because the predictions made by this theoretical analysis have allowed the identification of a new generalisation: in the Guierrian tradition, it had never been observed that a specific rule applies to verbs.[23]

To sum up, all three analyses of the rules referring to rank can account for the data. However, although the third analysis is only a first approximation of how the rules of vowel value can be analysed using feet and extrametricality, it seems worth further research, as it has already allowed the unveiling of an empirical fact which had been missed by previous Guierrian works. Furthermore, if the entire system of rules for vowel values can be analysed using foot structure, it means that all the phenomena evoked above (e.g. flapping, aspiration, syncope) which have been attributed to foot structure could now be accounted for in a model which, at this stage, cannot account for them.

5.2. Semantically transparent prefixes (n=388)

5.2.1. Results
The vocalic behaviour in this inventory is extremely uniform: 380 words (99%) can only be realised with a $\overline{V}$ and six additional words may have it as a variant. The number of following consonants (or syllables) does not have any influence, as shown by the examples in (15).

(15)   C: *asexual, co-pilot, decipher, precook, redeploy…*
        C_2:   *astable, deskill, pre(-)flight, prestressed, reschedule…*

Prefixed constructions with bound bases such as those in (16) overall have the same behaviour as those with free bases.

(16)   *cohabit, deflate, desalinate, decelerate, premonitory, regenerate, regress…*

There is one exception with a bound base in which the prefix is followed by two consonants: *agnostic* [(ˌ)æɡˈnɒstɪk]. If we compare it to words which share the same base, *diagnostic* and *prognostic*, it seems difficult to argue that the [g] is actually part of the prefix because it is present in these words too, although their prefix is different. A possible explanation might be that the [gn] is ungrammatical

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[23] There is a rule which I did not evoke in §2.2 because it concerns disyllables only: -iC# → $\breve{V}$. The verbs that could owe their $\breve{V}$ to this rule have been excluded from Table 7 but, actually, if one considers the only relevant case, *imagine*, which should obey the rule of the penultimate, the new rule for verbs should precede the rule of the penultimate. As the rule of the penultimate itself dominates the -iC# rule, then this means that verbs with -iC# should actually be integrated within the new rule for verbs. The following words, all with $\breve{V}$, should then be integrated: *merit, posit, visit, vomit, abolish, admonish, astonish, cohabit, demolish, diminish, elicit, exhibit, inhabit, inherit, inhibit, prohibit, replenish, establish, solicit*. Doing so would bring the efficiency of the rule to 89%.

domain-initially and that this forces the prefix to merge with the domain of its base, allowing the consonant cluster to influence the realisation of the vowel preceding it.

In analysing these data, it is important to identify which elements can be used to support the idea that prefixes can have their own phonological domain. Words for which the prefix is followed by C_2 are fairly straightforward: leaving aside *agnostic* (which was discussed in the previous paragraph), all 26 words have a $\bar{V}$. This is clear evidence that the prefix has its own domain because, if it belonged to the same domain as the base, we would expect the rule $C_2 \rightarrow \breve{V}$ to apply, which it does not.

However, the words for which the prefix-final vowel is followed by a single consonant and is in the initial pretonic position (e.g. *àséxual, dèráil, rèfúnd*) cannot be used as evidence for the phonological autonomy of prefixes because they could be obeying the Rule of Initial Pretonic found in §5.1.1. If we consider the words for which the prefix-final vowel is followed by a single consonant and whose second syllable is unstressed (e.g. *còprodúce, dèseléct, prèdefine, rèdeplóy*), 69/74 words (93%) can only be realised with a $\bar{V}$, and 73/74 (99%) have $\bar{V}$ as a possible pronunciation. Note that there is only one exception out of 66 words with free bases: *athematic*, which will be discussed below. Among words with bound bases, the situation is rather unclear, as shown in (17).

(17) $\bar{V}$: *predecessor, predilection, recapitulate, repercussion*
  $\bar{V} \sim \breve{V}$: *premature, premonition, recrudesce*
  $\breve{V}$: *reviviscence*

The reason for this is that the words with bound bases included in this dataset constitute a rather heterogeneous group. I have included into this group words for which the meaning of the prefix *could* be accessed at least by some speakers, based on the definitions given by the OED. This lead to the inclusion of relatively unproblematic cases such as those listed in (16) but also to that of more problematic cases such as the ones in (17). Therefore, the $\breve{V}$s observed in these words can be attributed to the fact that, to most speakers, the semantics of the prefixes are not transparent and that, as a consequence, they can undergo Luick's rule. To sum up, we can say that there is solid evidence for the phonological autonomy of prefixes in constructions with free bases but that the evidence is less conclusive in constructions with bound bases.

Let us conclude by noting the curious behaviour of the privative prefix *a-*. As shown in (18), three words can have a $\breve{V}$, including two in the initial pretonic position, making them exceptions both to the Rule of the Initial Pretonic and to the general behaviour of transparent prefixes.

(18) $\bar{V} \sim \breve{V}$: *amoral, atonic*
  $\breve{V} \sim \bar{V}$: *athematic*
  $\bar{V}$: *acyclic, asexual, atonal, atypical, avirulent, ahistorical, apolitical, aperiodic + astable* (C_2)

5.2.2. Interpretation

The high uniformity of the vocalic behaviour observed in this inventory makes the interpretation relatively easy. The large majority of significant cases point to the fact that prefixes behave like independent phonological units: Luick's rule and the rule $C_2 \rightarrow \breve{V}$ have no effect. Therefore, these results are consistent with an analysis in which this type of prefix has its own phonological domain, as discussed in §2.3.2.

5.3. Stress-shifted suffixal derivatives

5.3.1. Vowel preservation

5.3.1.1.　　One pretonic syllable (n=12)

There are hardly any derivatives stressed /(2)1(-)/ and which are derived from a base with primary stress on its first syllable. This is hardly surprising considering that English normally prohibits stress clashes. In the twelve relevant words in the corpus listed in (19), only $\overline{V}$s are attested.

(19)　　*cocaine, demarcative, dinette, irate, limeade, migration, migratory, motet, nineteen, payee, pineal, piratical, poseur*

These vowels can be accounted for by vowel preservation or by the Rule of the Initial Pretonic. As there is no way to tell which is applying here, these words will not be treated as evidence for any of these rules and will not be discussed any further.

5.3.1.2.　　Two pretonic syllables (n=793)

In the vast majority of cases, the derivative has the same value as that of the vowel in the base, even if that vowel is unstressed in the base. Only the cases for which a full vowel can be found in the base (see the examples in (20)), as a main pronunciation or as a variant, were included in this analysis. The words for which the base has a reduced vowel are discussed in §5.3.2.

(20)　　*enigma* [iˈnɪgmə ~ **e**-, ə-] → *enigmatic* [ˌ**e**nɪgˈmætɪk]
　　　　molest [məˈlest ~ m**əʊ**-] → *molestation* [ˌm**əʊ**leˈsteɪʃən]

Cases for which the vowel is a $\overline{V}$ or is alternating between a $\overline{V}$ and a $\breve{V}$ provide evidence that the pronunciation of the derivative depends on that of its base (see (21)).

(21)　　*glóbalize* → *glòbalizátion*　　　　$\overline{V}$
　　　　negótiate → *negòtiátion*　　　　　$\overline{V}$
　　　　aménable → *amenability*　　　　　$\overline{V} \sim \breve{V}$

Indeed, if the pronunciation of the derivative were calculated independently of the base, we would expect Luick's rule to apply, regardless of the value of the vowel in the base. However, as shown in Table 7, the value found in the derivative is almost systematically identical to that found in the base.

Value base	$\overline{V}$			$\breve{V}$	$\overline{V}$ or $\breve{V}$	
Value derivative	$\overline{V}$	$\overline{V}$ or $\breve{V}$	$\breve{V}$	$\breve{V}$	$\overline{V}$ or $\breve{V}$	$\overline{V}$
V stressed in the base	124	3	2	479	29	1
	(96%)	(2%)	(2%)	(100%)	(97%)	(3%)
V unstressed in the base	55	1	0	95	3	1
	(98%)	(2%)	(0%)	(100%)	(75%)	(25%)

Table 7. Vowel preservation in suffixal derivatives

The exceptions are all listed in (22).

(22)　　a.　　$\overline{V} \rightarrow \overline{V}$ or $\breve{V}$: *íris* → *ìridáceous, sópor* → *sòporífic, ária* → *àrióso*
　　　　　　$\overline{V} \rightarrow \breve{V}$: *méthane* → *mèthanóic, Póland/Pólish* → *pòlonáise*
　　　　　　$\overline{V}$ (unstressed) → $\overline{V}$ or $\breve{V}$: *prorógue* → *prorogation*

　　　　b.　　$\overline{V}$ or $\breve{V} \rightarrow \overline{V}$: *símony* → *sìmoníacal*
　　　　　　$\overline{V}$ or $\breve{V}$ (unstressed) → $\overline{V}$: *psoríasis* → *psòriátic*

There are two striking observations about these exceptions. First, whenever the base has a $\breve{V}$, that value is also found in the derivative, without a single exception. Second, whenever a value that is absent from the base can be found in the derivative, it is always $\breve{V}$ (as in (22a)). These two observations confirm the idea that, in this environment, Luick's rule is the default, as was observed with non-derived words. The words of (22a) can be argued to have a semantic relationship that is not completely transparent, which could explain that the derivatives would develop pronunciations that are independent from that of their base and which would abide by general structural rules. In the case of bases with a $\breve{V}$, such cases would be undetectable from their pronunciation because both vowel preservation and Luick's rule would predict the same pronunciation.

5.3.1.3. Three or more pretonic syllables (n=402)

Words with a longer pretonic sequence preserve the vowel value found in their base without a single exception, even when there is variation in the base. Examples are listed in (23).

(23) $\breve{V}$: *abóminátion, càtegorizátion, èducabílity, famìliárity, rèlativístic…*

  $\bar{V}$: *acètificátion, chamèleónic, degràdabílity, expèriéntial, glòbalizátion…*

  $\bar{V} \sim \breve{V}$: *amènabílity, ephèmerálity, excòriátion, scàrificátion…*

This preservation also operates in a few words which may have two possible bases, such as the two examples in (24).

(24) a. *acádemy → acàdemícian* $\breve{V}$
      àcadémic → àcademícian $\breve{V}$
   b. *aróma → aròmatícity* $\bar{V}$
      àromátic → àromatícity $\breve{V}$

There is also one case where stress preservation optionally fails and where secondary stress falls on the first syllable of the derivative, a syllable which bears no stress and has a reduced vowel in the base: *vaticination* /20-/ ~ /02-/ ← *vatícinate*. When stressed /20-/, this word has a $\breve{V}$, as predicted by Luick's rule.

5.3.2. Stress shift and V^{red} in the base (n=85)

For a number of words, stress preservation cannot operate because it would generate a stress clash (although this does occur sporadically; see Dabouis (2017b)), as in (25).

(25) *cemént → cèmentátion (*cemèntátion)*

When a full vowel occurs in the first syllable of the base (even as a variant), the word has been included in the previous counts. When the vowel is reduced, then we would expect Luick's rule to apply, just as it does for non-derived words, because there is no retrievable source for the value of the vowel. However, this is not exactly what we find, as shown by the results in Table 8.

[Tapez ici]

V̆	V̆ ~ V̄	V̄ ~ V̆	V̄
55	8	13	9
(65%)	(9%)	(15%)	(11%)

63	22
(74%)	(26%)

Table 8. Vowel values in stress-shifted derivatives whose base has a reduced vowel

If we evaluate the efficiency of Luick's rule in these words in the same way as it was evaluated for non-derived words in §5.1.3, i.e. measuring the proportion of words which have a V̆ as a main pronunciation, we can observe that this proportion is about 20% lower than that found in non-derived words (74% vs 92%). Indeed 35% of words here can have a V̄, as in the examples in (26).

(26) V̄:   *d*[ì:]*partméntal ← department; c*[ì:]*mentátion ← cemént*
       V̄ ~ V̆:   *d*[ə̀ʊ ~ ɒ̀]*mestícity ← domestic;* [ì: ~ è]*lastícity ← elástic*
       V̆ ~ V̄ :   *d*[è ~ ì:]*molítion ← demólish ; pr*[ɒ̀ ~ ə̀ʊ]*ductívity ← prodúctive*

The issue is to explain this unexpected presence of V̄s in these words. A series of hypotheses can be made. First, the dataset contains a number of historically prefixed words, which have been shown to have an effect on phonology (Dabouis 2017a), so it may be that the V̄ that we observe can be attributed to morphology. Second, it may have to do with the vowel found in the second syllable. Indeed, Videau (2013: §3.5) observes that the prefixes *de-* and *re-* may be realized with a V̄ when the second syllable is not reduced, even when they are semantically opaque. This is reminiscent of the so-called "Arab Rule", which applies to words showing vowel reduction in syllables closed by a non-coronal obstruent and preceded by a light syllable (e.g. *Arab* [ˈærəb]) but not when the preceding syllable is heavy (e.g. *Arab* [ˈeɪræb]) (Collie 2007; Hayes 1980; Pater 1995, 2000; Ross 1972). The directionality of the relationship between the two syllables is unclear so, if a relationship between the absence of reduction and the value of the first vowel were to be found, we would have to determine whether the absence of reduction is causing the preceding vowel to be free or if it is the presence of a free vowel in the first syllable that prevents vowel reduction in the second syllable. Finally, the last hypothesis has to do with the reduced vowel that is found in the base. In the data, considering the main variant only and excluding <i> realised as [ɪ] (which could be both a full or a reduced vowel), only two reduced vowels are found: [i] and [ə]. We could expect words whose base has [i] to be more likely to have a V̄ than those whose base has [ə] because, in Wells (2008), [i] is actually a representation of the neutralization of the [i:] ~ [ɪ] contrast. The free vowel in that pair of vowels is the normal realization of <e>, which is how [i] is spelled in this dataset. Therefore, one could assume that having [i:] in the derivative is a form of vowel preservation (as opposed to a direct computation of the vowel).

These three potential factors (morphology, vowel reduction in the second syllable[24] and the reduced vowel in the base) were tested together in a binary logistic regression with the vowel value of the derivative as the dependent variabl, coded as a binary variable: V̄ possible or V̆ only. The results of this analysis are shown in Table 9.

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[24] [ɪ] was coded as reduced when found in the second syllable. This was done to avoid excluding a large part of the dataset (17 words out of 85 have [ɪ] in their second syllable) and was based on the observation that vowel reduction is extremely common in this position (see §5.3.3 below).

[Tapez ici]

| | 95% CI | | | p-value |
	Inf	OR	Sup	
Vʀᴇᴅ-i	1,27	4,22	16,15	0,0237
V2-Rᴇᴅ	0,02	0,08	0,24	0,00002

Table 9. Binary logistic regression for the value of the secondary stressed vowel in suffixal derivatives whose base has a reduced vowel

This analysis shows that there are two significant predictors: the vowel in the base (weakly) and the reduction of the second vowel in the derivative. The chances of having a $\overline{V}$ in the derivative are greater if the base has [i] and if the second vowel of the derivative is full. Because I have already proposed how to interpret the difference between [i] and [ə] and that this parameter is only a weak predictor of the vowel value in the derivative, I will not discuss it any further and will focus on vowel reduction in the second syllable. As I mentioned above, we need to establish the directionality of the relationship between the value of the vowel of the first syllable and the (absence of) vowel reduction in the second syllable. In order to do so, it is necessary to establish what determines vowel reduction in this environment.

5.3.3. Parallel issue: vowel reduction in /201(-)/

Before evaluating the parameters that determine vowel reduction, let us go through those that have been proposed in the literature. It has been claimed that:
➢ Vowels in open syllables are more likely to reduce than vowels in closed syllables (Burzio 1994: 113; Fudge 1984; Halle & Keyser 1971).
➢ 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).
➢ Initial pretonic closed syllables normally do not reduce except if that syllable is a prefix Chomsky & Halle 1968: 118; Collie 2007: 129, 215, 318; Guierre 1979: 253; Halle & Keyser 1971; Halle & Vergnaud 1987: 239; Hammond 2003; Hayes 1982; Liberman & Prince 1977; Pater 2000; Selkirk 1980).
➢ Vowels spelled with a digraph reduce less than monographs, especially in the initial pretonic position (Dahak 2011; Deschamps 1994: 111; Deschamps *et al.* 2004: 217; Guierre 1984, 1987).
➢ Vowels in a syllable closed by a non-coronal obstruent and preceded by a heavy syllable should not reduce (e.g. *Àl*[ə]*xánder* vs. *Tìmb*[ʌ]*któo*; see the discussion on the "Arab Rule" in the previous section).
➢ More frequent words show more reduction than less frequent words (Fidelholtz 1975).

These parameters have been evaluated for non-derived words in a recent preliminary study on vowel reduction (Dabouis *et al.* 2018). The dataset used in this study contains 478 words taken from Wells (2008) which are stressed /201(-)/, are monomorphemic or derived from bound roots, do not contain a historical prefix in the second syllable and are not proper names (which were not included as this stage in the study). Words with <i> realised as [ɪ] in the second syllable were left out. The following predictors where used in a binary logistic regression:
➢ Cʟᴏsᴇᴅɴᴇss: syllables are coded as Oᴘᴇɴ or Cʟᴏsᴇᴅ.
➢ NᴀᴛᴜʀᴇᴏғFᴏʟʟᴏᴡɪɴɢC: the nature of the following consonant was coded ((non)coronal, nasal, etc.).
➢ LᴏɢFʀᴇǫᴜᴇɴᴄʏ: 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).
➢ Sᴘᴇʟʟɪɴɢ: vowels were coded as Mᴏɴᴏɢʀᴀᴘʜ or Dɪɢʀᴀᴘʜ.

[Tapez ici]

> ➤ WEIGHTOFS1: The first syllable was coded as HEAVY or LIGHT.

The dependent variable, vowel reduction, was coded as a binary variable (REDUCED vs. FULL), based on the main pronunciation given by Wells (2008). As mentioned above, this is a preliminary study and a possible refinement could be the inclusion of the pronunciation variants given by Wells so that vowel reduction could be coded as a four-point scale depending on the existence and ordering of variants, as in Hammond (2003). The results from the analysis are shown in Table 10.

| | 95% C.I. | | | p-value |
	Lower	OR	Higher	
SPELLING-MONOGRAPH	3.1	12.8	28.6	1.55 e-04
CLOSEDNESS-OPEN	5.8	12.3	44.2	2.38 e-10
LOGFREQUENCY	1.1	1.3	1.7	0.011

Table 10. Binary logistic regression for vowel reduction in the intertonic position in non-derived words

These results show a significant effect of spelling, syllable structure and log-frequency. Vowel reduction is less likely: if the vowel is spelled with a digraph, if the syllable is close and if the word has a low frequency.

It has also been claimed that the existence of a morphological base in which the vowel is stressed can reduce its chances to reduce (Chomsky & Halle 1968: 112, e.g. *reláx → rèlaxátion*), even more so if that base is more frequent than the derivative (Bermúdez-Otero (2012: 32), after Krazka-Szlenk (2007: §8.1.2). Therefore, I conducted another study on a subset of the dataset used in Dabouis (2017b). This dataset contains derived words stressed /201(-)/ with a base stressed /01(-)/ which are taken from Wells (2008). For the purposes of this study, certain words had to be left out:
> ➤ Words with <i> realised as [ɪ] in the second syllable because it is impossible to know whether the vowel is full or reduced;
> ➤ Words with a disyllabic prefix (e.g. *inter-, super-*), because the systematic reduction in their second syllable could be attributed to idiosyncratic properties of the prefix itself;
> ➤ Words with a re-writing of the stressed vowel in the base (e.g. *reveal → revelation*), because having a diacritic mark of length in the base (i.e. the digraph) and not in the derivative could bias the results;
> ➤ Words with a frequency of 0 and a base with a frequency superior to 0, because a frequency ratio cannot be computed for these words.

The final dataset contains 200 words. The same variables as for non-derived words were used and some new ones were added:
> ➤ LOGFREQUENCY-BASE: the frequency of the base, again taken from SUBTLEX-UK and log-transformed. The name of the frequency variable for the derivative was changed to LOGFREQUENCY-DERIVATIVE.
> ➤ RELATIVEFREQUENCY: the ratio of the base frequency and the derivative frequency.
> ➤ SEMANTICTRANSPARENCY: Semantic transparency was coded using Dictionary.com (http://dictionary.reference.com/, accessed 04/06/2018). The relationship between the base and its derivative was coded as TRANSPARENT if the base appeared in the definition of the derivative. Otherwise, the relationship was coded as NON-TRANSPARENT.

These variables were tested in a binary logistic regression with vowel reduction (again coded as FULL or REDUCED) as the dependent variable. The results are shown in Table 11.

	95% C.I.			p-value
	Lower	OR	Higher	
CLOSEDNESS-OPEN	8.4	17.8	40.9	8.31 e-13
SPELLING-MONO	1.2	9.8	103.0	0.039730
LOGFREQUENCY-DERIVATIVE	1.2	1.3	1.6	0.000101

Table 11. Binary logistic regression for vowel reduction in the intertonic position in derived words

These results show that the exact same variables turn out to be significant predictors of vowel reduction in derived words as those found in non-derived words. Note, however, that the effect of spelling is only marginally significant. No effect can be found for the weight of the first syllable, for the nature of the following consonant or for relative frequency, contrary to what has been claimed in the literature. Let us now compare non-derived words and derived words.
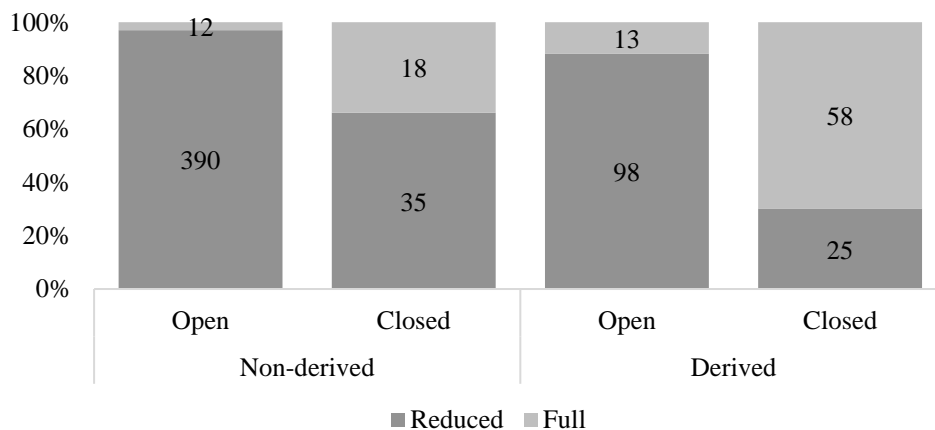

Figure 1. Vowel reduction in the intertonic position of non-derived and derived words

Figure 1 shows that, overall, vowels reduce less in derived words than in non-derived words. The pairwise comparison between open syllables in non-derived and derived words (χ^2=12.469, 1 df, p < 0.001) and between closed syllables in non-derived and derived words (χ^2=15.5, 1 df, p < 0.0001) confirms that this observation is significant. This suggests that, although no effect of relative frequency or semantic transparency could be found, the mere existence of a base reduces the chances of vowel reduction in this position. A complementary element goes in the same direction: 8/25 derivatives in which the second vowel is not reduced can also be stressed /021(-)/. This highly exceptional stress pattern can very clearly be attributed to isomorphism with the base (see Dabouis 2017b), which suggests that the lower rate of vowel reduction can be too.

Significantly, no effect of the first syllable on the reduction of the second vowel could be shown. These results suggest that in words such as *c*[ɪː]*mentation*, the $\overline{V}$ observed in the first syllable can be attributed to the non-reduction of the second vowel, and not the opposite.

5.3.4. Interpretation

First, we have seen that vowel preservation is the main force determining vowel values in derived words. A new finding is the fact that this vowel preservation operates even when the first syllable is unstressed in the base and that it bears secondary stress in the derivative (e.g. *molest* [məˈlest ~ məʊ-] → *molestation* [ˌməʊleˈsteɪʃən]. Fournier's (1994) analysis supposes than if secondary stress shifts to the first syllable to avoid a stress clash, then the value of the first vowel should be computed directly, even if it is full in the base. The results reported here clearly show that this is wrong: whenever a full vowel exists in the base, its value is preserved in the derivative.

[Tapez ici]

The results have also shown that, whenever a vowel value which cannot be attributed to vowel preservation is found in the derivative (when it contains a full vowel), it is always a $\breve{V}$, comforting the idea that this is the default value in this environment.

Finally, we have seen that derivatives whose base has a reduced vowel overall obey Luick's rule, although much less efficiently than would be expected if they behaved like non-derived words. Indeed, 35% of these derivatives can have a $\overline{V}$. It was shown that this value can be attributed to the absence of vowel reduction in the second syllable and (marginally) to the reduced vowel found in the base. The study of vowel reduction in the intertonic position has shown that vowel reduction was not conditioned by properties of the first syllable, suggesting that it is indeed the absence of reduction that causes $\overline{V}$s in the first syllable and not the opposite. Interestingly, the results on vowel reduction have shown that vowels were less likely to reduce in derived words than in non-derived words. Therefore, to some extent, the presence of $\overline{V}$s in the stress-shifted derivatives can indirectly be attributed to isomorphism with the base. This observation once again shows how strong isomorphism is in English.

Once again, using feet as a theoretical tool to represent the distinction between reduced and full vowel can prove useful to analyse the data I have just described. First, let us assume that the conjunction of syllable structure and identity with the base forces the preservation of the foot that bears primary stress in the base, as in (27).

(27)   *cemént*   →   *cementátion*
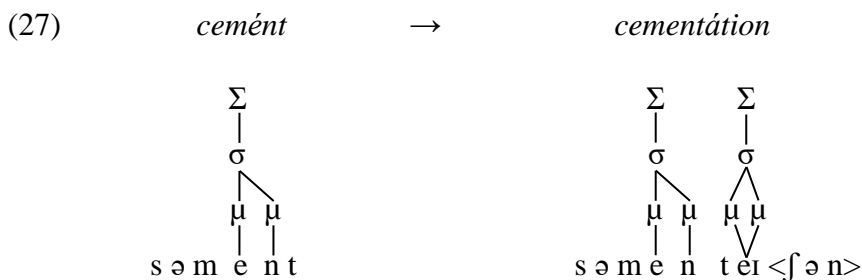
As stress cannot be preserved on the second syllable because of the prohibition of stress clashes, secondary stress is going to have to be placed on the first syllable. As the second syllable already belongs to a foot, the first syllable will have to form a foot of its own. Finally, because this syllable is open and that a foot must be at least bimoraic, then the first vowel will have to be long, as shown in (28).[25]

(28)   *cementátion*
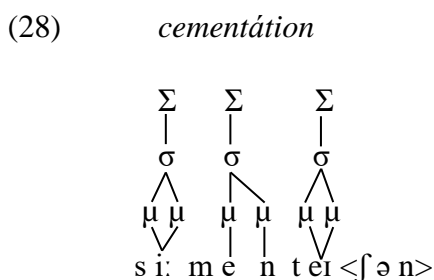
6. Conclusion
This paper has provided an extensive empirical study of the pronunciation of vowels with secondary stress. Most of the results confirm previous analyses but some newly unveiled phenomena require revisions of these analyses.

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[25] The stepwise derivation used here is adopted for the purposes of the demonstration. This could perfectly be achieved in a parallel derivation using constraints, as in Optimality Theory (Prince & Smolensky 1993).

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[Tapez ici]

Non-derived words have been found to obey two rules: the (new) Rule of the Initial Pretonic when they have one pretonic syllable and Luick's rule in all other contexts. There was no evidence to support analyses claiming that the CiV rules also applies to vowels with secondary stress. Several possible analyses have been proposed to accommodate the Rule of the Initial Pretonic. One of them is an exploratory analysis using feet which, if it could be extended to the whole system of spelling-to-sound rule, would considerably broaden the empirical coverage of the theory because a number of phenomena which have been related to foot structure could now be integrated in the model. In this analysis, Luick's rule was revised so as to refer to the presence of a following (non-extrametrical) syllable rather than to rank.

Vowel-final semantically transparent prefixes have a vocalic behaviour which supports claims that they have their own phonological domain. Under this assumption, they can be analysed as obeying the $C^0 \rightarrow \overline{V}$ rule, regardless of their right-hand context.

Finally, it has been shown that suffixal derivatives almost systematically preserve the vowel value of the vowel found in the base, provided that this vowel is not reduced in the base. The observation that this preservation can operate even when the vowel is unstressed in the base contradicts Fournier's (1994) that structural rules should apply in these conditions. I have also shown that whenever a value that is absent from the base can be found in the derivative, it is always $\breve{V}$. This was taken as evidence confirming that the default pattern in words with more than one pretonic syllable is to have a $\breve{V}$, as predicted by Luick's rule. Derivatives stressed /201(-)/ with a base stressed /01(-)/ whose first syllable is reduced have been shown to have a greater proportion of $\overline{V}$s, contrary to what Luick's rule predicts. These $\overline{V}$s have been mainly attributed to the absence of vowel reduction in the second syllable. I have shown that an analysis using feet could be used to account for the interaction between the two syllables.

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