

ON THE APPLICATION OF VELAR PALATALIZATION IN ITALIAN

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The phonological process

- The palatalization of a velar consonant, caused by a following front vowel or a glide involves the fronting of the dorsal constriction to a palatal position.

$k \rightarrow tʃ / _ [-back]$

$g \rightarrow dʒ / _ [-back]$

- In modern Italian it is restricted to apply across the morpheme boundary and, it is only triggered by the front vowel /i/, in nouns and adjectives.
- In the lexicon of Italian, certain masculine nouns and adjectives palatalize in the plural, and others do not:

	<u>Palatalizing</u>	<u>Non-Palatalizing</u>
<u>Nouns</u>	mediko, meditʃi ‘doctor’	arabesko, arabeski ‘arabesque’
	filologo, filolodʒi ‘filologue’	sfogo, sfogi ‘rash’
<u>Adjectives</u>	comiko, comitʃi ‘comic’	antiko, antiki ‘antique’
		lungo, lungi ‘long’

Overview

- First Part:

 - Results from a Corpus study

 - Results from a nonce-word test

 - They will argue for the fact that velar palatalization in contemporary Italian is largely predictable as a function of stress (*contra* Celata and Bertinetto, 2005; Krämer 2009).

- Second Part:

 - Results from a acoustic study

 - Indicate that the effect of stress on palatalization might be due to the increase in perceived distance between velar stops and affricates in post-stress position.

Some previous work on palatalization in Italian

Dressler (1985)

- Nonce-word experiment

Stress	Palatalizing?	YES	NO
	Antepenultimate	≈ 90%	≈ 10%
Penultimate	≈ 55%	≈ 45%	

Celata&Bertinetto (2005)

- Lexical decision task
- On the basis of these results they conclude that:
 - 1) Palatalization is an irregular morpho(phono)logical process;
 - 2) Plural allomorphs of nouns and adjectives whose roots end in a velar stop have to be stored in the mental lexicon;
 - 3) Plurals of non-velar ending words are computed compositionally.

Krämer (2009)

- Nonce-word experiment;
How active is the process of velar palatalization in nouns?
- Speakers differ in the choice they make based on their individual grammar: “Overpalatalizers” vs. “Underpalatalizers”

Corpus study the lexicon of Standard Italian

- The Corpus: “LaRepubblica” a corpus of Italian newspaper text (~380M tokens);
- Results:

The stress-conditioned distribution hinted at by Dressler seems to be overwhelmingly present in our corpus:

Nouns

Stress \ Pal?	YES	NO
Antepenult	240	20
Penult	5	217

Adjectives

Stress \ Pal?	YES	NO
Antepenult	32	5
Penult	4	153

- The vast majority of palatalizing words in *-co* and *-go* have antepenultimate stress;
- The vast majority of non-palatalizing words bear penultimate stress.

Descriptive generalization:

(a) The synchronic distribution of velar palatalization is predictable by stress;

(b) Plural nouns and adjectives bearing antepenultimate stress palatalize.

→ Contexts where palatalization applies: $(\text{'CV})\text{CVki} \rightarrow (\text{'CV})\text{CVtʃi}$
 $(\text{'CV})\text{CVgi} \rightarrow (\text{'CV})\text{Cvdʒi}$

(c) Plural nouns and adjectives bearing penultimate stress do not palatalize.

→ Contexts where palatalization does not apply:

$(\text{CV})\text{'CVki} \rightarrow \text{CV}'\text{CVki}$	$*(\text{CV})\text{'Cvtʃi}$
$(\text{CV})\text{'CVgi} \rightarrow (\text{CV})\text{'CVgi}$	$*(\text{CV})\text{'Cvdʒi}$

Productivity of the stress generalization: A nonce-word test

- In the Corpus Study we found a correlation between the position of main stress and the application of palatalization;
- Do speakers still apply palatalization according to this generalization?

- *Material*

The nonce-words were created following the procedure described in Albright and Hayes (2003)

Total = 84 Test items + 42 Fillers

- *Participants*

- Ten native speakers of Italian were recruited as participants;

- *Method*

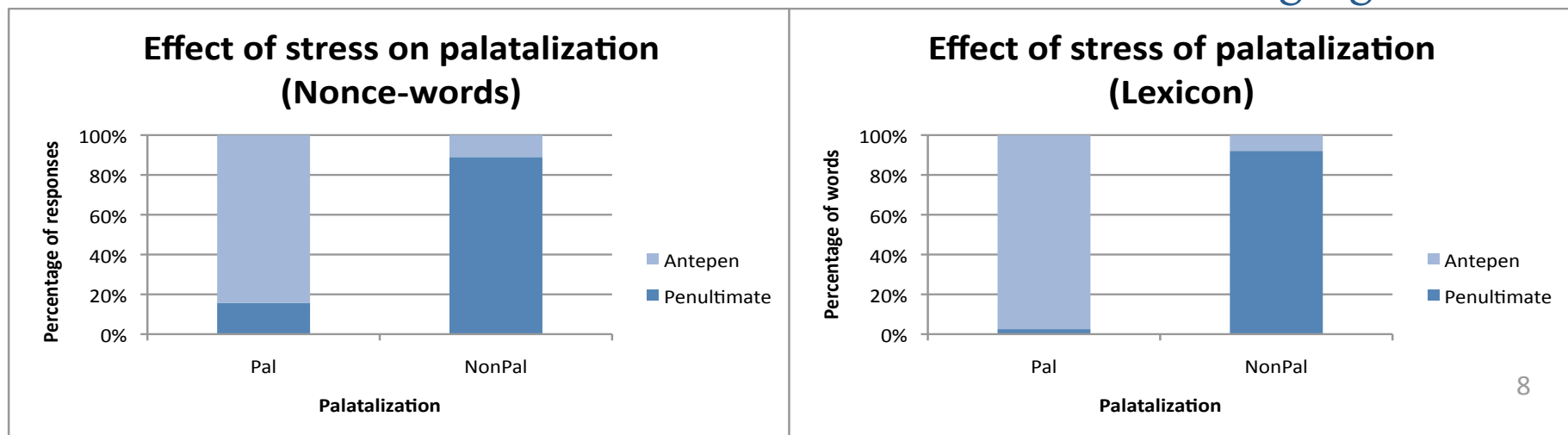
- Participants were given a written list of singular nonce words. They were asked to read the words out loud, decide where to put the stress and form the plural of the nonce-word.

Productivity of the stress generalization: Results

- Speakers of Italian apply palatalization according to the stress generalization:

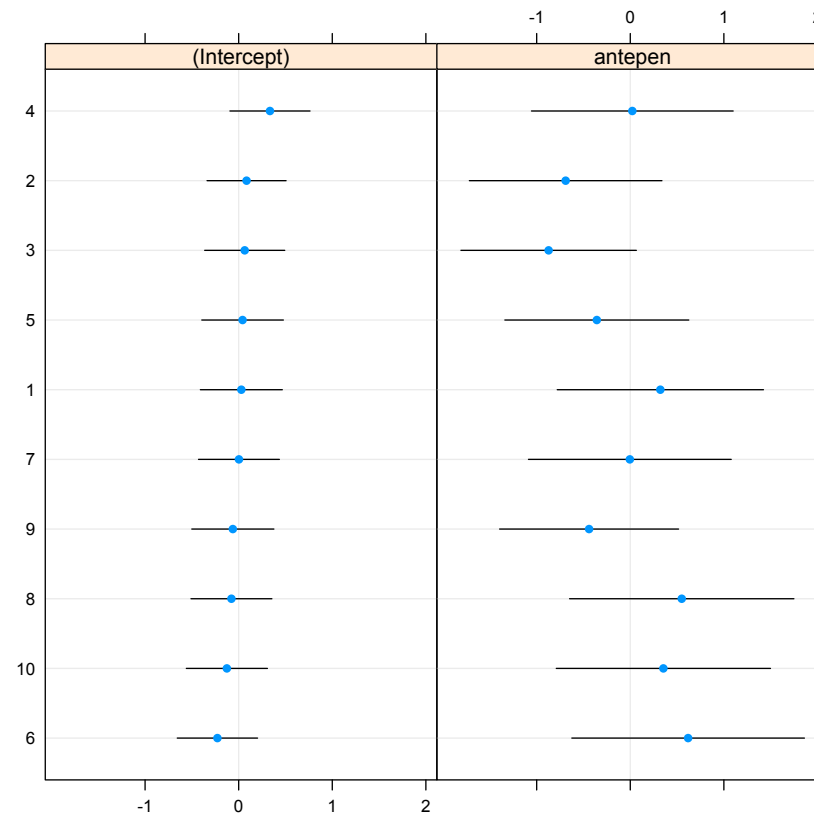
Random effects:				
Groups Name	Variance	Std.Dev.		
item (Intercept)	0.000000	0.00000		
sub (Intercept)	0.068793	0.26228		
Fixed effects:				
	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	-2.0597	0.2092	-9.845	< 2e-16 ***
antepen	4.5207	0.2799	16.152	< 2e-16 ***
liq	0.3432	0.2623	1.309	0.19070
velbin	-0.6045	0.2817	-2.146	0.03187 *
palnei	0.8460	0.3099	2.730	0.00634 **
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

- Distribution Nonce-words = Distribution in the lexicon of the language:



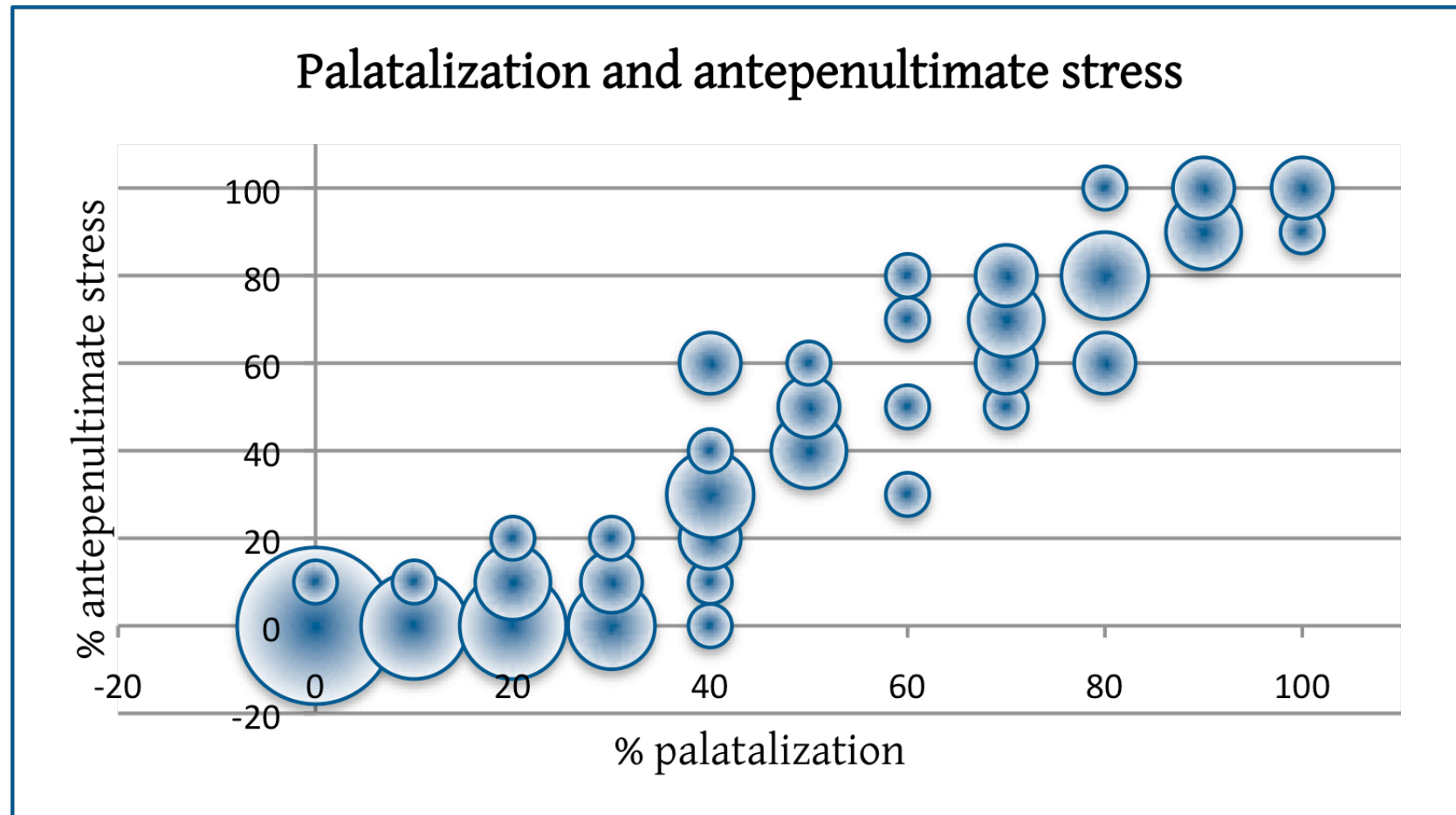
Productivity of the stress generalization: Results

- The effect of stress on palatalization did not differ between the speakers (unlike what found by Krämer 2009):



Productivity of the stress generalization: Results

- There was variation among subjects as to where the stress was placed, but no departure from the stress-generalization.



Why should stress matter?

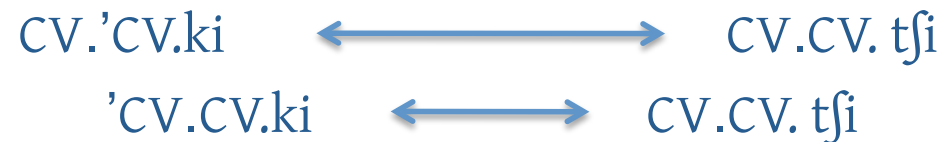
- If palatalization is a perceptually driven change this is not a surprising fact ...
- *Background: Palatalization as a perceptually driven change*

Guion (1996):

Based on acoustic and perceptual analyses, the author concludes that the change from /ki/ to /tʃi/ occurs because the acoustic resemblance between the velar stop and the palatoalveolar affricate when they occur before a palatal vowel (cf. Ohala 1994 and Wilson 2006).

Why should stress matter? Proposal (I)

- In Italian, unlike e.g. Late Latin, greater acoustic similarity between the velar and the palatoalveolar is required in order for palatalization to be triggered.
- In immediately post-tonic position (i.e. CV.'CV.ki) the contrast between the two sounds is *more* perceptible than when the velar consonant is far from stress (i.e. 'CV.CV.ki)

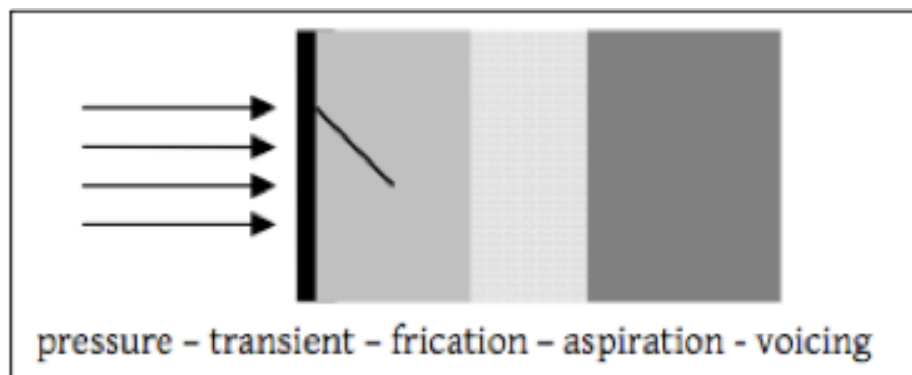


- Less perceptible contrasts are more marked than more perceptible contrasts, and they are more prone to neutralization (Flemming 1995, 2006);
- Velar stops and palatoalveolar affricates only neutralize when they are far from stress.
- In immediately post-tonic position the contrast is distinct enough to be licensed, no palatalization occurs.

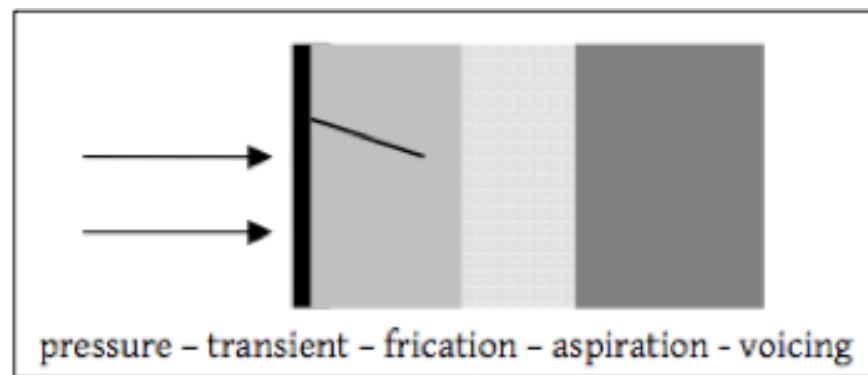
Why should stress matter? a proposal (II)

- How does the greater similarity arise?
- Acoustic effects of stress on the immediately following velar stop:
 - Increased pressure build-up behind the stop closure (cf. Ladefoged 2004);
 - Sharp burst and rapid fall in the frication intensity (cf. Imbrie 2005)

(A) Rapid decrease in intensity between the transient and the frication after a stressed vowel (clear stop consonant):

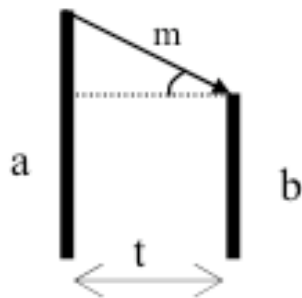


(B) Gradual intensity contour and evenly spread frication noise between the transient and the frication phase, in a consonant far from stress (more similar to an affricate):



Acoustic study

- One native speaker of Italian (age 32; male; from Milano) was recorded in a sound attenuated booth;
- The speech material consisted in 144 tri-syllabic pseudo Italian words (48 blocks) containing the sequence -Ki- word-medially (K = /k/, /g/ and /t/ was used as a filler) and 72 pseudo Italian words (24 blocks) containing the sequences -tʃi- and -dʒi-.
- Acoustic measures:
 - burst and closure duration of the consonant;
 - burst to closure ratio;
 - slope of the intensity contour between the transient and the frication:



a = intensity value at the peak of the transient
b = intensity value at the first minimum of the frication
t = time interval between the peak and the minimum
m = slope

$$m = \frac{a - b}{t} = \text{Intensity slope}$$

Results: Intensity slope

- The intensity slope is steeper in immediately post-tonic position
 - The ANOVA indicated an effect of prosodic condition on the intensity contour

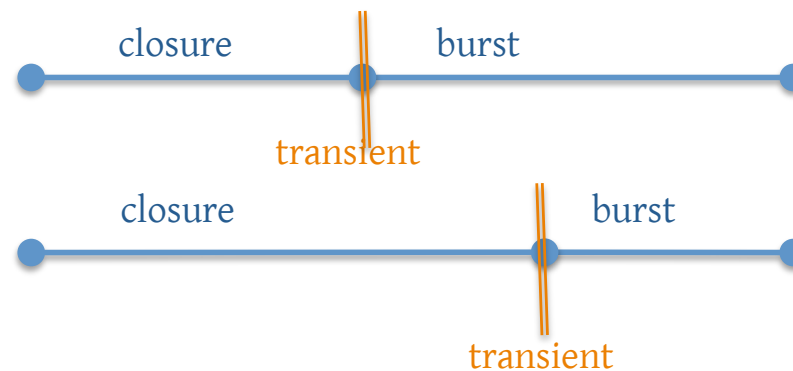
Segment	Condition	m (slope)
K	far-from-stress (Cvki'CV)	-1.345
	post-tonic ('CvkiCV)	-2.228
G	far-from-stress (Cvki'CV)	-0.625
	post-tonic ('CvkiCV)	-0.942

- A similar analysis could not be carried out for the affricates, since a clear burst was often not visible.
 - Frication in affricates is homogeneously spread across the burst, without a sharp transient marking its beginning.
- The increased slope in post-stress position is making the velar stop less similar to its affricate counterpart.

Results: Burst/Closure duration

	Stop consonants	Alveopalatal affricates
Mean ratio “far from stress”	0.570	2.752
Mean ratio “post-tonic”	0.447	1.913

- Differences in burst/closure duration were found for both stops and affricates;



Conclusions

- The corpus study showed that the distribution is strongly correlated with the position of main stress.
 - The nonce-word experiment showed that speakers of Italian productively apply palatalization following the stress-generalization.
 - The acoustic analysis of velar stops in different prosodic conditions revealed an acoustic basis for the link between velar palatalization and stress.
- ➔ The distribution of palatalization is determined by the specific acoustic realizations of stops in the different prosodic conditions, which trigger, or block the perceptually driven change.

Thank you

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- Thank you also to Hyesun Cho, Emmanuel Chemla, Gillian Gallagher, Jonah Katz and Peter Graff for their comments.

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Appendix 1: Nonce-word stimuli

- The nonce-words were created with the help of the Minimal Generalization Learner (Albright and Hayes, 2002) following the procedure described in Albright and Hayes (2003)
 - Rules extracted from the lexical alternations (only the general rules are listed):
 - Subsets of Rule (1) ko → ki/ _ko Non-palatalizing rules
 - Subsets of Rule (2) ko → tʃi/ _ko Palatalizing rules
 - The model was tested on 2400 constructed candidate nonce words ending in -ko;
 - The model generated plural forms using the applicable rules and returns output with different confidence intervals.
 - A set of 84 masculine testing words was created: all the well-formedness scores were equally represented in the testing material.

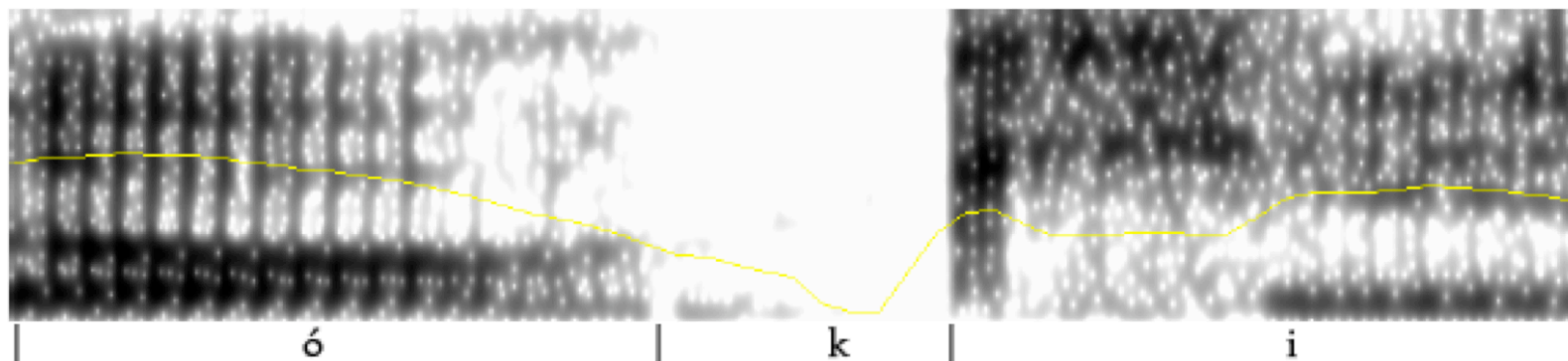
1 > Confidence value Rule 1 > 0.8	1 > Confidence value Rule 2 > 0.8
0.8 > Confidence value Rule 1 > 0.7	0.8 > Confidence value Rule 2 > 0.7
0.6 > Confidence value Rule 1 > 0.3	0.6 > Confidence value Rule 2 > 0.3

Appendix 2: Acoustic study

Experimental conditions: an example

Stress condition \ Velar segment	Voiceless velar /ki/
Pre-tonic velar	Mangió cosochí so per cena
Post-tonic velar	Sputó cosóch iso per lo schifo
Far-from-stress velar	Visitó sochisó co per Natale

Spectrogram and intensity contour of /cosóchiso/ (only /óki/ is reported)



Why should stress matter? two related facts

- *Question*

Why should the vicinity to stress have an effect on the rate of change of the intensity between the transient and release of the closure?

- *Ladefoged (2004)*

In investigating the aerodynamics of stress the author identifies increased pressure below the vocal folds as being always a correlate of stress.

- *Imbrie (2005)*

Children generate a higher subglottal pressure during stop production than adults:

Children between 2 -3 years of age were found to have short burst durations; this could be due to the use of high subglottal pressure at burst release.

High subglottal pressure can have as an acoustic consequence that the burst is realized in a different manner: increased pressure pushes the constriction open quickly, *reducing* burst duration.