Metaphony with unary elements

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1. Introduction

In this article[1], I analyze several vowel harmony systems, generally referred to as metaphony. These systems (which come in many different varieties; see below) have been described or analyzed in terms of binary features, either using the feature [±high] (Walker 2005) or [±ATR] (Calabrese 2011) or in terms of unary features. In the latter case some authors have supported the use of unary features (Maiden 1991; Canalis 2016; d'Alessandro & van Oostendorp 2016), while others have argued against their use (Kaze 1991). In this article, I adopt the use of unary elements, such as the 'AIU' system that has been proposed in Dependency Phonology (Anderson & Ewen 1987), Government Phonology (Kaye, Lowenstamm & Vergnaud 1985), with some modifications that have been proposed in Radical CV Phonology (van der Hulst 2005, in prep.; van der Hulst & van de Weijer, to appear).

My main goal is not to motivate in general that unary features are preferred over binary features. Rather, given that we use unary elements, I investigate which set of such features is required and how metaphony is best formally represented. Kaze (1991) has argued that an 'AIU' system fails to provide an adequate analysis of metaphony, based on the argument that in such a system it is not immediately obvious how one can account for processes that are triggered by high vowels (such as [i] and [u]), arguing that the 'AIU' system is unable to treat high vowels as a natural class of vowels that share the property 'high'. Similar objections have been raised in Clements & Hume (1995). Staun (2003), making reference to discussions of other processes that seemingly require access to a feature [high] in dependency-based analyses, remarks that "[I]n each such account the notion of a negated component, in particular negated |a| has played a central part. […] despite the claims of both Clements and Hume and Kaze, a unique specification of high vowels is perfectly possible within the dependency-based model, viz. as |~a|." Clearly, there is a 'risk' in appealing to (the spreading of) negated elements when one advocated for a unary feature system. Here I will take a different route. Whatever the merits (and dangers) of using negated elements, the adoption of a unary system does by no means imply a necessary commitment to the 'AIU' set, without any other features. Indeed, Anderson and Ewen (1987), as well as Kaye, Lowenstamm and Vergnaud (1985), propose additional features. The set of features in binary or unary systems can vary, depending on various considerations, both empirical and theoretical. The choice between binarism or unarism does not depend on the analysis of specific processes. As discussed in Kaye (1988) and van der Hulst (2016a), postulating a unary system is by and large the null hypothesis, since, keeping the set of feature 'names' constant, treating these 'names' as unary features leads to a more restricted theory; it only allows for half the number of natural classes and processes. Additionally, a unary system provides a head-on answer to the problem of markedness that was 'noted' in chapter 9 of Chomsky & Halle (1968). For these reasons, my point of departure is to explore the consequences of a unary approach which, then, requires a specific choice of unary features. While the 'AIU' set of features is well-founded and widely used, my own

[1] This article uses material from chapter 6 in van der Hulst (to appear-a). I am grateful for two anonymous reviewers for their very useful comments.

work has pursued a theory of features which derives the actual set of features from several general factors, which are partly grounded in the phonetic substance that features capture, and partly in cognitive principles of categorization of the phonetic substance. In section 2 I will outline this model, called Radical CV Phonology (RcvP), that adheres to these considerations. A specific consequence of this theory is that the set of features contains a feature that roughly refers to the notion 'high'. In section 3, I will then explore how in this model metaphony processes can be handled. Given the enormous variety of metaphony systems, it will not be possible to do justice to all reported systems. The data that I will analyze are all drawn from Calabrese (2011). As shown there, in various Romance dialects metaphony is morphologized. Such case can perhaps best be accounted for in terms of lexically listed allomorphs. The focus in the present article is on metaphony that relies on phonological conditions only which I assume is the case in at least some of the dialects that Calabrese discusses.

2. The framework[2]

Radical CV Phonology (RcvP for short, van der Hulst (1995), (2015a), (2015b), (in prep.); van der Hulst & van de Weijer (to appear) is a version of Dependency Phonology (DP; Anderson & Ewen 1987).[3] This model adopts the following principles:

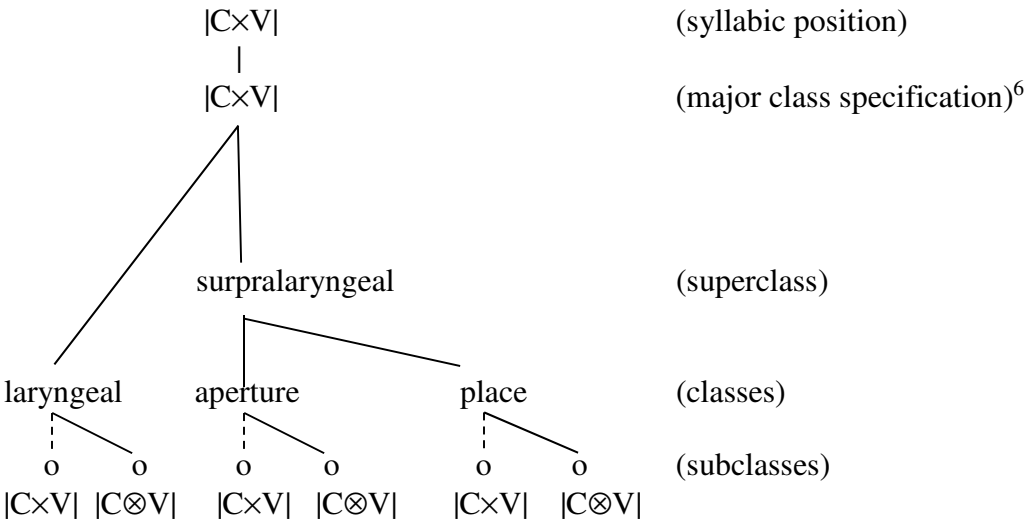
(1) Fundamental principles of my proposal

a. Phonological primes are unary (they are called *elements*), organized into classes[4]
b. There are only two elements: |C| and |V| which occur in all classes
c. Element specification is *minimal*
d. Vowel harmony involves the *licensing* of *variable* elements in nuclei, with licensers typically being vowels in adjacent nuclei that contain a licensed instance of the relevant element
e. A variable element is phonetically interpreted only if it is licensed
f. Licensing is strictly *local*

In (2) we represent the full RcvP geometry:

[2] See van der Hulst (to appear-a, chapter 2) for details concerning the model summarized in this section.
[3] The present state of RcvP differs somewhat from van der Hulst (2005), making use of a discussion of this proposal in Anderson (2011b), who, in his turn, adopts some aspects of van der Hulst (2005), thus modifying some of the proposals in Anderson and Ewen (1987).
[4] The idea to acknowledge element classes occurs in the earliest version of Dependency Phonology (e.g., see Anderson & Jones 1974). The same idea later led to versions of what was called 'feature geometry' (see Clements 1985).

(2) The 'geometry' of elements in Radical cv Phonology[5]



The various labels for the classes are for convenience only and have no formal status in RcvP. Each unit in the structure can be defined in purely structural terms. The elements |C| and |V| are also strictly formal units, which, depending on their place in the segmental structure, correlate with specific phonetic properties. Additionally, their interpretation is also dependent on the major class specification and the syllabic position of the entire segmental structure. This means that both elements have several different (albeit related) interpretations (on this see (5) below).

How is segmental phonological complexity encoded in this model? Within a head class, an element can occur alone or in combination. In (2), the symbol '×' means that elements *can* combine and enter into a dependency relation. This allows for a four-way distinction, given here in two notations:

(3) a.

C	C | V	V | C	V

b. {C} {C;V} {V;C}[7] {V}

[5] This geometry deviates somewhat from the one adopted in Anderson & Ewen (1987) and bears a close resemblance to the original geometry that was proposed in Clements (1985). In van der Hulst (in prep.) this model is compared to other models with which it shares certain properties.

[6] It is assumed here that the major class specifications and syllabic positions, although both characterized as C/V structure are distinct; see van der Hulst (in prep.) and van der Hulst and van de Weijer (to appear) for motivation and discussion.

[7] DP uses 'x;y' to indicate that x is the head and y is the dependent. Underlining, used in Government Phonology, is an alternative notation to indicate headedness.

The two elements can furthermore occur in a secondary (dependent) subclass[8], where, however, element combinations are *typically* not allowed[9] (which is indicated by the symbol '⊗' in 2). This, in principle, allows the following list of representations for each class, where the lower case symbols represent the secondary occurrence of the element:

(4)

{C}	{C;V}	{V;C}	{V}
{{C}c}	{{C;V}c}	{{V;C}c}	{{V}c}
{{C}v}	{{C;V}v}	{{V;C}v}	{{V}v}

In van der Hulst (2015b), it is proposed that the limitation of the set of elements to two units per class can be seen as resulting from a basic principle of categorization (rooted in categorical perception), called the Opponent Principle which creates perceptually maximally opposed categories.[10] Assuming that each subclass in (4) correlates with a 'phonetic dimension', |C| and |V| correlate with (and phonologize) maximally opposed phonetic categories ('polar opposites') within such a dimension. While the elements are strictly formal, cognitive units, they do correlate with phonetic events (or phonetic categories, covering a subrange of the relevant phonetic dimension). In fact, we can think of elements as (subconscious) cognitive percepts and propriocepts that correlate with phonetic events/categories.[11] The relation between formal units such as elements and phonetic events is referred as Phonetic Interpretation (PI), which embodies a set of interpretation functions (see 5). Naturally, since the elements |C| and |V| occur in all classes, these elements correlate with a wide variety of phonetic interpretations. Additionally, interpretation is dependent on syllabic position and major class specification:

[8] This distinction is also adopted in Anderson (2011a, volume 3).

[9] In van der Hulst (in prep.) I motivate this, referring to the fact that in a dependency approach it is 'natural' for dependent to display fewer structural options than heads; see Harris (1990) and Dresher & van der Hulst (1998).

[10] A question that could be asked is why the Opponent Principle (or an extended version thereof) does not enforce four phonetic spaces rather than three. This is because the emergence of categories is also dependent on the phonetic substance which, in specific cases, does not allow for a four-way distinction. This is discussed in van der Hulst (in prep.),where it is also shown that there are only three major class categories (obstruents, sonorant consonants and vowels).

[11] I assume that elements have both an acoustic correlate (a percept) and an articulatory plan (a propriocept).

(5) Phonetic Interpretation Functions for elements in head classes

PI (|Man: C|, head class, consonant, onset) = [[stop]]
PI (|Man: C|, head class, vowel, nucleus) = [[high]]

PI (|Man: V|, head class, consonant, onset) = [[fricative]]
PI (|Man: V|, head class, vowel, nucleus) = [[low]]

PI (|Place: C|, head class, consonant, onset) = [[palatal]]
PI (|Place: C|, head class, vowel, nucleus) = [[front]]

PI (|Place: V|, head class, consonant, onset) = [[labial]]
PI (|Place: V|, head class, vowel, nucleus) = [[round]]

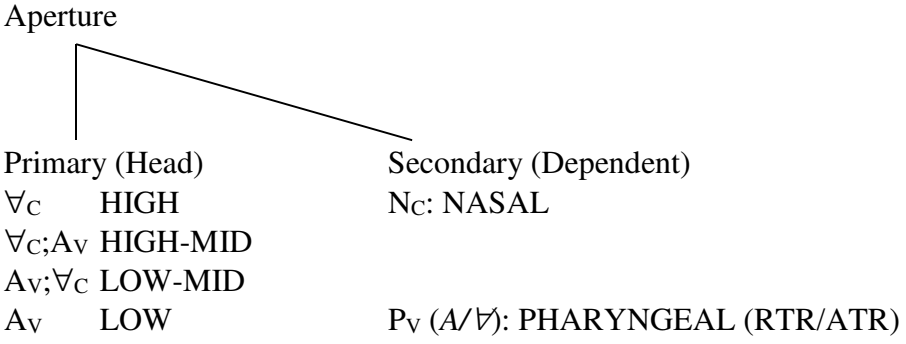
PI (|Lar: C|, head class, consonant, onset) = [[fortis]]
PI (|Lar: C|, head class, vowel, nucleus) = [[high tone]]

PI (|Lar: V|, head class, consonant, onset) = [[voiced]]
PI (|Lar: V|, head class, vowel, nucleus) = [[low tone]]

I refer to van der Hulst (in prep.) for a complete discussion and motivation of all the interpretations.

In this article, I will only be concerned with the aperture class. While the primary subclass indicates aperture differences in the oral cavity, the secondary subclass allows activation of the other cavities, i.e. the nasal and pharyngeal ones. As a shorthand, I will use the common AIU labels (with less common labels such as ∀ and P), here with the C/V 'nature' added as a subscript (which I will not continue to add):

(6)

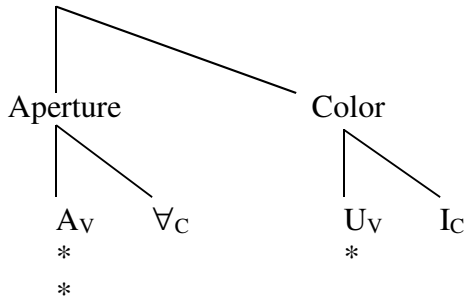


Note that the Opponent Principle 'enforces' a polar counterpart to |A|, symbolized as |∀|, which together creates four degrees of aperture. There are two secondary elements, |N| and |P|, both referring to activation of an extra resonating cavity. The secondary P-element refers to activation of the pharyngeal cavity, which can take two forms: expansion (ATR, indicated with |∀|) or contraction (indicated with |*A*|). I regard these two option as different phonetic *implementations* of the same phonetic *interpretation* (which is simply [[pharyngeal]]) to explain why they cannot both

occur contrastively in the same language. In a sense, these two different phonetic realizations of the pharyngeal cavity element display a C/V split in the phonetic domain.[12]

Minimal specification, (1c), is achieved by following an algorithm proposed in Dresher (2009), the *Successive Division Algorithm* (SDA).[13] This algorithm uses a specific ranking of the elements which I derive from (7), by assigning a grid mark to each head position:[14]

(7) a.



b. Ranking: $A_V > U_V > I_C / \forall_C > \{N_C, P_V\}$

(7b) also assumes that primary elements come before secondary elements (for which I do not postulate a relative ranking). The equal ranking of |∀| and |I| allows for 'free' variation. However, I will assume that |I|, which denotes a more *salient* phonetic event, takes precedence over |∀|, unless this element is non-distinctive (as in Finnish where [i] and [e] are so-called neutral vowels). In section 3 I will explain how the SDA in conjunction with the element ranking in (7b) accounts for *a minimal, redundancy-free representation* of vowel systems.

(1d) presents a crucial innovation of the RcvP account of vowel harmony. The motivation for using the variable notation is that it allows a distinction between invariant 'negative' vowels (i.e. vowels that lack the harmonic element) in *disharmonic roots* and *non-alternating affix vowels* on the one hand, and alternating vowels on the other. Thus, the model allows the following three-way distinction (where 'ε' stands for 'any element'):

(8)

a.	b.	c.
ε	(ε)	–
X	X	X

a = invariant ε (*positive vowel*)
b = alternating vowel, element must be licensed to get interpreted
c = invariant non-ε (*negative vowel*)

[12] My use of italic |∀| and |*A*| is motivated by the fact that their phonetic interpretation is near-identical to that of the primary elements |∀| and |A|.

[13] This algorithm is similar to the notion of 'Recursive Splitting' (following the Opponent Principle) in RcvP (see van der Hulst 2005: 195).

[14] While elements within class nodes can enter in dependency relations with either one being a possible head, both the |A| element and the |U| elements are 'natural heads' in nuclear position. This is because the nuclear position is a V-position which thus favors V-type elements. I do not include a relative ranking for laryngeal elements here, nor a ranking of laryngeal elements with respect to manner and place elements. See van der Hulst (in prep.) for details on these various matters.

This distinction parallels the distinction between [+F], [0F] and [-F] in a binary system.[15] While (8) allows a three-way distinction in how vowels in the lexicon are represented with respect to a given element, this proposal does not undermine the unary nature of the elements. Contrast *in the vowel system* is only expressed through presence or absence of an element. The variable notation encodes that certain vowels *as part of specific morphemes* have a dual character in displaying an alternation between presence and absence of the element. The notation '(ε)' simply means that for the relevant vowel it is undecided *in the lexicon* whether it will surface with or without the element in question.[16]

One potential difference between the present proposal and comparable three-way distinction in a binary system is that the notation in (8) suggests that the two 'marked values' of element |ε| are effectively (8a) ('|ε| is definitely present') and (8b) ('|ε| is potentially present, contingent on licensing'), while (8c) ('|ε| is definitely absent') is unmarked.

(1e) is derived from approaches to vowel harmony in *Government Phonology* (GP; Kaye, Lowenstamm & Vergnaud 1985; Harris & Lindsey 1995; Ritter 1995; Charette & Göksel 1998, among others). In the present model (1e) implies that variable elements that are not licensed remain 'silent'. The notion of licensing has been widely referenced as playing a role in phonological generalizations (see e.g. Walker 2010). In my account of vowel harmony, the key type of licensing will be *lateral licensing*[17] along phonological 'tiers'. I will assume that the default setting for licensing directionality is 'bidirectional'. This is necessary for both root-control systems that have both harmonic prefixes and suffixes and for dominant-recessive systems.[18]

(1f), locality, is a central theme in the discussion of vowel harmony (if not of all linguistic relations). The notion of locality has been used in different ways even within the study of vowel harmony. While virtually all accounts of vowel harmony appeal to some notion of locality, frameworks differ in important details of defining the relationship or in dealing with apparent violations of locality. I will adopt a *strict* interpretation of locality, which avoids mechanisms such 'discontinuous association' or 'feature/element insertion' to account for apparent violations. I emphasize that, for me, locality does *not* mean establishing a relation between two entities that are 'as close as possible' (as proposed in Nevins 2010), but rather between elements that are adjacent with reference to the nuclear tier (*nuclear locality*).[19] Languages that display vowel harmony for some element 'ε' are subject to a constraint of the general format in (9):

(9) All units X in domain D must be positive or negative for element |ε|

In the usual case X=nucleus, but X can also be another element (when we are dealing with bridge locality). The constraint in (9) is satisfied by specifying alternating vowels with the variable element, which automatically triggers the licensing relation. Vowel harmony is thus *not* the result of a (repair) rule that fills in or changes segmental structure.

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[15] Inkelas (1995) exploits this three-way difference in a binary system for much the same purpose that I exploit the three-way distinction in (8).

[16] This notation does not mean 'floating', as in autosegmental models, which is used for different purposes.

[17] In van der Hulst (to appear-a) I also make use of another kind of licensing called *positional licensing*.

[18] In van der Hulst (to appear-a: chapter 4), I propose that licensers must be head elements. This refers to the head status of elements within a class.

[19] To account for some cases of expected 'transparency' I will also invoke *bridge locality*, in which case the locality requirement for licensing is satisfied on an element tier that differs from the harmonic tier (such cases fall under the rubric of 'parasitic harmony', as first described in Steriade (1981), but form a special subclass of this rubric).

A key aspect of my approach to vowel harmony (mentioned for its key importance in the study of vowel harmony, although it is not at issue in this article) is that vowels that refuse to alternate, and as such either block harmony or are (seemingly) 'ignored' by it, should not simply be designated as 'opaque' or 'transparent' on a language-specific basis. In fact, following a proposal made by van der Hulst & Smith (1986), the behavior of non-alternating vowels is largely predictable from their element structure (which depends on the structure of the vowel system). So-called 'transparent' behavior is possible when a vowel is *compatible* with the harmonic element. Thus, a vowel [i] can behave as 'transparent' in a palatal system because it is compatible with the presence of the palatal element |I|. As such, this vowel could carry the harmonic element.[20] On the other hand, vowels that are *incompatible* with the harmonic element, such as a non-advanced [a] in advanced tongue root (ATR) systems are predicted to be opaque, because the licensing relation cannot ignore or 'skip' an intervening vowel, as per strict locality.[21]

The proposed elements allow the following vowel distinctions in terms of primary elements, with in the top row the ATR difference shown for high vowels. Of course, ATR can also apply to mid-vowels and low vowels, which is not shown here; when ATR applies to mid-vowels, there is likely to be only one mid aperture degree. I refer to van der Hulst (to appear-a, b) for detailed discussion of the complementarity of ATR and aperture with reference to mid-vowels.[22]

(10)

	I	I̲U	-	U̲I	U
$\forall_C$ + $\forall$	i	y	ɨ	ʉ	u
$\forall_C$	ɪ (>i)[23]	ʏ	ɨ̞	ʊ̟	ʊ (>u)
$\forall_C$;A_V	e	ø	ʌ	ɵ	o
A_V;$\forall_C$	ɛ	œ	ɐ	æ	ɔ
A_V	æ	ɶ	a	ɑ	ɒ

Kaze (1991) focuses on metaphony in Italian with the specific purpose of showing that 'AIU' models are inadequate. He states that the problem with these models is that there is no equivalent to the feature [+high], which appears to be needed for raising. I will show that RcvP, having adopted the element |∀|, does not 'solve' this issue since this element is *not* an exclusive property of high vowels, being present in all non-low vowels. However, it will be shown here that the model can account for the various types of metaphony in spite of this.

In section 3, following Calabrese (2011), I will discuss two possible analyses of the most common metaphony patterns. The first one mirrors the analysis of Calabrese who used the feature [±ATR], which in RcvP correlates with secondary | ∀|. Due to the particular properties of the RCVP system of elements, this approach necessitates a dual analysis of mid vowels. I will then suggest a

[20] However, such vowels can also act opaquely. In fact, there are four different ways in which a vowel such as [i] can behave in palatal harmony systems, following an important typological study of harmony on Balto-Finnic languages by Kiparsky & Pajusalu (2003). Importantly, none of the four types violate strict locality. See van der Hulst (to appear-a: chapter 4).

[21] Apparent counterexamples to the expected opacity of incompatible vowels can be explained in terms of allowing locality to be defined with reference to another element tier (i.e. in terms of bridge locality). See van der Hulst (to appear-a: chapter 3). A special case of apparent non-locality is discussed toward the end of this article.

[22] This complementarity is dependent on the structure of the overall vowel system as shown in Casali (2003, 2008).

[23] In the absence of an ATR distinction the vowels in this row would be phonetically advanced due to 'enhancement'.

second type of analysis which uses a mechanism of *stress-driven element copy* and conclude that this analysis is superior to the first analysis within the context of the unary feature model that is assumed here.

3. Metaphony in Italian dialects

3.1. Representative examples

Calabrese (2011) provides a comprehensive overview of metaphony in Italian dialects.[24] Metaphony selects stressed vowels are targets. Calabrese notes that in all cases there is raising of high mid stressed [e, o] to [i, u]. The target is thus in a stressed syllable and the trigger is a following *unstressed high vowel*. Low mid vowels ([ɛ, ɔ]) are targets only in certain dialects, and these vowels then raise (to [e, o]) or, more commonly, diphthongize. In this case, the precise nature of the diphthongs varies depending on the dialect ([je], [jɛ], [iə], [ia] and [wo], [wɔ], [uə], [ua]). Calabrese regards the difference between high and low mid vowels in terms of [±ATR] and I will follow him in this respect in the first analysis of the data. In this first RcvP account, I will use the P$_{\forall}$-element (or |∀| for short) as the active element, which corresponds to an ATR interpretation. The following three cases represent three possible outcomes of metaphony for low mid vowels, while in all three high mid vowels raise to high:

(11) The dialect of Calvello (Gioscio 1985)
Metaphonic alternations: [e o] → [i u]; [ɛ ɔ] → [je wo]
a. [+ATR] [e o]

	singular	plural	
masc	súlu	súli	‘alone’
fem	sóla	sóle	
	kavróne	kavrúni	‘charcoal’
	mése	mísi	‘month’
	vérde	vírdi	‘green’

b. [–ATR] [ɛ ɔ]

masc	vjékkju	vjekkji	‘old’
fem	vɛ✎kkja	vɛ✎kkje	

(12) The dialect of Servigliano (Camilli 1929)
Metaphonic alternations: [e o] → [i u]; [ɛ ɔ] → [e o]
a. [+ATR] [e o]

	singular	plural	
masc	kúrtu	kúrti	‘short’
fem	kórta	kórte	

[24] There are numerous descriptions and analyses of metaphony in Romance languages: Blayblock (1965); Calabrese (1985); Frigeni (2003); Kaze (1989, 1991); Zetterstrand (1996); Maiden (1986, 1991); Walker (2011). Here I will base myself on some representative examples that are discussed in Calabrese (2011). Kaze (1989) is based on a study of 90 dialects in which he distinguishes four different types of harmony.

	fjóre	fjúri	‘flower’
	bótte	bútti	‘barrel’
	vérde	vírdi	‘green’

b. [–ATR] [ɛ ɔ]

	singular	plural	
masc	véccu	vécci	‘old’
fem	vɛcca	vɛcce	
masc	pjottsu	pjótsi	‘slow’
fem	pjɔttsa	pjɔtse	

(13) The dialect of Grado (Walker 2005)
Metaphonic alternations: [e o] → [i u]; no metaphony for [ɛ ɔ]

a. [+ATR] [e o]

	singular	plural	
masc	véro	víri	‘true’
masc	róso	rúsi	‘red’
masc	fjór	fjúri	‘flower’
fem	amór	amúri	‘love’

b. [–ATR] [ɛ ɔ]

	singular	plural	
masc	mɔrto	mɔrti	‘dead’
fem	mɔrta	mɔrte	

In several southern dialects, low mid vowels, like the high mid [e o], are raised to high [i u]. This could either be the result of monophthongization of the diphthongs ([ɛ ɔ] → [je wo] → [i u]) or, as argued in Calabrese (1985, 1998), be a direct outcome of raising:

(14) The dialect of Foggia (Valente 1975)

móßßa	múßßu	‘soft FEM SG/MASC SG’
kjéna	kjínu	‘full FEM SG/MASC SG’
pɛte	píti	‘foot SG/PL’
grɔsa	grússu	‘big FEM SG/MASC SG’

Additional variations occur as well. In some dialects, the low vowel [a] can also be raised, becoming [ɛ], [e] or a diphthong [je, jɛ]. In the Teramo dialect of the Abruzzo region, *all* vowels become high: vowels [e ɛ a] raise to [i] and [o ɔ] raise to [u] in a metaphonic context. In some dialects the trigger [u] has lowered to [o]. This change could occur before metaphony started (dialects in which only [i] triggers raising), or after, in which case raising before [o] (<[u]) is derivationally opaque. The change could also take place after raising of high mid vowels but before raising of low mid vowels. In such dialects, metaphony of the high mid vowels is triggered by both

[i] and [o] (<[u]) but low mid vowels only by [i].[25] In many Italian dialects, further changes, such as reduction to schwa, deletion, or raising, have affected final vowels, leading to morphologization of raising. Another cause of derivational opacity occurs when high mid vowels become low mid resulting in low mid vowels having two phonological behaviors in many southern dialects.

3.2. Formal analysis

In this section I will explore two alternative analyses of the data presented in the previous section. The difference lies in the analysis of the 'high mid' vowels [e] and [o]. From studies of African seven-vowel systems it is well-known that seven-vowel systems can either display a distinction between two high series (2H) or between two mid series (1H) (Casali 2003, 2008). Casali (2003: 326 ff.) devotes considerable attention to the fact that the difference between 2H systems with one series of mid vowels and 1H systems may be difficult to establish.

(15) a. 2H-system b. 1H-systems

i	u			i	u
ɪ	ʊ			e	o
ɛ	ɔ			ɛ	ɔ
	a				a

Indeed, he cites cases in which a single language has been analyzed both ways by different linguists or even by the same linguist. Casali (2003, 2008) has shown that 2H and 1H system differ in terms of the dominance of [+ATR] or [-ATR]. In 2H system [+ATR] is dominant, while [-ATR] is dominant in 1H systems. In van der Hulst (to appear-a) I show how the dominance of [+ATR] in 2H systems is due to the fact that the ATR element |ꟻ is necessarily activated. 1H systems in this account distinguish the two series of mid vowels in terms of A-headedness.

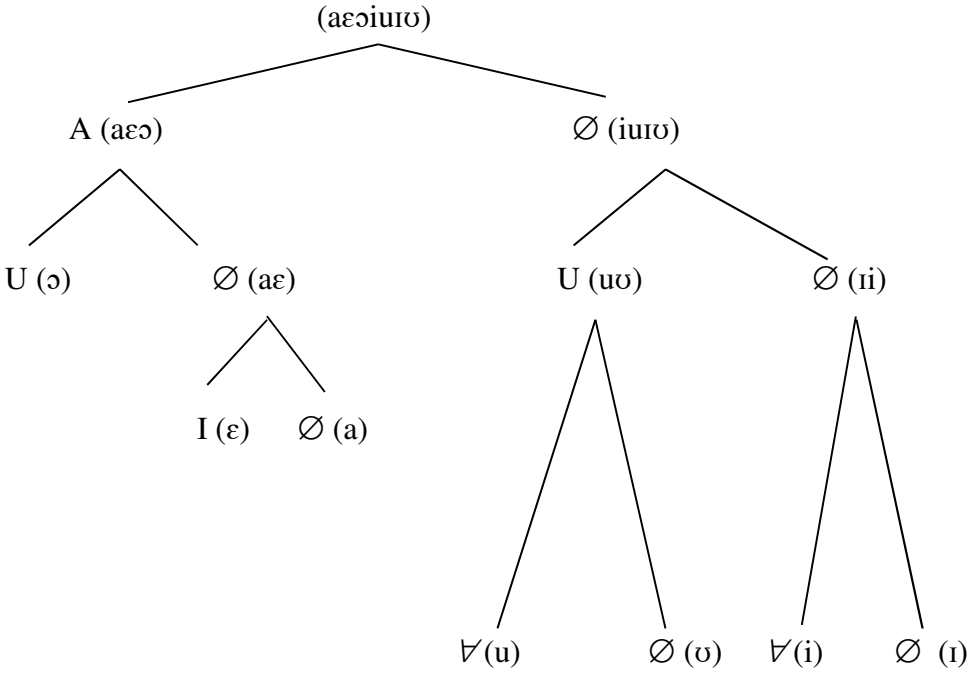
3.2.1. Metaphony in terms of ATR-dominance

If we analyze the Italian seven-vowel system in terms of two high series (as in 15a), the effect of raising can be analyzed as ATR harmony. This implies that that phonetic [e] and [o] are analyzed as bare [ɪ] {I} and [ʊ] {U} with a variable ATR-element. Adopting this choice, let us see how the licensing approach can derive the various types of dialects. In (16a) I show the specification of a seven-vowel system with two high series and one mid series following the SDA and the element ranking in (16b):

[25] This raises a potential problem for the approach in which [o] is the phonetic interpretation of [u] because this would then also necessarily have to attribute the raising of [−ATR] vowels to phonetic interpretation.

(16) A seven-vowel system (aɛɔiuɪʊ)

a.



b.

[ɔ]	[ɛ]	[a]	[u]	[ʊ]	[i]	[ɪ]
A	A	A				
U			U	U		
	I					
			∀		∀	

In terms of this analysis of the vowel system, metaphony in the Servigliano dialect is accounted for as the licensing of variable ATR on stressed vowels by the ATR element of unstressed vowels:

(17) The dialect of Servigliano (Camilli 1929)
Metaphonic alternations: [e o] → [i u]; [ɛ ɔ] → [e o]
Interpretation: [ɪ ʊ] → [i u] in raising context, elsewhere [ɪ ʊ] (18a)
[ɛ ɔ] → [e o] (18b)

With this analysis of the vowel system, metaphony brings about the following changes:

(18)

a.

[ɪ]	[ʊ]	>	[i]	[u]
	U			U
(∀)	(∀)		∀	∀

b.

[ɛ]	[ɔ]	>	[e]	[o]
A	A		A	A
	U			U
I				
(∀)	(∀)		∀	∀

In this analysis, [ɪ]/[ʊ] (when not raised) and [e]/[o] (the product of raising [ɛ] and [ɔ]) must merge into phonetic [e]/[o] due to phonetic *implementation*.[26] In dialects in which [a] also raises to [ɛ], [a] is provided with the variable harmonic element in which case {A ∀} receives the same phonetic interpretation as {AI}.[27]

In the dialect of Calvello, raising of low mid vowels leads to diphthongization:

(19) The dialect of Calvello (Gioscio 1985)
Metaphonic alternations: [e o] → [i u]; [ɛ ɔ] → [je wo]
Interpretation: [ɪ ʊ] → [i u] in raising context, elsewhere [e o]
[ɛ ɔ] → [je wo]

Following Calabrese (2011) I will assume that the diphthongal output of raising low mid vowels is the result of a process of 'breaking':

(20) Breaking

{I/UA ∀}	→	{I/U} +	{I/UA ∀}
		[j/w]	[e/o]

In the dialect of Grado, raising does not affect low mid vowels:

(21) The dialect of Grado (Walker 2005)
Metaphonic alternations: [e o] → [i u]; no metaphony for [ɛ ɔ]
Interpretation: [ɪ ʊ] → [i u] in raising context, elsewhere [e o]
[ɛ ɔ] do not have variable (∀)

Finally, in the dialect of Foggia, all raised vowels end up as [i] and [u]:

(22) The dialect of Foggia (Valente 1975)
Metaphonic alternations: [e o] → [i u]; [ɛ ɔ] → [i u]
Interpretation: [ɪ ʊ] → [i u] in raising context, elsewhere [e o]
[ɛ ɔ] → [i u]

When the output for raising [ɛ ɔ], unexpectedly, yields [i u], this can be interpreted, following Calabrese's idea, as a simplification of the breaking output:

(23) Breaking plus Simplification

{I/UA ∀}	→	{I/U} +	{I/UA ∀}	→	{I/U ∀}
		[j/w]	[e/o]		[e/o]

While the preceding analysis is possible and consistent, it is perhaps not satisfactory, because of the need to represent high mid vowels in terms of two distinct structures. While RcvP does not forbid this kind of phonological ambiguity (see van der Hulst 2016c), I will explore a different

[26] In van der Hulst (to appear-a, c)I motivate that such phonetic merger is always *monotonic*, i.e. it can 'add' phonetic properties not rooted in a specified element, but it cannot ignore an element that is specified.
[27] Technically, this means that raising of [a] is not structure preserving in that it delivers an output that is not a contrastive vowel.

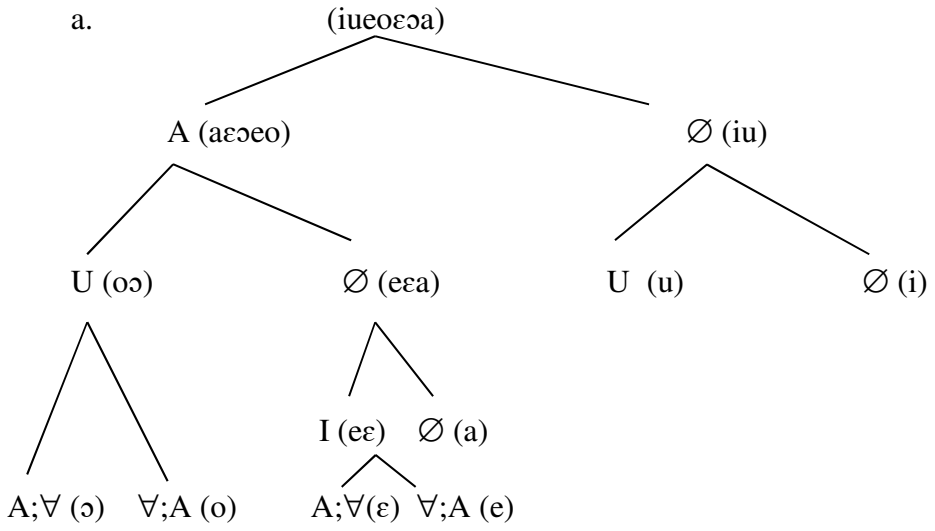
analysis in the next section that attributes metaphony to activity of the primary element |∀|. This analysis avoids phonological ambiguity (which arguably makes it simpler) and it also acknowledges the role of stress, which the previous analysis ignored.

3.2.2. Metaphony in terms of HIGH-dominance

Analyzing the seven-vowel systems as a 1H system leads to the following result:

(24) Seven-vowel system (iueoɛɔa)

a.



b.

[ɔ]	[o]	[ɛ]	[e]	[a]	[u]	[i]
A	A	A	A	A		
U	U				U	
		I	I			
∀	∀	∀	∀			

In this case, there is no reason to activate the secondary ATR-element. The distinction between the mid vowels can be made in terms of headedness, which requires specification of the ∀-element. While African tongue root system that have a 1H vowel system display dominance of [-ATR], which is formally represented in terms of A-headedness "agreement", Italian metaphony takes a different (in some sense, an opposite) route, namely licensing of the ∀-element. The choice between analyzing the harmony as in terms of A-activity or ∀-activity is dependent on which vowels (high mid or low mid) occur in the absence of a harmony trigger. In African systems, the default is high mid, showing that low mid is the result of harmony (i.e. licensing), but in the Italian cases the default is the lower mid vowel, or when the alternation is between [e]/[o] and [i]/[u] (as in the dialect of Grado; 13), the mid vowels as in the feminine singular *amor* 'love'. This shows that the non-raised vowels are the default. Raising is what happens in a specific context, namely when [i] or [u] are following. Thus, while in African 1H systems and alternation between high-mid and low-mid vowels, shows dominance of the low mid vowels (indicated by the arrow in (25)

on the left), metaphony involves dominance of the high vowels [i] and [u] (as indicated by the arrows on the right):

(25)

	[i]	[u] ↑
↓	[e]	[o] ↑
	[ɛ]	[ɔ] ↑

I will now develop an analysis of metaphony which appeals to the ∀-element as the active element. This analysis will make crucial reference to the role of stress.

It has been suggested that the cause for metaphony is that vowels in unstressed position 'weaken' and that this results in the need for licensing. This notion of the need to license elements in the unstressed position is also present in Walker's (2011) account of metaphony. However, by giving stressed vowels the role of licensers, we do not account for the fact that the stressed vowels need to raise. In a sense, stressed vowels always act as licensers for following unstressed vowels, if these vowels form a 'trochaic foot'. Another angle on metaphony is that raising is a direct result of transferring a height feature from the unstressed vowel to the stressed vowel. This notion of transfer is also applied in analyses of umlaut in Germanic languages, where the frontness of unstressed vowels is transferred to the preceding stressed vowel, often followed, in a diachronic sense, by loss of frontness in the unstressed vowels.[28] In the analysis developed here we could say that the height element in unstressed vowels becomes variable (as a formal expression of their reduction), which then necessitates an increase in the preponderance of this same element in the stressed vowels. However, to account for all three possible instances of raising, increasing preponderance *must* be formally implemented in terms of *adding* the |∀|-element (especially when the target of raising is a low vowel which does not contain this element). However, a theory that allows addition of elements runs the danger of being too powerful, unless element addition is somehow constrained. We could therefore propose that elements can only be added if needed to license a variable element. This means that the added element must be identical to the variable element. Alternatively, we could think of the metaphony process as an 'attraction' by the stressed vowel of the ∀-element of the unstressed vowels; this approach avoids the notion of 'just adding' an element. Attraction could be formalized as a copying of this element, or, literally, as a case of movement. In this case we could construe the variable elements on the unstressed vowels as a 'trace' that needs to be licensed, although, strictly speaking, an attraction analysis does not require that the element on the high vowels become variable. The effect of attracting a copy of the ∀-element to stressed vowels triggers a convention called **resolution**, which was already proposed in Anderson & Jones (1974):

(26)

A	>	A<u>B</u>	>	A<u>B</u>	>	B
	Add B		Add B		Add B	

In the case at hand, this schema applies as follows:

[28] After such loss, the frontness of stressed vowels will either be captured in term of a morphologically conditioned rule, or be attributed to a floating feature.

(27) Add ∀ to A => A;∀ (low becomes low mid)
Add ∀ to A;∀ => ∀;A (low mid vowel becomes high mid; loss of A-headedness)
Add ∀ to ∀;A => ∀ (high mid vowel becomes high; loss of |A|)

This schema allows the representation of processes that involve the apparent deletion of elements in a very specific circumstance, namely when the element is 'pushed' by an increase in preponderance of the antagonistic element that it combines with. It can be applied both to the vowel-related shifts (e.g. the Great Vowel Shift in the history of English), to consonant-related phenomena such as lenition or, as in our case, to step-wise raising:

(28) a. (V V)$_F$
e/o > i/u i/u
{∀;A} {∀}
{∀;A$_V$+∀} (∀) copying/movement of the ∀-element
{∀} » (∀) resolution: loss of |A|

b. (V V)$_F$
ɛ/ɔ > e/o i/u
{A;∀} {∀}
{A;∀+∀} (∀) copying/movement of the ∀-element
{∀;A} » (∀) resolution: loss of A-headedness

c. (V V)$_F$
a > ɛ i/u
{A} {∀}
{A +∀} (∀) copying/movement of the ∀-element
{A;∀} » (∀) resolution: no change

The likelihood of copying/movement of ∀ follows the following ranking:

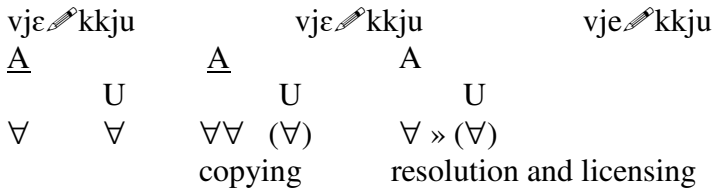
(29) e/o > ɛ/ɔ > a

This ranking show that addition of |∀| is increasingly dispreferred in proportion to the preponderance of the |A| element in the recipient.

In (30) and (31) I illustrate raising of mid vowels and breaking of low mid vowels, respectively (data from the dialect of Calvello in 11):

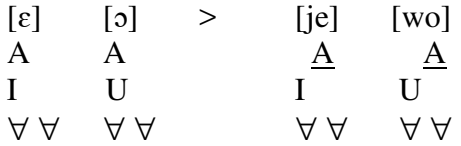
(30) a. só lu só lu sú lu
A A
U U U U U U
∀ ∀ ∀∀ (∀) ∀ » (∀)
copying resolution and licensing

b.



The emergence of diphthongs is the result of a different kind of resolution. The added element does not fuse, but gets its own realization as a glide:

(31)



In conclusion, metaphony can be formally represented in terms of '∀-attraction' by a recipient stressed nuclei, which leads to variability of the element in the source. While the latter step is not crucial to account for raising, it does capture the 'intuition that the need to be licensed is part of the process. Both the attraction (or movement) of the harmonic element by the stressed syllable and the variability of the harmonic element variable in unstressed syllables are two sides of the same coin. The formalization of '∀-attraction' as the addition of the ∀-element triggers the resolution convention which accounts for the raising effect. Attraction harmony can be seen as a natural consequence of the strengthening of a stressed vowel and a concomitant weakening of an unstressed vowel within a foot. This alternative to the ATR-analysis does justice to the fact that stress-induced harmony has traditionally been considered to be distinct from non-stress-induced harmony. The present proposal provides a theoretical basis for this traditional view, placing metaphony in a broader class of harmonies that have been variously referred to as umlaut, mutation or affection (see Majors 1998; van der Hulst, to appear-a: chapter 6; Mascaró 2016).

So far I have not discussed locality aspects of metaphony. Can the stressed vowel and the source vowel be separated by a third, non-participating vowel? Hualde (1989) discusses a relevant example. In the Lena Bable dialect of Spanish, a final high vowel causes raising of a stressed vowel. Stressed [a, e, o] raise to [e, i, u], respectively, as shown in (32a). As shown by the data in (32b), the vowel [a] is transparent to harmony when it intervenes between the final vowel and the stressed antepenultimate vowel:

(32) Lena Bable Spanish height harmony

a. stressed vowel target:

gétu	'cat' m.sg.	(cf. gátos m.pl.)
nínu	'child' m.sg.	(cf. nénos m.pl.)
kúku	'worm' m.sg.	(cf. kókos m.pl.)

b. unstressed vowel:

burwíbanu	'wild strawberry' m.sg.	(cf. burwébanos)
kékabu	'wreck' m.sg.	(cf. kakabos)

The fact that the post-stress [a] can be skipped might mean that the locality for licensing is, or can be, defined at the level of foot heads, if we stick to strictly binary feet which would mean that licensing is not local at the first nuclear projection, but rather at a second nuclear projection.

(33)

	N	»	N
	(N	$N)_F$	$(N)_F$
	∀		(∀)
	ké	ka	bu
(cf.	se	ka	só)

As shown in Walker (2011), the vowel [a], while never blocking metaphony, may or may not be affected. This raises the question of how we account for cases in which the vowel is affected. It seems to me that the explanation for interveners to be affected must be attributed to a low level co-articulatory effect.

4. Discussion and conclusions

Metaphony has been analyzed as an instance of stress-induced vowel harmony. Metaphony involves the attraction of properties of following unstressed vowels by stressed vowels. This leads, at the same time, to strengthening of the stressed syllable and weakening of the unstressed syllable, thus enhancing the contrast in two ways. Both the attraction (or movement) of the harmonic element by the stressed syllable and the variability of the harmonic element variable in unstressed syllables are two sides of the same coin. The formalization of '∀-attraction' as the addition of the ∀-element triggers the resolution convention which accounts for the raising effect. Since metaphony is clearly stress-related, it would be almost perverse to disregard stress as an important factor in this process. In fact, following an important proposal in Van Coetsem, McCormick & Hendricks (1981), McCormick (1982) and Van Coetsem (1996), I assume that this is precisely what distinguishes metaphony (and umlaut) from vowel harmony proper. In van Coetsem's theory, umlaut (and, I will assume, metaphony) occurs in languages with 'strong' (often lexical) stress, whereas (non-stress related) vowel harmony is more typical of language with 'weak', typically predictable stress. A correlation of this type has been noted in many typological studies (see van der Hulst (2016b) for an overview).

The use of a 'high' |∀|-element in RcvP allows an analysis of metaphony (and, more generally raising processes) to make reference to this element. There is no direct reference to the A-element in raising processes (although there will be in 'lowering' processes in African languages), which gets removed from high mid vowels due to a general resolution convention. Unary analyses of metaphony that use models without a high element have either been restricted to cases of metaphony that only involve fronting (see Canalis (2016), who also appeals to the resolution notion in order to 'get rid of the A-element' in some cases) or they have postulated A-deletion Maiden (1986, 1991) or use of a negated element (Staun 2003). It seems to me that both deletion and negated elements should be avoided at all cost. D'Alessandro and van Oostendorp (2016) propose an original method to 'get rid' of the A-element. Rather than using deletion, they analyze metaphony in terms of an inserted mora that 'eats' or absorbs the A-element. They provide some independent evidence for the appearance of the A-element outside the stressed vowels.

The preceding formal account of metaphony makes explicit use of stress-driven |∀|-attraction (or movement) which causes an extra 'insertion' of |∀| into the stressed vowels which then has three different consequences: simply adding |∀|, demoting the |A|-element to non-head status and pushing out the A-element. While these are seemingly three different responses, I maintain that all three constitute natural formal consequences of |∀|-addition in a system that does not allow multiple occurrence of the same element[29], as such formally expressing the increase in preponderance of an element. I fully realize that the array of data that I have used to illustrate this type of analysis does not do justice to the full array of metaphony cases in Romance dialects. This means that further work needs to be done to test the account presented here.

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[29] Here the expression 'the same element' refers to the occurrence of the basic C- or V-element in the same structural position. By disallowing multiple occurrences of the same element, RcvP (as well as DP and GP) distinguish themselves from the element theory proposed in Schane (1984).

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