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Vowel reduction in European Portuguese and the removal of structure

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Abstract

This article applies the proposals for the internal structure of vowels made within Government Phonology (GP) 2.0 (Pöchtrager 2006, 2018) to vowel reduction in European Portuguese. GP 2.0 assumes that openness is a structural property and that reduction consists in removing parts of that structure. This approach not only allows us to model various reduction patterns, but also makes it possible to establish a non-arbitrary link between differences in the extent of reduction and the context where it occurs. As will be shown throughout the text, taking aperture as structural has broader cross-linguistic coverage than existing alternatives.

Keywords: European Portuguese, Government Phonology, elements, vowel reduction, structural, aperture

1. Introduction

Vowel reduction (VR) provides the opportunity to pry into the internal structure of vowels, and is of particular interest to phonological theories employing privative building blocks of melody (such as the classic trio **A**, **I**, **U**), as some of those are assumed to be lost under reduction, thus revealing the component parts that go into a given segment. VR also provides a fertile testing ground for Government Phonology (GP) 2.0 (Kaye & Pöchtrager 2013; Pöchtrager 2006, 2015a,b, 2018, 2020, 2021a,b, 2023; Živanovič & Pöchtrager 2010), a further development of 'classic' GP (Charette 1990, 1991; Kaye 1990, 1995; Kaye, Lowenstamm & Vergnaud 1985, 1990). GP 2.0 holds that many properties previously thought to be melodic (i.e. mediated by privative building blocks, elements) are actually structural. This also concerns the element **A**, expressing (amongst other things) vowel aperture, which has been replaced by structure in this theory.[1]

This article looks at European Portuguese (EP), where aperture plays a crucial role in VR. We will apply to EP the representational format for the internal structure of vowels and reduction as proposed in Pöchtrager (2018), which looked at Brazilian Portuguese and Eastern Catalan. EP provides reduction patterns that are more 'dramatic' and in some sense also more complex than either one of those two languages: EP distinguishes two VR patterns, the choice of which depends on the preceding onset. In addition, there is an asymmetry between front and back vowels (similar to Eastern Catalan) that plays a role in both VR patterns.

This contribution is structured as follows. Section 2 looks at the EP vowel system and at how VR works. Section 3 presents arguments for the GP 2.0 view that aperture is to be represented structurally and that removal of part of that structure is the formal expression of VR. Section 4 applies this to EP and shows how several details of the reduction patterns and the front/back asymmetries follow from general assumptions of the theory. Section 5 concludes and also compares the present analysis to that of Carvalho (1994, 2011), which has been an important source of inspiration for the present work.

2. The EP vowel system and VR

EP displays the full range of seven oral monophthongs in stressed position, but that number shrinks when the vowel is unstressed. As Table 1 reveals, an asymmetry emerges when stressed vowels are lined up with their unstressed counterparts, to be discussed in more detail presently. Furthermore, two environments need to be kept apart: When the vowel in question is preceded by a realised onset (C_) and when it is preceded by an empty onset (Ø_). Transcription follows the practice in Mateus & d'Andrade (2000); the slight centralisation found for unstressed vowels (Martins 1982) is left untranscribed. Shading of cells on the same line indicates the various mergers that occur.

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[1] The elements **I** (for frontness) and **U** (for rounding) are still employed in GP 2.0. This text will assume basic familiarity with elements, at least with their privative nature. For a relatively recent overview and summary of arguments in their favour cf. Backley (2011).

Table 1. Stressed and unstressed vowel correspondences

stressed	i	e	ɛ	a	ɔ	o	u
unstressed C_	i	ɨ	ɨ	ə	u	u	u
unstressed Ø_	i	i	i	ə	o	o	u

Examples (drawn from Carvalho 2011) for both patterns are given in (1). Underlining in the orthographic form indicates the stressed vowel, while boldface marks the vowels that alternate/that are under discussion.[2]

(1) a. following a realised onset (C_)

[i] ~ [i]	*v**i**ro ~ v**i**rar*	'I/to turn'
[e] ~ [ɨ]	*s**e**co ~ s**e**car*	'dry/to dry'
[ɛ] ~ [ɨ]	*s**e**co ~ s**e**car*	'I/to dry'
[a] ~ [ə]	*b**a**to ~ b**a**ter*	'I/to beat'
[ɔ] ~ [u]	*g**o**sto ~ g**u**star*	'I/to like'
[o] ~ [u]	*c**o**zo ~ c**u**zer*	'I/to cook'
[u] ~ [u]	*f**u**ro ~ f**u**rar*	'I/to make a hole'

b. following an empty onset (Ø_)

[i], *[ɨ]	*H**e**lena*	(name)
[i], *[ɨ]	***e**xército*	'army'
[o], *[u]	***o**rar*	'to pray'
[o], *[u]	***o**brigado*	'obliged'

As can be seen in Table 1, the system of stressed vowels is symmetrical: We find the same number of front vowels (characterised by the element **I**) as of back rounded vowels (characterised by **U**). The low unrounded vowel contains neither element.

When looking at VR, we want to keep the two contexts separate. As for C_, two observations can be made. Firstly, all vowels raise: The low vowel to (mid) schwa, all other vowels to high. Secondly, there is an asymmetry between the front and back mid vowels: The unstressed counterparts to the stressed round vowels are all round themselves, i.e. **U** survives reduction unscathed. The element **I** is not so lucky; the unstressed counterpart to the front *mid* vowels is central, i.e. **I** is lost here. (But note that **I** is *not* lost when the high vowel [i] becomes unstressed.) As for Ø_, reduction is less 'dramatic', in that the back mid rounded vowels merge as [o], not as a high vowel. Furthermore, the front mid vowels do not lose their **I**, but merge as (and with) [i]. But again, there is an asymmetry between front and back mid vowels, in that [ɛ/e] merge as high [i], while [ɔ/o] merge as mid [o]. That is, both C_ and Ø_ show an asymmetry between vowels containing **I** and those containing **U**, and ideally we want to identify

[2] Since GP does not distinguish between levels of representation different *in kind*, I use square brackets throughout; cf. in particular Harris (1999) for discussion. Note also that VR does not require there to be an alternation as in (1a); vowels that are consistently unstressed (like the first vowel in *Helena* in 1b) will be restricted just like the ones that have their stress removed due to suffixation.

a factor that allows us to derive both asymmetries and also link them to the context that they occur in.[3]

This is all we need for VR in EP at this point. There are some further quirks (such as the fact that diphthongs and nasal vowels do not reduce), and we will get to them in section 4. Before that, we need to look at some theoretical machinery that will provide the background to help us make sense of the patterns we have seen so far. We will now move on to some basic tenets of GP 2.0, in particular as concerns the element **A**.

3. GP 2.0 and a structural approach to the element A

3.1. The special status of A

Out of the three elements **A**, **I**, **U** (which are common to all versions of GP), **A** behaves differently from the other two.[4] This is an asymmetry that has been noted time and again within GP. Kaye (2000) assumes that **A** in a segment makes that segment a better governor, hence non-high vowels are preferred first members in falling diphthongs such as [aʊ] or [oɪ]. Cobb (1997) argues that in a combination of elements (a so-called phonological expression), e.g. in an *e*-type vowel containing both **A** and **I**, the element **A** prefers not to be the head of that phonological expression.[5] Similar provisos are made in related theories: Particle Phonology (Schane 1984; Broadbent 1999) allows the **a**-particle (~element **A**) to occur multiple times in a expression, unlike other particles. Anderson and Ewen (1987: 215), within Dependency Phonology, note that **A** combines more freely with **I** and **U** than do those two with each other, thus front rounded vowels are rarer than mid vowels. Many other weird properties could be added.

While those special properties of **A** seem widely recognised, it is unclear why they should exist at all in theories that treat **A** on a par with other elements. GP 2.0 (Pöchtrager 2006; Kaye & Pöchtrager 2013; Živanovič & Pöchtrager 2010) tried to tackle this problem head-on. It argues that many properties previously assumed to be melodic (i.e. as elements) are actually better understood as structural. This includes the (former) element **A**: One of its recurring properties is the interaction with structure, discussed in great detail in Pöchtrager (2006, 2010, 2012, 2013, 2020, 2021a, 2021b, 2023). That is, **A**, especially (but not only) in consonants, allows for bigger structures

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3 There is a further complication: In (morpheme-internal) hiatus VR behaves like in the C_ context: In *geó̱grafo* ‘geographer’ vs. *ge**o**grafia* ‘geography’ stressed [ɔ] alternates with unstressed [u], which differs from the (word-initial) examples in (1b). I will leave open whether this is due to the location in the morpheme/phonological word (initial or not) or whether there is a way to ‘make it phonological’ as suggested in footnote 12 (or both).

4 Two comments are in order. Firstly, I follow Broadbent (1991, 1999), Cyran (1997), Goh (1997) etc. and take **A** to characterise non-high vowels and coronals. The latter assumption is not uncontested: Backley (2011) argues that **I** *or* **A** represent coronality, on a language-specific basis. Those arguments are addressed in Pöchtrager (2013). Luckily for us, coronality plays no role in this article. Secondly, the claim that **A** differs from **I** and **U** does *not* imply that the latter two behave identically; on that note cf. the asymmetries between **I** and **U** discussed in Živanovič & Pöchtrager (2010) and Pöchtrager (2015).

5 Headedness will not be relevant for our purposes and therefore not mentioned again.

than otherwise possible. Translated in more concrete terms: coronal consonants (which contain **A**) allow for more complex structures than non-coronal ones. This can easily be illustrated with examples from English. The upper size limit of English monosyllabic words (ignoring initial consonants) is VVC (*seek*, *late*) or VCC (*sink*, *left*), but when both consonants are coronals we also find VVCC *fiend* [fiːnd] (*[fiːmp], *[fiːŋk]), *count* [kaʊnt] (*[kaʊmp], *[kaʊŋk]), *feast* [fiːst] (*[fiːsp], *[fiːsk]) etc. (Southern British) *draft* [dɹɑːft] or *task* [tɑːsk] show that one coronal consonant (*t*, *s*) is enough with long [ɑː], i.e. the sole **A** in the vowel [ɑː] makes up for the **A** that we would expect to find in a second coronal.[6]

Those properties of coronals have of course been known for a long time. For example, both Fudge's (1969) and Selkirk's (1982) respective models of the (English) syllable have a special position reserved for (certain) coronals. The notion of appendix (Hall 2002; Vaux & Wolfe 2009) continues that tradition, as does the onset-specifier approach by Botma, Ewen & van der Torre (2008) within GP. Obviously, the introduction of special syllabic positions for coronals does not solve the basic mystery: Why are coronals special to begin with? We will address this in the next subsection.

3.2. A as structure

One of the proposals of GP 2.0 is as follows: Former **A** is replaced by *empty* structure. Segments which in the past were thought to contain **A** are actually characterised by containing more empty structure than those without (now defunct) **A**. The more open a vowel is, the more empty structure it has. The same is true of coronals: They are structurally big, but much of that structure is empty. This has two immediate consequences: Firstly, those empty positions can be claimed by adjacent segments: The vowel in *fiend* is long because it can "borrow" room from the final cluster, whose two members are coronal, i.e. contain a certain amount of empty structure. Secondly, and this will be of particular interest in the context of this article, such a reinterpretation allows for a scalar expression of aperture: Higher vowels will have fewer empty positions than mid vowels, which in turn will have fewer than open vowels. This idea will be crucial in our account of VR in sections 3.3 and 4.

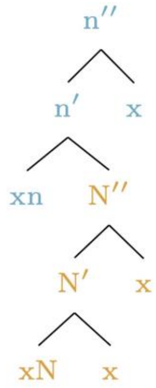
How is this idea formally implemented? GP 2.0 has two basic types of skeletal positions: heads and non-heads. When it comes to heads, we need to distinguish between onset heads (for consonants) and nuclear heads (for vowels), each of which comes in two flavours, i.e. there are two kinds of nuclear head (xn and xN) and two types of onset head (xo and xO), i.e. four different heads in total. These are provided by the theory as part of the formal machinery and take over slightly different functions, as will also become clearer throughout this paper. For obvious reasons we will limit ourselves to nuclear heads here; cf. Pöchtrager (2021b) for a discussion of onset heads.

In a particular representation, xn will sit on top of xN, if both are present (they do not both have to be present, as we shall see—the two heads are independent of one another). That is, vowels can have a bipartite structure, one half headed by xn, and the other half by xN. Each head can project upwards maximally twice, i.e. xn–n′–n″ and xN–N′–N″. This means that the maximal structure we can build is the one in (2); xn

[6] The patterns are in fact much more complex than shown here; the reader is invited to consult the aforementioned references for further details.

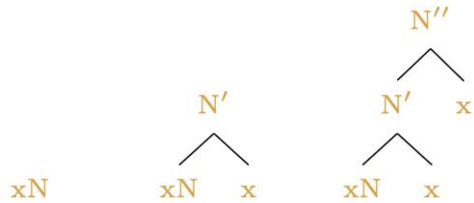
and xN mark the two heads, simple x's are non-head skeletal positions. (The different colours are intended to aid the reader.)

(2)



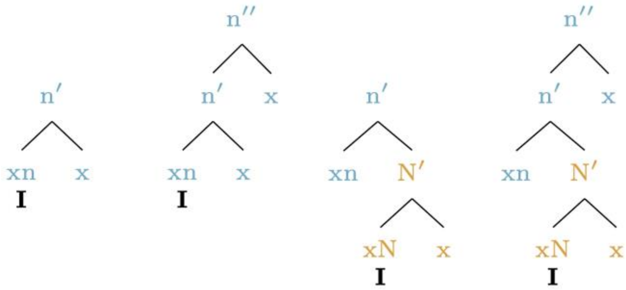
In such structures, the amount of empty positions gives an indication of openness, as shown in (3).

(3)



The positions in those structures can also be associated with elements: **I** to give us front vowels, **U** for a round vowel etc. The examples in (4) illustrate this.

(4) a. [i] b. [e] c. [e] d. [ɛ]



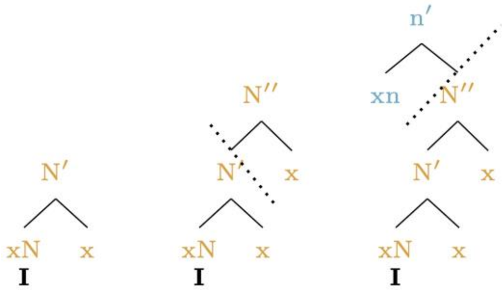
As a rule of thumb, one empty position characterises a high vowel, two a mid-close one and so on. Note also that there is some leeway to model cross-linguistic differences, as shown in (4b) vs. (4c): (i) The position where a given element sits can vary. (ii) The type of heads involved and the levels of projection can vary. Both (4b) and (4c) are given as an example of a vowel that comes out roughly like [e]: There is an element **I** and two empty positions. But while it consists of a single head xn with two projections in (4b), it consists of two nuclear heads, each projecting once, in (4c). This implies that what might be perceived as the same sound across two different languages, might actually be a different phonological object with different phonological behaviour. The phonetic realisation might be the same, while the internal composition differs.[7] An application of this will be seen in the next subsection.

While important questions remain at this point (e.g. what are the limits of variation?), we will now have to move on and look at how this representational format can handle VR.

3.3. Vowel reduction

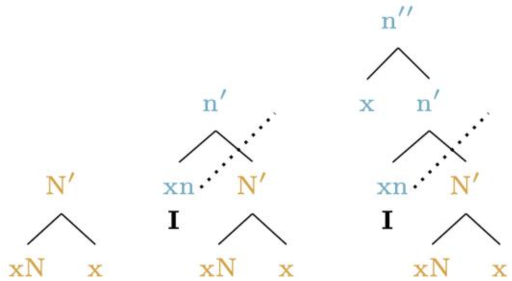
Pöchtrager (2018) contrasts the reduction patterns of Brazilian Portuguese to Eastern Catalan. In certain varieties of Brazilian Portuguese, stressed [ɛ] reduces to [e] when unstressed, and even further to [i] in final unstressed position (Cristófaro Alves da Silva 1992; Mateus & d'Andrade 2000; Wetzels 1995).[8] This can be interpreted as the successive removal of layers of structure in progressively more unfavourable prosodic positions. (5) illustrates how this will work when using the bipartite structure of the nucleus advocated in the previous section.

(5) [i] [e] [ɛ]



Loss of stress implies loss of xn along with its projection (a property we will come back to in section 4), which leads to [ɛ] being raised to [e]. Being in final position has additional detrimental effects, leading to the removal of a further layer of structure; we end up with [i]. Contrast this now to Eastern Catalan (data from Wheeler 2005) in (6).

(6) [ə] [e] [ɛ]



[7] There is a certain similarity to the Borer-Chomsky Conjecture (first suggested by Borer, later popularised by Chomsky; cf. Baker 2008: 353), according to which cross-linguistic variation can be attributed to differences in lexical features of particular items.

[8] The picture is complicated by an additional height harmony in some varieties (Segundo 1993).

In Eastern Catalan, loss of stress takes both [ɛ] and [e] to [ə]. Careful comparison of (5) to (6) immediately reveals why: The removal of stress in (6) leads to the removal of xn and its projection, thus merging [ɛ] and [e]. Furthermore, since **I** is assumed to sit in the higher head xn, that element will be lost along with the structure hosting it. We are left with a central vowel with two empty positions, i.e. schwa. The different composition of [ɛ] and [e] in the two languages in terms of which head projects how far allows us to express that those vowels react differently: unstressed [e] can be found in Brazilian Portuguese, but not in Eastern Catalan. Furthermore, the exact position of elements (**I** in this case) helps us understand why they are lost in one case but retained in another.

We now have all the ingredients to deal with VR in EP, to which we will turn in the next section.

4. VR in EP

4.1. Reduction following empty onsets

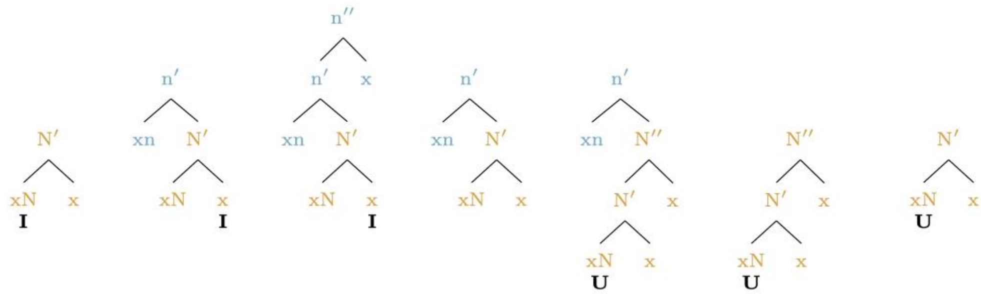
Reduction in vowels following empty onsets (Ø_ in section 2) is less 'dramatic' than elsewhere, and this is the environment we will start out with. Table 2 repeats the relevant part from Table 1.

Table 2. Stressed and unstressed vowel correspondences in Ø_

stressed	i	e	ɛ	a	ɔ	o	u
unstressed Ø_	i	i	i	ə	o	o	u

As mentioned before, what stands out is the asymmetry in mid-vowels: While front [e/ɛ] reduce to the high vowel [i], and thus merge with the (vacuous) reduction of (stressed) [i] to (unstressed) [i], back [o/ɔ] merge as high-mid [o]. I propose the representations in (7) for the stressed vowels and submit that the asymmetry under VR can be adequately derived from them.

(7) [i] [e] [ɛ] [a] [ɔ] [o] [u]



Openness is captured by the amount of empty positions within each representation: High vowels have one empty position, high-mid vowels two, open-mid and open vowels three. All front vowels contain the element **I**, all rounded vowels **U**, and the central vowel neither. Note that **I** sits in a different position in [i] on the one hand, and [e/ɛ] on the other. The reason for this difference will concern us in section

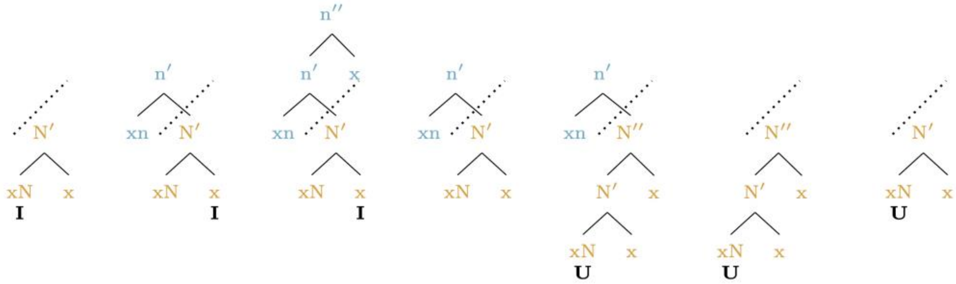
4.2. Note furthermore that the front and back mid vowels differ in their internal structure. Mid-high front [e] and back [o] have the same number of empty positions, but their overall composition (in terms of heads and their projections) is different. The same holds true of mid-low [ɛ] and [ɔ].

As argued in section 3.3, VR can be modelled as the loss of structure. With the representations for EP vowels in place, (8) will capture what happens to unstressed vowels *in general*: Vowels preceded by an empty onset (type Ø_) will only undergo (8), while unstressed vowels preceded by a realised onset (type C_) will suffer further losses, to be addressed in section 4.2.

(8) VR leads to the loss of xn and its projection.

That it should be xn and its projection that gets removed when stress is gone is not accidental; the same happens in Brazilian Portuguese and in Eastern Catalan, as shown in section 3.3. The head xn plays an important role in the formal expression of stress.[9] Application of (8) to (7) yields the representations in (9). In order to make comparison easier, dotted lines indicate the effect of (8): Everything above the dotted lines is removed by (8); only the material below those lines remains.

(9) [i] [e]→[i] [ɛ] →[i] [a]→[ə] [ɔ]→[o] [o] [u]



This is exactly the result we want. The high vowels are unaffected by VR as they do not contain xn to begin with, so there is nothing to remove. The low vowel [a] will lose xn along with the projection of that head and reduce to schwa.

The structure of mid vowels, in particular the structural difference between front and back vowels, explains why VR takes the course it takes: Front [e] and [ɛ] differ in the amount of empty positions (two vs. three), and with the exception of one, all of those empty positions are contained within the projection of xn. As regards the projection of the lower head xN, the two vowels are identical: They contain xN and a single empty position, projecting up to N’. The fact that the two vowels are identical in the projection of xN is of course crucial. VR removes xn and its entire projection, which leads to (i) a loss of openness but also (ii) a merger of the two vowels. The result is [i]. Notice that lexical [i] differs from the reduction outcome [i], but this is immaterial: We still have one position annotated with **I** and one empty position. (Recall the discussion of (4b) vs. (4c).)

9 It would be too simplistic to call xn *the* formal representation of stress, as the relationship to stress is somewhat more indirect; cf. Pöchtrager (2021a) on the role of xn in the representation of prosodic prominence (in English) and Pöchtrager (2017) on its role in Finnish vowel harmony.

Contrast this now to back [o] and [ɔ]. Again the two vowels differ in openness (two vs. three empty positions), but the *distribution* of positions differs from front [e] and [ɛ]. Both back mid vowels contain two empty positions as part of the projection of xN; for [ɔ] the greater openness vis-à-vis [o] is expressed by xn. Those empty positions within the projection of xN are unaffected by VR, since (8) removes the upper head xn along with its projection: [ɔ] loses the one position that distinguished it from [o] and merges with that vowel, while [o] stays unaffected for the same reason that the high vowels stayed unaffected: There is no position of the "offending" kind that needs to be removed.

This is all that needs to be said about the vowels following empty onsets. However, this might not be very satisfactory yet: VR proceeds as it does because of the internal structure of vowels, but the exact internal structure of vowels was of course posited in order to facilitate VR. There will be two crucial questions now, the answers to which will help us move the analysis beyond circularity: (i) Can the representations given in (7) also explain what happens to vowels that follow a realised onset? (ii) Why should it even matter what type of onset precedes a vowel? What is the connection between onset type and the kind of reduction we observe? Those two issues will be addressed in the next two subsections.[10]

4.2. Reduction following realised onsets

As we said before, when an unstressed vowel follows a realised onset, the effects of VR will be even more dramatic, which means that more structure will be lost. Table 3 repeats the relevant part from Table 1.

Table 3. Stressed and unstressed vowel correspondences in C_

stressed	i	e	ɛ	a	ɔ	o	u
unstressed C_	i	ɨ	ɨ	ə	u	u	u

Formally, what this means is that in addition to (8), which removes xn and its projection (no matter the type of onset preceding), we also see the effects of (10), which cuts the projection of the lower head xN to size.

(10) Within the projection of xN:
a. remove any specifier
b. remove any complement that is non-empty

We will first look at what (10) effects and then at the justification for the two clauses, in particular for (10b). (11) shows the combined effects of (8) and (10). Again,

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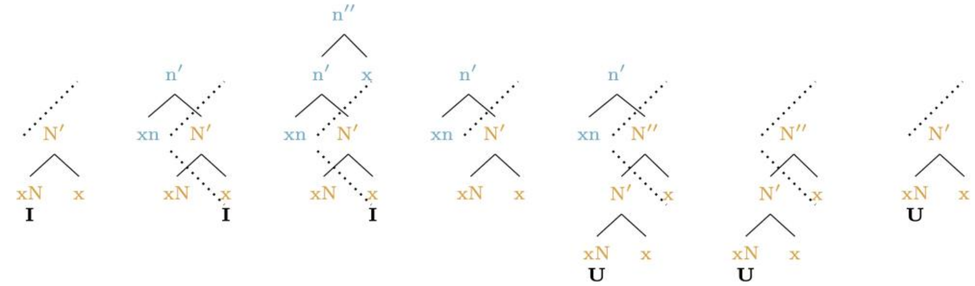
[10] Ideally, we would want the choice of representations in (9) to be motivated by some higher, more fundamental principles. Like in any other theory, such higher principles are still lacking, though; *any* analysis has to start from *some* assumptions about representations. On the same issue, a reviewer queries whether the asymmetries in the position of **I** and **U** in (9) can be linked to other asymmetries between the two as argued in Pöchtrager (2015b), which, however, addresses asymmetries when *both* elements are present (as in front rounded vowels, or in diphthongs), so that line of reasoning is inapplicable to (9), where no vowel contains both **I** and **U**.

everything above the dotted lines is taken to be removed. (The higher line is due to (8), while the lower line shows the effects of (10).)

(11) [i] [e]→[ɨ] [ɛ] →[ɨ] [a]→[ə] [ɔ]→[u] [o]→[u] [u]



As per (8), xn (along with its projection) is gone altogether. In addition, the internal structure of the projection of xN will be affected, in that all specifiers need to be removed (10a). In practice, this will only affect the back mid vowels [o] and [ɔ], as those are the only ones that contain a specifier of xN to begin with. As a result, all vowels have a structure that projects up to N' as a maximum. Finally, (10b) deals with the complement to xN. An empty complement position will be unaffected, but a complement position annotated with melody will be cut off. This is crucial for the front mid vowels. They are characterised by the element **I** in complement position, which will accordingly be lost, together with the melody. This captures the centralisation of those vowels under VR. Note that [ɨ], the reduction outcome of [e] and [ɛ], contains exactly one empty position (xN), just like any other high vowel.

Let us now look at the reasoning behind the individual statements that govern VR. What they all have in common is that unstressed positions only support smaller/less complex structures (cf. also Harris & Lindsey 1995, Harris 1997 for a discussion in terms of melodic primes). The clause in (8) in section 4.1 required removal of the upper head xn, along with any projection emanating from it. Since there is some indication that xn characterises prosodic heads (at least partially, cf. footnote 8), its loss in unstressed position is unsurprising. Many of the resulting vowels are less complex structurally, and they are uniform in the sense that they only contain a projection of xN. (10a) achieves further reduction of structural complexity (as well as more uniformity) by imposing an absolute upper limit to size: Reduced vowels following a realised onset will project maximally to N', i.e. (10a) should be read in a way that specifiers are not interesting per se, but only in so far as they go beyond the limit of N'. The reasoning behind (10b) is slightly different: A complement to xN is possible in principle, but only if that complement is empty. A complement position annotated with melody counts as too complex, and is thus removed. From the point of view of GP 2.0, where reduction is generally expressed as the loss of structure and the loss of melody only as a side-effect (cf. section 3.3), this state of affairs is somewhat surprising: Here it seems that melody is a driving factor behind the loss of melody, instead of the other way round. Those details should not distract from the overall picture, though: (10a–b) together lead to fairly uniform structures, with a projection up to maximally N' and an empty complement. (That complement is missing only in the cases where it had contained melody and was therefore removed.) Note furthermore that in *all* cases so far (including section 3.3) reduction works its way from more peripheral positions inwards/downwards to the lowest head xN; we are not removing random positions, but rather follow a path defined by the geometry of the tree.

4.3. The status of the onset

Our analysis so far separates conditions that apply to any unstressed vowel and those that apply to unstressed vowels that follow a realised onset. While this accounts for the facts, it does not yet answer two crucial questions that arise in this context. Firstly, why should the kind of onset matter at all? Secondly, why does the dividing line run between an empty onset on the one hand and realised onsets on the other? The answer to both questions lies in the Empty Category Principle (ECP).

Empty categories, i.e. skeletal positions with no melodic content, have a long history within GP and play an important role in various phonological phenomena, for example in alternations between a realised vowel and zero. Following Charette (1990, 1991) and Kaye (1990, 1995), alternations like the one in French (*j'*)*appelle* [apɛl] '(I) call' vs. *appeler* [aple] 'to call' involve an empty nucleus (a single position in earlier versions of GP) that can either be realised ([apɛ̱l]) or remain silent ([apØle], with [Ø] indicating an empty position). The phonological ECP demands that a *p-licensed* empty position do not receive a phonetic interpretation. In the case at hand the empty nucleus counts as p-licensed in [apØle] because it is properly governed by the following vowel [e]; proper government is one way to make sure that an empty position is p-licensed. In [apɛl] there is no proper governor for the empty nucleus (as there is no realised vowel following the [l]), which is therefore *not* p-licensed and gets spelled out. The result in this case is [ɛ], since the nucleus is stressed. *Un*stressed non-p-licensed empty nuclei are spelled out as [ə] in French.[11] Similar alternations can be found in Turkish, Arabic, Polish, and many other languages (cf. also the introductory chapter of Charette 1991).

The ECP speaks of empty positions in general, not only nuclei, and Charette (1991: 88ff) also discusses cases of empty onsets, as in a word like *rehausser* [rəose] 'to raise again'. Schwa is the realisation of an empty nucleus, so the form [rəose] is surprising as there is a realised vowel [o] that could act as a proper governor for the preceding schwa. However, since the theory requires that every nucleus be preceded by an onset, we must conclude that there is also an onset between [ə] and [o], albeit empty, i.e. [rəØose], with [Ø] marking an empty *onset* in this form. As an empty category, this onset needs to be p-licensed to remain inaudible, calling upon the following vowel [o] to act as a proper governor. Since the empty onset is closer to the potential proper governor than the empty nucleus is, the onset wins. This uses up the governing potential of the vowel [o], and the empty nucleus preceding it must be realised (as schwa).[12]

[11] This is a slight simplification, since empty nuclei that are realised in French do not appear in their 'pristine' form but rather have elements added to them to give them their exact shape (**A** and **I** to get [ɛ], **A** to get [ə]). Where these elements come from is unclear in Charette's analysis, but this is of no relevance to us. (It is mildly comforting that in the present theory **A** is replaced by empty positions; there might thus be way to reduce the problem to the mysterious appearance of **I**.)

[12] Again, the French facts are actually slightly more complex: French distinguishes two types of empty onset; the *h-aspiré* type (as in *rehausser*) that requires p-licensing and blocks liaison vs. a 'truly empty' onset that does neither. The implementation in Charette's work (via

Note that there are certain additional conditions on proper government. For example, proper governors cannot be p-licensed themselves. In a string of subsequent nuclei N_1N_2, if N_2 is p-licensed, it will not be able to properly govern a preceding empty nucleus N_1, as in *devenir* [dəvØnir] 'to become', where the empty nucleus between [v] and [n] is p-licensed (by proper government) and can thus no properly govern itself. Additional conditions have been invoked in the literature, for example that in Korean the availability of proper government also depends on the nature of the consonants flanking the empty nucleus (Heo 1994: 125ff). Lastly, for government in general (i.e. the relationship that proper government is a subtype of), Harris (1990) argues that complexity effects can be observed, with the governor having to be more complex than the governee.

Where does this long discussion of (proper) government and empty categories leave us with respect to EP? EP makes VR dependent on the emptiness of the onset preceding the reduction site. Assuming that an empty onset in EP needs to be properly governed as it does in French, it does seem likely that the difference between the two types of VR pattern is linked to conditions on proper government. More concretely, I will assume the following:

(12) The projection of an xN that needs to properly govern cannot be reduced.

Put differently, VR removes xn and its projection in any case. This does not seem to be detrimental to the governing potential of the vowel. However, the projection of the lower head xN (the ultimate core of the vowel in a sense) does seem to be more important and must not be tampered with. This can be likened to the condition that only nuclei of a certain type (namely those that are not p-licensed themselves) can act as governors.[13] This establishes a link between the type of onset and the kind of VR reduction we find. Note finally that a realised onset does not require proper government (as it does not constitute an empty category), so therefore VR is not bound by (12) and can proceed further as outlined in section 4.2.[14]

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the presence/absence of a skeletal point) and the distinction as such are not relevant here, but might present a solution to the problem raised in footnote 3.

13 A minimal amount of complexity on the part of the governor, as per Harris's (1990) proposal mentioned in the main text, does not seem to be necessary: The representations in (9), where the projection of xn is removed but that of xN stays untouched, are quite diverse in internal complexity, and do not seem to fulfil a minimal size requirement. The only requirement seems to be that xN must stay. — Charette (1991) also discusses cases where an empty nucleus following a cluster is realised due to its licensing obligations, as do Enguehard & Faust (2018) in an analysis of Modern Hebrew.

14 A reviewer inquires whether this also means that a nucleus properly governing another empty *nucleus* fails to undergo VR (because of its governing duty). This is an interesting, but tricky issue. Proper government in EP often emanates from a stressed vowel (*securo* [ʃØˈguɾu] 'sure'), where VR would not apply anyway. Many of those cases are problematic for the ECP as commonly envisioned, since several nuclei in a row are kept silent (*devedor* [dØvØˈdoɾ] 'debtor'), but again this does not speak to VR. The only real problematic case that I have been able to find is *rememorar* [ʀØmØmuˈɾaɾ] 'to remember'. Stress alternations in the present tense suggest that its [u] is in fact the reduced version of a mid vowel; but notice that we find two p-licensed nuclei in a row, yet again. At this point I have no solution for this issue and can only hope that a better understanding of the ECP in EP can shed some light on it.

The idea that the amount of VR is linked to the governing duties of a nucleus can also be exploited to explain another context where reduction is blocked, viz. in diphthongs. We will address this in the next subsection.

4.4. Diphthongs and nasal vowels

Diphthongs in EP fail to undergo VR. Carvalho (2011) argues that diphthongs are immune from reduction as they share melodic primes between the two members, drawing on an idea by Honeybone (2005) that sharing material makes one stronger, somewhat reminiscent of the notion of geminate inalterability (Hayes 1986, Schein & Steriade 1986). It is certainly correct that diphthongs share melodic material in some cases: The (unstressed) [eɪ] in *deitar* 'to throw' has an **I**-element that extends over both members. But cases like unstressed [aɪ] as in *pairar* 'to soar' or unstressed [oɪ] as in *açoitar* 'to whip' remain unexplained, as no element is shared between the two halves of the diphthong, despite Carvalho's explicit claim to the opposite.[15] The sharing of elements cannot be the reason why VR is blocked then.

A more likely explanation is the fact that there is by definition a (head-initial) governing relationship holding between the two members of a (falling) diphthong like [eɪ], [aɪ], [oɪ] etc. Shared material *can* be a side-effect of a governing relationship but does not have to be; what is more important is that the governor imposes certain restrictions on the governee and that the governor itself fulfils certain conditions, however stated.[16]

With this in mind, let us reappraise the falling diphthongs of EP. The second member is always either [ɪ] or [ʊ], i.e. vowels that are maximally simple structurally. They can reasonably be assumed to be unaffected by reduction, just as stressed [i] and [u] do not undergo VR when unstressed. The first members of diphthongs are more varied and they are systematically exempt from VR. I will assume that this is because they have a governing duty to do: The head of a diphthong governs the non-head, and this is what blocks reduction.

Again, there is a certain similarity to another one of Charette's ideas, that of government licensing (Charette 1990, 1991), or rather the blocking thereof. Let us briefly look at this. Government licensing is the notion that the governor (head) of a branching onset (e.g. the *-t-* in Engl. *t̲ree*) or of a coda-onset cluster (the *-t-* in *unt̲il*) needs a license to actually govern. This license derives from the following nuclear head; so in *tree* [triː] the vowel [iː] licenses the [t] to govern its complement [r], and in *unt̲il* [ənˈtɪl] the [ɪ] licenses the [t] to govern its complement [n] etc. Furthermore, (Québec) French demonstrates what happens when government licensing conflicts with proper government. A word like *marguerite* [maʁɡəˈʁit] 'daisy' contains a schwa (i.e. a realised empty nucleus) even though that empty nucleus is followed by a realised

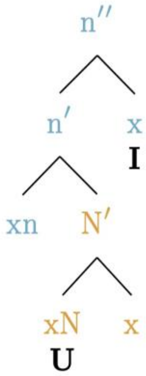
15 Carvalho (2011: 57, ex. 11b), taking falling diphthongs as branching nuclei as in Kaye, Lowenstamm & Vergnaud (1990), gives [aɪ] as a structure where an **A**-element is linked to both halves of the diphthong, and an **I** to the second half only. Why this does not yield a realisation more akin to [ae], since the offglide contains both **A** and **I**, remains unaddressed and unexplained by Carvalho.

16 The precise conditions vary by author. Kaye, Lowenstamm & Vergnaud (1990) assume that the individual nature of elements plays a role (their so-called charm value), as does Kaye (2000) by pointing out the excellent governing abilities of **A**, while Harris (1990) relies more on the absolute number of elements, i.e. the internal complexity of a segment.

vowel ([i]) which should act as a proper governor. And yet, proper government fails, because the empty nucleus has to government license the head [g] of the preceding coda-onset cluster [ʁg]. Schwa is spelled out because the empty nucleus has to do its duty and cannot be p-licensed.

The scenario where the government licensing duties of an empty nucleus block proper government is of course very similar (at least in spirit) to what we see in EP diphthongs: Even though diphthongs are fairly complex structures, VR fails to apply to the head of a diphthong because that head has an offglide to license. (13) gives the representation of [oɪ], with [o] as the head of the diphthong and an offglide [ɪ].

(13) [oɪ]



Diphthongs are treated as complex nuclei in GP 2.0, with melody of the offglide integrated as a specifier (of xn). I submit that this offglide needs to be licensed since it contains melody, and it is this licensing that 'saves' the diphthong from undergoing VR. In a manner of speaking, the diphthong forms an island. Similar island-like behavior can be shown for complex nuclei in Mandarin, cf. Živanovič & Pöchtrager (2010) for details.[17]

The idea that complex structures fail to undergo VR can be extended to nasal vowels, as also argued by Carvalho (2011). Their historic origin of vowel plus nasal consonant is still reflected in their synchronic distribution, i.e. they behave as complex nuclei comparable to diphthongs. If the nasality element **L** is assumed to sit in the same position where offglides sit in (13), the immunity of nasal vowels to VR will follow.

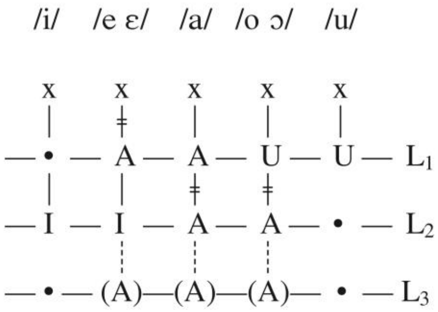
5. Conclusions

This article has argued that VR in EP can be adequately modelled within GP 2.0, in particular under the assumption that openness is expressed as structure, instead of by the element **A**. VR simply consists of the removal of certain layers of structure, with loss of melody ([ɛ/e] → [ɨ]) being a side-effect of the loss of the particular positions that the elements sit in. By way of conclusion, let us compare the present account of EP with that in Carvalho (2011) which, while couched within a more classic version of GP, still shows interesting parallels.

[17] In earlier examples, e.g. in (9), xn in its entirety (i.e. along with the specifier) was targeted/removed by VR; but in all those earlier examples the specifiers were empty.

In his insightful article, Carvalho shows that a successful analysis of VR in EP requires at least two ingredients: (i) The element **A** (he employs the classic trio **A**, **I**, **U**) needs to be allowed to occur multiple times within a given segment to model openness. In this, Carvalho explicitly follows Schane (1984). (ii) Elements need to be hierarchically arranged on individual tiers to model asymmetries in their behaviour. Example (14) reproduces Carvalho's (2011: 61, ex. 18) representation of the EP vowels.

(14)



The vowels [ɛ/ɔ] have one more **A** than their less open counterparts [e/o] (hence the **A** in brackets), otherwise [e/ɛ] and [o/ɔ] are identical. The vowel [a] has three **A**'s, and the representation with only two **A**'s is intended to cover the vowel [ɐ] that [a] stands in complementary distribution with before nasal onsets.[18] Since those tiers are hierarchically ordered (L_1, L_2 etc.), VR can thus be modelled as the loss of the highest **A** with all elements depending on it: If an [e/ɛ] loses the highest **A** along with everything that it dominates, nothing remains (=[ɨ]) etc. Notice that certain tiers can remain empty, which is indicated by a dot.

Even from this very short presentation it becomes clear that the present account owes a tremendous debt to Carvalho's work (even though the two were independently conceived, and for different purposes). However, despite numerous points of contact, there are at least three areas where the analysis I presented here seems preferable, and we will now look at them one by one.

The first issue, and also the most important one, has to do with the nature of **A**. While Carvalho's conclusion that **A** is different from other elements is certainly correct, the solution cannot simply be to allow multiple occurrences of the same element, since a number of facts would go unaccounted for: Allowing multiple instances of **A** would raise the question why other elements cannot do the same. (Faust 2017 does assume that any element can occur up to twice; but that then obscures the special nature of **A**.) Also, if **A** can be repeated twice or three times, why not more often? If there is a natural upper limit (and distinctions in aperture do seem to have a limit), then what is it determined by? Both kinds of criticism have also been levelled at Schane's Particle Phonology (cf. Broadbent 1996 for discussion). Finally, one characteristic property of **A** is not only that it seems to occur multiple times, but also

[18] Neither Carvalho nor I have anything to say on *why* [ɐ] appears before nasal onsets, and I will leave open at this point whether it needs to be represented at all. In the present account the distinction between [a] and [ɐ] could be represented in the same way as Carvalho does: Give [a] an additional specifier of xn and reserve the representation that was given for [a] in (7) for [ɐ] instead.

that it interacts with structure, as shown in sections 3.1 and 3.2 (and references given there). Allowing for several **A**'s in a segment does nothing to address that particular property. In contrast, all these three aspects follow from fundamental assumptions within GP 2.0: The element **A** seems to interact with structure because it is structure itself; there is no *element* **A**, only structure that expresses what in the past was expressed by an element. At the same time, this also explains why other elements behave differently (because they are really elements, for all we know). Lastly, there is an upper limit to how big the structures can be, and that is given by the two heads and their potential to project maximally twice.[19]

The second issue where our present account differs from that by Carvalho is its cross-linguistic scope: Carvalho's account is tailormade for EP, while the analysis presented here draws upon insights from other reduction cases and beyond. To be fair, one has to start somewhere, and Carvalho's account could certainly be extended to several of those other phenomena. But to the extent that it seems unable to take into account interactions with structure it remains unsatisfactory. Furthermore, within GP 2.0 the role that each head plays has become clearer over time (cf. footnote 8 and references therein on the role of xn), while it is unclear what the role of Carvalho's tiers is, beyond providing segment-internal organisation.

The third and final issue to be discussed here has to do with the actual modelling of VR in Carvalho (2011) and the difference in reduction patterns of vowels following an empty onset vs. a realised onset. When discussing (14), we saw how removal of the highest **A** and everything dependent on it takes us from [e/ɛ] to [ɨ]. But if the hierarchy in (14) is correct, there is no potential route that could take us from [e/ɛ] to [i] before an empty onset: The element **I** on L_2 in [e/ɛ] is dominated by an **A** on L_1, and if we want to keep **I** (for a front vowel) then the highest line we can cut is between L_2 and L_3, thus retaining **A** in L_1. Put differently, there is no way to keep **I** without also keeping one **A**, so no way to create a high vowel. In order to account for the reduction patterns in nuclei following empty onsets, Carvalho has to assume that the tiers are reorganised in this particular context, such that L_1 and L_2 swap places. **I** thus becomes the highest element in the hierarchy, and will remain even if other material is cut away.[20] There is no motivation for why that interchange should happen (except that it is needed to account for the facts) and why it should happen in that particular context. Contrast this to the analysis presented here, where both VR patters can be modelled as successive removals of layers of structure, and where a link between the type of onset and the amount of reduction is established via the notion of proper government.

While many open questions remain also within the GP 2.0 account of European Portuguese vowel reduction, I am confident that it is a step towards a better understanding of the internal structure of vowels.

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[19] One could argue that having two heads is arbitrary, too, and such criticism is correct in the sense that there being exactly two does not follow from any more basic assumption of the theory. There is, however, a certain parallel in syntax with having two types of verbal head, v and V.

[20] I will not reproduce Carvalho's example (24), where that reorganisation is shown, as it seems to have been compromised in some way in the typesetting process and suffers from various issues: Several association lines are missing, [ə] is shown as containing **A** and **I** even though the text makes clear that it does not contain **I** etc.

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