

# **Production and Perception Mechanisms of Sound Change**

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# Nasalized mid back vowel raising in Gascon and Basque

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## Abstract

In this paper I analyze mid back vowel raising in Gascon and Basque. A comparison between the evolution of mid high and mid low vowels in the two languages is carried out and an unified account of all triggering contexts is proposed. Mid vowel raising mainly occurs before a nasal obstruent, but can also be found in other contexts which have not been appropriately characterized. After compiling examples from both Gascon and Basque, I propose that the process under study is more accurately described as a sporadic raising of phonetically nasalized [ɔ̃] and [õ̃]. Following Beddor and colleagues (Beddor 1982, Beddor et al. 1986, Krakow et al. 1988), this sound change is attributed to the acoustico-perceptual ambiguity leading to changes in vowel height which results from adding nasal formants to the F1 vowel space. In short, this paper analyzes a phonetic development that cannot be easily accounted for by means of phonological descriptions but is straightforwardly explained in phonetic terms, thus emphasizing the importance of phonetics in historical and phonological research.

## 1 Introduction<sup>1</sup>

In addition to several other sound patterns, Gascon and Eastern Basque varieties share a historical process of raising of the mid back vowels /ɔ/ and /o/, respectively, to /u/.<sup>2</sup> In Gascon, this raising process has occurred mainly when /ɔ/ preceded /n/, but some examples of /ɔ/-raising operating before a different nasal may be found as well; moreover, in some varieties of Gascon, such as Bearnese, /ɔ/-raising also occurs when the vowel follows a nasal obstruent. This pattern of sound change is found throughout the Gascon domain, including a South-Western speaking area in contact to Basque. In Basque, on the other hand, /o/ raising has taken place in all Eastern dialects both when the vowel is followed and preceded by a nasal obstruent. This sound change is primarily found in Zuberoan (Souletin), although it is present, to a lesser degree, in Low Navarrese and Lapurdian as well.

While mid vowel raising has been discussed by several authors for both Gascon (Bouzet / Lalanne 1937; Rohlfs 1970; Allières 1994; Massourre 2012, etc.) and Basque (Michelena 1977 [2011]; Zuazo 2008; Martínez-Areta 2013, etc.), no comparison between the two neighboring languages has been carried out and no analysis that unifies all triggering contexts has been put forward in either language. Regarding Basque, the seemingly heterogeneous contexts that have caused raising of the mid back vowel /o/ were previously described as “not [...] easy to define” (Martínez-Areta 2013: 62; cf. Zuazo 2008: 44-45). Here

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<sup>2</sup> This raising process is distinct from the systematic raising of Latin /o:/ to /u/ in Occitan/Gascon (Rohlfs 1970: 122; Allières, 2001: 19ff.; Masourre, 2012: 58).

I propose that all cases involve raising of contextually nasalized /o/, which is more accurately depicted as sporadic raising of phonetically nasalized [õ].

Section 2 presents examples of vowel raising in Gascon and Basque, with a new analysis of this sound change. Section 3 offers typological parallels of this process as well as a phonetic explanation for it. In both languages, mid back vowel raising is attributed to the perceptual ambiguity in vowel height caused by the addition of “nasal formants” to the F1 space in nasalized vowels. Section 4 presents some concluding remarks.

## 2 Raising of nasalized vowels in Gascon and Basque

Many languages, including several Romance languages, show different kinds of raising involving nasalized vowels. In most Gascon varieties, raising occurs when the target mid back vowel precedes a nasal obstruent, and both Bearnese Gascon and Basque show raising when the vowel in question follows the nasal obstruent as well.

In this section, I first describe three sporadic nasalized vowel raising processes found in different Gascon varieties. Then, I deal with the sporadic raising of the nasalized mid back vowel in Basque. Lastly, I analyze a systematic process turning contrastively nasalized mid back vowels into a higher vowel in word-final position, which has developed in two language varieties, i.e., Bearnese Gascon and Zuberoan Basque, which have stayed in historical contact.

### 2.1 Nasalized vowel raising in Gascon

Gascon, as well as most if not all Romance languages and as assumed for Latin itself (Sampson 1999: 19; Loporcaro 2011: 139), shows a certain degree of phonetic nasalization due to coarticulation with nasal consonants. This coarticulation process affects vowels preceding a tautosyllabic nasal obstruent to a larger degree than those following it. In addition, Gascon had contrastively nasalized vowels that are absent from most dialects nowadays, with the exception of Western Bearnese Gascon from the Orthez region which lies close to the Basque Country. According to Sampson (1999: 154), nasalized vowels in Bearnese Gascon are nowadays confined to a small geographical area in Artix, where examples such as /l̥œ̃/ ‘moon’ < LUNAM, /p̃ã/ ‘bread’ < PANEM or /b̃i/ ‘wine’ < VINUM can still be found.

Different Gascon speaking zones show diverse contextually conditioned nasalized vowel raising processes. I will briefly discuss some of them before turning to the raising of mid back vowels, which is the focus of this study.

In Gascon, as well as in Occitan dialects such as Lengadocian and Provençal, the vowel /ɛ/ is raised to /e/ in contact with a following nasal consonant as well as a preceding nasal (apud Massourre 2012: 73). Examples in (1) were taken from the Atlas Linguistique de la France (Gilléron / Edmont 1902-1910) by Allières (1994: 136), and are presented together with Mistralian Provençal equivalents for comparison.

(1) /ɛ/ > /e/ raising in nasalization contexts in Gascon (ALF; Allières 1994: 136)

Gascon	Provençal	Latin	Gloss
[ <sup>h</sup> bɛŋgo]	[ <sup>h</sup> vɛŋgo]	<i>veniō</i>	‘I come’ <sup>3</sup>
[bɛŋ] / [bɛ] / [bɛ̃]	[vɛŋ]	<i>venit</i>	‘he comes’
[bɛnt] / [bɛn] / [bɛŋ]	[vɛŋ]	<i>ventum</i>	‘wind’

In addition to the more spread raisings of [ɛ̃] and [õ], we find a geographically localized raising of /a/ in the Gascon variety of the valley of Aure (Cremona 1956; Rohlfs 1970: 117).

<sup>3</sup> Note, however, that the presence of a yod in the next syllable in the Latin form could have affected the vowel in this example.

In this case, a preceding or following nasal stop provides with the context for the change /a/ > /ɔ/. Illustrative examples include those in (2), with Standard Gascon forms appended for comparison.

(2) /a/ > /ɔ/ raising in nasalization contexts in Aure Gascon (Cremona 1956)

Aure Gascon	Gascon	Latin	Gloss
[pɔ]	[paŋ] / [pã]	<i>panem</i>	‘bread’
[lɔ]	[laŋ] / [lã]	<i>lanam</i>	‘wool’
[mɔ]	[maŋ] / [mã]	<i>manum</i>	‘hand’
[kɔm]	[kam]	<i>campum</i>	‘field’
[a'nɔ]	[a'nar]	<i>*anditāre</i>	‘to walk’

An older variety of Gascon underwent yet another phonetically nasalized vowel raising process analogous to the ones discussed above, namely, the raising of [ã]. Anglade (1921: 51) mentions certain Gascon texts from Bayonne, attested as far back as the 13<sup>th</sup> and the 15<sup>th</sup> centuries, where /an/ was raised to /en/ in stressed syllables.<sup>4</sup> Such cases are given in (3).

(3) /a/ raising in nasalization contexts in Bayonnese Gascon (Anglade 1921: 51)

Bayonnese Gascon	(Late) Latin	Gloss
<i>enz</i>	<i>antius</i>	‘but’
<i>quen</i>	<i>quantum</i>	‘how much’
<i>ten</i>	<i>tantum</i>	‘so much’
<i>sen</i>	<i>sanguem</i>	‘blood’
<i>sent</i>	<i>sanctum</i>	‘Saint’ <sup>5</sup>

The sound changes involving contextually nasalized vowels discussed above do not seem to have a parallel in any Basque dialect in contact with Gascon. Nevertheless, Gascon shows a third raising process, namely that of the nasalized mid back vowels, which finds a parallel in Basque, as discussed in the following section.

As pointed out above, I explain the sporadic /o/-raising found in Gascon as a change induced on the phonetically nasalized mid low back vowel [ɔ̃]. In contrast to the sound changes discussed in (2-3), [ɔ̃]-raising can be found in most varieties of Gascon where, as stated by Rohlfs (1970: 120), lax /ɔ/ raises to tense /o/ and then to /u/ when it is preceded or followed by a nasal consonant.

[ɔ̃]-raising in Gascon is especially common when the etymological Proto-Romance tense vowel \*ɔ precedes /n/, as in the case of Latin *fonte(m)* > *hont* /hun/ ‘source, fountain’ or Latin *bonu(m)* > *bo* /bu/, *bon* /bun/ ‘good’, but can apply before other nasal obstruents as well: Latin *hom(i)ne(m)* > *ome*, *omi* /'ume/, /'umi/ ‘man’. It also occurs dialectally when the vowel follows a nasal obstruent (cf. Latin *morte(m)* > *mort* /mur/ ‘dead’, cf. Rohlfs 1970: 120; Massourre 2012: 89), “sur une aire pyrénéenne qui va de l’Ariège aux ¾ des Pyrénées-Atlantiques et des Landes” (Allières 1994: 135). It is difficult to establish a date for the raising process [ɔ̃] > [õ] > [ũ] based on written documentation, since the orthographic tradition in Gascon did not discern <o> from <u> before <n>, systematically using <o> instead. Nevertheless, we know that this sound change occurred after the fronting of Proto-Romance tense \*u into /y/ and the general raising of Proto-Romance tense \*o into /u/, both

<sup>4</sup> It is worth mentioning that the variant *sent* for ‘Saint’ in which /a/ has raised to a mid front vowel does not usually carry stress in constructions such as *Sent Pé* < *sanctum Petrum* ‘Saint Peter’ (Anglade 1921: 51).

<sup>5</sup> Cf. *sein*h in 1251 as well as *sen* in 1451 in the Cartulary of Limoges (cf. Anglade 1921: 51).

found in Occitan as well as in Gascon. [õ]-raising is absent from other Gallo-Romance languages such as Catalan or French, referred to here as a means of comparison. The examples in (4) show instances of [õ] raising before a nasal obstruent in Gascon.

(4) /ɔ/ raising before a nasal obstruent in Gascon

Gascon	Transcription	French	Transcription	Gloss
<i>pont</i>	[pun]	<i>pont</i>	[põ]	‘bridge’
<i>bon</i>	[bun]	<i>bon</i>	[bõ]	‘good’
<i>font</i>	[fun], [hun]	<i>font</i>	[fõ]	‘well, fountain’
<i>son</i>	[sun]	<i>son</i>	[sõ]	‘sound’
<i>rond</i>	[run]	<i>rond</i>	[ʁõ], [ʁõd]	‘round’
<i>long</i>	[lun]	<i>long</i>	[lõ], [lõg]	‘long, extended’
<i>contunhar</i>	[kuntɥ'ɲa]	<i>continuer</i>	[kõtɥi'nɥe]	‘to continue’
<i>conduir</i>	[kun'duʝ]	<i>conduire</i>	[kõt'duʝiʁ]	‘to take, drive’
<i>continuèl</i>	[kuntɥi'nɥɛl]	<i>continuel</i>	[kõtɥi'nɥɛl]	‘abiding’
<i>bombardar</i>	[bunbar'da]	<i>bombarder</i>	[bõbaʁ'de]	‘to bomb’
<i>viulon</i>	[bju'lun]	<i>violon</i>	[vjõ'lõ]	‘violin’
<i>bona</i>	[bunɔ]	<i>bonne</i>	[bõn]	‘good, tasty’

[õ]-raising can also be found when the nasal stop precedes the target vowel. Examples of [õ]-raising after a nasal obstruent in Gascon are given in (5) as transcribed by Massourre (2012: 90), alongside their Latin source.

(5) /ɔ/ raising after a nasal obstruent in Gascon (Massourre 2012: 90)

Gascon	Transcription	Latin	Gloss
<i>móla</i>	[ <sup>1</sup> mulɔ]	<i>molam</i>	‘mill, millstone’
<i>móler</i>	[ <sup>1</sup> mule]	<i>molere</i>	‘to mill, to grind’
<i>mórta</i>	[ <sup>1</sup> murto]	<i>mortam</i>	‘dead, fem.’
<i>noças</i>	[ <sup>1</sup> nuses]	* <i>noptias</i>	‘nuptials’
<i>nora</i>	[ <sup>1</sup> nurɔ]	* <i>noram</i>	‘daughter-in-law’
<i>noste</i>	[ <sup>1</sup> nuste]	<i>nostrum</i>	‘our, masc.’
<i>novi</i>	[ <sup>1</sup> nuβi]	* <i>novium</i>	‘husband’
<i>novia</i>	[ <sup>1</sup> nuβjɔ]	<i>noviam</i>	‘wife’

After discussing the process of [õ]-raising in Gascon, I turn to the analogous /o/-raising process found in Eastern Basque dialects.

## 2.2 /o/-raising in Zuberoan Basque

Alongside contrastively nasalized vowels (Egurtzegi 2015: 4-6), most authors (cf. Larrasquet 1939; Michelena 1977 [2011]; Hualde 1993, 2003; Zuazo 2008: 46) describe vowels surrounding nasal consonants as nasalized in Zuberoan Basque. Examples of this predictable – i.e. contextual – nasalization include any vowel in contact with a nasal consonant, as in the words *khatiña* [k<sup>h</sup>a'tĩɲã] ‘chain’, *ihitz* [i<sup>h</sup>ĩtʃ] ‘dew, frost’ or *ene* [e<sup>n</sup>ẽ] ‘mine’.

In Zuberoan Basque, most instances of /u/ were fronted to /y/ (Lafon 1937 [1999], 1958 [1999]; Michelena 1977 [2011]), with the exception of those cases in which /u/ appeared in some seemingly heterogeneous inhibitory contexts (see Egurtzegi 2014; 2017). In addition to lexical items where /u/-fronting was blocked, there is another source of /u/ in Zuberoan: many instances of etymological /o/ raised to /u/ (cf. Michelena 1977 [2011]: 43-44). Although this raising is widespread in the dialect, it is not systematic. As a consequence of lexical diffusion (Labov 1994), exceptions to the process may be found both in unaffected words such as

*kompasione* [kompa'sjone] ‘mercy’, and in specific words only being subject to raising in some varieties of Zuberoan as *gizun* [ˈgiʒun] and *gizon* [ˈgiʒon] ‘man’. /o/-raising is also found very sporadically in other Eastern dialects of Basque. The near-gap produced by high back vowel fronting – which caused most instances of /u/ to shift to /y/ – probably contributed to the high frequency of the raising of nasalized mid back vowels in Zuberoan as opposed to other Eastern Basque dialects that did not develop /u/-fronting.

Peillen (1992: 253) places the beginning of /o/-raising in Basque in the 18<sup>th</sup> century, but this is far from obvious, especially given that there is a clear tendency to interchange <o> and <u> in the earliest works written in any Eastern dialect of Basque. Variation of this kind can be found in Dechepare (1545 [1980]) and Leizarraga (1571 [1900]) (cf. Michelena 1977 [2011]: 44-45). The Low Navarrese author Dechepare, for instance, uses the raised variants *hun*, *unsa* and *ungi* alongside *hon* ‘good’, *onsa* ‘well’ and *hong* ‘well’. The graphematic <o>s that appear in Zuberoan texts until the 18<sup>th</sup> century are probably due to the writing tradition of this dialect, which was adopted from Gascon, where <o> represents /u/. The use of <u> before <n> in the 18<sup>th</sup> century does not correspond to a recent sound shift but ought to be ascribed to a change in the writing system.

The consonant environment where modern Zuberoan shows /u/ instead of common /o/ has usually been described as “before *-n* as well as in some other barely specifiable contexts” (following Michelena 1954 [2011]: 617; 1977 [2011]: 43; cf. Egurtzegi 2013a: 132; Martínez-Areta 2013: 62; Zuazo 2008: 44-45; Camino 2011 [2014]). Under the new analysis proposed here, the sporadic mid back vowel raising may target any instance of phonetically nasalized /o/ – or [õ]. Namely, /o/ > /u/ affects /o/s adjacent to a nasal consonant, allowing us to propose a simple [õ] > [ũ] change.

The analysis of Zuberoan Basque data is based on a survey (cf. Egurtzegi 2014, 2017) extracted from the *General Basque Dictionary* (Michelena / Sarasola 1987-2005), Lhande’s (1926-1938) *Dictionnaire basque-français*, Larrasquet’s (1939) *Le Basque de la Basse-Soule Orientale* and recent dialectological literature (Camino 2009a, 2009b; Zuazo 2008). The examples in (6) show instances of /o/-raising in contact with all the nasal consonants in the language /n, m, ɲ, ñ/, as well as with the allophones [ɲ, ɲ̟, ɲ̠, ɲ̡, ɲ̣]<sup>6</sup> of /n/ before an obstruent, thus revealing that the phonological context triggering the process was not limited to a following alveolar nasal, but that any nasal consonant could follow or precede the target /o/. Note that this process operated on native words and borrowings in the same way (cf. Michelena 1977 [2011]: 44).

(6) /o/-raising in Zuberoan Basque

a) Raising adjacent to /n/

Standard Basque	Zuberoan	Transcription	Gloss
<i>on</i>	<i>hun</i>	[hun]	‘good’
<i>gizon</i>	<i>gizun</i>	[ˈgiʒun]	‘man’
<i>honen</i>	<i>hunən</i>	[ˈhunən]	‘of this’
<i>hona</i>	<i>hunat</i>	[huˈnat]	‘here’
<i>bonet</i>	<i>bunet</i>	[buˈnet]	‘hat’
<i>onest</i>	<i>unest</i>	[uˈneʃt]	‘honest’
<i>desonest</i>	<i>desunest</i>	[dezuˈneʃt]	‘dishonest’
<i>pertsona</i>	<i>persuna</i>	[perˈʃuna]	‘person’

<sup>6</sup> As in many other languages, nasal stops share place with the following obstruent in Basque. The symbols listed here stand for dental, apico-alveolar, lamino-alveolar, prepalatal and velar, respectively. It should be noted that some varieties of Basque contrast apico-alveolar and lamino-alveolar fricatives and affricates.

<i>estonatu</i>	<i>estunati</i>	[eʃtuˈnati]	‘to astonish’ (cf. Eastern <i>estonatu</i> )
<i>nor</i>	<i>nur</i>	[nur]	‘who (abs)’
<i>nork</i>	<i>nurk</i>	[nurk]	‘who (erg)’
<i>norbait</i>	<i>nurbait</i>	[nurˈβait]	‘somebody’
<i>nornahi</i>	<i>nurnahi</i>	[nurˈnahi]	‘anybody’
<i>nola</i>	<i>nula</i>	[ˈnula]	‘how’
<i>noiz</i>	<i>nuiʒ</i>	[nuʒ]	‘when’
<i>noble</i>	<i>nuble</i>	[ˈnuβle]	‘noble’

### b) Raising adjacent to /m/

Standard Basque	Zuberoan	Transcription	Gloss
<i>zenbait</i>	<i>zunbait</i>	[ʃumˈbait̪]	‘a few’ (cf. Eastern <i>zonbait</i> )
<i>tronpatu</i>	<i>trunpatü</i>	[trumˈpaty]	‘to err; deceive’ (cf. Bearnese Gascon <i>trumpá</i> )
<i>komentu</i>	<i>khumentü</i>	[kʰuˈmenty]	‘convent’
<i>amodio</i>	<i>amurio</i>	[amuˈio]	‘love’
<i>amore</i>	<i>amure</i>	[aˈmue]	‘love’
-	<i>musde</i>	[ˈmuzðe]	‘sir, (cf. Fr. <i>monsieur de</i> )’
<i>moda</i>	<i>muda</i>	[ˈmuða]	‘style’
<i>molde</i>	<i>mulde</i>	[ˈmulde]	‘manner, way’
<i>moldatu</i>	<i>muldatü</i>	[mulˈdaty]	‘to adapt’
<i>motz</i>	<i>mutz</i>	[mutʃ]	‘short’
<i>moztu</i>	<i>muxtü</i>	[ˈmuʃty]	‘to cut’

### c) Raising adjacent to /ɲ/

Standard Basque	Zuberoan	Transcription	Gloss
<i>soin</i>	<i>su(i)ñ</i>	[ʃuiɲ]	‘body’
<i>soineko</i>	<i>suñeko</i>	[ʃuɲeko]	‘dress’
<i>zein</i>	<i>zu(i)ñ</i>	[ʃuiɲ]	‘what, which one’ (cf. Eastern <i>zoin</i> )
<i>oin</i>	<i>hu(i)ñ</i>	[huɲ]	‘foot’
<i>amoina</i>	<i>amuina</i>	[aˈmuɲa]	‘alms, hand out’ (cf. Eastern <i>a(u)moina</i> ) <sup>7</sup>
-	<i>u(i)ñhu</i>	[uiɲˈhu]	‘onion’ (cf. Bearnese <i>onhon</i> ) <sup>8</sup>
<i>liburu-txo</i>	<i>lübürüñu</i>	[lyβyˈyɲu]	‘little book’ <sup>9</sup>
<i>gaixo-txo</i>	<i>gaxoñu</i>	[gaˈʃoɲu]	‘(little) poor thing’

### d) Raising adjacent to /h̃/

Standard Basque	Zuberoan	Transcription	Gloss
<i>ohore</i>	<i>uhure</i>	[uˈh̃ue]	‘honor’
<i>ohoin</i>	<i>uhuiñ</i>	[uˈh̃uiɲ]	‘thief’
<i>inor</i>	<i>ihur</i>	[iˈh̃ur]	‘nobody’
<i>inon</i>	<i>ihun</i>	[iˈh̃un]	‘nowhere’

<sup>7</sup> Cf. also the parallel Gascon development *\*aumoine* > *aumouyne* ‘alms, hand out’.

<sup>8</sup> The /h/ in this word is non-etymological. These /h/s are rare, but present in modern Eastern dialects nevertheless. Other examples of non-etymological /h/ include *harma* ‘weapon’ (< Latin *arma*), *hira* ‘wrath’ (< Latin *ira*) and *hezka* ‘ringworm’ (< Latin *scabies*) (see Egurtzegi, 2014: §4.5.1).

<sup>9</sup> The suffix *-ño* is found in other dialects as well, cf. *andereño* ‘miss’.

<i>inola</i>	<i>ihula</i>	[i <sup>h</sup> hula]	‘by no means’
<i>inoiz</i>	<i>ihuiz</i>	[i <sup>h</sup> huiz̃]	‘never’
<i>laino</i>	<i>lanhũ</i>	[lan <sup>h</sup> hu]	‘cloud’
<i>anoa</i>	<i>anhua</i>	[an <sup>h</sup> hua]	‘food portion, supply’

### e) Raising before nasal stops with non-contrastive place features

Standard Basque	Zuberoan	Transcription	Gloss
<i>arrunt</i>	<i>arrunt</i>	[a <sup>h</sup> ru <sup>h</sup> nt̃]	‘common, ordinary’ (cf. <i>arront</i> )
<i>konde</i>	<i>kunte</i>	[ <sup>h</sup> ku <sup>h</sup> nte]	‘count’
<i>kontra</i>	<i>kuntre</i>	[ <sup>h</sup> ku <sup>h</sup> ntre]	‘against’
<i>ondu</i>	<i>huntü</i>	[ <sup>h</sup> hu <sup>h</sup> nty]	‘to mature, to age’
<i>kontatu</i>	<i>khuntatü</i>	[k <sup>h</sup> hu <sup>h</sup> ntat̃y]	‘to tell’
<i>kontu</i>	<i>khuntü</i>	[ <sup>h</sup> k <sup>h</sup> hu <sup>h</sup> nty]	‘total, count’
<i>kontent</i>	<i>kuntent</i>	[ku <sup>h</sup> nt̃ent̃]	‘happy’
<i>hontaz</i>	<i>huntaz</i>	[ <sup>h</sup> hu <sup>h</sup> nt̃as̃]	‘about this’
<i>ezkondu</i>	<i>ezkuntü</i>	[e <sup>h</sup> s̃ <sup>h</sup> ku <sup>h</sup> nty]	‘to marry’
<i>hondar</i>	<i>hundar</i>	[ <sup>h</sup> hu <sup>h</sup> ndar]	‘remainder’
-	<i>untsa</i>	[ <sup>h</sup> u <sup>h</sup> nt̃sa]	‘well’ (cf. <i>ontsa</i> )
<i>kontserbatu</i>	<i>kuntserbatü</i>	[ku <sup>h</sup> nt̃ser <sup>h</sup> βaty]	‘to preserve’
-	<i>munstra</i>	[ <sup>h</sup> mu <sup>h</sup> nt̃stra]	‘showing, sample’
<i>ontzi, untzi</i>	<i>untzi</i>	[ <sup>h</sup> u <sup>h</sup> nt̃si]	‘ship’
<i>ontza</i>	<i>untza</i>	[ <sup>h</sup> u <sup>h</sup> nt̃sa]	‘ounce’
<i>esponja</i>	<i>espunja</i>	[e <sup>h</sup> s̃ <sup>h</sup> pu <sup>h</sup> nt̃za]	‘sponge’
-	<i>hunki</i>	[ <sup>h</sup> hu <sup>h</sup> nt̃ki]	‘profit’
<i>ongailu</i>	<i>hunkallü</i>	[hu <sup>h</sup> nt̃ka <sup>h</sup> ly]	‘fertilizer’

Given that the instances of vowel raising discussed above did not undergo fronting, it may be hypothesized that this process is probably more recent than /u/-fronting (Egurtzegi to appear). As expected, instances of \*u in nasalization contexts like *lagün* [‘laɣyn] ‘friend’, *egün* [‘eɣyn] ‘day’, *alhargün* [al‘harɣyn] ‘widow(er)’, etc., show high back vowel fronting.

### 2.3 Systematic raising of contrastively nasalized /õ/

While all the examples in (6) have undergone sporadic [õ]-raising triggered by an immediately adjacent nasal obstruent, Zuberoan shows a parallel /õ/-raising process which is systematic, and affects contrastively nasalized /õ/ instead of [õ] in contact to a nasal obstruent. Note that contrastively nasalized vowels are limited to word-final position in Zuberoan Basque (Egurtzegi 2015). Examples of this process include those in (7).

#### (7) Regular raising of word-final stressed /õ/

Standard Basque	Zuberoan	Transcription	Gloss
<i>ardo</i>	<i>ardũ</i>	[ar <sup>h</sup> ðũ]	‘wine’
<i>saloi</i>	<i>salũ</i>	[sa <sup>h</sup> lũ]	‘living room’
<i>arratoi</i>	<i>arratũ</i>	[ara <sup>h</sup> t <sup>h</sup> ũ]	‘mouse’
<i>lehoi</i>	<i>lehũ</i>	[le <sup>h</sup> hũ]	‘lion’
<i>arrazoi</i>	<i>arrazũ</i>	[ara <sup>h</sup> zũ]	‘reason’
<i>patroi</i>	<i>patrũ</i>	[pa <sup>h</sup> trũ]	‘patron’
-	<i>presũ</i>	[pre <sup>h</sup> zũ]	‘prison’
<i>sasoi</i>	<i>sasũ</i>	[sa <sup>h</sup> zũ]	‘season, time’
<i>millioi</i>	<i>milliũ</i>	[mi <sup>h</sup> ʎjũ]	‘million’

The examples in (7) correspond to a regular sound change that has yielded the merger of /õ/ and /ũ/ in /ü/. The first example in (7) involves a potentially inherited word, while the other examples correspond to loanwords of different periods. Two observations are worth mentioning here: all contrastively nasalized vowels in Zuberoan occur in stressed position (Egurtzegi 2015: 4); most listed words are loanwords from Gascon and exhibit Proto-Romance tense \*o, which was systematically raised to /u/.

As shown in (7), word-final contrastively nasalized /õ/ was raised to /ü/ in Zuberoan Basque. Given that most of the words in (7) have been borrowed from Bearnese Gascon, a comparison between the sound changes in both languages is in order. Examples of this raising process in Bearnese Gascon taken from Agirre Sarasola (2001: 666) are given in (8) alongside with Zuberoan parallels. Although phonemic nasalization is already lost in most Bearnese varieties (cf. Rohlfs 1970: 6, footnote 11), it is transcribed here for the sake of comparison. Note that all the examples correspond to Latin *-ōnem*, so that systematic raising unrelated to the nasal context is expected to take place in Gascon but not in Zuberoan.

(8) Word-final /õ/ raising in Bearnese Gascon and Zuberoan Basque (Agirre Sarasola 2001)

Bearnese Gascon	Transcription	Zuberoan Basque	Transcription	Gloss
<i>lèu</i>	/le'ũ/	<i>lehũ</i>	[le'hũ]	'lion'
<i>arraton</i>	/ara'tũ/	<i>arratũ</i>	[ara'thũ]	'mouse'
<i>arrason</i>	/ara'zũ/	<i>arrazũ</i>	[ara'zũ]	'reason'
<i>patron</i>	/pa'trũ/	<i>patrũ</i>	[pa'trũ]	'patron'
<i>preson</i>	/pre'zũ/	<i>presũ</i>	[pre'zũ]	'prison'
<i>sason</i>	/sa'zũ/	<i>sasũ</i>	[sa'zũ]	'season, time'
<i>million</i>	/mi'ʎjũ/	<i>milliũ</i>	[mi'ʎjũ]	'million'
<i>salon</i>	/sa'lũ/	<i>salũ</i>	[sa'lũ]	'living room'

Many of the words in this list show evidence of a late incorporation into Zuberoan: three of the words show voiced sibilants – segments that have been borrowed from Gascon and are not found in other Basque dialects –, while *patrũ* exhibits a cluster only present in recent stages of the language (Blevins / Egurtzegi in press). In this scenario, examples like Bearnese *lèu*/Zuberoan *lehũ* 'lion' are especially interesting, given that the Zuberoan form shows evidence of early borrowing into Basque. In these forms, intervocalic /n/ shifted to nasalized /ñ/ before Common Basque<sup>10</sup> (cf. Igartua 2015; Egurtzegi 2014: §4.2.3, in press) and metathesized to the second syllable in the Eastern varieties (cf. Lakarra 2009; Egurtzegi 2011, 2013b, 2014: §4.4.4, §8.2.1): Latin *leone(m)* >> Common Basque \**leoñe* > Old Eastern Basque \**leñoe*. In the case of Gascon *lèu*, after the early loss of Latin final *-e*, Proto-Romance tense \*o was independently raised to *u* and word-final *-n* was simply lost giving rise to vowel nasalization, as in Latin *pane(m)* > *pan* > *pã* > *pa* (cf. Rohlfs 1970: 158). As indicated in (9), this seemingly independent sequence of changes points towards different reconstructed paths to arrive from Latin *leōne(m)* to the forms *leũ* and \**lehõ*, respectively. The presence of the aspirate in the second syllable makes a borrowing from Gascon unlikely, and argues for a raising of [õ] instead, at least for this particular case.

<sup>10</sup> Common Basque (or Old Common Basque) is the stage of the language preceding the dialectal division proposed by Michelena (1981).

(9) The evolution of Lat. *leōnem* ‘lion’ in Zuberoan Basque and Bearnese Gascon

	Latin	Reconstructed process	Modern form	Transcription
<b>Bearnese:</b>	<i>leōne(m)</i>	> * <i>leon</i> > * <i>leun</i> > <i>leũ</i> >	<i>lèu</i>	/le'u/
<b>Zuberoan:</b>	<i>leōne(m)</i>	> * <i>leoñe</i> > * <i>leñō(i)</i> > * <i>lehō</i> > <i>lehũ</i>		/le'hũ/

The similarity of the mid vowel raising processes in the two neighboring languages makes it difficult to determine whether vowel raising happened in the donor language or occurred in both languages in a parallel way (cf. Blevins 2017).<sup>11</sup> While one could argue that the examples in (8) that were borrowed from Gascon into Zuberoan involve the general raising of Latin *ō* /o:/ into /u/ – found in Gascon as well as in Occitan –, other borrowings from Gascon in which Latin /o:/ (Proto-Romance tense \*o) was not in contact to a nasal do not show raising in Zuberoan: compare Gascon *bouts* /buts/ < Lat. *vōce(m)* ‘voice’ with Zuberoan *botz* /boʦ/ ‘voice’, presumably borrowed from older Gascon *bots*. A word with /o/ in non-nasal context like *botz* has not yielded \*\**butz* in Zuberoan, which contrasts with Gascon [buts] as well as with other lexical items with nasalized vowels such as its near-minimal pair *motz* > *mutz* /muʦ/ ‘short’. In addition, it cannot be argued that Basque borrowed these words after the raising process took place in Gascon, given that /ō/-raising also affected native words such as *ardũ* /ar'dũ/ ‘wine’ (< \**ardō* < \**ardãō* < \**ardaño* < \**ardano*).

Alongside all the borrowings from different periods, inherited words such as *ardũ* show that Zuberoan Basque raised all /ō/s in the dialect. Nevertheless, the case of Gascon is less clear, given that an independent process of /o/-raising yielding a similar outcome also affected /o/ (< Lat. *ō* /o:/) in this language. Specific research on the chronology of the two sound changes that raised /o/ in Gascon is required in order to find out whether the systematic shift of contrastively nasalized mid back vowels in Zuberoan Basque developed in the same way in Gascon. In any case, given the number of borrowed words in which /ō/ turned into /ũ/ word-finally in Zuberoan Basque, it seems clear that Gascon has played a role in the development of this second sound change as well as in the more general [ō]-raising process. Whether the role of Gascon was limited to loaning a sound change or it also facilitated the reinterpretation of Zuberoan Basque /ō/ as /ũ/ due to the high number of shared lexical items showing /ũ/ (< \*ō), /ō/ > /ũ/ developed as a natural sound change within Zuberoan Basque.

### 3 Vowel nasalization and vowel height

Instances of nasalized vowel raising and lowering like those seen in the Eastern Basque dialects are common. Beddor (1982) lists up to 75 languages that show sound patterns of allophonic or phonemic variation involving oral and nasal vowel height with specific references. Other surveys include Bhat (1975), Foley (1975), Ruhlen (1978) and Schourup (1973). Changes in height of nasalized vowels are found, among many other languages, in Romance languages such as French and Portuguese, and other Indo-European languages such as Breton, Hindi, Armenian and Dutch. Outside of Indo-European, Niger-Congo languages such as Swahili and Ewe, Oto-Manguean languages such as Mixtec and Zapotec, Arawakan languages such as Shiriana and Asháninka, as well as the North American isolates Yuchi and Haida, all show raising or lowering of nasalized vowels. Cases parallel to the specific mid back vowel raising studied in this paper for Gascon and Basque exist in Dutch (Germanic), Batak (Malayo-Polynesian), as well as the Khoekhoe (Nama) Kho language, which raised both mid back vowels /o/ and /ɔ/ when contextually nasalized by an adjacent nasal consonant (see Beddor 1982 for references on each language).

<sup>11</sup> According to Blevins’ (2017) model, language experience may alter phonetic perception in a situation of language contact and yield sound changes that, although developed due to linguistic contact, appear to be natural and phonetically motivated.

While nasalized high vowels are lowered and nasalized low vowels are raised in both contextual and non-contextual situations, the general surveys show different sound change patterns for nasalized mid vowels (cf. Maddieson 1984). The presence or absence of a segmental source of the vowel nasalization characteristic seems to affect the final outcome: mid vowels are usually lowered when there is no surrounding nasal consonant but raised when they are adjacent to the contextual source of vowel nasalization. The observation that the presence or absence of a segmental source of the nasality property yields different outcomes implies that the vowel raising in examples (1-6) may be different from the /*õ*#/ > /*ũ*#/ raising cases in oxytonic words shown in (7-9). Separating these two sets of examples into two distinct processes would be consistent with the fact that [*õ*]-raising has been described as sporadic while /*õ*/-raising has been characterized as systematic, as well as with the dialectal distribution of the two processes in Basque: while the former sound change is widespread throughout the Eastern varieties, the latter is limited to Zuberoan, the only modern dialect that has maintained contrastive vowel nasalization (cf. Hualde 2003: 31; Egurtzegi 2013a: 126-127; 2015: 4).<sup>12</sup> There is yet another asymmetry affecting mid vowels: front mid vowels are more likely to lower whereas back mid vowels are more likely to raise (Beddor et al. 1986). This asymmetry may also apply to high vowels but is more prominent in mid vowels.

As in any given process that is found in such a wide range of languages across the world, we expect a natural phonetic explanation for this sound pattern. Articulatory, acoustic and perceptual constraints have been invoked in order to account for the reinterpretation in oral height of nasalized vowels (see Beddor et al. 1986 for extensive bibliography on each perspective). Acoustically, the ambiguity in height is attributed to nasal coupling. The coupling of the two tracts adds a pole-zero pair to the lower frequencies of the vowel spectrum (cf. Fant 1960). The nasal pole (or nasal formant, FN) and the nasal zero (FZ) almost cancel each other, but the first formant is altered in the process (F1'). This alteration increases along with the level of coupling in production, which makes the nasal formant more prominent. The perceived height of oral vowels is reflected by the center of gravity, which is determined by the frequency and amplitude of spectral prominences in the F1-F2 region (Bedrov et al. 1978; Chistovich / Lublinskaya 1979; Chistovich et al. 1979). The center of gravity is shifted with the addition of the pole-zero pair in nasal vowels. Beddor (1982) measured the center of gravity of nasal and oral vowels of different languages, and she found that it is lower for nasalized low and mid back vowels than for their oral counterparts and higher for [*ĩ* *ẽ*] than for [*i* *e*], while it is similar for [*u*] and [*ũ*]. This is consistent with the observations inferred from the various surveys (Wright 1980), namely that high and low nasalized vowels are perceived as mid, as well as with the tendency for nasalized [*õ*] to raise and nasalized [*ẽ*] to lower.

There have also been perception experiments dealing with the perceptual ambiguity in the height of nasalized vowels. Krakow et al. (1988) showed that English speaking listeners perceived nasalized vowels as differing in height from their oral counterparts except when they preceded /*n*/, an environment where listeners could attribute nasalization to the phonological context. This experiment suggests that a listener's inability to find the source of the nasalization in a vowel can yield a reinterpretation in terms of oral height, especially in

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<sup>12</sup> This is alongside the now defunct Roncalese dialect, which showed a different distribution of these segments (Egurtzegi, 2014: §6.2.2; 2015: 3-4).

languages without phonologically nasalized vowels. This perceptual ambiguity may play a role in the development of contrastive vowel nasalization.<sup>13</sup>

“One account of phonemicisation of vowel nasalisation with concomitant nasal consonant loss is that the perceptual salience of vowel nasality increased as the perceptual salience of the conditioning nasal consonant decreased (see Kawasaki 1986). However, at the transition stage, distinctive vowel nasalisation is not fully integrated into the language. If listeners do not expect non-contextual nasal vowels but also do not perceive the now weakened nasal consonant, then they might attribute the acoustic effects of vowel nasalisation to either (a) nasal coupling, (b) change in tongue configuration, or (c) both nasal coupling and change in tongue configuration. Under these conditions, we would expect /VN/ or /NV/ to result historically in (a) / $\tilde{V}$ / with nasalisation but no height change, (b) /V'/ with height change but no nasalisation, or (c) / $\tilde{V}'$ / with height change and nasalisation” (Beddor et al. 1986: 211).<sup>14</sup>

According to the authors, there is no consensus in the relative chronology of the lowering and the development of contrastive nasalization in the literature (cf. Entenman 1977; Haden / Bell 1964; Martinet 1965; Pope 1934), thus suggesting that both changes may have occurred in the same period.

I propose that the Zuberoan raising of stressed word-final nasalized / $\delta$ / may be a similar development. Although possibly related, this / $\delta$ #/ > / $\tilde{u}$ #/ process is different from the more general change [ $\delta$ ] > [ $\tilde{u}$ ]. Contextually nasalized raising and raising with no clear nasal environment are distinguished in the phonetic literature (cf. Beddor et al. 1986), and the former is sporadic whilst the latter is systematic in Zuberoan Basque, in addition to having different isoglosses in the Eastern Basque dialects. The perceptual experiment by Krakow et al. (1988) suggests that nasalized vowels in oral contexts are most ambiguous in height in languages with no contrastive nasality in vowels, and this is consistent with the very limited distribution of contrastive nasalization in Zuberoan. The fact that Zuberoan contrastive nasalization exhibits low productivity may make / $\delta$ #/ prone to reinterpretation (Krakow et al. 1988). This propensity towards height reinterpretation alongside the prosodic prominence and longer duration of contrastively nasalized vowels due to their stressed status in Zuberoan (Hualde 1993; Egurtzegi 2015) may account for the systematic nature of / $\delta$ / > / $\tilde{u}$ /.

#### 4 Conclusions

This paper has discussed the raising of the nasalized vowels in Gascon and Basque. Focusing on the raising of mid back vowels, I have proposed a new analysis for the raising processes, namely, phonetically nasalized [ $\delta$ ] was reinterpreted as [ $\tilde{u}$ ], which was then phonologized as /u/.

I have shown that the raising of the mid back vowel [ $\delta$ ] occurred in essentially all nasalization context conditions in Gascon: not only when followed by /n/, but also when followed or preceded by any other nasal stop. Although the paper focuses on mid back vowel raising, I have briefly discussed three other raising processes involving the raising of a

<sup>13</sup> Recent studies (Carignan et al. 2011; cf. also Shosted et al. 2012) suggest that speakers of American English may compensate for the low-frequency shift in spectral energy due to velopharyngeal opening by raising the tongue during the production of nasalized /i/. Thus, oral articulation may play a complex role in vowel nasalization and the effects of nasalization in vowels may, in some cases, be compensated by a lingual gesture.

<sup>14</sup> Beddor et al. (1986) use the symbol V' to refer to a vowel with a modified height (due to nasalization effects) throughout the paper.

nasalized vowel in Gascon varieties: [ẽ̃] > [ē] which is widespread in the Gascon domain, [ã] > [ǣ] in Aure Gascon, and [ã]-raising to a mid-front vowel in medieval Bayonnese Gascon.

The case of Basque, which was previously only roughly described, has been analyzed on the same terms. In addition, the raising of [õ] has been divided into two different processes: the more general process described as [õ] > [ũ] and the raising of stressed /õ/ into /ũ/. While the raising of contextually nasalized vowels is sporadic and present in many Eastern Basque varieties, the raising of the nasalized stressed phoneme /õ/ to /ũ/ in word-final position occurs systematically and only in Zuberoan.

All nasalized vowel raising processes present in Gascon and Basque have been accounted for in terms of the perceptual ambiguity produced by the replacement of F1 of the non-nasal vowel with a zero, a nasal formant and a shifted F1'. FN becomes more prominent with greater coupling, which causes a shift in the center of gravity of nasal vowels as compared to their oral counterparts. This can yield changes in vowel height (Beddor et al. 1986: 200), most especially in languages where the nasality contrast is not very prominent. Such is the case of Gascon and Zuberoan Basque, both with contrastive nasalization restricted to the stressed syllable. The systematic nature of /õ/ > /ũ/ may be due to the lack of nasal context in the sound pattern, a situation that has been shown to facilitate the listener's reanalysis of spectral changes associated with nasalization as affecting oral vowels in languages lacking vowel nasality contrasts (Krakow et al. 1988). The direction of the sound change observed in cross-linguistic surveys is consistent with the center of gravity data for nasal mid back vowels (Beddor 1982).

After looking at nasalized vowel raising processes in both languages, it seems very likely that nasalized mid back vowel raising has proceeded similarly in Gascon and Zuberoan. This context-dependent sound change is relatively recent and geographically restricted – it is not found in other Romance languages such as French or Catalan. All in all, a more complete account of vowel nasalization and sound changes operating on nasalized vowels may be obtained by integrating contact linguistics and phonetics as a means of describing and explaining historical sound patterns which have received little attention in the past.

## References

- Agirre Sarasola, P. 2001. "Catechima laburra, zubereraren ezaugarri fonologikoen lekukoa", *International Journal of Basque Linguistics and Philology* [ASJU] 35, 653-787.
- Anglade, J. 1921. *Grammaire de l'ancien provençal ou ancienne langue d'Oc*, Paris: Klincksieck.
- Allières, J. 1994. "La nasalisation et l'action des nasales à travers l'histoire de l'occitan", *Communication and Cognition* 27 (1-2), 133-140.
- Allières, J. 2001. *Manuel de linguistique romane*. Paris: Honoré Champion.
- Beddor, P. S. 1982. *Phonological and Phonetic Effects of Nasalization on Vowel Height*, Minneapolis, MN: University of Minnesota dissertation [reproduced by Indiana University Linguistics Club].
- Beddor, P. S. / Krakow, R. A. / Goldstein, L. M. 1986. "Perceptual constraints and phonological change", *Phonology* 3, 197-217.
- Bedrov, Ya. A. / Chistovich, L. A. / Sheikin, R. L. 1978. "Frequency position of the 'center of gravity' of formants as a useful feature in vowel perception", *Soviet Physics Acoustics* 24, 275-278.
- Bhat, D. N. S. 1975. "Two studies on nasalization". In: C. A. Ferguson, L. M. Hyman / J. J. Ohala, eds. *Nasálfest: Papers from a symposium on nasals and nasalization*, Stanford: Stanford University Press, 27-48.

- Blevins, J. 2017. "Areal sound patterns: From perceptual magnets to stone soup". In: R. Hickey, ed. *The Cambridge Handbook of Areal Linguistics*, Cambridge: Cambridge University Press, 55-87. doi: <https://doi.org/10.1017/9781107279872.006>.
- Blevins, J. / Egurtzegi, A. in press. "Unexpected obstruent loss in initial obstruent-sonorant clusters: The apparent case of Romance loans in Basque", *Phonology*.
- Bouzet, J. / Lalanne, Th. 1937. *Du gascon au latin*. Saint-Vincent-de-Paul: Bénése.
- Camino, I. 2009a. "Mugako hiztun eta aldaerak ipar-mendebaleko Zuberoan", *Fontes Linguae Vasconum* 111, 153-218.
- Camino, I. 2009b. "Hizkuntza-aldakortasunari Amiküzetik so", *Lapurdum* 13, 61-80.
- Camino, I. 2011 [2014]. "Ekialdeko euskararen iraganaz". In: I. Epelde, ed. *Euskal dialektologia: lehena eta oraina (Supplements of the International Journal of Basque Linguistics and Philology [ASJU] 69)*, Bilbao: University of the Basque Country, 87-153.
- Carignan, Ch. / Shosted, R. / Shih, Ch. / Rong, P. 2011. "Compensatory articulation in American English nasalized vowels", *Journal of Phonetics* 39, 668-682.
- Chistovich, L. A. / Lublinskaya, V. V. 1979. "The 'center of gravity' effect in vowel spectra and critical distance between the formants", *Hearing Research* 1, 185-195.
- Chistovich, L. A. / Sheikin, R. L. / Lublinskaya, V. V. 1979. "'Centers of gravity' and spectral peaks as the determinants of vowel quality". In: B. Lindblom / S. Öhman, eds. *Frontiers of Speech Communication Research*, New York: Academic Press, 143-157.
- Cremona, J. A. 1956. *The Dialect of the Vallée d'Aure (Hautes-Pyrénées)*, London: Westfield College (Queen Mary) - University of London dissertation.
- Dechepare, B. [Etxepare, B.]. 1545 [1980]. *Linguae vasconum primitiae. Edizio kritikoa*, Bilbao: Euskaltzaindia / Mensajero [edited by P. Altuna].
- Egurtzegi, A. 2011. "Euskal metatesiak: abiaburua haien ikerketarako", *International Journal of Basque Linguistics and Philology [ASJU]* 45, 1-79.
- Egurtzegi, A. 2013a. "Phonetics and phonology". In: M. Martínez-Areta, ed. *Basque and Proto-Basque. Language-internal and typological approaches to linguistic reconstruction [Mikroglottika 5]*, Frankfurt am Main: Peter Lang, 119-172.
- Egurtzegi, A. 2013b. "Diferentes tipos de aspiración en vasco (con análisis espectrales del dialecto suletino actual)". In: E. Blasco, P. Francalacci, A. Nocentini / G. Tanda, eds. *Iberia e Sardegna. Legami linguistici, archeologici e genetici dal Mesolitico all'Età del Bronzo*, Firenze: Le Monnier, 151-169.
- Egurtzegi, A. 2014. *Towards a Phonetically Grounded Diachronic Phonology of Basque*, Vitoria-Gasteiz: University of the Basque Country dissertation.
- Egurtzegi, A. 2015. "Different distributions of contrastive vowel nasalization in Basque", *Loquens* 2(1), e017. doi:<http://dx.doi.org/10.3989/loquens.2015.017>
- Egurtzegi, A. 2017. "Phonetically conditioned sound change: Contact induced /u/-fronting in Zuberoan Basque". *Diachronica* 34:3, 331-367. doi: <http://dx.doi.org/10.1075/dia.34.3.02egu>.
- Egurtzegi, A. in press. "On the phonemic status of nasalized /h/ in Modern Zuberoan Basque", *Linguistics* 56.
- Entenman, G. 1977. *The Development of Nasal Vowels*, Austin, TX: University of Texas at Austin dissertation.
- Fant, G. 1960. *Acoustic Theory of Speech Production*, The Hague: Mouton.
- Foley, J. 1975. "Nasalization as universal phonological process". In: C. A. Ferguson, L. M. Hyman / J. J. Ohala, eds. *Nasálfest: Papers from a symposium on nasals and nasalization*, Stanford: Stanford University Press, 197-212.
- Gilléron, J. / Edmont, E. 1902-1910. *Atlas linguistique de la France*, Paris: Champion [9 vol., supplement 1920].

- Haden, E. F. / Bell, Jr. E. A. 1964. "Nasal vowel phonemes in French", *Lingua* 13, 62-69.
- Hualde, J. I. 1993. "Topics in Souletin phonology". In: J. I. Hualde / J. Ortiz de Urbina, eds. *Generative Studies in Basque Linguistics*, Amsterdam: John Benjamins, 289-327.
- Hualde, J. I. 2003. "Segmental phonology". In: J. I. Hualde / J. Ortiz de Urbina, eds. *A Grammar of Basque*, Berlin / New York: Mouton de Gruyter, 15-65.
- Igartua, I. 2015. "Diachronic effects of rhinoglottophilia, symmetries in sound change, and the curious case of Basque", *Studies in Language* 39, 635-663.
- Krakow, R. A. / Beddor, P. S. / Goldstein, L. M. / Fowler, C. A. 1988. "Coarticulatory influences on the perceived height of nasal vowels", *Journal of the Acoustical Society of America* 83, 1146-1158.
- Labov, W. 1994. *Principles of Linguistic Change, Vol. 1: Internal factors*, Oxford: Blackwell.
- Lafon, R. 1937 [1999]. "Tendance à la palatalisation de la sonante *u* dans les parlers basques du Nord-Est", *Revue de Linguistique Romane* 13, 73-82; reissued in *Vasconiana* (Iker 11), Bilbao: Euskaltzaindia, 85-93.
- Lafon, R. 1958 [1999]. "Contribution à l'étude phonologique du parler basque de Larrau (Haute-Soule)". In: D. Catalán, ed. *Estructuralismo e historia. Miscelánea homenaje a André Martinet* (Vol. 2), La Laguna: Universidad de La Laguna, 77-106; reissued in *Vasconiana* (Iker 11), Bilbao: Euskaltzaindia, 113-133.
- Lakarra, J. A. 2009. "«\*h<sub>3</sub> > h<sub>1</sub>, \*h<sub>2</sub> > h<sub>1</sub> eta horiei datxezkien zenbait fenomenoak»", *Lapurdum* 13, 211-231.
- Larrasquet, J. 1939. *Le basque de la Basse-Soule orientale*, Paris: Klincksieck.
- Leizarraga, I. [Leizarraga, J.]. 1571 [1900]. *I. Leizarragas baskische Bücher von 1571 (Neues Testament, Kalender und Abc)*, Strasbourg [edited by Th. Linschmann / H. E. Schuchardt].
- Lhande, P. 1926-1938. *Dictionnaire basque-français (dialectes labourdin, bas-navarrais et souletin)*, Paris: Gabriel Beauchesne.
- Loporcaro, M. 2011. "Phonological processes". In: M. Maiden / J. C. Smith / A. Ledgeway, eds. *The Cambridge History of the Romance Languages. Volume 1: Structures*, 109-154.
- Maddieson, I. 1984. *Patterns of Sounds*, New York: Cambridge University Press.
- Martinet, A. 1965. "Les voyelles nasales du français", *Linguistique* 2, 117-122.
- Martínez-Areta, M. 2013. "Basque dialects". In: M. Martínez-Areta, ed. *Basque and Proto-Basque. Language-internal and typological approaches to linguistic reconstruction [Mikroglottika 5]*, Frankfurt am Main: Peter Lang, 31-87.
- Massourre, J.-L. 2012. *Le gascon, les mots et le système*. Paris: Honoré Champion.
- Michelena, L. [Mitxelena, K.]. 1954 [2011]. "La posición fonética del dialecto vasco del Roncal", *Via Domitia* 1, 123-157; reissued in J. L. Lakarra / Í. Ruiz Arzalluz, eds. *Obras completas VII: Fonética y fonología. Morfosintaxis. Dialectología*, Donostia-San Sebastián, Vitoria-Gasteiz: Diputación Foral de Guipúzcoa, University of the Basque Country, 611-647.
- Michelena, L. [Mitxelena, K.]. 1958 [2011]. "Introducción". In: M. Agud / L. Michelena, N. Landuchio, *Dictionarium linguae cantabricae (1562) [Publicaciones del Seminario "Julio de Urquijo"]*, Donostia-San Sebastián: Diputación Foral de Guipúzcoa, 7-48; reissued in J. L. Lakarra / Í. Ruiz Arzalluz, eds. *Obras completas XII: Textos arcaicos vascos. N. Landuchio, Dictionarium linguae cantabricae (1562)*, Donostia-San Sebastián, Vitoria-Gasteiz: Diputación Foral de Guipúzcoa, University of the Basque Country, 202-232.
- Michelena, L. [Mitxelena, K.]. 1977 [2011]. *Fonética histórica vasca [Publicaciones del Seminario "Julio de Urquijo"]*, Donostia-San Sebastián: Diputación Foral de Guipúzcoa [1961, 2<sup>nd</sup> ed. 1977]; reissued in J. A. Lakarra / Í. Ruiz Arzalluz, eds. *Obras*

- completas VI: Fonética histórica vasca*, Donostia-San Sebastián, Vitoria-Gasteiz: Diputación Foral de Guipúzcoa, University of the Basque Country.
- Michelena, L. [Mitxelena, K.]. 1981 [2011]. “Lengua común y dialectos vascos”, *International Journal of Basque Linguistics and Philology [ASJU]* 15, 291-313; reissued in J. L. Lakarra / Í. Ruiz Aralluz, eds. *Obras completas VII: Fonética y fonología. Morfosintaxis. Dialectología*, Donostia-San Sebastián, Vitoria-Gasteiz: Diputación Foral de Guipúzcoa, University of the Basque Country, 517-542.
- Michelena, L. [Mitxelena, K.] / Sarasola, I. 1987-2005. *Orotariko euskal hiztegia [General Basque dictionary]* (16 vols.), Bilbao: Euskaltzaindia  
<http://www.euskaltzaindia.net/oeh/>, accessed on 20-10-2016.
- Peillen, T. 1992. “Zubereraren bilakaeraz ohar batzuk”. In: Euskaltzaindia, ed. *Nazioarteko dialektologia biltzarra. Agiriak (Iker 7)*, Bilbao: Euskaltzaindia, 247-272.
- Pope, M. K. 1934. *From Latin to Modern French*, Manchester: Manchester University Press.
- Rohlf, G. 1970. *Le gascon: Études de philologie pyrénéenne*, Tübingen / Pau: Max Niemeyer / Marrimpouey Jeune [2<sup>nd</sup> ed.].
- Ruhlen, M. 1978. “Nasal vowels”. In: J. H. Greenberg / C. A. Ferguson / E. A. Moravcsik, eds. *Universals of Human Language. Vol. 2: Phonology*, Stanford: Stanford University Press, 203-242.
- Sampson, R. 1999. *Nasal Vowel Evolution in Romance*, Oxford: Oxford University Press.
- Schourup, L. 1973. “A cross-language study of vowel nasalization”, *Ohio State Working Papers in Linguistics* 15, 190-221.
- Shosted, R. / Carignan, Ch. / Rong, P. 2012. “Managing the distinctiveness of phonemic nasal vowels: Articulatory evidence from Hindi”, *Journal of the Acoustical Society of America* 131.1, 455-465.
- Wright, J. 1980. “The behavior of nasalized vowels in the perceptual vowel space”, *Report of the Phonology Laboratory* (University of California Berkeley) 5, 127-163.
- Zuazo, K. 2008. *Euskalkiak. Euskararen dialektoak*, Donostia-San Sebastián: Elkar.