Enhancing stressed /a/ low frequency components in the context of sonorants. Some proposals on the phonological representations

Leonardo M. Savoia
Università di Firenze

1. Introduction

In this article two main topics are addressed: the treatment of vowel-sonorant interaction processes and, as a crucial point, the nature of phonological representations. As to the first point, data from some Italo-Romance and Romansh varieties will be examined. In particular the relation between segmental phonological content and its prosodic manifestation will be explored combining the experimental observations with the documented phenomena. The second point has been recently explored and in particular the most debated points concern the explanatory role of structure and its relation with the melodic content of segments (Kaye 2014, Pöchtrager and Kaye 2013, Pöchtrager 2006, 2015, van Oostemdorp 2013).

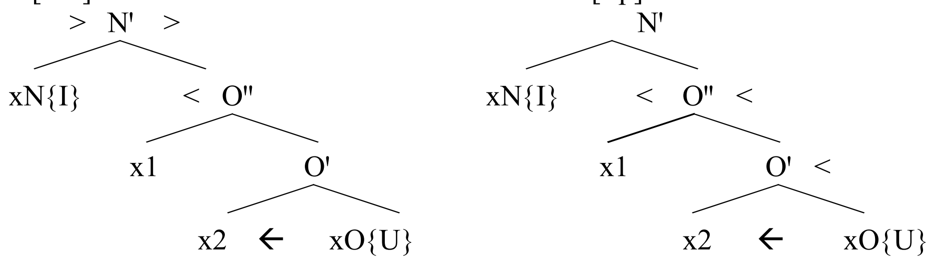
In what follows the fundamental tenets of Government Phonology (GP) will provide the starting point for analysis. In this light, prosodic organization and licensing relations between positions will be analysed as a reflex of the phonological content of segments in the relevant domains. A fundamental point I will adopt is the requirement concerning the phonetic interpretability of representations, assuming the *Projection principle* and *Non-arbitrariness* of processes (Kaye 1986/87, Kaye 1990, Kaye, Lowenstamm e Vergnaud 1990). The consequence of these constraints, preserved in successive versions of the theory, is that "all phonological representations are fully interpretable at any stage in a phonological derivation". (Kaye and Pöchtrager 2013)".

2. Some theoretical and empirical questions

In a classical GP framework (Kaye 1990, Charette 1991, Harris 1994, Kaye, Lowenstamm, Vergnaud 1990) the acoustic potential of a segment depends on whether it is in a licensed position or is a licenser or governor. A critical point is the relation between the phonological potential of the segments and the structural and prosodic organization, insofar as some degree of redundancy is present in the autosegmental model. With *Non-segmentalist Hypothesis* Jensen (1994) aims to reduce these redundancies, assuming that acoustic differences of segments "are direct phonetic interpretations of particular positions within the constituent structure". The structure is to be "understood weakly as the governing and licensing relations that obtain between points in a given domain" (Jensen 1994: 73). In particular, a line of this type has inspired the CV model proposed in Lowenstamm 1996. Recent discussion in GP has applied the idea that at least a part of the traditional melodic properties can be treated as structural properties. Pöchtrager (2006, 2010), Pöchtrager & Kaye (2013), and Kaye (2014) support a revision of GP whereby processes concerning the melodic content of segments can be reduced to structural relations, a solution that has the undesirable effect of multiplying abstract positions.

For the sake of clarity, let us consider the proposal by Pöchtrager (2006) and Pöchtrager and Kaye (2013), whereby prosodic structure is a sort of recursive projection of the nucleus (cf. van Oostendorp 2013). In this approach, for example, strong consonants contrast with weak consonants in terms of the structural properties inherent in single segments, as in (1a,b), where xN and xO are possible heads.

(1) a. [rɪ:b] b. [rɪp]



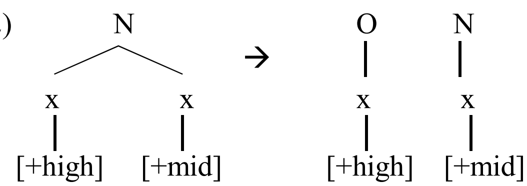
So, the contrast between [bɪt] and [bɪ:d] is represented by the two strutture in (1a,b) (Pöchtrager 2006: 71), projected on the basis of two types of relations, m-command (>, <), whereby "the interpretation of a terminal node A controls the interpretation of terminal node B" and control (←), a licensing "that does not contribute to length" (Pöchtrager and Kaye 2013: 57). In (1a), the nucleus licenses (m-commands) the first position inside the following consonants, as suggested by the > and <, which is realized as the weak variant [b]. In (1b), it is the consonant head that also licenses its highest position, giving rise to the strong outcome [p]. So, the number and interpretive power of the phonological distinctions can be re-interpreted in terms of structural positions and their relations..

Another direction is, however, at hand, namely dealing with structure as an externalization procedure of melodic properties in the string. In other words, the melodic content can be understood as what it appears to be, i.e. the true side of the prosodic interpretation. Actually, there are grounds for reconsidering the idea that constituent structure is the exhaustive way of representing relations between elements. Pursuing a minimalist line of analysis, Chomsky (2013) proposes a revision of phrase structure grammar PSG whereby the order of constituents depends on third factor externalization procedures at the Sensory-Motor interface (cf. Manzini and Savoia submitted). In particular, the computational operation that forms the syntactic objects, namely *Merge*, yields non-ordered couples (sets) of the type {X, Y}. Applying this idea to the structural categories in phonology, we can assume that an operation of phonological *Merge* takes phonological objects, x and y, and forms a new object, i.e. the set {x,y} - a domain. The sequential order of phonological segments/ positions in the time seems to be a primitive SM property. Nevertheless, other structural arrangements emerge in phonological representations as well, as head-complement relations in syllable, foot, etc., that can be interpreted as the result of procedure of externalization at the SM interface, in the sense of Chomsky 2013.

If we are on the right track, we can think that the arrangement of the phonological elements is not fixed once and for all by an universal structural model. It will correspond to the ability of a segment to play a prominent role and take in its scope other elements in the string. In this perspective, metrical constructs are projected from heads, vowels or consonants, which license the phonological atoms which they combine with. In other words, prosodic structure is a reflection of the phonological content present in the string. So, syllable, stress, foot, are interpreted by virtue of the Sensory-Motor properties which occur in the string and express the different domains of prominence/ licensing. Similarly the order head-complement inside the constituents does not need to be preliminarily fixed, but follows from licensing, as the ability of the stressed vowel to subsume and control the melodic properties in the string. Relations between adjacent consonants, like sonorant-obstruent, i.e. traditional coda-onset combinations, derive in turn from the sonority degree and the cavity content of the segments.

Consider, by way of an example, rising (light), like [jɛ wɔ], vs falling (heavy), like [ai au], diphthongs. Usually the literature based on metrical models and GP assign different structures to rising diphthongs, treated as contour segments or syllabic sequences, and to falling diphthongs, considered true complex nuclei. So, the head role is assigned to the first position inside the nucleus. This excludes the possibility of interpreting rising diphthongs as a realization of a binary nucleus. Along this line, Booij (1989), resuming a proposal of Anderson (1974), analyses the rising sequences of Frisian, like [fwotən] *fuotten* "feet", as combinations where the first part is associated with the syllabic onset. According to Booij (1989: 326) a process of breaking removes the first parts of the diphthongized mid vowels from the nucleus, associating it to the onset through the universal CV-rule that assigns a prevocalic segment to the onset (cf. Levin, 1985), as in (1).

(2)



In GP this asymmetry is expressed in terms of a universal constraint requiring left-right governing inside the constituents (Kaye 1986/1987, Kaye, Lowenstamm and Vergnaud 1995); this solution is substantiated in Harris (1990) on the basis of the requirement whereby the head cannot be less complex than the governed position (Complexity Condition). So, Harris (1990: 276) considers only heavy diphthongs genuine ones, assuming that "in branching nuclei the governee can only ever be simplex", so only nuclei as (3a,b) are true diphthongs.

(3) a. N [au] b. N [ei]

```
     N                 N
    / \               / \
   x   x             x   x
   |   |             |   |
   A   U            A, I  I
```

Fallacies in this characterization of diphthongs are highlighted in Pøchtrager (2015); in particular, he points out that the Complexity Condition does not exclude diphthongs like *ia*, i.e. typical light diphthongs. Nevertheless, in other approaches, complex nuclei including onglide sequences are admitted on the basis of general considerations concerning sonority prominence. For example, Harris (1985) analyses Spanish rising diphthongs, occurring both in open and closed syllables, cf. [ˈhjerro] *hierro* "iron", [ˈpwerta] *puerta* "door", assuming that anyway the full vowel has the role of head in virtue of its sonority degree. Actually in many languages the distribution of rising diphthongs is sensitive to the syllabic structure, connecting them to the open syllables exactly like falling diphthongs in other languages. This distribution characterizes standard Italian (Marotta 1988), as in (4):

(4) [ˈpjɛde] "foot" vs. [ˈpɛtto] "chest"
[ˈrwɔta] "wheel" vs. [ˈpɔrta] "door"

A natural conclusion is that a clear-cut distinction between rising and falling diphthongs on the basis of their relation with syllabic contexts is not proved by the data. Pøchtrager (2015) and Kaye (2014) submit a treatment that gets over the impasse that occurs in the traditional analysis of diphthongs, by assigning a richer structure to the vocalic sequences, reproducing traditional X-bar organization of syntactic phrases. So, the difference between light and heavy diphthongs is accounted for by the different points of insertion of onglide, in a spec position (further removed by the head), and offglide (closer to the head) in an adjunct to the head position, as in (5).

(5)

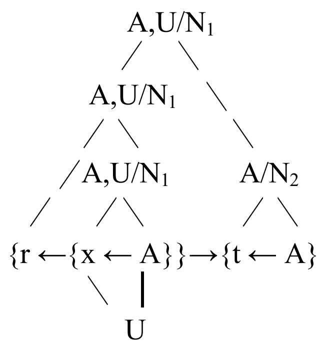
```
          NP
         /  \
        x    N'
  onglide   /  \
          xN    x
         /  \   offglide
       xN    x
      head
```

These structural solutions show the same difficulties as the cartographic treatment of syntax, in the sense that sequencing of elements gives rise to rigid universal templates, with the effect of a large recourse to the stipulation. Anyway, important insights are implied in the proposals of Pøchtrager and Kaye: in particular, the idea that some sort of embedding characterizes phonological structures/ categories, as shown in

(1) and (5), and that the coda consonant is simply the consonant licensed by the nucleus, as in (1a).

In what follows I will try to apply a revised and reduced notion of structure in phonological representations starting from the representation of diphthongs. In the light of a minimalist model the organization in syllabic sequences is understood as the projection from the segmental content inside the string. Diphthongs can be represented as a set including two slots hosting cavity properties sufficient/ specialized to license the stress domain. In the spirit of Pöchtrager 2006, Pöchtrager and Kaye 2013, the structural relations can be reduced to licensing of the melodic content in the sequence. We go a step further and assume that licensing is nothing but the concord between the prominent part and the complement in a domain created by combination (merge) mechanism. Labelled structure or arrows indicate licensing, where licensing involves the ability of a nucleus (or eventually of a consonant) to authorize a phonological string, i.e. its domain. Normally a domain involves either properties sharing, like in (4), or other types of properties concord or simply phonological fullness/ prosodic strength, i.e. the scope (between braces) of a phonological content, e.g. the nucleus in (6). In (6) the projection is marked by the prominent combination, for example [A,U] and [A] in the case of the second domain, and alternatively N_1, N_2 is indicated.

(6)



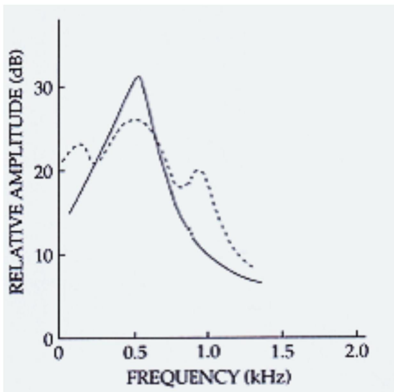
[ˈrwɔta]

Then, there is no longer need for a head as a category fixed in virtue of a particular structural constituent, but all that is needed is identification of the phonological content which is perceptively prominent or determination of the melodic properties of the other slots in its domain. In particular, in (6) the prominent part of the nucleus takes the second part in its scope of licensing (domain) admitting both right-left and left-right orders. So, the order head-V or V-head depends on the different SM level interpretations associated with the vowel slots.

3. Nasals and liquids

In the phonetic and descriptive literature the effects that nasals and liquids exert on the surrounding vowels are well known. Generally speaking a nasal or liquid context involves a low first formant frequency in the spectrum that can be connected with enhancing low frequency components in the adjacent vowels. Stevens (1997: 486) highlights the fact that the velopharingeal port in the nasal consonants introduces two resonances, one around 250-300 Hz and the other around 800-1.000Hz. Nasalized vowels imply increasing the bandwidth of the first formant, enhancing low-frequency energy in the glottal spectrum and introducing an additional prominence in the spectrum over the first formant. On the whole, nasality causes flattening of the spectral structure in the vicinity of F1 due to the widening of F1, thus reducing the prominence of F1 as an "isolated peak" (Stevens 1997:484-485), as the graph in (7) illustrates. In (7) the continuous line shows the spectral envelope for a non-nasal mid vowel in the F1 region. The dashed line illustrates the modified spectrum when the same vowel is nasalized. The overall result of nasalization is a levelling of the spectrum in the region of F1.

(7) Stevens (1997: 486)



This characterization of nasality allows us to connect both low-mid properties and nasality in the spectrum. For example, in many languages nasality effects show up in particular on stressed /a/ favouring a low frequency component in the vocalic spectrum. Concerning liquids, Stevens (1997: 488) notes that "there are three general properties of liquids and glides…: a reduced low-frequency spectrum amplitude, an additional decrease in amplitude at high frequencies, and a reduced prominence of the second or third formant peak." In fact, the empirical data register a specialized range of vocalic phenomena in liquid contexts, where the low frequency spectral region is exploited. A link between low frequency components and duration in vowels is highlighted in experimental research, e.g. see Maddieson (1997). We know that conditions being equal, lower vowels are longer. Moreover, vowels that precede voiced consonants are longer than those preceding unvoiced consonants; in high vowels F0 is on average higher than in low vowels. Finally F0 is lower in correspondence of voiced consonants.

Krakow et al. (1987) observe that the low-frequency component of nasals (FN) leads to two different effects according to the height of the adjacent vowel. If we consider the oral vowel F1 frequencies as "hypothetical target values" the following picture emerges:

- In a high/ mid vowel, nasalization determines lowering by shifting F1 frequency upwards. FN is higher than F1 determining the "lowering" effect.
- In low vowels an opposite result appears, i.e. raising. The low-frequency component of the nasal is lower than the vocalic F1 and a raising effect is determined when FN is prominent.

More to the point, enhancing the low frequency component of an original low vowel and its upward shift (a > ɛ/ ɔ) can be a manifestation of the syllabic duration as well.

Acoustic properties of nasals and liquids can account for the quality adjustment observable in adjacent vowels. In particular we will concentrate on the acoustic effects of nasal or liquid contexts on the low vowel [a]; specifically, a lower F1 is favoured which creates the configuration of a low-mid vowel [-high, -ATR]. According to the vocalic prototypes in the corpus UPSID (UCLA Phonological Segment Inventory Database) in [+back] low-mid vowel [ɔ] F1 is around 561 Hz and in [-back] low-mid [ɛ] F1 is about 536 Hz, i.e. values which are much lower than the F1 of [a], typically about 742 Hz. In the systems we will examine acoustic effects of nasality induce a peripheral cavity configuration realized as [ɔ]/ [ɛ] or as a diphthong, which increases the low resonance properties.

3.1. Vowels in nasal contexts: Velarization

Consider the vocalism of Romansh Surselva (*Vattiz*) and Engadine (*Müstair*) varieties, where stressed [ɔ] corresponds to an etymological /a/ in contexts where it is followed by a nasal in coda, __*NC*, including original geminate nasal, as in [ɔn] "anno", as in (8a)-(9a). In a subset of dialects, a following liquid selects in turn a velarized outcome, as we will see below. Before a velar nasal in word final position or in intervocalic position [au]/ [ɛu] occur, according to different varieties, as in (8b)-(9b). As suggested by transcription, in these contexts word final or onset nasal in (8b) is realized as velar or pre-velarized [ᵑn]. Labials and palatals imply a geminate structure, which closes the rhyme, as suggested by [ɔ] in (8c)-(9c). Data in (8d)-(9d) illustrate the occurrence of stressed [a] in all other contexts, independently of the nature of the following consonant and syllabic structure. In the *Müstair* variety, the outcome [au] also occurs in some contexts of closed rhyme. More precisely, the diphthong precedes __ *N[-voiced]* contexts, in (9a), whereas [ɔ] occurs in __ *N[+voiced]* contexts, in (9a').

(8) *Vattiz*

a. context ___ N_{coda}]
[jau ˈkɔntəl]/ [nus kanˈtain] "I sing/ we sing", [ˈkɔmba] "leg", [ɔn(s)] "year/s"

b. context ___N
[mɛuŋ] "hand", [tʃɛuŋ] "dog", [pɛuŋ] "bread", [sɛuŋ]/ [ˈsɛuᵑna] "healthy.m/f"
[ˈlɛuᵑna] "wool"

c. [ju ˈklɔməl] "I call", [fɔm] "hunger", [bɔɲ] "bath"

d. [na:s] "nose", [sa:l] "salt", [ˈka:za] "house", [fra:(rs)] "brother/s",
[bratʃ]/ [ˈbratʃa] "arm/s", [ˈvaka] "cow"

(9) *Müstair*

a. context ___ N_{coda}]

[jau ˈtʃaunt]/ [nu tʃaunˈtaiŋ] "I sing/ we sing"

a'. [grɔnd]/ [ˈgrɔnda] "big.m/f"

b. context ___N

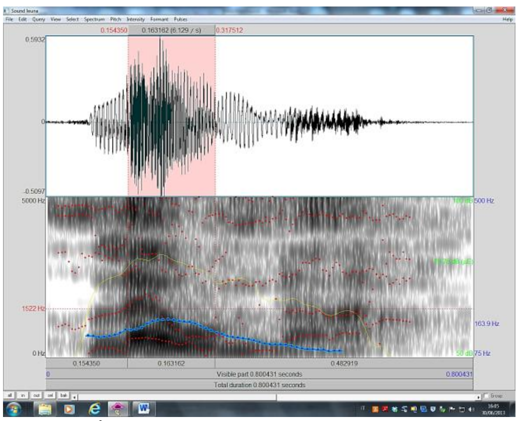
[mauŋ] "hand", [tʃauŋ] "dog", [grauŋ] "corn", [duˈmauŋ] "tomorrow" [ˈlauŋa] "wool", [sauŋ]/ [ˈsauŋa] "healthy.m/f", [ɛ:s ˈfauŋ] "they make.3pl"

c. [i ˈklɔmən] "SCl call", [fɔm] "hunger", [ˈjɔma] "leg", [tʃɔmp] "field", [ɔŋ(s)] "year/s"

d. [na:s] "nose", [ba:p] "father", [ˈsa:l] "salt", [ˈa:la] "wing", [tʃarn] "meat", [bratʃ]/ [ˈbratʃa] "arm/s", [ˈvatʃa] "cow"

Descriptively, these outcomes can be dealt with by assuming that nasals spread a velar resonance component that can be realized as [U]. Stressed nuclei in the contexts where the nasal is not in the domain of a following consonant, subsume resonance properties of the nasal it licenses. The association of element [U] with the velar configurations is motivated in the literature (Backley 2011), on the basis of a great deal of empirical evidence which brings to light the link both between round back vowels and velar consonants, and between labial and velar consonants. This is particularly clear in the contexts where the diphthong is realized in the presence of a velar or (pre)velarized quality of the final or intervocalic nasal, as in (8b)-(9b). The spectrogram of [ˈlɛuŋna] in (10) illustrates this realization.

(10) *Vattiz*



[ˈl ɛ u ᵑn a]

In (10) a clearly perceptible velar appendix is realized in an intervocalic context that extends the velar part of the diphthong combining with the coronal specification of the nasal.

Now, the question is how this assimilation can be analysed in a coherent theoretical framework. As has been seen, licensing operations concerning stressed nucleus and its immediate domain are represented assuming a simpler notion of structure, as discussed around (6). The present proposal is that positions and licensing (prominence) relations derive from the phonological potential of segments, which triggers licensing, i.e. properties sharing, as in (6), or other types of properties concord. Licensing corresponds to the ability of a nucleus or another phonological element to authorize a phonological string, i.e. subsume (a part of) its prosodic/ melodic properties. As for the content of nasals, according to Harris and Lindsey (1995), and Backley (2011), it includes an inherent acoustic low frequency configuration expressed by [L]. In our varieties this low frequency property is interpreted by [U] in the vowels. The difficulty is evident: Element Theory does not provide any way for connecting this acoustic component with the cavity content of vowels. Tentatively, we propose that the stressed vowel [A] licenses a low frequency component, as in (11):

(11) A stressed nucleus corresponds to a sequence in which:
 a. [A] licenses an element realizing a low F1 [U]/ [I]
 b. [A] licenses the phonological content in its domain.

The different possibilities in (11) depend on the different prosodic domains where stressed nucleus acts as a licenser. Consider first the case of diphthongs in (8b)-(9b), where the licensing mechanism is implemented by the sharing of the [U] element. In (12) the stressed nucleus takes on the [U] element, licensing it. Since the final nucleus is devoid of phonetic instantiation, the head vowel [ɛ] is the sole licenser of the velar nasal in its domain, as indicated by the arrow between the two braces. The nucleus subsumes the low-frequency properties of the nasal in the form of the colour element [U]. In this light, metrical structure is nothing but the arrangement determined by content properties of the vowel.

(12)
```
        N
       / \
tʃ {{A → x}→{L   ∅ }
     |     \   |
     I       U
```
[tʃɛuŋ]

In the contexts where the nasal is an intermediate onset, as in (12), a long nucleus is admitted which realizes in turn the [U] element as its complement position, licensing through sharing of [U] associated with the following nasal. Alternatively, if selecting a second position is excluded, licensing is implemented by realizing the [U] element inside the vowel, as in (13).

(13)
```
      N
      |
k {{A}→ x }→{b ← a}
     \    |    /
          U
```
[ˈkɔmba]

The head vowel [ɔ] includes the low-frequency component in its domain, subsuming this property. If the nasal is followed by a consonant (in traditional terms, it is a coda), the short nucleus [ɔ] occurs, as in (13). In this case the low frequency element [U] is directly associated with the vowel content. This solution seems to be insensitive to the cavity configuration of the nasal, whereby velarization of /a/ emerges in labial, coronal and palatal contexts as well. So, stressed nucleus includes the head [A̲] combined with the element [U], "spectral low peak" (Harris & Lindsey 1995, Harris 1996). In these varieties, nasals enhance their intrinsic acoustic configuration [L] selecting the component [U]; in other words, the stressed vowel interprets the low frequency configuration requiring [U], as in (8a,c)-(9a',c).

(13) characterizes a sequence in which the two consonants share a part of their content, namely [U]. Phonological content sharing corresponds to the traditional coda-onset context, in which normally the following consonant is assumed to govern the preceding one. In our terms we will say that the first consonant is in the immediate domain of the vowel, as indicated by the braces in (13).

3.2. Micro-variation in nasal contexts

A phenomenon connected with formant lowering discussed in the preceding paragraph is colouring of /a/ in contexts where a long outcome is realized. An example is provided by the system of *Garbagna* (Piedmont), where [ɔ:] realizes a long stressed /a/, (14d), including nasal and liquid contexts, (14a, a',b). The diphthong [ɑu] is triggered by an intervocalic nasal, (14c). Nasals are (pre)velarized in intervocalic/ final position, in (14b,c). A short [a] occurs, (14d,e).

(14) *Garbagna*
- a. context__ N_{coda}]
  [a ˈkɔ:ŋtu] "I sing", [a ˈmɔ:ŋdʒu] "I eat", [ˈkɔ:mpu] "field"
- a'. [ˈlɔ:rgu] "large", [ˈsɔ:rʑu] "willow"
- b. context __N#
  [mɔ:ŋ] "hand", [kɔ:ŋ] "dog", [sɔ:ŋ] "healthy"
- c. context __NV
  [ˈsɑuŋa] "healty.f", [ˈrɑuŋa] "frog", [ˈlɑuŋa] "wool"
- d. [ˈnɔ:zu] "nose", [a ˈlɔ:vu]/ [a laˈvuma] "I wash/ we wash", [sɔ:] "salt"
- e. [ˈvaka] "cow", [ˈgatu] "cat"

The data in (14) show that nasals and liquids in coda combine with long [A] stressed vowel. As in the case of velarization, lenghtening combines with a more complex content including [U], as in (15)-(16).

(15)
N
/ \
n {A → x} → {z ← u}
| /
U
[ˈnɔ:zu]

(16)

```
        N
        |
k{{A → A}→ x } → {t ← u}
    \ / /    |
     U       L
```

[ˈkɔ:ŋtu]

Lengthening in the head position of the foot enhances the downward shift of F1, selecting colour resonances that can be shared with the nasal. In [ˈlɑuŋa] in (14c) lengthening and velarization combine. The nasal is independently licensed by its following nucleus; the diphthong [ɑu] licenses the domain subsuming the element [U], as in (17).

(17)

```
       N
      / \
l { A → x }→{L← A}
     \  |  /
        U
```

[ˈlɑuŋa]

In the variety of S. Nazzaro Sesia (Novara) in (18) the outcome [ø] occurs before a nasal in coda or a word final nasal, as in (18a,b). In the other contexts in (18a',d,e), including intervocalic position in (18c), the realization [ɑ] appears. [ø] is anyway present in the system, corresponding to stressed original /e/ in closed syllable, as in (18a').

(18) *S. Nazzaro Sesia*

a. context ___ N_{coda}]
[ˈgømba] "leg", [grønt]/ [ˈgrønda] "big.m/f", [kømp] "field",
[i ˈkønt]/ [i kanˈtuma] "I sing/ we sing"

a'. [frøtʃ] / [ˈfrøtʃa] "cold.m/f", [søk]/ [ˈsøka] "dry.m/f", [ˈʃøndra] "ash"

b. context ___N#
[møŋ] "hand", [pøŋ] "bread", [køŋ] "dog"

b'. [fa:m] "hunger"

c. context ___NV
[ˈlaŋa] "wool",

d. [na:s] "nose", [sa:l] "salt"

d'. [kaˈdɛŋa] "chain", [ˈsɛda] "silk", [ˈstɛla] "star"

e. [ga:t] "cat", [ˈvaka] "cow"

The occurrence of [ø] is connected to contexts in which the nasal is in coda or is followed by an empty vocalic position, like in (18b). In both contexts the nucleus is the only available licenser for the nasal. In these contexts the realization [ø] interprets its prominence by introducing the low frequency components [I,U]; an especially rich content is externalized as in (19).

```
(19)      N
          |
   p {{A }→{L  ∅}
        | \    |
        I   U                      [pøŋ]
```

Velarization of stressed /a/ adjacent to a nasal emerges in many Central-Southern Italian varieties. The system of *Gallo* (Caserta) shows [ɔ], variably nasalized, in all contexts with nasal, both preceding and following, independently of the syllabic position of the nasal, as illustrated in (20a-e). So, velarization emerges when the nasal is in coda, in (20a), in the following onset, in (20b), and in the preceding onset, in (20c). [ɔ] occurs also in stressed final position, as in (20d), where it includes a nasal resonance. The examples in (20e) document the occurrence of [a] in the other contexts. Surface alternations [ɔ] vs [a] are present, as the data in (20b,c') show. We can derive velarization of /a/ in *Gallo* variety from the same explanation we have adopted for the preceding varieties. The interesting difference is that in (20) the preceding nasal is operating as well, selecting [ɔ] in the stressed vowel, as in (21); phonosyntactic contexts are included, as illustrated in (20c').

(20) *Gallo*

a. [ˈkɔntə] "I sing", [ˈpɔnnə] "cloth"
b. [ˈkɔ:nə] "dog", [ˈfɔ:mə] "hunger", [ˈcɔ:mə]/ [caˈmɔ:tə] "I call/ you call"
c. [ˈnɔ:sə] "nose", [ˈnɔ:tə] "born", [ˈmɔ:lə] "ill"
c'. [ˈn ɔ:ku]/ [ˈl a:ku] "a needle/ the needle"
d. [kanˈtɔ] "to sing", [llɔ̃] "there"
e. [aˈla:və] "I wash", [ˈsa:lə] "salt", [ˈvakkə] "cow"

```
(21)          N
             / \
   L ←{{A → x} → { s ← ə }
         |  /
         U                            [ˈnɔ:sə]
```

The fact that there are grammars, like that of *Gallo* in (20), in which velarization applies also in contexts where the nasal precedes the stressed nucleus, confirms the idea that classical intrasyllabic relations are not sufficient to account for the assimilatory processes. Indeed, we could expect that the relation between onset and nucleus is not so strong to induce a left-right assimilation. Generally the nucleus subsumes properties in its rhyme domain or in the vowels in its foot domain. In this case it is sensitive to the acoustic properties of the onset, normally left out by the metrical models for the prosodic computation. This point has already emerged in cases like (12), (19), where a following nasal in a position identifiable with the onset of an empty nucleus, is suitable for being phonetically interpreted (licensed) by the preceding stressed nucleus, as in (21). Again, this context is not a canonical licensing context for the vowel. These facts lead us to conclude that many aspects of the traditional syllabic and foot structural implementation are too restrictive, cutting out possible relations between the segments in the string. Naturally, GP structural principles capture important assimilatory phenomena in terms of government or licensing, but many phenomena escape the relations defined by the theory suggesting a treatment based on a different notion of structure.

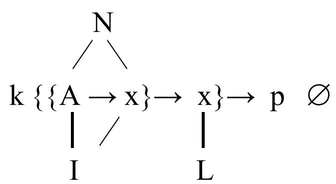
A second point concerns the fact that nasality does not necessarily involve velarization. In the Lombard-Alpine variety of *Villa di Chiavenna* in (22), [ɛ] realizes the original /a/ before a nasal in coda (22a), in onset (22b), in final position (22c). In the other contexts [a] occurs independently of duration.

(22) *Villa di Chiavenna*

a. [kɛ:nti] I sing", [kɛ:mp] "field"
a'. [ˈgambɛ] "leg", [gra:nd]/ [ˈgrandɛ] "big.m/f"
b. [ˈsɛ:nɛ] "healthy.f", [ˈlɛ:nɛ] "wool", [ˈrɛ:nɛ] "frog"
c. [mɛ:n] "hand", [sɛ:n] "healthy.m", [kɛ:n] "dog",
d. [ˈkaɲɲɛ] "bitch", [ˈkannɛ] "reed"
d'. [al me ˈtʃammɛ] "he calls me"
e. [a me ˈla:vi] "I wash up", [tʃa:f] "key", [na:s] "nose"
f. [al ˈparlɛ] "he talks", [ˈvakɛ] "cow", [gat] "cat"

Lowering of F1 in the stressed nucleus exploits the nasal low frequency subsuming it, in the rhyme domain or in its foot, as in (23). Colour element [I] is not shared by the nasal; it concurs to realize the low F0 frequency properties of the following nasal.

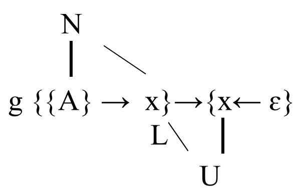
(23)



[kɛ:mp]

[ɛ] is excluded in contexts where a nasal precedes a voiced obstruent in (22a'), which preserve [a]. If we relate the realization of [ɛ] to a wider phonological space in the nucleus, we must conclude that a voiced obstruent is computed in the domain of the nucleus, without making its lengthening possible, as in (24). More precisely, resonance properties of a voiced obstruent are able to contribute to the acoustic interpretation of the domain.

(24)



[ˈgambɛ]

(24) recalls the proposal of Jensen (1994), resumed in Pöchtrager (2006, 2012), whereby only unvoiced obstruents govern the coda, while a voiced obstruent is unable to license the preceding nasal. In reality, (20) only suggests that a voiced obstruent can be interpreted in the domain of a nucleus without requiring a specialized implementation of it.

Palatalization to [ɛ] characterizes the realization of /a/, both stressed and unstressed, in the variety of *Molfetta* (Apulia) in (25). In this system as well all nasal contexts, including phonosyntactic ones, trigger fronting, as illustrated in (25a) for word-internal contexts and (25b) for syntactic contexts, giving rise to alternations like in (25b').

(25) *Molfetta*
a. [ˈnɛ:sə] "nose", [ˈmɛ:nə] "hand", [mɛˈraitə] "husband", [ˈkɛmbə] "field"
b. [lɛ ˈmɛ:nə] "the hand", [ker altɛ: ˈmɛ:nə] "the other hand",
b'. [ɔn ɛˈpɛrtə] 'they.have open" vs [aˈpɛrtə] "open"

In conclusion, we can expect that nasality can be realized through palatalized outcomes including, in turn, a lower value of F1. Naturally, the process that brings about the particular realization is instantiated at SM level, before that phonological mechanism subsumes it.

4. Stressed vowels preceding liquids

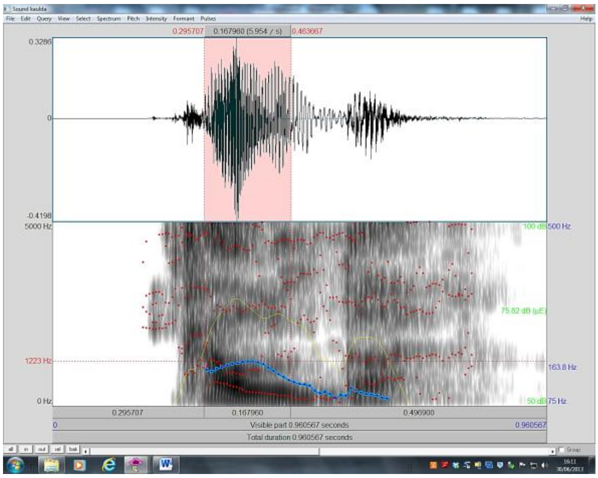
In many varieties velarization emerges in contexts __*lateral C.* In the case of *Vattiz* [au] corresponds to an original stressed /a/, in (26). The diphthong occurs in the contexts where the lateral precedes a coronal [t d] or a palato-alveolar [tʃ] in onset, in (26a). Elsewhere, [a] is realized, (26b). Analogously, in the dialect of *Villa di Chiavenna*, the velar outcome [o] occurs in contexts where a lateral precedes a coronal, like in (27a); elsewhere we find [a], as in (27b).

(26) *Vattiz*
a. [kaul^{t}]/ [ˈkaulda] "warm.m/f", [ault]/ [ˈaulta] "tall.m/f", [faultʃ] "scythe"
b. [ˈpalma] "palm"

(27) *Villa di Chavenna*
a. [o:lt]/ [ˈoltɛ] 'high/ a', [ko:lt]/ [ˈkoldɛ] 'caldo/ a', [fo:ltʃ] 'falce', [ˈoltrɛ] 'altra', [ko:lts] 'calzini'
b. [ˈmalgɛ] 'malga', [falˈkevillat] 'falchetto'

Stevens (1997: 488) characterizes acoustic properties of liquids as "a reduced low-frequency spectrum amplitude, an additional decrease in amplitude at high frequencies, and a reduced prominence of the second or third formant peak". The spectrogram in (28) shows the acoustic configuration of the lateral in [ˈkaulda]. In particular the lateral has a 216Hz F1 and a 1320Hz F2. These values coincide with those given in Ladefoged and Maddieson (1996: 193) for the velarized lateral. So, the adjacent lateral determines the downward shift of F1 towards the values of [u], around 300Hz, favouring a second phase [u] in the diphthong, or, in Lombard varieties, a low-mid back vowel [ɔ]/ [o].

(28) *Vattiz*



[ˈk a u l d a]

The effect induced by the liquid is to favour an acoustic configuration similar to that of back vowels, which can be characterized by assigning [U] to the lateral (cf. Backley 2011).

Again, [au] realizes velar properties connected to the downward shift of F1, manifesting lengthening, as in (29). In other words, lateral can be licensed by virtue of the duration of the head nucleus in the domain. Possibly, sharing [U] with following lateral enhances the licensing capacity of the nucleus.

(29)

N

k {{A → x}→ L}→ {d ← a}

A U [ˈkaulda]

An interesting point is manifested by the distribution in (26)-(27): labial and velar consonant following lateral block velarization in spite of the fact that they include the element [U], involved in velarization. A possible explanation is that velarization is a mechanism that contributes an accessory vocalic content to the adjacent vowel implementing its prominence. In these dialects, [U] is associated to the stress domain and this prevents consonants endowed with [U] from sharing this property with the prominent vowel in the domain.

4.1. Introducing [A] in contexts of liquid

Lowering of the low-mid front vowels to [a] before coronal trills characterizes Corsican (*Munacia*) and Gallurese (*S. Teresa di Gallura*) varieties. In Corsican, the original front low-mid vowel opens to [a] in the contexts where [r] closes the stressed rhyme, as in (30a) where [r] is followed by an obstruent, and in (30b) for geminate consonants. Back low-mid vowel is preserved, as in (30c).

(30) *Munacia*
- a. [kuˈparta] "blanket", [aˈpartu] "open" , [ˈarba] "grass"
- b. [ˈtarra] "earth", [ˈsarru]/[sarˈrɛmu] "I lock/ we lock"
- c. [ˈpɔrta] "door", [ˈdɔrmu] "I sleep"

In Gallurese varieties in (31), [r] is preserved in the contexts of geminate, in (31b), while in preconsonantal contexts a lateral [lʲ] occurs.

(31) *S.Teresa di Gallura*
- a. [kuˈpalʲta] "blanket", [ˈpalʲdu]/ [palʲˈdimu] "I.lose/ we.lose"
  [ˈsalʲpi] "snake", [tʃalʲˈbeɖɖu] "brain"
- b. [ˈtarra] "earth", [ˈfarru] "iron"

[A] resonance component is licensed in the nucleus which realizes it, in (32). [a] in contexts in (30)-(31) can be viewed as the result of the stressed nucleus subsuming frequency components of the following sonorant that it licenses. In other words, licensing is satisfied by including [A] in the prominent part.

(32)
N
| \
{{A}→A}→{b←a}   [ˈarba]

Finally, let us consider the lowering phenomenon that characterizes Romagna varieties. In these dialects, stressed nuclei followed by a liquid in their immediate domain (in coda) have the same outcome, in (33a), that occurs in open syllable as well, in (33b). The diphthongs [ɛɐ] and [ɔɐ] occur respectively from original /a/ and /ɔ/.

(33) *Alfonsine*
- a. [kɛɐlt]/ [ˈkɛɐldз] "warm.m/f"
  [lɛɐrg]/ [ˈlɛɐrgз] "large.m/f"
  [pɔɐrk] "pig"
- b. [ˈɛɐvз] "bee"
  [ˈroɐdз] "wheel"

Pöchtrager (2006, 2010) and Pöchtrager and Kaye (2013) highlight the relation between [A] and structural properties, as duration and height of the nucleus. In particular, Pöchtrager (2006, 2010, 2012) examines the distribution of long or diphthongized nuclei in English in contexts *coronal nasal-C* and *r-C*, as in [tɔːnt] *taunt*, [bɔːrd] *board* which show a systematic relation between intrinsic properties of the nucleus and sonority degree of the consonant sequence. The presence of [A] in the vowel relates to sonority properties of the consonant. So, *nd* can follow both vowels devoid of [A] and including only [A], *rd* can follow vowels with head [$\underline{\text{A}}$], *nt* can follow any expression with [A]. There is a complex of phenomena where [A] interacts with non-melodic properties, i.e. length and laryngeal mechanisms, in different languages. For example, in French nasalized nuclei are long and long nuclei must contain [A]. A relation exists that involve length, nasality and melodic properties of [A]. The conclusion of Pöchtrager (2010) and Pöchtrager and Kaye (2013) is that [A] can be treated as a structural property, corresponding to an adjunction, whereby [A] introduces a sort of reduplication. Naturally a question arises: why does this solution concern only [A]? In fact we have seen that [U] and [I] are involved as well in contexts where sonorants favour the lengthening of the stressed nucleus. If so, all elements could or should be translatable into distinctive structural configurations, with the paradoxical result of assigning the structure a complete descriptive power.

In the present proposal, diphthongs [ɛɐ ɔɐ] can be treated as the effect of lengthening in contexts where the expansion of the nucleus is able to license a liquid by including its resonance component [A]. In other words, [ɛɐ ɔɐ] allow liquids to anchor in the acoustic space of their licenser, as in (34).

(34)
```
        N
       / \
k {{A → x}→L }→ t  ∅
   |      \ |
   I        A                [kɛɐlt]
```

We know that in standard GP framework liquids [l r] have a phonological content which allow them to be governed by the sole following onset. Coronal tap has a phonological content coinciding with the single component [A] (Pöchtrager 2006, Backley 2011). Lateral sounds are more complex including the manner element [ʔ] besides the cavity property (Harris and Lindsey 1995). In general, in the terms of Halle and Stevens (1971), features [spread glottis] and [slack vocal cords] put together sonorants and vowels, so suggesting that simple sonorants like [l r] are sufficiently vocalic to admit a larger autonomy compared with obstruents. In virtue of these properties liquids accept to be governed by the sole following consonant, even in the contexts where its licenser nucleus is not realized.

Naturally we do not leave out the fact that diphthongs [ɛɐ ɔɐ] include a second position [A]. We could conclude that these diphthongs permit liquids to anchor to the acoustic space of the nucleus licensing them independently of prosodic structure. The liquid shares [A] with melodic content of the stressed nucleus. In particular, the combination of a long nucleus with the sequence *r-obstruent* can be related to a structure where the weak coronal [r] is in the onset of a unrealized nucleus, as in (19).

A final velar obstruent is licensed on the base of its phonetic force; [r] is licensed by the nucleus with which it shares its melodic content.

5. Conclusions

We have concentrated on cavity and duration properties of stressed nuclei in contexts preceding a sonorant and in contexts involving the acoustic space associated to long nuclei. In both cases the creation of a complex stressed nucleus corresponds to the insertion of a cavity component triggering F1 lowering effects in the vowel. Colour and length properties in the stressed nucleus license a second cavity component, manifesting its licenser role in the prosodic domain. In accordance with Walker 2011 (cf. Kaun 1995) the stressed/ strong nucleus subsumes resonance properties in the string, thus preserving their informational/ interpretive force.

The preceding discussion has highlighted that there is no descriptive means for expressing downward shift of F1 in sonorant contexts without having recourse to intrinsic properties of [I] and [U]. In other word we have simply connected [L] in sonorants with [I], [U] in the nucleus. Naturally we could assume that it is [L] that corresponds to the [downward shift of F1] property, as in (35), reproducing (12).

```
(35)          N
             / \
     tʃ {{A → x}→{x   ∅ }
          |      \   |
          I        U                     [tʃɛuŋ]
                   L
```

In (35) the different interpretations [u] and [ŋ] for [U, L] would depend only on the type of licensing, inside the nucleus and outside the nucleus. This, however, would introduce a redundant specification for vowels, in the sense that [I], [U], already imply this acoustic property.

A second main subject examined in this article concerns the nature of phonological representations. We have pursued a model based on a ‘merge’ mechanism which creates domains in which a prominent melodic content licenses the other segments. In particular, we assume that the structure is derived by projecting from the licensing element, step by step. This perspective aims to reduce the strong explanatory capacity that many authors assign to the structural relations, and to capture the role of the melodic content as the true device which construes the prosodic organization of the string.

As for the status of phonological procedures in the grammar, we note that phonology is strictly intertwined with the interpretive content of lexical items and sentence, that it expresses. In the light of the proposals of Berwick and Chomsky (2011: 15) phonology and morphology are “the linguistic processes that convert internal syntactic objects to the entities accessible to the sensorimotor system”. This is compatible with the hypothesis that processes as metaphony, propagation, assimilation and dissimilation are not insensitive to the morpho-syntactic information, that they concur to externalize. So, licensing mechanisms are involved in enhancing the perceptibility of phonological features, as in phenomena we have explored in this research.

References

Backley, Phillip. 2011. *An Introduction to Element Theory*, Edinburgh, Edinburgh University Press.

Berwick, Robert and Noam Chomsky. 2011. "The biolinguistic program: the current state of its evolution and development". In Anna Maria Di Sciullo and Cedric Boeckx (eds.), *The Biolinguistic Enterprise*, 19–41. Oxford, Oxford University Press.

Booij, Geert. 1989. "On the representation of diphthongs in Frisian". *Journal of Linguistics* 25, 1: 319-332.

Charette, Monik. 1991, *Conditions on phonological government*, Cambridge, Cambridge University Press.

Chomsky, Noam. 2005. "Three Factors in Language Design". *Linguistic Inquiry* 36, 1, 1-22

Chomsky, Noam. 2013. "Problems of projection". *Lingua* 130, 33-49

Halle, Morris and Kenneth N. Stevens. 1971. "A note on laryngeal features". *MIT Quarterly Progress Report* 101: 198-212.

Harris, James W. 1974. "Evidence from Portuguese for the 'Elsewhere Condition' in phonology". *Linguistic Inquiry* 5 (1): 61–80.

Harris, John. 1990. "Segmental complexity and phonological government". *Phonology* 7: 255–300

Harris, John. 1994. *English Sound Structure*, Oxford, Blackwell.

Harris, John. 1996. "Phonological output is redundancy-free and fully interpretable". *UCL Working Papers in Linguistics* 8: 1-26.

Harris, John and Geoff Lindsey. 1990. "Phonetic interpretation in generative grammar". *UCL Working Papers in Linguistics* 2: 355-369.

Harris, John and Geoff Lindsey. 1995. "The elements of phonological representation". In Jacques Durand and Francis Katamba (eds.), *Frontiers of phonology*, London, Longman: 34-79.

Jensen, Sean. 1994. "Is P an Element? Towards a Non-segmental Phonology". *SOAS Working Papers in Linguistics & Phonetics*, 4: 71–78.

Kaun, Abigail. 1995. *The Typology of Rounding Harmony. An Optimality Theoretic Approach*, Ph. D dissertation, UCLA

Kaye, Jonathan. 1986/87. "Government in phonology. The case of Moroccan Arabic". *The linguistic Review*, 6: 131-159.

Kaye, Jonathan. 2014. "The Ins and Outs of phonology". In Sabrina Benjaballah, Noam Faust and Mohmed Lampitelli (eds.), *The Form of Structure, the Structure of Form*, Amsterdam & Philadelphia: John Benjamins: 255-269.

Kaye, Jonathan, Jean Lowenstamm and Jean-Roger Vergnaud. 1990. “Constituent structure and government in phonology”. *Phonology* 7:293-231.

Krakow Rena A., Patrice S. Beddor, Louis M. Goldstein and Carol A. Fowler. 1987. “Coarticulatory Influences on the Perceived Height of Nasal Vowels”. *Haskins Laboratories - Status Report on Speech Research*, 92: 31-53.

Ladefoged, Peter and Ian Maddieson. 1996. *The sounds of the world’s languages*. Oxford, Blackwell.

Lowenstamm, Jean. 1996. “CV as the Only Syllable Type”. In Jacques Durand (ed.), *Current Trends in Phonology Models and Methods*, European Studies Research Institute, University of Salford: 419-442.

Maddieson, Ian. 1997. “Phonetic Universals”. In William J. Hardcastle and John Laver (eds.), *The handbook of phonetic sciences*, Oxford, Blackwell: 619-639.

Manzini, Maria R. and Leonardo M. Savoia. submitted. *Enclisis/ proclis alternations in Romance: allomorphies and (re)ordering*.

Marotta G. (1988), “The Italian diphthongs and the autosegmental framework”. In Pier Marco Bertinetto and Michele Loporcaro (eds.), *Certamen phonologicum, Papers from the 1987 Cortona Phonology Meeting,* Torino, Rosenberg & Sellier: 389-420.

van Oostendorp, Marc. 2013. “σ strikes back: A defense of headedness and constituency in phonology**”.** *The Linguistic Review*, 30(2): 347 – 371.

Pöchtrager, Markus. 2006, *The Structure of Length*, Ph.D. thesis, University of Vienna.

Pöchtrager, Markus. 2010, *The Structure of A*, communication at the “33rd GLOW Colloquium”, Breslavia.

Pöchtrager, Markus. 2012, *Beyond the segment*, online relation, CUNY Conference on Segment, New York City.

Pöchtrager, Markus. 2015. “Binding in Phonology”. In Marc van Oosrendorp and Henk van Riemsdijk (eds.), *Representing structure in phonology and syntax*, Amsterdam & Philadelphia: John Benjamins: 255-275.

Pöchtrager, Markus and Jonathan Kaye. 2013. “GP2.0”. *SOAS Working Papers in Linguistics*, 16: 51-64.

Savoia, Leonardo M. 2015. *I dialetti italiani. Sistemi e processi fonologici nelle varietà di area italiana e romancia*. Pisa, Pacini.

Stevens, Kenneth N. 1997. “Articulatory-Acoustic-Auditory Relationships”. In William J. Hatdcastle and John Laver (eds.), *The Handbook of Phonetic Sciences*, London, Blackwell: 462-506.

Walker, Rachel. 2011, *Vowel patterns in language*. Cambridge, Cambridge University Press.