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Context-dependent perception of geminates

Bożena Pająk
University of California, San Diego
bpajak@ling.ucsd.edu http://idiom.ucsd.edu/~bpajak

Summary

Geminates in different contexts (defined in terms of word position and adjacent segments) are not evenly distributed cross-linguistically. Intervocalic geminates are the most common and non-vowel-adjacent geminates are the most rare. I provide experimental evidence that this typological pattern has some basis in perception: the geminate-singleton contrast is easiest to perceive in the intervocalic context and hardest in the non-vowel-adjacent environment.

Background

Geminates:

long consonants
1.5-3 times as long as singletons
(Ladefoged & Maddieson 1996)

Many languages use consonant length contrastively:

[bel**l**o] vs. [bel**l**o]	'beautiful' /'I bleat'	(*Italian*)
[tak**k**a] vs. [tak**k**a-]	'fireplace' / 'back'	(*Finnish*)

Geminates & context:

intervocalic
[fa**tt**o] 'fact' *Italian*
(Loporcaro 1996: 125)

single vowel-adjacent
[tan**gg**al] 'date' *Taba*
(Bowden 2001: 39)
[**pp**efto] 'I fall' *Cypriot Greek*
(Arvaniti 2001: 23)
[ʔi**mm**] 'mother' *Palestinian Arabic*
(Abu Salim 1980: 6)

non-vowel-adjacent
[**tt**lata] 'Tuesday' *Moroccan Arabic*
(Heath 1987: 38)

Context & typology:

Cross-linguistically
intervocalic geminates ← most common
non-vowel-adjacent geminates ← least common
(Thurgood 1993, Muller 2001)

Implicational universal
If a language has **non-intervocalic geminates**, it also has **intervocalic** ones.
(Thurgood 1993)

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Proposal

Perceptually-based contextual markedness hierarchy of geminates:

non-vowel-adjacent > single vowel-adjacent > intervocalic
#GGC, CGG#, CGGC #GGV, VGG#, VGGC, CGGV VGGV

Non-intervocalic geminates are marked because they are perceptually less salient.

Factors that diminish the perceptibility of geminates:
- ❖ non-medial word position
- ❖ adjacency to consonants

Experiment 1 - Acoustics

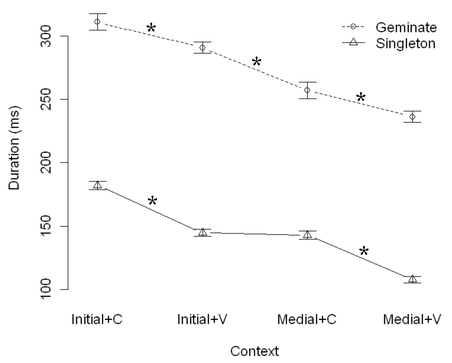
Purpose: Investigation of the acoustic properties of geminates in different contexts

Recordings:
❖ 4 conditions

Position in a word	Following segment: V	Following segment: C
medial	[assa]~[asa] [azza]~[aza]	[assta]~[asta] [azzda]~[azda]
initial	[ssa]~[sa] [zza]~[za]	[ssta]~[sta] [zzda]~[zda]

❖ recorded by a native Moroccan Arabic speaker (where these sequences are phonotactically legal)
❖ 36 repetitions for each condition (18 'voiceless' & 18 'voiced')

Fricative duration:



The **duration of geminates** *decreases* along the markedness scale:
initial+C > {medial+C , initial+V} > medial+V

However, the **geminate/singleton duration ratio** *increases* along the markedness scale:
(the lower the ratio, the closer the geminates and singletons are in duration)
initial+C > {medial+C , initial+V} > medial+V
1.7 1.8 2.0 2.2

How might this relate to perception?
❖ If perceptibility simply correlates with **duration**, then the initial+C geminates should be the easiest to perceive and the medial+V the hardest to perceive.
❖ If the **geminate/singleton duration ratio** is more important for perceptibility, the opposite is expected.

Experiment 2 - Perception

Hypothesis: If the markedness hierarchy of geminates has some basis in perception, the geminate-singleton contrast should be the easiest to hear in the medial+V context, and the hardest to hear in the initial+C context.

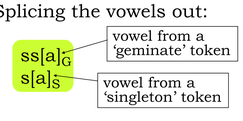
Method:

Design
❖ AX discrimination task:
Measuring sensitivity to the geminate-singleton contrast in 4 conditions: medial+V, medial+C, initial+V, initial+C.
Participants listened to 'same' (e.g., [assa]~[assa]) and 'different' (e.g., [assa]~[asa]) word pairs.
❖ Each participant heard 24 repetitions of each test condition.

Stimuli
❖ Built using tokens recorded in experiment 1. For each condition, tokens were selected as follows:
- 10 tokens where the duration of fricatives approximated mean duration
- 10 tokens where the duration of vowels approximated mean duration

❖ In order to ensure that participants paid attention to the fricatives and not to the vowels, all the vowels were spliced. Different combinations of spliced vowels and fricatives were created in the following way:

Splicing the vowels out:



Creating test pairs with different vowel-fricative combinations:

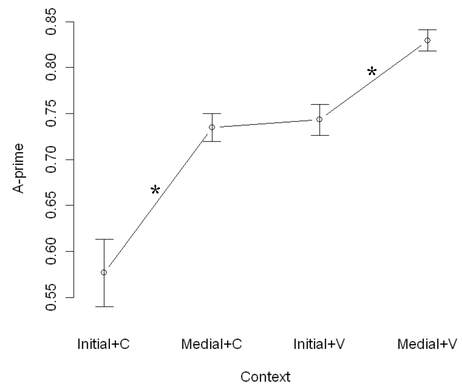
$ss[a]_G$ ~ $s[a]_S$
$ss[a]_S$ ~ $s[a]_G$
$ss[a]_G$ ~ $s[a]_G$
$ss[a]_S$ ~ $s[a]_S$

❖ In order to control for random variation between tokens, 40 different vowel+fricative combinations were created. Each participant heard 4 of them.

Participants
❖ 80 undergraduate students with no previous exposure to a geminate-singleton contrast (native English speakers)

Results:
❖ A-prime score calculated for each subject and each condition
❖ A significant main effect of context [$F(3,237)=28.3$; $p<.001$]
❖ No effect of spliced vowels [$F<1$]

A-prime:
non-parametric analog of d-prime
measures sensitivity to a given contrast
(roughly) yields scores from 0 to 1
0 – no sensitivity, 1 – perfect sensitivity



❖ Subjects' **sensitivity to the geminate-singleton contrast** increased along the markedness scale: initial+C > {medial+C, initial+V} > medial+V

❖ This result supports the hypothesis that the geminate markedness scale is based in perception.

❖ This result also suggests that perceptibility correlates with the geminate/singleton duration ratio (as opposed to simple duration).

❖ Increased duration of marked geminates might be an attempt to compensate for their lesser perceptibility, but it is not enough to overcome the difference in perceptibility between the contexts.

Conclusion

The results of the present study provide support for the **perceptual basis** of the **contextual markedness hierarchy** of geminates:

non-vowel-adjacent > single vowel-adjacent > intervocalic
#GGC, CGG#, CGGC #GGV, VGG#, VGGC, CGGV VGGV