Some issues about the inception of velar softening

Daniel Recasens

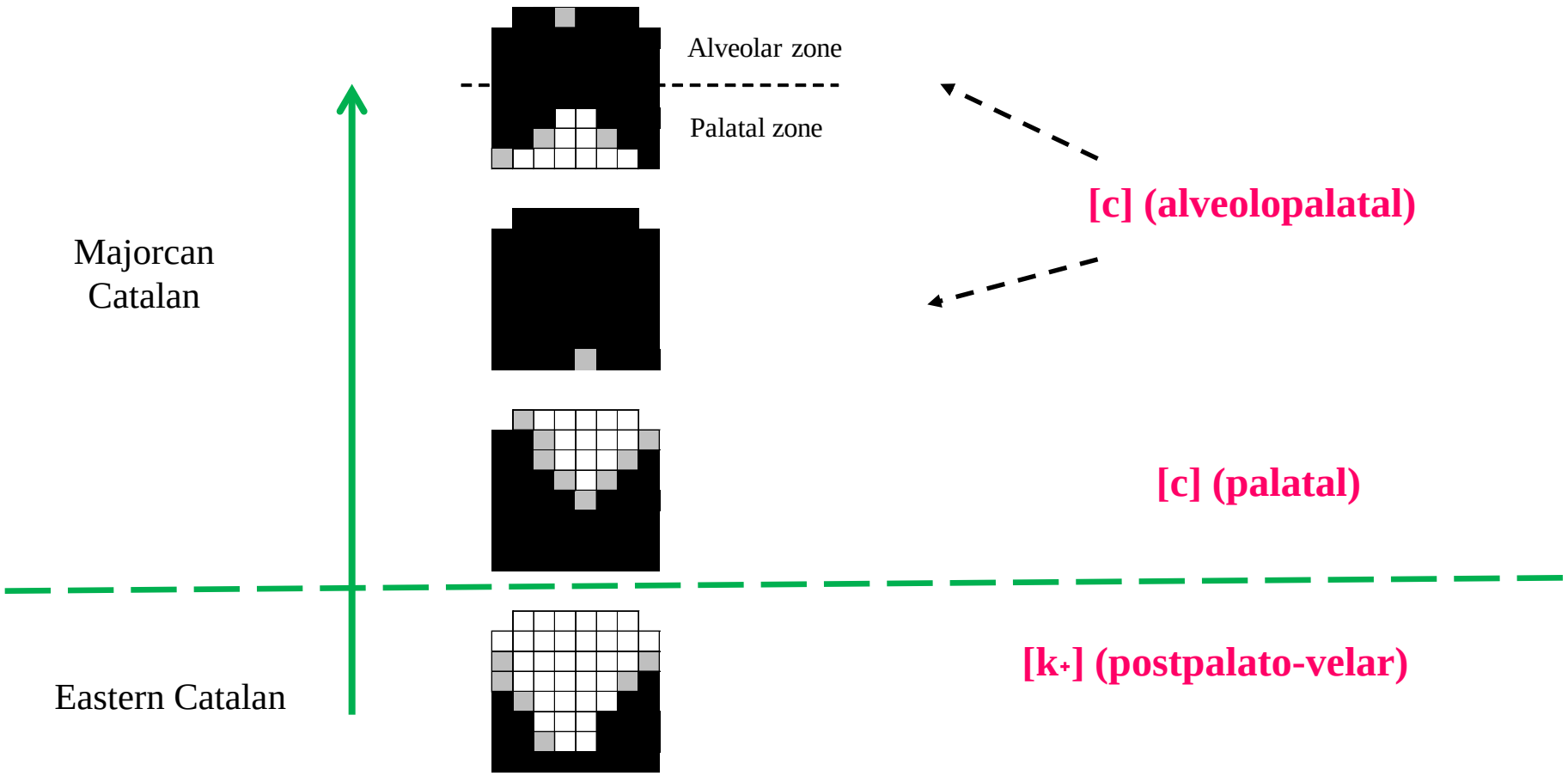
Universitat Autònoma de Barcelona & Institut d'Estudis Catalans

GENERAL INTRODUCTION

Velar softening is a sound change process by which front /k/ (/k/ + /i,e, j/) turns into a affricate or fricative exhibiting a palatoalveolar or an alveolar place of articulation ([(t)ʃ], [(t)s]).

Latin /ˈ**k**ɛnto/ CENTU “one hundred”> Italian [ˈ**tʃ**ɛnto], Old Catalan [**ts**en].

Based on evidence from phonetic alternations and sound change, I assume that velar softening is achieved via the stop realization [c] and therefore after closure location for front /k/ has shifted from the **postpalato-velar** zone to the **palatal** or **alveolopalatal** zone.


Alveolar zone
Palatal zone
Majorcan Catalan
[c] (alveolopalatal)
[c] (palatal)
Eastern Catalan
[k+] (postpalato-velar)

How can [c] give rise to a /(t)ʃ/ percept?

/tʃ/ identification percentages are prone to be obtained when an **increase in linguopalatal constriction narrowing** and **airflow volume** passing through the constriction at the [c] release causes the (alveolo)palatal stop burst to approach the affricate frication noise.

RESEARCH ISSUES

(1) Whether the **dentoalveolar outcome [ts]** of the velar softening process has been generated

- directly from [c]

(Latin /ˈkɛnto/ [ˈ**c**ɛnto] > Old Catalan [**ts**en]), or else

- from the intermediate realizations [t(ʲ)] or [tʃ]

(Latin /ˈkɛnto/ [ˈ**k**ˀɛnto] >[ˈ**t**$^{(j)}$ɛnto] > Old Catalan [**ts**en])

(Latin /ˈkɛnto/ [ˈ**c**ɛnto] > [ˈ**tʃ**ɛnto] > Old Catalan [**ts**en])

(2) How can velar softening in **non-front vocalic context** conditions (i.e., before /a/ and word finally) be accounted for?

(Fr. ***ch****ar* CARRU “trolley”, Ladin Rhaeto-Romance [fwɛ**c**, fwɛ**tʃ**] FOCU “fire”)

(3) Which **acoustic cues** for the (alveolo)palatal stop [c] act as velar softening triggers?.

THE ALVEOLAR OUTCOME [ts] OF VELAR SOFTENING

In the world's languages velar softening yields much more often a palatoalveolar affricate or fricative ([(t)ʃ]) than an alveolar affricate or fricative ([(t)s]).

Palatoalveolar outcome

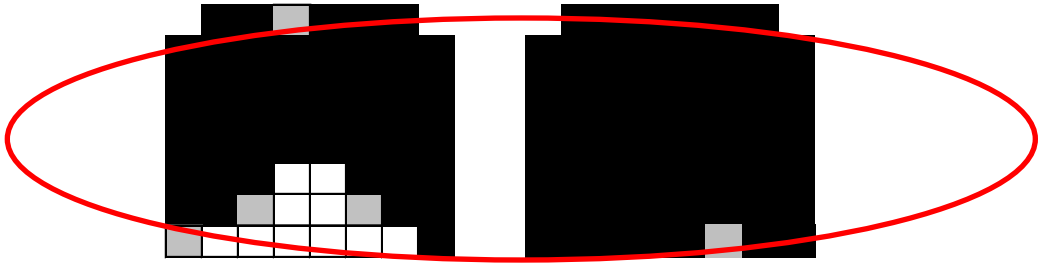
Pre-Proto-Slavic **pla:**kj**o:m*	>	Old Church Slavic *pla**tʃ**õ* "I cry"
Pre-Proto-Indo-Iranian **__ke__*	>	Sanskrit *__tʃ__a* "and"
Proto-Salish **__ki__taq-*	>	Cowlitz Salish *__tʃ__æq-* "argue"
Proto-Bantu **-__ké__ngédé*	>	Jomvu *__tʃ__endʒele* "bell"
Old English *__ki__rike*	>	Modern English *__ch__urch*

Alveolar outcome

Late Proto-Slavic **vlĭ__ki__*	>	Old Church Slavic *vlĭ__ts__i* "wolves"
Proto-Bantu **-__kí__ndo*	>	Shona *mu-__ts__índo* "audible footstep".

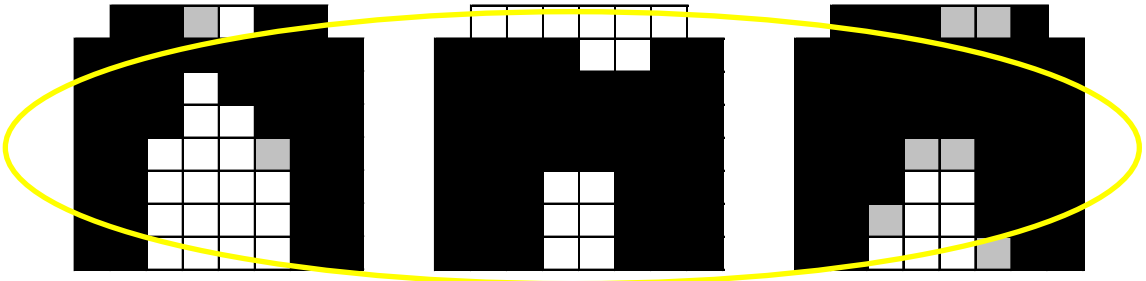
(Data taken from Guion, 1996)

c



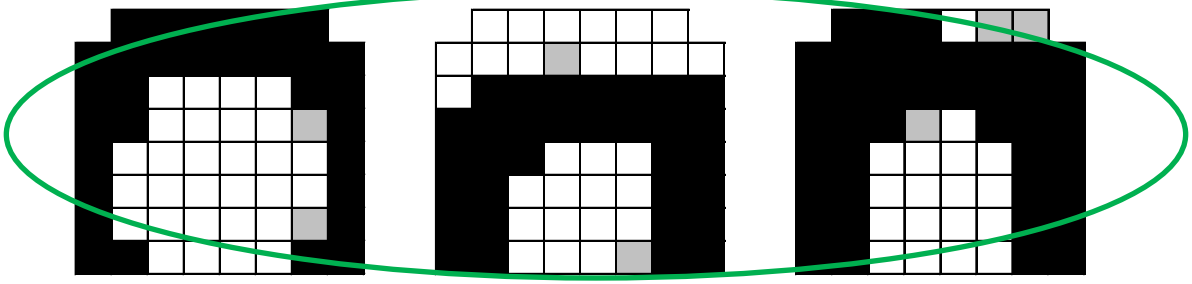
Majorcan Catalan

tʃ



Eastern Catalan

ts



The Romance languages are somewhat special in this respect. Indeed, word initial Latin front /k/ (/k/ +/i, e, j/) has yielded typically

[ts], [s] or [θ] in Western Romance

(Catalan [sen], Spanish [θjen] CENTU “one hundred”,
French [sjɛl] CAELU “sky”)

[tʃ] in Eastern Romance

(Tuscan [ˈtʃɛnto] CENTU, Romanian [tʃer] CAELU)

Several explanatory hypotheses have been proposed in order to account for the outcome **[ts]** of velar softening, which will be evaluated in the present talk:

(1) **[k+] before /i, j/> [t] > [ts]** (Chang et al., 2001)

(2) **[k+] > [c]> [tʃ]> [ts]** (Rohlfs, 1966: 201, Lausberg 1970: 316-317)

(3) **[k+] > [c] > [ts]** (Scripture, 1902: 434-441, Anttila, 1989: 73, Meyer Lübke,1974: 339-340).

Hypothesis (1)

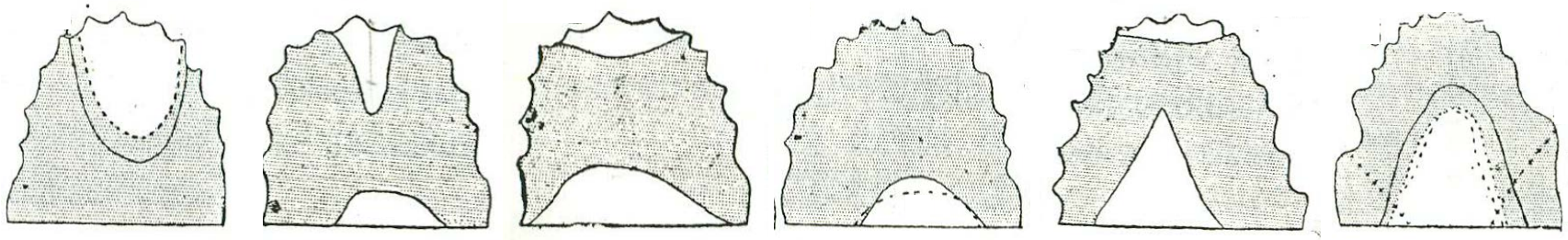
[kʲ] > [t] before /i, j/ > [ts]

This hypothesis is based on data showing that **/k+/ may be confused with /t/** perceptually since the two stop realization share similar high frequency burst and F2 vowel transitions.

(Tuscan)	*s**tj**ena* < *s**chi**ena* “back”, *fis**ti**are* < *fis**chi**are* “to whistle” (Rohlfs, 1966: 351)	
(hills east Pisa)	***ti**ave* < ***kj**ave* “key” (Malagoli, 1939)	
(Latin)	II-III c. A.D *Praste**ti**um* ‘Praeste**ci**um’	(Aski, 2001: 38)
	VI c. *menda**ti**um*	(Grandgent, 1991: 179)
	VI-VII c. *Albu**ti**us*, *Alvi**ti**us*, *Vini**ti**ana*	(Carnoy, 1906: 141-143)
(Francoprovençal)	[se**tj**e] SE**CA**RE (ALL, map 29)	
(French dialects)	[**tj**ɔʃ] ***cl**oches* “bells” (AChB, map 158)	
	[a**dyi**l] *an**gui**lle* “eel” (ALN, map 611)	

There are reasons to assume that it is not the postpalato-velar realization of front /k/ which is identified as /t/ but an **(alveolo)palatal realization [c]** of the front velar stop. Therefore, strictly speaking, the phonetic development would be not [k+] > [t] but **[c] > [t]**.

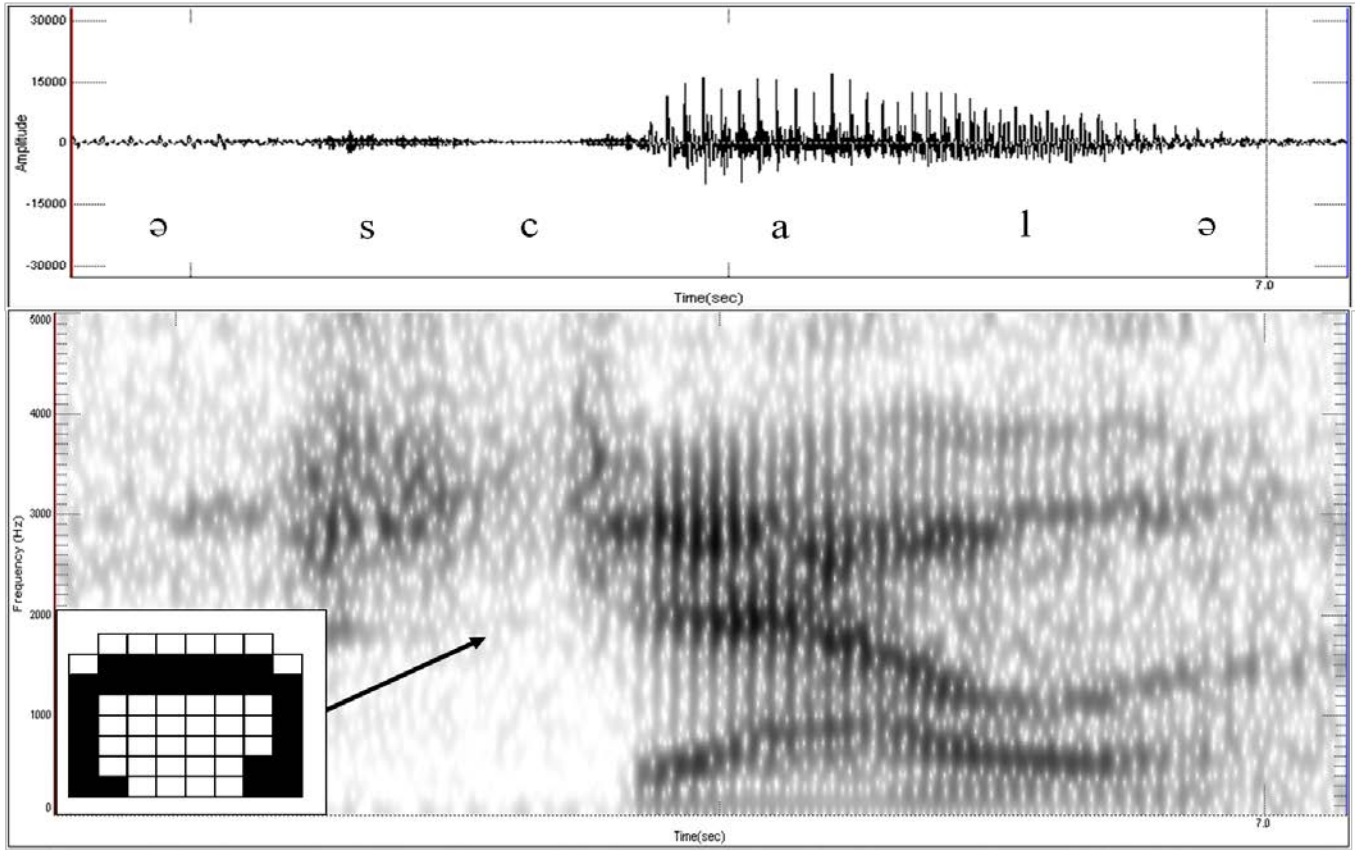
Different variants of [c] (/k/ + /i, j/) showing progressive closure fronting



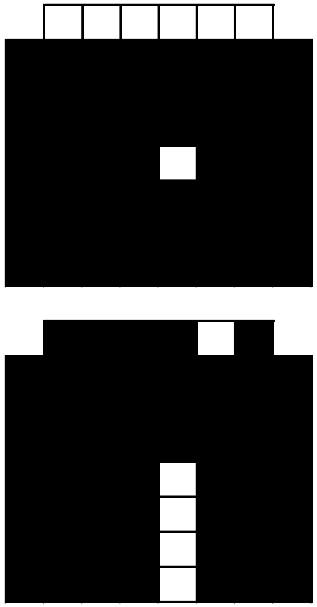
/k/-like → **/t/-like**

(Data on French and Occitan dialects taken from Rousselot, 1897-1901: 614)

Majorcan speaker CA shows highly variable realizations of [c] some of which are alveolar (/skV/) or approach an alveolar realization and may sound /k/-like or /t/-like.



speaker CA.WAV



Supporting evidence

(1) The presence of the (alveolo)palatal realization [c] of front /k/ in the same or nearby dialectal areas where front /k/ may be replaced by /t/.

(Florentine /(k)kj/)	[**tʲ**ave, **c**ave] “key”,	[o**tʲ:**o, o**c:**o] “eye”	(Giannelli, 1976: 24)
(Arezzo /(k)kj/)	[**tʲ**ave] “key”,	[o**tʲ:**o] “eye”	(Giannelli, 1976: 78).
(Perugia, Pistoia /skj/)	[**kʲ**], [**tʲ**] *maschio* “male”, *schiena* “back”		(Aski, 2001: 40).
(Francoprovençal)	[**c**ju] *clou*, “nail”, [**c**ø] *queue* “tail”		(ALL, maps 282, 697).

(2) Instances of the **reversals** /tj/ > [kj], /ti/ > [ki] in dialectal areas where front /k/ may be realized as [c].

(Arezzo)	[ˈ**kj**ene] ***ti****ene* “(he/she) has”, [ˈ**kj**eb:eto] ***ti****epido* “feeble” (Giannelli, 1976: 78)	
(Pisa countryside)	***chi****epito* < ***ti****epido*, *bes****chi****a* < *bes****ti****a* “beast”	(Malagoli, 1939: XVIII)
(Normandy)	*ami****ki****é* < *ami****ti****é* “friendship”, *pi****ki****é* < *pi****ti****é* “pity”, ***ki****ens* > ***ti****ens* “have, 2nd person imp.”	(Carnoy, 1906: 147).
(Latin)	II-III c. A.D *mundi****ci****ei* ‘mundi**ti**ei’, *justi****ci****a*, *termina****ci****ones*	(Aski, 2001: 38)
	IV-VII c. *o****ci****o*, *servi****ci****um*, *ora****ci****onem*	(Grandgent, 1991: 178-179)
(Angevin)	*tu****qui****lle* < *tu****ti****lle*, ***gui****re* < ***di****re* “to say”	(Rousselot ,1924-25, 1: 613-614)

Possible interpretation:

(a) Hypercorrection

In places where front /k/ is realized as [c] and perceived as /t/, instances of originary /tj, ti/ may be taken to be realizations of /kj, ki/.

(b) Both /t/ and /k/ before /i, e, j/ are realized as [c] (as in Forez Francoprovençal and Angevin French).

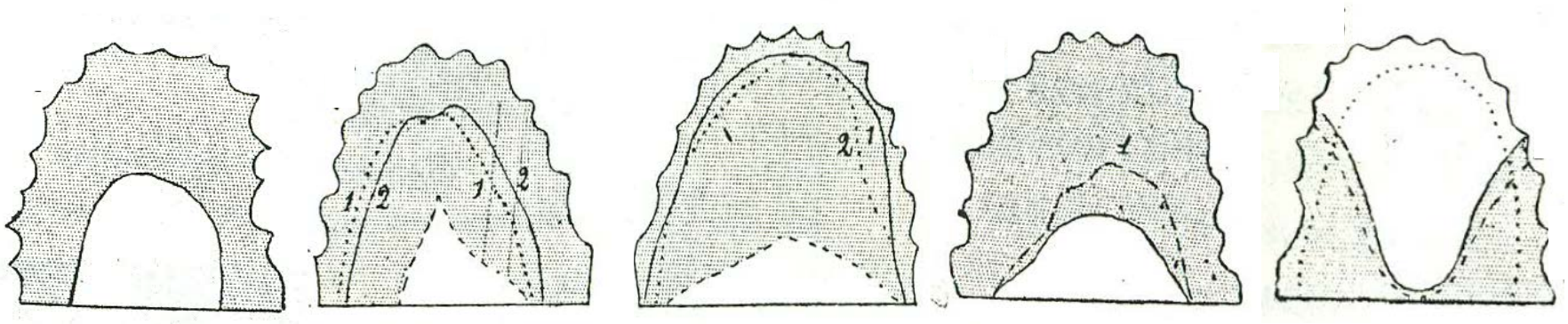
(dial. Italian; Aski , 2001)

/tj/ > [cj] > [tʃ] (*cominciare* *COMINITIARE “to begin”, [ˈkat:ʃa] *caccia* *CAPTIA “the hunt”, as opposed to [ˈpɾettso] *prezzo* PRETIU)

/kj/ > [cj] > [ts] ([ˈkaltsa] *calza* CALCEA “tights, stockings”, as opposed to [ˈfattʃa] *faccia* FACIE “face”).

Different realizations of palatalized /t/ showing progressive closure backing

/t/-like **/k/-like**



(Data from French and Occitan dialects taken from Rousselot,1897-1901: 602, 607, 614, except for palatogram 4 which belongs to Irish).

Hypothesis (2)

[kˌ] > [c] > [tʃ]> [ts]

There are descriptive data showing that, at least in specific dialectal areas, the change [c] > [ts] is **more plausible** than the development [c] > [tʃ]> [ts], which is in support of the notion that [ts] may be issued directly from [c].

(Francoprovençal) Phonetic alternations between [(t)s] and [c] derived from Latin CA, CL.

(E. Franc-Comtois)	[**tʲ**joʃ, **s**jotʃ] *cloche* “bell”, [**tʲ**ju, **s**jo] *clou* “nail”	(Dondaine, 1991: maps 114, 425)
(Lyonnais)	[seˈ**tj**e, seˈ**ts**i] *secher* SECARE “to dry”	(Gardette 1984: map 29)
(Vionnaz, Valaisan dialect)	[ˈ**tj**evra] *chèvre* CAPRA “goat”, [**ts**əˈvo] *cheval* CABALLU “horse”	(Grammont, 1933: 214).

(N.and E. Occitan) The velar softening outcome of Latin CA may be **[ts]** exclusively ([**ts**o] CALDU).

(Greek dialects) Phonetic alternations between the realization [c] of front /k/, and [tʃ] and/or [ts].

[c]	(Peloponnese)
[c], [tç], [tʃ], [ts]	(Cyclades, Euboea)
[c], [tç], [ts]	(Crete, Chios)
[c], [ts]	(Megara, N. Rhodes)
[ts]	(several islands,e.g., Lesbos)
[tʃ]	(Cyprus)

(Newton, 1972, Lengeris & Kappa, 2014, Manolessou & Pantelidis, 2012, Syrika et al., 2011).

Summary

Descriptive and experimental data lead to the following conclusion regarding the three hypotheses on the outcome **[ts]** of velar softening :

[k+] > [c]> [tʃ]> [ts]	**POSSIBLE**
[k+] > [c] > [ts]	**POSSIBLE**
[k+] > [t] before /j, i/ > [ts]	**NOT FEASIBLE**

VELAR SOFTENING IMPLEMENTATION IN NON-FRONT VOCALIC CONTEXTS

Velar softening may occur not only before a front vocalic segment but before **/a/** as well.

(French) ***ch****ar* < Latin [ˈ**ka**ro] CARRU “trolley”

ch*ien* < Latin [ˈ**ka**ne] CANE “dog”

It has been hypothesized that, in order for velar softening to apply before /a/, the low vowel should have a **fronted** [æ]-like realization (Buckley, 2009).

[Supporting evidence]

In Old French and related languages and dialects, stressed /a/ shifted to *e* when occurring in an open syllable and was preceded by the realization [c] of /k/, which became [tʃ] a later date.

(Old French) [cær] > [cjær] > [tʃjɛr] > XIIIc. [ʃ**ɛ**r] *cher* C**A**RU “expensive”

(Francoprovençal) [tsarˈdzi] < **chargi**e**r* CARRIC**A**RE “to carry” vs *portar* PORTARE “to bring”

Picard has maintained the (alveolo)palatal stop [c], as in *ki**è**vre* CAPRA “goat”, *ki**e**r* C**A**RU “expensive”.

[Problematic data]

(a) /a/ fronting may **not** occur after [c].

[c] > [tʃ]

(French, stressed /a/ in **checked** syllables) — *ch**a**r* CARRU, *j**a**mbe* GAMBA

[c, ɟ]

(Majorcan, Lombard) — [c**a**r] CARU “expensive”

(Rhaetoromance) — [c**a**f] (Friulian), [c**a**w] (Surselvan) CAPUT “head”

[c**a**ˈval] (Marebbano) CABALLU “horse”

(Parisian French) — *qu**a**tre* (Rousselot,1899)

(Lazio) — *c**a**lcio* (Romano et al., 2005)

(Eastern Virginia, S. Carolina, Midlands and Southwest of England) — *g**a**rden* (Peter, 2014).

(b) Velar palatalization and velar softening may occur **word finally** after any vowel.

[c]

(Majorcan Catalan, Lombard)	[sa**c**] SACCU “sack”
(Engadine, Majorcan Catalan)	[po/ɔ**c**] PAUCU “little”
(Parisian French)	*ba*[**c**] “baccalaureat”, *fa*[**c**] “facultée”
(Persian)	[xɑ**k^{j}**]‘earth’, [sus**k^{j}**] ‘beetle’.

[c] > [tʃ], [ts]

(Surmeiran)	[ɟy**c**, ɟy**tʃ**] IOCU “game”	(Jaberg & Jud 1935: maps 740, 1128)
(Sutselvan)	[be**c**, be**ts**] BECCU “beak”	
	[la**c**, la**tʃ**, la**ts**] LACTE “milk”	(Goebl 1998: map 126, Luzi 1904: 811)
(Ladin)	[fwɛ**c**, fwɛ**tʃ**] FOCU “fire”	(Politzer 1967: 34)
(English)	*su**ch*** < Old English *swil*[**c**]	
	*pit**ch*** < Old English *pi*[**c**]	

These descriptive data suggest that the change /k/ > [c] (> [tʃ], [ts]) before /a/ and word finally may be triggered by **articulatory strengthening**, i.e., an increase in tongue dorsum contact resulting into an (alveolo)palatal stop articulation.

Articulatory strengthening may occur before /a/ through an increase in tongue blade and predorsum contact since these two articulatory structures do not intervene actively in the production of the low vowel.

It is also prone to take place word finally because consonants lengthen and may be reinforced articulatorily in this word position.

In support of the articulatory strengthening account, Latin /ka/ CA has yielded [ca] **only in stressed syllables** in Surselvan, Surmeiran and Friulian areas (Recasens, 2011: 214).

Along these lines it may be argued that articulatory strengthening is also involved in the change /k/ > [c] (> [tʃ], [ts]) **before a front vocalic segment**.

Straka (1965: 128): “Une palatale peut naître sous le seul effet d’un renforcement articulatoire, tandis que la présence seule d’une voyelle palatale ou un yod ne suffit pas. Dans ce dernier cas, il faut encore qu’une certaine énergie articulatoire de la consonne s’ajoute à l’attraction assimilatrice de l’articulation subséquente”.

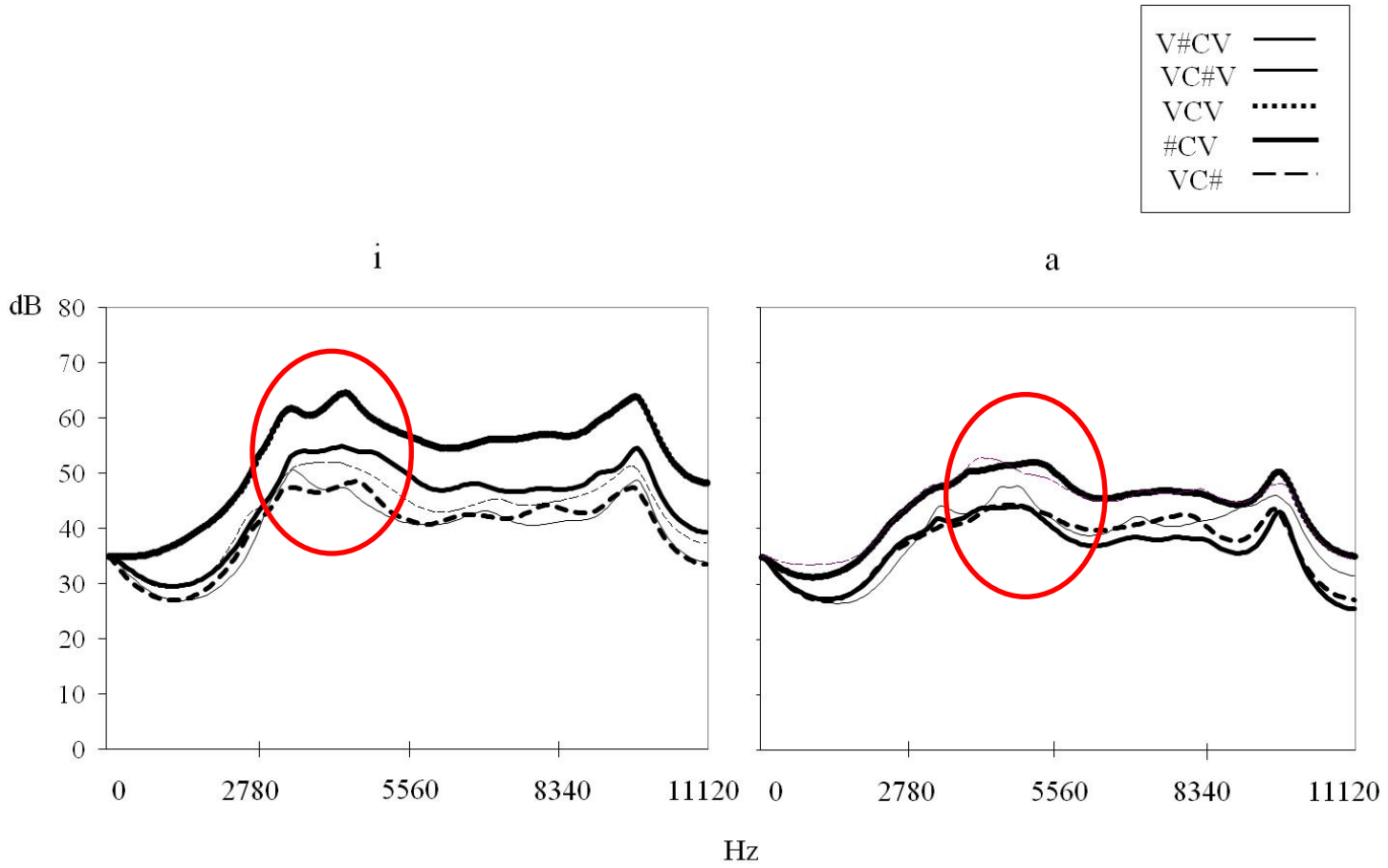
WHICH ACOUSTIC CUES FOR [c] ACT AS VELAR SOFTENING TRIGGERS?

Acoustic cues

The (alveolo)palatal stop [c] and the palatoalveolar affricate [tʃ]

- share a **similar spectral structure**,
- differ in their **duration and intensity characteristics**.

(Spectral structure) The [c] burst has a 3500-5000 Hz spectral peak which matches the spectral peak frequency for the [tʃ] frication noise.



(Duration)

[tʃ] frication (80-90 ms) is longer than the [c] burst (35-75 ms).

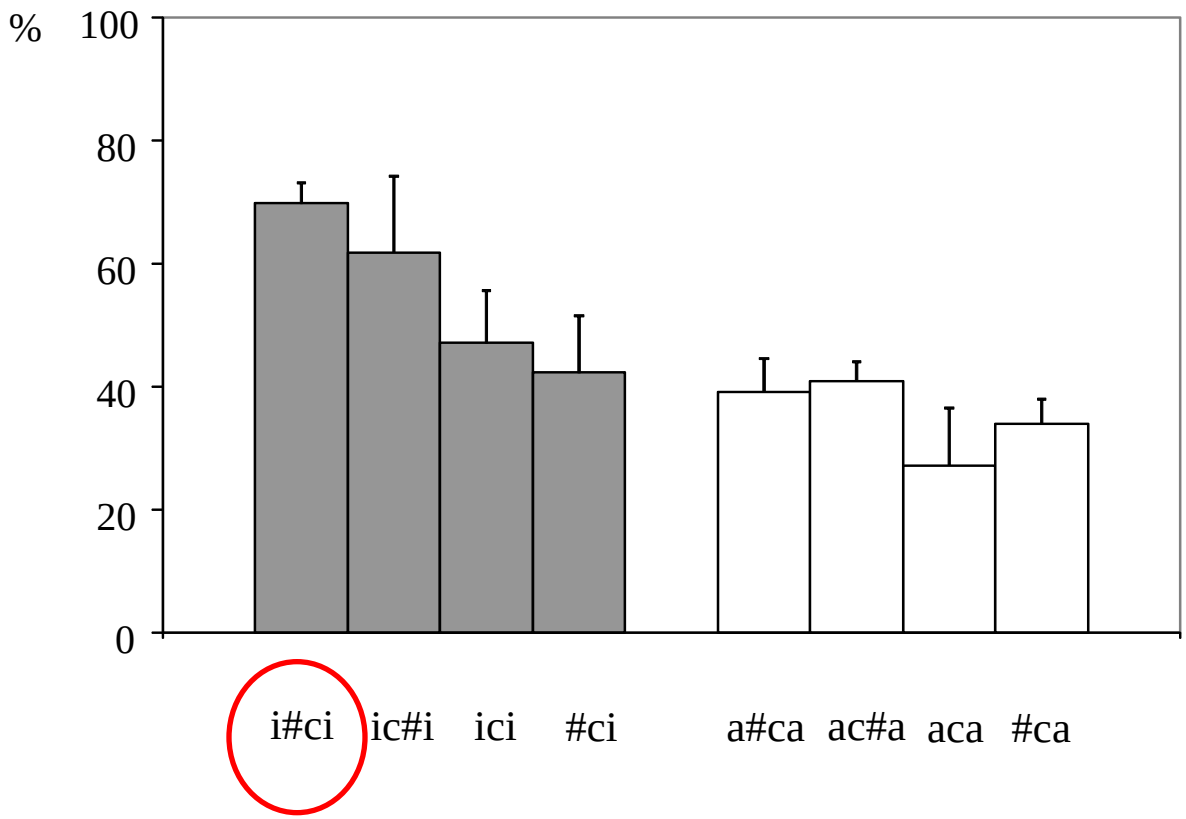
(Intensity level)

[tʃ] frication (55-65 dB) is more intense than the [c] burst (50 dB).

Given this scenario, the question is whether burst duration and/or burst intensity are responsible for the change [c] > [tʃ].

Word position

In a previous study (Recasens, 2014) we found that the /tʃ/ identification percentages for Majorcan Catalan [c] before /i/ vary in the progression **V#CV** [[alsoVC#V]] > **VCV** > **#CV**.



Presumably, the V#CV condition elicited the highest /tʃ/ identification percentages because the burst frication noise is

(a) **most intense** when [c] is flanked by two vowels,

(b) **longest** word-initially where consonants may be reinforced.

The question is then whether word position has any effect on the identification of [c] as an affricate.

Method

In order to test the effect of place of articulation and word position on velar softening, ***two*** perceptual identification tests were prepared with **[ci]** and **[ici]** stimuli using the ASL (Analysis-Synthesis Laboratory Model 5104) program of Kay Elemetrics.

ASL provides synthesis of the LPC signal after manipulation of LPC-extracted parameters.

The perception stimuli were built up from a single token of [ci] and [ici] produced by a speaker of Majorcan Catalan.

Problem regarding the word position condition:

Strictly speaking the test allows investigating the effect of burst duration and intensity on velar softening for the #CV position but **not for the V#CV position**. This is so since:

(1) The [ci] stimuli may be considered to be **word and phrase initial** (#CV) in real speech.

(2) The [ici] stimuli could be either **word initial intervocalic** (V#CV) **or word medial intervocalic** (VCV).

Duration values (in ms) and absolute intensity values (in dB) for the speech stimuli used in the [ci] and [ici] identification tests.

Stimulus number	Duration/ Intensity
1	50 ms /50 dB
2	50/55
3	50/60
4	50/65
5	50/70
6	60/50
7	60/55
8	60/60
9	60/65
10	60/70
11	70/50
12	70/55
13	70/60
14	70/65
15	70/70
16	80/50
17	80/55
18	80/60
19	80/65
20	80/70

[c]-like stimuli

[tʃ]-like stimuli

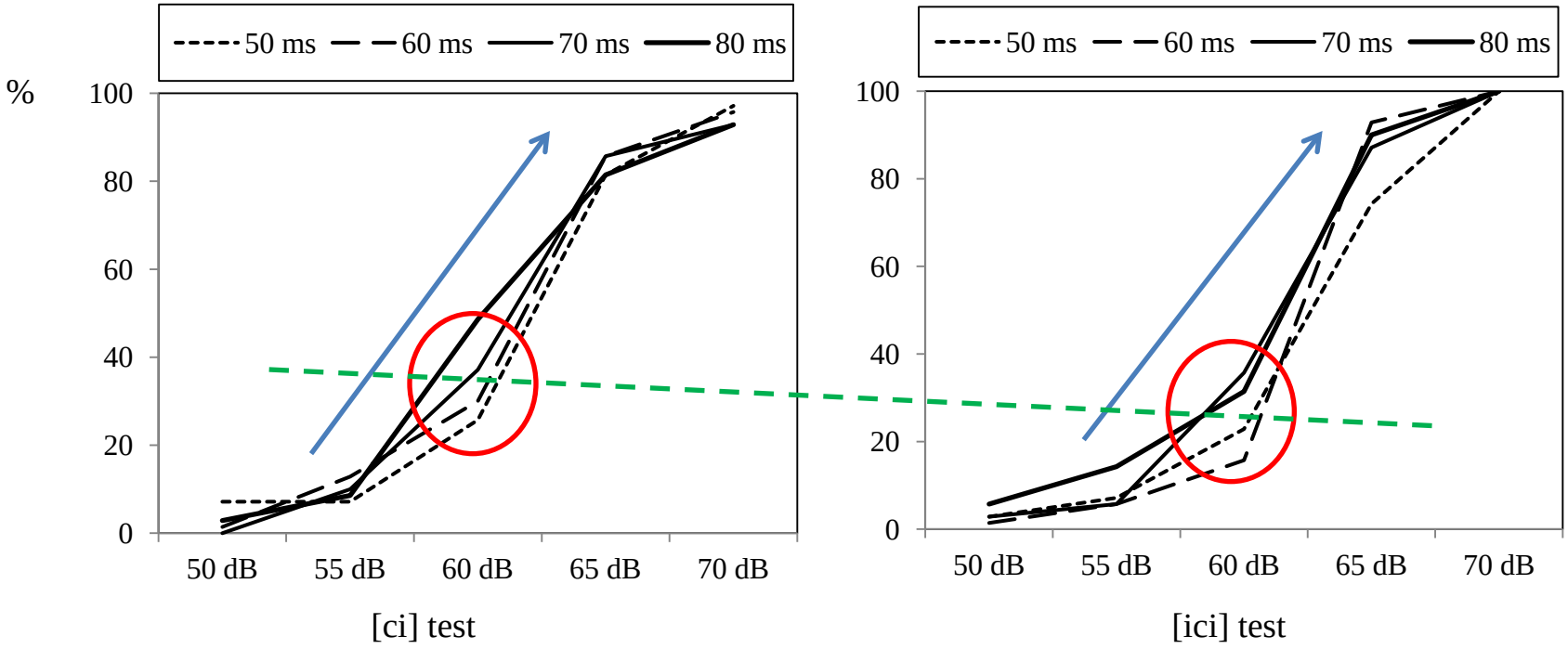
Each identification test included 5 tokens per stimulus.

There was a 3 s interstimulus silence and a 5 ms silence between blocks of 10 stimuli.

The two tests were administered to **14 Eastern Catalan speaking subjects** of 20-60 years of age through loudspeakers connected to a portable PC with a high quality sound card.

Subjects were asked to identify the stimuli as /k/ or as /tʃ/ by writing either K (for /k/) or TX (for /tʃ/) on a response sheet. (The digraph ‘tx’ is the most common orthographic symbol for marking the affricate in Catalan).

Results



-Main effect of **Intensity** ($p < .001$) but no main effect of Duration or Word Position. Affricate reponses rise categorically as the [c] burst intensity shifts from 55 dB to 65 dB.

-Intensity*Duration was barely significant ($p<0.05$). Affricate responses were higher whenever an **ambiguous 60 dB** [c] burst was rendered longer.

-Intensity*Word Position barely reached significance($p<0.05$). Affricate responses were higher **for the [ci] vs [ici] condition** when the [c] burst **intensity level was also 60 dB**.

Summary

-Velar softening may be triggered by the **(alveolo)palatal stop** [c].

-[c] **burst intensity** is a better affricate identification cue than burst duration. There is a categorical increase in affricate responses whenever the burst intensity level raises from 55 dB to 65 dB.

-An increase in [c] burst duration contributes to an increase in affricate identification **only** in the case of 60 dB stimuli which were **ambiguous** and thus not clearly perceived as either a stop or an affricate.

-Affricate identification responses were **not higher in intervocalic vs word initial position** presumably since listeners were lacking information about whether intervocalic [c] was the first consonant of a word or a word medial consonant (which calls for a more explicit evaluation of word position in future perception tests).

GENERAL SUMMARY AND DISCUSSION

(Topic 1) The alveolar outcome of velar softening **[ts]** may be issued directly from **[c]** ([c] > [ts]) or from **[tʃ]** ([c] > [tʃ]> [ts]) but probably not from **[t]** ([c] > [t] >[ts]). This sound change may conform then to **more than one evolutionary path**, the same as for other sound changes.

(Topic 2) Velar softening may be triggered by **more than one articulatory mechanism**, i.e., closure fronting in front vocalic contexts and articulatory strengthening alone before /a/ and word finally.

(Topic 3) [c] **burst intensity** is a better velar softening cue than **burst duration**. Velar softening is prone to originate in the intervocalic word initial position.

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