The role of contact in phonetically-based sound change

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/u/-fronting in Zuberoan Basque

Introduction

Introduction

- As many other languages in Europe, Zuberoan Basque has developed a contrastive high front rounded vowel /y/.

- While the development of the sound pattern itself may be due to contact, the specific inhibitory contexts found in Basque are unparalleled.

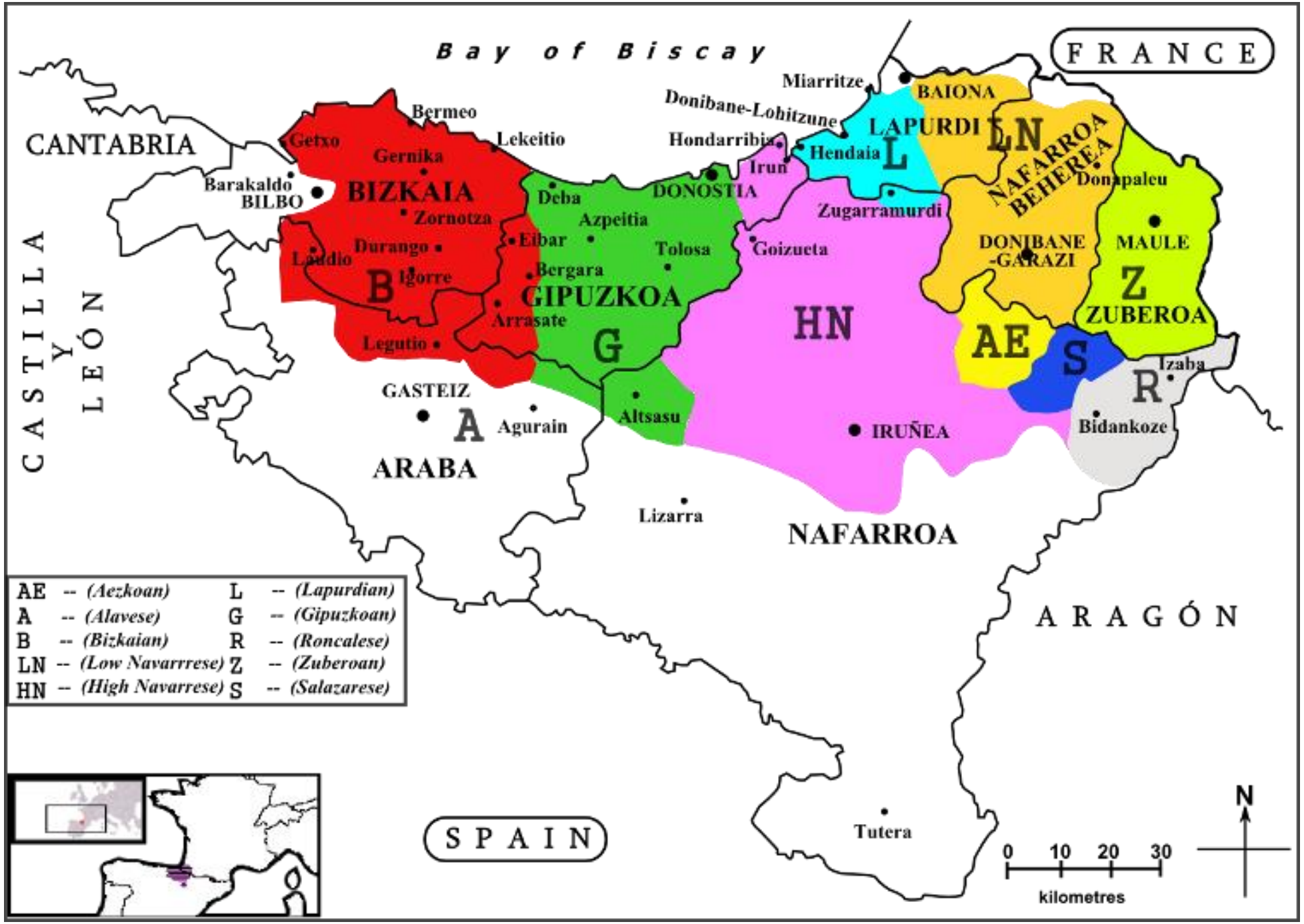
Introduction

- The phonological classification of the contexts that inhibit /y/ fronting has been a longstanding problem.
  - First described more than a century ago (Uhlenbeck 1903).

- I argue that these inhibitory contexts are phonetic in nature and form a segment set difficult to classify by means of phonological natural classes.

Introduction

- Zuberoan is the easternmost Basque dialect.
- It is usually regarded as the most deviant variety of the language.
- It possesses both archaic features such as the nasality-based contrast between two laryngeals (Egurtzegi 2018) and innovations such as a sixth vowel quality /y/.


Bay of Biscay
FRANCE
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ARAGÓN
NAFARROA
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BIZKAIA
BILBO
GIPUZKOA
DONOSTIA
LAPURDI
NAFARROA BEHEREA
ZUBEROA
Miarritze
BAIONA
Donibane-Lohitzune
Hondarribia
Hendaia
Irun
Bermeo
Getxo
Lekeitio
Gernika
Barakaldo
Zornotza
Durango
Laudio
Igorre
Deba
Azpeitia
Eibar
Bergara
Tolosa
Arrasate
Legutio
Zugarramurdi
Goizueta
Donapaleu
DONIBANE -GARAZI
MAULE
Izaba
Bidankoze
Altsasu
Agurain
IRUÑEA
Lizarra
Tutera
AE -- (Aezkoan)
A -- (Alavese)
B -- (Bizkaian)
LN -- (Low Navarrese)
HN -- (High Navarrese)
L -- (Lapurdian)
G -- (Gipuzkoan)
R -- (Roncalese)
Z -- (Zuberoan)
S -- (Salazarese)
0 10 20 30
kilometres
N

/u/-fronting

The process itself

Zuberoan /u/-fronting

- Zuberoan /u/ was systematically fronted to /y/ (Egurtzegi 2017).
- This sound-pattern developed during the second half of the Middle Ages.
- It affected native words and borrowings in a similar way.

Examples of the fronting:

Std.	Zub.	Trans.	Gloss
zu	*zü*	[s̻y]	‘you’
egun	*egün*	[eɣ̟yn]	‘day’
punta	*phünta*	[pʰyn̪ta]	‘top’
uko	*ükho*	[ykʰo]	‘refusal’
urgatzi	*ürgaiztü*	[yrɣ̟ai̯s̻ty]	‘to help’
-	*ürpho*	[yrpʰo]	‘manure pile’

Std.	Zub.	Trans.	Gloss
lur	*lür*	[lyr]	‘ground’
urre	*ürhe*	[yrhe]	‘gold’
txakur	*txakhür*	[ʧakʰyr]	‘dog’
guzti	*güzi*	[gyʂi]	‘all’
leku	*lekhü*	[lekʰy]	‘place’
ume	*hüme*	[hyme]	‘child’

/u/-fronting in Zuberoan

- However, some specific phonological contexts inhibited /u/-fronting:
  - before apico-alveolar fricative sibilants /s̪, z̪/
  - before an alveolar tap /ɾ/
  - before rhotic-dental clusters /rt^{h}, rt, rd/

Examples of inhibition:

Std.	Zub.	Trans.	Gloss
ikusi	*ikhusi*	[ikʰuʂi]	‘see’
itsusi	*itsusi*	[itʂuʂi]	‘ugly’
pusatu	*phusatü*	[pʰuʂaty]	‘to push’
uste	*uste*	[uʂte]	‘thought’
busti	*busti*	[buʂti]	‘wet’
usna	*usna*	[uʐna]	‘instinct’

Std.	**Zub.**	**Trans.**	**Gloss**
ur	*hur*	/hur/	‘water’
zur	*zur*	/s̪ur/	‘wood’
hura	*hura*	[hura]	‘he’
zure	*zure*	[s̪ure]	‘your’
urte	*urthe*	[urtʰe]	‘year’
urdin	*urdin*	[urd̪iɲ]	‘blue’

/u/-fronting in Zuberoan

- Consonants and clusters that inhibit /u/-fronting when following the vowel:
  - /s̪, z̪, ɾ, rt, rtʰ, rd/

- Consonants that do not inhibit /u/-fronting:
  - /p, b, t, d, c, ɟ, k, g, f, s̪, z̪, ʦ̪, ʃ, ʒ, ʧ, m, n, ɲ, l, ʎ, h, ɦ̃/

/u̟/-fronting

Back glide fronting in diphthongs

Fronting in diphthongs

- In addition to /u/, /u̟/ was also systematically fronted to /i̟/.
  - Rounding is lost.

- The fronting affected instances of both /au̟/ and /eu̟/.

- On-glides are almost absent from the language.

Examples of the glide fronting:

Std.	Zub.	Trans.	Gloss
gau	*gai*	[gaɪ̯]	‘night’
gauza	*gaiza*	[gaɪ̯ʂa]	‘thing’
laudatu	*laidatü*	[laɪ̯ð̞aty]	‘to laud’

Std.	**Zub.**	**Trans.**	**Gloss**
leun	*lein*	[leiɲn]	‘soft’
iraun	*irain*	[iraiɲn]	‘to last’
irauli	*iraili*	[iraiʎi]	‘to spin’

Glide fronting: Inhibitory contexts

- As in the case of /u/-fronting, /u̟/-fronting was also inhibited in certain contexts:
  - before apico-alveolar sibilants /s̻, z̻, ʦ̻/
  - before an alveolar tap /ɾ/
  - before an alveolar trill /r/
  - after a tautosyllabic /#ʒ/ (< /#j/)

Examples of inhibition:

Std.	Zub.	Trans.	Gloss
haur	*haur*	/haʊ̯r/	‘this’
zauri	*zauri*	[s̪aʊ̯ri]	‘wound’
euri	*euri*	[eʊ̯ri]	‘rain’
hauts	*hauts*	[haʊ̯t̪s̪]	‘dust’

Std.	Zub.	Trans.	Gloss
deus	*deus*	/deu̯z̪/	‘something’
haur	*haur*	/hau̯r/	‘child’
jaun	*jaun*	/ʒau̯n/	‘sir’
jauzi	*jauzi*	/ʒau̯ṣi/	‘to jump’

Glide fronting: Inhibitory contexts

- Consonants that inhibit /u̟/-fronting when following the vowel:

  /s̻, z̻, ʦ̻, ɾ, r/

- Consonants that do not inhibit /u̟/-fronting:

  /p, b, t, d, c, ɟ, k, g, f, s̪, z̪, ʦ̪, ʃ, ʒ, ʧ, m, n, ɲ, l, ʎ, h, ɦ̃/

Inhibitory contexts

A detailed look into them

Inhibitory contexts

- The group of consonants that inhibit fronting of /u/ to /y/ when following the affected segment and that of the consonants inhibiting fronting of /u̯/ to /i̯/ are very similar:

- Consonants that inhibit /u/ > /y/:

  /s̻, z̻, ɾ, rt, rtʰ, rd/

- Consonants that inhibit /u̯/ > /i̯/:

  /s̻, z̻, t̻s̻, ɾ, r/

Inhibition: Special cases

1- /t̪s̪/

- It does not show inhibition now, but in the oldest Zuberoan texts non-fronted variants appear when followed by this segment.
  - cf. older *huts* vs. more recently attested *hüts* ‘empty’.

- It still inhibits fronting in diphthongs.
  - cf. *hauts* ‘dust’, *hautsi* ‘to break’.

Inhibition: Special cases

2- /r/

- There are some isolated cases of /u/-fronting inhibition before /r/
  - cf. *kurrinka* ‘growl, grunt’.
- In addition, the inhibition before /r/+/T/ clusters is systematic.
- /r/ does inhibit fronting in diphthongs.
  - cf. *haur* ‘child’.

Inhibition: Special cases

- /t͡s/ and, potentially /r/, may have inhibited fronting in older times.
  - Isolated examples are attested.
  - The inhibition is still found in diphthongs.

- Variants involving /y/ before these segments may have been adopted later.
  - Phonetic differences?
  - Analogical extension + lexical diffusion?

Inhibitory contexts

- Excluding the sequence *jau-, all contexts that inhibit fronting involve a coronal consonant or, more specifically, an alveolar consonant, following the /u/.
- However, not all alveolar consonants inhibit fronting:

- Alveolar consonants that inhibit fronting:

/s̪, z̪, ʦ̪, ɾ, r/

- Alveolar consonants that do not inhibit fronting:

/t, d, s̪, z̪, ʦ̪, n, l/

Phonetics of the development of /y/

The phonetic origin of /u/-fronting

- Harrington (2012) argues that context-free fronting of /u/ may start from coarticulatory contexts.

- The most usual fronting context involves alveolar consonants (Flemming 2003).

- Both the onset and offset of /u/ in /tut/ and the onset of /u/ in /kuk/ tend to be well into the /y/ space (Harrington et al. 2011).

The phonetic origin of /u/-fronting

- Perception and production tend to be aligned in the stable coarticulatory patterns of a language.

- Sound change occurs as the context-dependent and context-independent phonetic variants come closer together in either perception or production (Harrington 2012).

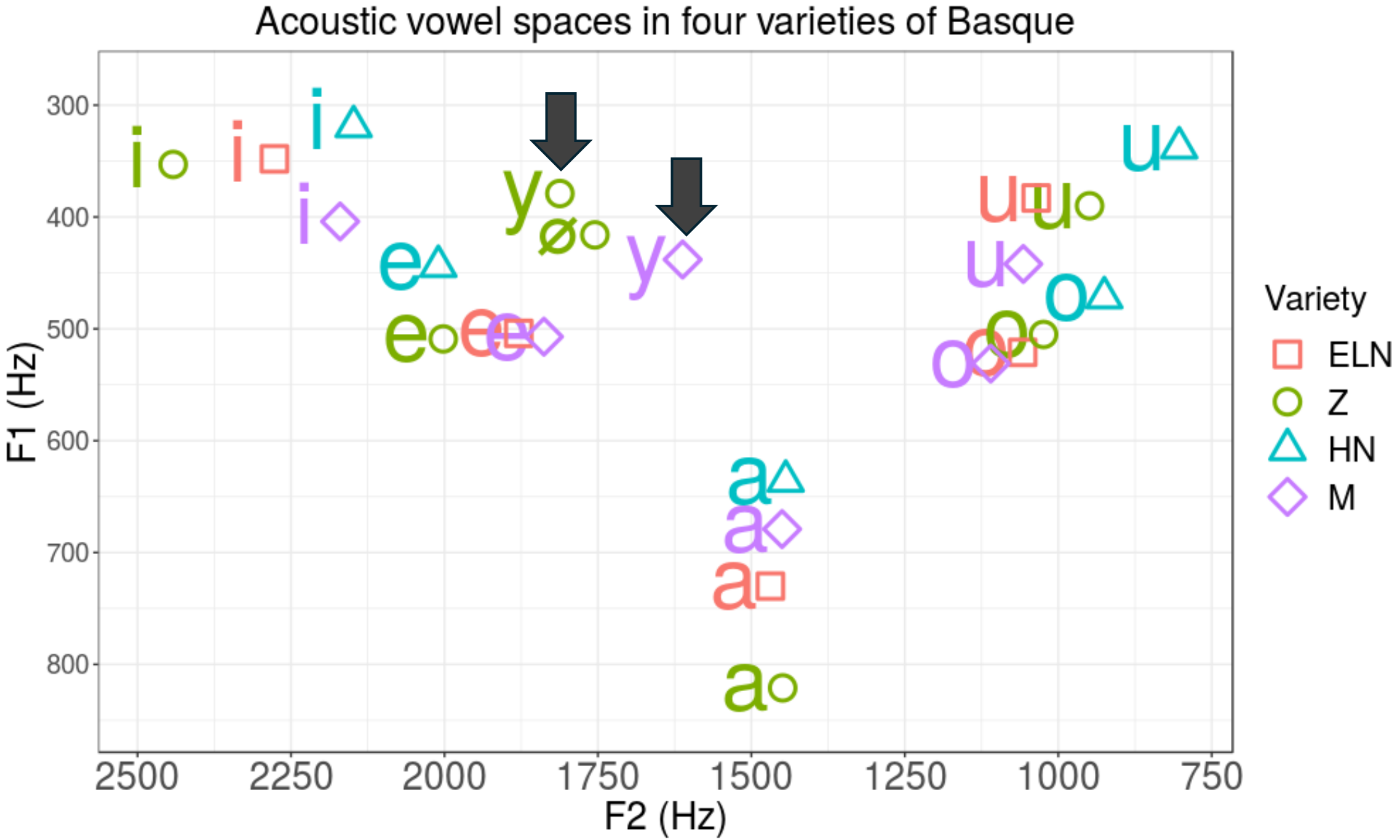
- Reduction of perceptual compensation for coarticulatory effects gives rise to a new production-perception alignment (Harrington 2012: 104).

/y/ or /ʉ/ in Zuberoan and Mixean?

Table 1: Vowel formant summary from Urrutia et al. (1995), Pagola (1992), and the current study.

Variety	Vowel													
	/i/		/e/		/a/		/o/		/u/		/y/		/ø/	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
East. Low Navarrese (Urrutia et al., 1995)	348	2277	504	1879	730	1469	521	1058	383	1036				
Zuberoan (Urrutia et al., 1995)	353	2442	509	2002	821	1449	505	1024	390	949	379	1812	416	1755
High Navarrese (Pagola, 1992)	319	2148	444	2010	636	1444	472	925	338	803				
Mixean	404	2170	507	1838	679	1450	531	1110	442	1057	438	1612		

Egurtzegi & Carignan 2020: “An acoustic description of Mixean Basque”. *Journal of the Acoustical Society of America* 147.4, 2791–2802.


Acoustic vowel spaces in four varieties of Basque
F1 (Hz)
300
400
500
600
700
800
2500
2250
2000
1750
1500
1250
1000
750
F2 (Hz)
Variety
ELN
Z
HN
M

Phonetic variation of /y/ in Eastern Basque: A gradual, incremental sound change

- The variation observed from Mixean to Zuberoan Basque, argues for an incremental fronting process.

- The fronting process might have stopped at different points in the different varieties.

- This argues against direct borrowing of the sound (e.g. borrowing through loanwords).

Phonetics behind the inhibition of /u/-fronting

The phonetics behind the inhibition

- As in Zuberoan Basque, in some varieties of English, /u/-fronting is inhibited in certain contexts, such as preceding [ɬ] (Labov et al. 2006).

- The inhibition of English /u/ > /ʉ/ by a following dark [ɬ] may be attributed to the high degree of shared gesture of the consonant and the affected vowel.

- However, the consonants that inhibit fronting in Zuberoan Basque do not directly fit in this description.

The phonetics behind the inhibition

Nonetheless, Recasens and Pallarès (2001) suggest reasons for the resistance to coarticulatory processes that might fit the Zuberoan pattern:

- Highly constrained consonants have large coarticulatory effects in contiguous vowels and can inhibit vowel-dependent effects.

- Some consonants involving apical activity of the tongue also require a concrete dorsal placement of the tongue.

The phonetics behind the inhibition

- This dorsal placement of the tongue may inhibit neighboring vowels from articulatory processes towards the palatal zone (Recasens & Pallarès 2001: 288).
- The shift from /u/ to /y/ involves fronting in the placement of the tongue.
- Consonants “involving demanding manner requirements and little dorso-palatal contact” crucially require a lowering and back placement of the tongue dorsum.
- Thus, they may inhibit /u/-fronting.

The phonetics behind the inhibition

- All consonants that inhibit /u/-fronting in Zuberoan Basque involve precise movements of the tip of the tongue and little to no dorso-palatal contact.
- Alveolar consonants that require dorsal contact do not inhibit /u/-fronting.

- Alveolars that inhibit fronting:

  /s̻, z̻, t̻s̻, ɾ, r/

- Alveolars that do not inhibit fronting:

  /t, d, s̪, z̪, t̪s̪, n, l/

Typology

Typological parallels

- Languages with context-free high back vowel fronting include:

  - Gallo-Romance languages (French, Occitan, etc.).
  - Gallo-Italic languages (Piedmontese, Lombard, Emilian, Romagnol, etc.).
  - Arpitan (Franco-Provençal).
  - Lolo-Burmese (Akha).
  - Albanian.
  - Standard Southern British English, Australian English, New Zealand English, Southern and General American English.
  - Swedish.
  - Açorean and some varieties of European Portuguese.

Typological parallels

- Contextual assimilatory fronting of back vowels (umlaut) is found in:
    - Germanic languages (Old High German, Old Dutch, Old Saxon, Old English, Old Norse, Old Frisian…).
    - Rotuman.
- In addition, /u/-fronting is one of the sound changes involved in chain shifts proposed by Labov (1994: 116).

Typological parallels

- Only 6.6% of the languages (37 out of 562) in the WALS database (Maddieson 2013) have front rounded vowels.
- 78% of the languages in the survey (29 out of 37) are found in the North-Central area of the Eurasian continent.
- Languages with front rounded vowels are far from uncommon in Europe.
- Languages with front rounded vowels outside of this area are scarce (cf. Blevins 2017).


Languages in Europe
Icelandic
Faroese
Scottish Gaelic
Irish
English
Welsh
English
Sami
Sami
Karelian
Finnish
Norwegian
Swedish
Estonian
Latvian
Lithuanian
Russian
Russian
Danish
Friesian
Dutch
German
Polish
Belarusian
Kazakh
Ukrainian
Breton
Luxembourgish
French
Czech
Slovak
Romansh
Hungarian
Gagauz
Romanian
Caucasian and Altaic languages
Ossetic
Georgian
Azeri
Armenian
Slovenian
Croatian
Bosnian
Serbian
Montenegrin
Albanian
Macedonian
Bulgarian
Galician
Basque
Portuguese
Spanish
Catalan
Italian
Turkish
Greek
Turkish
Greek
Maltese
Scale
1:6.000.000

Linguistic contact

Contact-induced sound change

- /u/-fronting in Zuberoan appears to be related to Romance influence.
- French and Gascon, the languages in contact to Zuberoan Basque today, share this sound pattern.
- Bearnese Gascon, the variety that was in contact to Zuberoan when the sound pattern developed, shows context-free /u/ > /y/, with no inhibition.
- Zuberoan shows the same sound pattern, but with inhibitory contexts as described before.

/u/-fronting in Gascon and French

Bearnese Gascon	**Donzacese Gascon**	**French**	**Transcription**	**Latin**	**Gloss**
utile	/y'tile/	*utile*	/ytil/	*ūtĭlis*	‘useful, helpful’
lua, lu	/'lyno/	*lune*	/lyn/	*lūnam*	‘moon’
ua, u	/'yno/	*une*	/yn/	*ūnam*	‘a, one (fem.)’
lèituga	/lɛj'tygo/	*laitue*	/lety/	*lactūcam*	‘lettuce’
dur	/dyr/	*dur*	/dyʁ/	*dūrum*	‘hard’
cuu, cu	/kyw/	*cul*	/ky/	*cūlum*	‘ass’

Contact

- Blevins (2017) suggests that language experience alters phonetic perception, by the “perceptual magnet effect” (cf. Kuhl 2000).
- When first acquiring a language, proto-categories act as magnets, drawing nearby perceptual stimuli into them.
- In language contact situations, continuous exposure to a second language may result in a warping of perceived distances of phonetic tokens.
- An external phonetic prototype may be internalized and act as a perceptual magnet in the first language of the infant.

Contact

- The establishment of a phonetic prototype requires:
  - Perceptual saliency of the segment involved.
  - Intense language contact spanning multiple generations.
- Such a sound change will appear to be natural and phonetically motivated.
- Zuberoan /u/-fronting:
  - /y/ is perceptually salient.
  - Speakers of Zuberoan and speakers of Bearnese Gascon have been in close and continued contact.

Contact

- The Zuberoan /u/-fronting sound change appears to be natural and phonetically motivated.

- It looks “independent” from these found in nearby Romance languages.
  - It deviates from them in the inhibitory contexts it shows.

Conclusions

Conclusions

- /u/-fronting occurred systematically in Zuberoan Basque except before /ɾ/, /r/, /s̻/, /z̻/, and /t̻s̻/, where it was inhibited.
- Since the inhibitory contexts do not form a natural phonological class, there might have been a phonetic source (Egurtzegi 2017).
- Maintenance of *u was a consequence of the coarticulation caused by consonants requiring active tongue dorsum lowering and backing.

Conclusions

- This tongue dorsum placement is required to perform the fine movements of the tip of the tongue involved in the production of the inhibitory segments /ɾ, r, s̻, z̻, t̻s̻/.
- The production of other alveolar segments such as /t, d, s̻, z̻, t̻s̻, n, l/ does not require this particular placement of the tongue dorsum. Thus, these segments do not inhibit /u/-fronting.

Conclusions

- Even if there is a phonetic conditioning factor for the development of /y/, an areal origin is very likely.
- /u/-fronting also occurred in Gascon, a Romance language in close and long-standing contact with Zuberoan Basque.
- The perceptual saliency of /y/ alongside the continued contact with Bearnese Gascon have facilitated the development of this sound pattern in Zuberoan Basque.

Conclusions

- Blevins' (2018) model predicts such contact-based sound changes to be indistinguishable from other phonetically motivated, "natural" sound changes.

- This is indeed the case of /u/ fronting in Zuberoan Basque.

- Overall, the Zuberoan /u/-fronting sound pattern illustrates the importance of considering perception, production and contact in the analysis of historical developments.

Nasalized [õ]-raising in Zuberoan Basque and Gascon

Introduction

/o/-raising in Basque

- A sporadic raising of the mid back vowel /o/ affected Gascon as well as the neighboring North-Eastern Basque dialects.

- The seemingly heterogeneous phonogical contexts that trigger raising of the mid back vowel /o/ have been described as “not […] easy to define” (Martínez-Areta 2013; Zuazo 2008).

- All cases involve raising of coarticulatorily nasalized /o/, the raising process being more accurately described as raising of [õ].

/o/-raising in Basque

Std. Bsq.	**Zuberoan**	**Trans.**	**Gloss**
on	*hun*	[hun]	‘good’
gizon	*gizun*	[gis̪un]	‘man’
honen	*hunen*	[hunen]	‘of this’
hona	*hunat*	[hunat]	‘here’
bonet	*bunet*	[bunet]	‘hat’
norbait	*nurbait*	[nurβ̪ai̯t̪]	‘somebody’
komentu	*khumentü*	[khumen̪t̪y]	‘convent’
moda	*muda*	[muð̪a]	‘style’
molde	*mulde*	[mul̪de]	‘manner’
motz	*mutz*	[mut̪s̪]	‘short’
konde	*kunte*	[kun̪t̪e]	‘count’
kontra	*kuntre*	[kun̪t̪re]	‘against’

[õ]-raising in Basque

- Primarily found in Zuberoan Basque.
  - Present, to a lesser degree, in other eastern Basque dialects.
- Following /u/ > /y/, many old /o/s were raised to /u/ in Zuberoan.
  - Any instance of phonetically nasalized /o/ may be targeted.
- [õ] > [ũ] is widespread in Zuberoan, but not systematic.
- Exceptions:
  - Unaffected lexical items (*konpasione* [kompas̻jone] ‘mercy’)
  - Words only affected in limited varieties (*gizun* [gis̻un] but also *gizon* [gis̻on] ‘man’).
- Contrastively nasalized /õ/ was systematically raised to /ũ/.

Systematic /õ/-raising in Zuberoan

Brn. Gsc.	**Trans.**	**Zub.**	**Trans.**	**Gloss**
lèu	/le'ũ/	lehũ	[lẽ'ɦũ]	‘lion’
arraton	/ara'tũ/	arratũ	[ara'thũ]	‘mouse’
arrason	/ara'zũ/	arrazũ	[ara'z̪ũ]	‘reason’
patron	/pa'trũ/	patrũ	[pa'trũ]	‘patron’
preson	/pre'zũ/	presũ	[pre'z̪ũ]	‘prison’
sason	/sa'zũ/	sasũ	[s̪a'z̪ũ]	‘season’
milion	/mi'ʎjũ/	milliũ	[mi'ʎjũ]	‘million’
salon	/sa'lũ/	salũ	[s̪a'lũ]	‘room’

[õ]-raising in Gascon

- In the Bearnese dialect of Gascon, in contact to Zuberoan, word-final contrastively nasalized /õ/ was raised to /ũ/.

- A parallel raising of a different nasalized vowel, /a/ [ã] > [ẽ] /e/, occurred in the south-western varieties of Gascon (e.g. Bayonne).

- These sound patterns are absent from other Gallo-Romance languages such as French or Catalan.

[õ]-raising in Gascon

Gsc.	Trans.	French	Fr. Trans.	Gloss
pónder	/'punde/	*pondre*	/pɔ̃dʁ/	‘to lay’
pont	/pun/	*pont*	/pɔ̃/	‘bridge’
bon	/bun/	*bon*	/bɔ̃/	‘good’
mon	/mun/	*mon*	/mɔ/	‘my’
nom	/nun/	*nom*	/nɔ/	‘name’
son	/sun/	*son*	/sɔ̃/	‘sound’
contunhar	/kunty'ɲa/	*continuer*	/kɔ̃tinɥe/	‘to continue’
conduir	/kun'dɥi/	*conduire*	/kɔ̃dɥiʁ/	‘to drive’
situacion	/sitɥa'sjun/	*situation*	/sitɥasjɔ̃/	‘situation’
continuèl	/kunti'nɥɛl/	*continuel*	/kɔ̃tinɥɛl/	‘abiding’
avion	/a'bjun/	*avion*	/avjɔ̃/	‘airplane’
vagon	/ba'gun/	*wagon*	/vagɔ̃/	‘wagon’
bolhon	/bu'ʎun/	*bouillon*	/buʎɔ̃/	‘broth’
puençon	/pwɛn'sun/	*poinçon*	/pwɛ̃sɔ̃/	‘punch’
oncle	/'unkle/	*oncle*	/ɔ̃kl/	‘uncle’
ombra	/'umbro/	*ombre*	/ɔ̃bʁ/	‘shade’
non	/nu/	*non*	/nɔ/	‘no’
pomèr	/pu'mɛ/	*pommier*	/pɔmje/	‘apple tree’

[ã]-raising in (South-western) Gascon

Bay. Gsc.	**(Vlg.) Latin**	**Gloss**
enz	*antius*	‘but’
quen	*quantum*	‘how much’
ten	*tantum*	‘so much’
sen	*sanguem*	‘blood’
sent	*sanctum*	‘Saint’

Typology and phonetics

The typology of the process

- Raisings and lowerings of nasalized vowels like these seen in the eastern Basque dialects or Gascon are typologically common
  - Beddor (1982) lists up to 75 cases.

- Cases parallel to the specific [õ] > [ũ] change exist in Dutch (Germanic), Batak (Malayo-Polynesian) and the Khoekhoe (Nama) Khoe language (Beddor et al. 1986), among others.

- As in other widespread changes, a phonetic reason may underlie this sound change.

The phonetics behind the process

- 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) and the nasal zero almost cancel each other, but the F1 is altered in the process.
  - A more prominent nasal formant.

The phonetics behind the process

- The frequency of the nasal formant is lower than F1 in low vowels and higher than F1 in high vowels.
  - Both nasalized high and low vowels are perceived as mid (Beddor et al. 1986).

- The center of gravity of nasal mid back vowels is lower than that of oral mid back vowels and the center of gravity of nasal mid front vowels is higher than that of oral mid front vowels (Beddor 1982).
  - A cross-linguistic tendency for [õ] to raise and [ẽ] to lower (Beddor et al. 1986).

Conclusions

Conclusions

- Nasalized [õ] was raised to [ũ] in Basque and Gascon.
- The raising of nasalized vowels is a consequence of the ambiguity created by the addition of two nasal formants in the F1 domain (Beddor et al. 1986).
- This ambiguity can result in a change in vowel height, especially in languages whose nasality contrast is not very prominent.

Conclusions

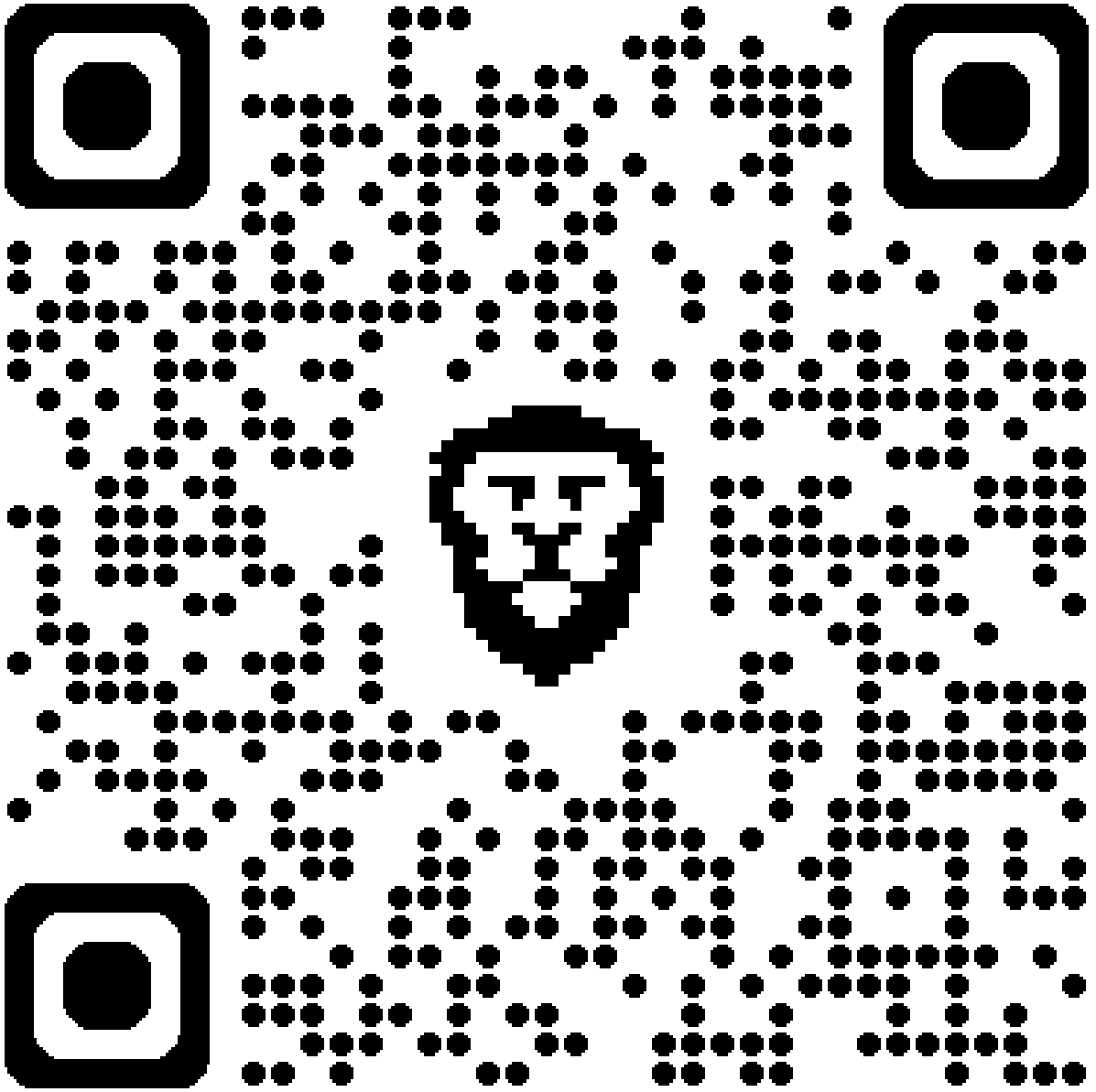
- The direction of the change in vowel-height is consistent with:
  - Generalizations made from cross-linguistic surveys.
  - CoG measurements of nasal and oral mid back vowels (Beddor 1982).

- A more complete account of the process is obtained by integrating phonetics in historical phonology.

Today's paper:

Egurtzegi. 2017. Phonetically conditioned sound change: Contact induced /u/-fronting in Zuberoan Basque. *Diachronica* 34.3, 331-367.

Open access here:
https://egurtzegi.github.io/papers/Egurtzegi-u-fronting-preprint.pdf



All papers are freely accessible here: egurtzegi.github.io/publications

Next paper:

Egurtzegi et al. 2024. An acoustic exploration of sibilant contrasts and sibilant merger in Mixean Basque. *Journal of the IPA* 54.2, 677-706.

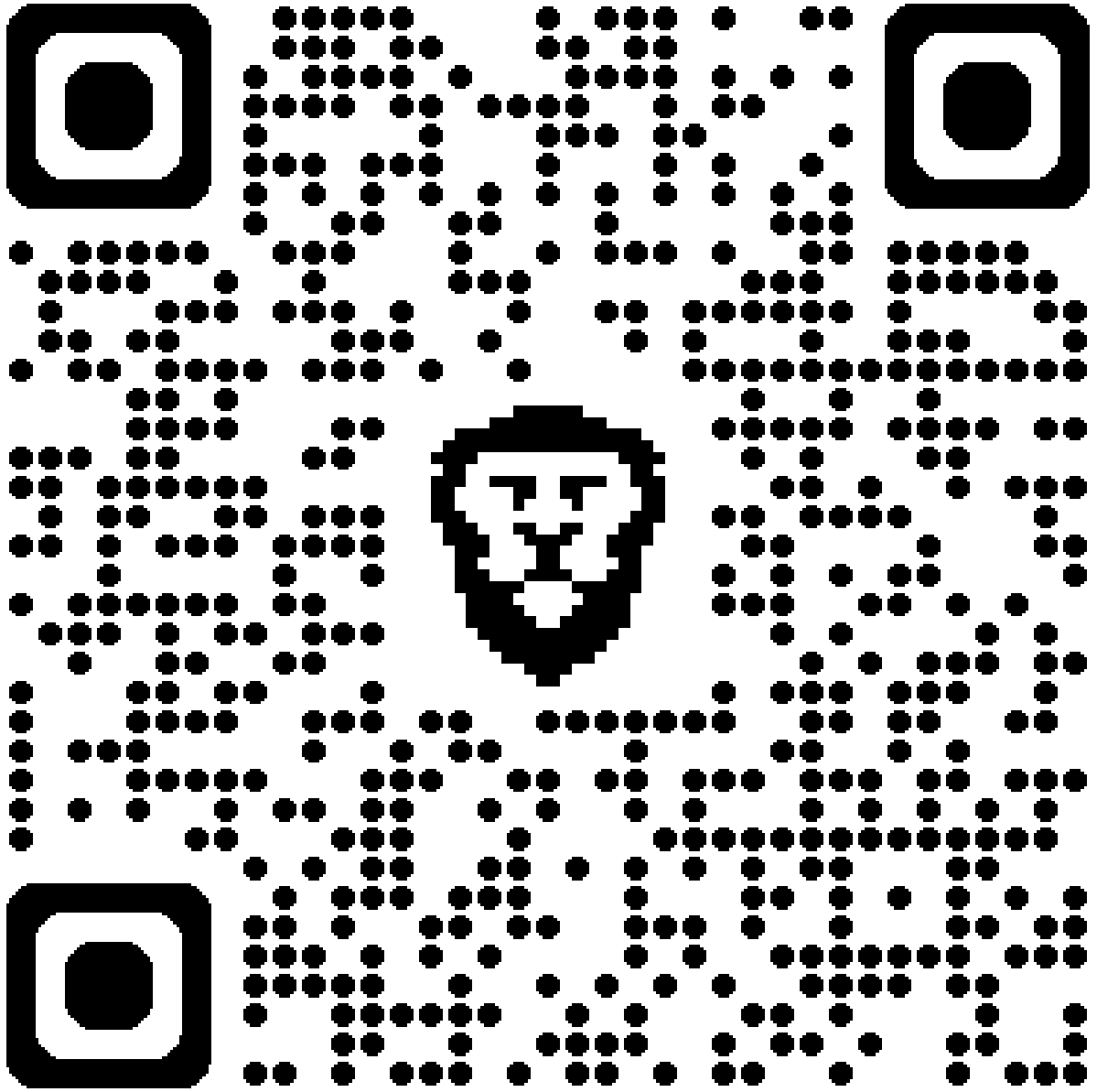
Open access here:
https://www.cambridge.org/core/journals/journal-of-the-international-phonetic-association/article/an-acoustic-exploration-of-sibilant-contrasts-and-sibilant-merger-in-mixean-basque/839C776F241162A02D7505FE4D042A7E

All papers are freely accessible here: egurtzegi.github.io/publications

Next paper:

Krajewska et al. 2022. Sibilant mergers in 18th-century Basque: Aquantitative study. *Phonological Data & Analysis* 4:5, 1–31.

Open access here:
https://phondata.org/index.php/pda/article/view/67/43



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