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ARTICLE

Is metaphony (and sound change) sensitive to grammatical category? The case of verbs in the dialects of the Lausberg area

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Abstract

This study examines the extent to which metaphony is sensitive to grammatical category in three varieties of the Lausberg dialect area of Southern Italy. Results from acoustic analyses show that metaphony, expressed through raising or diphthongisation of mid stem vowels triggered by high suffix vowels, is present in nouns and adjectives, but significantly reduced or absent in verbs. In certain cases, verbs display paradigmatic levelling, with metaphonic patterns extending even to forms lacking a triggering environment. These findings suggest that grammatical category can influence sound change before full phonologisation. The reduced susceptibility of verbs to metaphony is attributed to their morpho-syntactic prominence and the functional need to preserve inflectional distinctions. Overall, the results highlight a complex interaction between phonetics, phonology, and morpho-syntax in the development of metaphony.

Contents

1. Introduction

The present study focuses on the influence of grammatical category on metaphony in an Italo-Romance dialect region of Southern Italy known as the Lausberg area, which extends across the border between Basilicata and Calabria (Lausberg 1939; Martino 1991; Conte 2014). Metaphony has its phonetic origins in trans-consonantal vowel-to-vowel coarticulation (Recasens 2014), in which a vowel is synchronically influenced by a following vowel across one or more intervening consonants (Öhman 1966; Cole *et al.* 2010; Hoole & Pouplier 2017). In this case, the suffix has an anticipatory influence on vowels in the preceding stem, typically in the direction of vowel raising (Schürr 1936; Lausberg 1939; Rohlfs 1966: I, §5-7; Maiden & Savoia 1997; Torres-Tamarit *et al.* 2016). In the Lausberg area, metaphony affects primarily stems containing phonetically mid vowels while the trigger is typically one of two high vowels, /i, u/, in a word-final, unstressed, inflectional suffix that provides information about gender and number in nouns, and person, number, and tense in verbs (Lausberg 1939; Rensch 1964; Romito *et al.* 2006). Metaphony can be manifested, however, not only by mid-stem vowel raising, but also by diphthongisation (Lausberg 1939; Rensch 1964; Rohlfs 1966: I, §7, §123; Falcone 1976; Romito *et al.* 2006).

In the dialects of the Lausberg area, the stressed (so-called "Sardinian") vowel system includes five phonemes (/i, e, a, o, u/), with a contrast between high, mid, and low vowels, but not between mid-high and mid-low. In this system, Latin vowel qualities were preserved, while vowel length distinctions have been lost (e.g., Latin Ē/Ĕ > /e/, Ō/Ŏ > /o/) (Lausberg 1939; Rohlfs 1966: I, §2; Savoia 1997). However, in spite of the absence of a phonological contrast between mid-high and mid-low vowels, in the Lausberg area mid-stem vowels can be realised as mid-low – possibly due to a coarticulatory influence – in mid or low-suffix vowel (i.e. non-metaphonic) contexts (Greca *et al.* 2024). In this study, metaphony in verbs vs nouns and adjectives was analysed in three regions of the Lausberg area that, following previous studies (Lausberg 1939; Rensch 1964; Romito *et al.* 2006; Greca *et al.* 2024), are expected to show three different metaphony types. For example, /b[ɛ]lla/, 'beautiful', fem. sg., becomes in the masculine /b[e]llu/ in the mountain village of Mormanno (henceforth MM), and /b[i]llu/ in the region that Lausberg (1939) named *Mittelzone* (henceforth MZ), mainly extending from the Eastern coast of the area to the border between Calabria and Basilicata.

Besides raising, metaphony may also result in diphthongisation in the region that Lausberg called *Zwischenzone* (ZZ), concentrated in the western part of the area. In this region, /ˈb[ɛ]lla/ becomes /ˈb[jɛ]llu/ or /ˈb[iə]llu/ in the masculine singular. Similar shifts occur in /o/-stemmed words such as /ˈboni/ ('good', masc. pl.), which can surface as /ˈb[wɔ]ni/ or /ˈb[uə]ni/ in ZZ, while they are expected to be realised as /ˈb[o]ni/ in MM and /ˈb[u]ni/ in MZ (see Table 1 for further examples). Loporcaro (2016: 83) and earlier authors (Lausberg 1939: 40; Rensch 1964: 30) argued that raising and diphthongisation are distinct historical processes, with raising occurring first. In most southern Italian dialects, diphthongisation primarily affected originally mid-low vowels (deriving from Latin short Ĕ, Ŏ). However, in the Lausberg area, it took place after the merger of Proto-Romance mid-low and mid-high vowels that led to the Sardinian vowel system described before. As a result, some etymologically mid-high vowels can show metaphonic diphthongisation as well, depending on factors such as syllable structure (open vs closed, Lausberg 1939) and the chronological sequence with which the merger between mid-high and mid-low vowels and diphthongisation affected the dialect in question (Lausberg 1939: 9; Rensch 1964: 31).

The categoriality and/or graduality of metaphony across different varieties has been debated by many phonologists in the last decades (see e.g. Russo 2002; Grimaldi 2003; Walker 2005; Torres-Tamarit & Linke 2016; Greca *et al.* 2024; just to mention some studies on Italo-Romance metaphony). In this respect, the degree of opacity of the phonological triggers of metaphony certainly plays a role, since many studies suggest that stem vowel metaphony may be well connected to suffix vowel reduction in different Italo-Romance languages (Lausberg 1939; Rohlfs 1966: I, §5-7; Russo & Barry 2004; Delucchi *et al.* 2012; Bucci *et al.* 2019; Romano 2020). For the varieties in question, it was previously shown that an inverse relationship existed between presence of the cues to the suffix vowel in the stem and suffix vowel erosion, meaning that the degree of erosion was inversely related to the magnitude of stem vowel metaphony, being greatest in varieties of the Mittelzone, least in Mormanno, and intermediate in the Zwischenzone (Greca *et al.* 2024). With reference to the previous examples, while we expect /bellu, bonu/ to be phonetically realised as [bellu, bonu] in Mormanno, in the Mittelzone we expect [bill(ə), bun(ə)] with a suffix vowel that is more centralised (and sometimes deleted), while in the Zwischenzone the degree of phonetic erosion of the suffix vowel would be less marked than in the Mittelzone (see also Table 1).

In verbs, metaphony mainly occurs in second person singular forms of the indicative (Maiden & Savoia 1997: 19), but in some dialects in Calabria outside the Lausberg area it can also be observed in the first person singular, triggered by the ending /u/, e.g. in Limpidi [duːrmu] < Latin DORMIO, '(I) sleep' (Maiden & Savoia 1997: 23). However, metaphony in verbs in the Lausberg area seems to represent an exception to these observations, as they are reported not to generally show metaphonic alternations in the stem (Lausberg 1939; Rensch 1964). In particular, in the dialects along the Calabrian northern east coast of the Lausberg area, it has been observed that first person singular forms of the present indicative do not show metaphony, since the original Latin suffix vowel for these forms was /o/ and therefore not a high vowel (Lausberg 1939; Trumper 1997). In these dialects, only verbs derived from the Latin 4th conjugation (infinitive in

Metaphony?	Suffix	Stem-/e/			Stem-/o/		
		MM	ZZ	MZ	MM	ZZ	MZ
No	/a/	vɛkkja	vɛkkj(a)	vɛkːʲ(ə)	bɔna	bɔn(a)	bɔn(ə)
	/e/	vɛkkje	vɛkkj(e)	vɛkːʲ(ə)	bɔne	bɔn(e)	bɔn(ə)
Yes	/i/	vekki	vjɛkk(i)	vikːʲ(ə)	boni	bwɔn(i)	bun(ə)
	/u/	vekkju	vjɛkkj(u)	vikːʲ(ə)	bonu	bwɔn(u)	bun(ə)

Table 1: Lexical stems /vekkj-/ ('old') and /bon-/ ('good') in different suffix vowel contexts in the three regions. The expected pronunciation is reported. Suffix realisations between parentheses indicate that the suffix vowel in question can be variably reduced or deleted (Greca *et al.* 2024).

ɪʀᴇ) are expected to show metaphony, historically triggered by a /i/-suffix in the second and third person singular (Lausberg 1939; Rohlfs 1968: II, §538).

Differences in metaphonic influences on stems across regions and grammatical categories in the Lausberg varieties might have implications for modelling the relationship between phonetic variation and phonological change: analysing such a phenomenon can shed light on whether sound changes show a clear directionality between the phonetic, phonological, and morpho-lexical levels. Different models of sound change have conceptualised the progression from phonetic variation to phonologisation in different ways. Following lexical phonology (Bermúdez-Otero & Trousdale 2012; Kiparsky 2015; Ramsammy 2015), phonological change forms part of a modular, feed-forward phonological system (Bermúdez-Otero & Trousdale 2012; Ramsammy 2015), in which phonetic variation, which is initially not under cognitive control, becomes phonological and then stabilises as it enters the lexicon as quasi-phonemes (see e.g. Kiparsky 2015). This modularity implies that there can be no direct influence of lexical or morphological levels on gradient phonetic, non-phonologised output.

However, other studies have pointed out that, for instance, morpheme boundaries alone (Strycharczuk & Scobbie 2016) or morphological conditions linked to the grammatical class (Blevins & Lynch 2009) can play a role in phonetic variation and sound change in various languages. In episodic models of speech (Johnson 1997, 2006; Pierrehumbert 2003, 2006), the lexicon can have a direct influence on sound change. In this type of model, there is a stochastic association between words, phonological units, and memorised speech signals (Wedel 2006, 2012; Todd *et al.* 2019; Gubian *et al.* 2023), while produced and perceived exemplars carry word-specific phonetic details (Pierrehumbert 2001). The lexical level can bias the direction of a sound change, which can be manifested as a general preference for languages to avoid homophony and ambiguity between grammatical classes (Blevins & Wedel 2009; Wedel 2012). This stochastic view of phonology as a generalisation over exemplars does not therefore exclude the possibility of a top-down influence of the lexical level on phonetic output.

Some studies have shown that phonological processes affect lexical categories differently (Sereno & Jongman 1995; Smith 2011). Evidence that verbs can be more

or less sensitive to sound change than other grammatical categories seems to support this view (Maiden 1991; Sereno & Jongman 1995; Blevins & Lynch 2009; Smith 2011). Smith (2011), for instance, analysed whether segmental and suprasegmental phenomena affect nouns and verbs differently and argued that, in a variety of languages (including Romance varieties such as Spanish), nouns (and, to a lesser extent, also adjectives) tend to support a greater array of phonological contrasts and assimilatory processes than verbs; also, even if this is not the case, prosodic and, to a minor extent, segmental rules tend to apply differently between the two grammatical categories (the results of this phonological meta-analysis are summarised in Table 1 of Smith 2011). The main reason for this noun/verb difference is, according to Smith, because nouns are typologically more frequently free forms with no or less affixation required than verbs, as a result of which they can more easily give up phonological alternations in stems to express morpho-syntactic meaning. Sereno & Jongman (1995) found for English that speakers may introduce prosodic variation in order to compensate for morpho-syntactic ambiguity of noun/verb homophones (the validity of this conclusion has been however challenged, see Lohmann 2020). Blevins & Lynch (2009) also discussed that erosion of word-initial /l/ before non-high vowels in some languages of Central Vanatu seems not to affect verbs (presumably due to analogical restoration of this affix) but is systematic in other grammatical classes.

Evidence that sound changes might, in isolated cases, affect some grammatical categories but not others (with a tendency for verbs to resist change: see Smith 2011), or that these might affect segments differently according to grammatical categories, has also been attested for metaphony in some Italo-Romance varieties. For some Lucanian (southern Italian) varieties, Maiden (1991: 200) noted the absence of metaphony in the stems of inflected verbs in spite of the presence of a high suffix vowel: this may be because analogical levelling only applies to verb stems. As regards Northern varieties, Maiden (1991: 203–205) also noticed that stem vowel differences that cue person and number in dialects with metaphony are more likely to be eroded in the stem vowel of verbs than of other grammatical categories. The explanation for this may be morpho-phonological and functional: the verb can afford to lose the alternation in the stem when metaphony is morphologically redundant, since other affixes provide the information of person and number. On the other hand, metaphony in verbs is relatively common in Italo-Romance varieties (Rohlfs 1968: II, §538), and, in some varieties in Central and Southern Italy, there is evidence that metaphony may even affect stem vowels of verbs to a greater extent than other grammatical categories (Maiden 1991). In summary, while the attested exceptions are not numerous, anomalous patterns of metaphony (i.e. either its absence in the potentially triggering environments, or its extension to phonological environments that would not trigger it) mainly apply to verbs rather than to other grammatical classes such as nouns and adjectives.

In the present study, we want to establish whether metaphony in the Lausberg area affects verbs differently than other lexical categories, and if so, whether this is in the direction of an overextension of metaphonic raising or diphthongisation, or of an absence of metaphony also in high suffix vowel contexts. The main overall concern is, however, whether metaphony is affected by grammatical category and, if so, how we can explain the connection between synchronic variation and diachronic change taking into

account this kind of variation in grammatical category. To achieve these objectives, the main hypothesis to be tested in Section 2 was that the degree of metaphony is influenced by grammatical category, that is, that the influence is different in nouns/adjectives vs verbs. Following previous auditory-based analyses (Lausberg 1939; Rensch 1964), tests were also made in Section 3 of whether there are suffix-dependent differences within the same verb as well as variation across different verb stems in the same suffix vowel context. Finally, in an attempt to test whether metaphonic effects shown in Section 2 are phonetically gradient or, rather, phonologically categorical (given that it is still unclear whether only categorical effects can show interfaces with morpho-syntax, see e.g. Bermúdez-Otero 2015 and Strycharczuk & Scobbie 2016), we included an analysis of the relationship between stem vowel height and suffix vowel height in Mormanno and in the Mittelzone in Section 4.

2. Region and grammatical category

2.1. Method

2.1.1. Speakers and villages

Acoustic data was analysed from 99 participants (53 females and 46 males, age range 13 to 92 years, mean age 48.2, *SD* = 19.2), who were remunerated a small amount of money for their participation. Before carrying out the recordings, all participants answered some questions related to their sociolinguistic background, so as to make sure that only proficient speakers of the local variety were recruited. In this analysis, local varieties were considered from three clusters of villages in the Lausberg area that, according to previous studies (Lausberg 1939; Rensch 1964; Romito *et al.* 2006; Greca *et al.* 2024), show a metaphonic change in the stem vowel to different degree: least in *Mormanno* (henceforth MM, showing a mid-vowel raising from mid-low to mid-high vowels; 28 speakers), intermediate in the *Zwischenzone* (ZZ, opening diphthongisation of mid vowels, 26 speakers), and most advanced in the *Mittelzone* (MZ, raising of mid vowels to high ones, 45 speakers). "Region" here is based on the expected metaphonic patterns and does not strictly refer to geography. In particular, MZ now includes also Orsomarso (a village that has monophthongal raising within ZZ), Lauria (which is Mittelzone but on the western side of Basilicata), and Castrovillari (*Südzone*, monophthongising metaphony), while ZZ also includes Schiavonea, which is on the East coast but belongs to the Südzone (see division in zones by Lausberg 1939). Figure 1 shows the different villages (n = 16) included in the study, including the number of participants for each village. A further summary of some of the speaker attributes and numbers per village is shown in Appendix A, Table 3.

2.1.2. Elicitation and materials

The lexical items containing the analysed stem vowels were elicited through a picture-naming task which was carried out using the software SpeechRecorder, version 3.28.0 (Draxler 2011), installed on a laptop, and a headset with integrated microphone (Sennheiser SC 60). The order of appearance of the pictures was randomised differently for each speaker. Each picture corresponded to one inflected form of a lexical item. The

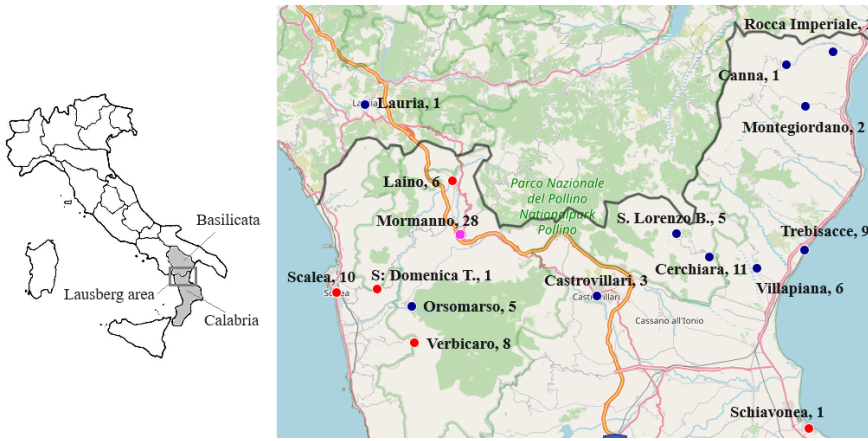


Figure 1: Localisation of the Lausberg area and the villages in the study (map data ©OpenStreetMap 2024), including numbers of speakers per village. The dots are colour-coded: magenta for Mormanno, red for the Zwischenzone, blue for the Mittelzone.

nouns and adjectives were first produced in isolation, and subsequently within the carrier sentence "I say ... two times" ([(jɛ) ˈdiku ... dui ˈvotə]), in the dialect. Verbs could not be elicited in isolation but within a sentence described by a picture (some examples of eliciting stimuli are available in Appendix B in Greca *et al.* 2024). Similarly, inflected adjectives had to be elicited in combination with a noun (e.g. by showing a picture of a red rose, in the dialect [ˈrosa ˈrussa], to elicit [ˈrussa], i.e. 'red', fem. sg.).

The target words were primarily selected on the basis of their stem vowel phoneme, which in most cases corresponded to the stem vowel in the Latin etymon (Lausberg 1939; Savoia 1997). Each speaker produced a total of 123 different word types out of a total of 57 different lexical stem types, e.g. the words /mese, mesi/ share the lexical stem /mes/. The word types contained phonologically primary stressed mid vowels /e, o/ in the stem (these are the most likely targets for metaphony: see Section 1) and suffix vowels varying in height: /a, e, i, u/. More specifically, 58 words (27 lexical stem types) included a stem-/e/ vowel and 65 words (30 lexical stem types) a stem-/o/ vowel (Appendix B, Table 4). These words included 104 different nouns and adjectives (out of 50 different lexical stem types) and 19 verbs (out of 7[1] different lexical stem types). Most verbs were organised in triplets[2] (first, second and third person singular of the indicative, e.g. /ˈdormu, ˈdormisi, ˈdorme/, 'to sleep'); nouns and adjectives were mainly (but not exclusively) organised into pairs (mainly singular vs plural, or feminine vs masculine). The relationship between morphological inflection and suffix vowels is shown in Table 2.

[1]The reduced number of verbs in the database is because specific forms of verbs are mostly not picturable.

[2]For the verb stem /vol/ 'to want', only the first and second person singular were analysed (/u, i/-suffixed forms respectively), since the third person singular ('he/she wants') usually carries no suffix, i.e. /vɔ/. For the verb stem /mor/, we only have first and second person singular and overall very few tokens, as the word list was slightly modified during the recording phase, so that these forms were elicited from only a couple of speakers.

Most word types (n = 92) were disyllabic, while there were some words (n = 31) that were trisyllabic and in which the stem and suffix vowels were either adjacent (e.g. /niˈpote/, 'grandchild') or separated by one syllable (e.g. /ˈtenisi/, '(you) have'); see Appendix B, Table 4).

The total number of potentially available stem vowels for analysis was: 123 words (stem and suffix combinations) × 2 repetitions × 99 speakers = 24,354 tokens. However, some productions had to be removed either because they had been misarticulated, or produced in Standard Italian, or because they did not correspond to the target word: this left 17,259 vowels for the analysis, including 15,195 nouns and adjective tokens and 2064 verb tokens. The division of these tokens between stems-/e, o/ and metaphonic vs non-metaphonic context was the following: there were 4903 /e/-stems preceding one of the high vowel (i.e. metaphonic) suffixes /i, u/ and 3585 in non-metaphonic, suffix-/a, e/ contexts. For /o/-stems, there were 5245 in metaphonic and 3526 tokens in non-metaphonic contexts. As far as the division in regions is concerned, 5161 tokens were produced by speakers from Mormanno, 3983 tokens by speakers from the Zwischenzone, and 8115 tokens by speakers of the Mittelzone.

In addition to these mid stem vowels, other words (see Appendix B) were elicited with high and low /i, a, u/ stressed stem vowels. These words were used to extract the F1 and F2 values of their stem vowels that were necessary for the speaker-normalisation of vowel formants (see Section 2.1.3).

Suffixes	**Inflectional meaning**	**Examples**	
		Stem-/e/	**Stem-/o/**
/a/	Feminine singular (nouns and adjectives)	petra *'stone'*	nova *'new'*
	Indefinite feminine plural (irregular; nouns)	–	ossa *'bones'*
	Present indicative, 3rd pers. sg. (1st-conjugation verbs)	pensa *'(s)he thinks'*	trova *'(s)he finds'*
/e/	(Mostly) masculine singular (nouns and adjectives)	pede *'foot'*	niˈpote *'grandchild'*
	Present indicative, 3rd pers. sg. (2nd-conjugation verbs)	tene *'(s)he has'*	dorme *'(s)he sleeps'*
	Feminine plural (nouns and adjectives)	seddʒe *'chairs'*	bone *'good'*
/i/	(Mostly) masculine plural (nouns and adjectives)	pedi *'feet'*	niˈpoti *'grandchildren'*
	Present indicative, 2nd pers. sg. (verbs)	ˈtenisi *'you have'*	ˈdormisi *'you sleep'*
/u/	Masculine singular (nouns and adjectives)	vekkju *'old'*	mortu *'dead'*
	Present indicative, 1st pers. sg. (verbs)	tengu *'I have'*	dormu *'I sleep'*

Table 2: The suffix vowels and their inflectional meaning, with examples of words (phonemic transcription) for both stem vowels.

2.1.3. Pre-processing and data analysis

The speech signals were segmented and labelled on the basis of manually given phonemic transcriptions using MAUS (*Munich Automatic Segmentation System*, Kisler

et al. 2017), a forced alignment system integrated in the `emuR` package (version 1.1.2) (Winkelmann *et al.* 2017) available in the R programming environment R Core Team 2024. The first two formant frequencies (F1, F2) of stem vowels were extracted using the `PraatR` package (version 2.4) (Albin 2014) in R with a 25 ms window and a 5 ms frame shift. Around 40% of the data had to be manually corrected because of misplaced segment boundaries or mistracked formants.

Formant trajectories were time-normalised to 11 equidistant time points between the acoustic onset and offset of the stem vowel. Formants were then speaker-normalised following the method by Lobanov (1971) described by Eq. (2.1):

$$F^{*}_{i,j,k}(t) = \frac{F_{i,j,k}(t) - \text{mean}(F)_{i,j}}{\text{sd}(F)_{i,j}} \tag{2.1}$$

$F^{*}_{i,j,k}(t)$ and $F_{i,j,k}(t)$ are, respectively, the time-normalised and raw formant frequency values of formant number j (j = 1, 2) produced by speaker i in utterance k at time-point t, while $\text{mean}(F)_{\text{i,j}}$ and $\text{sd}(F)_{\text{i,j}}$ are the mean and the standard deviation of all formant values between the acoustic onset and offset for formant number j (i.e. for each F1 and F2) in the same speaker's /a/, /i/, and /u/ stem vowels (contained in the words carrying these stems, see Table 5 in Appendix B).

An analysis of the time-varying shape of speaker-normalised F1 of /e/ and /o/ vowel stems (n = 17,259) was carried out using the discrete cosine transformation (DCT). F1 values of /e/ and /o/-stems were analysed together since there is the same relationship between F1 and vowel height in both vowels. The DCT decomposes any time-varying signal into a set of ½ cycle cosine waves such that the amplitudes or coefficients of the first three coefficients, k_0, k_1, k_2, are proportional respectively to the signal's mean, linear slope, and curvature (Watson & Harrington 1999; Harrington 2010). The expected association between these coefficients and vowel quality is as follows: k_0 varies with changes in mean F1 / acoustic vowel height, while diphthongisation is associated with a greater deviation of k_1 from zero (because diphthongisation causes a formant trajectory's slope to be rising or falling over the vowel interval).

In order to test for significance of differences in metaphonic influence in verbs vs adjectives and nouns, statistical tests were carried out with mixed models by using the `lmerTest` package (Kuznetsova *et al.* 2017) in R (version 4.4.0, R Core Team 2024). The model was of the form (R notation):

$$k \sim \text{Region} * \text{Grammatical category} * \text{Metaphony} + (\text{Region}|\text{Stem}) + (\text{Metaphony}|\text{Speaker}) \tag{2.2}$$

The response k was either k_0 or k_1 and in which there were fixed factors metaphony, i.e. high vs mid or low suffix vowels (two levels: high /i, u/ vs non-high /e, a/), grammatical category (two levels: nouns and adjectives vs verbs) and region (three levels: MM, ZZ, MZ) and their interaction. Stem was a unique identifier for the lexical stem of the word, independently of its suffix (e.g. the stem representation for the different inflected forms of 'months' was /mes/).

The random factors originally included intercepts and all logically possible slopes to measure the interaction between the fixed and random factors. These were dropped if they were non-significant by means of the function `step` available in the R environment.

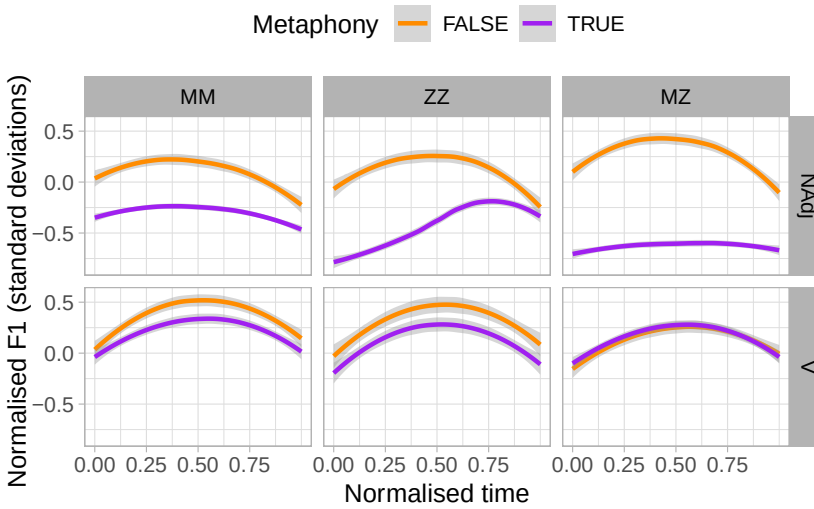


Figure 2: Mean F1 trajectories (including 95% confidence intervals) aggregated across /e, o/ stem vowels, separately by region, grammatical category ("NAdj" = nouns and adjectives; "V" = verbs), and metaphonic context (TRUE = suffix vowels /i, u/; FALSE = suffix vowels /a, e/).

Post-hoc tests were computed using the `emmeans` package (version 1.10.2, Lenth 2024) in R whenever the fixed factors interacted and were Bonferroni-corrected to take into account the number of post-hoc tests.

2.2. Results

The top row of Figure 2 shows clear effects of metaphony in nouns (compare the gold with the magenta trajectories), either through F1 lowering (i.e. phonetic raising) in MM and MZ, or through a changing diphthongal quality in ZZ. However, these metaphonic effects that are so clear in nouns are virtually absent in verbs (Figure 2, lower panel).

The further parameterisation of the time-varying F1 trajectories using the DCT coefficients is consistent with these observed differences. Thus, in Figure 3, which shows k_0 (which is proportional to the F1 mean), there are very clear differences between Noun/adjectives and verbs as a comparison of the blue plots between non-metaphonic and metaphonic stems shows. By contrast, these differences are all but absent in verbs. Figure 4 shows that the differences in k_1, which is proportional to the linear slope, are clearly evident for nouns/adjectives but not for verbs.

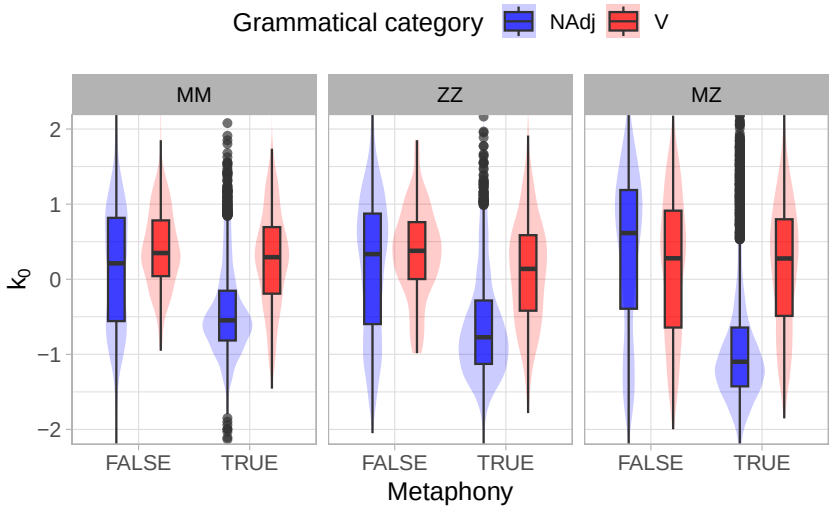


Figure 3: Distribution of k_0 DCT-scores for stem vowels /e, o/ shown separately by region, grammatical category (blue for nouns and adjectives, red for verbs), and metaphonic context (TRUE = suffix vowels /i, u/; FALSE = suffix vowels /a, e/).

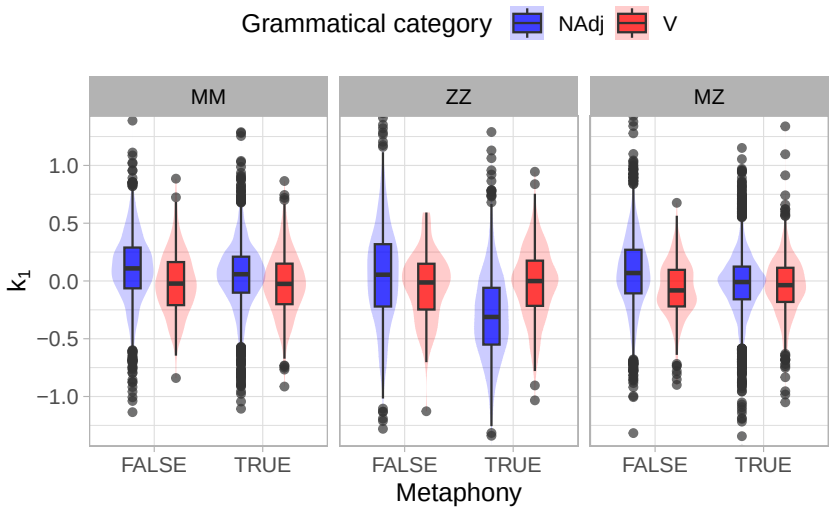


Figure 4: Distribution of k_1 DCT-scores for stem vowels /e, o/ shown separately by region, grammatical category (blue for nouns and adjectives, red for verbs), and metaphonic context (TRUE = suffix vowels /i, u/; FALSE = suffix vowels /a, e/).

Consistently with these data, the statistical analysis with k_0 as the dependent variable showed a significant interaction between region, grammatical category, and metaphony ($F_{2,\ 16709.6} = 43.8$, $p < 0.001$). Post-hoc tests showed a significant influence of the suffix on the stem vowel only for nouns and adjectives (MM: $z = 11.4$, $p < 0.001$; ZZ: $z = 13.4$, $p < 0.001$; MZ: $z = 30.9$, $p < 0.001$) but not for verbs. The results also showed a greater metaphonic effect in nouns/adjectives compared with verbs in all three regions (MM: $z = –3.7$, $p < 0.01$; ZZ: $z = –3.4$, $p = 0.01$; MZ: $z = –4.0$, $p = 0.001$.).

As far as k_1 is concerned, the statistical analysis showed a significant interaction between region, grammatical category, and suffix vowel context ($F_{2,\ 15704.5} = 17.7$, $p < 0.001$) . Post-hoc tests showed a lower k_1 in metaphonic context in ZZ than both MM ($z = –8.0$, $p < 0.001$) and MZ ($z = –7.1$, $p < 0.001$). Consistently with Figure 4, the extent of k_1 lowering was significantly greater in nouns and adjectives than verbs in ZZ ($z = 12.4$, p < 0.001) and MZ ($z = 4.6$, $p = 0.0001$).

2.3. Discussion

These data show that metaphony was present to a different magnitude between the three regions. As regards the degree of raising of stem vowels (analysis of k_0, see also Figure 3), this is mostly marked in MZ, least marked in MM, and present to an intermediate extent between the two in ZZ. In addition, from the k_1 analysis it emerged that metaphony in ZZ is mainly characterised by diphthongisation, in which F1 has lower values at the onset but rises towards the offset (this was also clearly visible in the aggregated formants in Figure 2). These results are in line with previous descriptions of these dialects (Lausberg 1939; Rensch 1964) and more recent acoustic analyses (Greca *et al.* 2024).

The second main finding was that verbs showed overall less metaphony than both adjectives and nouns together (Figures 3 and 4). This was the case for all regions: even in MM, in which metaphony was less marked than in the other two regions, effects were still greater in nouns and adjectives than verbs (Figures 2 and 3). Whether this applied to all verb stems and all suffix contexts equally is considered in Section 3 below.

3. Verbs

There were two aims in the present analysis. The first was to test for each verb separately whether there were any differences in the stem across 1st, 2nd and 3rd person singular forms that had not been identified in the analysis so far. The second was to determine for all regions in verbs originating from 4th conjugation Latin ending in -ĪRE whether any metaphonic effects triggered by suffix-/u/ and /i/ respectively extended to the 3rd person singular, a non-metaphonising context with suffix-/e/.

3.1. Method

The method was the same as in Section 2.1, except that it was applied separately to the seven verbs available in the database. In the results below, k_0 was analysed for

regions MM and MZ only and k_1 for ZZ only since these were the region/ parameters combinations which showed the greatest effect of metaphony.

Following the previous analyses, positive values on either of these two DCT parameters are indicative of no metaphony: that is, no stem vowel raising (a high k_0) or no diphthongisation ($k_1 \geq 0$). By contrast, negative values indicate metaphony either through stem vowel raising (a low k_0 and a low F1) or through diphthongisation (a low k_1).

Three tests were designed to test for three possible conditions:

– *No metaphony.* The DCT distributions are greater than zero and do not differ between persons.

– *Metaphony without paradigm levelling.* The metaphonic contexts (1st and 2nd person singular) have DCT values lower than those of the metaphonic context (3rd person singular).

– *Metaphony with paradigm levelling.* The DCT distributions for all persons are less than zero and do not differ between persons: this would come about if the metaphonic influence on the 1st and 2nd person, in which there is stem vowel lowering (k_0) or diphthongisation (k_1), has been generalised i.e., extended to the third person.

For this purpose, the type of statistical test was of the form:

$$k \sim \text{Region} * \text{Stem} * \text{Person} + (1|\text{Speaker}) \tag{3.1}$$

The dependent variable was either k_0 or k_1, the fixed factors *Region* (three levels), *Stem* (five levels) and *Person* (three levels), with the speaker as the random factor. *Stem* was a factor for the lexical stems (corresponding to the five verbs /pens, trov, ten, dorm, ess/). The statistical tests of the above three conditions could not be applied to 2 out of 7 of the verb stems (/vol/ and /mor/) because there was no non-metaphonising (3rd person singular) context. This left a total of 1813 tokens for this analysis.

3.2. Results

Based on the predictions in Section 3.1, it is evident from Figures 5 and 6 that the stems /pens/ and /trov/ show no evidence of metaphony in any region (because there is no apparent difference in the distributions across the three persons and the distributions are greater than zero). On the other hand, /dorm/ in MZ and ZZ as well as /ess/ in MM and MZ show not only metaphony but also paradigm levelling (since these distributions are also undifferentiated by person but are negative in all cases).

The results of the statistical analysis showed no significant differences between the persons, thereby indicating no metaphony (because the distributions were greater than zero) in /pens/, /trov/, /ten/ in MM and MZ. They also showed no significant differences between persons but with metaphony and paradigm levelling (because the distributions for all persons were less than zero) in the case of MM and MZ /ess/[3], and MZ and ZZ /dorm/. Finally, they showed significant differences between the metaphonic and non-metaphonic contexts for /ten/ in ZZ: for k_1, differences were significant between first and second person, and between first and third person ($p < 0.001$).

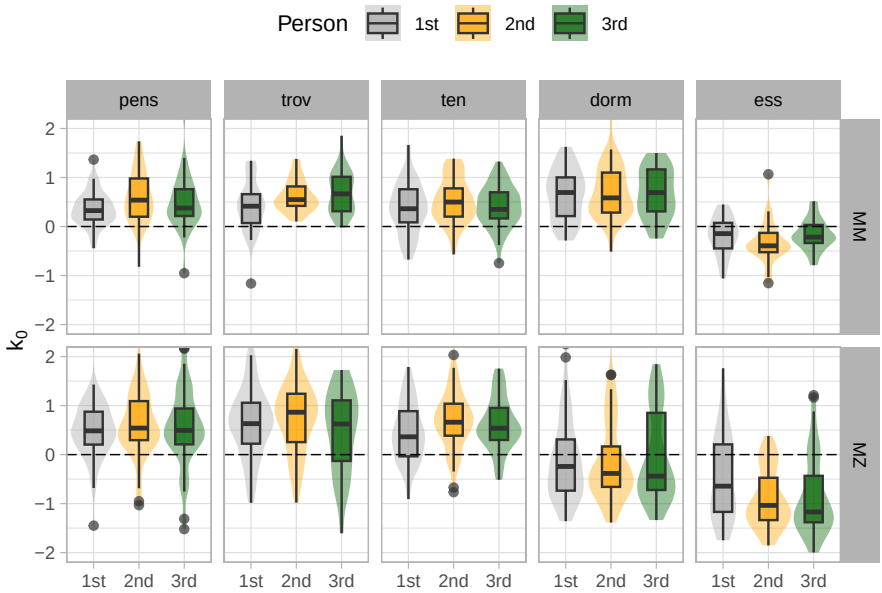


Figure 5: Distribution of k_0 in MM and MZ by verb stem and person: 1st person = suffix-/u/; 2nd = suffix-/i/ (in suffixes such as *-asi* or *-isi*, depending on the conjugation); 3rd = suffix-/e/.

[3] However, there was a slight, but significant difference between first and second person in /ess/ in MZ, see also Figure 5: $t_{1692} = 3.9$, $p = 0.01$)

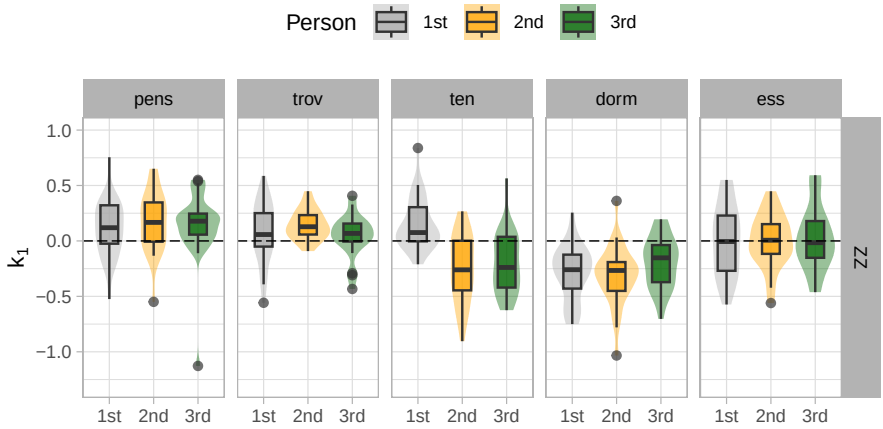


Figure 6: Distribution of k_1 values in ZZ by verb stem and person: 1st person = suffix-/u/; 2nd = suffix-/i/ (in suffixes such as *-asi* or *-isi*, depending on the conjugation); 3rd = suffix-/e/.

3.3. Discussion

In summary, two main results emerged from the analyses of single verbs in each region: (i) within the same verbs, differences between suffix vowels were in most cases non-significant and with a clear absence of metaphony; (ii) in some verbs, there was metaphony of the stem vowel, which was also extended to the third person singular, i.e. in a non-metaphonic suffix vowel context. This was particularly evident for /dorm, ess/ for MZ, which is also the region with most advanced metaphony. According to Lausberg (1939), in some verbs derived from the Latin 4th conjugation, metaphony also overextended to the first person singular, possibly, through analogy, e.g. Latin DORMIO, DORMIS, DORMIT became [durmə, ˈdurməsə, ˈdurmə] ("I, you sleep, he/she sleeps") in Canna, in the eastern part of MZ (Lausberg 1939). In ZZ, only /dorm/ showed overextension of metaphony for all persons. There was no levelling in /dorm/ in MM (the region with least metaphony), but we found metaphonic levelling shown by a lower k_0 mean (i.e. higher F1 mean values in the stem) for all persons in /ess/ (Figure 5). Also in ZZ, there was diphthongisation in the second and third persons (/i, e/-suffixes respectively) of /ten/ (Figure 6). This might be because the pattern of diphthongisation is the same in Standard Italian (*vieni, viene*) and in the neighbouring Campanian varieties (Ledgeway 2009). The presence of diphthongisation in /dorm/ independently of the suffix is, instead, in line with previous qualitative studies (Lausberg 1939; Rensch 1964).

4. Relationship between stem and suffix vowel height

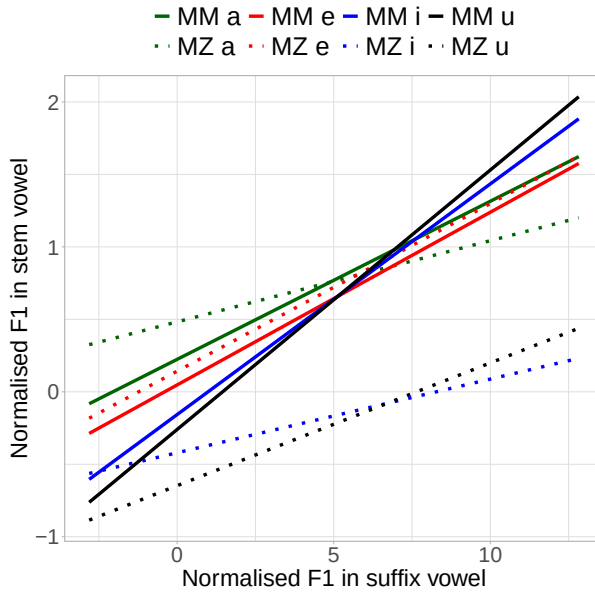
In order to assess whether there was any evidence of within-dialect gradience, a test was made of whether the first formant frequency (F1) of stem vowels could be predicted from F1 of suffix vowels. This was done only for nouns and adjectives (given that verbs were found to have either no metaphony or paradigm levelling) and only for those tokens for which a suffix vowel had actually been produced (that is, not deleted). The analysis was carried out only for MM and for MZ, firstly because these dialects differ most clearly in whether or not there is a predictable relationship between the stem and suffix vowel; and secondly because ZZ, being diphthongal, was not amenable to this type of analysis which focused on F1 at the temporal midpoint of the stem vowel. Finally, the analysis was concerned with whether such a relationship between the stem and suffix vowel holds within (and not pooled across) the suffix vowel contexts. This is because pooling across suffix vowel contexts would show nothing more than a metaphonic variation in the stem vowel due to the differences between suffix vowel contexts (which is not a test of gradience). On the other hand, covariation between the stem and suffix within any suffix vowel context (e.g., a test of whether F1 of the stem vowel in /bona, kotta, nova/ covaries with F1 in suffix-/a/) is evidence for gradience. This is because such a finding is consistent with a low-level coarticulatory association, such that marginal height differences in the suffix vowel are predictive of marginal height changes in the stem vowel.

4.1. Method

The method was the same as in Section 2.1, with the exception that the analysis was based on speaker-normalised F1 at the temporal midpoint of the stem and the F1 mean averaged over all time points in suffix vowels. The analysis included 8223 stem and suffix vowels belonging to the same words (either a noun or an adjective) produced by MM and MZ speakers only. The linear mixed regression model used to test the association between these stem and suffix vowels was the following:

$$\mathrm{F1}_{\mathrm{stem}} \sim \mathrm{F1}_{\mathrm{suffix}} * \mathrm{Region} * \mathrm{Suffix\ vowel} + (\mathrm{Region}|\mathrm{Stem}) + (1|\mathrm{Speaker}) \qquad (4.1)$$

In this model, $\mathrm{F1}_{\mathrm{stem}}$ and $\mathrm{F1}_{\mathrm{suffix}}$ were the Lobanov-normalised (see Section 2.1.3) first formant frequency values in the stem and suffix vowel respectively. The fixed factors were Region (two levels: MM, MZ) and Suffix vowel (four levels, /i, e, a, u/) and their interaction. As in the previous statistical models presented in Sections 2 and 3, Stem (n = 50) and Speaker (n = 68: 23 MM and 45 MZ) were modelled as random factors. Šidák-adjusted correlation slopes between F1 in the stem and suffix were computed with the `emtrends()` function from the `emmeans` package (version 1.11.2, Lenth 2025) in R.



e

Figure 7: The association within suffix vowel contexts predicted by the mixed model 4.1 between F1 at the temporal midpoint of the stem vowel ($F1_{stem}$, *y*-axis) and F1 averaged across all time-points in the suffix vowel ($F1_{suffix}$, *x*-axis). Green, red, blue, black slopes are for suffix vowel contexts /a, e, i, u/ respectively; solid lines for MM and dashed ones for MZ.

4.2. Results

The results showed a significant association between $F1_{stem}$ and $F1_{suffix}$ within all four suffix vowels for MM (/a/: $z = 2.9$, $p < 0.05$; /e/: $z = 2.9$, $p < 0.05$; /i/: $z = 3.8$, $p = 0.001$; /u/: $z = 4.8$ p < 0.0001) and for two out of four suffix vowels for MZ (/e/: $z = 4.0$, $p < 0.001$; /u/: $z = 3.5$, $p < 0.01$). The reconstructed linear slopes from the model 4.1 shown in Figure 7 show a positive association between $F1_{stem}$ and $F1_{suffix}$ and a stronger association as shown by the steeper lines for MM compared with MZ, especially as regards the metaphony-triggering suffix vowels /i, u/ (blue and black lines respectively in Figure 7).

4.3. Discussion

Overall, these results suggest that there is a gradient, coarticulatory association between the phonetic height of stem and suffix vowels in both MM and MZ: higher/lower F1 in the stem vowels correlated with higher/lower F1 in suffix vowels. However, consistently with the results in this study and those of Greca *et al.* (2024), the degree of gradience is stronger in MM or, equivalently, the coarticulatory (and, consequently, metaphonic) effects on MM stem vowels are less categorical than those in MZ.

Although these results are consistent with an interpretation of stem vowel gradience due to coarticulation, they might also (or entirely) have been caused by factors such as speaker and word differences or even differences in speaking style across both words and speakers. However, this type of variation should be predominantly removed by the random factors in the statistical model. Moreover, an explanation based entirely on non-coarticulatory forces would be difficult to reconcile with the finding that the association between stem and suffix vowel was stronger for MM than for MZ – whereas just such a difference between the regions is predicted if coarticulation is one of the causal factors in the association between stem and suffix vowels.

5. General discussion

Consistently with previous studies (Lausberg 1939; Rensch 1964; Romito *et al.* 2006; Greca *et al.* 2024), the results show the presence of major metaphonic effects on stems in the Mittelzone, least effects in the village of Mormanno, and an influence on stem vowel raising that was intermediate between these two regions in the Zwischenzone. Also, in the Zwischenzone metaphony was predominantly marked by diphthongisation. A further main finding was that, in metaphonic contexts (/i, u/-suffixes), there was more stem vowel raising in nouns and adjectives compared to verbs for all regions, while for ZZ there was less opening diphthongisation for nouns and adjectives compared with verbs. Therefore, the data showed that metaphony affected nouns and adjectives differently from verbs. Additionally, the analysis of the relationship between stem and suffix vowel height for nouns and adjectives showed a gradient, coarticulatory influence of suffixes on stems that was most marked in Mormanno. Focusing on each verb type, in most cases metaphony was absent and there were no differences between suffix contexts. In particular, there was paradigm levelling of metaphony in the stems of the verbs deriving from the Latin 4th conjugation, i.e. /dorm, ess/. This was most advanced in the Mittelzone (both verbs presented levelling), while Mormanno showed metaphonic levelling only in /ess/ and the Zwischenzone in /dorm/ and only partially in /ten/ (2nd and 3rd person singular). The results overall showed that the metaphonic influence of the suffix on the stem vowel was much less for verbs than for nouns and adjectives.

These results can shed some further light on the question on whether not fully phonologised or morphologised/lexicalised sound changes can show an influence of morpho-syntax level or not (Bermúdez-Otero 2015; Strycharczuk & Scobbie 2016). Metaphony in the Mittelzone may be analysable as a fully stabilised and stem-domain narrowed (Ramsammy 2015) phenomenon: the source of metaphony has been eroded (suffix vowel qualities are centralised and very often suffixes are deleted, see Greca *et al.* 2024), and the output of metaphony has been magnified with vowel raising from /e, o/ to /i, u/, resulting in minimal pairs such as /mes, mis/ (‘month, months’) and /nov, nuv/ (‘new’, fem. sing. vs masc. sing.). This phonological contrast in the vowels of the stem is associated with a clear vowel height distinction in this Mittelzone variety, as shown by the distinctive F1 trajectories – see Figure 2). Nevertheless, the presence of residual gradience of coarticulatory effects in the stem vowel as shown in our data for nouns and adjectives in the Mittelzone speaks rather against strict categorical distinctions.

As shown in Greca *et al.* (2024), there is an ordered progression of change across the three regions, such that the degree of suffix erosion is MZ > ZZ > MM (i.e. the Zwischenzone showed less suffix erosion than the Mittelzone, but more than Mormanno) and such that the extent to which the cues to the morphological suffix have been transferred to the vowel of the word stem was also MZ > ZZ > MM (in line with our results, see Section 2.2). In addition, the analysis in Section 4 suggested a gradient coarticulatory connection between the stem vowel and each of the four suffix vowels (especially so for Mormanno). Taken together, this finding and those in Greca *et al.* (2024) suggest that metaphony is more gradient in MM than in ZZ, and more gradient in ZZ than in MZ. However, degrees of gradience are not straightforwardly predictable under a strict modular reading, in which a phonetic change is either gradient or not.

In MZ, paradigm levelling in the verb seems to be well established and even to have advanced compared to older descriptions of the dialect (stem vowel raising in the first person of /ess/, which is not expected following Lausberg 1939: 158). However, and for all the reasons outlined above, the vowel differences in the stem in Mormanno are far more likely to be under a certain degree of coarticulatory control, e.g. 'm[ɛ]se, m[e]si', both because of the findings in Greca *et al.* (2024) that suffix vowels in MM did not show significant phonetic erosion and because of the results in the present study showing that there is likely to be a coarticulatory dependence between stem and suffix for all four suffix vowel contexts. In spite of this, in MM there was, just as in MZ, paradigm levelling of metaphony in verbs – attested in this study for the verb /ess/. Therefore, our findings for Mormanno (and to a certain extent for the Mittelzone) suggest that non-contrastive sounds can enter the underlying morphemic representations. It seems difficult to explain otherwise our findings in MM that the initial vowel in e.g. the third person singular form [esse] ('s/he exits') has been levelled towards the metaphonic form with a raised [e] in the context of the final non-metaphonic suffix vowel /e/.

In summary, a variety with non-eroded suffixes like MM shows similar levelling as in the MZ variety, in which metaphonic effects on the stem vowel are more categorical and closer to the completion of the stabilisation process (Ramsammy 2015). The results from MM in particular suggest that the morpho-lexical layer has an influence on metaphony before full phonologisation has taken place, i.e. while the stem is still under a certain degree of coarticulatory control.

The diachronic development of metaphony was sensitive not only to the noun/adjective vs verb distinction, but also applied to different extents across regions. In the MZ variety, metaphony must have applied at a very early stage to verbs with the Latin 4th conjugation (originally triggered by the Latin endings -/is/, -/it/ in the second and third person singular). Metaphony probably developed chronologically later in the other two varieties, so that, as in the case of the verb stem /ten/ in ZZ, even the -/isi/ ending (-/eːs/ in Latin) would trigger diphthongising metaphony. A notable difference compared with nouns and adjectives is, however, that diphthongising metaphony in ZZ has lexical exceptions, given that it did not apply to verb /ess/ (Figure 6). This, again, may suggest an interaction between phonetic change and morpho-syntax and the lexicon, at a stage in which, similarly as for Mormanno, the sound change may not be fully phonologised.

Verb suffixes in pro-drop languages like the Lausberg dialects carry information about person and number that has to be perceptually salient to the listener, whereas in nouns and adjectives inflectional information can also be retrieved word-externally through determiners and inflected modifiers. It is possible, therefore, that the higher functional load on suffixes in verbs may inhibit their reduction and cue transfer to the stem. There is also some evidence that speakers may modulate semantic load prosodically (Sereno & Jongman 1995). If this is so, then specific morpho-syntactic markers such as final suffixes may be phonetically less eroded in some words because of their saliency and informativeness (Walker 2005, Ohala 2012). In numerous sound changes, a discrepancy between verbs and other grammatical categories has been observed, although the direction and extent of the sound change is language or dialect-dependent (Smith 2011). This has most probably to do with both the morphological structure and the morpho-syntactic function of verbs: on the one hand, their central role in the syntax and semantics makes them highly relevant and informative for both speaker and hearer; on the other hand, however, not all morphemes within a verb may carry the same functional load: for example, inflectional information may be redundant and easily retrievable from the context. A similar observation has been made for northern Italian varieties (Maiden 1991), in which the absence of metaphony in the verb is functionally interpreted as a way to avoid linguistic redundancy, since other affixes already express inflectional information. In this respect, the case of paradigmatic overextension of metaphony in some verbs of the Lausberg dialects has to be seen as a phenomenon which is posterior and detached from coarticulation: Since the suffix is crucially informative in these varieties, alternations in the stem would be redundant and not contribute to meaning, no matter whether this uniformity goes in the direction of raising or not. In conclusion, paradigm levelling in these verbs can be both interpreted functionally (as a way to avoid linguistic redundancy) and morphologically (as a form of superimposed paradigmatic levelling).

While metaphony in nouns and adjectives seems to show a progression from "lower" phonetic coarticulatory effects to increasingly phonologised and, ultimately, morphologised or lexicalised effects in the final stages of the same sound change, the clear inhibition of stem vowel distinctions in verbs is more in line with those phonological frameworks that argue for the presence of a phoneme-to-lexeme mapping (Pierrehumbert 2006; Wedel 2006). How the grammatical or morpho-lexical category of a word may influence sound change may vary across languages, but there is increasing evidence from this and other studies mentioned above and in the Introduction (Section 1) that sound change is not blind to higher levels of the grammar, such as morphology (e.g. Strycharczuk & Scobbie 2016) and the lexicon (Smith 2011; Wedel 2012; Hay & Foulkes 2016).

6. Conclusions

Overall, the data analysed in this study suggest that the morpho-lexical level can influence sound change that is still not completely phonologised (or morphologised) in a "top-down" fashion. Although sound changes do generally move up from phonetics

to a higher degree of cognitive control through any form of phonologisation, grammaticalisation or lexicalisation, there is still the possibility that higher levels in the grammar can bias sound change in a certain way, as for the data of this study showing that sound change may be inhibited depending on grammatical class.

We also suggested that the levelling observed in verb paradigms can be linked to the functional load of suffixes, which is, in pro-drop languages like the varieties analysed, higher in verbs than in nouns and adjectives: Thus, paradigm levelling in verbs arises from the functional pressure to preserve morphological information and, at the same time, avoid redundancy in inflectional marking.

Future research might consider in greater detail lexically-specific phonetic effects and, in general, phenomena that point to a bi-directional contact between phonetics, phonology and higher linguistic levels. In particular, a far larger base of evidence would be necessary that takes into account typologically diverse languages.

Competing interests. The authors have no competing interests to declare.

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Data availability statement. The data and scripts used for this study can be accessed here: https://doi.org/10.5282/ubm/data.716. The document "Greca-Harrington26_analyses.html" also contains all details from the statistical analyses.

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Supplementary materials: Appendices

A. Information about speakers

The first two letters of the speakers' code in Table 3 refer to the village (specified in the table). The column "Region" refers to the three main village groups examined: MM = Mormanno, MZ = Mittelzone, ZZ = Zwischenzone. The column "Age" indicates the biological age of each speaker when recorded. The column "Education" refers to the highest level of education attained: 1 = elementary school, 2 = middle school (in Italy "scuola media"), 3 = high school ("maturità"), 4 = university.

Table 3: The recorded speakers: codes, villages, regions, age, and education level

Speaker	Region	Village	Age	Education
CA01F	MZ	Canna	44	2
CC01F	MZ	Cerchiara	65	4
CC01M	MZ	Cerchiara	27	3
CC02F	MZ	Cerchiara	13	1
CC02M	MZ	Cerchiara	47	3
CC03F	MZ	Cerchiara	44	3
CC03M	MZ	Cerchiara	46	3
CC04F	MZ	Cerchiara	51	2
CC05F	MZ	Cerchiara	81	2
CC06F	MZ	Cerchiara	14	2
CC07F	MZ	Cerchiara	19	2
CC08F	MZ	Cerchiara	44	3
CV01F	MZ	Castrovillari	32	3
CV02F	MZ	Castrovillari	24	4
CV03F	MZ	Castrovillari	22	3
LA01F	MZ	Lauria	31	4
LI01M	ZZ	Laino	82	1
LI02M	ZZ	Laino	80	1
LI03M	ZZ	Laino	90	1
LI04M	ZZ	Laino	92	1
LI05M	ZZ	Laino	67	3
LI06M	ZZ	Laino	85	1
MG01M	MZ	Montegiordano	45	4
MG02M	MZ	Montegiordano	67	3
MM02F	MM	Mormanno	25	4
MM03F	MM	Mormanno	28	4
MM03M	MM	Mormanno	26	4
MM04F	MM	Mormanno	26	4
MM04M	MM	Mormanno	25	3
MM05F	MM	Mormanno	25	4
MM05M	MM	Mormanno	22	3
MM06F	MM	Mormanno	72	4
MM06M	MM	Mormanno	75	3
MM07F	MM	Mormanno	47	4
MM07M	MM	Mormanno	81	1
MM08F	MM	Mormanno	54	3
MM08M	MM	Mormanno	43	3
MM09F	MM	Mormanno	63	2
MM09M	MM	Mormanno	73	2
MM10F	MM	Mormanno	54	2
MM11F	MM	Mormanno	45	3

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Speaker	Region	Village	Age	Education
MM11M	MM	Mormanno	46	4
MM12F	MM	Mormanno	75	2
MM12M	MM	Mormanno	33	4
MM13F	MM	Mormanno	17	2
MM13M	MM	Mormanno	42	3
MM14F	MM	Mormanno	53	2
MM14M	MM	Mormanno	48	3
MM15F	MM	Mormanno	20	3
MM15M	MM	Mormanno	15	2
MM16F	MM	Mormanno	20	3
MM16M	MM	Mormanno	56	2
OM01F	MZ	Orsomarso	72	3
OM01M	MZ	Orsomarso	59	4
OM02F	MZ	Orsomarso	58	3
OM02M	MZ	Orsomarso	65	3
OM03F	MZ	Orsomarso	52	3
RI01M	MZ	Rocca Imperiale	45	3
RI02M	MZ	Rocca Imperiale	47	2
SC01F	ZZ	Scalea	44	3
SC01M	ZZ	Scalea	40	4
SC02F	ZZ	Scalea	47	3
SC02M	ZZ	Scalea	33	4
SC03F	ZZ	Scalea	61	2
SC03M	ZZ	Scalea	20	3
SC04M	ZZ	Scalea	44	4
SC05M	ZZ	Scalea	52	3
SC06M	ZZ	Scalea	72	3
SC07M	ZZ	Scalea	66	2
SD01F	ZZ	S. Domenica Talao	27	4
SH01M	ZZ	Schiavonea	41	3
SL01F	MZ	San Lorenzo Bellizzi	14	1
SL01M	MZ	San Lorenzo Bellizzi	81	0
SL02F	MZ	San Lorenzo Bellizzi	46	2
SL02M	MZ	San Lorenzo Bellizzi	66	3
SL03F	MZ	San Lorenzo Bellizzi	39	2
TR01F	MZ	Trebisacce	77	3
TR01M	MZ	Trebisacce	50	4
TR02F	MZ	Trebisacce	67	4
TR02M	MZ	Trebisacce	73	4
TR03F	MZ	Trebisacce	60	3
TR03M	MZ	Trebisacce	63	4
TR04F	MZ	Trebisacce	73	2
TR05F	MZ	Trebisacce	68	4
TR06F	MZ	Trebisacce	46	2
VB01F	ZZ	Verbicaro	74	1
VB01M	ZZ	Verbicaro	65	3
VB02F	ZZ	Verbicaro	62	4
VB02M	ZZ	Verbicaro	70	3
VB03F	ZZ	Verbicaro	49	4
VB04F	ZZ	Verbicaro	76	1
VB05F	ZZ	Verbicaro	69	4
VB06F	ZZ	Verbicaro	72	2
VI01F	MZ	Villapiana	70	3

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Speaker	Region	Village	Age	Education
VI01M	MZ	Villapiana	55	3
VI02F	MZ	Villapiana	50	3
VI02M	MZ	Villapiana	63	3
VI03F	MZ	Villapiana	28	3
VI03M	MZ	Villapiana	59	2

B. Lexical items analysed and used for formant normalisation

The first column of Tables 4 and 5 list in alphabetical order in Standard Italian the lexical items elicited for this study. The words' transcription indicated in the second column is a phonemic reconstruction of the dialect target form and does not take into account possible phonetic realisations. In disyllabic words, the stressed syllable is always the first one, while in other cases the stress is marked. The third column provides a translation of each item into English.

Table 4: List of lexical items containing a mid stem vowel used for analysis in this study

Target word	Target phonemic form	Meaning
anelli	aˈnelli	rings (masc. pl.)
anello	aˈnellu	ring (masc. sg.)
bella	bella	beautiful (fem. sg.)
bello	bellu	beautiful (masc. sg.)
buona	bona	good (fem. sg.)
buone	bone	good (fem. pl.)
buoni	boni	good (masc. pl.)
buono	bonu	good (masc. sg.)
cappelli	kapˈpelli	hats (masc. pl.)
cappello	kapˈpellu	hat (masc. sg.)
capretta	kraˈpetta	kid (goat) (fem. sg.)
capretti	kraˈpetti	kids (goat) (masc. pl.)
capretto	kraˈpettu	kid (goat) (masc. sg.)
cervelli	tʃerˈvelli	brains (masc. pl.)
cervello	tʃerˈvellu	brain (masc. sg.)
coltelli	kurˈtelli	knifes (masc. pl.)
coltello	kurˈtellu	knife (masc. sg.)
corna	korna	horns (fem. pl.)
corno	kornu	horn (masc. sg.)
cotta	kotta	cooked (fem. sg.)
cotto	kottu	cooked (masc. sg.)
cuore	kore	heart (masc. sg.)
cuori	kori	hearts (masc. pl.)
dente	dente	tooth (masc. sg.)
denti	denti	teeth (masc. pl.)
donna	ˈfemmina	woman (fem. sg.)
donne	ˈfemmine	women (fem. pl.)
dorme	dorme	(he/she) sleeps
dormi	ˈdormisi	(you) sleep
dormo	dormu	(I) sleep
esce	esse	(he/she) goes out
esci	ˈessisi	(you) go out
esco	esku	(I) go out
ferri	ferri	irons (masc. pl.)
ferro	ferru	iron (masc. sg.)
foglia	foʎʎa	leaf (fem. sg.)

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Target word	Target phonemic form	Meaning
foglie	foʌʌe	leaves (fem. pl.)
fuochi	foki	fires (masc. pl.)
fuoco	foku	fire (masc. sg.)
grossa	grossa	big (fem. sg.)
grosso	grossu	big (masc. sg.)
letti	letti	beds (masc. pl.)
letto	lettu	bed (masc. sg.)
lunga	longa	long (fem. sg.)
lungo	longu	long (masc. sg.)
mela	mela	apple (fem. sg.)
mele	mele	apples (fem. pl.)
mese	mese	month (masc. sg.)
mesi	mesi	months (masc. pl.)
morta	morta	dead (fem. sg.)
morti	morti	dead (masc. pl.)
morto	mortu	dead (masc. sg.)
muoio	moru	(I) die
muori	ˈmorisi	(you) die
nipote	niˈpote	grandchild (masc. sg.)
nipoti	niˈpoti	grandchildren (masc. pl.)
nuova	nova	new (fem. sg.)
nuovo	novu	new (masc. sg.)
occhi	okki	eyes (masc. pl.)
occhio	okkju	eye (masc. sg.)
ossa	ossa	bones (fem. pl.)
osso	ossu	bone (masc. sg.)
pecora	ˈpekura	sheep (fem. sg.)
pecore	ˈpekure	sheep (fem. pl.)
pensa	pensa	(he/she) thinks
pensi	ˈpensasi	(you) think
penso	pensu	(I) think
pesca	peska	peach (fem. sg.)
pesche	peske	peaches (fem. pl.)
pettine	ˈpettine	comb (masc. sg.)
pettini	ˈpettini	combs (masc. pl.)
pezza	pettsa	piece of cloth (fem. sg.)
pezzo	pettsu	piece (generic) (masc. sg.)
piede	pede	foot (masc. sg.)
piedi	pedi	feet (masc. pl.)
pietra	petra	stone (fem. sg.)
pietre	petre	stones (fem. pl.)
ponte	ponte	bridge (masc. sg.)
ponti	ponti	bridges (masc. pl.)
porci/maiali	portʃi	pigs (masc. pl.)
porco/maiale	porku	pig (masc. sg.)
prete	ˈprevite	priest (masc. sg.)
preti	ˈpreviti	priests (masc. pl.)
rosa	rosa	rose (fem. sg.)
rose	rose	roses (fem. pl.)
ruota	rota	wheel (fem. sg.)
ruote	rote	wheels (fem. pl.)
sedia	seddʒa	chair (fem. sg.)
sedie	seddʒe	chairs (fem. pl.)

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Target word	Target phonemic form	Meaning
sole	sole	sun (masc. sg.)
sposa	sposa	bride (fem. sg.)
sposo	sposu	groom (masc. sg.)
stella	stella	star (fem. sg.)
stelle	stelle	stars (fem. pl.)
tengo	tengu	(I) have
tiene	tene	(he/she) has
tieni	ˈtenisi	(you) have
topi	ˈsoritʃi	mice (masc. pl.)
topo	ˈsoritʃe	mouse (masc. sg.)
trova	trova	(he/she) finds
trovi	ˈtrovasi	(you) find
trovo	trovu	(I) find
uomini	ˈommini	men (masc. pl.)
uomo	ˈommine	man (masc. sg.)
uova	ova	eggs (fem. pl.)
uovo	ovu	egg (masc. sg.)
vecchia	vekkja	old woman (fem. sg.)
vecchio	vekkju	old man (masc. sg.)
venti	venti	winds (masc. pl.)
vento	ventu	wind (masc. sg.)
verme	verme	worm (masc. sg.)
vermi	vermi	worms (masc. pl.)
voglio	voʎʎu	(I) want
vuoi	voi	(you) want
zoppa	tsoppa	lame woman (fem. sg.)
zoppo	tsoppu	lame man (masc. sg.)

Table 5: List of lexical items containing /i, a, u/ stem vowels used for formant normalisation

Target word	Target phonemic form	Meaning
aghi	agi	needles (masc. pl.)
ago	agu	needle (masc. sg.)
apre	apre	(he/she) opens
apri	ˈaprisi	(you) open
apro	apru	(I) open
beve	vive	(he/she) drinks
bevi	ˈvivisi	(you) drink
bevo	vivu	(I) drink
braccia	vrattsa	arms (fem. pl.)
braccio	vrattsu	arm (masc. sg.)
cane	kane	dog (masc. sg.)
cani	kani	dogs (masc. pl.)
capelli	kaˈpilli	hair (masc. pl.)
capello	kaˈpillu	hair (masc. sg.)
casa	kasa	house (fem. sg.)
case	kase	house (fem. pl.)
cenere	ˈtʃinnira	ash (fem. sg.)
corre	kurre	(he/she) runs
corri	ˈkurrisi	(you) run

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Target word	Target phonemic form	Meaning
corro	kurru	(I) run
corta	kurta	short (fem. sg.)
corti	kurti	short (masc. pl.)
corto	kurtu	short (masc. sg.)
croce	krutʃe	cross (masc. sg.)
croci	krutʃi	crosses (masc. pl.)
dita	ˈjidita	fingers (fem. pl.)
dito	ˈjiditu	finger (masc. sg.)
dolce	durtʃe	sweet (masc. sg.)
dolci	durtʃi	sweets (masc. pl.)
forni	furni	ovens (masc. pl.)
forno	furnu	oven (masc. sg.)
fredda	fridda	cold (fem. sg.)
freddi	friddi	cold (masc. pl.)
freddo	friddu	cold (masc. sg.)
fumo	fumu	smoke (masc. sg.)
galli	galli	roosters (masc. pl.)
gallo	gallu	rooster (masc. sg.)
gatti	gatti	cats (masc. pl.)
gatto	gattu	cat (masc. sg.)
ginocchia	jiˈnukkja	knees (fem. pl.)
ginocchio	jiˈnukkju	knee (masc. sg.)
giorni	jurni	days (masc. pl.)
giorno	jurnu	day (masc. sg.)
ladri	latru	thief (masc. sg.)
ladro	latri	thieves (masc. pl.)
latte	latte	milk (masc. sg.)
legna	linna	wood (fem. sg.)
legno	linnu	piece of wood (masc. sg.)
luce	lutʃe	light (fem. sg.)
luna	luna	moon (fem. sg.)
mani	manu	hands (fem. pl.)
mano	manu	hand (fem. sg.)
mare	mare	sea (masc. sg.)
nera	ˈnivura	black (fem. sg.)
neri	ˈnivuri	black (masc. pl.)
nero	ˈnivuru	black (masc. sg.)
noce	nutʃe	walnut (fem. sg.)
noci	nutʃi	walnuts (fem. pl.)
pasta	pasta	pasta (fem. sg.)
peli	pili	body hair (masc. pl.)
pelo	pilu	body hair (masc. sg.)
pesce	piʃʃu	fish (masc. sg.)
pesci	piʃʃi	fish; fishes (masc. pl.)
rossa	russa	red (fem. sg.)
rosso	russu	red (masc. sg.)
santa	santa	saint (fem. sg.)
santi	santi	saint (masc. pl.)
santo	santu	saint (masc. sg.)
unghia	uɲɲa	nail (fem. sg.)
unghie	uɲɲe	nails (fem. pl.)
uva	uva	grapes (fem. sg.)
vacca	vakka	cow (fem. sg.)

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Target word	**Target phonemic form**	**Meaning**
vacche	vakke	cows (fem. pl.)
vedi	ˈvidisi	(you) see
vedo	vidu	(I) see
verde	virde	green (masc. sg.)
verdi	virdi	green (masc. pl.)
volpe	vurpe	fox (fem. sg.)
volpi	vurpi	foxes (fem. pl.)