An experimental analysis of metaphony and sound change in the dialects of the Lausberg area (Southern Italy)

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List of Abbreviations

ANOVA	Analysis of variance
CL	Confidence level
df	Degrees of freedom
dV	Dependent variable
EMMs	Estimated marginal means
F1	First formant
F2	Second formant
fem.	Feminine
FPCA	Functional principal components analysis
GLMM	Generalised linear mixed model
Hz	Hertz
IPA	International Phonetic Alphabet
LMER	Linear mixed-effects regression
m	(Estimated) mean
masc.	Masculine
MAUS	Munich automatic segmentation system
MM	Mormanno
MMN	Mismatch negativity
MZ	Mittelzone
n. s.	Non-significant

PC	Principal component
PC1	First principal component
PC2	Second principal component
PC3	Third principal component
pers.	Person
pl.	Plural
r	Reduction index
$R^2{}_{\mathrm{c}}$	Conditional R^2
$R^2{}_{\mathrm{m}}$	Marginal R^2
s_1	First principal component score
s_2	Second principal component score
s_3	Third principal component score
sd	Standard deviation
SE	Standard error
sg.	Singular
Sig.	Significance
V_1	First (stem) vowel
V_2	Second (suffix) vowel
$\mathrm{V}_{\mathrm{back}}$	Back suffix vowel
$\mathrm{V}_{\mathrm{front}}$	Front suffix vowel
VAS	Visual analogue scale
VCV	Vowel-consonant-vowel
ZZ	Zwischenzone

Zusammenfassung

Die vorliegende Arbeit befasst sich mit der phonetischen und phonologischen Analyse der Metaphonie im Lausberg-Gebiet (Lausberg, 1939) und ihrer Beziehung zur Vokalschwächung in den Suffixen. Metaphonie ist eine Art regressiver Assimilation, bei der ein hoher Suffixvokal den Stammvokal innerhalb eines Wortes beeinflusst. Die Folge der Metaphonie ist entweder Vokalerhöhung, z.B. [ˈfrɛska, ˈfrisku] (‘frisch’, fem. sg. vs. mask. sg.), oder Diphthongierung des Stammvokals, z.B. [ˈpɛːdə, ˈpiːədi] (‘Fuß, Füße’). Diese sowie der Grad der Suffixschwächung können sowohl über Generationen hinweg als auch zwischen den relativ isolierten Dörfern der „Area Lausberg“ unterschiedlich sein. Insbesondere existieren zwischen verschiedenen Dörfern dieses Gebiets unterschiedliche phonetische Outputs der Metaphonie, die wiederum die Kristallisierung verschiedener Phasen desselben metaphonischen Lautwandelprozesses vertreten könnten (Barbato, 2008; Lausberg, 1939, 1947; Lüdtke, 1956; Martino, 1991; Trumper, 1997). Die verschiedenen phonetischen Ergebnisse der Metaphonie könnten außerdem in manchen Dörfern rein koartikulatorisch und in anderen Dörfern komplett phonologisiert worden sein. Da der Suffixvokal als Begleiterscheinung einer Phonologisierung der Metaphonie geschwächt oder getilgt werden kann, ist die Rolle der akustischen Realisierung und Wahrnehmbarkeit des Suffixvokals, die die Metaphonie ausgelöst hat, relevant.

Einerseits gibt es zahlreiche theoretische Studien zur Metaphonie in den italienischen Dialekten (e.g. Conte, 2014; Maiden and Savoia, 1997; Rensch, 1964), die jedoch meistens auf Höreindrücken beruhen und durch repräsentative Hörproben nur unzureichend gestützt werden. Anderseits bestehen viele dieser Studien, sogar die neuesten (siehe z. B. Torres-Tamarit, Linke, and Oostendorp, 2016), aus abstrakten phonologischen Berichten, die sehr wenig oder gar keine Unterstützung von akustischen und quantitativen Daten haben. Darüber hinaus wurde die unklare und geschichtete Korrelation zwischen metaphonisierenden Vokalen und einer abschließenden Vokalschwächung oder Neutralisierung des auslösenden Suffixvokals bis jetzt von keiner systematischen Studie in Bezug auf das Lausberg-Gebiet untersucht.

Das Hauptziel dieser Arbeit ist deswegen, die Mechanismen der Produktion und Perzeption der Metaphonie und ihre Beziehung zur Vokalschwächung im Lausberg-Gebiet durch

einen vollständig datengetriebenen und experimentellen Ansatz zu beleuchten. Solche allgemeinen Mechanismen auf der Grundlage von einem Lautwandel wie der Metaphonie sind sowohl für die historische Linguistik als auch für die Phonologie im Allgemeinen wichtig, um zu verstehen, wie diachrone Lautveränderungen aus synchroner Variation entstehen können. Dennoch geht diese Studie auch über phonetische Details hinaus, indem sie die Rolle der Morphologie bei der Metaphonie berücksichtigt. Diese Forschungsaspekte, die die menschliche Sprachverarbeitung betreffen, sind daher auch für die allgemeine Sprachwissenschaft relevant.

Diese Arbeit besteht aus drei analytischen Hauptbereichen: Die akustischen Analysen der Stammvokale in metaphonischen und nicht-metaphonischen Kontexten (Kapitel 2 und 3), die akustische Analyse der Suffixvokale (Kapitel 4) und die Perzeptionsanalyse der Metaphonie nur anhand von Stammvokalen (Kapitel 5). Die Arbeit wurde wie folgt gegliedert.

Der erste Teil des **Kapitels 1** wirft einen Blick auf die Literatur über Metaphonie und Vokalschwächung des Suffixes mit besonderem Fokus auf Süditalien. Beide Phänomene werden in die phonologische Theorie eingerahmt und mit den wichtigsten Lautwandeltheorien in Beziehung gesetzt. Dazu wird das Lausberg-Gebiet und seine Unterteilung in verschiedene Regionen unter besonderer Berücksichtigung der unterschiedlichen metaphonischen Ergebnisse beschrieben. Im zweiten Teil des Kapitels werden die Forschungsziele meiner Arbeit und die experimentelle Erhebungsmethode der akustischen Daten dargelegt. Die Zusammensetzung der akustischen Datenbank bestehend aus den Auswahlkriterien der elizitierten Wörtern, der Komposition der Probandenstichprobe auf Basis von Geschlecht und Alter sowie der drei definierten Regionen *Mormanno* (MM), *Zwischenzone* (ZZ), und *Mittelzone* (MZ) wird dazu beschrieben.

Kapitel 2 stellt eine explorative akustische Analyse des metaphonischen Einflusses auf die Stammvokale dar. Insbesondere werden Alter und Region der Sprecher, so wie alle Stammvokale /i, e, a, o, u/, und Suffixvokalpaare – vordere /e, i/-Suffixe vs. hintere /a, u/-Suffixe, wobei /i, u/ definitionsgemäß die metaphonischen Suffixe sind – berücksichtigt. Diese erste Analyse umfasst Wortpaare, in denen eines der beiden Suffixe ein hoher Vokal ist. Es werden die Formantenunterschiede der Stammvokale berechnet, die getrennt für Alter, Stammvokal, Suffixvokalpaar und Region das Ausmaß des metaphonischen Einflusses zeigen. Die Ergebnisse weisen auf einen insgesamt weniger ausgeprägten metaphonischen Einfluss bei jüngeren Sprechern hin, der jedoch in den meisten Fällen nicht statistisch signifikant ist. Stattdessen sind die Unterschiede im metaphonischen Einfluss zwischen den drei Regionen so wie zwischen Suffixen solide und in den meisten Fällen signifikant. Mittlere Stammvokale zeigen außerdem die stärksten metaphonischen und koartikulatorischen Effekte.

Kapitel 3 konzentriert sich auf die hier getrennt analysierten mittleren Stammvokale /e, o/ und auf die Unterschiede zwischen den drei Regionen MM, ZZ und MZ. In dieser Phase werden alle lexikalischen Elemente mit einem mittleren Stammvokal und der Einfluss einzelner Suffixvokale /a, e, i, u/ (unabhängig von Suffixpaar) berücksichtigt. Durch die Anwendung der *Functional Principal Components Analysis* (FPCA) werden die Formantformen dynamisch analysiert: Zwei Hauptkomponenten (*Principal Components*) wurden extrahiert, die sich entweder auf das Erhöhung oder Senkung der Vokale (PC1) oder auf steigende oder fallende Diphthongierung (PC3) beziehen. Insbesondere ist PC1 die Hauptkomponente für die Modellierung der metaphonischen Formantenformvariation in MM und MZ, während PC3 die Metaphonie hauptsächlich in ZZ modelliert. Die Ergebnisse zeigen: Im Allgemeinen ist die Koartikulation der Vokalhöhe das Hauptmerkmal des phonetischen Einflusses des Suffixvokals auf den Stammvokal. Insbesondere ist nicht nur ein Einfluss von hohen Suffixvokalen vorhanden, sondern auch der tiefe Suffixvokal /a/ löst eine signifikante Vokalabsenkung aus. Die progressive metaphonische und koartikulatorische Stärke folgt eindeutig der Progression MM < ZZ < MZ, d. h. Metaphonie und Vokalkoartikulation ist bei MM weniger ausgeprägt als bei ZZ, und weniger ausgeprägt bei ZZ als bei MZ. Schließlich wird argumentiert, dass die metaphonischen Outputs dieser drei Regionen drei Lautwandel-Hauptphasen darstellen können, die ebenfalls gemäß der Sequenz MM < ZZ < MZ diachronisch verknüpft sind.

Kapitel 4 analysiert die Schwächung und Tilgung der Suffixvokale und insbesondere, wie sich die beiden Phänomene je nach Region unterscheiden. Hinsichtlich der Suffixtilgung stellt sich heraus, dass diese in MZ am häufigsten und in MM am seltensten ist, während in ZZ die Suffixtilgung nicht so oft wie in MZ, aber öfter als in MM vorkommt. Um die Suffixschwächung zu quantifizieren, wurde anhand eines *ad hoc*-Algorithmus aus jedem Formantpaar jedes Suffixvokals ein Reduktionsindex (r) extrahiert. Ähnlich wie bei der Suffixtilgung, spiegelt der Schwächungsgrad der Suffixvokale die Sequenz MM < ZZ < MZ wider: MM Sprecher reduzieren ihre Suffixe zwar nicht wie ZZ Sprecher, aber ZZ Sprecher reduzieren weniger als MZ Sprecher. Unterschiede zwischen den Regionen im Grad, sowohl der Suffix-Vokalschwächung als auch der Tilgung, sind im Allgemeinen ebenfalls statistisch signifikant. Die festgestellte parallele Progression, sowohl bei der Metaphonie in Stammvokalen, als auch bei der Schwächung und Tilgung der Suffixvokale, gilt als weiteres Argument dafür, dass das von den drei Regionen gezeigte Koartikulationsmuster drei verschiedene Phasen des Phonologisierungsprozesses der Metaphonie wiederspiegeln könnten.

In **Kapitel 5** wird die Metaphonie nicht akustisch, sondern aus der Perspektive des Hörers, analysiert. Die durchgeführten Perzeptionsexperimente werden beschrieben, in denen die Teilnehmer die lexikalischen Stämme, denen der Suffixvokal entzogen wurde, unterscheiden mussten. Damit wurde getestet, ob sich die Hörer aus den drei Regionen darin unterscheiden, wie sie metaphonische und nicht-metaphonische Stämme wahrnehmen, die von Sprechern derselben Region produziert wurden. Obwohl die Hörer aller drei Regionen bei der Unterscheidung von metaphonischen Stämmen von nicht-metaphonischen gute Leistung erbringen, schneiden MZ-Hörer leicht, aber statistisch signifikant besser ab als MM- und ZZ-Hörer. Parallel zu dem, was sich in den akustischen Analysen der Kapitel 2 und 3 herausgestellt hat – d. h. dass die hinteren Suffixvokale /a, u/ den größten koartikulatorischen Einfluss auf die Stämme haben – können Hörer im Allgemeinen Stämme in Wortpaaren mit hinteren Suffixen /a, u/ leichter unterscheiden als Paare mit vorderen Suffixen /e, i/. Die Korrelation zwischen der Antworten der Teilnehmer und den s_1- und s_3-Werten (als Indikatoren für den Grad der Vokalerhöhung bzw. der Diphthongierung in den Stimuli) weist in die erwartete Richtung für alle drei Regionen und insbesondere für die Metaphonie-auslösenden hohen Suffixvokale /i, u/. Dazu wurde auch getestet, ob sich MM- und MZ-Hörer darin unterschieden, metaphonische und nicht-metaphonische Stämme in ZZ-Stimuli korrekt wahrzunehmen. MZ-Hörer schneiden leicht besser ab als MM-Hörer bei der Unterscheidung der Stämme. Auch die Korrelation zwischen s_1 und Antwort sowie s_3 und Antwort ist bei MZ-Hörern stärker als bei MM-Hörern.

Im letzten Abschnitt wird diskutiert, dass die Ergebnisse der Perzeptionsexperimente in Kombination mit den akustischen Analysen insgesamt kohärent zu einem Sprachverarbeitungsmodell sind, in dem phonologisches Wissen aus erinnerten sprachphonetischen Kategorien extrahiert und dann auf mentale phonologische Kategorien abgebildet wird. Aus dieser Perspektive könnte die Metaphonie im Lausberg-Gebiet als graduelles Phänomen aufgetreten sein, da beispielsweise MM-Sprecher eine weitaus schwächere Metaphonie und Koartikulation als Sprecher aus Regionen wie z. B. MZ in der Produktion zeigen, aber eine sehr gute Genauigkeit bei der Unterscheidung von Stämmen aufweisen. Asymmetrie zwischen Produktion und Wahrnehmung ist potenziell die Grundlage vieler Arten von Lautwandel (Ohala, 2012, 1993) und stellt somit ein weiteres Argument für die Hypothese dar, dass Metaphonie im MM eine erste Phase der metaphonischen Lautwandel im Raum Lausberg darstellen könnte, die chronologisch vor den anderen Phasen steht, die von den anderen Regionen repräsentiert werden.

Im **Kapitel 6** werden schließlich alle wichtigen Ergebnisse der Studie zusammengefasst und sowohl aus einer phonetischen und phonologischen als auch einer geolinguistischen und dialektologischen Perspektive kommentiert. Es wird insbesondere diskutiert, wie ein so genannter „cue trading"-Mechanismus, der als Konsequenz koartikulatorischer Phänomene entsteht, an der Basis von Phonologisierungsphänomenen wie der Metaphonie sein kann. Trotzdem kann so ein Mechanismus in Interaktion mit vielen anderen intra- und extralinguistische Komponenten zu verschiedenen Lautwandelsergebnissen führen. Was die Metaphonie im Lausberg-Gebiet betrifft, hat möglicherweise eine Vielzahl von Faktoren, einschließlich nicht nur der Überschnitt zwischen Metaphonie und Flexionsmorphologie, sondern auch die Geographie und die historischen Ereignisse, die die Isolation des Gebiets (und auch bestimmter Zentren innerhalb des Gebiets) verursacht haben, einen Einfluss auf die Entwicklung der metaphonisierten Vokalen. Die konsequente sprachliche Fragmentierung und die damit verbundene Anwesenheit unterschiedlicher Arten von Metaphonie innerhalb eines nichtsdestotrotz relativ begrenzten geographischen Territoriums, die nur wenige Dörfer an der Grenze zwischen Kalabrien und Basilikata zählt, bleibt eine Besonderheit der „Area Lausberg“. Diese Besonderheit wird dennoch in dieser Arbeit verwendet, um einen Blick in die Komplexität bestimmter Lautwandel- und Phonologisierungsmechanismen, wie der Metaphonie, zu werfen, die koartikulatorische Voraussetzungen haben.

Chapter 1

Introduction

1.1 Literature review

1.1.1 What is metaphony?

The term "metaphony" originates from a calque translation of the German word "Umlaut" (in which 'um-' is in turn a translation of the Greek prefixoid *meta-*, while 'Laut' corresponds to the suffixoid *phoné*, '-phony'), which can be translated into English as "change in/of sound". Similarly to Umlaut, in fact, metaphony is a kind of regressive vowel harmony, originating from trans-consonantal vowel-to-vowel coarticulation, and is triggered by a still-existing or previously-existing high vowel in the unstressed suffix, influencing the quality of the stressed stem vowel (less typically, also the pre-tonic vowel in trisyllabic words). These suffixes may indicate a variety of morpho-syntactic categories, mainly gender and number in nouns and person, and number and tense in verbs. The regressive coarticulatory type and the interface with the morphological layer are common to both phenomena. The only substantial difference is that the term "Umlaut" is mainly applied to the Germanic languages nowadays and indicates a phonologised or even lexicalised vowel fronting (e.g. Old High German /ˈgasti/, Modern Standard German [ˈɡɛstə]), while metaphony is the term mostly used for Romance languages[1], designating an either purely phonetic, or rather phonologised or lexicalised vowel raising or diphthongisation – as, for instance, Maiden and Savoia (1997) pointed out when referring to Southern Italian dialects. Metaphony is present in several Romance languages such as Brazilian and European

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[1]However, it was not always the case, especially among German authors: see e.g. Schürr (1936), who wrote in German about "Umlaut in der Romania", or also Rensch (1964) and Lausberg (1939), who referred to metaphony as "Umlaut" in their description of dialects in Southern Italy.

Portuguese (Cunha, 2000; Miranda, 2002), some Spanish dialects (Barnes, 2019; Hualde, 1998; Penny, 2009), Romanian (Chitoran, 2002; Russo, 2014) and is very common in the dialects of Italy (Maiden & Savoia, 1997; Rohlfs, 1966; Torres-Tamarit et al., 2016). With different phonetic outcomes, metaphony is mostly present in Central and Southern Italian dialects, and it is absent only in some areas of Northern Italy, including Liguria, the subalpine and the Po Plane area, in most dialects in Tuscany, in some other dialects in Central Italy, in parts of Sardinia, in parts of the Cilento region in Campania, in some dialects in the extreme south of Calabria and Apulia, and in western Sicily (Maiden and Savoia, 1997, p. 35, with some reviews). Whilst the high vowels /i, u/ act as vocalic triggers, the preferred targets for metaphony, especially in Southern Italian dialects, are the mid vowels /ɛ, e, ɔ, o/. Basically, all dialects presenting metaphony share this trait, while dialects presenting the low vowel /a/ as a target are much rarer (Rohlfs, 1966; Maiden, 1991; Savoia, 2015, p. 203).

Metaphony results not only in vowel shifting (typically raising), but also diphthongisation or fronting. Vowel raising usually involves mid-low vowels, less frequently mid-high ones and more rarely the low central vowel: ɛ→ e/_i, u; ɔ → o/_i, u; e → i/_i, u; o → u/_i, u; a → ɛ, æ/_i, u. In particular, Maiden (1991, p. 115) claims that an implicational hierarchy exists for stem vowels undergoing metaphony: a raising of low vowels implies a raising of mid vowels, and a raising of mid-low vowels implies a raising of mid-high vowels. Nevertheless, this rigid hierarchy is not without exceptions, as Maiden himself (Maiden & Savoia, 1997; Maiden, 1991) remarks. Mid-vowel raising is, for instance, present in the Salentino dialect of Apulia (Calabrese, 1985; Grimaldi, 2003; Grimaldi & Calabrese, 2018; Grimaldi, Calabrese, Sigona, Garrapa, & Sisinni, 2010; Grimaldi, Miglietta, Sigona, & Calabrese, 2016), largely attested in Sardinian varieties (Frigeni, 2003; Torres-Tamarit, Linke, & Vanrell, 2017) as well as in Calabrian varieties with the so-called Sardinian vowel system (which will be better described in Section 1.1.3). Very exceptionally (D'Alessandro & van Oostendorp, 2016), the raising is extreme (/a/ > /i/), thereby signalling morphologisation (following the definition given by Cser, 2015, p. 196).

Here are two examples of metaphonic vowel raising of mid vowels:

(1) Brindisi, Apulia: [ˈfreska] – [ˈfrisku] ('fresh', fem. sg. vs. masc. sg.) (Savoia, 1997, p. 368)

(2) Mascioni, Abruzzo: [ˈɔrmo] – [ˈormi] ('(I) sleep, (you) sleep') (Maiden & Savoia, 1997, p. 34).

Diphthongisation usually involves mid-low vowels (which, in turn, presumably evolved from the Latin short <ĕ> and <ŏ>): ɛ → jɛ, je/_i, u; ɔ → wɔ, wo/_i, u. More rarely, we can also find falling diphthongs such as e.g. [iə, iɐ; uə, uɐ] (Savoia, 2016, p. 11). Raising diphthongisation is a very common metaphonic outcome in Campanian dialects (Russo, 2007; Russo & Sánchez Miret, 2009) and, in general, in several Central and Southern Italian dialects, while falling diphthongisation is not as common and mainly attested in some Apulian and Lucanian dialects (Maiden and Savoia, 1997, p. 18; Rohlfs, 1966).

(3) Naples, Campania: [ˈpɛːrə] – [ˈpjeːrə] (‘foot, feet’) (Loporcaro, 2011, p. 120)

(4) Iacurso, Calabria: [ˈpɛːðə] – [ˈpiːɐði] (‘foot, feet’) (Savoia, 2015, p. 229).

A further monophthongisation of previous metaphonic diphthongs has been hypothesised for some dialects (Martino, 1991, p. 14; Trumper, 1997, p. 361; Maggiore and Variano, 2015). Monophthongisation was presumably also accompanied by compensatory lengthening: [je, ie] > [iː], [wo, uo] > [uː].

(5) *[ˈbiellu] > [ˈbiːllə] (‘beautiful’, masc. sing.) (Trumper, 1997, p. 361).

(6) *[ˈkuottu] > [ˈkuːttu] (‘cooked’, masc. sing.) (Trumper, 1997, p. 361).

However, there is still some discussion about whether the diphthongisation and subsequent monophthongisation processes are actually separate phonological phenomena (Loporcaro, 2016; see also Section 1.1.4).

Finally, vowel fronting is very rarely attested in some Northern Italian dialects: u → i, y /_i (Benincà, Parry, & Pescarini, 2016, p. 190).

1.1.2 Metaphony as a morpho-phonological phenomenon

Metaphony is a historically attested example of vowel harmony that has often been either morphologised – when metaphonic alternation is the only cue for identifying a morpho-syntactic category (Maiden & Savoia, 1997, p. 15) – or lexicalised, in cases in which the stem vowel does not alternate anymore. Some evident boundaries between vowel quality change and some other correlating phonetic changes, as well as the link to morphological information, makes this phenomenon particularly complex to analyse as a whole. Morphologisation and lexicalisation processes seem to also correlate to the increasing neutralisation (or phonetic reduction) of the word-final suffix vowel. In fact, metaphony tends to coexist with a process in which the phonetic contrast among a set of suffixes is weakened or neutralised. In the latter case, height neutralisation is more common, whose result is typically (although not always) a schwa /ə/. Metaphony coexisting with suffix neutralisation has been labelled by some phonologists as “opaque” metaphony, in those cases in which the high vowel trigger has been neutralised to schwa [ə] and whose vowel quality is therefore not acoustically perceivable (Russo, 2002; Torres-Tamarit & Linke, 2016; Torres-Tamarit et al., 2017).

As regards Southern Italian dialects, final vowel neutralisation, or sometimes even elision, is a very common phenomenon also attested in several studies (Bucci, Perrier, Gerber, and Schwartz, 2019; Lausberg, 1939; Rohlfs, 1966; Romano, 2020; Russo and Barry, 2004, among others). In addition, a few studies point out that final vowels might tend to be weakened in informal speech in dialects that do not otherwise neutralise suffix vowels as well (Loporcaro, Romito, Mendicino, & Turano, 1998; Romito, Turano, Loporcaro, & Mendicino, 1997). This tendency to neutralise final vowels was also detected in the dialects in the Vallo di Diano in Southern Italy (southern Campania and western Basilicata), and interpreted as an influence of the bordering Neapolitan dialect which systematically presents final vowel reduction (Delucchi, Cangemi, & Loporcaro, 2012).

The frequent co-occurrence of metaphony with suffix vowel reduction phenomena led some scholars (Dillon, 2003; Fanciullo, 1994; Krämer, 2009; Maiden, 1991) to argue that, synchronically speaking, metaphony should be considered to be a kind of morpheme realisation rather than a form of phonological vowel harmony. For instance, Devoto (1974, p. 183) sees metaphony as a mechanism to save inflectional marking which would otherwise be at risk of not emerging at all due to phonetic suffix erosion. According to Krämer (2009, p. 123), a morpho-syntactic feature, compromised by vowel neutralisation, has to migrate to a “safer” position, which is the stressed stem vowel. However, it can also happen that the triggering suffixes do not neutralise, thus generating in this case, from a morpho-lexical point of view, an instance of double marking – “double morphemic exponence” according to Dillon (2003, p. 8). Walker (2005), for instance, mentions the presence of prosodically weak triggers in metaphony in the Veneto dialect (north-eastern Italy). She advances the theory of “perceptual disadvantage” promoting metaphonic vowel shifts: a suffix, in spite not being elided, is still less acoustically and perceptually salient than the stem vowel, which implies that a morpho-synctactic feature is preferably phonetically manifested in the stem rather than the suffix.

In light of these studies, the role of informativity at the morpho-lexical level needs to be taken into account when analysing metaphonic phenomena, as it is plausible that morphology can somehow enhance a sound change originating from phonetic premises (Maiden, 1991). A possible relationship between the extent of suffix reduction or elision and the degree of metaphonic influence has previously received little interest and (to my knowledge) no systematic study exists on it for the Romance languages. Instead, most studies have previously focused on the fact that, as mentioned before, the vowel trigger is in many cases either neutralised or not phonetically realised, thus leading several scholars to opt to employ various morpho-phonological accounts to explain the phenomenon.

Although a link between cue loss in the suffix and modification of the stem vowel quality can be at least speculated, it is difficult to find a direct causal connection, since it is still not clear how a phonological change can be achieved and maintained in spite of lenition or complete elision of the trigger of the same sound change (Beddor, 2009, 2012; Harrington, Kleber, Reubold, Schiel, & Stevens, 2019b; Kiparsky, 2015). This is nevertheless just what happens for most cases of metaphony, in which the suffix might be either neutralised or elided and metaphonic change completely phonologised or even morphologised.

1.1.3 The dialects of the Lausberg area

In this study, the focus is on metaphony in a particular dialectal region in Southern Italy, the so-called "Lausberg area" (Lausberg, 1939), extending across the border between Basilicata and Calabria. As it can be easily deduced, this area was named after Heinrich Lausberg, who first systematically described it as particularly conservative when compared to other Southern Italian varieties[2]. According to Lausberg (1939) and following studies (Rensch, 1964; Rohlfs, 1966; Romito, Galatà, Lio, and Stillo, 2006), the dialects comprised within this area have undergone far fewer phonological changes from Latin compared to other Southern Italian dialects – see also Martino (1991), discussing the linguistic isolation and conservativity of the Lausberg area and its possible causes.

The northern isogloss of the Lausberg area is nowadays indicatively to be traced across the Basilicata villages of (from west to east) Maratea, Lauria, Castelsaraceno, San Chirico Raparo, Sant'Arcangelo, Tursi and Policoro (all in Basilicata), while the isogloss delimiting the area from other more southern dialect groups runs across the Calabrian villages of Diamante, Maierà, Grisolia, Verbicaro, Orsomarso, Saracena, Castrovillari, Cassano, and Sibari (Pellegrini, 1977; Trumper and Maddalon, 1988; Trumper, 1997, p. 360, see also Fig. 1.1).

As concerns the vocalism, most Lausberg dialects share the so-called Sardinian vowel system[3], keeping the Latin vowel qualities, but neutralising vowel length[4] (Krefeld, 2004; Lausberg, 1939; Rohlfs, 1966; Savoia, 1997). Therefore, this system presents (in non-metaphonic contexts) five tonic vowels: /i, e, a, o, u/[5].

Two main sub-regions can be distinguished within the Lausberg area. The *Mittelzone* – "central zone", i.e. located between northern Basilicata varieties and southern Calabrian ones, as Lausberg (1939) defined it – broadly begins from the High Ionic coast and extends internally up to include the eastern part of the Pollino National Park. It is considered to be the sub-area characterised by the uniform spreading of the Sardinian vowel system

[2]It is worth mentioning that, however, Lausberg's master Rohlfs (1937) had already anticipated some aspects of the particularly conservative vowel system in this area.

[3]The definition of "Sardinian" refers to the fact that the vowel system described above is the same one typical of Sardinian dialects. Therefore, I do not refer here to a hypothetical influence of Sardinian varieties onto Lausberg dialects.

[4]However, it should be mentioned that a minority of authors do not agree on the fact that the vowel system of the Lausberg area is Sardinian, see e.g. Parlangeli (1971) and Fanciullo (1988).

[5]Also on this point there is not a total consensus, see e.g. Trumper, Romito, and Maddalon (1991, p. 63), who suggested instead for some Lausberg dialects a system of seven vowels in tonic, non-metaphonic position, presenting the phonological distinction between mid-high vowels, distributed in closed syllables, and mid-low vowels in open syllables.

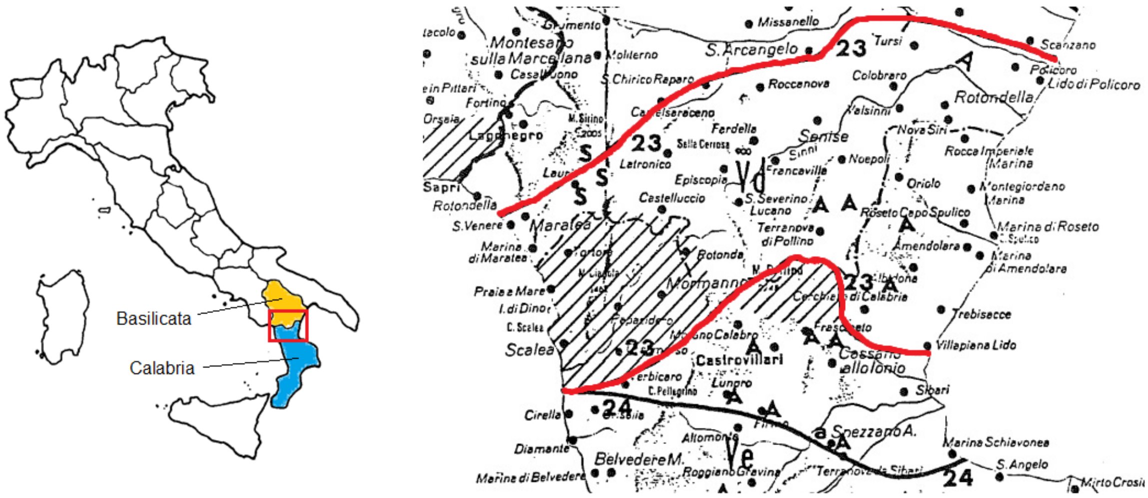

Figure 1.1: Geographical localisation of the Lausberg area and of its sub-areas (adapted from Pellegrini, 1977, and Martino, 1991).

(Lausberg, 1939; Martino, 1991). Along the transition area between the Lausberg area and the *Südzone* ("southern zone", as defined by Lausberg), traces of the Sicilian[6] vowel system, merging the Latin /i/, /iː/ and /eː/ into short /i/ and /u/ and /oː/ into short /u/ (Martino, 1991, p. 46), can often be found. The second and more linguistically stratified sub-region lies in the north-west and was referred to by Lausberg as the *Zwischenzone* – "intermediate zone", i.e. a zone presenting some features of both Central dialects of the Mittelzone and southern dialects of the Südzone, see Lausberg (1939). In this zone, the vowel systems of single varieties can present elements of both the Sardinian and the Sicilian vowel system.

The map of the Lausberg area is graphically represented in Fig. 1.1. The upper and lower borders of the area are highlighted in red. The Zwischenzone corresponds to the striped area on the left, while the remaining area left blank represents the Mittelzone. The area just below the southern red border represents the transition territory to the Südzone (below the black southern border). The extension and borders of this dialectal area and its sub-areas have been reviewed more than once (Rensch, 1964; Falcone, 1976; Trumper and Maddalon, 1988; Martino, 1991), but we lack recent studies providing updates on the status of the dialects in this area today. Literature on the Lausberg dialects is unfortunately limited. Some systematic studies, apart from the very first ones that first detected and described this linguistic area (Lausberg, 1939; Rensch, 1964), were carried out by Trumper (1979, 1997), Martino (1991), Romito et al. (2006), and Conte (2014) as concerns the part in Basilicata.

[6] Same consideration as for the Sardinian vowel system: "Sicilian" is here once again merely a label and does not indicate the Sicilian dialect itself.

1.1.4 Metaphony in the Lausberg area

Similarly to most Southern Italian dialects, in the Lausberg area the metaphonic effects have been shown to be confined principally to the influence of vowel height on the mid vowels /e, o/ (Lausberg, 1939; Rensch, 1964; Rohlfs, 1966, Maiden and Savoia, 1997, p. 17), which in the Sardinian vowel system can also be phonetically realised as [ɛ, ɔ]. One can expect most metaphonic effects in mid vowels not only because this is suggested by the literature (Lausberg, 1939; Rensch, 1964; Rohlfs, 1966), but also because in the Sardinian vowel system the opposition between tonic mid-high and mid-low vowels – in non-metaphonic contexts – is not phonologically relevant, but rather conditioned by the phonological environment. More specifically, a mid stem vowel is probably more open in words in which the suffix vowel is /a/ and slightly less open before /e/, but should instead be raised to a certain degree (thus undergoing metaphony) when the suffix vowel is high. The results of metaphony in the Lausberg area can be either a simple vowel raising of one degree of closure, from mid-low to mid-high – attested in only a few villages, namely Mormanno (Calabria) and Maratea and Rotonda (Basilicata), all within the Zwischenzone (Savoia, 1997, p. 371, 372; Savoia, 2015, p. 209; Martino, 1991, p. 46) – or an opening diphthong, either rising or falling. Diphthongs are typical of – but not exclusive to – the Zwischenzone (though not shared by all varieties) and of the northern part of the Mittelzone (which lies in the Basilicata region) (Lausberg, 1939).

Here are some examples of possible metaphonic realisations within the Lausberg area.

(7) Mormanno, Calabria: [ˈvɛcca] – [ˈveccu] (‘old woman, old man’) (Savoia, 2015, p. 209)

(8) Papasidero, Calabria [ˈmɔru] – [ˈmurisi] (‘I die, you die’) Trumper, 1997, p. 362)

(9) Trebisacce, Calabria: [ˈbɛllə] – [ˈbiəllə] (‘beautiful’, fem. sg. vs masc. sg.) (adapted in IPA from Rensch, 1964, p. 25)

(10) Castelluccio Superiore, Basilicata: [ˈɔːβə] – [ˈuəβə] (‘egg’, fem. pl. vs masc. sg.) (Savoia, 1997, p. 364)

Curiously, diphthongising areas seem to be geographically dispersed (Martino, 1991, p. 45), as many bordering villages to such areas might exhibit either monophthongising metaphony or even the coexistence of diphthongs and monophthongs, as documented in the 1960s by Rensch (1964) for Mormanno (although more recent accounts, including Savoia, 1997, 2015, have attested a simple vowel raising metaphony instead), and Papasidero, both in the Zwischenzone (Romito et al., 2006) – see also Trumper (1979) and Conte (2014) observing monophthong/diphthong variation in metaphonic contexts in some villages within the area. This situation finds a parallel example in Central Italy, in which many bordering villages can present either metaphonic vowel raising or diphthongisation (or even both forms coexisting in some varieties) and where the extension of each type of metaphony is not geographically compact (Maiden, 1991, p. 131; Maiden, 2016a, p. 655). In light of these data, and also considering that a vowel raising from mid-low to mid-high vowels might already have taken place (presumably only) for long mid vowels <ē, ō> in Vulgar Latin (Martino, 1991, p. 46), a diachronic phase *preceding* diphthongisation, consisting in vowel raising to only one degree of aperture of mid vowels of the type /ɛ, ɔ/ → [e, o], has possibly occurred (Barbato, 2008; Lausberg, 1947; Lüdtke, 1956, p. 92).

As far as the southern part of the Mittelzone is concerned, a possible diachronic reconstruction is that monophthongisation, typically also accompanied by compensatory lengthening, followed a diphthongising phase (Martino, 1991; Trumper, 1997, p. 361): [je, ie] > [iː], [wo, uo] > [uː]. The postulated historical phases of metaphony in the Calabrian Mittelzone can be summarised by the following examples:

(11) *[ˈbɛllu] >*[ˈbiellu] >[ˈbiːllə] (‘beautiful’, masc. sing.) (Trumper, 1997, p. 361)

(12) *[ˈkɔktu] >*[ˈkuottu] >[ˈkuːttu] (‘cooked’, masc. sing.)(Trumper, 1997, p. 361)

However, the idea that a vowel closure at two levels of height /ɛ, ɔ/ > [i, u] (thus with total assimilation of the trigger vowel height, /i, u/) comes from a previous diphthongising stage is even older, since it was also suggested by Lausberg (1939, p. 3, 11) and Rensch (1964, p. 18, 19) in relation to the Mittelzone. These authors postulated this previous phase due to the persistence of diphthongisation in varieties within the area or bordering it, especially with regard to diphthongising metaphony in some varieties of the northern part of the Mittelzone belonging to the Basilicata region. In this sense, the Calabrian Mittelzone should therefore represent the final step in the metaphonic sound change progress.

In general, the fact that diphthongisation might be somehow chronologically linked to metaphonic vowel raising (mainly following it, sometimes also preceding it) is a hypothesis common also to some other Italian varieties, e.g. the dialect of Bari, in Apulia (Valente, 1975, p. 15), Neapolitan in the XIV century (Russo, 2007), and even some Gallo-Italian northern varieties across the border between Italy and Switzerland (Canalis, 2016, p. 129). Some debate about a probable origin of diphthongisation as purely metaphonic outcome has been carried out by Sánchez Miret (1998a, 1998b) and more recently by Maiden (2016a, 2016b). Despite the fact that some have argued against this view of diphthongisation (see Loporcaro, 2011, 2016, who considers diphthongisation to be a distinct and independent phenomenon from metaphony), both Maiden and Loporcaro do agree on the fact that diphthongisation is, at least chronologically speaking, always subsequent to vowel raising in metaphonic contexts (Loporcaro, 2016, p. 73; Maiden, 2016b, p. 204).

In summary, different types of metaphony still coexist between bordering villages within the restricted territory of the Lausberg area: on the one hand, many villages in the Zwischenzone present diphthongising metaphony; on the other hand, other villages in the

Lausberg area, mainly outside the Zwischenzone, but in some cases also inside it, have monophthongising metaphony at different degrees of closure. The coexistence of different metaphonic outcomes, both in terms of level of closure and of presence or absence of diphthongisation, is a peculiarity that makes the Lausberg area a privileged territory for the study of metaphony and its different sound change phases.

1.1.5 Theories of sound change

Sound change has been one of the main interests of scholars since the beginnings of linguistics as an autonomous discipline. The very first method applied to sound change, the historical-comparative one, aimed to reconstruct the undocumented phonology of ancestor languages on the basis of overlapping phonetic features and tendencies across idioms belonging to the same family or group. A similar approach was also applied to dialects by Lausberg (1939) and contemporary and later scholars in the 20th century: this is evidenced, for instance, by attempts made by authors such as Lausberg (1939), Parlangeli (1971), Rensch (1964), Rohlfs (1966) to explain the dialects' vowel systems only by means of Latin and the great amounts of attention paid to etymologies. This method alone is nevertheless insufficient to justify certain patterns of sound change and to explain their causes and mechanisms.

Recent publications about experimental phonology (see e.g. Cohn, Fougeron, and Huffman, 2011) have shown renewed interest in the phonetic bases of various phonological phenomena including sound change. Some influential, phonetically-based approaches were suggested by Ohala (1990, 2012, 1993), Blevins (2004, 2015), and Garrett and Johnson (2013). Despite varying with regard to some details, all these approaches agree on the fact that acoustic, articulatory and perceptual aspects of speech can effectively help to elucidate the synchronic bases of sound change as well as identify typologically universal elements in sound production and perception.

Between the end of the 19th and the beginning of the 20th century, the Neogrammarians argued that sound change is gradual, regular, imperceptible, and mainly driven by unconscious simplification mechanisms at the articulatory level (Bloomfield, 1933; Hock, 1992). The more recent theories mentioned above rely instead on a non-teleological view of sound change, which is, under empirical evidence, basically phonetically driven, but not inevitably leading to (or driven by) an easier way to articulate sounds or to enhance perceivability in a universal sense. Any tendency for optimality should therefore be considered as the mere product of cumulative effects of individual acts of speaking and take into account both articulatory and perceptual components, which are strictly bound in each spoken communication (Ohala, 2012, 1993).

The study proposed in this work is based on an experimental approach to sound change processes, effectively designated by Ohala (1974) as "experimental historical phonology". More generative and abstract approaches to vowel harmony and metaphony, mainly based on feature-spreading mechanisms between vocalic segments (e.g. Savoia, 2015, 2016 and to a minor extent also on optimality constraints (see e.g. Gaglia, 2011; Gaglia, 2012) or element theory approaches (e.g. Maiden, 1991; Russo, 2002, 2007), are usually based on impressionistic accounts, entirely categorical and cannot consider how the fine-grained, time-varying coarticulatory information leads to sound change. My main goal in this work is instead to adopt a phonetically based and data-driven approach to metaphony and sound change in the Lausberg area by starting from phonetic, coarticulatory premises.

Coarticulation phenomena are pervasive and largely attested in most languages of the world. Since the very first studies on the topic (Öhman, 1966), coarticulation has been investigated not only from an acoustic point of view but also articulatorily (Hoole & Pouplier, 2017; Recasens, 1984, 2002, 2014) and by considering its effects on the perception of phonological units (see e.g. Beddor, Brasher, and Narayan, 2007; Beddor, Harnsberger, and Lindemann, 2002; Beddor and Krakow, 1999; Miglietta, Grimaldi, and Calabrese, 2013; Repp, 1982; Wright, 1986). In particular, assimilation processes involving vowels, often also indicated under the label of *vowel harmony*, have been the focus of attention as well as several different approaches and theoretical frameworks to the phenomenon. These processes can exhibit either a progressive or regressive direction (as it is the case for metaphony), the latter usually seen as a result of "articulatory, perceptual, and/or conceptual "pre-planning""(Hyman, 2002, p. 24). Coarticulation phenomena, including metaphony originating in regressive vowel-to-vowel assimilation, are the synchronically visible part of sound change: they might reveal biases and typologically universal tendencies and suggest on which premises a particular phenomenon in a specific language might have evolved and how a rising phonological pattern could further evolve in the future.

Apart from the phonetic or phonological level, however, higher levels of linguistic analysis might influence sound change. The very first studies on the vocalism of the Lausberg area (Lausberg, 1939; Rensch, 1964) primarily focused on the original Latin vowel quality and length and only a few suprasegmental aspects such as syllable openness and word accent. It is instead necessary that modern dialectal studies take into account a wider picture (Krefeld, 1999), which also includes synchronic variation within each dialect and between dialects, as well as "higher" levels of linguistic analysis such as morpho-syntax and semantics.

The interplay between morphology and phonology has so far been treated from a theoretical point of view and, for the most part, according to formal phonological accounts, with some even describing the role of morphology as predominant over the phonological aspect (see e.g. Dillon, 2003; Inkelas, 2014; Pöchtrager and Kaye, 2014). The role of informativity and predictability of certain language structures and the meaning connected to these is also an important element that might interact with sound change – in particular segment lenition or loss – and in general with language change (Blevins, 2015, p. 13). Since not everything can be explained on phonetic premises (Blevins, 2015, p. 11), it is therefore important to go beyond phonetic detail when considering how morphology (Fanciullo, 1994; Maiden, 1991) and statistical properties of the lexicon (Hay and Foulkes, 2016; Pierrehumbert, 2001; Wedel, 2012) also enhance or inhibit sound change.

1.2 Research aims

The numerous studies on metaphony and associated sound changes for Italian dialects (Lausberg, 1939, Rensch, 1964 Rohlfs, 1966, and many others) have mostly been based on auditory impressions and have not included quantitative analyses. This is also true for several phonological analyses on the topic, see e.g. Maiden (1991); Gaglia (2011), Gaglia (2012); Savoia (2015); and the volume on metaphony edited by Torres-Tamarit et al. (2016). It is only very recently that some first acoustic analyses of metaphony in Southern Italian dialects have also been published (see Grimaldi, 2003; Grimaldi and Calabrese, 2018; Grimaldi et al., 2010; Grimaldi et al., 2016; Romito and Gagliardi, 2009; Romito et al., 2006). However, these studies generally do not deal in detail with the whole vowel duration, i.e. most information on metaphony has been obtained from static snapshots of speech signals at particular time points (usually the midpoint) in the stem vowel (Grimaldi, 2003; Grimaldi et al., 2010; Grimaldi et al., 2016; Romito & Gagliardi, 2009; Romito et al., 2006).

Since diphthongisation can be a possible outcome of metaphony in the Lausberg area (see Section 1.1.4), it is also important for the acoustic analysis to take into account the formant variation along the vowel duration. Therefore, in contrast with the static approaches mentioned above, the present study seeks to make a further contribution to the acoustic knowledge of metaphony following a dynamic approach, based on the entire time-varying shape of the stem vowel formants. Assuming that the passage from vowel raising to diphthongs, and from diphthongs to monophthongs, postulated by Trumper (1997) and also suggested by Lausberg himself (Lausberg, 1939) and Rensch (1964), is true, then we can deduce that a major coarticulatory effect on the vowel onset should not only be expected for diphthongising dialects, but also for those dialects presenting either a simple raising or a total assimilation of the suffix vowel quality. This is because we might expect either some residues of diphthongisation in the latter monophthongising phase, or a beginning of diphthongisation in the first vowel raising phase. Also, a major metaphonic effect on the first half of the vowel duration could be a first sign of lexicalisation, as it shows that only the second portion of the vowel duration is significantly influenced by the following consonant, but not the first part.

Another aspect largely ignored by the literature on metaphony (with rare exceptions, see for instance Grimaldi et al. (2010, p. 1563) about /e/ targets of metaphony before /u/ triggers being more retracted than before /i/) is whether metaphonic outcomes can phonetically vary according to suffix vowel trigger type, that is, if the /i/ trigger influences the target stem vowel quality differently compared to the /u/ trigger. For instance, one could expect some form of slight lip rounding in front of /u/ suffix vowels, or a major degree of fronting before an /i/ suffix vowel, which could be possible in spite of such differences probably not being noticeable simply by just listening to a dialect speakers' production. Another issue that probably would have deserved more space in the literature on metaphony is the influence of other kinds of suffixes "competing" with the ones we refer to as "metaphonic" by definition. For example, some studies reveal that /a/ suffix vowels can have an opening effect on mid vowel stems (Grimaldi, 2003, p. 73; Delucchi, 2012). This aspect needs to be examined in more depth for the Lausberg area too, since this would mean that a type of opening vowel assimilation might exist parallel to metaphony as by definition, i.e. as vowel raising.

Finally, the link between metaphony and suffix vowel reduction still has to be solved. In phonologisation processes (like, presumably, the one leading to metaphony) it is common that the trigger for a phenomenon is either weakened or disappears, but it is still not clear how a phonological change can be achieved and maintained in spite of a lenition or deletion of the trigger of the same sound change (Beddor, 2009, 2012; Harrington et al., 2019b; Kiparsky, 2015; Kirby, 2014). As regards the Lausberg area specifically, the literature, at the moment, does not offer either any acoustic or any specific phonological account, apart from some general auditory observations on neutralised suffixes by Lausberg (1939); Rensch (1964); Falcone (1976); Canalis (2009). In general, what we know from these sources is that neutralisation of the suffix took place in some villages at some point, but none of these accounts directly explain the relationship between suffix elision or reduction and metaphony in its different manifestations within the Lausberg area. In addition to this, there is no mention in the literature of any perception data from the Lausberg area which might explain if metaphony can be considered as a compensatory mechanism for suffix reduction or loss, i.e. if a cue-trading mechanism between stem vowel and suffix vowel actually exists and to what extent such a mechanism is present across different types of metaphony and, in parallel, between different types of suffix lenition.

Although based on data from dialects, the main field of interest in this study is phonological, i.e. to achieve a further understanding of coarticulation, phonetic variability between villages and age groups – since a possible approach to sound change can make use of apparent-time analyses comparing two generations of speakers, see e.g. Labov (2001) – and how these phonetic parameters can interact to drive sound change. More specifically, the main research objectives concerning my project can be summarised into the following points:

1. A contribution to the understanding of coarticulation processes and their variation across speakers of different age groups as well as of different regions within the Lausberg area;
2. Establishing if there is any evidence of a diachronic progression of three main sound change phases of metaphony consisting in the shift from mid-high metaphonised vowels to opening diphthongs and from diphthongs to high monophthongs;
3. Establishing if a parallel progression is recognisable in the degree of suffix vowel reduction, too;
4. Establishing to what extent a correlation exists between suffix vowel reduction and metaphony from the acoustic and perceptual point of view;
5. A contribution towards explaining the role of morpho-lexical predictability and informativity in sound change;
6. More generally, a contribution to the explanation of the coarticulatory and perceptual mechanisms that underlie sound change.

1.3 The speech database

In this section I am going to illustrate how the speech database, consisting of acoustic data from speakers of different villages from the Lausberg area, was built. This includes how the participants were selected, how the acoustic data were elicited, the instrumentation used, what type of lexical items were elicited, and finally how the raw audio files were annotated and how acoustic information was extracted and structured into a database. The database described in the next subsections is the one used for the analyses provided in the Chapters 2, 3 and 4, while the method used for the perception experiment analysed in Chapter 5 is explained at the beginning of the same chapter. However, the audio input files used for Chapter 5 were also selected from the same speech database described in this section and used for all acoustic analyses.

1.3.1 Speakers and villages

35 participants (18 females and 17 males) from 8 villages in the Lausberg area were recorded in quiet conditions at their homes. The speakers were recruited either from my personal contacts (since I am a native speaker of this region), or through contacts provided by previous participants, or by recruiting participants on social media. All participants were paid a small amount of money for their participation. Before carrying out the recordings, all participants answered some questions related to their age, degree of

education, and use of dialect in everyday life. Only participants who declared to be able to speak and actually use the local variety of the village they were from at least relatively often were involved in the recordings. The speakers include 23 older (aged between 40 and 92, with an average age of 62.3) and 12 younger (aged between 13 and 32, with an average age of 23.1) speakers[7]. Fig. 1.2 shows the villages and regions involved and the number of speakers per village from which recordings were made. The regions included in this study are marked in colours: red for the Zwischenzone (ZZ), green for the one-village only region of Mormanno (MM, see below) and blue for the Mittelzone (MZ).

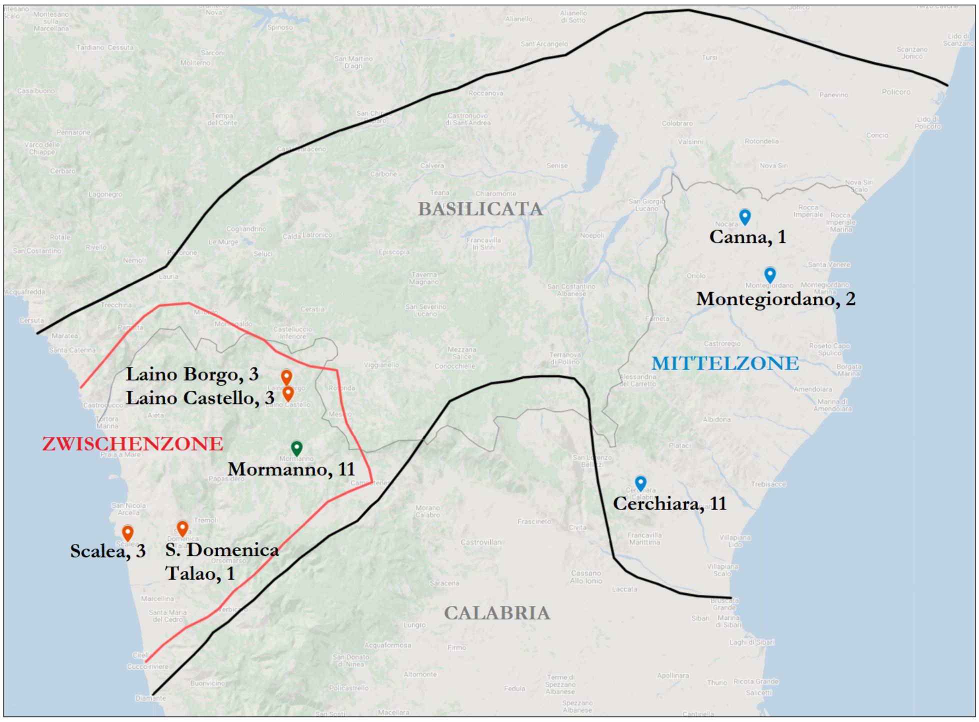

Figure 1.2: The Lausberg area (Map data ©2021 Google) and its main internal subdivisions (based on Pellegrini, 1977, and Trumper and Maddalon, 1988), including villages and numbers of speakers per village involved in this study.

Based on Pellegrini (1977) and Trumper and Maddalon (1988), the Zwischenzone corresponds to the red-bordered sub-area on the left, while the rest of the area represents the Mittelzone. The number of speakers involved per village is indicated after the village name. Unfortunately, Basilicata was not involved in these data, since the villages from which recordings were made are in Calabria, in the Province of Cosenza. Nevertheless, as Fig. 1.2 also shows, the whole Lausberg-Calabrian area has been broadly covered, taking both the Zwischenzone and Mittelzone into account. In particular, Laino Borgo, Laino Castello

[7] Any division into two age groups can only be relative and arbitrary, as no specific factor can indicate what "old" or "young" is from a sociolinguistic perspective. In previous phases of this study, other age groupings were analysed, but no relevant differences in the results were found. The division into two age groups was left as such since this was the most effective way to present the slight age differences present and further described in Chapter 2.

and S. Domenica Talao belong to the Zwischenzone; Canna, Montegiordano and Cerchiara belong to the Mittelzone. Mormanno is geographically situated within the Zwischenzone, but since it is an outsider village in its metaphony type (see Section 1.1.4), in this study it is considered as a region on its own. The number of speakers recorded from MM, ZZ, and MZ was 11, 10, 14 respectively. A further summary of some of the speaker attributes is shown in Tab. A.1 in Appendix A, including village of origin, sex, age group and biological age, and degree of education.

1.3.2 Eliciting stimuli and recording procedure

The lexical items in this study were elicited through a picture-naming task. A non-verbal type of elicitation stimuli was preferred to the more ‘classical’ approach usually consisting of a translation task in which participants have to translate single words or phrases from Standard Italian into their dialect. In order to avoid the use of the Standard and to encourage the participants to immediately start talking in their own dialect, all interactions between the investigator and each participant were carried out in the dialect, as far as this was possible. Each individual *inflected* lexical item form to be elicited corresponded to only one picture.

For the purpose of eliciting inflected lexical items just by using pictures, a slightly different strategy was adopted for each lexical category, as shown in Appendix B. In particular, while nouns could be elicited on their own, inflected adjectives had to be elicited in combination with a noun (e.g. [ˈmela ˈrussa], ‘red apple’, where [ˈrussa] is the target word, see Fig. B.2 in Appendix B) and inflected verbs had to be elicited within sentences which were graphically suggested by the pictures and thus different for each verb (see Fig. B.3 in Appendix B). In order to make sure that the participants had understood the task, a training phase consisting in observing the pictures and clarifying their meaning in the case of any ambiguities preceded the recording phase.

In order to make the task easier and more pleasant for the participant, the production task was divided into eight parts. Before the beginning of each new part, the participant had the possibility to take a short break. The first three parts elicited verbs only, the other five parts elicited nouns and adjectives together. Within each part, the nouns and adjectives had first to be repeated in isolation, and then, in a second moment, within the carrier sentence “I say ... two times”, in the dialect [jɛ ˈdiku ... dui ˈvotə]. Verbs could not be elicited in isolation, so that the same sentence containing the target verb had to be repeated twice. In this way, for each item, no matter the lexical category, the participants had to produce two repetitions. The order of appearance of each stimulus was randomised differently for each speaker within each part.

1.3.3 Instrumentation and software

The instrumentation used for the recordings included a laptop and a headset with integrated microphone (Sennheiser SC 60). The picture-naming task was carried out using the computer software *SpeechRecorder* (version 3.28.0) (Draxler & Jänsch, 2004). The raw speech data were then semi-automatically segmented and labelled using MAUS (*Munich Automatic Segmentation System*) (Kisler, Reichel, & Schiel, 2017), which is integrated in the `emuR` package (version 1.1.2) (Winkelmann, Harrington, & Jänsch, 2017) available in the R programming software environment. The segmentation process used for the data was based on the MAUS phoneme inventory for Italian, but a phonological transcription in the dialect for each word of the dataset using this inventory was given to the MAUS system before starting the segmentation and labelling process. Any obviously misplaced segment boundaries were manually corrected.

1.3.4 Formant analysis

The first two formant frequencies (F1, F2) were calculated using the Praat formant tracker included in the `PraatR` package (version 2.4)(Albin, 2014) in R (version 3.6.3), between the acoustic onset and offset of the stem vowel using a 25 ms window and a 5 ms frame shift. Around 40% of the data were manually corrected for misplaced segment boundaries or mis-tracked formants. The data were organised using the EMU Speech Database Management System (Winkelmann et al., 2017), and all analyses presented in this work were carried out using the `emuR` package (version[8] 2.1.0) in the R software environment.

Stem vowel formants were then linearly time-normalised into 11 equidistant time points. A speaker-normalisation procedure following Lobanov (1971) was then also applied to both stem and suffix vowel formant tracks, in order to filter out (as much as possible) the influences of the different shapes and sizes of each speaker's vocal tract. The Lobanov normalisation was implemented following a similar equation as in Harrington, Gubian, Stevens, and Schiel (2019a, p. 3328), reported below in (1.1):

$$F^*_{i,j,k}(t) = \frac{F_{i,j,k}(t) - \mathrm{mean}(F)_{i,j}}{\mathrm{sd}(F)_{i,j}} \tag{1.1}$$

$F^*_{i,j,k}(t)$ and $F_{i,j,k}(t)$ are, respectively, the values of the normalised and raw frequencies (in Hertz) of formant j (j = 1, 2) produced by speaker i in utterance k at timepoint t, while $\mathrm{mean}(F)_{\mathrm{i,j}}$ and $\mathrm{sd}(F)_{\mathrm{i,j}}$ are the mean and the standard deviation of speaker i's formant j values for the stem vowels /a, i, u/, i.e. the three "corner" vowels in the Lausberg dialects' phonological system, aggregated (marginalised) over time. The resulting

[8]The analyses were carried out at a later point in time, which explains why the two versions of `emuR` used for the annotation and for the analyses respectively differ.

Lobanov-transformed values correspond, therefore, to the distance between each given formant measurement and the formant mean in numbers of standard deviations.

1.3.5 Lexical items

The choice of the lexical items to be included in the database was mainly based on the Latin etymology of the stem vowels: given the fact that the Lausberg varieties are characterised by the so-called Sardinian vocalism (see Section 1.1.3), the same vowel quality of the Latin etymon is expected (although exceptions to this are also possible, see cited literature about the vocalism of the Zwischenzone in Section 1.1.3). A total of 195 word types and 94 lexical stem types were elicited.

Most recorded words included pairs of either adjectives, nouns, or verbs. Each pair included a lexical stem and two word-final competing suffixes. The two high suffixes /i, u/ are the ones that were expected to trigger metaphony. The other two possible suffixes /a, e/ were not expected (according to the literature, see Sections 1.1.4 and 1.2) to have any significant coarticulatory effect on the stem vowel. In some pairs, only one of the two possible suffixes was a metaphonic one, i.e. either /i/ or /u/ (e.g. /ˈbella, ˈbellu/, 'beautiful', fem. sg. vs. masc. sg.); in other cases, both suffixes were metaphonic (e.g. /ˈlettu, ˈletti/, 'bed, beds'); in yet others, both suffixes were non-metaphonic, i.e. either /a/ or /e/ (e.g. /ˈseddʒa, ˈseddʒe/, 'chair, chairs'). However, not all words were organised into pairs, since some of them were either included as distractors, e.g. /ˈsole/, 'sun', or because they contained in their stem one of the three corner vowels of the vowel chart /i, a, u/ whose acoustic values were used to normalise other formants, such as e.g. /ˈtʃinnira/, 'ash'. Also, most verbs were organised in triplets (first, second and third person singular of the indicative, e.g. /ˈdormu, ˈdormisi, ˈdorme/, 'to sleep'), similarly to some lexical stems such as /mort/, 'dead', with three possible suffixes: /ˈmorta, ˈmortu, ˈmorti/. The lexical stem /bon/, 'good', was the only one that was elicited with four possible suffix combinations: /ˈbona, ˈbonu, ˈbone, ˈboni/.

The stem vowels, which were always the nucleus of the syllable with primary lexical stress, varied over all five possible stem vowels in the Lausberg area vowel systems, i.e. /i, e, a, o, u/. Most words were disyllabic, while a minority of them were trisyllabic in that the stem and suffix vowels were either adjacent (e.g. /niˈpote/, 'grandchild') or separated by one syllable (e.g. /ˈtenisi/, '(you) have'). The choice to include a variety of words from different lexical categories containing all possible stem vowels, as well as all possible suffix pair combinations, was based on the intention to explore every possible coarticulatory and/or metaphonic influence throughout the lexicon.

At the end of the recordings of the 35 speakers, and after removing a limited amount of tokens pronounced in Standard Italian or that did not correspond to the target word suggested by the picture, the complete database included a total of 9029 elicited tokens. The specific lexical sub-sets selected for each type of acoustic analysis, and the reasons behind each sub-selection, are presented separately in each chapter (Chapters 2, 3 and 4). Each chapter also includes further information on the morphological meaning of each suffix, as well as on the precise number of vowel tokens used for each analysis (*stem* vowel tokens in Chapters 2 and 3, *suffix* vowel tokens in Chapter 4). The full list of the elicited lexical items is presented in Appendix C, while the sub-sets used for the following three chapters are presented in Appendices D and E.

Chapter 2

Initial acoustic exploration

2.1 Introduction

In the previous chapter it was pointed out that the available acoustic material on the Lausberg area is very limited. Due to the lack of such data, it is currently unclear whether metaphonic realisations in the Lausberg area are still widespread, or whether they have evolved, or whether they have even decreased under the influence of Standard Italian, in which there are no categorical metaphonic effects. In order to clarify these aspects and to provide a first description of metaphony, this chapter presents a preliminary acoustic analysis exploring metaphony relating to different stem vowels and taking into account speakers' geographic localisation and age.

In fact, while much attention has been given to dialectal differences between villages, other types of sociolinguistic variables have, so far, been largely neglected. Some isolated sociolinguistic and auditory impressionistic analyses of metaphony in Southern Italian dialects (e.g. Del Puente, 1995) and of various dialectal features in the Lausberg area (e.g. Trumper, 1979) describe some minor influences of sex and age on dialect use as the product of a convergence with Standard Italian, especially in younger generations. Nevertheless, an analysis attesting a weakening of metaphony in younger speakers under the influence of the standard variety (Del Puente, 1995, p. 60) for the dialects of the Lausberg area as well has never been carried out. Bearing this in mind, an apparent-time analysis (Bailey, Wikle, Tillery, & Sand, 1991; Labov, 2001; Weinreich, Labov, & Herzog, 1968) in which younger and older speakers are compared acoustically can help to elucidate whether metaphony is still present – and to what extent – in the Lausberg area by also considering its variation across different dialectal sub-regions.

A modified version of this chapter was published in *Studi AISV* (Greca & Harrington, 2020).

In summary, and assuming that metaphonic influence on the stem vowel emerges from our data, thus confirming the persistence of metaphony in the Lausberg area, the main questions that were considered for this analysis are the following:

1. whether the metaphonic influence of the suffix vowel on the stem vowel is strongest for mid (as opposed to high or low) vowels;
2. whether metaphony is principally due to a change in height rather than fronting or backing;
3. whether metaphonic effects are weaker for younger than older speakers (see Section 1.3.1 and Appendix A.1 for details);
4. whether there are differences in metaphonic outcomes between the three identified regions within the Lausberg area (see also Fig. 1.2 in Section 1.3.1), namely the Mittelzone (MZ), the Zwischenzone (ZZ), and the one-village region of Mormanno (MM).

2.2 Method

2.2.1 Lexical items and vowel tokens

The lexical items considered for this analysis are listed in Italian in Tab. D.1 in Appendix D. The phonemic form of the items in the dialect is also indicated. As anticipated in Section 1.3.5, these words, which vary in stem and suffix vowels, include all lexical categories that could be affected by metaphony, i.e. nouns, adjectives and inflected verbs (first, second and third person singular of the present indicative). Tab. D.1 in Appendix D also shows that the lexical items used for this analysis are organised into pairs in which the stem is shared and there are two competing suffixes. The stem vowel varied over /i, e, a, o, u/ (e.g. in /ˈkani/ – /ˈkane/, ‘dogs’ – ‘dog’, the stem vowel is /a/).

The suffix vowels could either be front vowels (henceforth: V_{front} = /i, e/, e.g. /ˈkani/ – /ˈkane/, ‘dogs’ – ‘dog’), or back vowels (V_{back} = /u, a/, e.g. /ˈvekkju/ – /ˈvekkja/, ‘old man’ – ‘old woman’). In particular, the suffix /i/ can mark either the plural for nouns whose singular counterpart is a non-metaphonic /e/-suffixed form (e.g. /ˈverm**i**/ – /ˈverm**e**/, ‘worms’ – ‘worm’), or the second person singular for some verbs contrasting with a non-metaphonic /e/-suffix in the third person singular, e.g. /ˈten**isi**[1]/ – /ˈten**e**/ (‘you have’ – ‘he has’). The other metaphony-inducing suffix was /u/. This marks either the second person singular contrasting with the non-metaphonic /a/-suffix in the third person singular in verbs, e.g. /ˈtrov**u**/ – /ˈtrov**a**/ (‘you find’ – ‘he finds’), or the masculine gender in nouns and adjectives that contrast with a non-metaphonic, feminine /a/-suffix,

[1]Here, there is a disyllabic high vowel suffix /isi/.

e.g. /ˈbon**u**/ – /ˈbon**a**/ (‘good’, masc. vs fem. sg.). 24 and 26 lexical stems preceded V_{front} and V_{back} suffixes respectively, with a total of 49[2] different lexical stem types and 100 different words containing either a metaphonic or non-metaphonic suffix.

The majority of words (n = 75) were disyllabic (e.g. /ˈtrovu/). There were some words (n = 25) that were trisyllabic, in which the stem and the suffix vowel were either separated by one syllable (e.g. /ˈtenisi/), or in which the syllable containing the stem vowel and the one containing the suffix vowel were adjacent (e.g. /niˈpote, niˈpoti/, ‘grandchild, grandchildren’). The total number of potentially available vowels for analysis for V_{front} was: 48 words × 2 repetitions × 35 speakers = 3360 stem vowel tokens; V_{back}: 52 words × 2 repetitions × 35 speakers = 3640 vowel tokens. However, following the removal of those words that had been misarticulated or produced in Standard Italian, 2278 stem vowels preceding V_{front} suffixes and 2523 stem vowels preceding V_{back} suffixes remained for analysis (see Tab. D.2 in Appendix D for further details about the amount of stem vowel tokens and their distribution in the data).

2.2.2 Formant analysis: calculation of formant differences

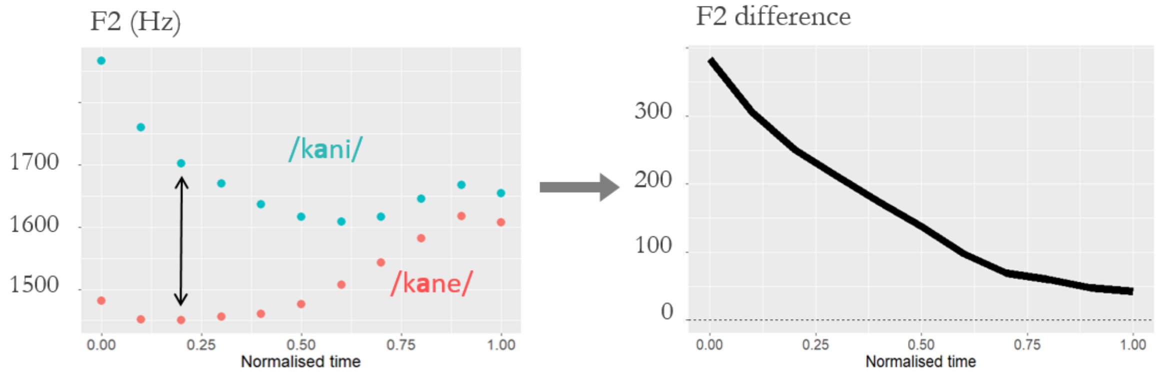

Figure 2.1: An example of the application of the formant difference plotting of F2 for a particular stem and speaker

An initial analysis of metaphony was made by subtracting the formant values at each time point in the non-metaphonic context from those in the metaphonic context separately by speaker and stem. For example, the mean F2-trajectory for the stem vowel in /ˈkane/ (non-metaphonising) was subtracted from the mean F2 for the stem vowel in /ˈkani/ (metaphonising) for a given speaker (Fig. 2.1). If the result of the subtraction is zero, then the suffix vowel /i/ vs suffix /e/ has no influence on the target, i.e. there is no metaphony. Instead, trajectories further away from zero indicate a greater influence of the suffix on the stem vowel.

[2] N.B.: the lexical stem /bon/ was combined to both V_{front} and V_{back} suffix vowel contexts.

The significance of differences in strength of metaphonic effects was assessed separately in the context of front suffix vowels /i, e/ (V_{front}) and back vowel suffixes /u, a/ (V_{front}) and separately for F1 and F2. Thus, for instance, the upper plots in Fig. 2.2 in Section 2.3.1 are based on subtracting F2 of e.g. /a/ in /ˈkane/ from F2 of /a/ in /ˈkani/, and the upper plots in Fig. 2.3 on subtracting F2 of e.g. /e/ in /ˈvekkja/ from F2 of /e/ in /ˈvekkju/. The plots in the lower rows are based on similar calculations but for F1.

The differences obtained in this way were then aggregated across speakers and lexical items and firstly grouped according to stem vowel type (Section 2.3.1). Secondly, the comparative analysis by means of formant differences as described above was also run for the age comparison between older and younger speakers (Section 2.3.2), and finally for the comparison between the three identified regions (Section 2.3.3; details about division into age groups and regions were provided in Section 1.3.1 of Chapter 1).

2.2.3 Statistical analysis

Linear mixed-effects regression (LMER) models were applied to the data, separately for V_{front} and V_{back} contexts, by using the `lmerTest` package (version 3.1.3) on R. The mixed models were of the form (R notation):

$$F_n \sim \text{Suffix vowel} * \text{Age} * \text{Stem vowel} * \text{Region} + (\text{Region}|\text{Stem}) + (1|\text{Speaker}) \qquad (2.1)$$

The dependent variable (F_n in the formula above) was the formant value extracted at time-normalised point 0.1, with the fixed factors *Stem vowel* (five levels: one of the stem vowels /i, e, a, o, u/), *Suffix vowel* (two levels: one of the suffix vowels), *Age* group (two levels: younger and older speakers), *Region* (three levels: Mormanno – henceforth MM; Zwischenzone – ZZ; Mittelzone – MZ). A total of four mixed models were applied: one for each of the two formants separately, and one for each of the front, /i, e/, and back, /u, a/, suffix pairs (i.e. V_{front} vs V_{back} contexts). The random factors originally included intercepts and all possible slopes to measure the interaction between the fixed and random factors, but these were dropped if they were non-significant. In the final models that were applied to the data (formula (2.1) above), the random factors were *Speaker* and (lexical) *Stem* (e.g. /mes/ for /mese, mesi/). In particular, the *Stem* random factor also had slope in *Region*, while the *Speaker* variable had no slope and was modelled as a random intercept.

The choice of the fixed factors was based on the variables that most influenced the degree of metaphony graphically represented by the formant difference plots (see figures in Section 2.3). The motivation for basing the dependent variable on time-normalised point

0.1 was that, in most cases, metaphonic effects were most marked at the vowel onset (see figures in Section 2.3). After applying the LMER models to the data, post-hoc tests in the form of estimated marginal means (EMMs) between different factor combinations were computed by using the `emmeans` package (version 1.5.3) in R. To make the interpretation of LMER and post-hoc tests easier and more visually interpretable for the reader, vowel space plots (Figs. 2.7 and 2.8) and boxplots (Figs. 2.9, 2.11, 2.10, 2.12) referring to the Lobanov-normalised formant values analysed by the LMER models were also provided.

2.3 Results

2.3.1 Differences according to stem vowel

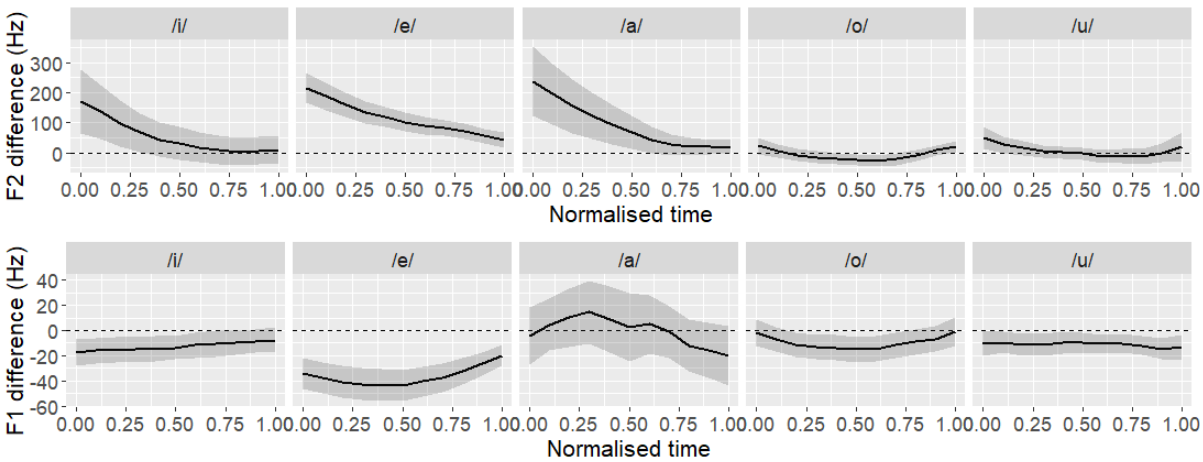

Figure 2.2: F2 and F1 differences in V_{front} contexts grouped by stem vowel and aggregated across speakers and lexical items, including the confidence interval of the mean difference values.

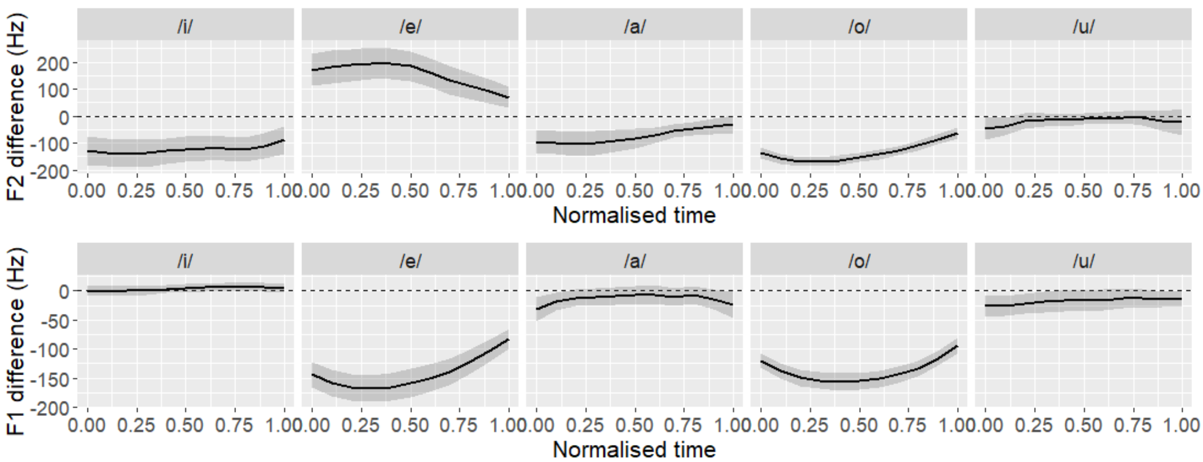

Figure 2.3: F2 and F1 differences in V_{back} contexts grouped by stem vowel and aggregated across speakers and lexical items, including the confidence interval of the mean difference values.

Fig. 2.2 shows formant differences grouped by stem vowel for V_{front} contexts: if the suffix influences the stem vowel, then the F2 difference plot should be positive (i.e. above the dotted zero line), given that F2 values for /i/ are expected to be higher than F2 values for /e/. Following a similar reasoning, the F1 difference plot should be negative (i.e. below the dotted zero line), given that F1 values for /i/ are expectedly lower than F2 values for /e/. Fig. 2.3 shows instead formant differences for V_{back} contexts. In this case, if metaphony occurs, then the F2 difference plot should be negative, since F2 /u/ < F2 /a/. Also, if metaphony takes place, then the F1 difference plot is expected to be negative as well, given that F1 /u/ < F1 /a/. For both Figs. 2.2 and 2.3, trajectories further away from zero indicate a greater influence of the suffix on the stem vowel. Overall, Figs. 2.2 and 2.3 provide clear evidence for metaphony. They also show that formant differences are generally more marked – most visibly for F2 in Fig. 2.2 and, to a minor extent, also for other formants – in proximity of the vowel onset.

Figs. 2.2 and 2.3 clearly show that the metaphonic influences were greatest on the mid vowel stems /e, o/. For stem /e/ in particular, the positive difference values for F2 and the negative difference values for F1 signal a vowel raising towards an [i] vowel quality, given that in a high front vowel like /i/ the first two formants are very ‘distant’, i.e. F1 is quite low and F2 quite high. For stem /o/, the lowering of both F2 and F1 differences signals a vowel raising to [u], since in a high back vowel like /u/ we expect very close and low F1 and F2 values. Also, the influence of metaphony on stem /o/ was most evident in the V_{back} context (Fig. 2.3).

In addition, there was a weaker metaphonic influence on /a/ stem vowels, especially in F2. This suggests that /a/ might be slightly fronted under the influence of the /i/ suffix, signalled by positive F2 difference values (Fig. 2.2), and slightly retracted before /u/ suffixes, due to negative F2 difference values 2.3). Also, a slight tensing of /i/ as regards V_{front} contexts (since F2 and F1 become more distant), and a small retraction as regards V_{back} contexts (noticeable because of F2 lowering), are visible from the difference plots. No striking metaphonic effects were observable for stem /u/, apart from a slight lowering of F1, suggesting a minimal raising of the vowel before a high suffix vowel /i/ or /u/.

Figs. 2.2 and 2.3 also show that, overall, the influence of the suffix vowel on the stem vowel was stronger in F1 (which is the main acoustic indicator for vowel height) than in F2 (indicating vowel frontness or backness), thereby also confirming that metaphony mainly affects vowel height rather than frontness or backness (see Section 1.1.1). The most marked F2 effects in the expected coarticulatory directions (i.e. positive difference values in V_{front} contexts and negative difference values in V_{back} contexts) were an F2 lowering of the stem /o/ in the V_{back} context and F2 raising of the stem /e/ in the V_{front} context.

2.3.2 Age differences

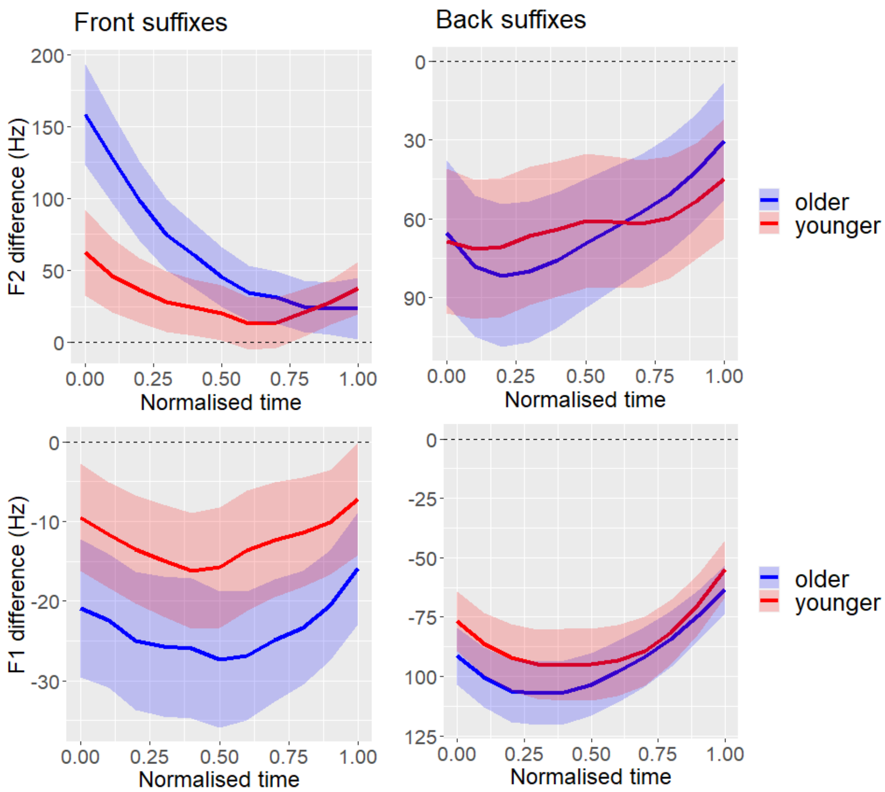

Figure 2.4: F2 and F1 differences in V_{front} and V_{back} contexts grouped by age and aggregated across lexical items and speakers, including the confidence interval of the mean difference values. The age groups are distinguished by the blue (= old) and red (= young) colours respectively.

Fig. 2.4 shows formant difference plots grouped by age separately for F2 and F1 and V_{front} and V_{back} context, across all stem vowel types and lexical items. The red difference plots refer to the younger speakers, the blue plots to the older speakers. Following the same reasoning applied to the previous plots (Figs. 2.2 and 2.3), if metaphony is present, then the F2 difference plots should be positive for the V_{front} context (thus indicating stem vowel fronting) and negative for the V_{back} context (thus indicating vowel backing), while F1 difference plots should be negative (thus indicating stem vowel raising) in both V_{front} and V_{back} contexts. Based on the difference plots in Fig. 2.4, the results show that metaphony was overall slightly stronger in the older than in the younger speakers in the V_{front} context, given that both F1 and F2 difference plots for older speakers are slightly more distant from the dotted zero line compared to the difference plots for younger speakers, while this difference is far less visible in the V_{back} context, since the younger and older speakers' confidence intervals are mostly overlapping (see Fig. 2.4).

2.3.3 Differences according to region

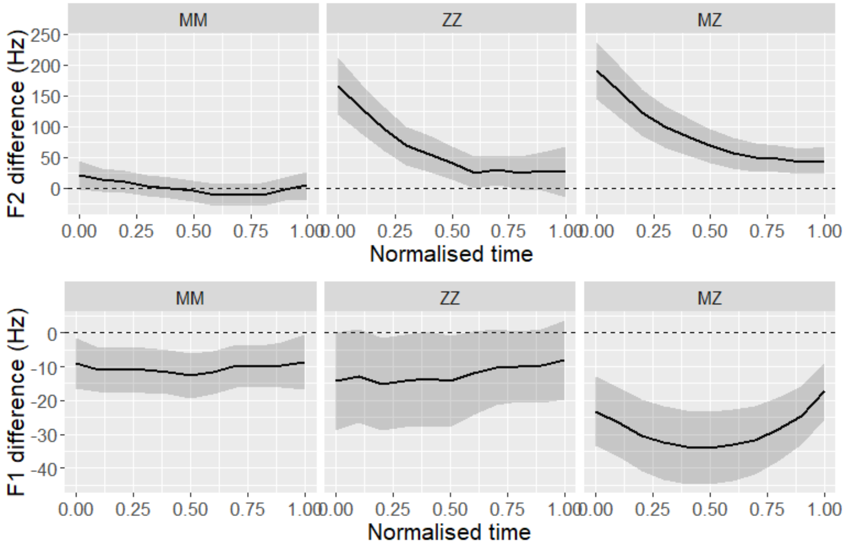

Figure 2.5: F2 and F1 differences in V_{front} contexts grouped by region and aggregated across lexical items and speakers, including the confidence interval of the mean difference values.

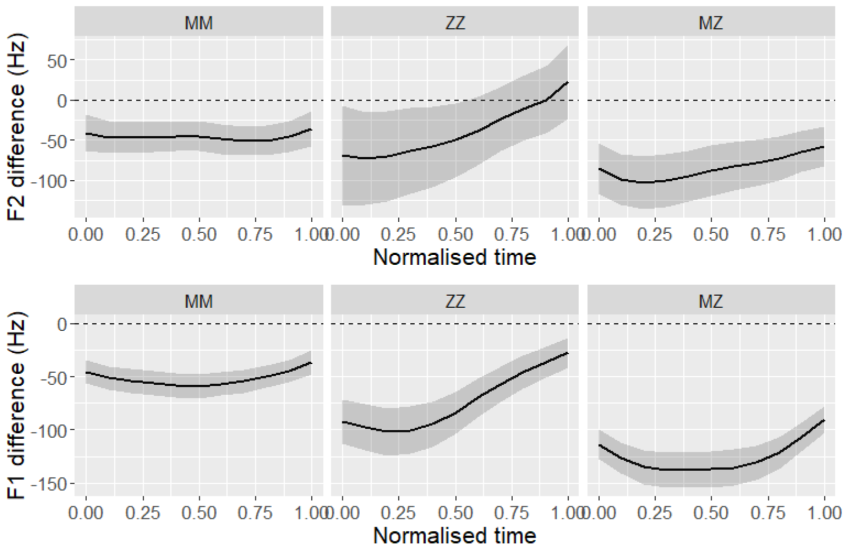

Figure 2.6: F2 and F1 differences in V_{back} contexts grouped by region and aggregated across lexical items and speakers, including the confidence interval of the mean difference values.

Figs. 2.5 and 2.6 show difference plots grouped according to region, again separately for V_{front} and V_{back} suffixes, and aggregated across speakers and lexical items. By observing the plots, it is noticeable that the three regions Mormanno (MM), Zwischenzone (ZZ) and Mittelzone (MZ) differ in the degree of metaphonic influence for both front and back suffix contexts. In particular, MM showed a minor metaphonic influence, mostly marked in F1 (in Fig. 2.5 F2 of MM is hardly affected) and with no particular curvature in the formant difference plots, which could suggest a major metaphonic influence in some specific points of the vowel duration (apart from a very slightly deeper curvature of the F1 difference plot in Fig. 2.6). In contrast, MZ had the most markedly negative formant differences for F1, which were most accentuated around the midpoint, in both suffix vowel contexts, and a positive difference for F2 in V_{front} (Fig. 2.5) and a negative one in V_{back} contexts (Fig. 2.6), with a more marked difference around the onset especially in V_{front} contexts.

For both suffix vowel contexts – and especially for V_{back}, see Fig. 2.6 – F1 differences in ZZ showed more marked negative values at the vowel onset compared to the offset. A more accentuated difference at the vowel onset was present in ZZ also for F2 and for both suffix contexts. Most importantly, ZZ showed an intermediate metaphonic influence between MM and MZ, since the distance between the dotted zero line and the F1 and F2 differences for both V_{front} and V_{back} contexts was visibly greater in ZZ than in MM, but not as marked as in MZ, especially as regards F1.

2.3.4 Statistical analysis

The LMER models described in Section 2.2.3 were applied to the vowel onsets of each stem vowel, and F1 and F2 (here referring to the formant values, not the formant differences) were considered separately. All significant results from the F-statistic of the LMER models are listed in Tab. 2.1.

Overall, these results showed a significant influence of the suffix vowel on the stem vowel for all formants and for both V_{front} and V_{back} contexts, both alone and also in interaction with the stem vowel type, which possibly indicates that there were some stem vowels that were more sensitive to metaphony than others. Also, the significance of region in interaction with both suffix vowel and stem vowel suggests that there were regional differences connected both to degree of metaphonic influence and to stem vowel quality in general. As regards the age factor, this was never significant alone but always in interaction with stem vowel type and region, thus indicating that some age differences might be linked to some specific stems and/or specific regions (see Tab. 2.1 for further details).

Suffix pair	Formant	Fixed factors	Statistic	Probability
V_{front}	F1	Suffix vowel	$F[1, 2146.1] = 4.1$	$p < .05$
		Stem vowel	$F[4, 18.5] = 7.2$	$p < .005$
		Suffix vowel * Stem vowel	$F[4, 2142.8] = 2.5$	$p < .05$
		Age * Stem vowel	$F[4, 2090.7] = 3.6$	$p = .005$
		Suffix vowel * Stem vowel* Region	$F[8, 2142.3] = 3.4$	$p < .001$
		Age * Stem vowel * Region	$F[8, 2101.6] = 2.7$	$p < .01$
	F2	Suffix vowel	$F[1, 2140.5] = 40.1$	$p < .001$
		Stem vowel	$F[4, 19] = 69.7$	$p < .001$
		Suffix vowel * Stem vowel	$F[4, 2139] = 8.8$	$p < .001$
		Age * Stem vowel	$F[4, 2121.2] = 5.6$	$p < .001$
		Suffix vowel * Region	$F[2, 2143.8] = 21$	$p < .001$
		Stem vowel * Region	$F[8, 21.3] = 3.16$	$p = .01$
		Suffix vowel * Stem vowel * Region	$F[8, 2141.8] = 4.1$	$p < .001$
		Age * Stem vowel * Region	$F[8, 2103.3] = 4.55$	$p < .001$
V_{back}	F1	Suffix vowel	$F[1, 2383.7] = 203$	$p < .001$
		Stem vowel	$F[4, 21.4] = 28.7$	$p = .05$
		Region	$F[2, 26.5] = 4.3$	$p < .05$
		Suffix vowel * Stem vowel	$F[4, 2383.4] = 54.9$	$p < .001$
		Age * Stem vowel	$F[4, 2349.1] = 4.9$	$p < .001$
		Suffix vowel * Region	$F[2, 2381.1] = 36.7$	$p < .001$
		Stem vowel * Region	$F[8, 24.1] = 2.7$	$p < .05$
		Suffix vowel * Stem vowel * Region	$F[8, 2381.7] = 15.3$	$p < .001$
		Age * Stem vowel * Region	$F[8, 2370.8] = 1.9$	$p < .05$
	F2	Suffix vowel	$F[1, 2390.1] = 10.7$	$p = .001$
		Stem vowel	$F[4, 21] = 69.3$	$p < .001$
		Suffix vowel * Stem vowel	$F[4, 2390.5] = 46.3$	$p < .001$
		Age * Stem vowel	$F[4, 2384.9] = 3.9$	$p < .005$
		Suffix vowel * Region	$F[2, 2390.9] = 8.2$	$p < .001$
		Stem vowel * Region	$F[8, 30.67] = 2.7$	$p < .05$
		Suffix vowel * Stem vowel * Region	$F[8, 2391.3] = 9.15$	$p < .001$
		Age * Stem vowel * Region	$F[8, 2390.5] = 3$	$p < .005$

Table 2.1: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their statistically significant interactions for the four mixed models (2.1) carried out separately for the F1 and F2 dependent variables in both V_{front} and V_{back} contexts separately.

Vowel spaces

To help the reader interpret the results from the estimated marginal means (EMMs) as well as the normalised formant values graphically represented in the boxplots in Figs. 2.9, 2.10, 2.11, 2.12, it can be useful to first observe the acoustic vowel spaces before and after metaphony and summarising relative F1 and F2 normalised values. In Figs. 2.7 and 2.8, the onset values (time point 0.1) of each stem vowel are plotted in both a non-metaphonic and metaphonic context, and separately for each region. As observable from the plots, lowering Lobanov normalised values on the F1 (y-)axis indicate vowel raising, while lowering Lobanov values on the F2 (x-)axis correspond to vowel backing. Vice versa, increasing Lobanov formant values on the F1 axis correspond to vowel lowering, and increasing Lobanov normalised formant values on the F2 axis indicate vowel fronting. By observing the vowel spaces, stem vowels before back suffix vowels (Fig. 2.7) are those in which metaphonic effects are most evident, since the single stem vowel categories emerge particularly distinct before an /a/ (non-metaphonic) suffix (upper row of Fig. 2.7), while metaphonic raising, implying a shift with partial or complete overlap towards the /i/ space for the mid stem vowel /e/[3], and a shift towards the /u/ space for the mid stem /o/ (most visible for the MZ region), is observable before a /u/ suffix.

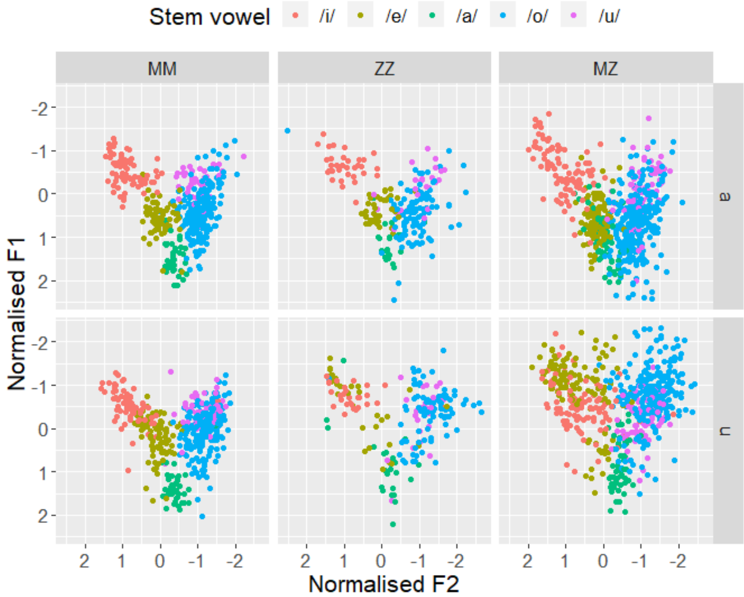

Figure 2.7: Vowel spaces of the five stem vowel phonemes /i, e, a, o, u/ in the V_{back} metaphonic (lower row, /u/ suffix) vs the non-metaphonic context plotted separately for each region.

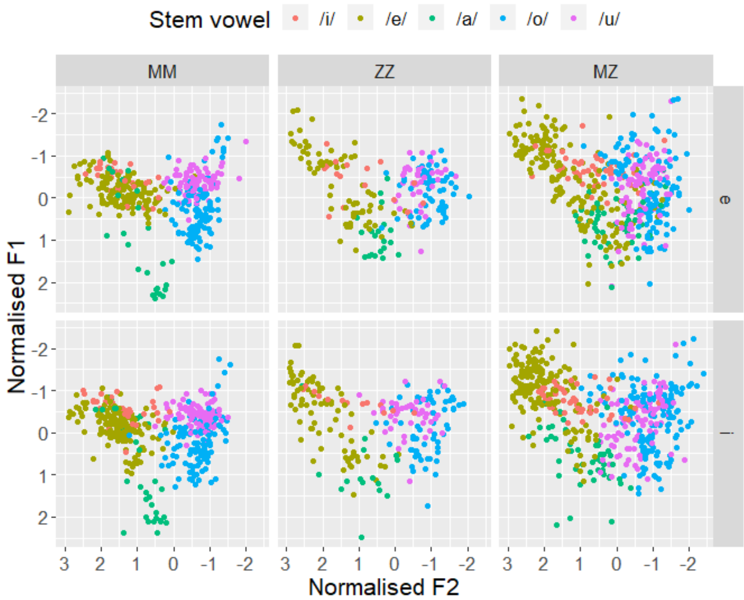

Figure 2.8: Vowel spaces of the five stem vowel phonemes /i, e, a, o, u/ in the V_{front} metaphonic (lower row, /i/ suffix) vs the non-metaphonic context plotted separately for each region.

[3]These vowel charts show that /e/ phonemes can shift even higher than /i/ phonemes in metaphonic contexts, and a similar observation is valid also for metaphonic /o/ in the /u/ suffix context (Fig. 2.7). This is in line with the assumption made by Trumper et al. (1991, p. 64) and Trumper (1997, p. 361) that there are two /i, ɪ/ and /u, ʊ/ phonemes in some centres of the Mittelzone.

Post-hoc tests

The statistical results are now further discussed in terms of post-hoc Tukey tests expanding on the factor interactions summarised in Tab. 2.1. All details on significant estimated marginal means (EMMs) are listed in Tabs. 2.2 (EMMs of contrasts between suffix vowels for each stem vowel type), 2.3 (contrasts between regions) and 2.4 (contrasts between age groups). Also, in Tabs. 2.2, 2.3 and 2.4 the mid stem vowels /e, o/ were highlighted in bold type. As a graphical support to the EMMs results, the boxplots in Figs. 2.9, 2.10, 2.11 and 2.12 compare onset (time point 0.1) Lobanov-normalised formant values for each formant separately for suffix vowel, stem vowel, age group and region.

Turning firstly to the mid-vowel targets /e, o/, for which major metaphonic effects were expected, the results of the post-hoc tests overall confirmed a major metaphonic influence of the suffix /u/ on both stem vowels (Figs. 2.11 and 2.12) compared to the other metaphony-triggering suffix /i/ (Figs. 2.9 and 2.10). In fact, significantly lower F1 values for both /e/ and /o/ ($p \leq .05$ for all significant contrasts, see Tab. 2.2 for all statistical details), together with higher F2 values for the stem vowel /e/ ($p < .001$ for all significant contrasts) and lower values for the stem vowel /o/ ($p < .01$ for all significant contrasts, see Tab. 2.2) describe a fronting for stem /e/ and a retraction for stem /o/ co-occurring for both stem vowels with vowel raising.

As regards F1, the influence of the /u/ suffix on both mid stem vowels was most evident for the MZ region, to a minor extent also visible in ZZ, and least visible in MM. This was valid for both age groups, with no visible differences between older and younger speakers ($p < .001$ for most contrasts, see Tab. 2.2 for statistical details). Relating to the influence of V_{front} suffixes on mid stems, the difference between metaphonic and non-metaphonic context was significant only for the /e/ stem in the MZ region, in both age groups ($p <$ .001, see Tab. 2.2), while it was only slightly visible (see Figs. 2.11 and 2.9) and statistically non-significant for stem /o/.

As regards F2, a significant effect in V_{back} metaphonic contexts was visible only in the ZZ and MZ regions for stem vowel /e/ ($p < .001$ in both cases and for all age groups, see Tab. 2.2 for details), while for /o/ a very slight, but statistically significant effect was also present in MM ($p < .001$ for both older and younger speakers, see also Tab. 2.2). A significant raising of the normalised F2 values was also observable in V_{front} metaphonic contexts for stem /e/ in both ZZ (older speakers only, t_{2156} = -5.5, $p < .001$) and MZ regions ($p < .001$ for both age groups, see Tab. 2.2 for details), while the effects on F2 for stem /o/ were minimal and statistically non-significant for any region and age group.

As far as contrasts between older and younger speakers are concerned (Tab. 2.4), there were no relevant differences in the metaphonic realisations of mid stem vowels between the two age groups (regardless of speakers' region). The only significant age contrasts detected by the post-hoc tests (EMMs) in metaphonic contexts were present in F1 for MM in /o/ stems in the V_{front} suffix context ($t_{74.9}$ = -2.7, $p < .01$), and in the V_{back} context in ZZ ($t_{60.3}$ = -2.6, $p < .05$) and for the /e/ stem vowel in the V_{back} context for both MM and MZ ($p < .05$ in both cases, see Tab. 2.4 for details). For F2, there was an age difference only in MZ for the /e/ stem before a V_{front} metaphonic suffix ($t_{49.6}$ = -3.1, $p < .005$).

The main differences in the degree of metaphonic influence on the mid stem vowels were linked to three regions detected within the Lausberg area. In particular, as evident from the results of the post-hoc tests listed in Tab. 2.3, the contrast between MM and MZ was statistically significant in all metaphonic contexts ($p < .05$ in all cases, see Tab. 2.3 for details), while the contrasts between MM and ZZ and between MZ and ZZ were only sporadically significant (see Tab. 2.3). However, a lack of contrast between ZZ and other regions might also be linked to the fact that we are only taking the vowel onset into account, and not the whole formant curvature. Indeed, the difference plots in Figs. 2.6 and 2.5 show that ZZ formant difference plots show a curvature with either a falling or rising slope. A dynamic analysis of formants and metaphony, zooming in on differences between ZZ and other regions, is presented in the following chapter (Chapter 3).

As regards the other stem vowels /a, i, u/, which, according to the literature on the Lausberg area, are not expected to undergo metaphony (see also 1.1.3), the metaphonic effects were generally non-significant. There were, nevertheless, the following exceptions.

For F2 in V_{front} contexts, there was a significant raising of the Lobanov-normalised formant values (thus describing a vowel fronting) in stem /a/ in the metaphonic context in the regions ZZ (older speakers only, t_{2141} = -2.4, $p < .01$) and MZ (both age groups, $p < .001$ in both cases, see Tab. 2.2 for details). For the stem vowel /u/, there were significant effects on F2 as regards the older speakers in ZZ (t_{2137} = -2.2, $p < .05$), while for the MZ region there was a tensing of /i/ for both age groups (signalled by higher F2 normalised values, $p < .05$).

As regards V_{back} contexts, older speakers in ZZ showed a significant, though slight raising of /a/, described by the lower F1 normalised values also shown in Fig. 2.11 (t_{2405} = 1.9, $p = .05$). Also, in ZZ (older speakers) a significant effect on F2 of the /i/ stem vowel corresponding to a very slight retraction was observable (see Fig. 2.12 (t_{2393} = 3.1, $p =$ .001). A slight retraction of the vowel (signalled by F2 lowering, see also Fig. 2.12) for both age groups in the stem vowels /a/ and /i/ was noticeable for MZ ($p < .05$ in both stems and for all age groups, see also Tab. 2.2 for details).

dV	Suffix pair	Stem vowel	Region	Age group	m	SE	df	t	Sig.
F1	e – i	**/e/**	MZ	older	0.59	0.07	2133	8.4	***
				younger	0.41	0.10	2131	4.1	***
F2	e – i	/a/	ZZ	older	-0.49	0.20	2141	-2.4	**
		/e/	ZZ	older	-0.55	0.09	2156	-5.5	***
		/u/	ZZ	older	-0.29	0.13	2137	-2.2	*
		/a/	MZ	older	-0.94	0.14	2133	-6.5	***
				younger	-0.81	0.18	2132	-4.3	***
		/e/	MZ	older	-0.77	0.07	2133	-11.0	***
				younger	-0.74	0.10	2131	-7.3	***
		/i/	MZ	older	-0.41	0.14	2132	-2.9	**
				younger	-0.51	0.20	2132	-2.5	**
F1	a – u	**/e/**	MM	older	0.26	0.13	2370	1.9	*
				younger	0.45	0.10	2379	4.3	***
		/o/	MM	older	0.31	0.09	2374	3.5	***
				younger	0.46	0.06	2384	7.4	***
		/a/	ZZ	older	0.34	0.18	2405	1.9	*
		/e/	ZZ	older	0.99	0.13	2397	7.4	***
				younger	1.07	0.28	2376	3.7	***
		/o/	ZZ	older	0.87	0.08	2366	10.5	***
				younger	0.69	0.16	2318	4.4	***
		/e/	MZ	older	1.74	0.08	2369	20.9	***
				younger	1.32	0.12	2366	10.9	***
		/o/	MZ	older	1.52	0.05	2370	28.1	***
				younger	1.44	0.08	2365	17.2	***
F2	a – u	**/o/**	MM	older	0.14	0.06	2389	2.4	**
				younger	0.14	0.04	2389	3.3	***
		/e/	ZZ	older	-0.51	0.09	2395	-5.6	***
				younger	-0.64	0.19	2389	-3.3	***
		/i/	ZZ	older	0.31	0.09	2393	3.1	***
		/o/	ZZ	older	0.36	0.05	2386	6.4	***
				younger	0.35	0.10	2377	3.3	***
		/a/	MZ	older	0.39	0.08	2388	5.1	***
				younger	0.26	0.12	2388	2.1	*
		/e/	MZ	older	-0.48	0.05	2391	-8.7	***
				younger	-0.39	0.08	2389	-4.8	***
		/i/	MZ	older	0.47	0.06	2388	8.0	***
				younger	0.41	0.09	2393	4.5	***
		/o/	MZ	older	0.39	0.03	2392	10.8	***
				younger	0.46	0.05	2389	8.3	***

Table 2.2: The estimated mean (m) and standard error (SE) of the statistically significant contrasts between the non-metaphonic and metaphonic context for a given suffix pair according to stem vowel, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$). The dependent variable (dV) is indicated in the first column.

dV	Suffix vowel	Stem vowel	Regions	Age group	*m*	*SE*	*df*	*t*	Sig.
F1	i	/e/	MM – MZ	older	0.71	0.26	31.9	2.7	*
				younger	1.07	0.26	33.4	4.0	***
			ZZ – MZ	younger	0.88	0.32	62.9	2.7	*
		/o/	MM – MZ	younger	0.78	0.29	32.0	2.6	*
F2	i	/e/	MM – ZZ	older	-0.71	0.19	54.2	-3.6	**
			MM – MZ	older	-0.61	0.19	50.7	-3.1	**
				younger	-0.84	0.20	52.3	-4.1	***
		/o/	MM – MZ	younger	0.54	0.22	50.7	2.5	*
F1	u	/a/	MM – ZZ	older	0.55	0.20	106.8	2.7	*
			MM – MZ	older	0.59	0.22	61.1	2.6	*
		/e/	MM – ZZ	older	0.89	0.16	143.4	5.6	***
			MM – MZ	older	1.32	0.15	72.6	8.5	***
				younger	0.73	0.16	74.5	4.6	***
			ZZ – MZ	older	0.43	0.16	58.5	2.7	*
		/o/	MM – ZZ	older	0.53	0.11	73.0	4.8	***
			MM – MZ	older	0.89	0.11	62.8	7.8	***
				younger	0.69	0.11	58.9	6.0	***
			ZZ – MZ	older	0.35	0.10	53.1	3.3	**
				younger	0.62	0.18	60.9	3.4	**
F2	u	/e/	MM – ZZ	older	-0.49	0.15	60.5	-3.2	**
				younger	-0.67	0.26	50.0	-2.6	*
			MM – MZ	older	-0.69	0.15	55.5	-4.5	***

Table 2.3: The estimated mean (m) and standard error (SE) of the statistically significant contrasts between regions only in metaphonic contexts according to stem vowel, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$). The dependent variable (dV) is indicated in the first column.

dV	Suffix vowel	Stem vowel	Region	*m*	*SE*	*df*	*t*	Sig.
F1	i	/o/	MM	-0.44	0.16	74.9	-2.7	**
	u	/a/	MZ	-0.46	0.16	467.9	-2.8	**
		/e/	MM	0.27	0.13	165.3	2.0	*
			MZ	-0.32	0.12	147.4	-2.7	**
		/o/	ZZ	-0.45	0.17	60.3	-2.6	*
F2	i	/e/	MZ	-0.45	0.14	49.6	-3.1	**
		/i/	MM	-0.51	0.23	258.9	-2.2	*

Table 2.4: The estimated mean (m) and standard error (SE) of the statistically significant contrasts between older and younger speakers only in metaphonic contexts according to stem vowel, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$). The dependent variable (dV) is indicated in the first column.

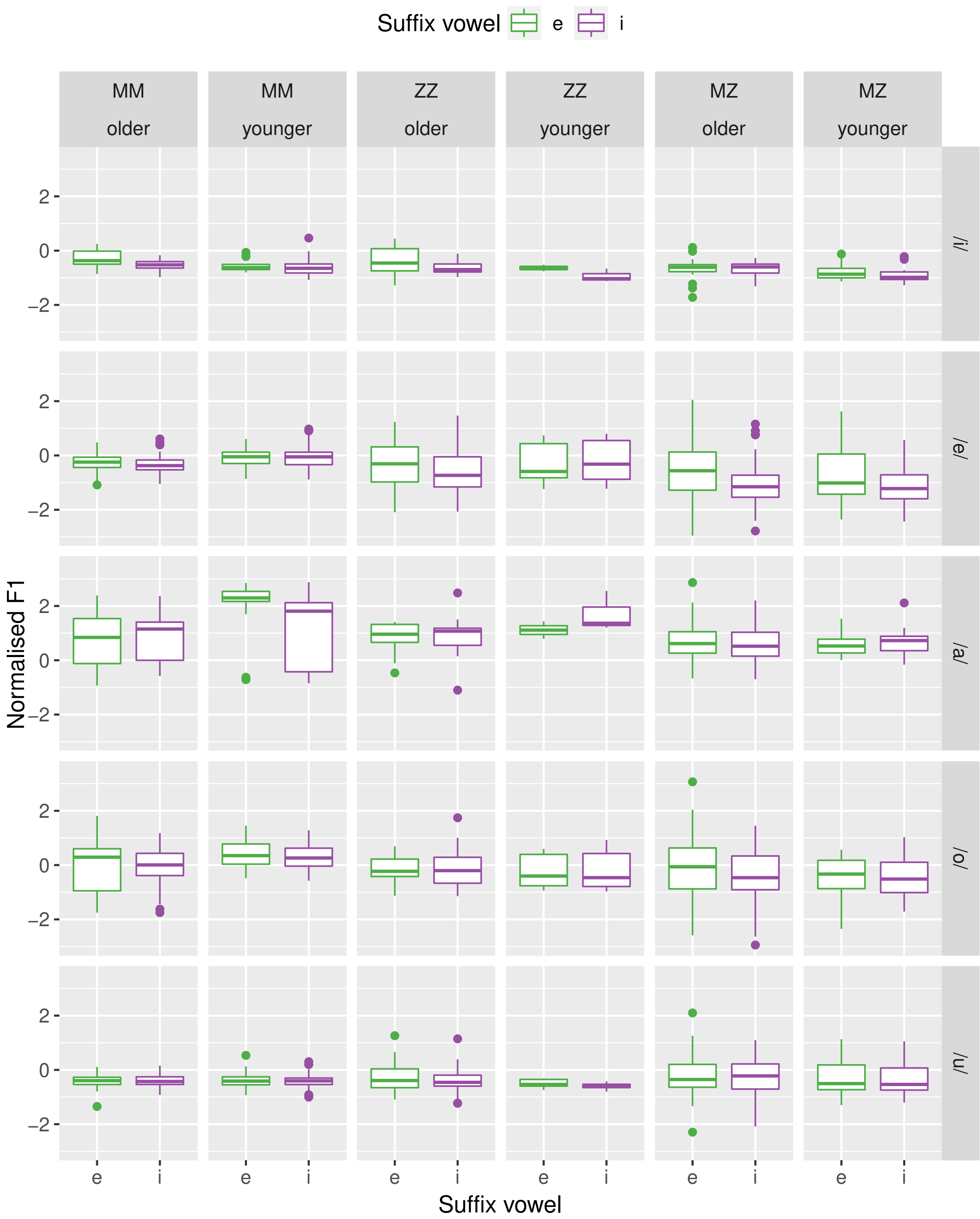

Figure 2.9: Lobanov-normalised F1 onset values in V_{front} contexts, shown separately for stem vowel, region, and age group.

Figure 2.10: Lobanov-normalised F2 onset values in V_{front} contexts, shown separately for stem vowel, region, and age group.

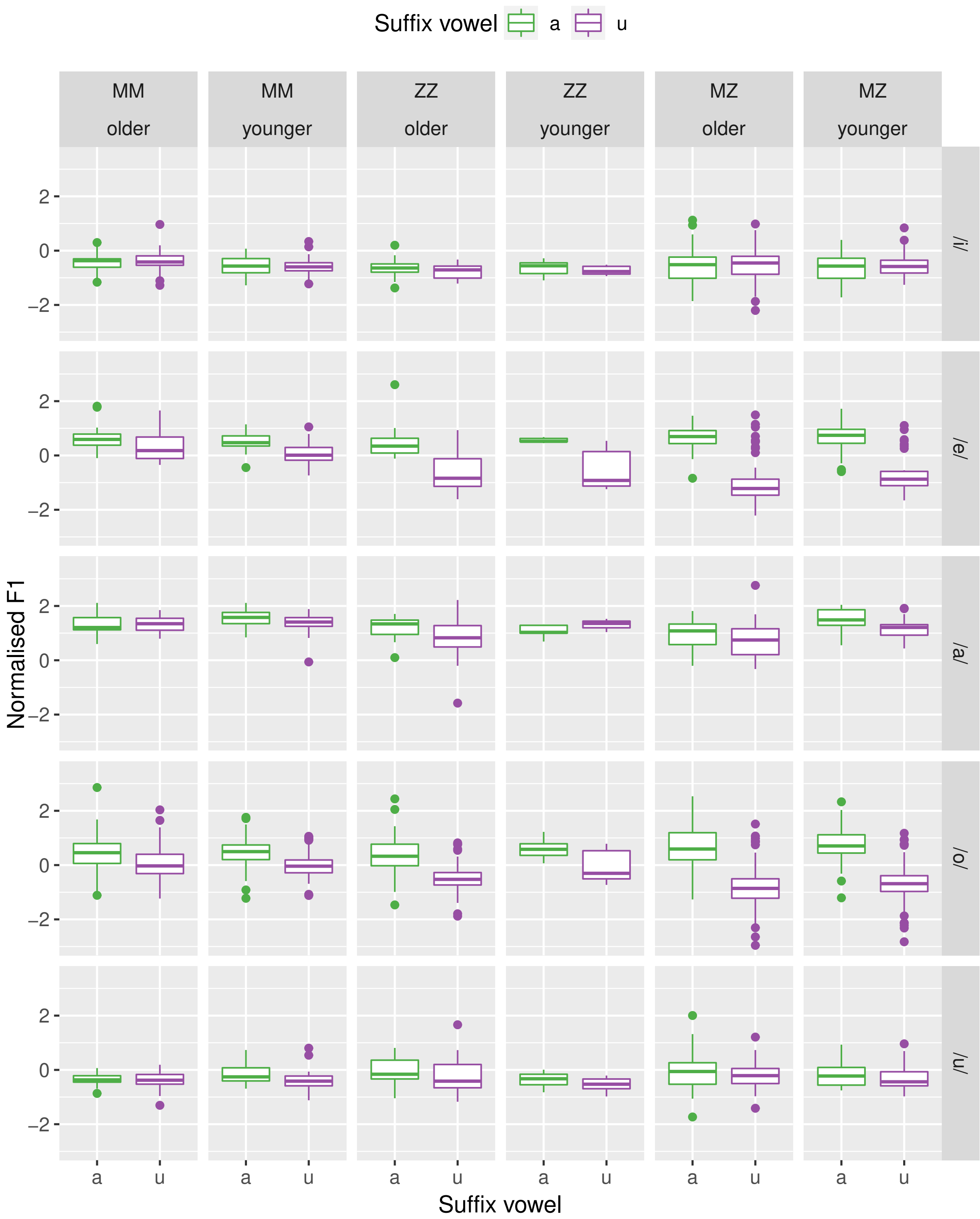

Figure 2.11: Lobanov-normalised F1 onset values in V_{back} contexts, shown separately for stem vowel, region, and age group.

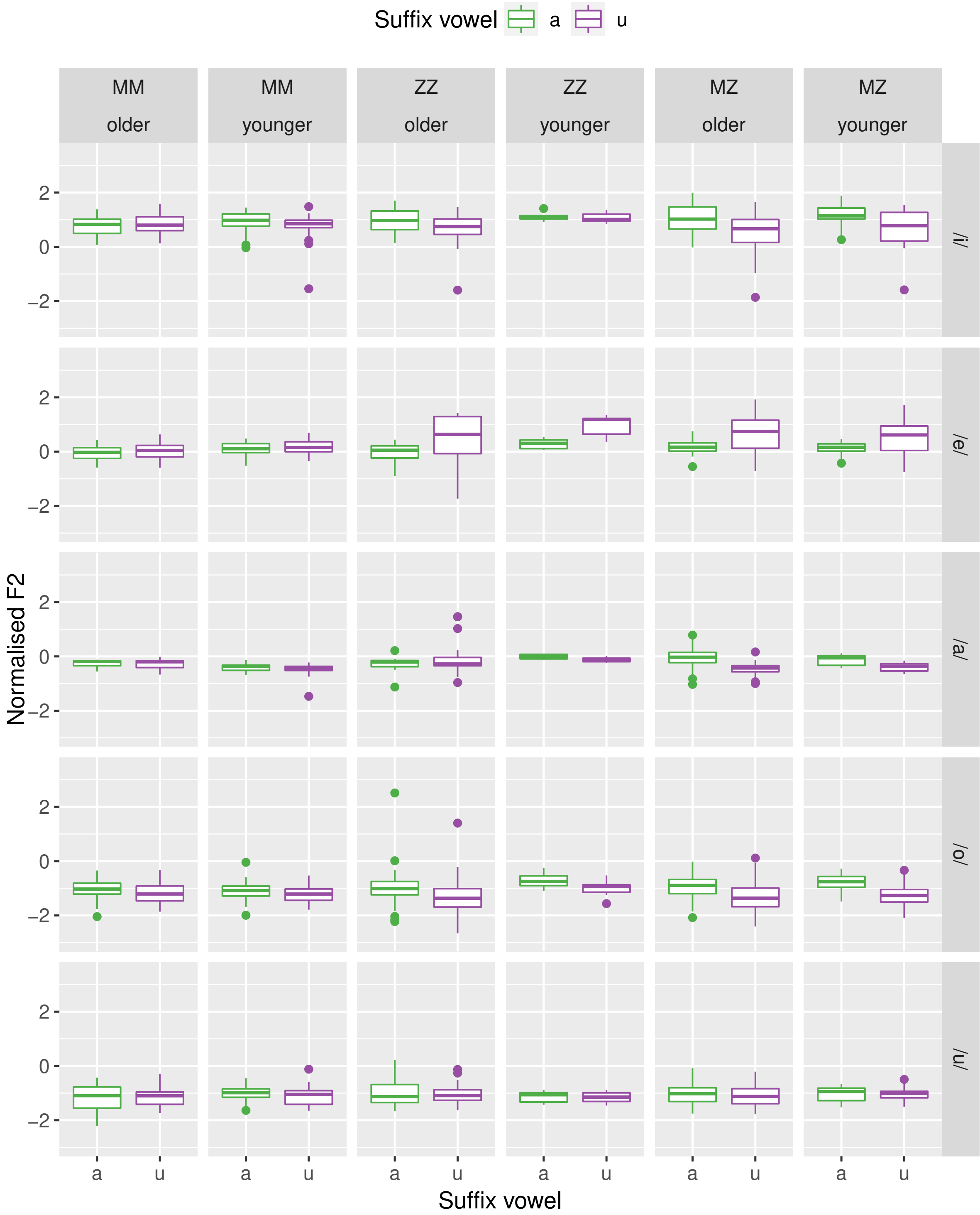

Figure 2.12: Lobanov-normalised F2 onset values in V_{back} contexts, shown separately for stem vowel, region, and age group.

2.4 Discussion

This preliminary analysis considered formant differences of a variety of lexical items' stem vowels that have either front or back suffix pairs. In addition to this, the statistical analysis took into account acoustic data from the onset of these stem vowels before metaphonic and non-metaphonic suffixes. The analysis focused on socio- and geolinguistic variables such as age and region, as well as on phonological variables such as both stem vowel and suffix vowel categories. The results show that metaphony is still present nowadays in the dialects of the Lausberg area, as also attested in most Southern Italian varieties and, to a certain extent, also in Northern Italy (Rohlfs, 1966; Savoia, 1997; Grimaldi, 2003; Grimaldi and Calabrese, 2018; and Walker, 2005, and Delucchi, 2012, as regards some Northern Italian dialects).

In keeping with the findings of earlier studies (Martino, 1991; Romito et al., 2006; Savoia, 2015), the suffix vowel had the greatest influence on the stem mid vowels /e, o/. There was also clear evidence that the influence of the suffix on the stem vowel was stronger in F1 than in F2, thereby also confirming that metaphony affects vowel height to a greater extent than vowel fronting or backing. In keeping with that which has been attested in the past for most Southern Italian dialects presenting metaphony (Rohlfs, 1966; Savoia, 2015), significant effects on frontness or backness of the stem vowel emerged only when the stem vowel and the metaphony-triggering suffix vowel were both either back or front: /e/ was more front (as shown by a raised F2) in the metaphonic /i/-suffix context, and /o/ was more back (as shown by a lowered F2) in the metaphonic /u/-suffix context.

Also, it emerged that some suffixes were more effective in triggering metaphony than others, also depending on stem vowel type. For instance, there was significantly more raising of stem /o/ before /u/ suffixes (see also Grimaldi, 2003, and Grimaldi and Calabrese, 2018, describing a similar phenomenon in Salentino metaphony), while significant metaphonic effects of suffix /i/ were mainly directed to /e/ stems. Overall, however, both mid stems /e, o/ showed the greatest and most significant metaphonic outcomes in V_{back} contexts, as emerged from the difference plots and confirmed from the post-hoc tests.

With regard to the age differences that emerged from my analysis and graphically summarised by Fig. 2.4, the fact that the older speakers seem to metaphonise more might suggest that younger speakers might converge to the standard variety as regards stem vowel quality. However, in Section 2.3.4 it was pointed out that such differences were in most cases non-significant according to the post-hoc tests. This tendency towards Standard Italian by the younger generation, mainly expressed by an overextension of the non-metaphonic stem vowel pronunciation also in metaphonic contexts (as also observed for Neapolitan by Del Puente, 1995, p. 55), is, more generally, in line with observations made by Parlangeli (1971) and Romito et al. (2006) that the increasing emigration of young people, together with the increasing importance and dominance of the standard variety also in informal contexts, might promote phonetic attrition in favour of the Standard Italian pronunciation.

The main differences in metaphonic influence on the mid vowels were detected between the three regions MM, MZ and ZZ. In particular, MZ showed the greatest and most statistically solid metaphonic effects, while MM presented only minor metaphonic influences whose statistical significance was not always confirmed by the post-hoc tests. ZZ presented an intermediate metaphonic influence, which emerged graphically from the formant differences that were not as marked as in MZ, but more evident than in MM, and which was also confirmed statistically by the post-hoc tests. In addition, ZZ presented a curvature in the formant difference plots showing that the coarticulatory influence concentrated most on the first portion of the vowel duration (Figs. 2.5 and 2.6), thus giving metaphonic stem vowels in ZZ a diphthongal quality (in line with what was described by previous authors such as Lausberg, 1939; Rensch, 1964, and more recently by Romito et al., 2006). However, MZ also showed a more marked difference only in F2 onsets (especially if metaphony was triggered by a high front suffix, see Fig. 2.5), which might represent a residue of a chronologically antecedent diphthongising phase postulated by many authors such as Lausberg (1939), Rensch (1964); and Trumper (1997) (see Section 1.1.4 and Chapter 3 on different diachronic phases of metaphony).

Since this analysis was mainly based on formant differences, it only took word pairs that alternated between having a metaphonic and a non-metaphonic suffix into account. Also, the statistical analysis considered only specific time points of the vowel formants, but not their variation in the whole stem vowel duration. In the next chapter, such limits are going to be overcome, on the one hand, by integrating more lexical items into the analysis, and, on the other hand, by using a more 'dynamic' approach, by which not only a single point of the vowel duration, but the entire formant pairs in their time-varying shapes can be analysed. Also, I am going to focus on regional differences and the associated different types of metaphony for the mid stem vowels /e, o/ only, as these were the vowels that exhibited major metaphonic effects.

Chapter 3

Regional variations in metaphony: implications for sound change

3.1 Introduction

In this chapter I discuss in more depth regional differences in metaphony in the Lausberg area and their implications for a diachronic reconstruction of the "coarticulation-to-phonologisation" process at the base of metaphony. A substantial difference to the previous statistical analyses discussed in Chapter 2 is that this analysis is based on the entire time-varying shape of the stem vowel formants. The importance of doing so is partly because V_1CV_2 coarticulation, with which metaphony is closely connected, itself varies depending on given points in time, in view of the fact that the metaphonic V_2 modifications may well extend to varying degrees across the entire V_1 stem vowel. The second reason is because metaphony, as discussed in Section 1.1.4, and as partially shown by the formant differences discussed in Chapter 2, can lead to diphthongisation, which is itself characterised by variation throughout its duration and therefore not well represented by acoustic analyses at particular points in time (Morrison & Assmann, 2013).

Section 1.1.4 put forward the hypothesis that the three main metaphony types in the Lausberg area, namely raising, diphthongisation and further monophthongisation by loss of the second element of the diphthong in mid-vowel stems, are also supposed to be chronologically linked and diachronically consecutive. In order to test whether there is further acoustic evidence that metaphony in the Lausberg area is acoustically manifested as a raising, diphthongisation, or monophthongisation of a previous diphthong, and also to explore whether there is any first evidence that diphthongisation is an intermediary

Parts of this chapter were included in a manuscript submitted for publication (Greca et al., 2022).

stage in sound change between raising and monophthongisation (see also Section 1.1.4), time-varying techniques were implemented for processing mid stem vowels across a larger number of lexical items and different suffix vowels.

Another question which has not been specifically addressed by the literature about the Lausberg area is whether a specific coarticulatory influence exists depending on single suffix vowel qualities, which could challenge the strict division between metaphonic high suffixes and other non-metaphonic suffixes as presented in the literature (a hypothesis already advanced in Section 1.2). Previous studies have not provided much information on the possible coarticulatory effect of the so-called "non-metaphonic" suffixes, so it is currently unknown, for instance, whether an /a/ suffix vowel can potentially trigger a vowel lowering, or whether acoustic differences can exist between stems preceding the low suffix vowel /a/ and those preceding the mid suffix vowel /e/. In order to explore such possibilities, additionally, the coarticulatory effect of each suffix vowel is analysed separately in this chapter.

3.2 Method

3.2.1 Three regions, three sound change phases

As anticipated in Section 1.3.1, the recordings used for the acoustic analysis involved 9 villages which were chosen as their metaphonic forms might correspond, according to the literature presented in Section 1.1.4, to the three main types of metaphony present in the Lausberg area. The distribution of the 35 participants within the three identified regions of Mormanno (MM), Zwischenzone (ZZ) and Mittelzone (MZ) was described in Section 1.3.1 (see also Appendix A.1 for further details). The number of speakers recorded from MM, ZZ, and MZ was 11, 10, and 14 respectively.

The three regions representative of three sound change phases – raising, diphthongisation, monophthongisation – respectively were established as follows (see also Fig. 1.2 in Section 1.3):

1. MM includes only one village within the Zwischenzone, Mormanno, which as pointed out by Martino (1991, p. 57) might represent an island within a diphthongising territory. Also, Savoia (2015, p. 209) has suggested that mid-vowel stems uttered by Mormanno speakers are raised phonetically by one degree (i.e. [ɛ] becomes [e] and [ɔ] becomes [o] in a metaphonic context). MM is therefore likely to represent the first part of the sound change in which stem vowels are raised.

2. ZZ includes diphthongising villages from the Zwischenzone (the Tyrrhenian coast and surroundings): Laino Borgo, Laino Castello, S. Domenica Talao, Scalea. In

these villages, the mid vowels /e, o/ are expected to turn into opening diphthongs before the high suffixes /i, u/ (see Section 1.1.4):

3. MZ includes Canna, Cerchiara di Calabria, and Montegiordano, all villages belonging to the monophthongising Calabrian part of the Mittelzone, in which the mid vowels /e, o/ are expected to be raised to the high vowels [i, u] in metaphonic contexts (see Section 1.1.4).

3.2.2 Lexical items and stem vowel tokens

As for the previous analyses, the words used for this analysis (see Appendix E) included either adjectives, nouns, or verbs. In contrast to the words used for the analysis in Chapter 2, only words with the stem vowels /e, o/ were considered, since these were the vowel stems showing the most relevant metaphonic effects. Additionally, in this chapter the focus is not only on word pairs in which one of the suffixes is a non-metaphonic one (see Section 2.2.1 for details). Instead, all elicited words that have a mid-vowel stem were used for analysis, regardless of suffix pairs. Therefore, not only word pairs such as e.g. /ˈponte, ˈponti/ (‘bridge, bridges’), or /ˈbona, ˈbonu/ (‘good’, fem. sg. vs masc. sg.) were included, in which there are two alternative suffixes and only one of them (either /i/ or /u/) triggers metaphony, but also word pairs such as e.g. /ˈrosa, ˈrose/ (‘rose, roses’), in which both suffixes /a, e/ are not supposed to trigger vowel raising i.e. metaphony, or pairs such as e.g. /ˈlettu, ˈletti/ (‘bed, beds’), in which both suffix vowels /i, u/ are expected to trigger metaphony. Not all words were organised into pairs, such as the word /ˈsole/ (‘sun’), while most verbs were organised in triplets (the 1st, 2nd and 3rd person singular of the present indicative). All items involved in the analysis are listed in detail in Tab. E.1 in Appendix E. All mid-vowel stems considered were always the nucleus of the syllable carrying the primary lexical stress.

The suffix vowels considered in this analysis were the same as those described in the previous chapter in Section 2.2.1. The metaphony-inducing suffix /i/ marks either the plural for nouns ending in the suffix /e/ in the singular form, or the second person singular of the present indicative in verbs. The other metaphony-inducing suffix /u/ marks either the first person singular of the present indicative in verbs, or the masculine singular in nouns and adjectives. On the other hand, the non-metaphonic suffixes /e, a/ can either mark the singular of (respectively) masculine and feminine nouns or adjectives, or the third person singular of the present indicative of verbs of the second and third conjugation (suffix /e/) or verbs of the first conjugation (suffix /a/) (see examples for each suffix vowel in Section 2.2.1). There was a total of 118 words consisting of 55 lexical stems (28 lexical stems for stem vowel /e/ and 27 for stem vowel /o/). As was the case in Chapter 2, the majority of words (n = 85) were disyllabic (e.g. /ˈossu, ˈossa/), while there were some words (n = 30) that were trisyllabic, in which the stem and suffix vowels were either

Stem vowel		/e/				/o/			
Suffix vowel		/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/
Metaphonic context			✓		✓		✓		✓
	MM	244	319	186	274	178	235	257	292
Region	ZZ	125	160	97	122	85	122	132	145
	MZ	284	373	222	346	181	299	317	377
	All regions	653	852	505	742	444	656	706	814

Table 3.1: Count of the stem vowels that were analysed in this study by suffix vowel and region.

separated by one syllable (for instance the second person singular forms of verbs such as /ˈtenisi/, ‘(you) have’, or nouns such as e.g. /ˈprevite/, ‘priest’), or in which the syllable containing the suffix and the one containing the stem were adjacent (e.g. /kraˈpettu/, ‘kid’). The total number of potentially available vowels for analysis for stem /e/ was: 60 words × 2 repetitions × 35 speakers = 4200 stem vowel tokens; for stem /o/: 58 words × 2 repetitions × 35 speakers = 4060 vowel tokens. However, some repetitions had to be removed either because they were misarticulated, produced in Standard Italian, or did not correspond to the target word (considering that the elicitation method was based on the naming of pictures rather than the direct translation of words from Italian, see also Section 1.3.2), leaving 2752 stem-/e/ and 2620 stem-/o/ vowels for the analysis (see Tab. 3.1).

3.2.3 Functional principal component analysis (FPCA)

In order to describe and quantify the influence of metaphony on stem vowels, as well as determine how such influence differs across the three regions MM, ZZ and MZ, and possibly between suffixes, a two-staged modelling procedure was applied to Lobanov-normalised (see Section 1.3.4) F1 and F2 tracks. First, formants were parameterised in order to obtain a set of quantitative descriptors of their shape. Such descriptors, or *scores*, were then used as response variables in a number of linear mixed-effects regression (LMER) models, as detailed at the end of this section.

Formant parameterisation was obtained by applying Functional Principal Component Analysis (FPCA, Ramsay & Silverman, 2010) following the same procedure described in Gubian, Torreira, and Boves (2015), which is summarised as follows. First, the time-normalised sampled formant track pairs (F1, F2), obtained as described in Section 1.3.4, were interpolated by means of standard smoothing techniques using B-splines, which are sequences of polynomial functions that, multiplied by specific coefficients and summed together, reproduce a sampled data contour by approximation to the original shape (Gubian et al., 2015, p. 20). As a result, each vowel token of /e/ or /o/ was represented by a pair of continuous functions $F1_i(t)$ and $F2_i(t)$, in which i is the token index and t is the continuous, normalised time variable. This set of function pairs was the input to

FPCA, which produced a parameterisation of the form:

$$F1_i(t) \approx \mu_{F1}(t) + \sum_{k=1}^{K} s_{k,i} \cdot PCk_{F1}(t) \tag{3.1a}$$

$$F2_i(t) \approx \mu_{F2}(t) + \sum_{k=1}^{K} s_{k,i} \cdot PCk_{F2}(t) \tag{3.1b}$$

in which $\mu_{F1}(t)$ and $\mu_{F2}(t)$ are the mean formant tracks, $PCk_{F1}(t)$ and $PCk_{F2}(t)$ are K pairs of Principal Component curves (PCs, $k = 1, \ldots, K$), which are fixed and depend on the entire data set, and $s_{k,i}$ are *scores*, which act as weights on PCk's and are different for every token. Each of the equations (3.1) is a weighted sum of a mean curve plus a small number (K) of other curves (PCs), which added together with weights (scores) reproduce the original formant tracks to an approximation – the more the K components, the better the approximation. Each score, say s_1, controls its own pair of PC curves, say $PC1_{F1}(t)$ and $PC1_{F2}(t)$; in other words, quantitative variations of a given score are associated with specific variations in the shape of *both* formants determined by (the shape of) the corresponding PCs, such that each score quantifies a different type of shape variation.

FPCA was applied separately to the 2752 /e/ tokens and to the 2620 /o/ tokens resulting in two independent FPCA formant parameterisations, hence two independent sets of scores. In both cases, the first $K = 3$ PCs were considered, which combined explained around 95% and 93% of the FPCA variance for /e/ and for /o/, respectively. The reason why FPCA was applied separately to /e/ and /o/ is because the considerable differences between these stem vowels in their formant frequencies would overwhelm the much smaller differences induced by metaphony and by the other factors of interest if FPCA had been computed on all tokens together.

3.2.4 Statistical analysis

In order to identify and quantify the influence of metaphony on the stem vowels, linear mixed-effects regression (LMER) models were run by using the `lmerTest` package (version 3.1.3) on R. The mixed models were of the form (R notation):

$$s \sim \text{Suffix vowel} * \text{Region} + (\text{Region}|\text{Stem}) + (1|\text{Speaker}) \tag{3.2}$$

in which the response s was one of two PC-scores and in which there were fixed factors *Suffix vowel* (four levels: one of the four suffixes, the ones inducing metaphony are /i, u/ and the ones that do not are /e, a/ – see Tab. 3.1), and *Region* (three levels: MM, ZZ, MZ). The random factors originally included intercepts and all possible slopes to measure the interaction between the fixed and random factors, but these were dropped if they were non-significant. In the final models, the random factors were *Stem* which interacted with the fixed factor *Region*; whilst the *Speaker* random factor was modelled as an intercept. *Stem* was a unique identifier for the lexical stem of the word independently from any suffix (e.g. the *Stem* representation for /mese, mesi/ was /mes/).

Four models of the form in (3.2) were run in which the response variable was either s_1 (the PC-score associated with PC1) or s_3 combined with data from either stem-/e/ or stem-/o/ vowels (Tab. 3.1): that is, stem-/e/ and stem-/o/ data were analysed separately. Post-hoc tests were computed in terms of estimated marginal means (EMMs), in order to zoom in on the significant interactions given by the fixed factors. The EMMs were computed by using the `emmeans` package (version 1.5.3) in the R environment.

The results from the LMER models (3.2), expressed in terms of PC-scores from the respective FPCA parameterisation (stem-/e/ or stem-/o/ vowels), were conveniently represented as formant tracks by means of Eq. (3.1). In particular, the EMMs of s_1 and s_3 for each combination of the fixed factors and for each stem vowel were substituted into Eq. (3.1) (setting the other s_k to zero) to obtain pairs of F1 and F2 curves reflecting the estimated formant shapes characteristic for each factor level (see Fig. 3.9 and 3.10).

3.3 Results

3.3.1 PCs and underlying time-varying shapes

Relationship between PCs, PC-scores, and shapes

Figs. 3.1 and 3.2 show the mean F2 and F1 trajectories (the thick black lines) across the entire database for stem /e/ and stem /o/ respectively. These mean trajectories show some of the typical acoustic characteristics associated with these vowels, such as an F2 curvature peak for /e/ and an F2 trough for /o/ that both occur close to the temporal midpoint of the vowel. The same figures also show the range of variation which resulted when the PC-scores, s_k, of the k^{th} Principal Component PCk were shifted in equal steps around the mean (for which, following Eq. (3.1), $s_k = 0$). This stepwise variation of s_k is expressed in relation to its standard deviation, i.e. $\frac{s_k}{\sigma_k}$, varying from -1 to +1, and is plotted both in a positive (increasingly red) or negative (increasingly blue) direction from the mean trajectory (black). Shifting s_k in this way can provide some insight into how each of the principal components models the variation in the /e/ and /o/ formant trajectories across all speakers, words, and repetitions.

Turning firstly to /e/, as far as PC1 is concerned (Fig. 3.1, left panels), decreasing and increasing s_1 caused the formants to shift further apart (blue) or to come closer together (red) respectively. Thus, the s_1 modulation of PC1 brings about a type of variation that is consistent with both a phonetic raising and simultaneous fronting, i.e. the change

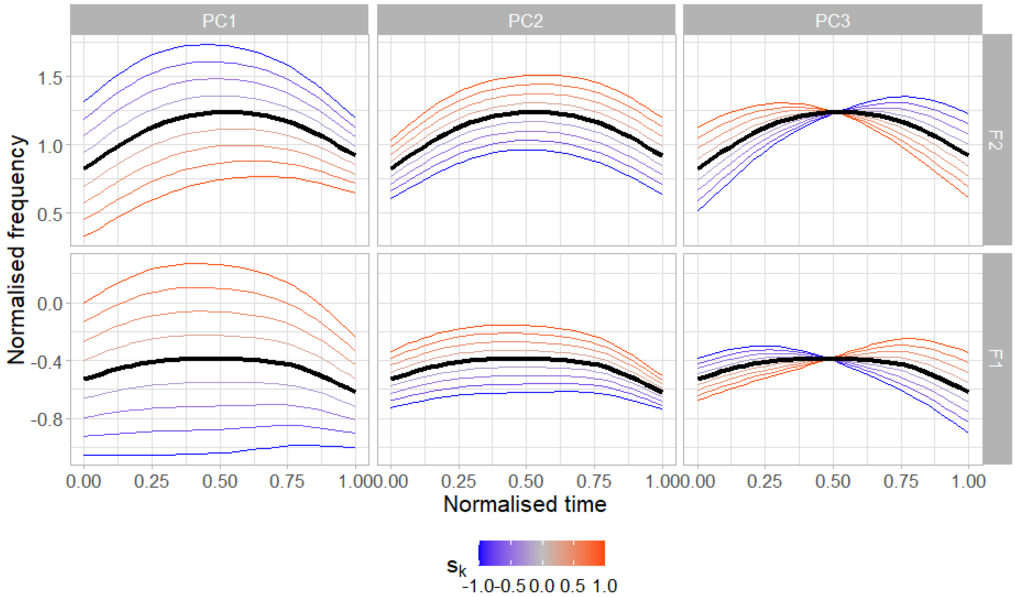

Figure 3.1: First three PCs for stem-/e/ vowels between their acoustic onset and offset for F2 (upper row) and for F1 (lower row) aggregated across speakers and word tokens containing /e/ stems.

between the extreme blue/red trajectories for PC1 in the left panels of Fig. 3.1 is likely to correspond to a shift from a (peripheral) phonetically high front [i] vowel (blue trajectories, in which F1 and F2 are maximally far apart) in the direction of phonetic centralisation and lowering, possibly in the direction of [e] or [ɛ]. The s_2 modulation of PC2 (central panels in Fig. 3.1) caused both formants either to decrease in frequency (blue trajectories) or to increase together (red trajectories). The phonetic interpretation of PC2 is less transparent than the one for PC1: it might, on the one hand, act to constrain the variation in PC1, but it could also be associated with a shift from a less (red trajectories) to a more (blue trajectories) rounded vowel, given that vocal tract lengthening due to lip rounding causes a decrease in formant frequencies (especially in F2, see e.g. Lindblom and Sundberg, 1971, and Fig. 2 in Vaissière, 2009, p. 24). The changes to the formant shapes caused by s_3 modulations of PC3 were from (i) to (ii):

(i) blue trajectories: in the first part of the vowel, F1 is above the mean curve and F2 is below the mean curve. Since the mean curve refers in this case to the /e/ stem vowel, then this quality corresponds to a tongue lowered [e̞] or to [ɛ]. In the second part of the vowel, F1 is below the mean and F2 above the mean. This is typical of a quality such as a tongue raised [e̝] or [i]. Consequently, the blue line from the vowel onset to the offset represents a range of phonetically closing diphthongs such as [e̞e̝] or [ɛi].

(ii) red trajectories: these are more or less the mirror image on the time axis of the blue ones. Thus, the red trajectories from the vowel onset to the offset represent a range of phonetically opening diphthongs such as [e̝e̞], [ie] or [jɛ].

Thus, the shift from (i) to (ii) corresponds to the variation between a closing and opening diphthong.

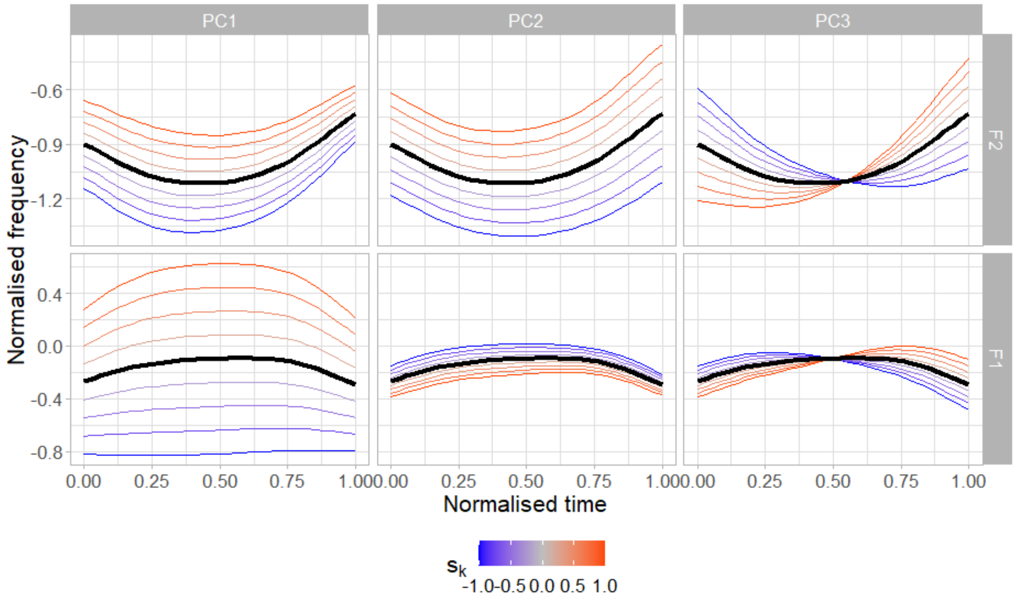

Figure 3.2: First three PCs for stem-/o/ vowels between their acoustic onset and offset for F2 (upper row) and for F1 (lower row) aggregated across speakers and word tokens containing /o/ stems.

The type of variation associated with the PCs for stem /o/ in Fig. 3.2 bears a striking similarity to that of stem /e/. As far as PC1 is concerned (Fig. 3.2, left panels), decreasing s_1 caused a lowering of both formants: that is, the change from negative (blue trajectories) to positive (red trajectories) s_1 values corresponds to a shift from a phonetically high vowel, in this case [u], towards a lower and more central vowel such as [ɔ] or [o]. The type of variation in PC2 is similar to that of PC1 except that, for PC2, F1 changes minimally: thus, the transition from blue to red trajectories in PC2 might correspond phonetically to an increase in vowel frontness or backness, but without much change in phonetic height. The s_3-induced variation in PC3 brings about a change in diphthongal quality from (i) to (ii):

(i) blue trajectories: in the first part of the vowel, both formants are above their respective means. Since the mean refers in this case to stem /o/, this quality possibly corresponds to a tongue lowered [o̞] or [ɔ]. In the second part of the vowel, both formants are below their respective means. This is typical of a quality in which the tongue is raised as for tongue raised [o̝] or [u]. Consequently, the blue line from the vowel onset to the offset represents a range of phonetically closing diphthongs such as [o̞o̝] or [ɔu].

(ii) red trajectories: these are more or less the mirror image on the time axis of the blue ones. Thus, the red trajectories from the vowel onset to the offset represent a range of phonetically opening diphthongs such as [o̝o̞], [uo] or [wɔ].

Thus, as for stem /e/, the change from (i) to (ii) represents a shift from a phonetically closing to an opening diphthong.

Discussion

The separate application of FPCA to the formant trajectories of /e/ and of /o/ resulted in a set of k PCs of which each one encoded different aspects of the variation in the formant trajectories across speakers and words. The nature of this variation was demonstrated by artificially shifting the associated PC-scores that modulated the PCs. This approach showed that PC1 is likely to be associated with simultaneous variations in phonetic height and frontness/backness towards high front in the case of /e/ and high back in the case of /o/. The phonetic interpretation of PC2 was much less obvious: it might be related to a variation in lip rounding for /e/ and in phonetic backness for /o/. PC3 for both /e/ and /o/ encode variations between phonetically closing and opening diphthongs. The issue to be considered next is the extent to which these variations in the formant trajectories were connected to the metaphonic influence of V_2 on V_1 and with the differences between the three regions outlined in Section 1.1.4 and mentioned again at the beginning of this chapter (Section 3.1). For this purpose, the analyses in the coming sections were based on PC1 and PC3 and relative scores, given the evidence (see Section 1.1.4 and the preliminary acoustic analyses in Chapter 2) suggesting that metaphony is mainly associated with variations in phonetic peripherality and diphthongisation in the stem vowel.

3.3.2 Metaphony, suffix vowels, and regions

Overview

In Section 3.3.1, the PC-scores that modulate the PCs were artificially varied in order to determine how the different types of variation in the formant trajectories that are represented by each PC were associated with changes to phonetic quality. The focus here is on the analysis of the PC-scores s_1 – whose variation indicates change in vowel height – and s_3 – whose variation corresponds to change in diphthongal quality – that were obtained for each of the stem vowel tokens to which FPCA was applied.

The Figs. 3.3 and 3.4 are scatter plots of data points showing, for /e/ and /o/ stems respectively, s_1 (x-axis) and s_3 (y-axis) values for each stem vowel token in metaphonic (/a, e/ suffixed forms together, mauve points) vs non-metaphonic contexts (/i, u/ suffixed forms together, green points) and separately per region. For both stems, decreasing s_1 values below 0 correspond to a vowel raising with simultaneous fronting (for stem /e/) or backing (for stem /o/). An increasing s_1 score above 0 indicates instead a vowel opening.

As regards s_3, increasing values above 0 indicate opening diphthongisation for both stems, while values below 0 correspond to closing diphthongs (see Section 3.3.1 and Figs. 3.1 and 3.2 for details).

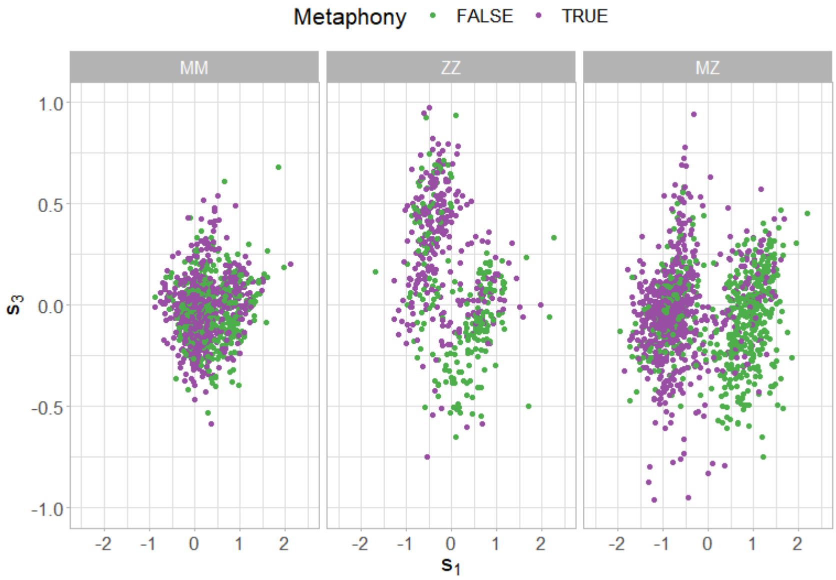

Figure 3.3: Scatter plots of the s_1 and s_3 PC-scores for stem /e/ vowels shown separately by region and metaphonic vs non-metaphonic context.

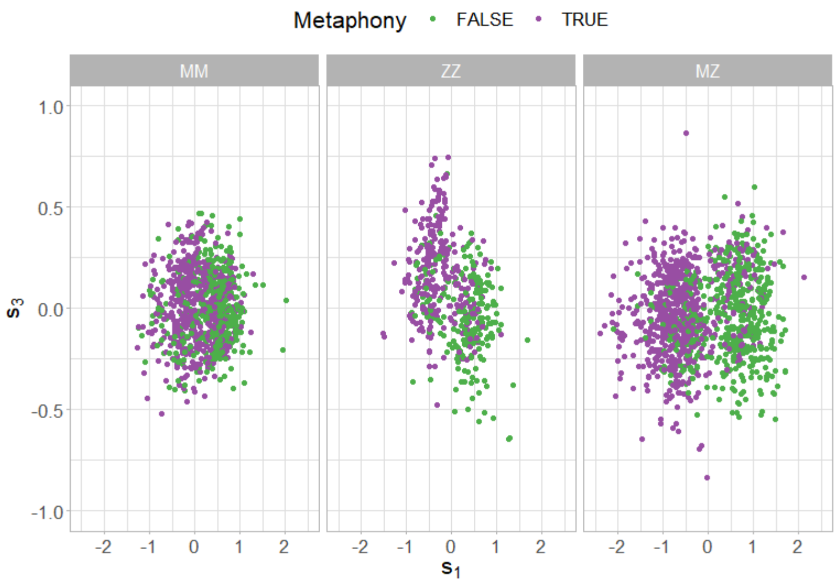

Figure 3.4: Scatter plots of the s_1 and s_3 PC-scores for stem /o/ vowels shown separately by region and metaphonic vs non-metaphonic context.

In both Figs. 3.3 and 3.4, a progressive separation of the mauve and green points, graphically representing metaphonic and non-metaphonic stems respectively, is visible starting from MM, moving to ZZ and finally to MZ. Also, as regards ZZ, we have a separation of the points mainly on the s_3 axis, while the separation between metaphonic and non-metaphonic stems in MZ is noticeable mainly on the s_1 axis[1]. In contrast to ZZ and MZ, MM only marginally shows a major concentration of metaphonic stems on the left side (more visibly in Fig. 3.4 for the /o/ stem vowel rather than for the /e/ stem vowel, see Fig. 3.3), thus suggesting that both stem vowels /e, o/ tend to be slightly raised before high vowels /i, u/, but either not as consistently or not to the same degree as in e.g. MZ.

Tab. 3.2 provides a statistical overview of how (and how significantly) the PC-scores s_1 and s_3 were influenced by the two fixed factors identified in Eq. (3.2), i.e. by *Suffix vowel* (/a, e, i, u/ suffixes considered separately; in particular, the vowels /i, u/ are supposed to trigger metaphony, as opposed to the possibly non-metaphonic suffixes /e, a/), and *Region* (MM, ZZ, MZ).

Stem vowel	**PC-score**	**Fixed factors**	**Statistic**	**Probability**
/e/	s_1	Suffix vowel	$F[3, 2493.6] = 122.1$	$p < .001$
		Region	$F[2, 49.1] = 9.7$	$p < .001$
		Suffix vowel * Region	$F[6, 1120.7] = 35.3$	$p < .001$
	s_3	Suffix vowel	$F[3, 2632.7] = 11.9$	$p < .001$
		Region	$F[2, 48.8] = 3.1$	$p = .05$
		Suffix vowel * Region	$F[6, 2068.1] = 14.7$	$p < .001$
/o/	s_1	Suffix vowel	$F[3, 1995.6] = 253.6$	$p < .001$
		Region	$F[2, 44.2] = 6.3$	$p < .01$
		Suffix vowel * Region	$F[6, 889.0] = 37.7$	$p < .001$
	s_3	Suffix vowel	$F[3, 2504.7] = 17.9$	$p < .001$
		Region	$F[2, 42.7] = 5.0$	$p = .01$
		Suffix vowel * Region	$F[6, 465.6] = 17.7$	$p < .001$

Table 3.2: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the four mixed models (3.2) carried out separately for stem /e/ and stem /o/ vowels with the PC-scores s_1 and s_3 as the dependent variables.

As Tab. 3.2 shows, there were significant interactions between the fixed factors for all four LMER models. For this reason, I will discuss the post-hoc tests associated with the models, comparing the influence of each suffix vowel on the stem vowel.

[1]Some green data points – representing non-metaphonic stem vowels – in Figs. 3.3 and 3.4 actually overlap the area where most mauve points – representing the metaphonic stem vowels – are grouped together, and vice versa. This fact suggests that some speakers or some lexical items might represent an exception to the usual metaphonic patterns. The Appendix F zooms in on this aspect.

Stem /e/ and s_1

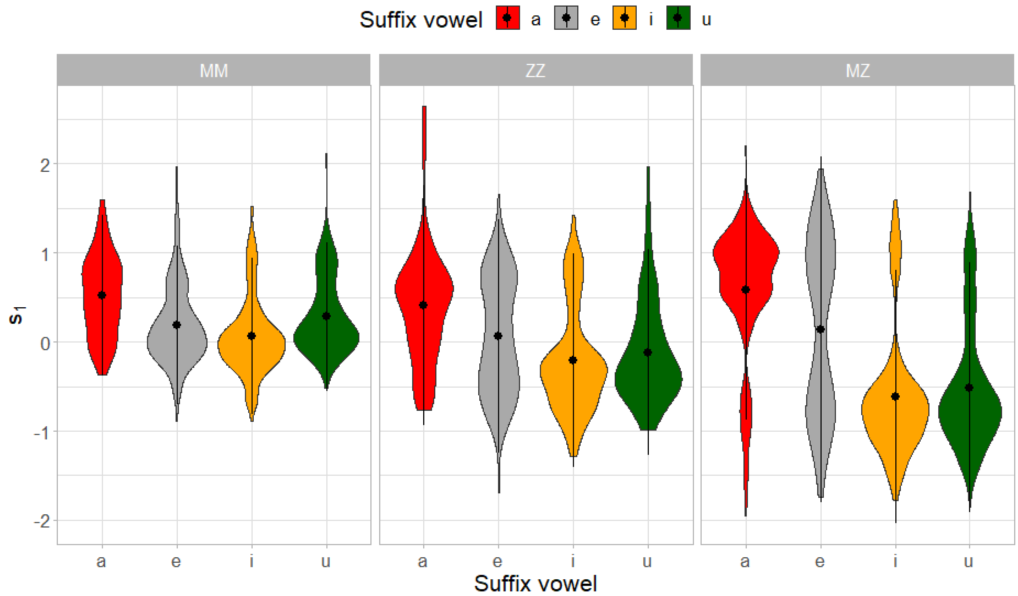

Figure 3.5: Violin plots of the s_1 PC-scores for the stem vowel /e/ shown separately by region and suffix vowel. The mean for each distribution is indicated by a black dot.

The violin plots in Fig. 3.5 show the distribution of s_1 values and their mean for stem-/e/ vowel tokens, separately by suffix vowel and region. These plots suggest that not only did the influence of suffix vowels vary according to region, but also each suffix vowel had its own influence on the s_1 values. By observing Fig. 3.5, and given that a decrease in s_1 was shown to be associated with an increase in phonetic height, it is evident that the stem vowels were not only raised in the context of the high suffix vowels /i, u/ – i.e. those suffixes that are supposed to trigger metaphony – but also lowered in the context of the low suffix vowel /a/[2]. In spite of some exceptions, however, it is generally clearly visible from the plots that the variation of the s_1 values was mainly linked to suffix vowel height and region, since the differentiated influence of each suffix vowel on s_1 was notably least marked for MM, greatest for MZ, and present to an intermediate extent between the two for ZZ.

The results of the post-hoc Tukey tests were consistent with these observations. Tab. 3.3 shows the mean contrasts (m) between s_1 values in different suffix vowel contexts. With the only exceptions of the /e, u/-suffix contrasts in both MM and ZZ, all other contrasts were significant for the three regions ($p < .05$, see Tab. 3.3 for details). However, we can also notice that the mean contrasts (m) were always greatest in MZ, the least in MM,

[2]The suffix vowel /e/ (see Fig. 3.5, grey plots) influenced the stem vowel in an apparently contradictory way, since it is observable from the plots that, for the MZ and ZZ regions in particular, around one half of the s_1 values in the suffix-/e/ context overlap the s_1 values in the suffix-/a/ context and the other half overlap the values in the suffix-/i, u/ (i.e. metaphonic) contexts (see Appendix F.3 for further discussion)

and intermediate between the two in ZZ. The t-ratios (t in Tab. 3.3) also confirmed this tendency.

Stem /o/ and s_1

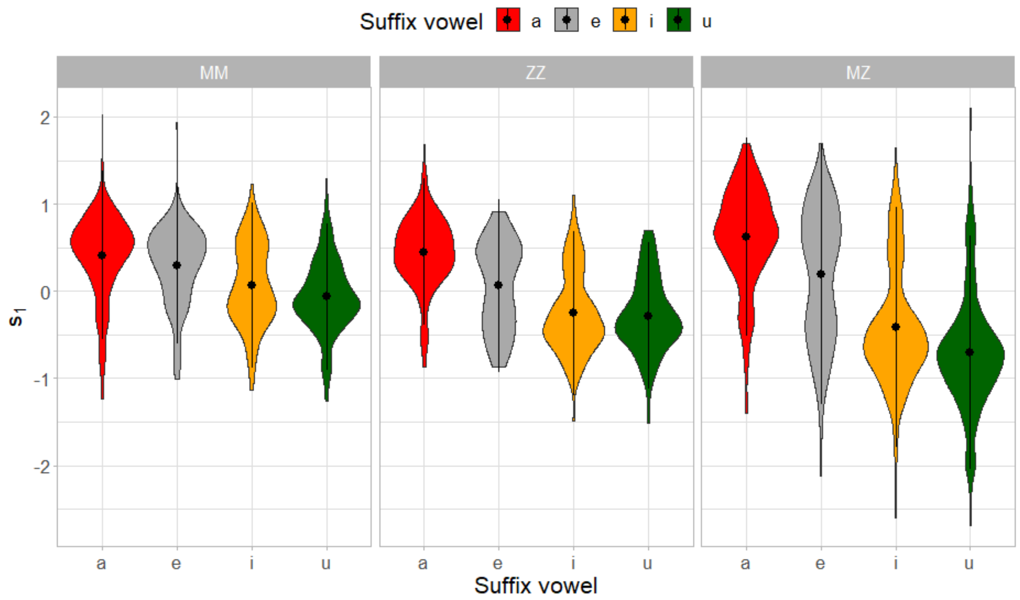

Figure 3.6: Violin plots of the s_1 PC-scores for the stem vowel /o/ shown separately by region and suffix vowel. The mean for each distribution is indicated by a black dot.

The violin plots for s_1 values in the /o/ stem vowel in Fig. 3.6 show, analogously to Fig. 3.5 regarding stem /e/, an influence of suffix vowel quality on s_1 in the different suffix vowel contexts that was greatest for MZ, least for MM, and halfway between the two (although possibly nearer to MM) for ZZ. As regards suffix /e/, the overlapping values with the metaphonic suffixes /i, u/ was reduced for stem /o/ when compared to the values shown in the analogous plot for stem /e/ (see Fig. 3.5). However, it can also be pointed out that the influence of each suffix vowel was, overall, visibly clearer for stem /o/ than for stem /e/, especially as regards the regions MM and ZZ (noticeable by a more visible progressive decrease of s_1 values in the suffix order /a, e, i, u/).

Analogously to the s_1 of /e/ stem vowels, the post-hoc Tukey tests also confirmed the statistical significance of such differences for /o/ stems. It is evident from Tab. 3.3 that the stem vowels were not only significantly raised in the context of the high suffix vowels /i, u/, but also significantly lowered in the context of the low suffix vowel /a/ (see Tab. 3.3 for details). Overall, MM was the region that showed the least metaphonic effects, which were however significant ($p < .05$ in all cases, see also Tab. 3.3; only the contrast between suffix /e/ and suffix /a/ was non-significant). MZ showed the highest suffix-dependent effects on s_1 (see also noticeably higher m and t absolute values for MZ in Tab. 3.3 compared to those for the other regions) highly significant contrasts in all cases ($p < .001$, see also

Tab. 3.3). ZZ did not show any significant contrast only between the suffixes /e, u/ and /e, i/, while all other contrasts were significant ($p < .001$; see Tab. 3.3 for further details).

Stem /e/ and s_3

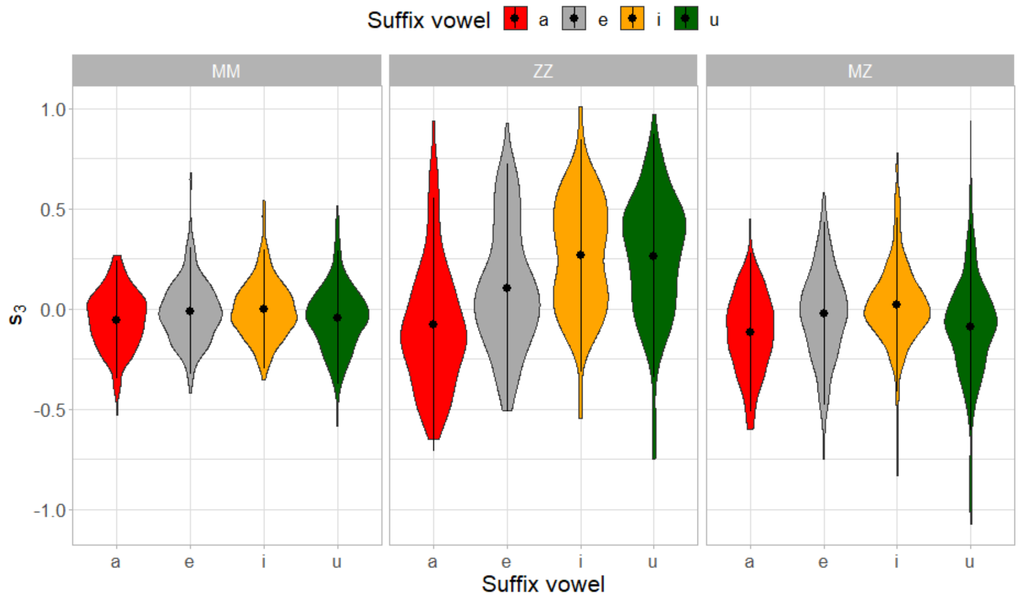

Figure 3.7: Violin plots of the s_3 PC-scores for stem /e/ vowels shown separately by region and suffix vowel. The mean for each distribution is indicated by a black dot.

Fig. 3.7 shows that the metaphonic influence on s_3 was greatest for ZZ, absent for MM, and marginal for MZ. In particular, s_3 values tended to increase in ZZ in a metaphonic context, i.e. when the stem vowel precedes a /i, u/ suffix, and only to a minor extent in front of an /e/ suffix. As discussed in Section 3.3.1, a raising of s_3 corresponds to a progressive curvature of the formant pairs so as to resemble to an opening diphthong such as /jɛ/ or /ie/.

Compatibly, the results of the post-hoc Tukey tests listed in Tab. 3.4 showed a significant influence of the suffixes /i, u/ on s_3 for ZZ (all contrasts between either suffix /i/ or /u/ and other non-metaphonic suffixes /a, e/ were significant, see Tab. 3.4 for details), and a significant influence for MZ as regards the /a, u/-suffix contrast only ($t_{2403} = 2.7$, $p < .05$). There were no significant influences of the suffix vowels on s_3 for MM.

Stem /o/ and s_3

Fig. 3.8 shows an influence of the suffix vowel on s_3 primarily for the region ZZ only, and more so in the context of /i, u/ vowel suffixes. As discussed in Section 3.3.1, a raising of s_3 in /o/ stems corresponds to a progressive curvature of the formant pairs so as to resemble to an opening diphthong such as /wɔ/ or /uo/.

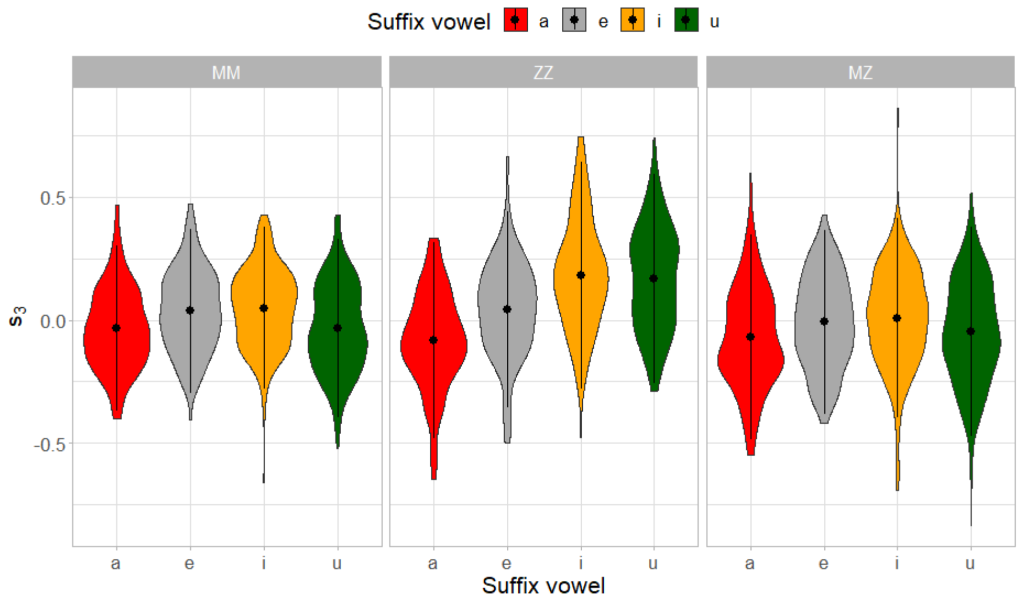

Figure 3.8: Violin plots of the s_3 PC-scores for stem /o/ vowels shown separately by region and suffix vowel. The mean for each distribution is indicated by a black dot.

The significance of these results was confirmed by the post-hoc Tukey tests shown in Tab. 3.4 ($p < .05$ for all significant contrasts). Only the contrast between the suffixes /e, i/ was non-significant. Also, there were no statistically significant metaphonic influences on s_3 for regions other than ZZ (see Tab. 3.4 for details).

Summary and comparison between regions

Comparing results related to PC-scores for both stem vowels between regions, in MM both stem vowels showed significantly lower s_1 values (i.e. a vowel raising) in the contexts of the suffixes /i, u/ compared to suffix /a/, while for stem /e/ only there was no contrast between the suffixes /e, u/, and no contrast, too, for stem /o/ only between the suffixes /e, a/ (see Tab. 3.3 for details). For ZZ, 4 out of 5 suffix vowel pairs caused significant differences in s_1 for the stem vowel /e/ and 3 out of 5 for stem /o/ (see Tab. 3.3). As far as the exceptions are concerned, the difference between suffixes /e, u/ was non-significant for both stem vowels, and the differences between suffixes /e, i/ had no influence on s_1 of stem /o/ (see Tab. 3.3 for further details). For MZ, all suffix vowel pairs caused significant contrasts for both stem vowels (see Tab. 3.3). Most importantly, in all cases in which both MZ and ZZ showed significant contrasts for a given stem vowel pair, the absolute values of the mean difference (m, see Tab. 3.3, fourth column) was greater for MZ than for ZZ. In turn, the size of the mean difference was greater for ZZ than for MM in those cases in which a suffix vowel pair caused significant effects on the stem vowel for both villages. As regards s_3, Tab. 3.4 clearly shows that this PC-score was significantly higher only for ZZ in suffix pairs in which the second element was a metaphonic suffix /i, u/, with the only exceptions being stem /e/ and suffix pair /a, u/, and suffix pair /e, a/ for both stem vowels.

Tab. 3.5 lists the post-hoc Tukey tests showing contrasts between regions embracing both stem vowels and PC-scores and all suffixes. The results confirmed that the greatest difference in coarticulatory influence was between the regions MM and MZ, while the contrast between MM and ZZ and between MZ and ZZ was not always statistically significant for s_1, while it was always significant for s_3 before the metaphonic suffix vowels /i, u/ ($p < .05$ in all cases, see Tab. 3.5 for further details). This fact confirms not only that the influence of the suffix on the stem vowel was at an intermediate level in ZZ between MM and MZ as regards vowel raising/lowering (expressed by PC1 and quantified by s_1), but it was also (and mainly) marked by changes in diphthongal quality of the stem vowel (expressed by PC3 and quantified by s_3) when the coarticulatory vowel change was triggered by the metaphonic suffixes /i, u/ (see also Tabs. 3.3, 3.4, and 3.5).

Suffix vowels	**Stem vowel**	**Region**	***m***	***SE***	***df***	***t***	**Sig.**
a – i	/e/	MM	0.27	0.05	1477	5.0	***
		ZZ	0.52	0.07	687	7.0	***
		MZ	1.13	0.05	2639	22.2	***
	/o/	MM	0.29	0.05	821	5.7	***
		ZZ	0.61	0.06	215	9.2	***
		MZ	1.01	0.05	2240	20.5	***
a – u	/e/	MM	0.20	0.05	1556	3.8	***
		ZZ	0.46	0.07	829	6.1	***
		MZ	1.10	0.05	2652	23.4	***
	/o/	MM	0.42	0.04	2138	9.7	***
		ZZ	0.63	0.06	859	10.7	***
		MZ	1.22	0.04	2528	31.6	***
e – i	/e/	MM	0.14	0.04	1809	3.1	**
		ZZ	0.24	0.06	1315	4.0	***
		MZ	0.73	0.04	2656	17.7	***
	/o/	MM	0.16	0.05	1527	3.0	*
		MZ	0.33	0.05	2465	6.4	***
e – u	/e/	MZ	0.71	0.04	2646	15.3	***
	/o/	MM	0.28	0.05	684	4.9	***
		MZ	0.54	0.06	2080	9.3	***
e – a	/e/	MM	- 0.13	0.05	2342	-2.6	*
		ZZ	- 0.28	0.07	1580	-4.1	***
		MZ	- 0.39	0.04	2656	-8.4	***
	/o/	ZZ	- 0.45	0.07	281	- 6.2	***
		MZ	- 0.68	0.06	2114	-11.9	***

Table 3.3: The estimated mean (m) and standard error (SE) of the statistically significant s_1 contrasts between two given suffix vowel contexts, separately for stem vowel and region, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Suffix vowels	Stem vowel	Region	m	SE	df	t	Sig.
a – i	/e/	ZZ	-0.19	0.03	2480	-6.9	***
	/o/	ZZ	-0.16	0.02	1379	-7.1	***
a – u	/e/	ZZ	-0.24	0.03	2504	-8.6	***
		MZ	0.04	0.01	2403	2.7	*
	/o/	ZZ	-0.19	0.02	2298	-10.2	***
e – i	/e/	ZZ	-0.11	0.02	2597	-4.9	***
e – u	/e/	ZZ	-0.16	0.03	2526	-5.8	***
	/o/	ZZ	-0.07	0.02	1214	-2.7	*
e – a	/e/	ZZ	0.08	0.02	2644	-3.3	**
	/o/	ZZ	0.12	0.02	1330	4.9	***

Table 3.4: The estimated mean (m) and standard error (SE) of the statistically significant s_3 contrasts between two given suffix vowel contexts, separately for stem vowel and region, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Stem vowel	PC-score	Suffix vowel	Regions	m	SE	df	t	Sig.
/e/	s_1	e	MM – ZZ	0.23	0.09	78.1	2.4	*
		u	MM – ZZ	0.34	0.09	76.3	3.6	***
			MM – MZ	0.79	0.11	55.0	7.0	***
			ZZ – MZ	0.46	0.13	56.5	3.5	**
		i	MM – ZZ	0.34	0.09	66.1	3.7	***
			MM – MZ	0.75	0.11	53.0	6.7	***
			ZZ – MZ	0.41	0.13	52.4	3.2	**
	s_3	u	MM – ZZ	-0.24	0.06	67.2	-3.8	***
			ZZ – MZ	0.29	0.06	67.0	4.8	***
		i	MM – ZZ	-0.17	0.06	63.7	-2.8	*
			ZZ – MZ	0.18	0.06	63.8	3.1	**
/o/	s_1	e	MM – ZZ	0.35	0.10	65.5	3.4	**
			MM – MZ	0.30	0.11	86.0	2.8	**
		a	MM – MZ	-0.24	0.10	65.2	-2.4	*
			ZZ – MZ	-0.28	0.10	71.4	-2.7	*
		u	MM – ZZ	0.26	0.09	50.8	2.8	*
			MM – MZ	0.56	0.09	61.2	5.7	***
			ZZ – MZ	0.31	0.10	67.1	3.0	**
		i	MM – ZZ	0.35	0.09	54.7	3.7	***
			MM – MZ	0.47	0.10	68.7	4.6	***
	s_3	e	ZZ – MZ	0.11	0.04	82.1	2.9	**
		u	MM – ZZ	-0.16	0.03	74.3	-5.7	***
			ZZ – MZ	0.15	0.03	56.7	4.3	***
		i	MM – ZZ	-0.10	0.03	82.4	-3.5	**
			ZZ – MZ	0.15	0.03	63.3	4.2	***

Table 3.5: The estimated mean (m) and standard error (SE) of the statistically significant s_1 and s_3 contrasts between regions, separately for stem vowel and suffix vowel, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Discussion

The results confirmed the presence of coarticulatory influences on stem vowels. The pattern of these influences was quite similar for stem vowel /e/ and for stem vowel /o/. For s_1, and where ">" denotes a greater metaphonic influence of the suffix vowel on the stem vowel, the strength of this influence is by region MZ > ZZ > MM. Taking the findings in Section 3.3.1 into account, the results discussed in this section show that metaphony had a progressively greater influence on the phonetic height of the stem vowel. Significant metaphonic effects on s_3 were mainly present in ZZ. Based again on Section 3.3.1, these results show that the difference between the metaphonic contexts in ZZ was one of opening diphthongisation in the stem vowel. For stem /o/ (for both s_1 and s_3), the metaphonic influence was greater when the metaphonic suffix was a back /u/ compared to a front /i/. As regards the degree of metaphonic influence between the suffixes /i, u/ for stem /e/, a minor difference was detectable for s_1 in the MM and ZZ regions, in which, overall, the suffix /i/ had a slightly greater influence on the stem /e/ compared to the suffix /u/, as also visible in the violin plots in Figs. 3.5 and 3.6.

Another most important observation is that not only did high suffixes influence stem vowel quality, the low suffix /a/ also visibly influenced s_1 values in the direction of a stem vowel lowering. This important aspect throws doubt on the traditional idea of metaphony as a mere vowel raising caused by high vowels, as so far always discussed in the literature on the dialects of the Lausberg area (see Section 1.1.3). The phenomenon seems indeed to be more complex and clearly shows coarticulatory premises, since, in these results, there was a general anticipatory assimilation of suffix vowel height onto the stem vowel.

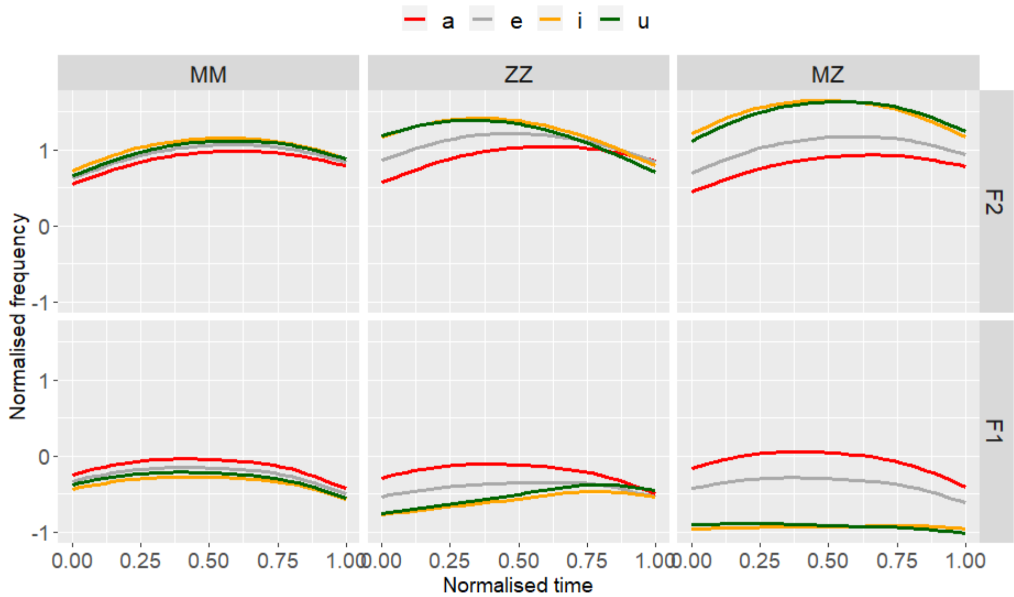

Figure 3.9: Reconstructed formant trajectories from the estimated marginal means (see Section 3.2.4 for details) for /e/ stems in the context of the four suffix vowels shown separately by region.

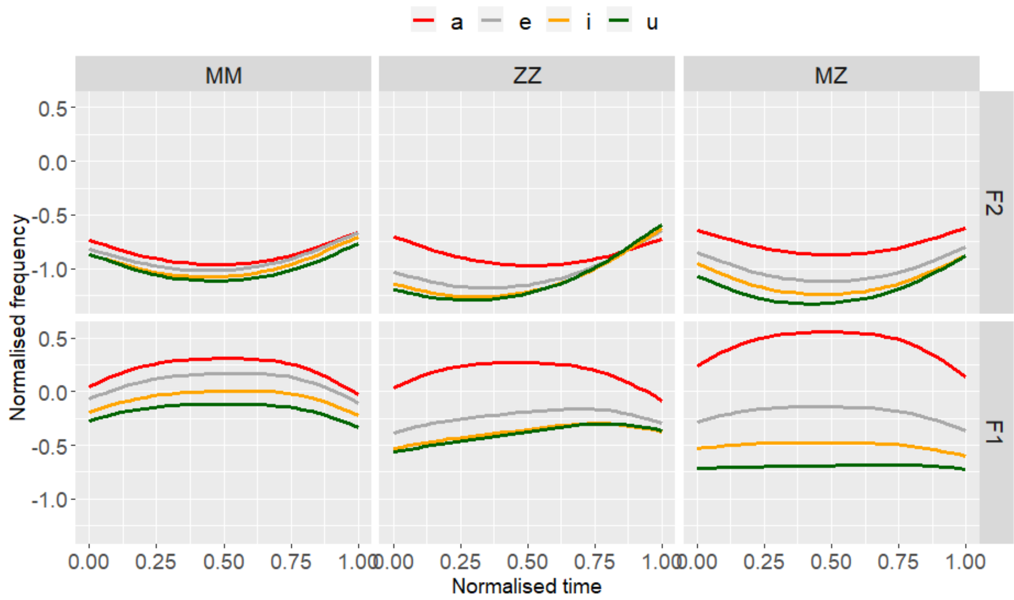

Figure 3.10: Reconstructed formant trajectories from the estimated marginal means (see Section 3.2.4 for details) for /o/ stems in the context of the four suffix vowels shown separately by region.

In order to shed further light on the phonetic interpretation of the PC-scores, formant trajectories were reconstructed by region and by suffix from the estimated marginal means associated with s_1 and s_3 following the procedure described in Section 3.2.4 and once again separately for stem-/e/ and stem-/o/ vowels (Figs. 3.9 and 3.10 respectively). The results of these reconstructions confirm that the size of the suffix influence on the stem vowel was greatest for MZ, least for MM and in between the two for ZZ.

High vowels are characterised acoustically by a low F1 (Fant, 1960). Thus, a greater influence of the suffix /i, u/ should be manifested by a lower F1 in the stem vowel. As both Figs. 3.9 and 3.10 show, F1 frequencies of the stem vowels in /i, u/ suffix contexts (the yellow and green lines respectively) were lowest for MZ, highest for MM, and intermediate between the two for ZZ. Acoustically, /i/ is also characterised by a high F2 i.e. by a broad separation in frequency between F1 and F2. The progressively greater influence of suffix /i/ from MM to ZZ to MZ was also manifested by a higher F2 and a wider separation between the formants across these regions in stem /e/ (but not in stem /o/).

Suffix /u/ caused a similar progressive F2 influence on stem /e/ vowels i.e. F2 was also higher (and F1 and F2 were further apart) from MM to ZZ to MZ. Given that suffix /u/ is a back vowel, from a mere coarticulatory point of view it should have induced F2 lowering in the stem vowel, not raising. The metaphonic influence of suffix /u/ is therefore primarily one of phonetic height and not of backness or frontness, i.e. stem /e/ was raised in an /u/ context just as it was in an /i/ context but – from the acoustic perspective in the absence of physiological evidence – without the tongue being retracted. This observation is consistent with previous studies on metaphony in the Lausberg area (e.g. Lausberg, 1939, Rensch, 1964, Romito et al., 2006).

The diphthongal aspect of metaphony in ZZ comes about as, for ZZ, the suffix influence was much greater in the first than in the second half of the vowel. Taking into account the evidence discussed above, relating to the fact that the influence of the suffix on the stem vowel for ZZ was intermediate between that of the other two regions, it follows that the transition from MM (hardly any metaphonic influence) to MZ (a considerable metaphonic influence) is likely to pass through an intermediate stage represented by ZZ, in which the influence of the suffix was manifested predominantly in the first part of the stem vowel (see Section 3.4). The EMMs-reconstructed F1 and F2 trajectories for the ZZ region show, for stem /e/ (Fig. 3.9, mid panels), a broader distance between the two formants in the first part of the trajectories that decreases after the temporal midpoint, especially so in the context of suffix /i/. A raised F2 and the greater distance from F1 in the first part of the trajectory are consistent phonetically with an opening diphthong such as /ie/ or /jɛ/. For stem /o/ (Fig. 3.10, mid panels), F1 and F2 have lower frequencies in the first part of the diphthong (more or less up to the temporal midpoint) than the second, especially so in the context of the suffix /u/ context and marginally so preceding the suffix /i/ context. A lowered F1 and F2 in the first relative to the second part of the trajectory are also consistent with an opening diphthong in which the first component is phonetically higher (i.e. with F1 and F2 lower) than the second, thus /uo/ or /wɔ/.

The traditional label of "non-metaphonic" for suffix /a/ is clearly inappropriate because of its marked influence on stem vowels. As Figs. 3.9 and 3.10 show, F1 trajectories in the context of /a/ were raised relative to those of the other suffixes. This is likely to be due to the greater mouth opening/jaw lowering that is characteristic of open vowels such as /a/ (Edwards, Beckman, and Fletcher, 1991; Lindblom and Sundberg, 1971) and that was induced anticipatorily in the stem vowels by suffix /a/. Figs. 3.9 and 3.10 also show that the F1 difference between /a/ and the other contexts was greatest for MZ. It is possible that the cues to the suffix vowel that are marginally evident in MM have been phonologised and further enhanced in MZ, leading to an even greater separation between stem vowels in /a/ and other suffix contexts. The presence of cue enhancement mechanisms as a consequence of phonologisation has been demonstrated for many other types of sound change in different languages (Beddor et al., 2007; Hyman, 2013; Kirby, 2014; Solé, 1992, 1995, 2007; see also Chapter 6 for further discussion on this topic).

3.4 Discussion

The analysis outlined in this chapter has shown that metaphony – by which the phonetic quality of V_1 is shaped by V_2 in a following suffix – is established to different degrees in the Lausberg area. The acoustic analysis showed that these metaphonic influences were least in the village of Mormanno (MM), marked to the greatest extent in a cluster of villages from the so-called Mittelzone (MZ), and showed a degree of influence that was intermediate between MM and MZ in another group of villages from the Zwischenzone (ZZ). The main influence of metaphony in the context of the suffix /i, u/ was a raising of the stem vowel such that the degree of raising was least in MM, intermediate in ZZ, and greatest in MZ. For MM and MZ, this stem vowel raising was manifested throughout the vowel: that is, there was more or less a uniform raising between the stem vowel acoustic onset to offset (but to a much greater degree for MZ than for MM). For ZZ, by contrast, the raising was confined predominantly to the first half of the vowel. As only the first, but not the second part of the vowel was raised in ZZ, the stem vowels for ZZ in a high vowel suffix context had a diphthongal quality i.e. [ie] (or [jɛ]) for stem /e/; and [uo] (or [wɔ]) for stem /o/. Metaphony was found to be conditioned not just by high vowels, but more generally by phonetic height. This is because the low vowel /a/ suffix induced lowering in the stem vowel more than /e/-suffixes did, i.e. in the opposite direction of the phonetic raising induced by the high vowel /i, u/ suffixes – an aspect which has not been paid any particular attention so far in the previous literature on the Lausberg area. There was very little evidence from these data that the stem vowel was influenced by whether the suffix was a front or back vowel.

Overall, these results are consistent with the hypothesis (discussed in Section 1.1.4 and referred to again in Section 3.1) that there are three types of coarticulatory influence that might represent three stages of the diachronic progression of metaphony. Firstly, there is a phonetic raising of stem vowels /e, o/ preceding suffixes /i, u/. Secondly, these phonetically raised vowels are presumably diphthongised such that the further raising only occurs in the first part of the stem vowel. Thirdly, monophthongisation takes place as a result of either the raising, or possibly the deletion, of the second component of the diphthong. The phonetic change from simple raising to diphthongisation (i.e. from the metaphony type found in Mormanno to that in the Zwischenzone) was hypothesised by Lausberg (1947); Lüdtke (1956, p. 92) and more recently by Barbato (2008). In addition, the phonetic change from diphthongisation to the reduction of the second element of the diphthong into a monophthong was also initially advanced by Lausberg (1939), and then also proposed decades later, first by Rensch (1964), Castellani (1973), subsequently by Martino (1991), Trumper (1997), and more recently by Romito et al. (2006) and again by Barbato (2008). Generalising on the basis of my analysis, in addition to the previous studies, the proposed diachronic progression in the stem vowel of metaphony is the following:

(i) [ɛ, e] → [e̝]; [ɔ, o] → [o̝]

(ii) [e̝] → [je̝, ie̝]; [o̝] → [wo̝, uo̝]

(iii) [je̝, ie̝] → [i], [wo̝, uo̝] → [u]

The results discussed in this chapter suggest that regions within the Lausberg area represent different fossilised stages in the diachronic advancement of this sound change, with Mormanno (MM), the Zwischenzone (ZZ), and the Mittelzone (MM) showing metaphonic patterns that correspond to these three diachronic stages of raising, diphthongisation, and monophthongisation respectively.

A further aim of this analysis was to link coarticulatory/metaphonic vowel shifts to their phonological abstract categorisations by means of extractions of Principal Components. Cronenberg, Gubian, Harrington, and Ruch (2020) argued that individuals apply a type of transformation analogous to FPCA to remembered speech signals in order to identify both the underlying time-varying shapes of a phonological category and the principal variation in these shapes across the words, speakers and the contexts in which they occur. This knowledge about underlying time-varying shapes occupies a space between remembered speech episodes and their phonological categorisation and is coherent with several episodic models of speech, in which phonological categories are extracted and stand in a stochastic relationship with remembered speech signals (Johnson, 1997; Pierrehumbert, 2003, 2006). As far as my data are concerned, it is important to recognise that the type of information represented by PCs in Figs. 3.1 and 3.2 is an abstract generalisation of the dynamic shapes and their variation across the three regions analysed. It can therefore be posited that, in order to produce a stem vowel, an individual might sample from a distribution of the kind shown in Figs. 3.3 and 3.4, in which each data point represents a remembered speech signal, and then convert these points into a physical phonetic representation corresponding to time-varying formant frequencies. The information provided by FPCA is therefore at once both abstract and physical, and this is why it provides an appropriate link between abstract phonological categories and time-varying speech signals.

Beyond these theoretical aspects, and from a methodological point of view, this analysis is novel in nature due to the application of FPCA to analyse metaphony. There are several practical advantages to using FPCA for quantifying synchronic variation and its relationship to diachronic change. So far, the acoustic analyses of metaphony have mainly been based on selected points within the vowel duration (see e.g. Grimaldi and Calabrese, 2018; Romito and Gagliardi, 2009; Romito et al., 2006). Because FPCA processes time-varying signals between two temporally defined landmarks (in this case the acoustic onset and offset of the stem vowel), quantifying speech sounds acoustically using specific time-points in the vowel duration – thus making it difficult to account for glide-vowel transitions and diphthongs – is not only no longer necessary (Gubian, Harrington, Stevens, Schiel, & Warren, 2019), but also not as effective as a dynamic analysis such as FPCA. Because FPCA provides a composite analysis of multidimensional time-varying trajectories, synchronic variation and inferences about diachronic change can be understood in terms of how all signals (in this case both formants) change together. Finally, categorical differences emerge from (and are not superimposed upon) time-varying signals using FPCA. In this analysis, both the differences between the three regions (as well as the progression between them as far as the strength of the metaphonic effects were concerned) and the identification of diphthongisation as an intermediary sound change between stem vowel raising (in MM) and its magnification (in MZ) emerged from the analysis, and in a parallel and analogue way between the two vowel stems, even though FPCA was blind to any such categorical differences.

While the differences between metaphonic realisations have been analysed, it is still not clear whether the change in the stem vowel quality triggered by the suffix vowel is purely allophonic and of a coarticulatory nature (e.g. in MM), or if it is instead fully phonologised (if not lexicalised) in at least some of the regions (such as in MZ). In order to cast some light on this aspect, it is necessary to enrich the study of metaphony with an analysis of the phonetic nature of the suffix vowels in question. As regards the Lausberg area, no acoustic accounts of suffix vowels are present in the literature, while this aspect is indeed important given the clear coarticulatory premises of metaphony which have been analysed in Chapters 2 and 3. In particular, in order to find an answer to the phonologisation question, it is important to clarify whether the suffix vowels are phonetically fully realised or rather reduced, neutralised or even elided. A full neutralisation or elision of suffixes acts namely as the main signal that the raising or lowering of the stem vowel should not be considered to be purely coarticulatory but rather to be a fossilised residue of an assimilatory process. The preservation of the suffix vowel quality in the suffix would instead mean that the coarticulatory process – by definition more markedly phonetic rather than morpho-phonological – at the basis of metaphony is still active. In the next chapter, the role of suffix reduction and elision is analysed so as to shed further light on the degree of phonologisation of metaphony in the three regions detected within the Lausberg area.

Chapter 4

Suffix reduction and elision

4.1 Introduction

The co-occurrence of vowel harmony phenomena – either progressive or regressive ones, such as metaphony – and vowel reduction processes in different languages has been the subject of several phonological accounts over the course of the last decades (e.g. Barnes, 2006, p. 193, and his "reduction-then-assimilation hypothesis"; see also Delucchi, 2011, 2012; Hyman, 2002, and the literature review on this topic in Section 1.1.2). In Southern Italian varieties, metaphony phenomena usually coexist with the general tendency to reduce final vowel suffixes, or even to completely elide them (Bucci et al., 2019; Delucchi et al., 2012; Lausberg, 1939; Rohlfs, 1966; Romano, 2020; Russo & Barry, 2004). As discussed in Section 1.1.2, some phonological accounts suggest that the loss of morpho-lexical informativity of the suffix vowel, due to the neutralisation of suffix vowel quality or to its elision, can result in the enhancement of a sound change originating from phonetic premises such as metaphony (Maiden, 1991), due to a mechanism of cue shift (Krämer, 2009, p. 123; Torres-Tamarit and Linke, 2016) or cue trading (Beddor, 2009; Repp, 1982, 1983). The hypothesis of a possible direct causal connection between metaphony and suffix reduction or elision has so far remained only speculative, since it is still not clear how a phonological change can be achieved and maintained in spite of a lenition or deletion of the trigger of the same sound change (Beddor, 2009, 2012; Harrington et al., 2019b; Kiparsky, 2015; Kirby, 2014).

As regards specifically the Lausberg area, the amount of suffix reduction and/or deletion has not yet undergone any acoustic or perceptual analysis, apart from some general auditory observations by Lausberg (1939, p. 75, 86–88), Rensch (1964, p. 69–72), having already

Parts of this chapter were included in a manuscript submitted for publication (Greca et al., 2022).

described the presence of unstressed vowel reduction and deletion in some villages, as well as, more recently, by Canalis (2009, p. 82, 83). Also, Martino (1991, p. 49) interestingly observed that suffix vowel neutralisation and elision as attested for Basilicata appears to be expanding from the Ionic coast in the east to the Tyrrhenian coast in the west (see also Lüdtke, 1979, p. 46) and from there further expanding to southern dialects in Calabria. These observations suggest therefore that the phonetic status of word-final vowels might have evolved from the situation described in the very first accounts by e.g. Lausberg (1939) and Rensch (1964).

This chapter reports the acoustic analysis of suffix vowel reduction and elision in our 35 speakers from the three identified regions within the Lausberg area, by taking both metaphonic and non-metaphonic contexts into account. The aim is to test if there is some form of correlation between degree of coarticulation/metaphony and suffix vowel reduction/elision, as well as to establish whether there is more or less suffix reduction or elision in those regions in which there was more or less metaphony (clear evidence of metaphonic differences between regions was provided by the acoustic analysis reported in Chapter 3).

4.2 Method

This chapter is based on two different analyses, one regarding suffix elision and the other one regarding the degree of suffix reduction in those cases in which the suffix has not been elided. The lexical items considered for analysis coincide with those analysed in Chapter 3 (see Section 3.2.2 for details), with the only obvious difference being that the analyses presented in this chapter focus on suffix vowels and not on the stem vowels of the same lexical items.

4.2.1 Suffix elision

Suffix elision (or "deletion") was negatively annotated by deleting the automatically inserted word-final vowel segment label during the semi-automatic annotation process described in Section 1.3.4. This was done in those cases in which, upon audiovisual inspection of the spectrogram, there was neither a visibly detectable formant structure (regardless of the presence of f_0, i.e. voiceless vowels were considered for this analysis as phonetically realised suffixes) nor an acoustically perceivable suffix vowel at the end of the uttered word. Across a total of 5372 tokens analysed (i.e. lexical items having either an /e/ or /o/ stem vowel), 696 words presented suffix elision ($n = 353$ elided suffixes for lexical items with an /e/ stem, $n = 343$ elided suffixes for lexical items with an /o/ stem).

4.2.2 Suffix reduction

For those suffixes that were phonetically realised (n = 4676, n = 2399 for stem /e/ and n = 2277 for stem /o/), a *reduction index* (henceforth r) was calculated in order to quantify the degree of vowel reduction. The calculations were run on Lobanov-normalised F1 and F2 values (following the procedure described in Section 1.3.4, Eq. (1.1)) aggregated across time points per suffix vowel (rather than e.g. on the suffix vowels' temporal midpoints, because of the particularly short duration of some suffix vowels), and were done separately by speaker for each suffix vowel token. r was calculated with Eq. (4.1):

$$r = \log\left(\frac{d}{m}\right) \tag{4.1}$$

in which 'd' is the Euclidean distance of any suffix vowel token to the same (suffix-)vowel's category centroid for the same speaker. For instance, for a specific /i/ suffix vowel token produced by a given speaker, d is the Euclidean distance from that /i/ vowel token to the mean of Lobanov-normalised F1 and to the mean of Lobanov-normalised F2 of all unstressed /i/ vowels produced by the same speaker.

'm' is the mean of the Euclidean distances to the other vowels' category centroids for the same speaker. Thus, for the same /i/ token, a calculation is made of the Euclidean distance to the /e/-centroid, to the /a/-centroid, to the /u/-centroid, and then these three distances are aggregated by their mean.

A small d value in Eq. (4.1) shows that the within-category variance i.e. dispersion of the vowels is low: that is, the tokens of a given vowel category are tightly clustered around the mean. On the other hand, a large value of d shows a high dispersion of the vowels in question, and means that they are not concentrated around the mean of their own vowel category.

If the m value in Eq. (4.1) is large, then the vowel categories tend not to overlap, since the inter-Euclidean distances between them are large. For example, the distance of an /i/ token to the centroids of /e, a, u/ is possibly very large if the four categories are separated enough (or are so far apart as) to not overlap. Thus, high values of m correspond to separation between the vowel categories whereas if m is low, then the vowel categories tend to overlap. Consequently, the ratio d/m has a low value if the suffix vowel categories are separated, but a larger value if the vowel categories overlap.

If $r = 0$ in Eq. (4.1), then a given vowel token is positioned just as close to its own category centroid as to the (average) centroids of the other three categories, i.e., that vowel is likely to have a reduced, /ə/-like quality. Thus, lower r values signal less suffix vowel reduction, higher r values signal higher suffix vowel reduction.

Suffix vowel tokens

Tab. 4.1 shows in detail the number of suffix vowel tokens analysed in this chapter (also including the number of elided ones), separately by region, stem vowel of the lexical items to which the suffixes in question were attached, and suffix vowel type.

Stem vowel	Region	Suffix vowel	N. of tokens	
			Elided	Realised
/e/	MM	a	6	180
		e	8	236
		i	14	305
		u	17	257
	ZZ	a	4	93
		e	6	119
		i	15	145
		u	11	111
	MZ	a	62	160
		e	56	228
		i	78	295
		u	76	270
/o/	MM	a	6	251
		e	7	171
		i	13	222
		u	12	280
	ZZ	a	8	124
		e	11	74
		i	24	98
		u	23	122
	MZ	a	66	251
		e	36	145
		i	64	235
		u	73	304

Table 4.1: Count of the suffix vowels that were analysed in this chapter by region, stem vowel, and suffix vowel type.

4.2.3 Statistical analysis

For the statistical models described below, all possible interactions between the fixed factors were tested, while the random factors originally included intercepts and all possible slopes to measure the interaction between the fixed and random factors; these were dropped if they were detected as non-significant by using the function *step* of the package `lmerTest` (version 3.1.3) in the R environment.

Elision of the suffix vowel was modelled with a logistic generalised linear mixed model (GLMM). The model (adopting R formula notation) was of the form:

$$\begin{aligned} \text{Elision} \sim \text{Region} + \text{Suffix vowel} + \text{Stem vowel} + \\ \text{Region} * \text{Suffix vowel} + \text{Region} * \text{Stem vowel} + \\ (1|\text{Stem}) + (0 + \text{Region}|\text{Stem}) + (1|\text{Speaker}) \end{aligned} \tag{4.2}$$

The dependent variable *Elision* (of the suffix vowel) was binary (two levels: true or false), *Region* had three levels (MM, ZZ, and MZ), *Stem vowel* had two levels (/e/, /o/), and *Suffix vowel* had four levels (/a, e, i, u/). These three fixed factors were considered in isolation, with the only exception being the factor *Region*, which interacted separately with *Suffix vowel* and *Stem vowel* respectively. The *Stem* random factor comprised a total of 55 lexical stems, which were the same involved in the analysis described in Chapter 3 (see Section 3.2.2 for details). This factor was modelled both as a random intercept and also with slope in *Region*, while the correlation between intercept and slope was excluded (this is why the model (4.2) indicates *(0 + Region|Stem)* and not just *(Region|Stem)*). The *Speaker* random factor, which was modelled as an intercept, included all usual 35 speakers. The GLMM was computed by means of the `lme4` package (version 1.1.26) in the R environment.

Reduction of the suffix vowel (quantified by the r index, see Eq. (4.1)) was modelled with a linear mixed-effects regression model (LMER) of the form (in R notation):

$$r \sim \text{Region} * \text{Suffix vowel} * \text{Stem vowel} + (1|\text{Stem}) + (1|\text{Speaker}) \tag{4.3}$$

The dependent variable was the r value calculated for each phonetically realised suffix vowel, while the levels of fixed and random factors were the same as in the GLMM (4.2). In particular, the three fixed factors *Region*, *Suffix vowel* and *Stem vowel* were in a three-way interaction, while the (lexical) *Stem* and *Speaker* random factors were modelled as intercepts. The LMER model was computed by means of the `lmerTest` package (version 3.1.3) in R.

Finally, post-hoc tests were computed in terms of estimated marginal means (EMMs) by using the `emmeans` package (version 1.5.3) in R, in order to zoom in on the significant interactions given by the fixed factors for both models (4.2) and (4.3).

Along the statistical analyses described above, the hypothesis of a direct influence of suffix reduction on metaphony was tested separately by stem vowel. LMER models were run in which the dependent variable was s_1; r, region and suffix vowel were fixed factors, and lexical stem and speaker were random factors. Similar models were also run for s_3 and ZZ data only. However, the influence of r on the PC-scores as tested by such models was proven to be non-significant. Similarly, models testing a hypothetical direct influence of suffix elision on PC-scores gave inconclusive results. Consequently, these analyses were not included.

4.3 Results

4.3.1 Suffix vowel elision

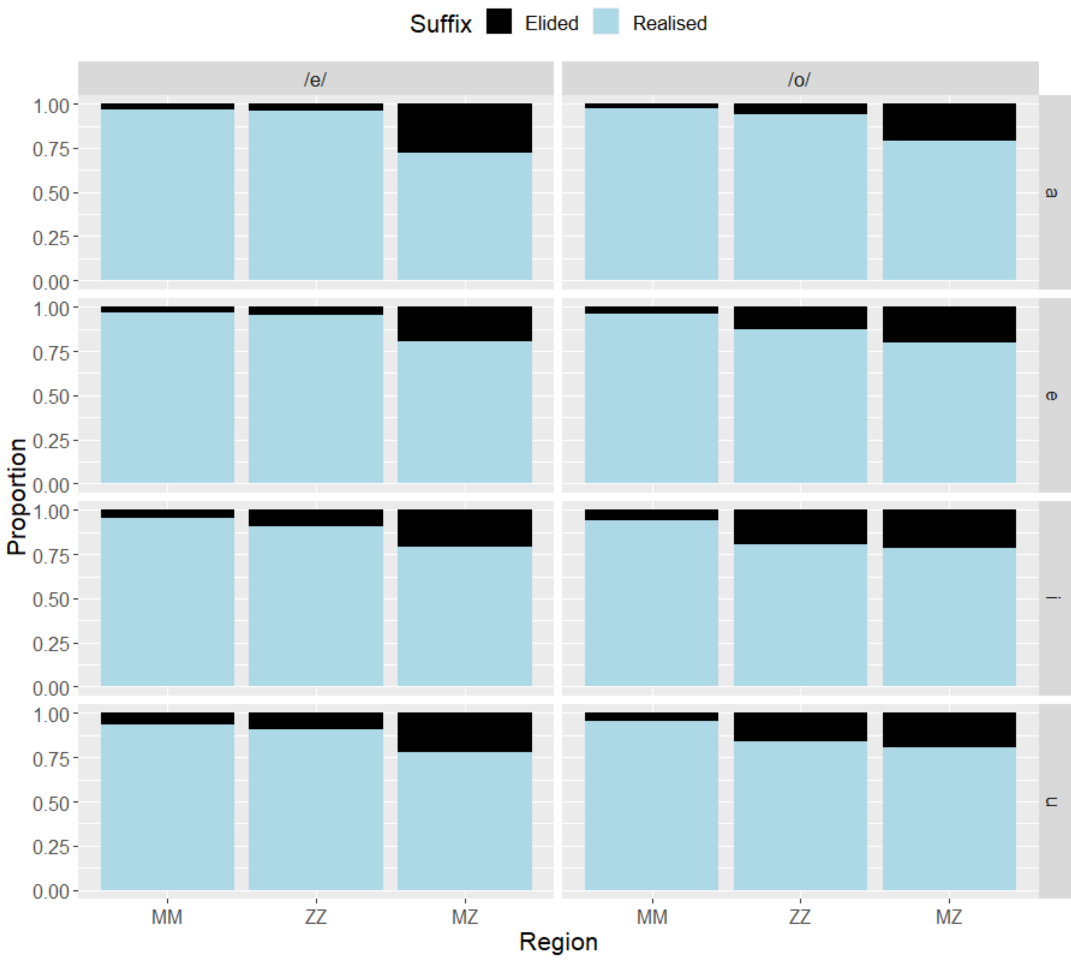

Figure 4.1: Amount in decimals of elided vs phonetically realised vowel suffixes in the analysed data, shown separately for the three regions, for stem vowel and for suffix vowel type.

Fig. 4.1 shows the amount in decimals of elided suffixes in the analysed data, separately by region, stem vowel and suffix vowel. By observing the bar charts, it is clear that MZ presented the greatest amount of suffix elision, regardless of suffix vowel type, and also with a comparable distribution between words presenting an /e/ stem and those with an /o/ stem. Similarly, MM presented the least suffix elision for all suffixes and for both stem-/e/ and stem-/o/ words. As far as ZZ is concerned, in most cases it presented an intermediate percentage of suffix elision between MM and MZ.

Fixed factors	***F*-value**	**Probability**
Region	6.5	$p = .001$
Suffix vowel	4.2	$p = .005$
Stem vowel	0.9	n. s.
Region * Suffix vowel	1.9	n. s.
Region * Stem vowel	5.7	$p < .005$

Table 4.2: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the GLMM (4.2) testing for differences in the amount of suffix elision between regions, suffixes and words containing either /e/ or /o/ stems.

Stem vowel	**Suffix vowel**	**Regions**	m	SE	z	**Sig.**
/e/	a	MM – MZ	3.03	0.77	3.9	***
		ZZ – MZ	2.48	0.78	3.2	**
	e	MM – MZ	2.43	0.74	3.3	**
	i	MM – MZ	2.19	0.71	3.1	**
	u	MM – MZ	2.14	0.72	2.9	**
/o/	a	MM – MZ	2.80	0.75	3.7	***
	e	MM – ZZ	1.85	0.79	2.3	*
		MM – MZ	2.20	0.75	2.9	**
	i	MM – ZZ	1.88	0.74	2.5	*
		MM – MZ	1.96	0.71	2.7	*
	u	MM – ZZ	1.91	0.75	2.6	*
		MM – MZ	1.91	0.71	2.7	*

Table 4.3: The estimated mean (m, expressed in log odds) and standard error (SE) of statistically significant contrasts related to the amount of suffix vowel elision between regions, and the associated post-hoc z-statistics (final two columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Tab. 4.2 shows the F-statistic confirming that the degree of suffix elision mainly depended on region and was, to a minor extent, also linked to suffix vowel type ($p < .01$ in both cases). The regional differences concerning suffix elision were also statistically confirmed by the post-hoc Tukey tests regarding contrasts between regions listed in Tab. 4.3. All contrasts between MM and MZ were significant, regardless of stem vowel or suffix vowel type ($p < .05$ in all cases, see Tab. 4.3 for details), while contrasts between either MM or MZ and ZZ were only sporadically significant ($p < .05$ in all cases, see Tab. 4.3 for details). Also, ZZ was the only region in which suffix elision possibly correlated with suffix vowel and stem vowel type. More specifically, there was significantly more suffix deletion in /i, u/ than in /a/-suffix contexts (/a, i/ contrast: $z = 3.0$, $p = .01$; /a, u/ contrast: $z = 2.9$, $p = .01$); and there was more suffix elision in words containing an /o/ stem than in words with an /e/ stem ($z = 2.2$, $p < .05$).

4.3.2 Suffix vowel reduction

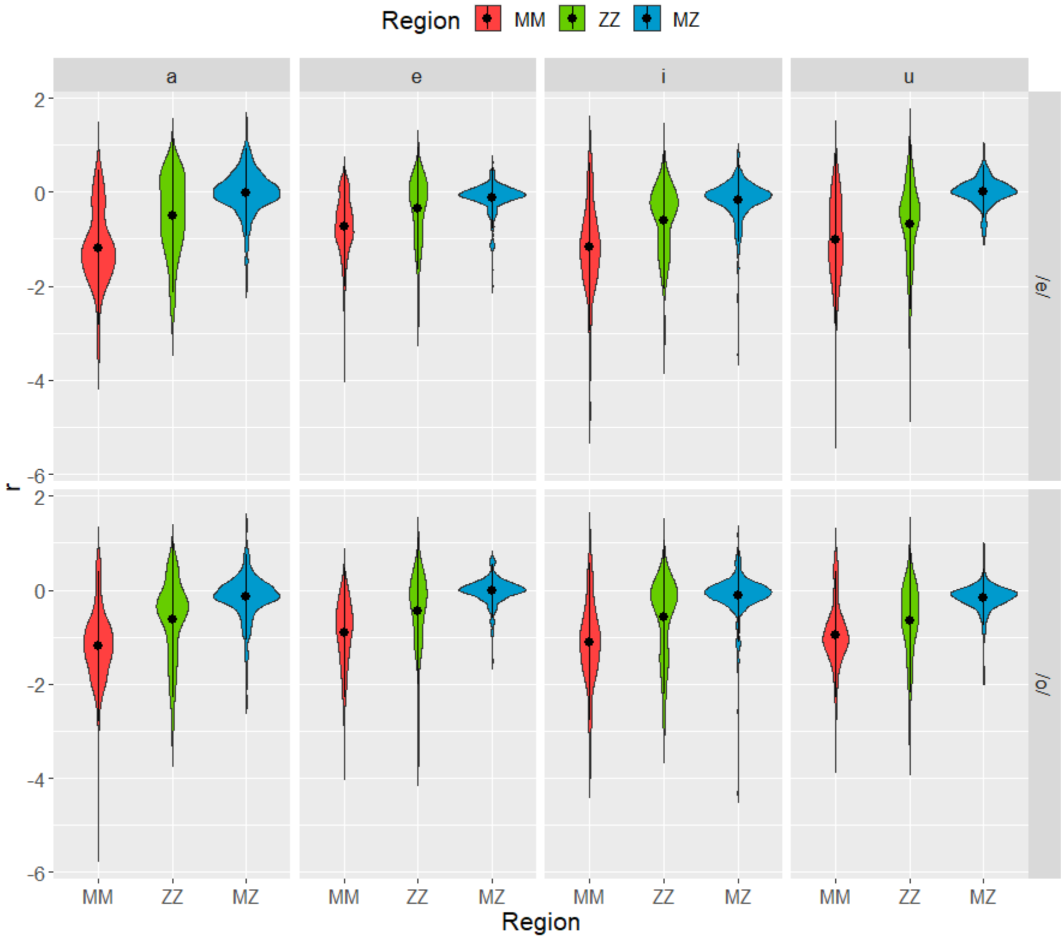

Figure 4.2: Reduction Index (r) values of phonetically realised suffix vowels, shown separately for the three regions, stem vowel (rows) and suffix vowel type (columns). The mean for each distribution is also indicated by a black dot.

The violin plots in Fig. 4.2 show r values for 4676 suffix vowel tokens, separately for region, stem vowel (i.e. the stem of the lexical items to which the suffix vowels belong), and suffix vowel type. MZ (blue plots) was the region that presented the largest amount of tokens showing a higher degree of suffix reduction, signalled by an average value of r around 0, while the other regions had, in general, lower r values corresponding to less reduced suffixes (see also Section 4.2.2). In a strikingly parallel way to the progression in the amount of suffix elision across the three regions (described in Section 4.3.1), suffix vowel reduction was also less in MM (red plots), far greater in MZ, and had, on average, a value in-between the two in ZZ (green plots). Apart from r values for suffix /e/, which were generally closer to 0 than for other suffixes (see Fig. 4.2, panels in the second column), no other particularly visible differences between stem vowels or between suffix vowel types were observable from the plots.

Fixed factors	Statistics	Probability
Region	F[2, 32.3]= 20.9	p < .001
Stem vowel	F[1, 47.3]= 0.04	n. s.
Suffix vowel	F[3, 3085.4]= 28.0	p < .001
Region * Stem vowel	F[2, 4618.2]= 0.5	n. s.
Region * Suffix vowel	F[6, 4590.3]= 10.7	p < .001
Stem vowel * Suffix vowel	F[3, 3084.9]= 2.1	n. s.
Region * Stem vowel * Suffix vowel	F[6, 4590.3]= 5.4	p < .001

Table 4.4: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the LMER model (4.3) whose dependent variable was the reduction index r of phonetically realised suffix vowels.

Stem vowel	Suffix vowel	Regions	m	SE	df	t	Sig.
/e/	a	MM – ZZ	-0.59	0.16	47.3	-3.6	**
		MM – MZ	-1.10	0.15	44.5	-7.4	***
		ZZ – MZ	-0.52	0.16	50.1	-3.3	**
	e	MM – MZ	-0.54	0.15	40.5	-3.7	**
	i	MM – ZZ	-0.52	0.16	40.6	-3.2	**
		MM – MZ	-0.93	0.14	37.9	-6.5	***
		ZZ – MZ	-0.41	0.15	42.1	-2.7	*
	u	MM – MZ	-1.03	0.14	39.0	-7.1	***
		ZZ – MZ	-0.75	0.15	45.0	-4.9	***
/o/	a	MM – ZZ	-0.51	0.16	42.8	-3.2	**
		MM – MZ	-0.98	0.14	39.4	-6.8	***
		ZZ – MZ	-0.47	0.15	44.3	-3.1	**
	e	MM – ZZ	-0.44	0.17	51.0	-2.6	*
		MM – MZ	-0.82	0.15	45.8	-5.4	***
	i	MM – ZZ	-0.45	0.16	45.6	-2.8	*
		MM – MZ	-0.92	0.14	40.5	-6.3	***
		ZZ – MZ	-0.47	0.16	47.2	-3.0	*
	u	MM – MZ	-0.72	0.14	38.1	-5.0	***
		ZZ – MZ	-0.52	0.15	43.7	-3.4	**

Table 4.5: The estimated mean (m) and standard error (SE) of statistically significant contrasts between regions for the suffix reduction index r, and the associated post-hoc t-statistics (final three columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

The LMER results confirmed the statistical significance of the influence of region in suffix reduction, as well as its interaction with stem vowel and/or suffix vowel type (see Tab. 4.4). In particular, the post-hoc Tukey tests (Tab. 4.5) confirmed the contrasts between the regions which were highly significant between MM and MZ for both stem vowels and all suffixes ($p < .001$ in all significant contrasts, see Tab. 4.5 for details), and also showed that there was significantly more suffix reduction in ZZ than MM in stem /e/ for the suffixes /a, i/ ($p < .01$ in both cases, see also Tab. 4.5) and in stem /o/ for the suffixes /a, e, i/ (p

$< .05$, see Tab. 4.5), while there was significantly more suffix reduction in MZ than ZZ in stem /e/ as well as in stem /o/ for the suffixes /a, u, i/ ($p < .05$ in all cases, see Tab. 4.5 for further details). In addition, a slight tendency of suffix vowel /e/ to be more reduced than other vowels was proven by the post-hoc Tukey tests to be significant across all three regions, in particular: for the suffix-/a, e/ contrast, t_{3194} = -7.0, $p < .001$; for the suffix-/e, i/ contrast, $t_{3663} = 8.5$, $p < .001$; for the suffix-/e, u/ contrast, $t_{2413} = 7.0$, $p < .001$. The fact that a vowel like /e/ tends to be more reduced than other vowels, especially in an unstressed position, is common also to other languages (see e.g. Delforge, 2008) and can be linked to its articulatory proximity to the vowel sound [ə].

In summary, all these findings showed that overall the degree of suffix reduction across the three regions manifested the progression MM < ZZ < MZ, in which "<" means that one specific region presented less suffix vowel reduction than the following one.

Is there any direct correlation between *r* and metaphony?

The results described above confirmed that the degree of both suffix elision and reduction varied significantly between the three regions, following in both cases the elision/reduction progression MM < ZZ < MZ. Nevertheless, a direct influence of r on s_1 (which is the PC-score describing vowel raising or lowering in both vowel stems /e/ and /o/) had to be excluded (see Section 4.2.3).

The absence of any direct correlation between the magnitude of coarticulatory influence in the stem vowel and suffix vowel reduction is clearly visible in Fig. 4.3, in which r suffix vowel values (x-axis) and s_1 stem vowel values (y-axis) were plotted for each of the 4676 words presenting a phonetically realised suffix. In particular:

1. in MM (left column panels), no evident trend in the variation of both r and s_1 values can be observed;

2. in MZ (right column panels), there was only a minimal variation of r – since most data points concentrate horizontally around y = 0 – but a visible variation in s_1: as already discussed in Chapter 3, s_1 values decreased in an /i, u/ suffix vowel context (thus signalling stem vowel raising), and tended to increase before an /a/ suffix vowel (thus signalling stem vowel lowering);

3. in ZZ (mid column panels), we can observe an intermediate situation, in which a major tendency for r values to be closer to 0 is more visible than in MM, but less evident than in MZ. In line with what has been discussed in Chapter 3, s_1 also showed more coarticulatory/metaphonic effects than MM, but less than MZ.

The s_1 and r variation patterns did not substantially differ between /e/ an /o/ stems (red and blue dots respectively in Fig. 4.3).

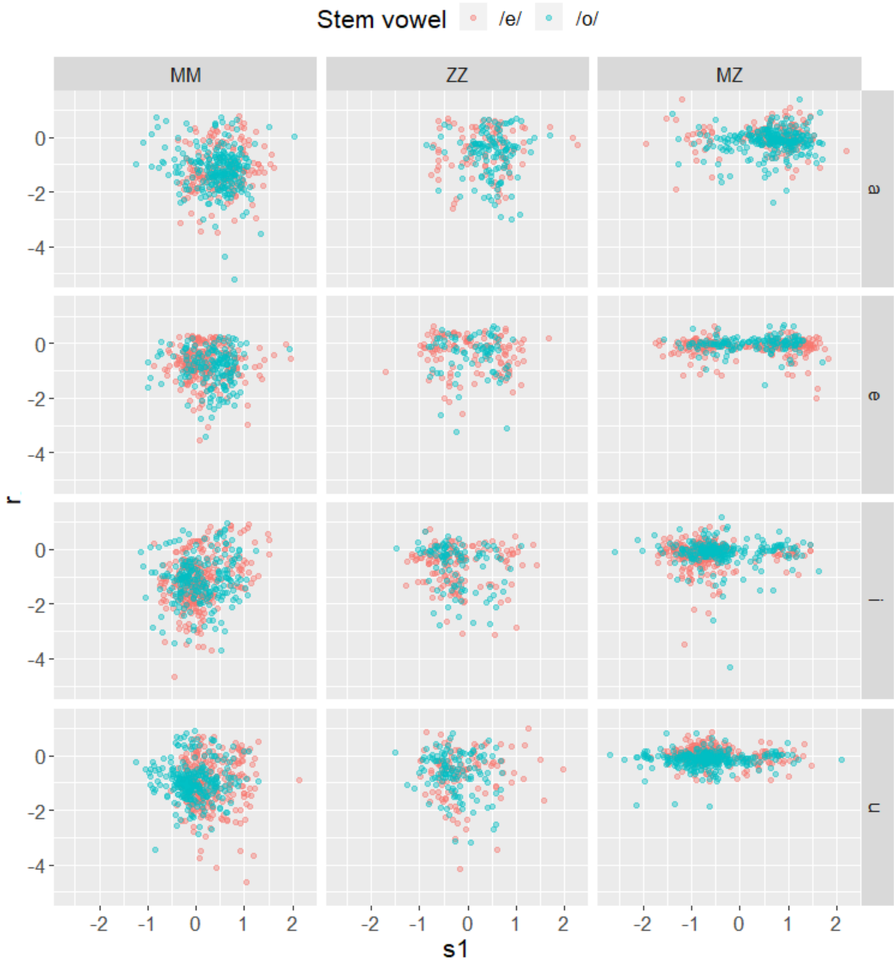

Figure 4.3: Scatter plot showing r (x-axis) and s_1 (y-axis) values for each data token, separately by region, stem vowel and suffix vowel type.

4.4 Discussion

The results presented in this chapter not only contribute to the description of the phonetic status of suffix vowels in the Lausberg area, but also provide evidence that the progressive metaphonic influence discussed in Chapter 3 in terms of PC-scores (especially as regards s_1, see also Section 3.3.2) is mirrored by the gradual increase of the amount of suffix elision and of suffix reduction following the order MM < ZZ < MZ, where '<' means that the region has a lower amount of *both* suffix elision and suffix reduction than the following one. Although metaphonic influence did not prove to be directly affected by suffix elision or reduction, there was clear evidence that the region was the main factor parallelly influencing, on the one hand, elision and reduction in the suffix vowel, and, on the other hand, magnitude of metaphony and coarticulation in the stem vowel. In particular, the region which showed the greatest metaphonic outcomes (MZ) was also the region that had the most suffix reduction and elision; vice versa, the region that had the least metaphony was also the region with the least suffix reduction and elision (MM), while ZZ presented an intermediate situation between MM and MZ for both metaphony and suffix reduction and elision.

The striking fact that metaphony and suffix reduction and elision follow a parallel development across the three regions supports the hypothesis that there are three phases to the development of metaphony in the Lausberg area, and that each of the three identified regions represents one single crystallised sound change phase:

1. in MM, we have minor coarticulatory effects, co-occurring with a reduced amount of suffix elision, as well as limited suffix vowel reduction;
2. in ZZ, we have a greater coarticulatory influence of the suffix on the stem vowel, which, in the case of the metaphonic suffixes /i, u/, is manifested through diphthongisation, as well as more cases of suffix elision and a slightly more marked suffix reduction than in MM, but far less accentuated than in MZ;
3. in MZ, we have a marked suffix reduction – possibly, most suffix vowels are reduced to a [ə] quality – and also the greatest amount of suffix elision between the three regions. At the same time, MZ is the region that shows the most marked coarticulatory and metaphonic effects, manifested by stem vowel lowering before /a/ suffixes and stem vowel raising before /i, u/ suffixes.

The phonetic mechanisms of coarticulation and concomitant vowel reduction that emerged from the data presented in this and the previous chapters can be interpreted and explained from different perspectives. The phonological-functional explanation of the "reduction-and-assimilation" mechanism of metaphony provided by Torres-Tamarit and Linke (2016, p. 340) involves different perceptually-driven stages, which can be summarised as follows. Firstly, speakers gradually shift their articulation of mid stem vowels preceding /i, u/ suffixes in order to enhance perception of the unstressed suffix high vowel cue. Later on, the speaking community learns to categorically distinguish the two stem vowels, i.e. the "metaphonised" vs the "non-metaphonised" one. After this shift at the phonological-cognitive level has taken place, vowel merger starts operating on the suffix vowels, thus neutralising the original vowel qualities. In spite of the absence of evidence – to my knowledge – of this chronological sequence of events (first metaphony, then the merger of the suffix vowel qualities), it is more than plausible that the two processes (if one did not take place as a consequence of the other) might have at least taken place synchronically and had an autonomous and chronologically parallel (although dissimilar) evolution inside the three regions. Such evolution must have stopped at some point so as to reach the final actual status shown by each single region. This would explain why all three regions present three different forms of metaphony along a gradient degree of suffix erosion following the above-mentioned sequence MM $<$ ZZ $<$ MZ. Also, while a too abstract and strictly functional motivation for metaphony would not take into account variability of phonetic outcomes, informativity and predictability of language features – including phonetic cues and inflectional marks – can indeed promote a sound change (Blevins, 2015, p. 13). Therefore, in varieties in which metaphony is phonetically advanced like in MZ, a full realisation of the suffix vowel quality would be redundant, since the stem vowel height would be enough to signal the difference between, say, the masculine singular of an adjective vs the feminine singular (e.g. [bɛll(ə), b**i**ll(ə)], 'beautiful', fem. sg. vs masc. sg.), or the plural of a noun instead of the singular form (e.g. [mɛs(ə), m**i**s(ə)], 'month, months').

The relationship between any form of phonetic erosion of the vowel trigger of an assimilatory process and the resulting sound change in the target vowel is a recurring aspect in many other languages – see for instance Barnes (2006, p. 193–195) for an account of the phenomenon in several language families. In particular, the coexistence of suffix reduction with vowel harmony processes in the stem vowel (either anticipatory, as is the case for metaphony, or carryover) is a phenomenon common to other Italo-Romance varieties and it is not merely restricted to Southern Italy (see e.g. Delucchi, 2011, 2012; Paciaroni, Schmid, Schwarzenbach, and Studer, 2009; Schirru, 2012). Also, zooming out to take a look at phonologisation phenomena in general, the link between trigger erosion and phonologisation of phonetic change in the target has been largely discussed for other types of sound change as well. As Harrington et al. (2019b, p. 413) pointed out, coarticulation and hypoarticulation are in some cases *additive*, since they can both contribute to the same sound change. In our case, hypoarticulation could contribute, on the one hand, to stem vowel raising in those words carrying high suffixes (since, in more casual and faster speech, vowels might be shortened and consequently raised to some level, see e.g. Moon and Lindblom, 1994). On the other hand, however, hypoarticulation certainly contributes to reduction (and possibly centralisation) of the suffix vowel, which is unstressed and occupies a word-final and therefore prosodically weak position (the example of Umlaut in German mentioned by Harrington et al., 2019b, p. 413, reflects a strikingly similar situation to metaphonic vowel raising).

Phonologisation can also be effectively described as a cue-trading process: there is, for instance, evidence (see e.g. Beddor, 2009) that the magnitude of anticipatory coarticulation in the vowel is often inversely proportional to the duration of the following segment that triggered coarticulation (Harrington, Kleber, & Reubold, 2012). Such a change must also have taken place in metaphony, as it is evident that, for metaphony and vowel-to-vowel coarticulation in the Lausberg area, too, an increasing change in the stem vowel quality is directly proportional to the degree of phonetic erosion of the suffix vowel – at least as regards the differences emerging between MM, ZZ and MZ. In more general terms, the mechanism behind the development and maintenance – by means of phonologisation or lexicalisation – of a phonetic change in spite of the phonetic erosion, or even the complete disappearance, of the source of the same change remains a core issue for many types of consonant and vowel shifts in a vast variety of languages (see e.g. Beddor, 2009, 2012; Harrington et al., 2019b; Kiparsky, 2015; Kirby, 2014).

In this chapter, the status of suffix vowel elision or reduction between the three regions has been analysed and discussed, thus shedding further light on the phonologisation status of metaphony in the Lausberg area. However, another aspect that is necessary to clarify is whether perceptual discerning between metaphonic and non-metaphonic stems is clear-cut, thus suggesting categorical phonologisation of metaphonised vowels, or whether native speakers are not able to easily distinguish between metaphony and non-metaphony – especially in a region such as MM, where both metaphonic influence and suffix erosion are minimal – as is typical for allophonic alternations. For this purpose, while Chapters 3 and 4 analysed metaphony and suffix vowel reduction acoustically, in the next chapter metaphony is analysed from a perceptual perspective, with particular attention being paid to whether acoustic parameters such as vowel height or degree of diphthongisation correlate to how metaphonic and non-metaphonic lexical stems are perceived by native speakers from the Lausberg area.

Chapter 5

Perception of metaphony

5.1 Introduction

5.1.1 The link between production and perception

Over the last few years, several studies have shown that a connection between speech production and perception exists when it comes to the initiation and actuation of a sound change (Harrington, Kleber, and Reubold, 2008; Kendall and Fridland, 2012; Kleber, Harrington, and Reubold, 2012). Various studies have demonstrated that the processing of phonetic detail and coarticulatory effects is an important part of speech perception (Alfonso & Baer, 1982; Fowler & Smith, 1986; Martin & Bunnell, 1982), and that listeners are generally able to perceptually compensate for coarticulation (Beddor et al., 2002; Beddor & Krakow, 1999; Harrington et al., 2008, 2012; Mann & Repp, 1980). It is also possible, however, that listeners do not always manage to accurately attribute coarticulatory perturbations in production to their source (Beddor et al., 2002; Beddor, Krakow, and Lindemann, 2001). Such perceptual parsing "errors" can be, either alone or in interaction with other phonetic factors, potential sources for sound change (Blevins, 2004, 2015; Garrett & Johnson, 2013; Ohala, 2012, 1993). In relation to this, variation between individuals in the phonological parsing of speech signals has also been argued to be one of the potential drivers of sound change (Beddor, 2012; Bermúdez-Otero, 2015; Coetzee, Beddor, Shedden, Styler, & Wissing, 2018; Cole, Lindebaugh, Munson, & McMurray, 2010; Harrington, 2012; Kuang & Cui, 2018; Yu, 2010; Zellou, 2017).

The interaction between production and perception and its influence on sound change shown by the studies mentioned above represent a valid argument in favour of incorporating perception into phonological and, more generally, linguistic theory, with production and perception corresponding, metaphorically speaking, to "two faces of the same communicative coin" (Krefeld and Pustka, 2010, p. 9, translation is mine), and acting as the main components from which linguistic codes emerge and evolve. The interplay of production and perception in language is therefore not only a component of phonetics, but also an important aspect at the morpho-syntactical level, and acts as a mirror to how we perceive and categorise the world around us (Krefeld, 2019). From this perspective, the merit of perception experiments is that they are the only tool able to expose the speaker/hearer to real, spontaneous language production, thus allowing the identification and study of cognitive representations of the language system within each speaker/hearer's mind (Krefeld & Pustka, 2010, p. 16).

5.1.2 Perception of metaphony

The mechanisms driving sound change in a certain direction might not only be due to articulatory factors, as also discussed by the several studies mentioned above, but might also be linked to the perceptual saliency of some linguistic features. For instance, Nichols (2021, p. 240) advanced the hypothesis for Bantu that progressive vowel height harmony could result from the need to enhance the perceivability of specific acoustic cues rather than from the fossilisation of coarticulatory effects due to hypocorrection. Also, work by Clayards, Gaskell, and Hawkins (2021) recently suggested that phonetic detail can drive morpheme recognition within words. These experimental studies can be added to several theoretical and phonological accounts of metaphony that suggest that the spreading of a place (of articulation) feature[1] from the suffix vowel to the stem vowel may make an inflectional mark more perceptually salient (Frigeni, 2003; Walker, 2005), or even more recognisable, especially in cases where the vowel quality in the suffix is completely neutralised (Barbato, 2008; Calabrese, 1985, 1998; Krämer, 2009; Savoia, 2016).

As regards experimental analyses of perception of metaphony, we can mention the (to my knowledge) isolated contributions by Grimaldi et al. (2016) and Manca, Di Russo, Sigona, and Grimaldi (2019), who used behavioural and neurophysiological procedures – such as discrimination tasks, mismatch negativity (MMN) response and magnetoencephalography – to test for discrimination between metaphonic and non-metaphonic (stem) vowels in specific dialects spoken in Salento (Apulia, Southern Italy). No (published) perceptual studies have been run on dialect speakers from the Lausberg area so far.

A perception study on metaphony in the Lausberg area can be interesting for a variety of reasons. For instance, in Standard Italian, the opposition between mid-low and mid-high vowels is not particularly productive in phonological terms (Renwick & Ladd, 2016), whereas this opposition might be crucial in some metaphonising dialects – such as the one spoken in Mormanno – in order to distinguish (or to contribute to the distinction of) some morpho-syntactic categories. The perceptual distinction between mid-low and mid-high

[1] *Place feature* is used here in a phonological sense: in the case of metaphony we are dealing with the feature '[+/− high]'.

metaphonic /e/ was already demonstrated for the Salentino metaphony (Grimaldi et al., 2016; Miglietta et al., 2013), but following an experimental paradigm detached from the morpho-syntactic component – the audio stimuli in these studies presented vowels in isolation and not embedded in a lexical stem – which is inevitably linked to metaphony, given the fact that the assimilated suffix vowel quality belongs to an inflectional suffix.

The perception experiments presented in this chapter aim to establish whether listeners from the Lausberg area rely on the stem vowel in the perception of certain morpho-syntactic categories and are therefore able to compensate in this way for the neutralisation or reduction of the word-final suffix vowel. In order to explore this aspect, it is important that the participant is asked to distinguish a morpho-syntactic category – e.g. feminine vs masculine forms, or singular vs plural – and not just an isolated sound, while listening to a lexical item whose final vowel is completed omitted. One possible outcome of such a test could therefore be that, in order to preserve the retrievability of morpho-syntactic information, perceptual compensation for suffix loss takes place by means of the phonological opposition triggered by metaphony between mid-low and mid-high vowels for Mormanno, between monophthongs and opening diphthongs in the Zwischenzone, and between mid-low and high vowels in the Mittelzone.

5.1.3 Hypotheses

A lexical recognition task was run in order to test for the perceivability of morpho-lexical cues based solely on the stem vowel quality and without the help of the inflectional suffix vowel. In order to test this, participants were asked to distinguish masculine vs feminine and singular vs plural forms based only on lexical stems that had been deprived of their suffixes (see Section 5.2.2 for details). Each region's participants listened to stimuli from their own region's speakers as well as to stimuli from ZZ speakers (see Section 5.2.3 for details).

The main two alternative hypotheses regarding the perception accuracy of participants listening to their own region's stimuli were the following:

1. Listeners from MM were expected to be less accurate than listeners from ZZ and MZ in distinguishing metaphonic from non-metaphonic stems (i.e. they were expected to correctly perceive a more reduced number of items than the other regions). On the contrary, listeners from MZ were considered to be likely to make the largest number of accurate distinctions, while listeners from ZZ were expected to show an intermediate level of accuracy when fulfilling the lexical recognition task. This hypothesis reflects the metaphonic progression discussed in Chapter 3, in which MM shows less metaphony than ZZ, and ZZ shows less metaphony than MZ but more metaphony than MM. If perception of metaphony is directly proportional

to its production, then one would expect that the more metaphony/coarticulation produced in the speaker's/hearer's own variety, the more he/she is able to perceive it.

2. Another possible hypothesis was that the accuracy in distinguishing metaphonic stems from non-metaphonic ones would be similar between all three regions, i.e. MM, ZZ and MZ would all perform comparably well in the recognition task. This could be because, as pointed out by previous studies (e.g. Beddor, 2012; Beddor and Krakow, 1999; Kleber et al., 2012), perception is usually more advanced than production in situations of phonetic change. This implies in our case that even if MM speakers did not metaphonise as strongly as the other two regions in production, they would still be able to perceive the difference between a metaphonic and a non-metaphonic lexical stem due to the effects of coarticulation linked to the influence of the suffix vowel onto the stem vowel.

Also, as regards accuracy in the perception of metaphonic stems by listeners from MM and MZ responding to ZZ stimuli (see Section 5.2.3), three alternative hypotheses were possible:

1. MZ listeners would be better at recognising metaphonic stems than MM listeners: as they are at a more advanced stage in metaphonic production, a major perception competence from MZ participants could be expected;
2. MM listeners would perform better than MZ listeners, which could be interpreted as a consequence of the geographical location of the village of Mormanno (MM) within the Zwischenzone: Mormanno listeners might therefore be able to easily recognise ZZ metaphonic features because of a background situation of language contact;
3. MM and MZ listeners would both be able to distinguish metaphonic from non-metaphonic stems in ZZ production stimuli similarly well, possibly due to the coexistence of the above-mentioned reasons, i.e. language contact with dialects that have diphthongising metaphony and metaphony perception competence.

Finally, as regards the role of suffix vowel type, the following was hypothesised:

1. The stimuli originally containing /e, i/ suffixes, which in the results of the acoustic analyses in Section 3.3.2 triggered "less" metaphony or coarticulation across the three regions, would also be less easily recognisable by the listeners. This hypothesis could be plausible because of the proximity within the vowel chart of these two vocalic segments (an aspect also pointed out in Appendix F). Secondly, in the acoustic analyses, /e/ suffix vowels underwent significantly more reduction than other suffixes (see Section 4.3.2), which could offer a further explanation as to why this suffix type might trigger less perceivable coarticulatory effects than other suffixes.

2. It might also be possible, however, that the perception abilities of the listeners could overcome minor metaphonic influences in production (according to the previously mentioned hypothesis that perception might be more advanced than production), so that there would be no significant differences in perceptual accuracy between suffix vowel types across listeners from different regions.

5.2 Method

5.2.1 Participants

All participants were recruited either from my personal contacts or by sharing a call for participants on social media. Upon completion of the task, they were also paid a small amount of money in the form of an Amazon voucher. Before starting the experiment, participants were asked to fill out a questionnaire asking for some biographic metadata such as their degree of education, where they grew up, where they live, which specific local dialect they speak, their dialect proficiency, and how often they speak their own dialect and in which contexts. Participants were considered suitable if they declared that they frequently used a dialect of one of the villages of the Lausberg area, that they had lived in the villages in questions at least up to young adulthood, and that they had learned the local dialect as their native language (either before the acquisition of Standard Italian or along with the standard variety). Data from participants who declared in the introductory questionnaire not to speak the analysed dialects proficiently, or who spoke dialects that stemmed from outside the Lausberg area (n = 14), were excluded. Filtering out these participants and their responses, the total number of responses used for the analysis was 26899, including 13264 responses to stimuli taken from words containing /e/ stems, and 13635 observations taken from stem-/o/ words.

Following the exclusion of noise data as described above, a total of 170 participants (93 females and 77 males) took part in the three experiments. In spite of the fact that it is a common occurrence that some participants taking part in remote online experiments abort the given task before ending it (Draxler, 2014), the vast majority of participants (n = 140) completed the online experiment in its entirety, while only 30 participants carried out their task only partially, thus not listening to all of the 197 stimuli. For the data analysed, all responses were considered, also including those ones obtained from the minority of participants who did not complete the whole task, with the objective of analysing all available data collected. 11 participants out of 170 also took part in the production experiment described in Chapter 1, Section 1.3.2, used to elicit the acoustic data that were analysed in the previous chapters.

The participants were distributed per region and experimental condition (see Section 5.2.3) as follows: there were 41 participants for MM (listening to stimuli produced by MM speakers), including 35 participants who completed the experiment by responding to all 197 stimuli. For MZ, there were 59 participants (listening to MZ stimuli), out of whom 48 completed the whole task. For ZZ stimuli only, three conditions were applied, in which not only participants from ZZ listened to ZZ stimuli, but also a limited number of MM and MZ participants listened to ZZ stimuli. These three groups of participants were considered separately (see Section 5.2.3 for details) and distributed as follows. There were 50 within-region ZZ listeners, 41 of which completed the task. There were 6 MM listeners who responded to ZZ stimuli (4 of whom completed the whole task), and 14 MZ listeners who responded to ZZ stimuli (12 of whom completed the task).

The participants' mean age throughout the whole data set was 37.6, and included a wide variety of biological ages ranging from 12 to 80. As regards MM, the mean age was 34.3, with participants' ages ranging from 12 to 69. For MZ, the mean age was 39.3, with an age range of 16 to 75 years. For ZZ participants listening to ZZ stimuli, the mean age was 40.2, with an age range of 19 to 80 years. Listeners of ZZ stimuli from MM had a mean age of 29.7, with an age range of 20 to 46 years. The mean age of MZ listeners to ZZ stimuli was 34.4, with an age range of 23 to 76 years.

Tab. G.1 in Appendix G shows further details about the single villages the participants came from and the participants' sex and levels of education, separately for region/experimental condition.

5.2.2 Materials and design

The audio recordings used for the experiments were selected from the production data. In particular, for each of the three regions, a sample of 197 audio stimuli was selected according to specific criteria. Firstly, the words had to belong to a word pair for which one possible suffix vowel was one of the metaphonic suffix vowels /i, u/, and the other possible suffix was either /e/ or /a/; consequently, lexical stems that had two possible metaphonic suffixes, e.g. /ˈlett**u**, ˈlett**i**/; or two non-metaphonic suffixes, e.g. /ˈstell**a**, ˈstell**e**/, were excluded. Secondly, these words had to either be nouns or adjectives (since verbs generally exhibited a tendency not to undergo metaphony, see Appendix F.3) and the syllable containing the stem vowel and the one containing the suffix vowel had to be adjacent, since (in line with that which was observed in the analysis reported in Appendix F.3) an unstressed high vowel between stem vowel and suffix vowel can cause a raising of the stem vowel regardless of suffix vowel quality.

Finally, out of this set of recordings containing such words, a random subset was selected as follows. 24 audio stimuli with words carrying /e/ stems and /e/ suffixes, 24 further audio stimuli containing /e/ stems and /a/ suffixes, 24 audio stimuli containing /e/ stems and /i/ suffixes, and 24 further audio stimuli containing /e/ stems and /u/ suffixes were randomly selected from the acoustic database. This operation was analogously repeated for each region and for stem-/o/ words. Following this procedure, 192 different audio stimuli were randomly selected for each region following the procedure described above, half of which (n = 96) had an /o/ stem, the other half an /e/ stem. The suffix vowels were consequently also equally distributed across the audio stimuli (24 audio stimuli for each stem vowel and suffix vowel combination), while lexical item types could be presented more than once (but each audio stimulus was presented only once, see Section 5.2.3). For each region, 5 further audio files were randomly selected for each of the three regions and were used at the beginning of the experiments as a training before the real task. The participants' response to such stimuli was not included in the analysis. Tab. 5.1 shows the list of the 40 words (presented as pairs, thus resulting in 20 lexical stems) used in the experiments in their phonological transcription (thus not taking into account possible changes in the stem vowel due to metaphony). The number of actual word occurrences resulting from the random selection of the stimuli sample for each region is also indicated.

Stem vowel	**Word pairs**	**N. of occurrences**		
		MM	**ZZ**	**MZ**
/e/	bell**a** - bell**u**	9 - 13	6 - 2	6 - 4
	dent**e** - dent**i**	9 - 6	3 - 4	4 - 9
	mes**e** - mes**i**	5 - 4	4 - 5	6 - 3
	petts**a** - petts**u**	5 - 5	6 - 6	11 - 12
	ped**e** - ped**i**	6 - 9	9 - 6	9 - 6
	vekkj**a** - vekkj**u**	10 - 6	12 - 13	7 - 8
	verm**e** - verm**i**	4 - 5	8 - 9	5 - 6
/o/	bon**a** - bon**u**	3 - 5	3 - 1	2 - 3
	korn**a** - korn**u**	2 - 3	1 - 3	3 - 3
	kott**a** - kott**u**	5 - 1	0 - 2	2 - 2
	kor**e** - kor**i**	12 - 11	8 - 11	6 - 7
	gross**a** - gross**u**	4 - 1	0 - 0	1 - 1
	loŋg**a** - loŋg**u**	3 - 3	4 - 4	2 - 2
	mort**a** - mort**u**	0 - 2	3 - 6	3 - 2
	niˈpot**e** - niˈpot**i**	5 - 7	6 - 6	10 - 5
	nov**a** - nov**u**	2 - 1	2 - 4	2 - 4
	oss**a** - oss**u**	3 - 2	4 - 2	4 - 4
	pont**e** - pont**i**	7 - 6	10 - 7	8 - 12
	ov**a** - ov**u**	1 - 4	4 - 3	1 - 1
	tsopp**a** - tsopp**u**	1 - 2	3 - 2	4 - 2

Table 5.1: Words used in the perception experiments (phonological transcription) listed in pairs, and the number of occurrences for each word (numbers per word are separated by a hyphen), separately for region.

After selecting the audio file sample, for each audio file, the suffix vowel was manually cut off on the basis of an audiovisual inspection of the sound wave and the spectrogram by using the software Praat (version 6.1.51) (Boersma, 2001), so that the suffix vowel quality was no longer audible. This implied that, in a minority of cases, part of the duration of the consonant preceding the suffix vowel had to be cut out, too, as vowel-to-consonant coarticulation (such as e.g. lip-rounding induced by /u/ suffixes) still enabled suffix vowel auditive perception in some cases.

The online platform used for the experiments was Percy (Draxler, 2011; Draxler, 2014), which allowed participants to take part in the experiment using either a computer or a mobile device (smartphone or tablet). In the written instructions that were meant to be read before taking part in the experiment, participants were encouraged to fulfil the task in a quiet place and preferably using headphones. Nevertheless, obviously, it was not possible to control this condition remotely.

5.2.3 Procedure

The experiments were structured so that the participants responded to stimuli produced by speakers from their own region (either MM, ZZ or MZ). ZZ posed the only exception, with some participants (as described in Section 5.2.1) from either MM or MZ listening to the ZZ stimuli[2].

By clicking on the web link to the experiment[3] (there were three links for each of the three experiments, i.e. one link for each region), a short introductory text appeared with a map on the right side illustrating the dialectal region the participant had to come from in order to participate in the experiment. By clicking on the *Avanti* button ('next') (see Fig. 5.1), the participant could move on to the questionnaire asking for biographic information (already introduced in Section 5.2.1). This questionnaire played an important role in making sure that the participant really did come from the target region, as it included a compulsory field in which the participant had to indicate which specific village dialect he/she spoke.

Having completed the questionnaire, the participant could start the task. The first five attempts were considered as a training phase, and were not taken into account for the following analysis (see also Section 5.2.2). At the very beginning, a written text appeared explaining what to do and how to give a response to each stimulus. In particular, the participants were invited to listen to the audio stimulus and to guess whether the word

[2]Although this experimental condition was not intentional, since due to an initial problem with the link sent to the potential participants for the ZZ experiment, the results were nevertheless analysed as a means of understanding whether speakers from the other two regions could recognise metaphony in ZZ stimuli as well.

[3]The links to the experiments were the following:

- https://webapp.phonetik.uni-muenchen.de/WebExperiment/parola_mm_it.html;
- https://webapp.phonetik.uni-muenchen.de/WebExperiment/parola_zz_it.html;
- https://webapp.phonetik.uni-muenchen.de/WebExperiment/parola_mz_it.html.

was either a singular or a plural, or if it was a feminine or a masculine. They were also informed that the last vowel in the audio recording had been intentionally deleted. In order to listen to the stimulus, the participant had to click on the headphone symbol that appeared on the experiment web page (see Fig. 5.2). Each of the 197 stimuli was presented only once, and the experiment was programmed so that each participant could listen to each stimulus only twice (after it had been played a second time, a red cross on the headphone symbol showed that participants could not listen to it a third time). The audio stimuli used in both the training phase and the 'real' experimental phase were presented to participants in random order.

In order to provide an answer, the participants had to place a vertical line by clicking their mouse on the horizontal bar which represented a *Visual Analogue Scale* (henceforth VAS, see Fig. 5.2). The two possible answer options were situated at the two extreme ends of the bar. The metaphonic item – either the plural /i/-suffixed form, or the masculine /u/-suffixed form of a word – could either sit on the right or on the left side of the horizontal bar, since the order of the two given options shown on the screen was randomised for participants. By means of the VAS, the participants could not only give their answer, but also express how certain they were about their answer, depending on how near the vertical line was to one of the two poles representing the two alternative answers. Placing the indicator in the middle of the VAS meant instead that the participant did not know the correct answer. During the training phase, the participant had to click on *OK* (see Fig. 5.2) in order to move on to the next stimulus, while after this phase, once an answer had been provided, the experiment moved on automatically to the next stimulus, so as to speed up the experiment's duration. The whole task was meant to take approximately 15 to 20 minutes, depending on how much time a single participant took to respond to each stimulus.

Each answer given by the participant on the VAS was converted by the software used into a value ranging from 0 to 100, such that – in spite of the randomised order of the two word options at the extremes of the VAS – the metaphonic item (i.e. either the masculine form with a /u/ suffix, or the plural form with a /i/ suffix) always corresponded to 100, and the non-metaphonic form to 0. The midpoint of the VAS corresponded to a value of 50.

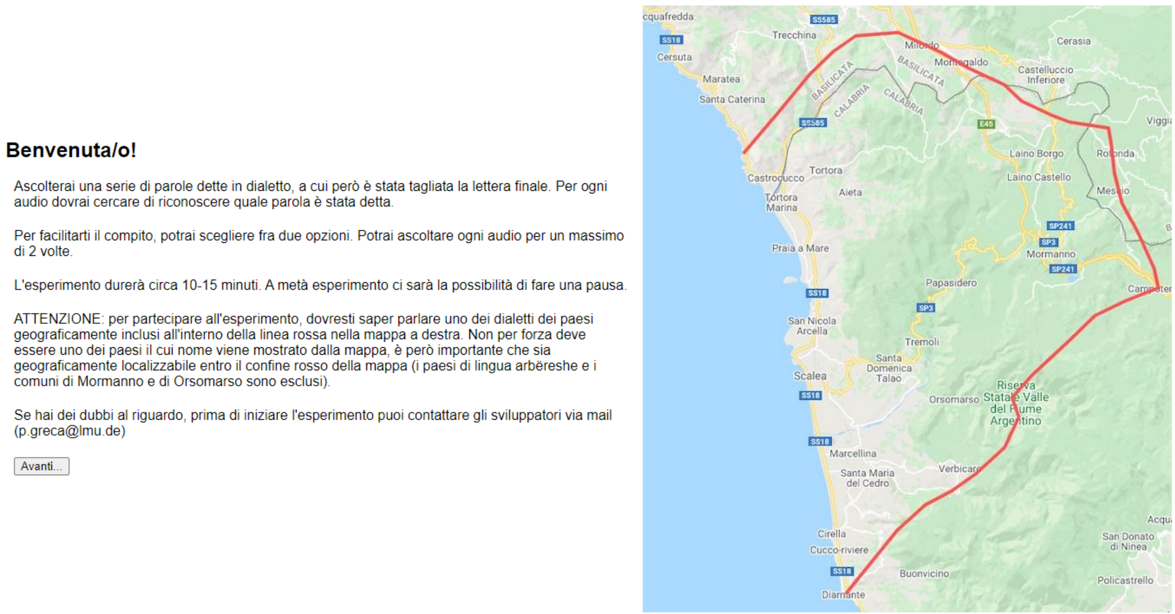

Figure 5.1: Example of the initial page of the web experiment, representing the map of the target region on the right (the map shown here refers to ZZ). Map data ©2021 Google.

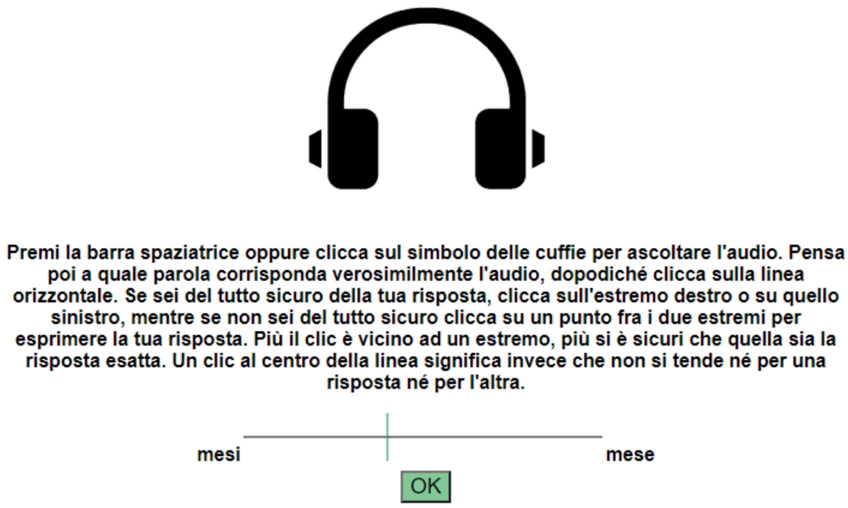

Figure 5.2: A screenshot of the experiment start page (training phase), including a written explanation of the task (i.e. how to express the answer using the VAS). The written text disappeared after participants had responded to the first five training stimuli.

5.2.4 Statistical analysis

For the statistical models described below, all possible interactions between the fixed factors were tested, while the random factors originally included intercepts and all possible slopes to measure the interaction between the fixed and random factors; these were dropped if they were detected non-significant by using the function *step* of the package `lmerTest` (version 3.1.3) in the R environment.

The statistical analysis focused on two aspects of the results. Firstly, it was tested whether there were significant differences in the correctness of the participants' answers between regions and experimental conditions. Secondly, it was tested whether the participants' response was dependent on acoustic factors such as vowel raising or suffix deletion and/or reduction.

The amount of correct answers in each experiment was modelled with a logistic generalised linear mixed model (GLMM), which was computed by means of the `lme4` package (version 1.1.26) in the R environment. The model (adopting R formula notation), applied separately for stem /e/ and stem /o/, was of the form:

$$\text{correct answer} \sim \text{Region} * \text{Suffix vowel} + (1|\text{Stem}) + (1|\text{Listener}) + (1|\text{Speaker}) \quad (5.1)$$

The dependent variable was binary (two levels: true or false). In order to create this variable (and only for this analysis) all responses were divided into two groups. Responses below 50 were considered as non-metaphonic perception of the stem, while responses equal to or above 50[4] were considered as metaphonic perception of the stem. If a participant's response matched the correct answer, then his/her answer was marked as 'true', otherwise it was marked as 'false'. *Region* had a total of 5 levels: in addition to the three usual regions MM, ZZ, MZ (within-region listeners), there were also outer-region listeners to ZZ stimuli, thus resulting in the creation of two further levels, i.e. "ZZ (MM listeners)", and "ZZ (MZ listeners)". The (lexical) *Stem* random factor was comprised of the 20 lexical stems of the words listed in Tab. 5.1, the *Speaker* random factor included all the usual 35 speakers involved in the production of the stimuli, the *Listener* random factor referred to each participant in the perception experiment. All random factors were modelled as intercepts.

The participants' numerical response obtained with the VAS was modelled with a linear mixed-effects regression (LMER) model, which was of the form (R notation):

[4] Out of a total of 26899 VAS responses, only 153 responses corresponded to a precise value of 50.

$$\text{response} \sim s_1 * \text{Region} * \text{Suffix vowel} + (1|\text{Stem}) + (1|\text{Listener}) + (1|\text{Speaker}) \quad (5.2)$$

The dependent variable *response*, corresponding to the VAS value indicated by each participant, could vary between 0 and 100 (see Section 5.2.3). As in the previous analyses, the fixed factor s_1 was the PC-score modulating the degree of stem vowel raising or lowering in the acoustic stimuli (see Chapter 3), while the levels of the other fixed and random factors corresponded to those in model (5.1).

A similar model was applied separately for the two vowel stems /e, o/ to responses to ZZ stimuli only. As the main indicator of metaphony in ZZ is opening diphthongisation of the stem vowel, in model (5.3) the fixed factor s_3 (i.e. the PC-score modulating diphthongisation, see Chapter 3) replaced the fixed factor s_1 in the previous model.

$$\text{response} \sim s_3 * \text{Region} * \text{Suffix vowel} + (1|\text{Stem}) + (1|\text{Listener}) + (1|\text{Speaker}) \quad (5.3)$$

In this case, *Region* included 3 levels that only corresponded to the experimental conditions reflecting who was listening to the stimuli: ZZ within-region listeners; MM listeners and MZ listeners.

The LMER models (5.2) and (5.3) were computed by means of the `lmerTest` package (version 3.1.3) in R. In addition, post-hoc tests were computed in terms of estimated marginal means (EMMs) in order to zoom in on the significant interactions given by the fixed factors. The EMMs were computed using the `emmeans` package (version 1.5.3) in the R environment.

The possible direct influence of suffix reduction and elision on how well listeners could perceive metaphony was statistically tested as well. Firstly, the influence of r (reduction index, see Chapter 4) on s_1 was tested separately for stem vowel by adding to the LMER models mentioned before the fixed factor r. Secondly, it was also tested, again separately for stem vowel, whether r could also influence s_3 for data relating to ZZ stimuli only. Another analysis was run in a similar fashion by replacing r with suffix elision as a binary fixed factor in the LMER models mentioned above. However, both analyses of suffix elision and reduction as possible influencing factors in the participants' responses were overall inconclusive[5], since there were either not enough data in particular to test the influence of suffix elision (regions like MM only had a small number of elided suffixes,

[5]The general non-significance of a possible relationship between any form of phonetic suffix erosion and the perceivability of metaphony in the stem mirrors the absence of a correlation between PC scores and suffix elision and reduction discussed in Chapter 3.

see also Chapter 4), or the resulting slope coefficients describing the relationship trend between variables were non-significant. Consequently, these analyses were not included in this study.

5.3 Results

5.3.1 Amount of correct answers between regions

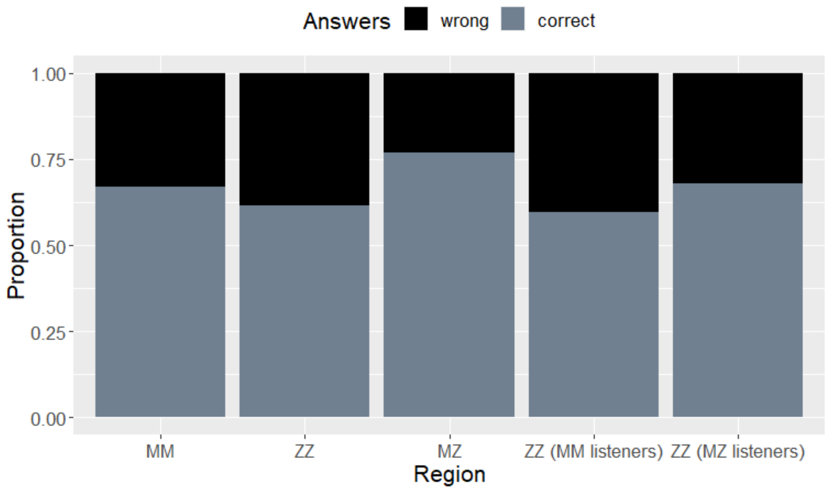

Figure 5.3: Bar charts showing the overall amount in decimals of correct and wrong answers (grey and black respectively) in the perception experiments, separately by region/experimental condition.

The bar charts in Fig. 5.3 provide a first general overview of the accuracy of the participants' answers by showing the amount in decimals ('proportion' y-axis) of correct and wrong answers (grey and black respectively) given by the participants in the perception test across all lexical items and both stem vowels presented in the audio stimuli, and separately for each of the five regions and experimental conditions. Fig. 5.3 shows no particular difference between the regions' performance, since the five correct answers' proportions were in fact relatively comparable. Participants from MZ gave the highest number of correct answers (77%); participants from MM also provided a good number of correct answers (67%), relatively close to the number given by the MZ participants, while ZZ participants performed only slightly more poorly (61% of answers were correct). Furthermore, it is striking to see that outer-region listeners to ZZ stimuli (last two bar plots on the right) did not radically differ in their accurateness from ZZ within-region listeners. It can be noticed, however, that MZ listeners to ZZ stimuli (68% of correct answers) performed slightly better than MM listeners to the same stimuli (60% of correct answers).

Tab. 5.2 illustrates the F-statistic confirming that all fixed factors in the GLMM models run separately for /e/ and /o/ stems (Section 5.2.4, model (5.1)) proved to be highly significant. Therefore, the results are further discussed in terms of post-hoc tests (see below).

Stem vowel	Fixed factors	***F*-value**	Probability
/e/	Region	18.2	$p < .001$
	Suffix vowel	5.2	$p = .001$
	Region * Suffix vowel	15.0	$p < .001$
/o/	Region	4.7	$p < .001$
	Suffix vowel	222.6	$p < .001$
	Region * Suffix vowel	9.9	$p < .001$

Table 5.2: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the GLMM (5.1) carried out separately for stem vowel and with answer correctness as a dependent variable.

Differences between regions, stem vowels and suffix vowels

Fig. 5.4 zooms in on the results by taking into account all the main factors that might have influenced listeners' accuracy in providing their answers. The results are shown separately for stem vowel (/e/ stem in the upper half of the figure, /o/ stem in the lower half) and for suffix vowel (indicated on the y-axis on the right of the plot), while each bar again represents a region and experimental condition (indicated on the x-axis). Details about the post-hoc Tukey tests results regarding contrasts between regions are listed in Tabs. 5.3 and 5.4.

The bar charts in Fig. 5.4 show that, overall, the results between the two stem vowels were very much comparable. Also, answer accuracy across regions and conditions was generally better for the /a, u/-suffix contexts, and worse for the /e, i/-suffix contexts.

As far as the results relating to stem /e/ are concerned, MZ participants performed better than both MM and ZZ participants, especially in the /a, i, u/-suffix contexts. This was also confirmed by the post-hoc Tukey tests: all contrasts with the other regions were significant ($p < .01$ in all cases, see Tab. 5.3 for details) with the only exception being the non-significant contrast between MZ and ZZ (MZ listeners) for the /a/ suffix. For the /e/ suffix, MZ participants performed significantly better only compared with ZZ and with MZ listeners to ZZ stimuli ($p < .01$ in both cases, see Tab. 5.3 for details). MM listeners gave significantly more accurate answers than ZZ ones in the /a/-suffix context ($z = 3.3$, $p < .01$). Again, we can observe that the amount of correct answers given by ZZ within-region listeners and MZ listeners of ZZ stimuli were very much similar; in the /a/-suffix context, MZ listeners were even more accurate than ZZ ones when listening to the same stimuli ($z = -6.6$, $p < .001$), but, in /e/ suffix contexts, MZ listeners to ZZ stimuli performed worse than ZZ within-region listeners ($z = 3.6$, $p < .01$).

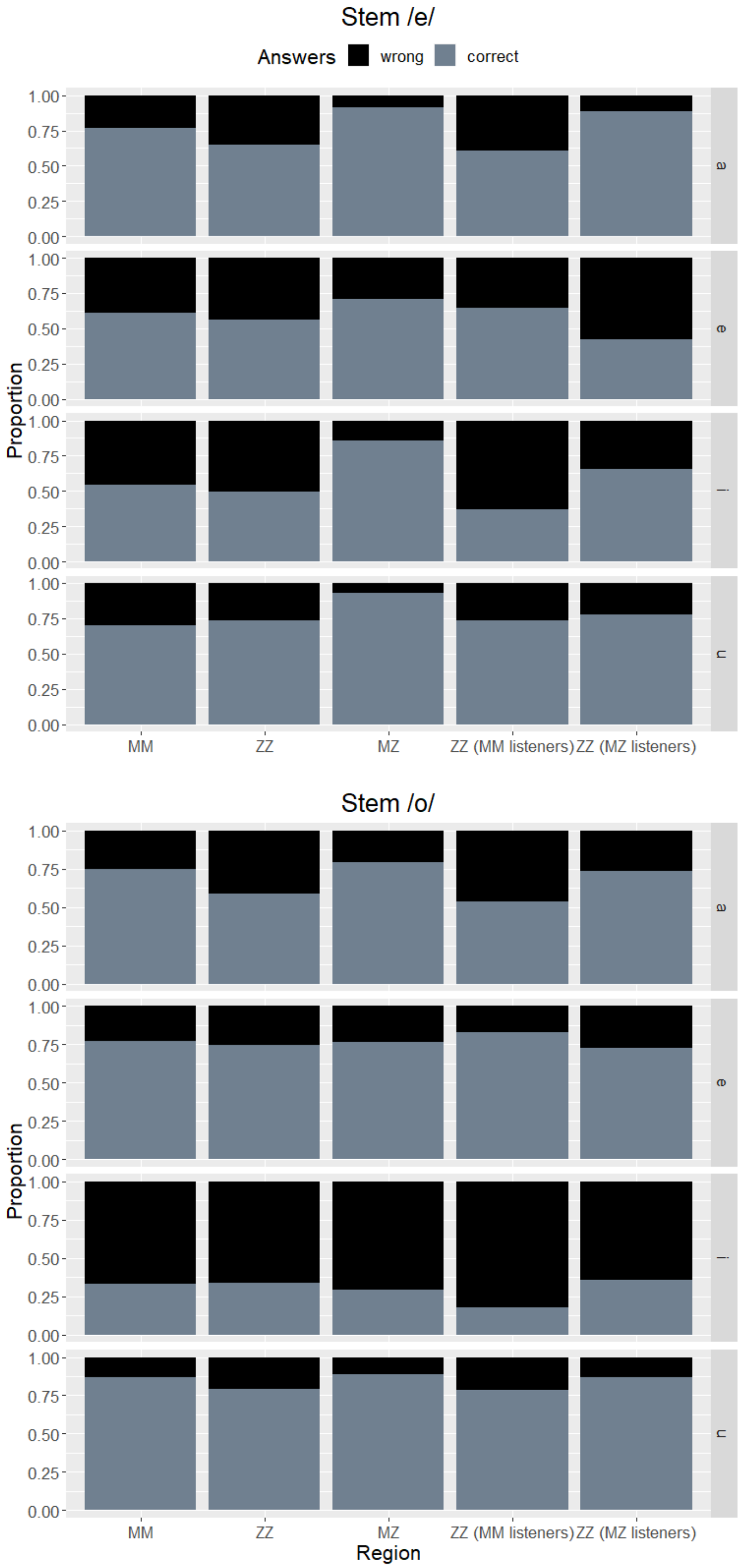

Figure 5.4: Bar charts showing the amount of correct and wrong answers (grey and black respectively) in the perception experiments, separately by region/experimental condition, stem vowel, and suffix vowel.

MM listeners to /e/ stems produced by ZZ speakers performed similarly to ZZ listeners confronted with the same stimuli. Nevertheless, they general they performed worse than MZ listeners confronted with the same ZZ stimuli (this is particularly visible for the /a, i/ suffixes, $p < .001$ in both cases, see Tab. 5.3 for details).

In general, also for stem /o/, answer accuracy across regions and conditions was better for the /a, u/-suffix contexts, while it was worse for the /e/-suffix context and worst for the /i/-suffix context (see Fig. 5.4, lower half, third row), in which all regions performed particularly poorly (also including MZ). This could be due to the fact that words such as /ponti, kori, nipoti/ included in the stimuli either exceptionally did not present metaphony in the stem vowel or in some cases overgeneralised it (see also Appendix F.3).

As far as /a, u/ suffixes are concerned, an overall similar accuracy in participants' answers across regions and experimental conditions is noticeable when comparing the plots relating to stem /o/ with the plots referring to stem /e/ shown in Fig. 5.4. In particular, participants from MM and MZ (including MZ participants responding to ZZ stimuli as well) exhibited a similar amount of right answers for /o/ stems in an /a/-suffix context, while the answers given by ZZ and MM listeners to ZZ stimuli were less accurate ($p < .01$ for all contrasts between both ZZ and MM listeners to ZZ stimuli and between the three regions, see Tab. 5.4 for details). A similar situation was also found for contrasts in /u/-suffix contexts ($p < .001$ for all significant contrasts, see Tab. 5.4 for details), with the only two exceptions being the contrasts between outer-region MM and MZ listeners to ZZ stimuli, and between MM and MM listeners to ZZ stimuli, which were non-significant.

With regard to the /e/-suffix context, all regions performed generally better for stem /o/ than for stem /e/ (see Fig. 5.4, lower half, second row), but there were no statistically significant differences between regions or experimental conditions in this same suffix context.

Suffix vowel	**Regions**	***m***	***SE***	***z*-ratio**	**Sig.**
a	MM – ZZ	0.77	0.23	3.3	**
	MM – MZ	-0.87	0.23	-3.7	**
	MM – ZZ (MM listeners)	0.94	0.32	2.9	*
	ZZ – MZ	-1.64	0.23	-7.1	***
	ZZ – ZZ (MZ listeners)	-1.46	0.22	-6.6	***
	MZ – ZZ (MM listeners)	1.81	0.32	5.7	***
	ZZ (MM listeners) – ZZ (MZ listeners)	-1.63	0.31	-5.2	***
e	MM – ZZ (MZ listeners)	0.86	0.25	3.4	**
	ZZ – MZ	-0.74	0.21	-3.4	**
	ZZ – ZZ (MZ listeners)	0.59	0.16	3.6	**
	MZ – ZZ (MZ listeners)	1.34	0.25	5.4	***
	ZZ (MM listeners) – ZZ (MZ listeners)	0.97	0.28	3.5	**
i	MM – MZ	-1.57	0.22	-7.1	***
	ZZ – MZ	-1.81	0.22	-8.2	***
	ZZ – ZZ (MZ listeners)	-0.70	0.17	-4.1	***
	MZ – ZZ (MM listeners)	2.30	0.31	7.3	***
	MZ – ZZ (MZ listeners)	1.10	0.25	4.3	***
	ZZ (MM listeners) – ZZ (MZ listeners)	-1.20	0.28	-4.2	***
u	MM – MZ	-1.56	0.24	-6.6	***
	ZZ – MZ	-1.79	0.24	-7.3	***
	MZ – ZZ (MM listeners)	1.75	0.35	4.9	***
	MZ – ZZ (MZ listeners)	1.55	0.28	5.4	***

Table 5.3: The estimated mean (m, expressed in log odds) and standard error (SE) of the statistically significant contrasts related to the amount of correct answers between regions for stem /e/ and separately for suffix vowel context, including the associated post-hoc z-statistics (final two columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Suffix vowel	**Regions**	***m***	***SE***	***z*-ratio**	**Sig.**
a	MM – ZZ	0.78	0.17	4.6	***
	MM – ZZ (MM listeners)	0.99	0.27	3.6	**
	ZZ – MZ	-1.02	0.16	-6.5	***
	ZZ – ZZ (MZ listeners)	-0.67	0.17	-3.9	***
	MZ – ZZ (MM listeners)	1.23	0.26	4.6	***
	ZZ (MM listeners) – ZZ (MZ listeners)	-0.88	0.27	-3.2	*
i	MM – ZZ (MM listeners)	0.87	0.32	2.7	*
	ZZ - ZZ (MM listeners)	0.86	0.30	2.9	*
	ZZ (MM listeners) – ZZ (MZ listeners)	-0.92	0.32	-2.8	*
u	MM – ZZ	0.64	0.18	3.5	**
	ZZ – MZ	-0.88	0.17	-5.1	***
	ZZ – ZZ (MZ listeners)	-0.57	0.20	-2.9	*
	MZ – ZZ (MM listeners)	0.89	0.28	3.1	*

Table 5.4: The estimated mean (m, expressed in log odds) and standard error (SE) of the statistically significant contrasts related to the amount of correct answers between regions for stem /o/ and separately for suffix vowel context, including the associated post-hoc z-statistics (final two columns; *** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$).

Correct answers and stem vowel height (s_1)

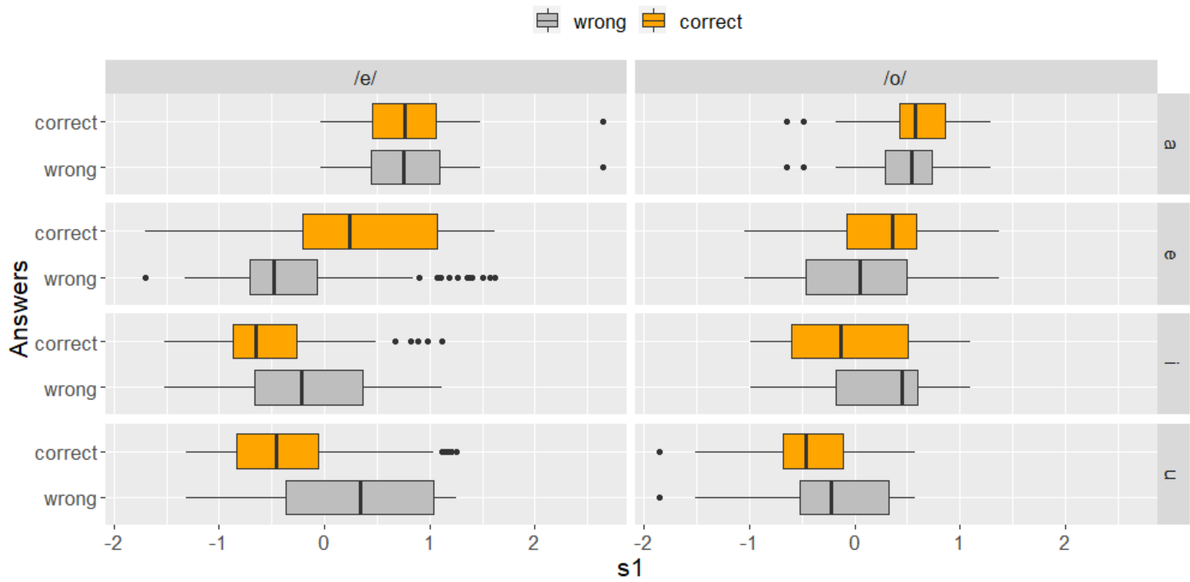

Figure 5.5: Boxplots showing the s_1 values of the stem vowels of the acoustic stimuli (x-axis) separately for correct and wrong answers given by the participants across all experiments.

A visual suggestion that answer accuracy might mainly depend on acoustic correlates such as stem vowel height (modulated by s_1, see FPCA analysis in Chapter 3) is given by Fig. 5.5. For both stem vowels /e/ and /o/, most correct answers (orange boxplots) across all regions in high-suffix contexts /i, u/ (last two rows) were given when the s_1 values of the stem vowel (x-axis) were lower (see Chapter 3 for a discussion of how low s_1 values correspond to increasing vowel height for both stems /e, o/). Consequently, in the next sections, the focus is conveniently shifted onto the participants' response values (ranging from 0 to 100, see also Section 5.2.3) predicted by the LMER models (5.2) and (5.3), and in particular on how participants' responses were dependent on the acoustic correlates of the stem vowel – i.e. vowel height and degree of diphthongisation, expressed by the PC-scores s_1 and s_3 respectively, see Chapter 3 – and also on differences between regions and experimental conditions.

5.3.2 Relationship between response and s_1

The F-statistic illustrated in Tab. 5.5 confirmed that all fixed factors of the LMER models applied separately for stem vowel (Section 5.2.4, model (5.2)) proved to be significant for both stem vowels /e, o/, with the only exception being the region factor for stem /o/. Therefore, the results are further discussed in terms of slope coefficients of linear trends (Tabs. 5.6 and 5.7) and post-hoc tests.

Stem vowel	Fixed factors	Statistic	Probability
/e/	s_1	$F[1, 9079.9] = 338.3$	$p < .001$
	Suffix vowel	$F[3, 17.5] = 185.0$	$p < .001$
	Region	$F[4, 121.3] = 3.7$	$p < .01$
	s_1 * Suffix vowel	$F[3, 11240.1] = 44.0$	$p < .001$
	s_1 * Region	$F[4, 11711.7] = 24.4$	$p < .001$
	Region * Suffix vowel	$F[12, 12713.7] = 17.6$	$p < .001$
	s_1 * Region * Suffix vowel	$F[12, 12323.3] = 9.1$	$p < .001$
/o/	s_1	$F[1, 6448.6] = 205.0$	$p < .001$
	Suffix vowel	$F[3, 49.9] = 112.0$	$p < .001$
	Region	$F[4, 113.6] = 0.3$	n. s.
	s_1 * Suffix vowel	$F[3, 13097.3] = 12.6$	$p < .001$
	s_1 * Region	$F[4, 7133.1] = 7.9$	$p < .001$
	Region * Suffix vowel	$F[12, 13027.4] = 8.5$	$p < .001$
	s_1 * Region * Suffix vowel	$F[12, 12985.7] = 5.4$	$p < .001$

Table 5.5: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the LMER model (5.2) carried out separately for stem vowel and using the participants' responses as the dependent variable.

Figs. 5.6 and 5.7 are interaction plots of estimated marginal means (EMMs) obtained from the fixed factors of the LMER models (i.e. model (5.2) applied separately to stem /e/ and stem /o/). In particular, they show the linear trend (either positive or negative, depending on the direction of the slope) of the relationship between the participants' response (in the plots "Predicted response", y-axis) and the PC-score s_1, indicating either vowel raising or lowering: increasing s_1 values indicate vowel lowering, decreasing s_1 values indicate vowel raising, i.e. metaphony by definition. As regards the participants' response (y-axis), its value could vary between 0 and 100 (see Section 5.2.3). A score above 50 basically meant that the participant perceived the lexical stem as metaphonic (i.e. he/she perceived that it was either a masculine singular /u/-suffixed form or a plural /i/-suffixed form), while a score below 50 meant that the stem was perceived as non-metaphonic (i.e. either a feminine singular /a/-suffixed form or a singular /e/-suffixed form). In the case of correct word recognition, one would expect a *negative* slope between s_1 and the response for both stem vowels /e, o/. In other words, if the s_1 value decreases, the response value should increase, given that higher (and metaphonic) stem vowels have lower s_1 values. Consequently, in such cases, participants' responses were expected to be high. On the contrary, the lower the stem vowel, the higher the s_1 score, so a lower participants' response was expected.

Stem /e/

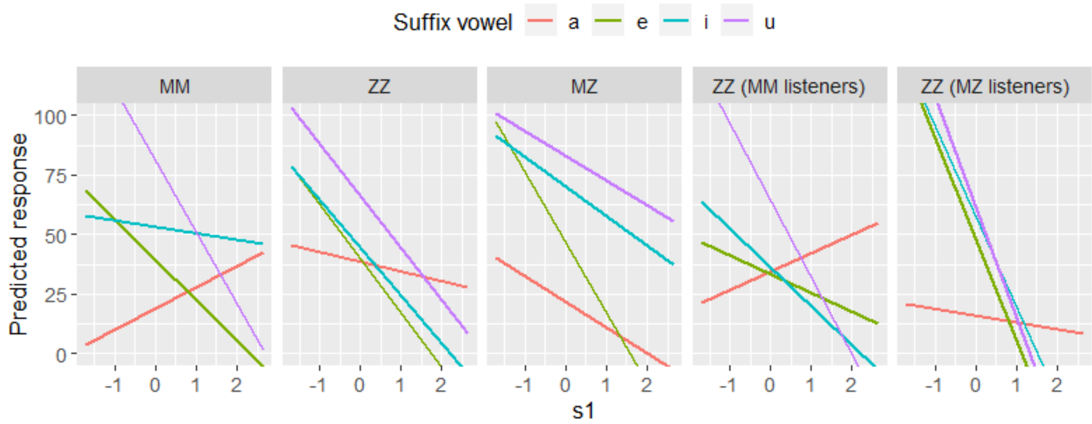

Figure 5.6: Interaction plots of EMMs for stem /e/ estimating slope coefficients for participants' response (y-axis) against s_1 (x-axis: $s_1 < 0$ signals vowel raising, $s_1 > 0$ signals vowel lowering) for each suffix vowel, separately by region/experimental condition.

Fig. 5.6 shows that for stem vowel /e/ the predicted negative trend for the response (y-axis) against s_1 (x-axis) was present for most suffix vowel contexts, with the only two exceptions represented by /a/-suffixed stems (red lines) in MM and for MM listeners exposed to ZZ stimuli (first and fourth panel respectively), where the slope took the opposite direction. The negative trend shown by the rest of the data was stronger (which translates in graphical terms as follows: the steeper the line, the stronger the relationship) for some specific suffixes within each region and experimental condition. Tab. 5.6 reports the estimated marginal mean values for the fixed effects of the model (5.2) applied to stem /e/, in which each row refers to a different suffix vowel. Column "s_1 trend" lists slope coefficients, each one reporting the effect of an increase of one unit in s_1 on the response (i.e. the dependent variable). These effects could be considered significant only when lower and upper confidence levels of the predicted coefficients did not include 0 (meaning that the slope steepness, and consequently the trend direction, could not be clearly established). As regards the trends shown in Fig. 5.6, almost all slopes were significant (i.e. slope coefficients' confidence levels did not include 0) with the following exceptions: MM, suffix /i/; ZZ, suffix /a/; ZZ (MM listeners), suffixes /a, e/; ZZ (MZ listeners), suffix /a/ (all statistical details about the estimated means are listed in Tab. 5.6).

The relationship between s_1 and response for each different region and experimental condition and across suffixes was significantly stronger for ZZ than for MM ($t_{10420} = 3.2$, $p = .01$); stronger for ZZ (MZ listeners) than for MM ($t_{11675} = 8.6$, $p < .001$); for ZZ (MZ listeners) vs ZZ ($t_{13048} = 8.0$, $p < .001$); for ZZ (MZ listeners) vs MZ ($t_{11678} = 7.5$, $p < .001$); for ZZ (MZ listeners) vs ZZ (MM listeners) ($t_{13053} = 6.1$, $p < .001$).

Stem /o/

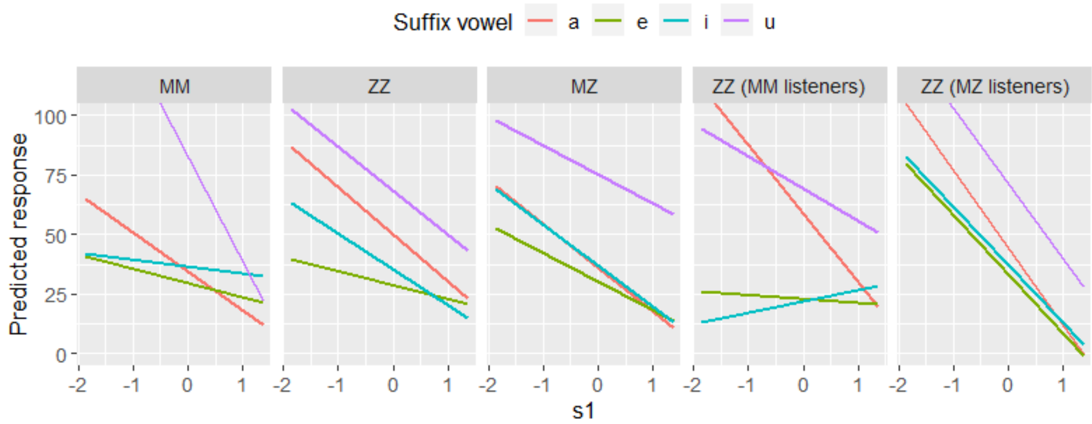

Figure 5.7: Interaction plots of EMMs for stem /o/ estimating slope coefficients for participants' response (y-axis) against s_1 (x-axis: $s_1 < 0$ signals vowel raising, $s_1 > 0$ signals vowel lowering) for each suffix vowel, separately by region/experimental condition.

Fig. 5.7 shows the interaction between s_1 (x-axis) and the response (y-axis) for stem /o/. The predominantly negative trend across all suffixes and regions is confirmed (the only exception is suffix /i/ in MM listeners to ZZ stimuli, fourth panel), in spite of differences in slope between suffixes and regions. As for stem /e/, a minority of slopes was non-significant; these were the following: MM, suffixes /e, i/, and ZZ (MM listeners), suffixes /i, u/ (all statistical details about the estimated means are listed in Tab. 5.7).

As far as regional differences are concerned, the relationship between s_1 and the response was significantly stronger in ZZ (MZ listeners) than in MM ($t_{5338} = 3.2$, $p = .01$), stronger in ZZ (MZ listeners) than in ZZ ($t_{13405} = 5.0$, $p < .001$), in ZZ (MZ listeners) than in MZ ($t_{12372} = 4.8$, $p < .001$) and in ZZ (MZ listeners) than in ZZ (MM listeners) ($t_{13436} = 4.1$ $p < .001$). Other than that, no other significant contrasts between regions were found. Furthermore, it is interesting to notice that, as for stem /e/, the averaged contrast across the four suffixes between MM and MZ, which were the two regions which most diverged in metaphonic production, was non-significant.

Summary

In summary, MZ was the most consistent region with regard to the expected negative trend between s_1 and participants' responses for all suffixes and both stem vowels (all slopes were significant and ran in the expected direction). Nevertheless, also ZZ and MM exhibited a comparable trend (in some cases slope coefficients were even higher than those for MZ, see Tabs. 5.6 and 5.7), although this was not always significant. By zooming into ZZ stimuli experiments, we can see that the relationship between stem vowel height (s_1) and response was strongest for MZ listeners exposed to the ZZ stimuli (in some cases also stronger than for ZZ listeners exposed to the same stimuli), while this relationship was much weaker for MM listeners exposed to ZZ stimuli. Overall, participants from all regions and experimental conditions strongly relied on stem vowel height to guess the vowel quality of the artificially cut-off suffix, even though there were different degrees of significance and also differences between suffix vowel types.

As regards metaphonic suffix vowels, a general predominance of a negative trend for the response against s_1 for suffix /u/ (the purple line in the plots in Figs. 5.6 and 5.7) was noticeable across all regions and conditions, while suffix /i/ did not always show the same degree of correlation (light blue line in the plots). The fact that the relationship between response and s_1 in suffix-/i/ contexts was, in general, not as strong as for suffix /u/ – this was especially true for stem /e/ – is evident not only when looking at the plots, but was also confirmed by the generally highly negative slope coefficients for suffix /u/ (see s_1 trend values for /u/ suffixes in Tabs. 5.6 and 5.7).

	Suffix vowel	**s_1 trend**	***SE***	***df***	**lower CL**	**upper CL**
MM	a	9.0	4.0	7624	1.1	16.9
	e	**-16.9**	4.7	12817	-26.1	-7.7
	i	-2.6	3.8	12029	-10.1	4.8
	u	**-30.2**	2.7	8400	-35.5	-24.9
ZZ	a	-4.1	2.3	12212	-8.6	0.4
	e	**-22.7**	1.8	4724	-26.3	-19.1
	i	**-20.0**	1.9	10919	-23.7	-16.3
	u	**-21.8**	2.1	12202	-25.8	-17.7
MZ	**a**	**-10.8**	3.5	10762	-17.8	-3.8
	e	**-29.5**	1.1	11483	-31.7	-27.3
	i	**-12.4**	3.0	9534	-18.4	-6.4
	u	**-10.3**	2.9	12179	-15.9	-4.6
ZZ (MM listeners)	a	7.6	7.1	13085	-6.2	21.5
	e	-7.8	4.7	12775	-17.1	1.5
	i	**-16.1**	5.2	13119	-26.4	-5.8
	u	**-32.1**	5.9	13080	-43.8	-20.5
ZZ (MZ listeners)	a	-2.8	3.9	13047	-10.5	4.9
	e	**-42.8**	3.0	10207	-48.7	-36.9
	i	**-38.0**	3.2	12883	-44.4	-31.7
	u	**-46.5**	3.6	13047	-53.6	-39.4

Table 5.6: Estimated marginal mean values for the fixed effects of the model (5.2) applied to stem /e/, including standard error (SE), degrees of freedom (df), and confidence levels. Significant trends in the expected direction are highlighted in bold.

	Suffix vowel	s_1 trend	*SE*	*df*	lower CL	upper CL
MM	**a**	**-16.4**	3.8	7059	-23.8	-9.0
	e	-6.0	3.6	6941	-13.2	1.1
	i	-2.9	2.9	2634	-8.7	2.7
	u	**-44.3**	5.3	7391	-54.7	-33.8
ZZ	**a**	**-19.7**	3.3	12464	-26.1	-13.2
	e	**-5.8**	2.7	9080	-11.1	-0.5
	i	**-15.0**	2.1	12662	-19.1	-10.9
	u	**-18.5**	2.9	12767	-24.2	-12.8
MZ	**a**	**-18.4**	3.4	9795	-25.1	-11.7
	e	**-12.0**	1.6	5200	-15.2	-8.8
	i	**-17.2**	1.9	10671	-20.9	-13.5
	u	**-12.2**	2.4	10394	-16.9	-7.4
ZZ (MM listeners)	**a**	**-28.5**	8.9	13451	-45.9	-11.2
	e	-1.7	7.5	13466	-16.4	13.0
	i	4.6	6.2	13440	-7.5	16.9
	u	-13.6	8.0	13451	-29.3	2.1
ZZ (MZ listeners)	**a**	**-32.7**	5.8	13425	-44.1	-21.3
	e	**-24.9**	4.6	12917	-33.9	-15.9
	i	**-24.5**	3.7	13425	-31.8	-17.2
	u	**-31.8**	5.1	13444	-41.9	-21.7

Table 5.7: Estimated marginal mean values for the fixed effects of the model (5.2) applied to stem /o/, including standard error (SE), degrees of freedom (*df*), and confidence levels. Significant trends in the expected direction are highlighted in bold.

5.3.3 Relationship between response and s_3

The relationship between participants' response and degree of diphthongisation in the stem vowel was analysed exclusively for responses to ZZ audio stimuli (see also Section 5.2.4), since opening diphthongisation is the typical feature of metaphonic stems in ZZ only (as observed also from the acoustic analyses in Chapter 3). Both within-region and outer-region responses were analysed and compared.

The F-statistic (Tab. 5.8) confirmed the principal role of s_3 (both alone and in interaction with the suffix vowel) in influencing participants' response. Dissimilarly to F-statistics for s_1, however, not all fixed factors or fixed factors interactions were statistically significant (see Tab. 5.8 for details).

Stem vowel	Fixed factors	Statistic	Probability
/e/	s_3	$F[1, 4686.2] = 252.8$	$p < .001$
	Suffix vowel	$F[3, 11.8] = 23.9$	$p < .001$
	Region	$F[2, 112.1] = 1.6$	n. s.
	s_3 * Suffix vowel	$F[3, 4946.5] = 1.0$	n. s.
	s_3 * Region	$F[2, 5228.5] = 15.1$	$p < .001$
	Region * Suffix vowel	$F[6, 5214.7] = 8.8$	$p < .001$
	s_3 * Region * Suffix vowel	$F[6, 5209.9] = 3.5$	$p < .01$
/o/	s_3	$F[1, 3123.0] = 14.1$	$p < .001$
	Suffix vowel	$F[3, 31.1] = 60.9$	$p < .001$
	Region	$F[2, 114.4] = 0.0$	n. s.
	s_3 * Suffix vowel	$F[3, 3575.5] = 0.3$	n. s.
	s_3 * Region	$F[2, 5532.9] = 1.5$	n. s.
	Region * Suffix vowel	$F[6, 5535.3] = 5.5$	$p < .001$
	s_3 * Region * Suffix vowel	$F[6, 5542.5] = 1.6$	n. s.

Table 5.8: A summary of the F-statistic (Type III ANOVA) and probability for the fixed factors and their interactions for the LMER model (5.3) carried out only for experiments with ZZ stimuli, separately for stem vowel, and using the participants' response as the dependent variable.

The results are further discussed in terms of slope coefficients of linear trends (Tabs. 5.9 and 5.10) and post-hoc Tukey tests (see below). Figs. 5.8 and 5.9 are interaction plots of EMMs obtained from the fixed factors of the LMER models applied to responses to ZZ stimuli only (i.e. model (5.3) applied separately for stem /e/ and stem /o/). In a similar fashion to the interaction plots shown before, these plots show the linear trend (either positive or negative, depending on the direction of the slope) between the participants' response (in the plots "Predicted response", y-axis) and the PC-score s_3, indicating the type and degree of diphthongisation: increasing s_3 values indicate progressively opening diphthongisation – exactly the type of diphthongisation we would expect in metaphonic stems, so e.g. /e/ → [jɛ, ie]; /o/ → [wɔ, uo], while decreasing s_3 values indicate a progressive closing diphthongisation, e.g. /e/ → [ɛi, ei]; /o/ → [ɔu, ou]. In the case of correct word recognition, and given that a response above 50 indicated that the participant perceived the stem as metaphonic (i.e. either a /u/ or /i/-suffixed form), we would expect that there is a *positive* trend for the response against s_3. This means that if the s_3 value increases, then the response value should increase as well, i.e. the higher s_3 is, the more clearly perceivable the metaphonic diphthong is. On the contrary, the lower the s_3 score, the lower the participants' response value should be, since the formant curvature associated with low s_3 scores does not correspond to a typical metaphonic diphthong. The positive trend was expected for all suffix vowel contexts and for both stem vowels /e, o/.

Stem /e/

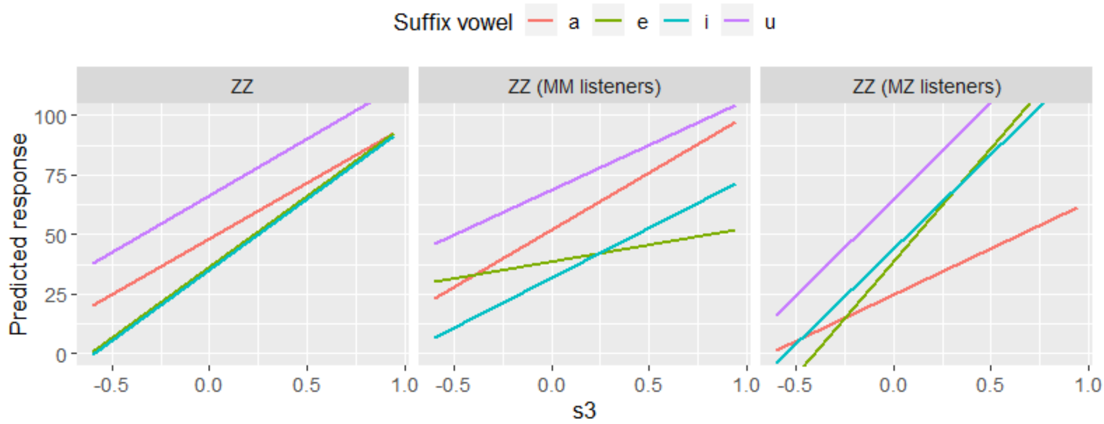

Figure 5.8: Interaction plot of EMMs for stem /e/ estimating slope coefficients for participants' response (y-axis) against s_3 (x-axis: $s_3 < 0$ signals closing diphthongisation, $s_3 > 0$ signals opening diphthongisation) for each suffix vowel, separately by experimental condition.

Almost all fixed factors and fixed factor interactions of the LMER model (5.3) applied to stem /e/ proved to be highly significant ($p < .001$), with only two exceptions: the experimental condition was not a significant factor in itself ($F[2, 112.1] = 1.6$, $p > .05$) as well as s_3 in interaction with the suffix vowel ($F[3, 4946.5] = 1.0$, $p > .05$; see also Tab. 5.8).

Fig. 5.8 shows that for stem vowel /e/ the expected positive trend for the response (y-axis) against s_3 (x-axis) was present for all suffixes, without any exception. Tab. 5.9 reports the estimated marginal mean values for the fixed effects of the model (5.3) applied to stem /e/, in which each row refers to a different suffix vowel. Similarly as for the s_1 analysis, column "s_3 trend" lists slope coefficients, each one reporting the effect of an increase of one unit in s_3 on the response (i.e. the dependent variable). Significant effects were only those in which lower and upper confidence levels did not include 0. As regards the trends shown in Fig. 5.8, only one slope was non-significant, i.e. the one for suffix /e/ in ZZ (MM listeners), while all other slopes were significant and all exhibited a trend in the expected direction (see Tab. 5.6 for further details). Also, within each condition all significant slopes were not significantly different from one another.

The trend of the relationship between s_3 and response in perception for each different experimental condition and averaged across suffixes was significantly stronger for ZZ than for MM listeners ($t_{5252} = 2.5$, $p = 0.02$); stronger for MZ listeners than for MM listeners ($t_{5246} =$ -4.9, $p < .001$) and for MZ than ZZ listeners ($t_{5217} =$ -4.4, $p < .001$).

Stem /o/

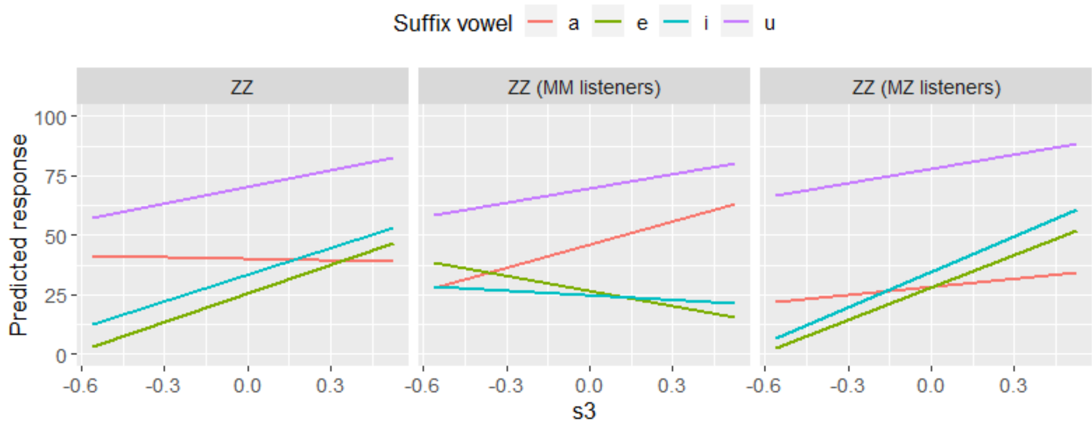

Figure 5.9: Interaction plot of EMMs for stem /o/ estimating slope coefficients for participants' response (y-axis) against s_3 (x-axis: $s_3 < 0$ signals closing diphthongisation, $s_3 > 0$ signals opening diphthongisation) for each suffix vowel, separately by experimental condition.

In comparison to what was shown by the LMER models applied to stem /e/, the fixed factors and fixed factor interactions of the LMER model described in (5.3) applied to stem /o/ proved to be highly significant ($p < .001$) only in three cases, while all other fixed factors or fixed factor interactions were non-significant: s_3 was significant ($F[1, 3123.0] = 14.1$, $p < .001$) as well as the suffix vowel ($F[3, 31.1] = 60.9$, $p < .001$) and the experimental condition in interaction with the suffix vowel ($F[6, 5535.3] = 5.5$, $p < .001$, see also Tab. 5.8).

Fig. 5.9 shows that for stem vowel /o/ the predicted negative slope of the response (y-axis) against s_3 (x-axis) was present for most suffixes, with the following exceptions: ZZ, suffix /a/, and ZZ (MM listeners), /e, i/ suffixes. Tab. 5.10 shows further details relating to the estimated marginal mean values of the slope coefficients for the fixed effects of the model (5.3) applied to stem /o/, in which each row refers to a different suffix vowel. As regards the trends shown in Fig. 5.8, the following slopes were non-significant: ZZ, suffix /a/; ZZ (MM listeners), all suffixes; ZZ (MZ listeners), /e, i/ suffixes (see Tab. 5.10 for further details). Also, all significant slopes were not significantly different from one another.

Interestingly, while for stem /e/ there were some differences between the three experimental conditions, in this case there were no significant contrasts between the estimated slope coefficients for the three different conditions, neither by averaging results over the four suffix vowels, nor by taking each suffix vowel category into account.

Summary

While results for s_1 were overall comparable between the two stems, with regard to s_3 some striking differences could be observed between responses to stem /e/ and stem /o/.

In particular, results for /e/ stems showed a generally significant positive trend of the response against s_3, while a considerable part of stem /o/ slopes were non-significant and/or exhibited a negative trend, which was not the expected direction according to the initial hypotheses. Also, some differences emerged for stem /e/ between the three experimental conditions, while no significant contrasts were found between the three conditions for stem /o/. Nevertheless, both analyses jointly suggested that opening diphthongisation was, overall, an important acoustic cue for listeners from any of the three region to discriminate metaphonic from non-metaphonic lexical stems in ZZ stimuli.

Generalising the results obtained for stem /e/ and stem /o/, it could be noticed that the suffix vowel type played a very marginal role in determining the trend direction. Instead, an important factor was the experimental condition, or explicitly, to which region the listeners exposed to ZZ stimuli came from. For both stems, the positive trend between s_3 and response was the strongest for MZ listeners, in between for ZZ listeners, and least strong for MM listeners. These results suggest that, for both stem /e/ and stem /o/ stimuli, MZ listeners relied on diphthongisation acoustic cues *more* than ZZ listeners exposed to the same ZZ stimuli, while MM listeners were least sensitive to diphthongisation cues. However, in spite of these differences, the results from all three groups of listeners were overall comparable, since a relatively consistent presence of a positive trend between s_3 and the response was found for all three conditions.

	Suffix vowel	**s_1 trend**	***SE***	***df***	**lower CL**	**upper CL**
ZZ	**a**	**46.7**	6.6	5016	33.8	59.6
	e	**59.1**	4.9	4608	49.4	68.9
	i	**59.3**	4.9	4802	49.7	69.0
	u	**47.2**	5.1	4587	37.2	57.2
ZZ (MM listeners)	**a**	**47.8**	15.1	5248	18.2	77.4
	e	14.1	13.07	5230	-11.6	39.7
	i	**41.6**	12.6	5243	17.0	66.3
	u	**37.6**	13.4	5234	11.3	64.0
ZZ (MZ listeners)	**a**	**38.7**	9.9	5210	19.2	58.2
	e	**95.1**	8.3	5171	78.8	111.3
	i	**79.6**	8.1	5188	63.7	95.4
	u	**80.7**	8.6	5173	63.8	97.5

Table 5.9: Estimated marginal mean values for the fixed effects of the model (5.3) applied to stem /e/, ZZ stimuli only, including standard error (SE), degrees of freedom (*df*), and confidence levels. Significant trends in the expected direction are highlighted in bold.

	Suffix vowel	s_1 trend	SE	df	lower CL	upper CL
ZZ	a	-1.8	8.1	1536	-17.7	14.1
	e	**39.9**	12.4	3446	15.7	64.2
	i	**37.6**	9.6	2472	18.7	56.5
	u	**23.1**	6.9	3988	9.5	36.7
ZZ (MM listeners)	a	32.6	19.7	5334	-6.0	71.2
	e	-20.6	32.7	5511	-84.8	43.5
	i	-6.5	26.2	5518	-57.8	44.8
	u	20.3	18.5	5553	-15.9	56.6
ZZ (MZ listeners)	a	11.3	12.5	4009	-13.1	35.8
	e	**45.3**	21.8	5308	2.7	88.0
	i	**49.3**	16.0	4965	17.9	80.7
	u	20.1	11.8	5348	-3.0	43.3

Table 5.10: Estimated marginal mean values for the fixed effects of the model (5.3) applied to stem /o/, ZZ stimuli only, including standard error (SE), degrees of freedom (df), and confidence levels. Significant trends in the expected direction are highlighted in bold.

5.4 Discussion

The analyses in this chapter focused on within-region perception of metaphony in the Lausberg area for MM, ZZ, and MZ separately, and also tested perception of outer-region forms of metaphony by means of ZZ stimuli. The experiments were designed so that participants only had the stem vowel at their disposal to recognise the morpho-lexical inflectional mark (either masculine/feminine or singular/plural), which would otherwise be carried by the suffix vowel. Not only correct and wrong answers were counted, but the forced choice experiments by means of a VAS also allowed participants to express how sure they were about the correct answer. The experiment was designed so that a negative trend for the response (whose value could vary from 0 to 100) against s_1 was expected if the participants used the vowel height cue correctly in order to guess the suffix. Instead, a positive trend for the response against s_3 signalled that listeners to ZZ stimuli could use diphthongisation cues in order to distinguish metaphonic stems from non-metaphonic ones.

The results showed that the accuracy of participants from all three regions for guessing the inflectional category was comparable, although participants from the MZ region exhibited better accuracy and a more consistent relationship between s_1 and response. As far as responses to ZZ stimuli were concerned, all three regions relied on diphthongisation acoustic cues to distinguish metaphonic stems from non-metaphonic ones. Participants from the MZ region, however, once again showed that they were able to most accurately identify such stems, and also exhibited the strongest positive trend for the response against s_3. As far as suffix vowels were concerned, the /u/-suffixed words were, in general, more easily recognisable – also in terms of the relationship between response and s_1 and s_3 – than the /i/-suffixed ones. This fact mirrors the more marked articulatory and acoustic distance between a low suffix such as /a/ and a high one such as /u/, which consequently results in major coarticulatory differences in the stem vowel (an aspect that also emerged in Section 2.3.4 and that was also indirectly taken into account in Appendix F.4, last paragraph). Also, a partial explanation for the fact that stem /o/ presented the most non-significant slopes, as well as the lowest rate of correct answers for suffix /i/, might be that some of the lexical stems used for the experiments were either less affected by metaphony, or alternatively (with respect to the analysis involving s_3) less affected by diphthongisation (see Appendix F for a discussion of lexical exceptions to metaphony).

These results confirm, in general, that, in spite of having different forms and also degrees of metaphony, all three regions can attribute a morpho-lexical meaning to metaphonic changes in stem vowel quality. With reference to the hypotheses formulated at the beginning of the chapter (Section 5.1.3), it was confirmed that all three regions performed overall well in recognising stems, since MZ only performed slightly better than the other two regions, while ZZ did not generally perform better than MM in the within-region-listeners condition. Also, ZZ stimuli were recognised better from MZ listeners rather than MM listeners in the outer-region condition, so the first hypothesis regarding this condition was confirmed. The hypothesis stating that the suffix pair /a, u/ should be more recognisable than words with /e, i/ suffix pairs was generally confirmed, too, although the main variation between the results was observed across regions and conditions. In more general terms, the main finding of this analysis was that MZ is only slightly more advanced in perception compared with the other two regions, while both MM and ZZ listeners were very accurate in distinguishing metaphonic stems from non-metaphonic ones, with an accuracy which was in general only slightly inferior to MZ (as Figs. 5.3 and 5.4 clearly showed).

In the light of the experiments' results, it is evident that the listeners used both vowel height and diphthongisation cues in order to attribute the morpho-lexical mark on the stem, regardless of which kind of metaphony they were listening to, and of whether the listeners were speakers of a variety with a very marked metaphony (such as in MZ dialects) or not (such as in the MM dialect). The presence of misalignment between production and perception has already been found for other kinds of sound change (in progress) in other languages (e.g. British English and East Franconian, see Harrington et al., 2012; Kleber et al., 2012; see also Ohala, 1990, 2012, 1993). In spite of being the metaphonic vowel shift described in Chapter 3 plausibly no more in process (as the results from these perception experiments combined with the production data discussed in the previous chapters also show), it is evident that MM speakers in particular show such a mismatch, which in metaphonic terms translates into a minor coarticulation in production between stem and suffix when compared to the other two regions, but a relatively high accuracy in perception when it comes to guessing the suffix vowel by only relying on the coarticulatory cues influencing stem vowel quality.

Perception and production do not therefore, in light of these data, exist in a one-to-one relationship – even if, at the moment, we do not have proof than in MM a metaphonic sound change is still in progress. On the contrary, we are possibly dealing with an already concluded sound change, whose three main phases (see Section 3.4) are now fossilised in the three regions of MM, ZZ and MZ respectively. The fact that MZ speakers were only slightly better than MM ones in distinguishing metaphonic and non-metaphonic stems in ZZ stimuli might be just another confirmation that listeners from MZ have reached the most extreme stage of metaphony possible, so that they might be the most sensitive ones to changes in the stem vowel, diphthongisation cues included.

The analyses presented in this chapter represent, to my knowledge, the first perceptual experiments in the Lausberg area. Previously, perceptual studies carried out in the area only aimed to categorise its varieties (Conte, 2014) according to speakers'/hearers' subjective impressions of dialect stimuli – that is, by asking informants whether they perceived the either written or auditive stimuli as belonging to their own dialectal variety or not. These types of surveys, which are typical for perceptual dialectology (see e.g. Krefeld and Pustka, 2010; Krefeld, 2020), do have an empirical basis, but it is one built on impressions. These studies lack, therefore, a strong experimental basis, which is especially necessary when the focus is on phonological or morphological detail. The study by Conte (2014) nevertheless serves to underline the fact that, in spite of dialectal fragmentation within the Lausberg area, in more recent times there has been more contact between the single communities, so that the speakers have a good general picture of what distinguishes one single dialect from another, at least as regards bordering villages. This is just what emerged in the outer-region experiments with ZZ stimuli: overall, both MM and MZ speakers (with MZ listeners performing slightly better) showed that they were able to interpret the metaphonic diphthongs they were exposed to as morpho-phonological cues to either the masculine singular or plural.

In this respect, the role of language contact between speakers of different varieties within the Lausberg area has also to be considered when interpreting the results of these perception experiments. In particular, participants from MM, ZZ and MZ showed that they were not only familiar with metaphonic forms inside and outside their regions, but also that they had an implicit metalinguistic knowledge, which could be consciously employed during the experiment. This mechanism might have contributed to the ability of outer-region listeners to ZZ stimuli to recognise diphthongising metaphony, and, in addition, this might also have pushed MM within-region listeners to pay more attention to the subtle contrasts between mid-high and mid-low stem vowels in metaphonic contexts (as emerged in the results discussed in Chapter 3).

Previous perception experiments on metaphony in other Southern Italian varieties showed the perceivability of metaphony also in non-lexicalised contexts. For example, the analyses carried out by Grimaldi et al. (2016) and by Miglietta et al. (2013) pointed out that the difference between mid-low and mid-high vowels can be perceived by speakers of varieties that have a type of metaphonic (allophonic) alternation similar to the one in MM, independently from lexical context, in a generally comparable way to how 'phonemic' and non-allophonic vowel pairs are perceived in contrast to one another (Grimaldi et al., 2016, p. 214). In this chapter, it has not only been confirmed that such 'light' forms of metaphony are perceivable in regions like MM as well, but it has also been explained how these vowel alternations act potentially as a morpho-syntactic discriminating feature morpho-phonologically encoded in MM speakers and listeners as well.

The results involving the perception of MM (i.e. Mormanno) stimuli might also imply that, in this variety, some changes have occurred to its original 'Sardinian' vowel system (see Section 1.1.3), which has, by definition, only two mid vowel phonemes /e, o/ and does not phonologically distinguish between mid-high and mid-low vowels. In contrast to this definition, mid-low and mid-high vowels might well have become two distinct phonemes in the Mormanno dialect (a similar suggestion for Mormanno was also advanced by Savoia, 2015, p. 256), given the fact that the participants were able to distinguish very well between the various stems in the lexical recognition task – i.e. word pairs such as e.g. [bɛll, bell] could be (in case of suffix deletion or neutralisation) minimal pairs, distinguishable just by the stem vowel. In these terms, an originally 'pentavocalic' vowel system has now become 'heptavocalic' (Trumper et al., 1991, p. 63; Chiodo and Trumper, 1999, p. 27), similarly to Italian vowel phonemes. However, it must also be considered that – at least as regards words produced in isolation – in Mormanno suffixes are not elided or neutralised as much as in MZ, i.e. the Mittelzone (as emerged from the suffix vowel analysis discussed in Chapter 4), so that we are not really dealing with minimal pairs here, but with *near* minimal pairs. However, it can be also assumed that the participants from Mormanno based their responses merely on the acoustic cue anticipating the artificially cut-off suffix by means of coarticulation, as has been the case in other experiments in which listeners have shown this ability, regardless (apparently) of further phonological implications (e.g. Beddor, 2009; Recasens, 1984, 2002; Whalen, 1990). The fact that metaphony-triggered allophones may, too, have their cognitive representation in the phonological system of a speaker's mind (Miglietta et al., 2013; Grimaldi et al., 2016) makes the task of precisely dividing phonemic from non-phonemic contrasts harder than one might expect. Regardless of these theoretical distinctions, however, it is indeed clear from these results that speakers from MM attributed morpho-syntactical information to the metaphonic stem vowel just as speakers from the ZZ and MZ regions do.

The results from the three regions are, to some extent, in line with the perceivability enhancing theory, already advanced by several phonologists analysing metaphony in various dialects (e.g. Barbato, 2008; Calabrese, 1985, 1998; Frigeni, 2003; Krämer, 2009; Savoia, 2016; Walker, 2005, see also Section 1.1.2), that a lost acoustic cue to a morpho-lexical mark must migrate to a more acoustically (and therefore perceptually) salient position within the prosodic word.

More generally, however, the findings related to the perception data presented in this chapter are also consistent with speech perception models Blevins, 2004, 2015; Fowler, 1984; Fowler and Smith, 1986; Garrett and Johnson, 2013; Ohala, 1990, 1993) in which listeners, who are sensitive to coarticulatory effects, base their mental categorisation of phonemes on the mapping of phonetic detail onto their mental phoneme inventory. In episodic models of speech following the so-called "Exemplar Theory", phonological categories are extracted and stand in a stochastic relationship to remembered speech signals (Pierrehumbert, 2003, 2006; Johnson, 1997). This knowledge is therefore located between remembered speech episodes and their phonological categorisation.

Applied to the present data (both acoustic and perception-based), an individual who has been exposed to the different Lausberg varieties analysed in this study in approximately equal measure is able to extract (perceptual) knowledge of the dynamic shapes of stem vowel formants and the main directions of variation across stem vowels that said individual has experienced and memorised. Therefore, an exemplary model of speech could explain the high accuracy shown in both within-region and outer-region conditions, and could also be consistent with the vowel shift patterns observed in the production data and discussed in the previous chapters.

Chapter 6

General discussion

6.1 Summary

The main aim of this thesis was to shed light on the general mechanisms behind the production and perception of metaphony and its relationship to vowel reduction in the Lausberg area, by means of a fully data-driven and experimental approach. These general mechanisms behind sound changes such as metaphony are important, both within historical linguistics and phonology in general, for understanding how diachronic sound change can arise from synchronic variation. The study also extended beyond phonetic detail by also taking into account the role of morphology and morpho-syntax in enhancing or inhibiting sound change. These aspects of research are therefore also relevant to general linguistics and its association with human speech processing.

On the one hand, there have been numerous theoretical studies of metaphony in Italian dialects, but most of them tend to be based on auditory impressions and are insufficiently supported by representative audio samples. As a consequence, variation has either potentially been underestimated in the past, or the studies conducted are now based on data that is no longer up-to-date. Also, most of these studies, even the most recent ones (see e.g. Torres-Tamarit et al., 2016) consist of purely abstract phonological accounts providing very little, if any, supporting acoustic and quantitative data. My study aimed to rectify this deficiency as much as possible by applying a fully experimental and data-based approach to metaphony in the Lausberg area, for which even fewer acoustic data analyses are available than those that can be found in the literature for other Southern Italian dialects.

Chapter 1 introduced the phenomenon of metaphony and suffix vowel reduction and their distribution with a particular focus on Southern Italy. Both phenomena were framed within phonological theory and their relationship to the main sound change theories was discussed. Also, a description of the Lausberg area and its subdivision was provided, with particular reference to the different metaphonic outcomes present in different regions. In the second part of the chapter, I introduced the research objectives of my work and the elicitation method used for the acoustic data later analysed using different tools and from different perspectives in Chapters 2 to 4. This elicitation method represented, to some extent, an innovation in traditional dialectology: in this field, data elicitation is usually reliant upon the use of translation tasks in which participants have to translate words or phrases from Standard Italian into the target dialect. Instead, I opted for a picture-naming task for all three lexical categories considered (nouns, adjectives and verbs) so as to elicit a dialectal production that was as spontaneous and genuine as possible. By using such a large variety of different elicited words, the aim was to capture all possible variations in metaphony by considering all possible lexical contexts. Additionally, speakers were recruited in such a way as to form a balanced sample with regard to region, sex and age, as far as was possible. The number of villages taken into account in this study was intended to be representative of the types of metaphony present in the three regions that were compared in this analysis.

Chapter 2 consisted of an exploratory analysis of the different degrees of metaphonic influence on the stem vowel carried out by taking into account the ages of the participants, the regions they stemmed from, as well as stem vowel and suffix vowel pairs (front vs back). This analysis included word pairs in which one of the two suffixes was a high vowel in order to calculate stem vowel formant differences. Once plotted, these differences showed the magnitude of metaphonic influence on the stem vowel separately for age, stem vowel, suffix vowel pair, and region. Confirmatory statistics were then run on the F1 and F2 formant values of stem vowels and suffix vowel pairs were considered separately. The results pointed to an overall less marked metaphonic influence for younger speakers, which was however in most cases non-significant. Instead, the differences in metaphonic influence between the three detected regions were solid and, in most cases, significant. Stem vowels in back suffix vowel contexts (/a, u/) showed more major metaphonic influence than in front suffix vowel contexts (/e, i/). Mid stem vowels exhibited the greatest metaphonic and coarticulatory effects, in line with previous literature on metaphony in the Lausberg area.

Chapter 3 focused on the mid stem vowels /e, o/, which were analysed separately, and on differences between the three regions Zwischenzone (ZZ), Mittelzone (MZ) and the one-village region Mormanno (MM). In this phase, all lexical items that had a mid stem vowel were taken into account, regardless of suffix vowel pairs. Therefore, the influence of the single suffix vowels /a, e, i, u/ was taken into account, in which /i, u/ were the metaphonic suffixes by definition. The application of FPCA allowed a dynamic analysis of formant shapes – the first of this kind applied to metaphony – and, in particular, was used to detect main shape variations in the acoustic data. Two principal components referred to vowel raising or lowering and opening or closing diphthongisation – PC1 and PC3 respectively. Added to the mean curve and multiplied by a specific score (either s_1 or s_3), these principal components allowed the mathematical reconstruction of the original formant pairs shapes. From the analysis it clearly emerged that PC1 was the main component modelling metaphonic formant shape variation in MM and MZ, while PC3 mainly modelled metaphony in ZZ. An important aspect that was novel compared to previous studies on metaphony in the Lausberg area was that in my data there was not only an influence of high suffix vowels, but the suffix vowel /a/ also triggered a significant vowel lowering. In general, coarticulation of vowel height was the main feature of the phonetic influence of the suffix vowel on the stem vowel. In MM and MZ, such coarticulatory effects were distributed along the whole stem vowel duration, while for ZZ they were mainly concentrated in the first half of the stem vowel, hence the diphthongal quality. The few lexical exceptions to such coarticulatory and metaphonic patterns were also discussed in a separate Appendix (F). The progressive metaphonic and coarticulatory strength clearly followed the progression MM < ZZ < MZ, i.e. metaphony/coarticulation was less marked in MM than in ZZ, and less marked in ZZ than in MZ. Finally, it was argued that metaphonic patterns for these three regions may represent three main sound change phases that are also diachronically linked according to the sequence MM < ZZ < MZ.

Chapter 4 analysed suffix vowel reduction and elision and in particular how these varied according to region. This chapter also represents the first acoustic and data-driven survey on suffix elision and reduction in the Lausberg area. As regards suffix elision, it emerged that this was most frequent in MZ, least in MM and in between the two in ZZ. In order to quantify suffix reduction, an *ad hoc* algorithm extracted a reduction index from each suffix vowel formant pair. Similarly to suffix elision, the degree of reduction mirrored the metaphonic sequence MM < ZZ < MZ, meaning that the suffix was not reduced as much in MM as in ZZ, while it was reduced more in ZZ than in MM, but less than in MZ. Differences between regions in the degree of both suffix vowel reduction and elision were generally also statistically significant. The search for a possible direct within-region or within-speaker correlation between either suffix elision or degree of suffix reduction and metaphonic strength was nevertheless inconclusive.

In **Chapter 5**, finally, metaphony was analysed from a perceptual perspective. Perception experiments were run in an online version and consisted of a lexical recognition task using the lexical stems deprived of the suffix. Such experiments represented a novelty for the Lausberg area and provided further data about perception of metaphony – an aspect which has, so far, received very little attention from researchers. Firstly, it was tested whether the three regions differed in how they perceived metaphonic and non-metaphonic stems produced by speakers from the same region. Although participants from all three regions showed great accuracy in distinguishing metaphonic stems from non-metaphonic ones, MZ listeners performed slightly, but significantly, better than MM and ZZ listeners. In parallel to what emerged in the acoustic analyses outlined in Chapters 2 and 3 – i.e. that the suffix vowels that have an overall greater coarticulatory influence on the stems are the back vowels /a, u/ – listeners could, generally, distinguish stems in word pairs with back suffixes /a, u/ (especially the /u/-suffixed forms) more easily than in pairs with front suffixes /e, i/. The correlation between the VAS response of the participants (converted into a value from 0 to 100) and the s_1 and s_3 scores (as indicators of degree of vowel raising or opening and of diphthongisation respectively) proved to run, overall, in the expected direction and to be significant across the three regions and, in particular, for the metaphonic suffixes. Secondly, it was also tested whether MM and MZ listeners differed when it came to distinguishing metaphonic from non-metaphonic stems in ZZ audio stimuli. MZ listeners performed slightly, but significantly, better than MM listeners in distinguishing the stems. Also, the correlation between s_1 and response, as well as between s_3 and response, was stronger for MZ listeners than MM listeners.

In the final section, it was discussed that the results of the perception test combined with the acoustic analyses pointed towards a speech processing model in which phonological knowledge is extracted from remembered speech phonetic categories and then mapped onto mental phonological categories. From this perspective, metaphony in the Lausberg area might have been a gradual phonologisation phenomenon, given that MZ speakers and listeners presented a clear-cut difference between metaphonic and non-metaphonic stems in both production and perception, while MM speakers presented far weaker metaphonic and coarticulatory effects in production, but exhibited very good levels of accuracy in distinguishing stems, almost comparable to MZ listeners. Asymmetry between production and perception is potentially at the basis of many types of sound change (Ohala, 2012, 1993) and consequently represents a further argument in favour of the hypothesis that metaphony in MM might represent the first phase of the metaphonic sound change that took place in the Lausberg area, followed by the phases represented by the other two regions.

In the following sections, I am going to discuss the most relevant findings and the arguments related to them presented in my dissertation within the framework of coarticulation and phonologisation theories, as well as from a geolinguistic point of view.

6.2 Metaphony between diatopy and diachrony

6.2.1 Coarticulation and phonologisation

An important issue at the basis of my analysis is how metaphony in the Lausberg area is connected to its phonetic origin, i.e. to synchronic vowel-to-vowel coarticulation. Since the first 'classic' coarticulatory analysis by Öhman (1966), transconsonantal VCV coarticulation has been well documented in many languages in acoustic (Cole et al., 2010; Whalen, 1990), articulatory (Alfonso & Baer, 1982; Butcher & Weiher, 1976; Fowler & Brancazio, 2000; Hoole & Pouplier, 2017; Recasens, 1984), and perceptual (Beddor et al., 2002; Fowler, 2005; Harrington, Kleber, & Reubold, 2013; Lehiste & Shockey, 1972) studies. Analyses of speech perception and coarticulation show that listeners are not only sensitive to anticipatory V_2 information in V_1 (Alfonso & Baer, 1982; Fowler & Smith, 1986; Martin & Bunnell, 1982), but also that they differ in the extent to which they parse acoustic cues with the source that originated them. For example, Beddor et al. (2002) showed for both of their investigated languages (English and Shona) that perceptual compensation for V_1CV_2 coarticulation was never perfect, which means that some of the coarticulatory influences of V_2 remained perceptually attached to V_1, i.e. were not parsed with V_2 (see also Beddor (2012), Beddor and Krakow (1999); and Fowler and Brown (2000) for similar results concerning the perception of coarticulatory nasalisation in a vowel preceding a nasal consonant).

This mechanism described in these studies is possibly the condition for the coarticulatory influences of the source (i.e. the influence of V_2 on V_1) to turn into a sound change in V_1. In metaphonic terms, this would explain how vowel raising of the stem vowel preceding a high suffix vowel is made possible. A further contributing factor to the establishment of metaphony is not just that the suffix (i.e. V_2) is in a weak syllable, but also that the reduction of unstressed, word-final vowels is very common in Southern Italian varieties (Rohlfs, 1966; Russo & Barry, 2004). Moreover, because V_1 is in a syllable with primary lexical stress, which is also often nuclear accented, the cues to the suffix vowel may be less variable in V_1 than in V_2. This greater stability of the suffix cues in V_1, compared with their high variability in V_2, may be a contributory factor in listeners' increasing tendency to derive phonetic information about the suffix vowel in V_1 rather than in V_2.

The VCV coarticulation mechanism with subsequent perceptual misparsing described above is a possible starting condition for metaphony in a region such as Mormanno (MM). As my results showed, the pattern of coarticulatory influences of V_2 on V_1 was quite similar in the MZ region albeit considerably magnified in comparison to the pattern for MM. This "exaggeration" might be a characteristic result of the stabilisation of a sound change (according to the definition given by Ramsammy, 2015, p. 36) in which the observed shifts (in this case in V_1) are too strong to be accounted for by coarticulation alone. This type of exaggeration occurs for many other kinds of phonetic variation that are connected to sound change. Some examples of this can be the size of the difference in vowel duration in phonologically contrasting pairs in English such as *seat/seed* (Solé, 2007); the historical development of Umlaut in German, in which e.g. /y/ in *Füße* ('feet') is more fronted than expected from the presumed VCV coarticulation process that took place in Old High German (Kiparsky, 2015, p. 563); and the extensive vowel nasalisation, which has been partly phonologised in American English (Beddor, 2012), in contrast with e.g. Spanish, in which anticipatory nasalisation in the vowel is mostly allophonic (Solé, 2007).

Such stabilisation of coarticulatory (or 'harmonic') outcomes mainly leads to phonologisation (Kiparsky, 2015) if we merely take the phonological segmental level into account. Nevertheless, in cases in which phonologisation is further functionalised at a higher linguistic level (i.e. morphologically or lexically), this can also lead to morphologisation or lexicalisation. *Morphologisation* is the stage at which the result of a sound change becomes restricted to, and therefore systematically signals, a morphological category: thus, in the case of metaphony, the stem vowel alternation is also morphologically distinctive (Krefeld, 1999, p. 103). The morphologisation process can be considered completed when the pattern can no longer be captured in phonological terms (Cser, 2015, p. 196). *Lexicalisation* instead refers to completely fossilised lexical idiosyncrasies resulting from older sound change processes that are not systematic in their distribution in the lexicon (Cser, 2015, p. 197). Following these definitions, morphologisation is a specific type of highly functionalised phonologisation that is also more linguistically regularised than lexicalisation.

In the light of both the acoustic and perceptual data analysed, it is apparent that full phonologisation/morphologisation has taken place in the case of the MZ type of metaphony, while phonologisation has also taken place to some extent in ZZ metaphony, for which the diphthongised metaphonic stem vowels are acoustically clearly distinct from the non-metaphonic ones both in production (as observed in Chapter 3) and in perception, as they are used by the listener as a morpho-lexical cue (see Chapter 5). Also, in a region such as MZ, metaphony is highly functional because it has become the only means of discriminating between some morpho-lexical categories such as number and gender (as shown in the experiments in Chapter 5), given also that, at the same time, the presence of a marked final vowel reduction (as discussed in Chapter 4) prevents the inflectional suffix of words from being informative.

From this perspective, the so-called cue-trading hypothesis (Beddor, 2009; Harrington et al., 2012) is in line with what happens to stem and suffix vowels in the Lausberg area: while the source for coarticulation wanes, the effects of coarticulation remain present in the stem vowel and, furthermore, are magnified in cases in which the source of the vowel shift completely disappears. This was evident in our three regions within the Lausberg area, for which a progression in metaphonic/coarticulatory influence on the stem vowel coincided with a progressive suffix reduction, as well as an increasing presence of suffix elision. These experimental findings are also in line with other phonological and more theoretical accounts, according to which suffix vowel reduction enhances the 'stabilisation' (Ramsammy, 2015) of a sound change due to the assimilation process between the vowel undergoing reduction and the harmonising target vowel (Barnes, 2006; Delucchi, 2011, 2012; Hyman, 2002; Krämer, 2009; Torres-Tamarit & Linke, 2016).

While the phonological status of metaphony in a region like MZ is relatively clear, for the Mormanno dialect, which apparently shows allophonic metaphony, the situation is more complex. On the one hand, Mormanno speakers are good at recognising the acoustic cue in the stem vowel and interpret it as a morpho-lexical mark (as the experiments in Chapter 5 demonstrated), but at the same time the stem vowel raising is in general slight and in all cases far more reduced than in MZ (see Chapter 3), while the source of the stem vowel raising – i.e. the suffix vowel – is generally only marginally reduced and almost never elided (see Chapter 4). This intermediate situation between allophonic alternation and phonologised contrast could be even defined as "quasi-phonemic" (Kiparsky, 2014, p. 82; Harrington et al., 2019b, p. 405). Behind this attempt of strict categorisation, however, a first phase of the phonologisation mechanism shifting the acoustic *and* contemporarily morpho-lexical cue from the suffix vowel to the stem vowel is recognisable in the Mormanno metaphony type.

The results discussed in this study are coherent with the fact that phonologisation is possibly a gradual phenomenon (Beddor, McGowan, Boland, Coetzee, & Brasher, 2013; Ohala, 2012), and that the limit between phonemic categories might, in some cases, not always be clear cut but instead blurred, especially during a sound change process. From this perspective, the three regions analysed in this study provide a demonstration of the progression of phonologisation and functionalisation/morphologisation of metaphony in the Lausberg area in *apparent time*, in an apparent diatopic continuum between allophony and phonologisation/morphologisation, since each region-specific type of metaphony possibly corresponds to a fundamental step in the metaphonic sound change process that has occurred in the Lausberg area.

6.2.2 The transition from monophthong to diphthong

The intermediate stage in which the subtle metaphonic shifts like those in Mormanno can give rise to diphthongisation as exemplified by ZZ – a hypothesis also advanced by Lausberg (1947), Lüdtke (1956, p. 92), and Barbato (2008) – before the phonologisation (or morphologisation) status such as the one present in MZ is achieved, is far more difficult to explain. Nevertheless, some speculative comments are possible and bring together different types of findings. Firstly, there is certainly evidence that V_2 coarticulatory influences can be as extensive at the onset as throughout V_1 (Magen, 1997; Rubertus and Noiray, 2018;

Whalen, 1990) and they may even be more extensive in the first part than in the second part of V_1 because vowel-to-vowel coarticulation can be suppressed by the intervening consonant (Fowler & Brancazio, 2000; Recasens, 1984, 2002). Secondly, it is known that the separate phonetic identities of sequential consonants (C) and vowels (V) are more distinctly preserved in onset CV than in coda VC sequences (Kohler, 2001; Ohala, 1990), especially if, as is the case for metaphony, the (suffix) vowel that follows the consonant is weak. It can therefore be speculated that the cues to the suffix vowel are more easily identified by listeners from the CV part of the stem vowel than from VC, in which the information for the vowel is confounded to a greater degree with that for the following consonant. Thirdly, listeners' sensitivity to, and use of, anticipatory coarticulation as soon as it becomes available (Beddor et al., 2013; Salverda, Kleinschmidt, & Tanenhaus, 2014), so as to facilitate cue perception for the listener, may be contributory factors in the enhancement of the suffix cues in the CV opening transitions leading to the observed diphthongisation in ZZ. The phonetic and perceptual explanation provided here might also be reinforced by what could be observed in the results of this study, namely that across the three regions (and not only in ZZ), metaphony was, in many cases, slightly more marked at the onset of the stem vowel than at the offset (see difference plots in Chapter 2).

A phonological and more abstract explanation as to why diphthongs may be a further evolution of simple vowel raising is provided by Maiden (2016a, p. 655): it is possible that during the earliest stages of metaphony the coarticulation process failed to lead to maximal assimilation, but instead involved maximal *deviation* from the original mid-low non-metaphonised vowel. Thus, according to Maiden, metaphony should be considered to be a mechanism of contrast maximisation between metaphonic and non-metaphonic stems rather than a 'simple' case of vowel harmony – see Maiden (2016a) for a summary on the main phonological and dialectological theories on the origin of diphthonigisation in Romance languages and Maiden (2016b) for a focus on Italian diphthongisation. In addition to such hypotheses, more recent views framed diphthongisation as a spontaneous phenomenon which is independent from any coarticulation phenomenon or influence at the segmental level, but rather a "spontaneous" consequence of stem vowel lengthening (Abete, 2013; Russo, 2007, 2014; Sánchez Miret, 1998b; see also Recasens, 2014, p. 31). However, this theory ignores the fact that in most varieties considered by these studies stem vowel diphthongisation shares the same phonological environment as other forms of metaphony (Maiden, 2016b, p. 202).

Additionally, diphthongisation triggered by metaphony can either synchronically coexist alongside the metaphonic raising of mid-high vowels in some dialects, or the diphthongal metaphony type is also often present in local varieties that are geographically adjacent to others that have 'simple' metaphonic raising and no diphthongisation (Maiden, 2016b, p. 202). Dialects that synchronically alternate monophthongs with diphthongs in metaphonic contexts are e.g. in Apulia (the dialect of Foggia, see Maggiore and Variano, 2015) as well as in some Central Italian varieties (Loporcaro, 2016). Traces of such alternations are also attested within the Lausberg area and surroundings: for instance, Rensch (1964) found monophthong/diphthong alternation in the 1960s in Mormanno, while in recent times Abete (2013) observed this alternation in the Tyrrhenian part of the Südzone, quite near to the Zwischenzone. Analogous observations were also made by Romito et al. (2006) and Conte (2014) with regard to some Lausberg dialects in Basilicata, as well as the dialect of Laino, Calabria (Zwischenzone). In addition, Lausberg (1939, p. 3) found diphthongising metaphony in Montegiordano, Calabria (MZ), although, based on my data, no diphthongising villages (Montegiordano included) were present within the Mittelzone. Finally, diphthongisation as a phase preceding or following a vowel raising is not only present in the Lausberg area, but also attested in other Italian dialectal varieties (Valente, 1975, p. 15; Russo, 2007; Canalis, 2016, p. 129). The frequent presence in many dialects of monophthong/diphthong alternations, either synchronically or diachronically, is a further argument in favour of a chronological transition between diphthongs and monophthongs as was hypothesised at the beginning of this thesis (Section 1.1.4).

As a final stage of the metaphonic sound change occurred in the Lausberg area, it was proposed (see Chapter 3) that metaphonic diphthongs were possibly reduced to monophthongs by deletion of the second component of the diphthong, thus giving rise to the metaphony type present in MZ. This hypothesis was not only defended by most scholars who collected or analysed impressionistic data within the field (Barbato, 2008; Castellani, 1973; Lausberg, 1939; Maggiore & Variano, 2015; Martino, 1991; Rensch, 1964; Trumper, 1997), but also further corroborated by recent findings by Abete (2013), in addition to some observations by Loporcaro (2016), according to which a non-prepausal position within the intonational phrase, along with a faster speech rate, can cause opening diphthongs to be reduced to high monophthongs. The interaction between segmental change and prosodic features might therefore have contributed to previous diphthongal metaphonic outcomes becoming monophthongs.

6.3 The geolinguistic perspective

In the literature review (Section 1.1.3) it was outlined how the Lausberg area is well-known for its linguistic conservativeness compared to the other surrounding southern dialects. Indeed, the geographic position and lack of infrastructure, along with the economical and social barriers that can derive from this situation (Trudgill, 1974, see also Krefeld, 2020), might have encouraged an isolation of the whole Lausberg area and also a fragmentation of some linguistic features. According to Bartoli (1945), speakers of local varieties who live in remote areas and therefore lack, due to their geographical and economic isolation, regular contact with other speech communities tend to maintain (or even reinforce) the conservative linguistic features that characterise their variety. An isolated area is therefore almost always also a linguistically fragmented area (Trumper, 1979; Martino, 1991, p. 51; see also Andersen, 2011, and De Cia and Iubini-Hampton, 2020, on the effects of geographic isolation on linguistic change).

Most parts of the Lausberg area are located within the mountains of the Pollino National Park, so that some mountain villages were objectively isolated (Martino, 1991, p. 18), especially if no natural connections by water existed – such as navigable rivers or lakes – or artificially built roads. Martino (1991, p. 24) points out how, even during the Roman era, the "Via Popilia", which was the long road connecting Rome to the southern part of the Italian peninsula, was actually a less commonly used and only served as an auxiliary path to the easier and safer maritime passages to Calabria or Sicily. This confirms that a certain fragmentation and, sometimes, "resistance" to linguistic innovations from outside (such as diphthongs) probably already existed in ancient times.

Chiodo and Trumper (1999) argued that, from the Middle Ages to the last decades of the 20th century, linguistic isolation was also partially promoted due to several earthquakes that occurred around the geographical area where the Lausberg varieties are spoken. These catastrophic events contributed to the isolation of the area by inhibiting the development of adequate infrastructure between the Lausberg area and its neighbouring regions and consequently slowed down its economic growth, so that the linguistic contact with other larger speech communities was also compromised. In addition, as Martino (1991, p. 18) pointed out, several areas on the coast, and on the Ionic coast in particular, had to cope with another type of isolation, this time due to repeated epidemic outbreaks (mainly malaria) from the Middle Ages to the early modern period.

As far as metaphony is concerned specifically, the diphthongising varieties in ZZ and the raised monophthongal forms in MZ are principally concentrated on the west and east coasts of the Lausberg area respectively. Separate studies also showed that the diphthongising metaphony characteristic of ZZ extends right up to the border of MZ, especially within the Basilicata region (Lausberg, 1939, Rensch, 1964, Martino, 1991). There is, by contrast, no obvious progression of geographic direction from the "metaphonically" conservative MM to the diphthongising ZZ area: indeed, the village of Mormanno is located within the ZZ region. One tentative explanation as to why Mormanno has been less prone to diphthongisation might be based on its isolation: it lies in a historically poorly connected area surrounded by mountains and is located at a higher altitude than any of the other surrounding villages (see below).

Historically, the geographical barrier between single villages (Mormanno included) and northern bigger centres only started to be broken during the Fascist era, while at the beginning of the century there were still villages that were not reachable by land (Martino, 1991, p. 39, 40). Both state roads connecting the Tyrrhenian side and the Ionic side of the Lausberg area (the two "Strada Statale" named S.S. 19 and S.S. 106 respectively) to the main city centres of Southern Italy in Campania and Apulia were only inaugurated in 1928[1]. In particular, diversion road works on the stretch of the S.S. 19 that connected the villages of Mormanno and Laino (Zwischenzone) to the main state road only started a few months after the Italian unification, in 1865 (Esposito, 2021, p. 156). Before this date, no main road connected these villages to the bigger northern cities. Furthermore, there were no main water connections between Mormanno and other villages of the Zwischenzone, which – along with the late development of the region's infrastructure, and the mountainous nature of its territory – might explain why Mormanno and a further few individual centres within the Lausberg area were relatively isolated and consequently more resistant to the 'diphthongising wave' that affected Southern Italian dialects (see Loporcaro, 2016, p. 67–69) and instead reached other bordering villages (Martino, 1991, p. 45, 46). Based on the idea that sound change can be propagated by imitation (Babel, McGuire, Walters, & Nicholls, 2014; Nguyen & Delvaux, 2015) as a consequence of social contact and interaction (Pardo, Gibbons, Suppes, & Krauss, 2012; Trudgill, 2008, 2011), the slower progression of metaphony in Mormanno may therefore have been affected by its geography (Nerbonne, 2010; Trudgill, 1974), i.e. by its relative isolation from the ZZ area that surrounds it.

To summarise all these observations, a large series of factors, including geography and historical events, determined the isolation of the area (and also of specific centres within the area) and its linguistic fragmentation, which is also mirrored by the presence of different types of metaphony within a relatively restricted territory. With reference to the current situation within these regions, closer contact between villages and also to bigger cities, possibly due to slightly improved infrastructure and mobility linked to inhabitants commuting to schools, universities and places of work, could, in the future, potentially contribute to dialect attrition (caused by the increasing importance and use of Standard Italian in everyday life) or levelling (Trumper and Maddalon, 1988; Trumper, 1979).

6.4 Conclusion and future directions

The analyses included in this study are not only important with regard to broadening and updating the existing data pool we have on the dialects of the Lausberg area, but are also relevant to phonological and linguistic theory in general. In particular, they provided further evidence relating to the general mechanisms behind sound change and phonologisation processes, with a focus on cue-trading relationships between phonetic

[1]The original decree is: Legge 17 maggio 1928, n. 1094 - "Istituzione dell'Azienda autonoma statale della strada". (1928). Retrieved from https://it.wikisource.org/wiki/L._17_maggio_1928,_n._1094_-_Istituzione_dell%5C%27Azienda_autonoma_statale_della_strada

cues such as, in this case, the stem vowel undergoing coarticulation and the suffix vowel triggering the coarticulatory effects.

Following the reasoning of several studies (Johnson, 1997; Pierrehumbert, 2003; Todd, Pierrehumbert, & Hay, 2019; Wedel, 2006), experience and memory of other interlocutors' speech signals can result in shifts in both perception and production. From this perspective, memorising new episodes of speech can result in an updating of an individual's model of phonological categorisation. Even if speakers from the same speech community share the same phonological categories, they will not necessarily agree upon how a given time-varying signal is categorised, if experience and memory have caused their individual phonological systems to be updated slightly differently. As a result, these individuals will also differ in compensation for coarticulation (Beddor, 2009; Zellou, 2017), i.e. in their parsing of acoustic signals into phonological categories. Such variation between individuals in the phonological parsing of speech signals has been argued to be one of the potential drivers of several sound changes (Beddor, 2012; Bermúdez-Otero, 2015; Coetzee et al., 2018; Harrington, 2012; Kuang & Cui, 2018; Yu, 2010; Zellou, 2017) and can therefore also be applied to explain the development of metaphony in the Lausberg area in its different forms.

Sound change can be also connected to the role of informativity linked to single phonemes or morphemes at the word level: if an acoustic cue, possibly also carrying a morpho-lexical meaning, is more morphologically or semantically 'important' than another cue, this cue can become more acoustically and perceptually salient than the other cue. This is presumably what happened in the case of metaphony: the stem vowel maintained and eventually magnified the sound change due to the influence of the suffix vowel, while the phonetic cue shift from the suffix vowel to the stem vowel made the suffix less informative than the stem. This mechanism might have promoted both metaphonic phonologisation and suffix reduction. This interaction between phonetics/phonology and morphology is the peculiarity that makes metaphony a type of morphologically promoted sound change, which, nevertheless, retains clearly recognisable phonetic roots (Maiden, 1991). These phonetic roots were explored in this study.

Much more has to be done in order to clarify the trade-off relationship between production and perception and how the understanding of this relationship might have influenced the diachronic evolution of metaphony. For instance, further perceptual studies would be needed to clarify whether listeners of dialects such as that in Mormanno use coarticulatory metaphonic cues already at the vowel onset of the stem vowel, as this would be a further argument for the evolution of metaphonic diphthongs from raised mid vowels. This aspect could be effectively tested by the use of other laboratory instruments, such as eye tracking. Another aspect that could be analysed in more detail is to what extent speakers from the single regions perceive and parse metaphonic and non-metaphonic acoustic cues in stems as pronounced in the other regions: while we have already analysed outer-region perception of ZZ metaphony, we still do not know if, for example, MZ or ZZ listeners would be able to recognise MM stem vowels better than MM listeners or not, i.e. if MZ or ZZ listeners are, in general, more sensitive to coarticulatory cues as they are at a more advanced stage of the metaphonic sound change. In addition, it would be interesting to see whether MM speakers perform better than Standard Italian speakers in discerning metaphonic from non-metaphonic stems as pronounced in MM. For instance, a perception experiment could prove whether MM listeners identify mid-low and mid-high vowels because of their sensitiveness to coarticulatory cues – in case they show the same levels of accuracy in distinguishing stems as Standard Italian listeners – or, instead, whether the opposition between mid-high and mid-low vowels has been phonologised, in which case MM listeners should perform significantly better than Standard Italian listeners.

The final important conclusion that can be drawn from this study is that sound change is always a complex, multi-faceted phenomenon. It begins with the phonetic conditions triggering a given sound change, it can develop through contact between different speakers and, eventually, spread to other contexts and to other speech communities (Harrington et al., 2012). Finally, the development of trading relationships between phonetic cues can precede a last stage of phonologisation and/or lexicalisation of the sound change.

In general, both this and previous studies have shown that sound change is neither deterministic nor teleological, but rather probabilistic and stochastic. This is because much depends not only on a range of linguistic factors (e.g. the lexical frequency of the items where the change primarily occurs, and the different possible outcomes from segmental and suprasegmental coarticulatory and perceptual phenomena), but also on extra-linguistic factors, such as interpersonal contacts within a speech community and between different speech communities, social roles, and the desirability of some traits compared to others. We are therefore dealing with a variety of factors, all of which transpire to create a particularly complex picture. As a consequence, both the occurrence and direction of sound change cannot always be established *a priori*.

Still, the actuation of sound change is a puzzle that needs to be completely solved. Further analyses of the production and perception of metaphony and other types of sound changes in diverse languages might help to shed light upon how different components of sound change are related to one another.

Appendix A

Speakers: Sociolinguistic metadata

Tab. A.1 lists the speakers' codes and contains information for each speaker who took part to the recordings used for the acoustic analyses presented in Chapters 2, 3 and 4.

The first two letters of the speakers' code refer to the village each speaker comes from: CA = Canna, CC = Cerchiara, LI = Laino Borgo / Laino Castello, MG = Montegiordano, MM = Mormanno, SD = S. Domenica Talao, SC = Scalea.

The column "Region" refers to the three main village groups within the Lausberg area examined as part of this study: MM = Mormanno, MZ = Mittelzone, ZZ = Zwischenzone.

The column "Age" indicates the biological age of each speaker when recorded, while the column "Age group" indicates whether the speakers were included in the younger or in the older speakers' group.

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.

A version of this appendix was also included in a manuscript submitted for publication (Greca et al., 2022).

Speaker	**Region**	**Age**	**Age group**	**Education**
CA01F	MZ	44	older	2
CC01F	MZ	65	older	4
CC01M	MZ	27	younger	3
CC02F	MZ	13	younger	1
CC02M	MZ	47	older	3
CC03F	MZ	44	older	3
CC03M	MZ	46	older	3
CC04F	MZ	51	older	2
CC05F	MZ	81	older	2
CC06F	MZ	14	younger	2
CC07F	MZ	19	younger	2
CC08F	MZ	44	older	3
LI01M	ZZ	82	older	1
LI02M	ZZ	80	older	1
LI03M	ZZ	90	older	1
LI04M	ZZ	92	older	1
LI05M	ZZ	67	older	3
LI06M	ZZ	85	older	1
MG01M	MZ	45	older	4
MG02M	MZ	67	older	3
MM02F	MM	25	younger	4
MM03F	MM	28	younger	4
MM03M	MM	26	younger	4
MM04F	MM	26	younger	4
MM04M	MM	25	younger	3
MM05F	MM	25	younger	4
MM05M	MM	22	younger	3
MM06F	MM	72	older	4
MM07F	MM	47	older	4
MM07M	MM	81	older	1
MM09M	MM	73	older	2
SC01F	ZZ	44	older	3
SC01M	ZZ	40	older	4
SC02F	ZZ	47	older	3
SD01F	ZZ	27	younger	4

Table A.1: The recorded speakers: codes, age, regions, and education level.

Appendix B

Data elicitation: examples of visual stimuli

Figs. B.1, B.2 and B.3 show some examples of the visual stimuli used for the picture-naming task used to elicit the lexical items listed in Appendix C and outlined in the general method part in the introduction (Section 1.3.2).

More specifically, Fig. B.1 is an example of noun elicitation; B.2 shows an example of how inflected adjectives were elicited; Fig. B.3 shows an example of how conjugated verbs could be elicited.

In Fig. B.2, the picture on the right used to elicit the feminine singular form of the adjective ‘red’ (in the dialect /ˈrussa/) shows a circled red apple in order to induce the speaker to specify its colour, i.e. to make the participants say ‘red apple’, in their dialect [ˈmela ˈrussa]. This combination of adjective and noun made the elicitation of the inflected target form possible.

In Fig. B.3, the picture on the left shows a man pointing at himself, providing a graphical representation of the subject of the sentence to be produced by the speaker, in this case the 1st person singular. In the picture on the right, instead, the man pointing in the direction of the drawing provides a graphical representation that the subject of the sentence to be pronounced is the 3rd person singular.

A version of this appendix was also included in Greca and Harrington (2020).

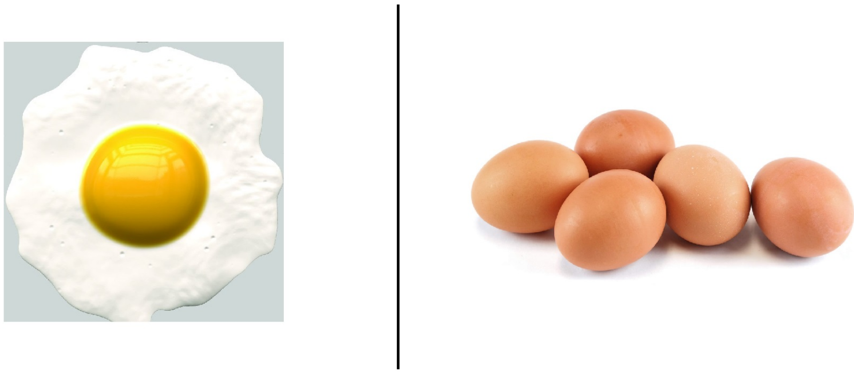

Figure B.1: Picture stimulus used to elicit the word ‘egg’ in its singular form (in the dialect under study /ˈovu/), on the left, vs picture stimulus to elicit the plural ‘eggs’ (in the dialect under study /ˈova/), on the right.

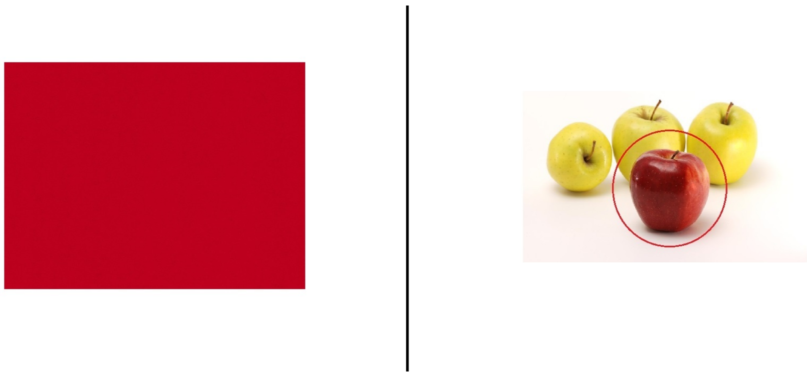

Figure B.2: Picture stimulus used to elicit the word ‘red’, masc. sg. (/ˈrussu/), on the left, vs picture stimulus to elicit the word ‘red’, fem. sg. (/ˈrussa/), on the right.

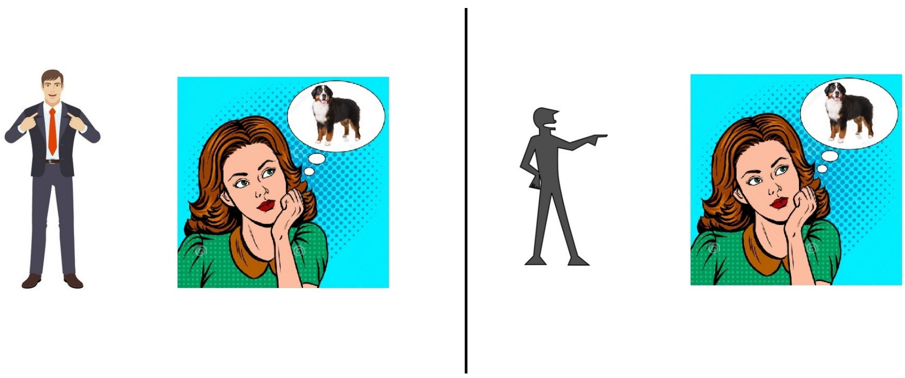

Figure B.3: Picture stimulus used to elicit the word ‘(I) think’, 1^{st} pers. sg. (/ˈpensu/), on the left, vs picture stimulus used to elicit the word ‘(he/she) thinks’, 3^{rd} pers. sg. (/ˈpensa/), on the right.

Appendix C

Lexical items elicited

Tab. C.1 shows the complete list of lexical items elicited during the recordings.

The first column lists in alphabetical order the lexical items in Standard Italian.

The words' transcription indicated in the second column is a phonemic reconstruction of the dialect target form and does not take into account consequences of coarticulation, metaphony or of suffix reduction and elision. In disyllabic words the stressed syllable is always the first one, while in other cases the stressed syllable is marked.

The third column provides a translation of each item into English (number and gender of nouns and adjectives are also indicated).

As explained in the introduction, in Section 1.3.5, some of these words were not included in the analyses presented in the Chapters 2, 3 and 4. See Appendixes D (for Chapter 2) and E (for Chapters 3 and 4) for the lexical items actually used for each acoustic analysis.

Table C.1: List of all lexical items elicited for this study

Target word	Target phonemic form	Meaning
aghi	agi	needles (masc. pl.)
ago	agu	needle (masc. sg.)
anelli	aˈnelli	rings (masc. pl.)
anello	aˈnellu	ring (masc. sg.)
apre	apre	(he/she) opens
apri	ˈaprisi	(you) open
apro	apru	(I) open
bella	bella	beautiful (fem. sg.)
bello	bellu	beautiful (masc. sg.)
beve	vive	(he/she) drinks
bevi	ˈvivisi	(you) drink
bevo	vivu	(I) drink
braccia	vrattsa	arms (fem. pl.)
braccio	vrattsu	arm (masc. sg.)
buona	bona	good (fem. sg.)
buone	bone	good (fem. pl.)
buoni	boni	good (masc. pl.)
buono	bonu	good (masc. sg.)
cane	kane	dog (masc. sg.)
cani	kani	dogs (masc. pl.)
capelli	kaˈpelli	hair (masc. pl.)
capello	kaˈpellu	hair (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.)
casa	kasa	house (fem. sg.)
case	kase	house (fem. pl.)
cenere	ˈtʃinnira	ash (fem. 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.)

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Target word	Target phonemic form	Meaning
corno	kornu	horn (masc. sg.)
corre	kurre	(he/she) runs
corri	ˈkurrisi	(you) run
corro	kurru	(I) run
corta	kurta	short (fem. sg.)
corti	kurti	short (masc. pl.)
corto	kurtu	short (masc. sg.)
cotta	kotta	cooked (fem. sg.)
cotto	kottu	cooked (masc. sg.)
croce	krutʃe	cross (masc. sg.)
croci	krutʃi	crosses (masc. pl.)
cuore	kore	heart (masc. sg.)
cuori	kori	hearts (masc. pl.)
dente	dente	tooth (masc. sg.)
denti	denti	teeth (masc. pl.)
dita	ˈjidita	fingers (fem. pl.)
dito	ˈjiditu	finger (masc. sg.)
dolce	durtʃe	sweet (masc. sg.)
dolci	durtʃi	sweets (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	ˈesku	(I) go out
ferri	ferri	irons (masc. pl.)
ferro	ferru	iron (masc. sg.)
foglia	foʎʎa	leaf (fem. sg.)
foglie	foʎʎe	leaves (fem. 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.)

continued on next page

Target word	Target phonemic form	Meaning
fuochi	foki	fires (masc. pl.)
fuoco	foku	fire (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.)
grossa	grossa	big (fem. sg.)
grosso	grossu	big (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.)
letti	letti	beds (masc. pl.)
letto	lettu	bed (masc. sg.)
luce	lutʃe	light (fem. sg.)
luna	luna	moon (fem. sg.)
lunga	longa	long (fem. sg.)
lungo	longu	long (masc. sg.)
mani	manu	hands (fem. pl.)
mano	manu	hand (fem. sg.)
mare	mare	sea (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
nera	ˈnivura	black (fem. sg.)
neri	ˈnivuri	black (masc. pl.)

continued on next page

Target word	Target phonemic form	Meaning
nero	ˈnivuru	black (masc. sg.)
nipote	niˈpote	grandchild (masc. sg.)
nipoti	niˈpoti	grandchildren (masc. pl.)
noce	nutʃe	walnut (fem. sg.)
noci	nutʃi	walnuts (fem. 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.)
pasta	pasta	pasta (fem. sg.)
pecora	ˈpekura	sheep (fem. sg.)
pecore	ˈpekure	sheep (fem. pl.)
peli	pili	body hair (masc. pl.)
pelo	pilu	body hair (masc. sg.)
pensa	pensa	(he/she) thinks
pensi	ˈpensasi	(you) think
penso	pensu	(I) think
pesca	peska	peach (fem. sg.)
pesce	piʃʃu	fish (masc. sg.)
pesche	peske	peaches (fem. pl.)
pesci	piʃʃi	fish; fishes (masc. 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.)

continued on next page

Target word	Target phonemic form	Meaning
rosa	rosa	rose (fem. sg.)
rose	rose	roses (fem. pl.)
rossa	russa	red (fem. sg.)
rosso	russu	red (masc. sg.)
ruota	rota	wheel (fem. sg.)
ruote	rote	wheels (fem. pl.)
santa	santa	saint (fem. sg.)
santi	santi	saint (masc. pl.)
santo	santu	saint (masc. sg.)
sedia	seddʒa	chair (fem. sg.)
sedie	seddʒe	chairs (fem. pl.)
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	teŋgu	(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
unghia	uɲɲa	nail (fem. sg.)
unghie	uɲɲe	nails (fem. pl.)
uomini	ˈommini	men (masc. pl.)
uomo	ˈommine	man (masc. sg.)
uova	ova	eggs (fem. pl.)
uovo	ovu	egg (masc. sg.)
uva	uva	grapes (fem. sg.)
vacca	vakka	cow (fem. sg.)
vacche	vakke	cows (fem. pl.)
vecchia	vekkja	old woman (fem. sg.)
vecchio	vekkju	old man (masc. sg.)
vedi	ˈvidisi	(you) see
vedo	vidu	(I) see

continued on next page

Target word	Target phonemic form	Meaning
venti	venti	winds (masc. pl.)
vento	ventu	wind (masc. sg.)
verde	virde	green (masc. sg.)
verdi	virdi	green (masc. pl.)
verme	verme	worm (masc. sg.)
vermi	vermi	worms (masc. pl.)
voglio	voʎʎu	(I) want
volpe	vurpe	fox (fem. sg.)
volpi	vurpi	foxes (fem. pl.)
vuoi	voi	(you) want
zoppa	tsoppa	lame woman (fem. sg.)
zoppo	tsoppu	lame man (masc. sg.)

Appendix D

Lexical items used for analysis in Chapter 2

Similarly to Tab. C.1 in Appendix C, the first column of Tab. D.1 lists in alphabetical order the lexical items in Standard Italian.

The words' transcription indicated in the second column is again 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 stressed syllable is marked.

The third column provides a translation of each item into English (number and gender of nouns and adjectives are also indicated).

Tab. D.2 counts the stem vowel tokens used for analysis, separately for age group, region, stem vowel, and suffix vowel.

A modified version of this appendix was also included in Greca and Harrington (2020).

Table D.1: List of lexical items used for analysis in Chapter 2

Target word	Target phonemic form	Meaning
apre	apre	(he/she) opens
apri	ˈaprisi	(you) open
bella	bella	beautiful (fem. sg.)
bello	bellu	beautiful (masc. sg.)
beve	vive	(he/she) drinks
bevi	ˈvivisi	(you) drink
braccia	vrattsa	arms (fem. pl.)
braccio	vrattsu	arm (masc. sg.)
buona	bona	good (fem. sg.)
buone	bone	good (fem. pl.)
buoni	boni	good (masc. pl.)
buono	bonu	good (masc. sg.)
cane	kane	dog (masc. sg.)
cani	kani	dogs (masc. pl.)
capretta	kraˈpetta	kid (goat) (fem. sg.)
capretto	kraˈpettu	kid (goat) (masc. sg.)
corna	korna	horns (fem. pl.)
corno	kornu	horn (masc. sg.)
corre	kurre	(he/she) runs
corri	ˈkurrisi	(you) run
corta	kurta	short (fem. sg.)
corto	kurtu	short (masc. sg.)
cotta	kotta	cooked (fem. sg.)
cotto	kottu	cooked (masc. sg.)
croce	krutʃe	cross (masc. sg.)
croci	krutʃi	crosses (masc. pl.)
cuore	kore	heart (masc. sg.)
cuori	kori	hearts (masc. pl.)
dente	dente	tooth (masc. sg.)
denti	denti	teeth (masc. pl.)
dita	ˈjidita	fingers (fem. pl.)
dito	ˈjiditu	finger (masc. sg.)
dolce	durtʃe	sweet (masc. sg.)
dolci	durtʃi	sweets (masc. pl.)
dorme	dorme	(he/she) sleeps

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Target word	Target phonemic form	Meaning
dormi	ˈdormisi	(you) sleep
esce	esse	(he/she) goes out
esci	ˈessisi	(you) go out
fredda	fridda	cold (fem. sg.)
freddo	friddu	cold (masc. sg.)
ginocchia	jiˈnukkja	knees (fem. pl.)
ginocchio	jiˈnukkju	knee (masc. sg.)
grossa	grossa	big (fem. sg.)
grosso	grossu	big (masc. sg.)
legna	linna	wood (fem. sg.)
legno	linnu	piece of wood (masc. sg.)
lunga	longa	long (fem. sg.)
lungo	longu	long (masc. sg.)
mese	mese	month (masc. sg.)
mesi	mesi	months (masc. pl.)
morta	morta	dead (fem. sg.)
morto	mortu	dead (masc. sg.)
nera	ˈnivura	black (fem. sg.)
nero	ˈnivuru	black (masc. sg.)
nipote	niˈpote	grandchild (masc. sg.)
nipoti	niˈpoti	grandchildren (masc. pl.)
noce	nutʃe	walnut (fem. sg.)
noci	nutʃi	walnuts (fem. pl.)
nuova	nova	new (fem. sg.)
nuovo	novu	new (masc. sg.)
ossa	ossa	bones (fem. pl.)
osso	ossu	bone (masc. sg.)
pensa	pensa	(he/she) thinks
penso	pensu	(I) think
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.)
ponte	ponte	bridge (masc. sg.)
ponti	ponti	bridges (masc. pl.)

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Target word	Target phonemic form	Meaning
prete	ˈprevite	priest (masc. sg.)
preti	ˈpreviti	priests (masc. pl.)
rossa	russa	red (fem. sg.)
rosso	russu	red (masc. sg.)
santa	santa	saint (fem. sg.)
santo	santu	saint (masc. sg.)
sposa	sposa	bride (fem. sg.)
sposo	sposu	groom (masc. sg.)
tiene	tene	(he/she) has
tieni	ˈtenisi	(you) have
topi	ˈsoritʃi	mice (masc. pl.)
topo	ˈsoritʃe	mouse (masc. sg.)
trova	trova	(he/she) finds
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.)
verde	virde	green (masc. sg.)
verdi	virdi	green (masc. pl.)
verme	verme	worm (masc. sg.)
vermi	vermi	worms (masc. pl.)
volpe	vurpe	fox (fem. sg.)
volpi	vurpi	foxes (fem. pl.)
zoppa	tsoppa	lame woman (fem. sg.)
zoppo	tsoppu	lame man (masc. sg.)

Older speakers (Tot. stem vowels: $n = 2809$)																					
Stem vowel		**/i/**				**/e/**				**/a/**				**/o/**				**/u/**			
Suffix vowel		/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/
Metaphonic context			✓		✓		✓		✓		✓		✓		✓		✓		✓		✓
	MM	13	12	26	26	54	55	27	31	15	14	12	14	34	35	65	67	24	27	19	19
Region	ZZ	15	11	28	22	59	72	32	27	18	13	15	19	45	48	77	76	34	36	21	19
	MZ	32	33	68	68	124	132	72	82	31	29	38	38	84	104	187	178	65	62	52	54
	All regions	60	56	122	116	237	259	131	140	64	56	65	71	163	187	329	321	123	125	92	92

Younger speakers (Tot. stem vowels: $n = 1992$)																					
Stem vowel		**/i/**				**/e/**				**/a/**				**/o/**				**/u/**			
Suffix vowel		/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/	/e/	/i/	/a/	/u/
Metaphonic context			✓		✓		✓		✓		✓		✓		✓		✓		✓		✓
	MM	14	22	51	50	84	95	42	56	16	22	28	26	76	87	139	142	56	61	29	34
Region	ZZ	2	3	5	7	13	14	7	6	2	3	5	3	12	13	24	19	8	9	6	6
	MZ	16	14	27	30	60	60	38	35	21	16	16	16	38	47	76	75	32	32	25	21
	All regions	32	39	83	87	157	169	87	97	39	41	49	45	126	147	239	236	96	102	60	61

Table D.2: Count of the stem vowels that were analysed in Chapter 2 by suffix vowel and region for younger and older speakers separately.

Appendix E

Lexical items used for analysis in Chapters 3 and 4

Similarly to Tab. C.1 in Appendix C and to Tab. D.1 in Appendix D, the first column of Tab. E.1 lists in alphabetical order the lexical items in Standard Italian.

The words' transcription indicated in the second column is again 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 (number and gender of nouns and adjectives are also indicated).

A version of this appendix was also included in a manuscript submitted for publication (Greca et al., 2022).

Table E.1: List of lexical items used for analysis in Chapters 3 and 4

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.)
capelli	kaˈpelli	hair (masc. pl.)
capello	kaˈpellu	hair (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	ˈesku	(I) go out

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Target word	Target phonemic form	Meaning
ferri	ferri	irons (masc. pl.)
ferro	ferru	iron (masc. sg.)
foglia	foʎʎa	leaf (fem. sg.)
foglie	foʎʎe	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.)

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Target word	Target phonemic form	Meaning
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.)
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.)

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Target word	Target phonemic form	Meaning
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.)

Appendix F

Lexical idiosyncrasies and variation in metaphony

F.1 Method

In order to quantify the role of random factors (see Section 3.2.4) in describing PC-score variation in the data analysed in Chapter 3, Pseudo-R^2 for Generalised Mixed-Effect Models (Nakagawa, Johnson, and Schielzeth, 2017) were computed for a number of LMER models applied separately to both s_1 and s_3. In particular, Pseudo-R^2 were applied to the LMER model (3.2) described in Section 3.2.4 (reported for convenience below, see model (F.1)), and then also to the models (F.2) and (F.3) reported below. The formula in (F.2) describes a model that is almost identical to the one in (3.2) and (F.1), but with the exclusion of the *Speaker* intercept, while the formula (F.3) describes an almost identical model to the one in (3.2) and (F.1), but deprived of the *Stem* intercept with slope in the fixed factor *Region*.

$$s \sim \text{Suffix vowel} * \text{Region} + (\text{Region}|\text{Stem}) + (1|\text{Speaker}) \tag{F.1}$$

$$s \sim \text{Suffix vowel} * \text{Region} + (1|\text{Speaker}) \tag{F.2}$$

$$s \sim \text{Suffix vowel} * \text{Region} + (\text{Region}|\text{Stem}) \tag{F.3}$$

The Pseudo-R^2 estimates were computed by using the homonymous function provided by the `MuMIn` package (version 1.43.17) in the R environment and are to be interpreted as follows. The Marginal R^2 (${R^2}_{\text{m}}$) represents the proportion of variance explained by fixed factors, while the Conditional R^2 ($R^2{}_\mathrm{c}$) represents the proportion of variance explained by both fixed and random factors (i.e. all the predictors except for the residual variance).

Finally, the plots in Section F.3 refer to variation predicted by the LMER model (F.1) related to the single levels of the (lexical) *Stem* random factor. In particular, these values were obtained by summing for all levels (i.e. for each lexical stem) the fixed effects estimates, providing the mean values predicted by the model, with the random effects – both stem intercepts and region slopes combined – which are zero-centered and express stem-specific adjustments to the fixed effects estimates. The plotted estimates therefore represent generalised predicted means averaged across the levels of *Suffix vowel*. This computation was run separately for each PC-score (s_1, Figs. F.1, F.2; and s_3, Fig. F.3), and for region (with the exception of the s_3 plots in Fig. F.3, which only refer to ZZ).

F.2 Influence of random factors

Tab. F.1 shows the Pseudo-R^2 estimates for the LMER models (F.1), (F.2), and (F.3), separately for s_1 and s_3 and for stem vowel. For instance, an $R^2{}_\mathrm{m}$ value of 0.26 (first line) means that, for the LMER model (F.1) applied to the dependent variable s_1 of stem /e/, 26% of variance is described by the fixed factors only. Analogously, we can also observe from the first line that around 66% of variance in the data is described by the fixed effects and random effects combined (expressed by the $R^2{}_\mathrm{c}$ value).

Overall, it is evident from Tab. F.1 that the $R^2{}_\mathrm{c}$ value systematically decreases – even quite dramatically, as in the case of s_3 and of s_1 in stem /e/ – when the *Stem* random factor is deleted, for both s_1 and s_3 dependent variables and for both stems, although the decrease of $R^2{}_\mathrm{c}$ is slightly more marked for stem /e/ than for stem /o/. By contrast, such a decrease is far from being as marked when the *Speaker* intercept is removed from the model. We can therefore deduce that variation in the data is linked to the lexical stems rather than single speakers. Consequently, the random factor analysis (see last paragraph of Section F.1) was run on the *Stem* random factor.

Stem vowel	PC-score	Model (F.1)		Model (F.2)		Model (F.3)	
		$R^2{}_\mathrm{m}$	$R^2{}_\mathrm{c}$	$R^2{}_\mathrm{m}$	$R^2{}_\mathrm{c}$	$R^2{}_\mathrm{m}$	$R^2{}_\mathrm{c}$
/e/	s_1	0.26	0.66	0.27	0.30	0.26	0.63
	s_3	0.08	0.59	0.11	0.15	0.06	0.52
/o/	s_1	0.30	0.55	0.36	0.41	0.31	0.49
	s_3	0.06	0.54	0.14	0.28	0.13	0.48

Table F.1: Pseudo-R^2 estimates for the LMER models (F.1), (F.2), (F.3), applied to the dependent variables s_1 and s_3 and separately for stem vowel.

F.3 Variation according to lexical stem

Since the lexical stem random factor is the one that explains most variation within the values predicted by the LMER model, we can expect that some stems might not show the same coarticulatory/metaphonic patterns described so far. The main hypothesis is therefore that stem vowels belonging to some specific lexical items do not show the expected coarticulatory patterns that are otherwise typical for the majority of the data. More specifically, two opposite situations are possible: either (i) /e, o/ stem vowels in some specific lexical items neither are raised/diphthongise nor lower when expected, or (ii) they are raised/diphthongise regardless of the suffix vowel.

Figs. F.1 and F.2 show the mean predicted values of s_1 for each lexical stem[1] for the regions MM and MZ. Fig. F.3 shows instead s_3 mean predicted values for the region ZZ only, since this score is the main indicator for metaphony in this region (as discussed in Section 3.3). These plots provide a visual account of whether a specific lexical stem is "near the mean" calculated across all lexical stems (graphically represented by a red line), or if it largely diverges from it, thus tending either to visibly higher or lower s_1 or s_3 values when compared to the majority of other lexical stems.

As regards Figs. F.1 and F.2, values on the right half of each panel that are considerably above the calculated mean value indicate that the s_1 score (values on the x-axis) tends to be higher. We can interpret this fact as the tendency for the specific lexical stem to open the stem vowel more than average, regardless of the suffix vowel. On the contrary, predicted s_1 values considerably below the mean value (on the left half of each panel) signal a general tendency towards stem vowel raising, regardless of the suffix vowel (the relationship between PC-scores and formant shapes was discussed in Section 3.3.1, see also Figs. 3.1 and 3.2). As regards Fig. F.3, s_3 values that are far higher than the mean value (right side of each panel) indicate for both stem vowels a generalised presence of opening diphthongisation (which is what one would expect in a metaphonic context, see also Section 3.3.2) regardless of the suffix vowel context. On the contrary, values far below the mean one (left side of each panel) suggest that the presence of closing diphthongisation extends to both metaphonic and non-metaphonic contexts (the relationship between s_3 and formant shapes was discussed in Section 3.3.1, see also Figs. 3.1 and 3.2).

In Figs. F.1, F.2 and F.3, some lexical stems markedly diverge from the mean values. In general, by observing the values on the x-axis in both MM and MZ (Figs. F.1 and F.2), we notice a greater variation in MZ than MM. This outcome is perfectly in line with the fact that MZ speakers "metaphonise" far more than MM ones (see Section 3.3.2), so that possible exceptions to metaphony emerge more markedly than in MM.

[1]The lexical stems shown in the plots are phonologically transcribed into IPA and are the same as those listed in Appendix E.

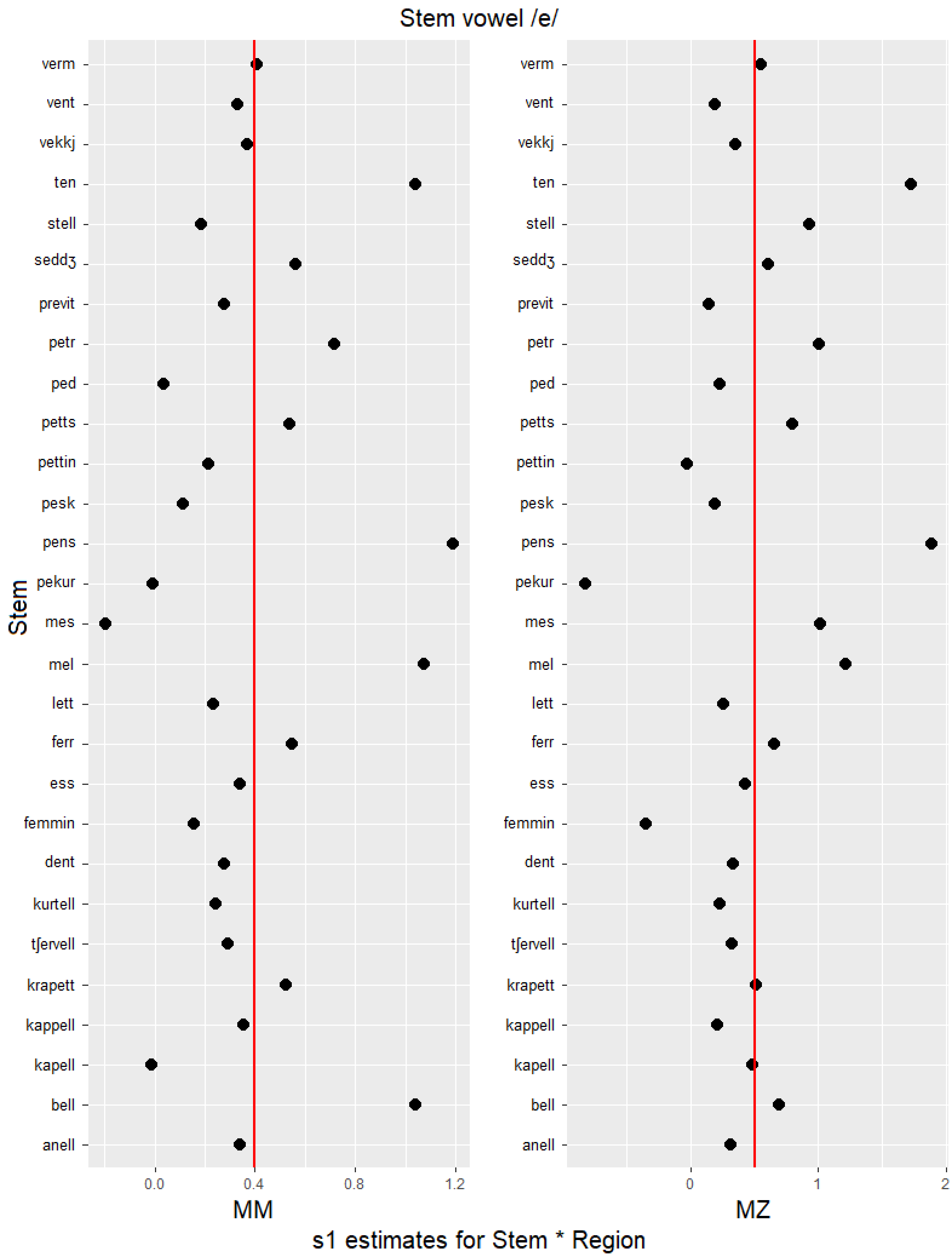

Figure F.1: Values of s_1 (x-axis) predicted by model (F.1) for stem vowel /e/ and the MM (left panel) and MZ (right panel) regions, averaged across all suffix vowels. The red vertical bar represents the mean prediction based on the fixed factors only; black dots are predictions adjusted according to the random effect *(Region|Stem)* in model (F.1) for each level of *Stem* (y-axis).

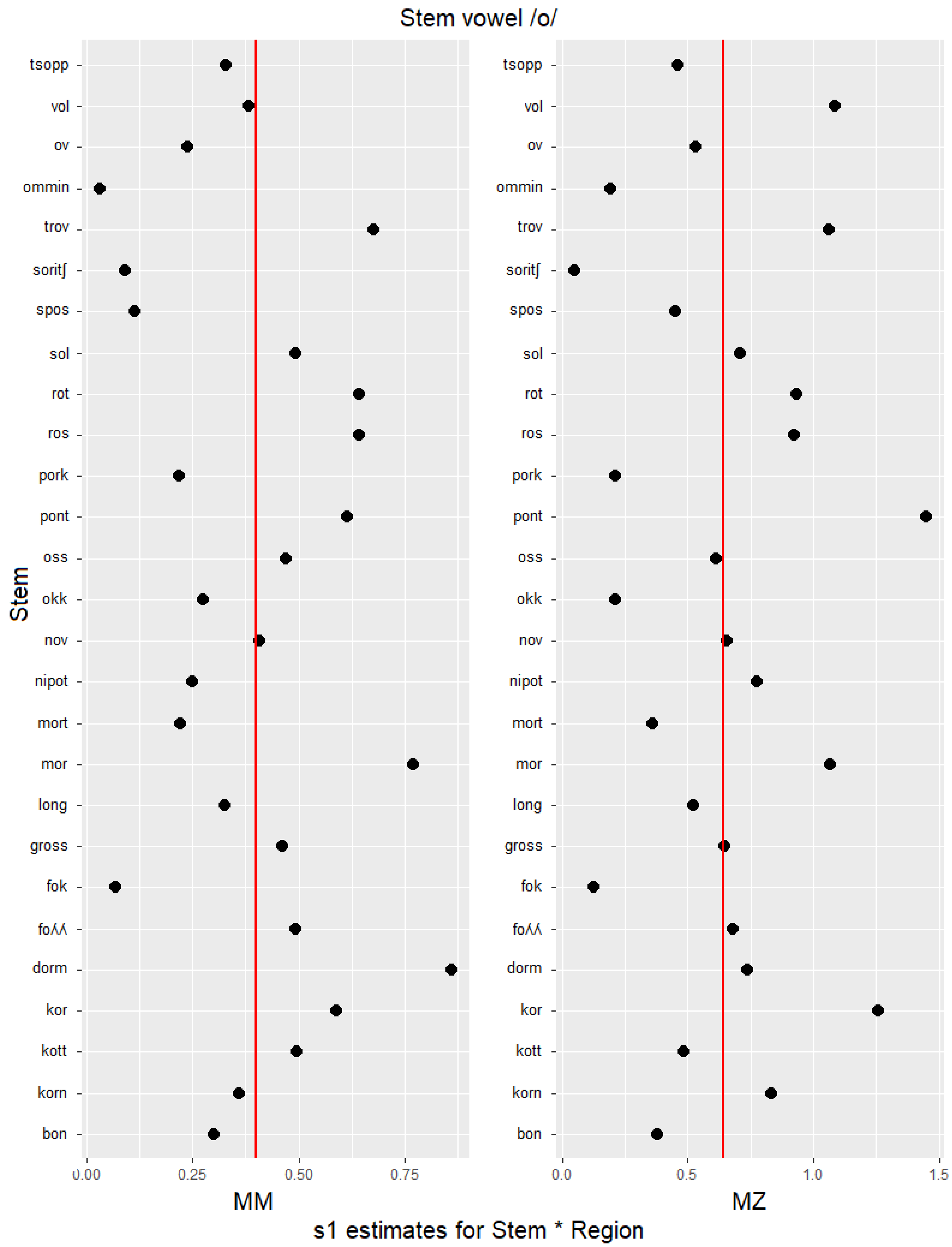

Figure F.2: Values of s_1 (x-axis) predicted by model (F.1) for stem vowel /o/ and the MM (left panel) and MZ (right panel) regions, averaged across all suffix vowels. The red vertical bar represents the mean prediction based on the fixed factors only; black dots are predictions adjusted according to the random effect *(Region|Stem)* in model (F.1) for each level of *Stem* (y-axis).

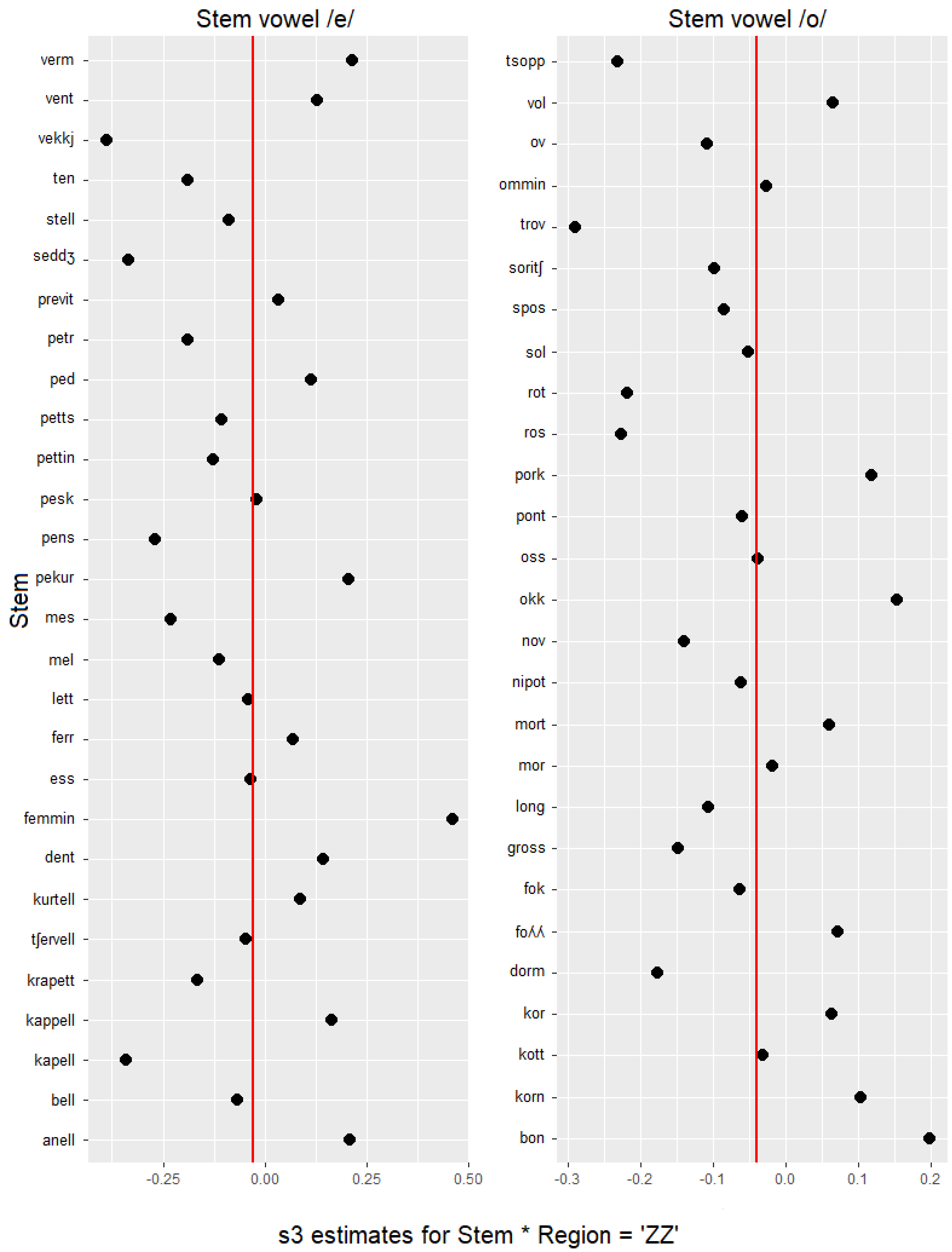

Figure F.3: Values of s_3 (x-axis) predicted by model (F.1) for the stem vowels /e/ (left panel) and /o/ (right panel) and the ZZ region, averaged across all suffix vowels. The red vertical bar represents the mean prediction based on the fixed factors only; black dots are predictions adjusted according to the random effect *(Region|Stem)* in model (F.1) for each level of *Stem* (y-axis).

Similarly to s_1 variation in MM, also s_3 variation in ZZ (Fig. F.3, x-axis) is not as broad as variation in MZ for s_1 values. While some lexical stems' predicted values might look idiosyncratic only because the two possible suffixes are either both non-metaphonic /a, e/ or both metaphonic /i, u/ (see also Appendix E), some other lexical stems that instead present a non-metaphonic vs metaphonic competing suffix (e.g. suffix /a/ vs suffix /u/ or suffix /e/ vs suffix /i/) might either be resistant to metaphony before high suffixes or, oppositely, overextend it also to non-metaphonic contexts.

F.4 Types of idiosyncrasy and possible reasons for variation

By observing the random effect plots (Figs. F.1, F.2 and F.3), we can overall distinguish five main groups of idiosyncrasies, which are listed below.

1. Some lexical items that tend to "over-metaphonise" (i.e. in which the s_1 mean prediction is visibly lower than the mean value) presented a long mid vowel <ē, ō> in the Latin etymon. As we know from the literature about the Lausberg area (Section 1.1.3), the tonic vowels of the current dialects have generally retained the same vowel quality as the Latin ones. Nevertheless, especially in the Zwischenzone, some sporadic influence of the Sicilian vocalism from dialects below the Lausberg area is possible (Rensch, 1964, p. 5, 10; Martino, 1991, p. 47). In these dialects of the so-called Südzone, the Latin long /oː/ became [u] and long /eː/ became /i/. The possible influence of this type of vocalism[2] can explain why e.g. the plotted value for stem /mes/ (Latin *mēnsis*) in MM (Mormanno is geographically located within the Zwischenzone) suggests an overgeneralised tendency towards vowel raising (see Fig. F.1, left panel), presumably to a mid-high [e] or even an [ɪ] or [i]. A similar observation can be made as regards the /o/ stem for /nipot/ (Latin *nepōtem*), whose s_1 mean predicted value tends slightly towards the left for MM (Fig. F.2, left panel), most probably for the same reason.

2. In ZZ, singular forms of stems such as /ped/ and /dent/ (Latin *pĕdem* and *dĕntem*, with a short [e]) can present diphthongisation in non-metaphonic conditions as well (Silvestri, 2009, p. 175). This tendency is also confirmed by the random effect analysis, although the s_3 mean predicted values for these two lexical items (see Fig. F.3, left panel) are only slightly higher than the general mean (represented by a red line). According to Silvestri (2009, p. 178), this is due to an analogical overextension of the metaphonic change also to /e/ stem vowel phonemes (etymologically corresponding to the Latin short ĕ) in a non-metaphonic context.

[2] It is interesting to consider that, in some rare ancient written sources from the early Middle Ages from the Lausberg area, lexical exceptions to the Sardinian vowel system similar to the ones reported here already existed (Angius, 2009, p. 15).

3. Some trisyllabic lexical stems, most of which are /e, i/-suffixed (the only exceptions are /femmin/, Latin *fēmina*, and /pekur/, Latin *pēcura*), have an intermediate high vowel between the stressed stem vowel and the final suffix vowel, which causes stem vowel raising independently of the final suffix vowel quality. In MZ, and to a minor extent in MM, in three-syllable words such as /previte/ (Latin *prěsbitem*), /pettine/ (Latin *pěctinem*), and /soritʃe/ (Latin *sŏrecem*), the stem vowel is raised (see correspondent lower s_1 mean predicted values in Figs. F.1 and F.2), so that in MZ we can expect e.g. [ˈsuritʃ(e), ˈsuritʃ(i)] with raising of the stem vowel /o/ in both words. Analogously, in ZZ, for stems such as /femmin/ or /pekur/ (Fig. F.3, left panel) we can observe higher predicted s_3 values than the general mean value, which indicate an overextension of opening diphthongisation. For instance, we can expect [ˈpjekur(a)] instead of [ˈpekur(a)], in spite of the final /a/ suffix: in this case, the /u/ vowel segment preceding the suffix vowel caused diphthongisation of the stem vowel.

4. Some lexical stems do not exhibit metaphony, in particular the noun stems /kor, pont/, which are highly idiosyncratic especially in MZ (Figs. F.1 and F.2, right panels). Previous studies by Recasens and colleagues (Recasens, 1984, 2002, 2014) have shown that both nasal consonants and alveolar trills can function as effective "coarticulation blockers". The fact that such consonants are present in these two words might have historically prevented metaphony from taking place. Also, it has to be pointed out that, in the case of /ponte, ponti/, the nasal consonant following the stem vowel might cause acoustic and perceptual vowel lowering, so that a nasalised /u/ might actually sound like a nasalised [o] (Krakow, Beddor, Goldstein, & Fowler, 1988; Wright, 1986). This could be another factor that inhibited metaphony from taking place in this specific word.

However, other explanations beyond the phonetic level might also be possible. Firstly, a lack of metaphony could help avoid an otherwise inevitable homophony, e.g. /ponti/ > [punti] would overlap with /punti/, 'points'. This hypothesis is, however, merely speculative, although arguments in favour might be found in more recent theories of phonological categorisation (Wedel, 2012). Another possible hypothesis is that some forms might be used more frequently than others, e.g. /kore/ 'heart' might be used more frequently than the plural /kori/ 'hearts', and the same might apply to /ponte, ponti/, so that the vowel stem quality of the singular form is also extended to the plural form by analogy. While the fact that the singular forms might be more frequent than the plural is again a speculative consideration, there are actually studies showing that statistical properties of the lexicon, such as word frequency, can also enhance or inhibit sound change (Hay and Foulkes, 2016; Pierrehumbert, 2001, 2003).

5. Alongside the four types of idiosyncrasies listed above, a fifth one is related to verbs. Metaphony in verbs mainly occurs in 2nd person singular forms of the indicative (Maiden & Savoia, 1997, p. 19). However, apparently, verb stems in our data seem, in general,

not to be favourite targets of metaphony – with the only exception being /ess/, whose s_1 (Fig. F.1) and s_3 (Fig. F.3, left panel) predicted values are near the mean. For instance, the lexical stem /ten/ shows an s_1 predicted value far above the mean for both MM and MZ (Fig. F.1), and an s_3 value quite below the mean in ZZ (Fig. F.3, left panel). Further examples are the stems /dorm, mor/, which are both highly idiosyncratic for MM (Fig. F.2, left panel). Similarly, the s_3 value for /dorm/ in ZZ (see Fig. F.3, right panel) and the s_1 value for /mor/ in MZ (see Fig. F.2, right panel) also signal resistance to metaphony.

The fact that verbs do not usually show metaphony in our data might be due to a series of reasons, some of them purely phonetic, as already mentioned above: the presence of a high vowel (or, in some verbs, of a low vowel, see below) between stem and suffix, or the presence of consonants that might block coarticulation. In addition, the lack of metaphony in the first person singular of the present indicative could be explained etymologically: the suffix vowel in Latin was, in fact, /o/ and not /u/ (e.g. Latin /ˈdormio/ vs /ˈdormu/ in the Lausberg area). The lack of stem vowel raising or diphthongisation in these verb forms would therefore suggest that metaphony in the Lausberg area historically preceded the reduction of the Latin desinence <ō> to /u/ (Lausberg, 1939, p. 5).

Another factor might also be linked to the presence of complex suffixes: the second person singular suffix of the present indicative is -*asi* for the first conjugation, and -*isi* for the other conjugations. Since erosion phenomena affect word-final vowels, these suffixes are never completely reduced or elided, which might in some terms inhibit the cue-trading process that is possibly behind metaphony (on the relationship between perception and production, the role of morpho-lexical informativity and the relative consequences for sound change see Chapter 6). Also, it can not be excluded that analogy between inflected forms might have levelled vowel stem alternations to just one phonetic realisation of the stem vowel for the whole verbal paradigm.

Finally, apart from these five groups of exceptions, it cannot be generally excluded, for those stems carrying the vowel suffixes /e, i/, that the simple fact that the vowel spaces of these two vowels are acoustically close within the vowel chart might lead to partially overlapping metaphonic/coarticulatory outcomes.

Appendix G

Perception: listeners' sociolinguistic metadata

Tab. G.1 summarises information regarding sex, village of origin, and education level of the participants to the perception experiments (see Chapter 5), separately for region/experimental condition.

The numbers in brackets indicate how many listeners come from a specific village or have a specific sex or degree of education for each region/experimental condition.

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.

N.B.: Data from Orsomarso (1 participant) were included in "ZZ (MZ listeners)" because, although this village is geographically located within the Zwischenzone, its dialect presents a type of metaphony like the one in the Mittelzone (Savoia, 2015, p. 230, 233).

Region	Villages	Sex	Education
MM (41 participants)	Mormanno (41)	F (27) M (14)	1 (1) 2 (4) 3 (16) 4 (20)
ZZ (50 participants)	Aieta (1) Grisolia (3) Marcellina (1) Laino Borgo (2) Laino Castello (1) Morano Calabro (1) Papasidero (1) S. Maria del Cedro (8) Scalea (30) Tortora (1) Verbicaro (1)	F (23) M (27)	1 (3) 2 (3) 3 (27) 4 (17)
MZ (59 participants)	Albidona (8) Canna (3) Cerchiara (4) Montegiordano (14) Rocca Imperiale (3) Trebisacce (8) Villapiana (19)	F (29) M (30)	1 (0) 2 (5) 3 (29) 4 (25)
ZZ (MM listeners) (6 participants)	Mormanno (6)	F (6) M (0)	1 (0) 2 (0) 3 (2) 4 (4)
ZZ (MZ listeners) (14 participants)	Albidona (8) Alessandria del Carretto (1) Amendolara (1) Castrovillari (1) Cerchiara (1) Orsomarso (1) Trebisacce (1)	F (8) M (6)	1 (0) 2 (0) 3 (9) 4 (5)

Table G.1: Number of participants (in brackets) to the perception experiments in Chapter 5 by village, sex, and education level, separately for region/experimental condition.

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