

Lenition, elision and recovery of Chilean Spanish /b, d, g/

There is hardly anything to hear,
but we are hearing it nonetheless



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Spanish /b, d¹, g/

The traditional account

Complementary distribution of allophones.
(e.g., Barlow, 2003; Parrell, 2011)

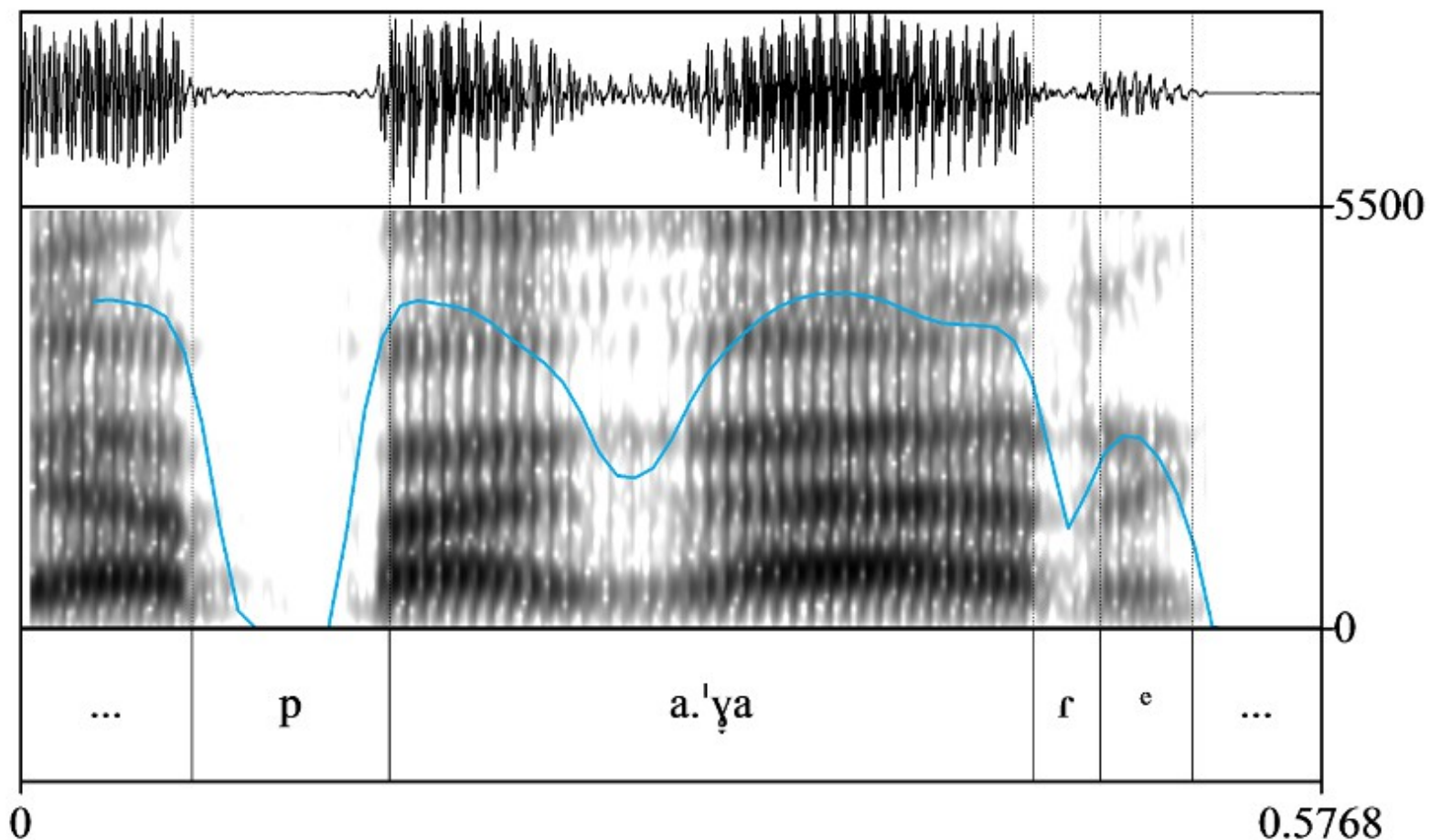
These approximants as members of a continuum.
(Simonet, Hualde & Nadeu, 2012)

Subclassification of approximant consonants: closed (CA),
open (OA) and vocalic approximants (VA).
(e.g., Martínez-Celdrán & Regueira, 2008; Pérez, 2007)

¹ In Chilean Spanish, all the variants of /d/ are always post dental.

Spanish /b, d, g/

The traditional account



Chilean Spanish word “pagar” (*to pay*), recorded in a word-list reading task. The intensity contour is shown as a continuous line (scale 30-65 dB).

Chilean Spanish /b, d, g/

Degrees of nonconformism

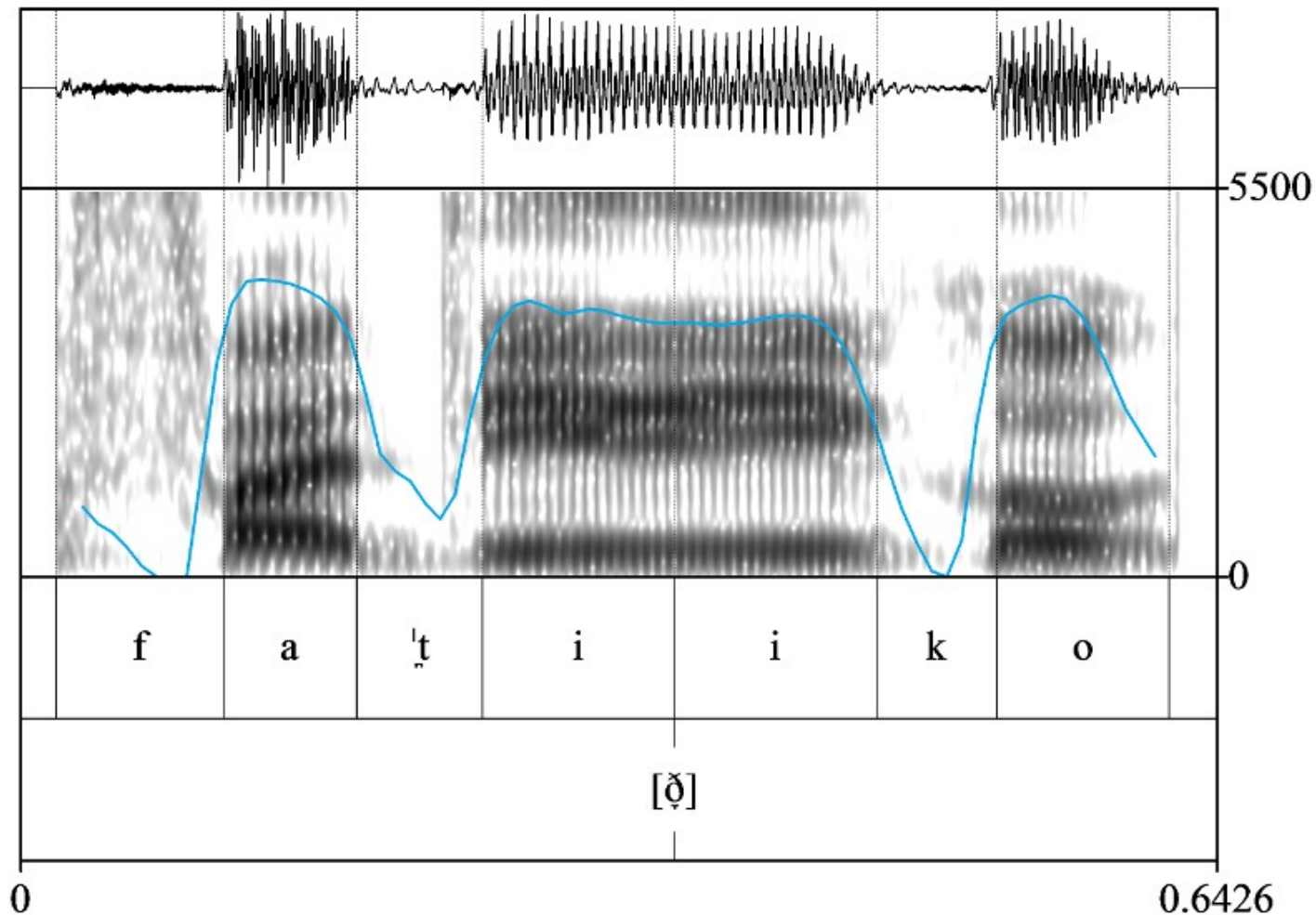
Some Spanish dialects show reinforcement of /b, d, g/.
(Carrasco, Hualde & Simonet, 2012)

Chilean Spanish presents higher degree of elision (17.1%).
(Cepeda, 1991; Pérez, 2007)

However, word recognition is not adversely affected by these reductions.

Chilean Spanish /b, d, g/

Degrees of nonconformism



Chilean Spanish word “fatídico” (fateful), recorded in a word-list reading task.
The intensity contour is shown as a continuous line (scale 30-65 dB).

The problem at hand

Are we really hearing these consonants?

Perception must be aided by the integration of acoustic and linguistic cues.

(Ernestus, Baayen & Schreuder, 2002)

Is it storing every possible combinatory form including reduced ones plausible?

More likely: listeners recover the missing information, and access full phonological form.

(Kemps, Ernestus, Schreuder & Baayen, 2004)

Study I: Production

The acoustic nature of the approximant variants of /b, d, g/ (from lenition to elision).

Study I: Production

The acoustic nature of the approximants

Purpose: to provide up-to-date acoustic measurements for Chilean Spanish /b, d, g/ approximant consonants.

Approximant consonants are quite difficult to measure.
(Turk, Nakai & Sugahara, 2006)

Most of the time it is unclear how previous studies obtained their measurements.

(e.g., Martínez Celdrán, 1984; Cepeda, 1991; Colantoni & Marinescu, 2010; Hualde, Shosted & Scarpace, 2011)

Study I: Production

The acoustic nature of the approximants

Ten adults, native speakers of Chilean Spanish, took part.

The degree of attention to speech produces different speech styles. Three tasks were used: word-lists, short texts and a semi-guided conversation.

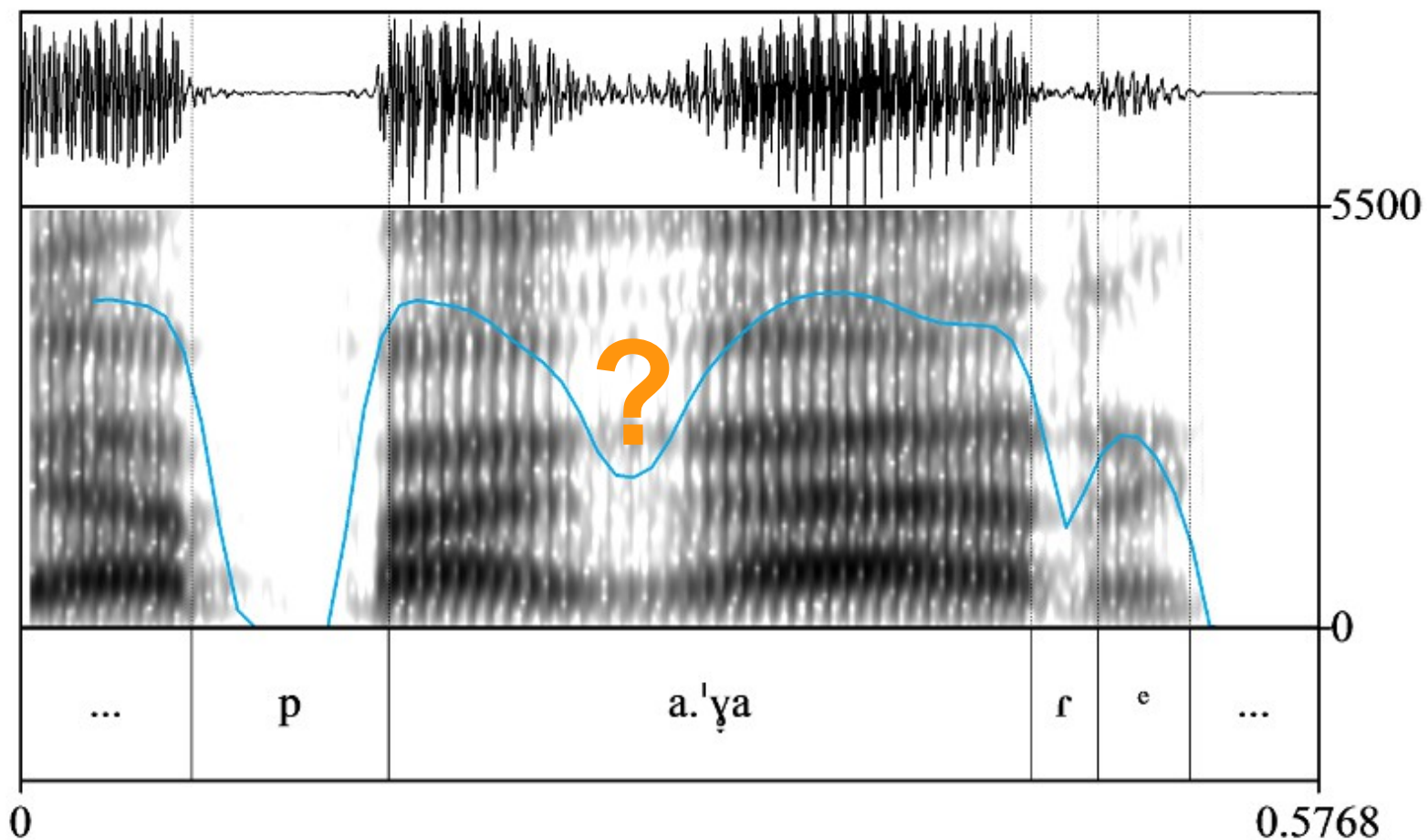
(Labov, 1972)

In the word-lists, the tokens were extracted from the LIFCACH word frequency list for Chilean Spanish and embedded in a carrier phrase.

(Sadowsky & Martínez Gamboa, 2004) || (Martínez Celdrán, 1984)

Study I: Production

Trying to measure the immeasurable



Chilean Spanish word “pagar” (*to pay*), recorded in a word-list reading task. The intensity contour is shown as a continuous line (scale 30-65 dB).

Study I: Production

Two complementary methods were used

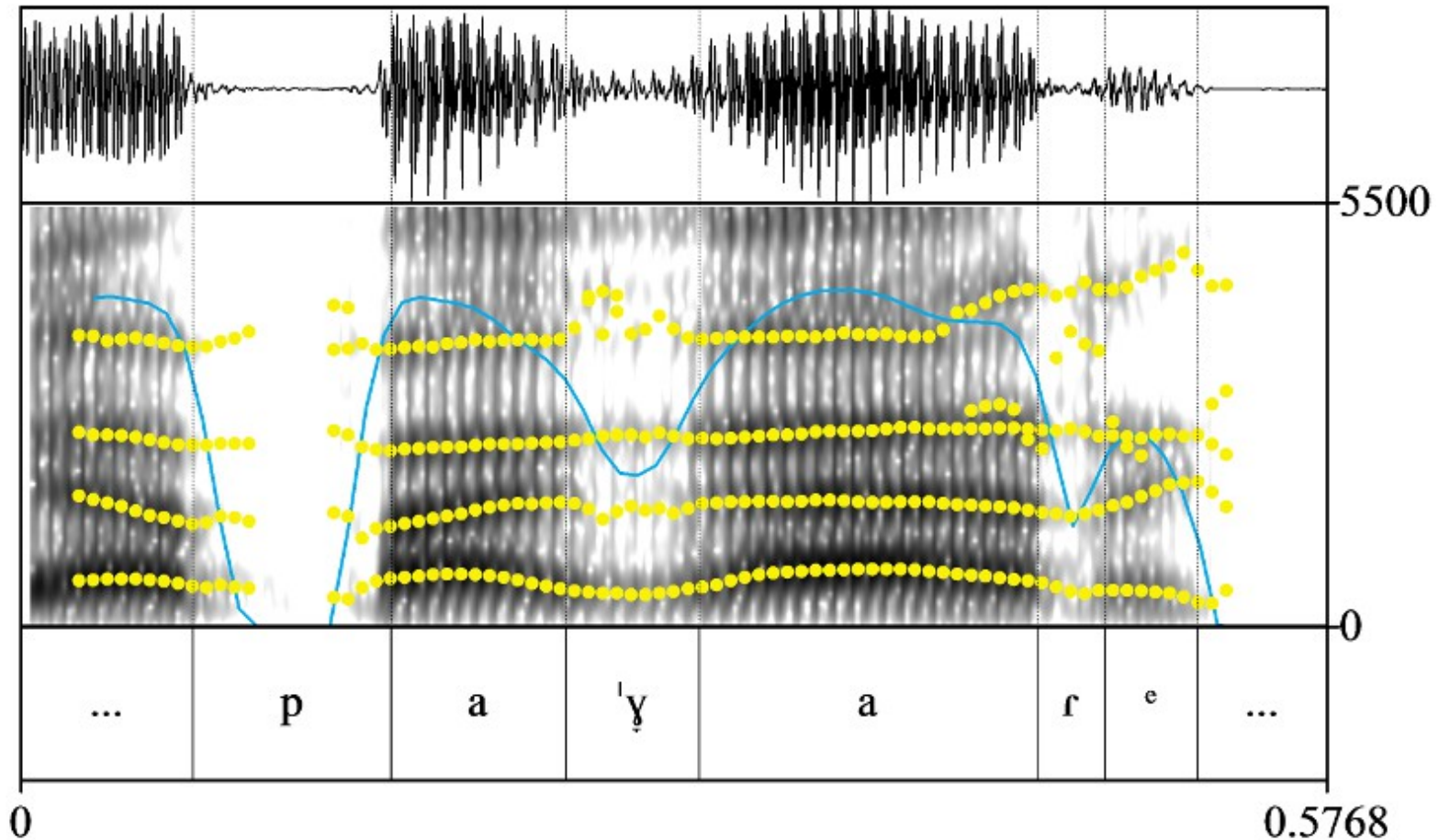
Researcher-led method: ecologically valid and linguistically relevant segmentation.

Based on acoustic patterns observable in the waveform and spectrogram; aided by intensity and formant contours. (Carrasco et al., 2012; Kingston, 2008; Martínez-Celdrán & Regueira, 2008)

Manual segmentation followed by optional auditory inspection.

Study I: Production

Two complementary methods were used



Spectrogram and waveform of [pəre] segmented following the researcher-led method. The intensity contour is shown as a continuous line (scale 30-65 dB) and the formants as speckles.

Study I: Production

Two complementary methods were used

Automated method: aimed to objectively identify relevant intensity landmarks.

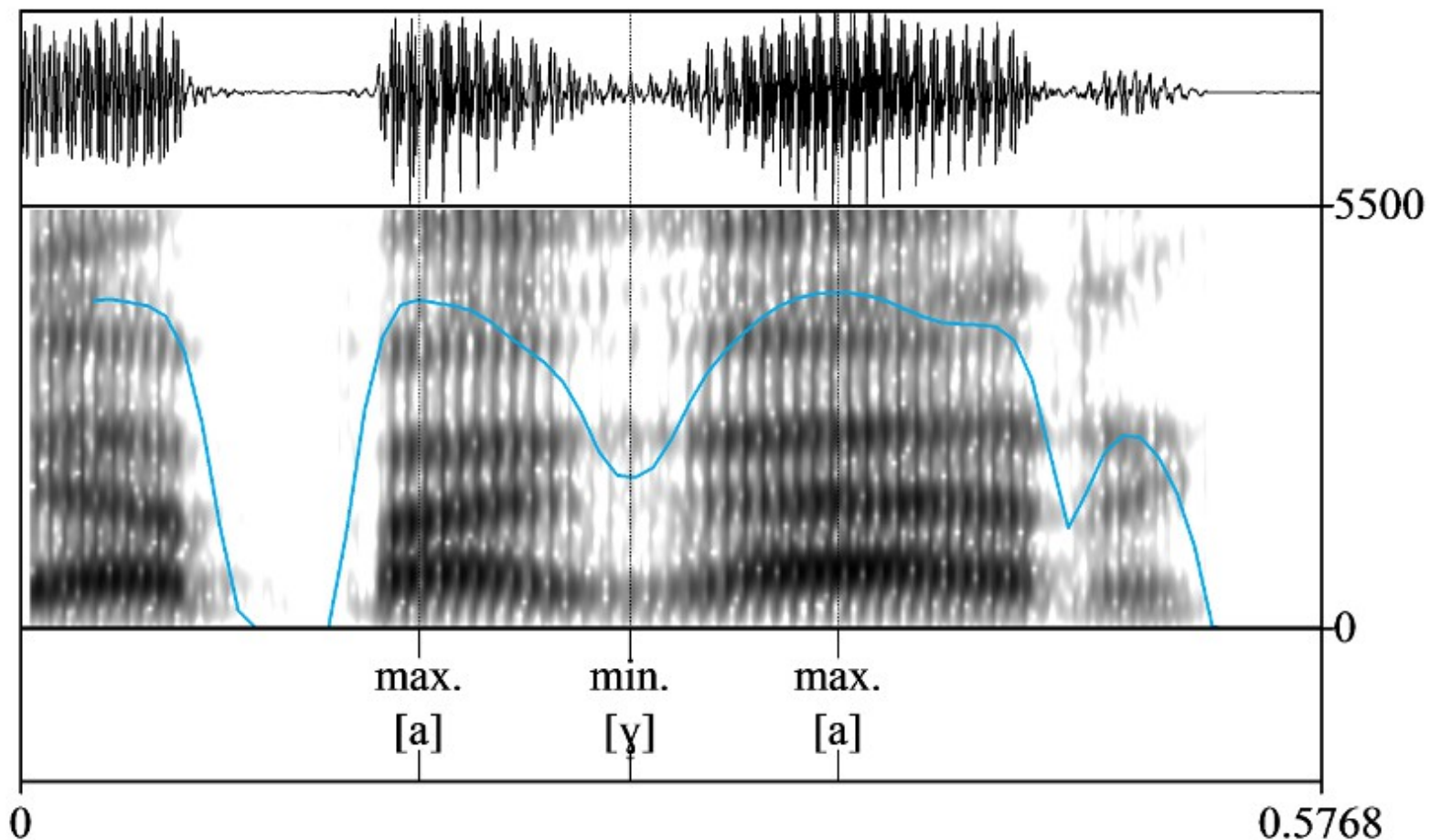
Peaks of intensity in the surrounding segments and the intensity pit in the approximant consonant are automatically identified.

This has been done before: to normalise measurements, to correlate with degrees of constriction, etc.

(Martínez-Celdrán & Regueira, 2008) || (Colantoni & Marinescu, 2010; Eddington, 2011; Hualde et al., 2011; Simonet et al., 2012; Parrell, 2010) || (Carrasco et al., 2012; Cole, Hualde & Iskarous, 1999; Kaplan, 2010).

Study I: Production

Two complementary methods were used



Intervocalic [ɣ] segmented following the automated criteria of minimums and maximums of intensity. The intensity contour is shown as a continuous line (scale 30-65 dB).

Study I: Production

Each method's reliability can be assessed

A multinomial logistic regression analysis was conducted with each data set to assess the reliability of the data at predicting a known categorical outcome variable (phoneme category).



Researcher-led method: 20 factors out of the 24 included were significant predictors of the outcome variable.



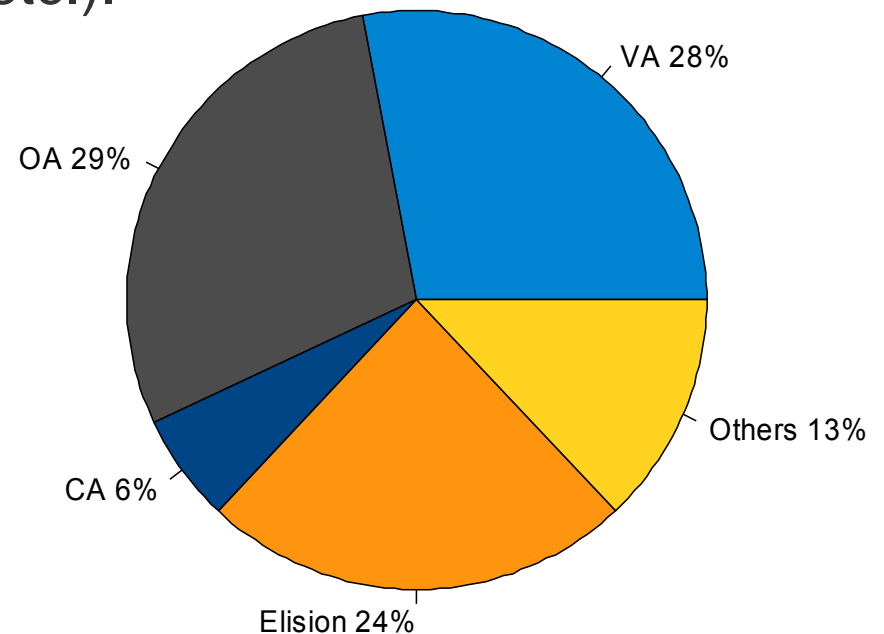
Automated method: 14 factors out of the 22 included were significant predictors of the outcome variable.

Study I: Production

General results

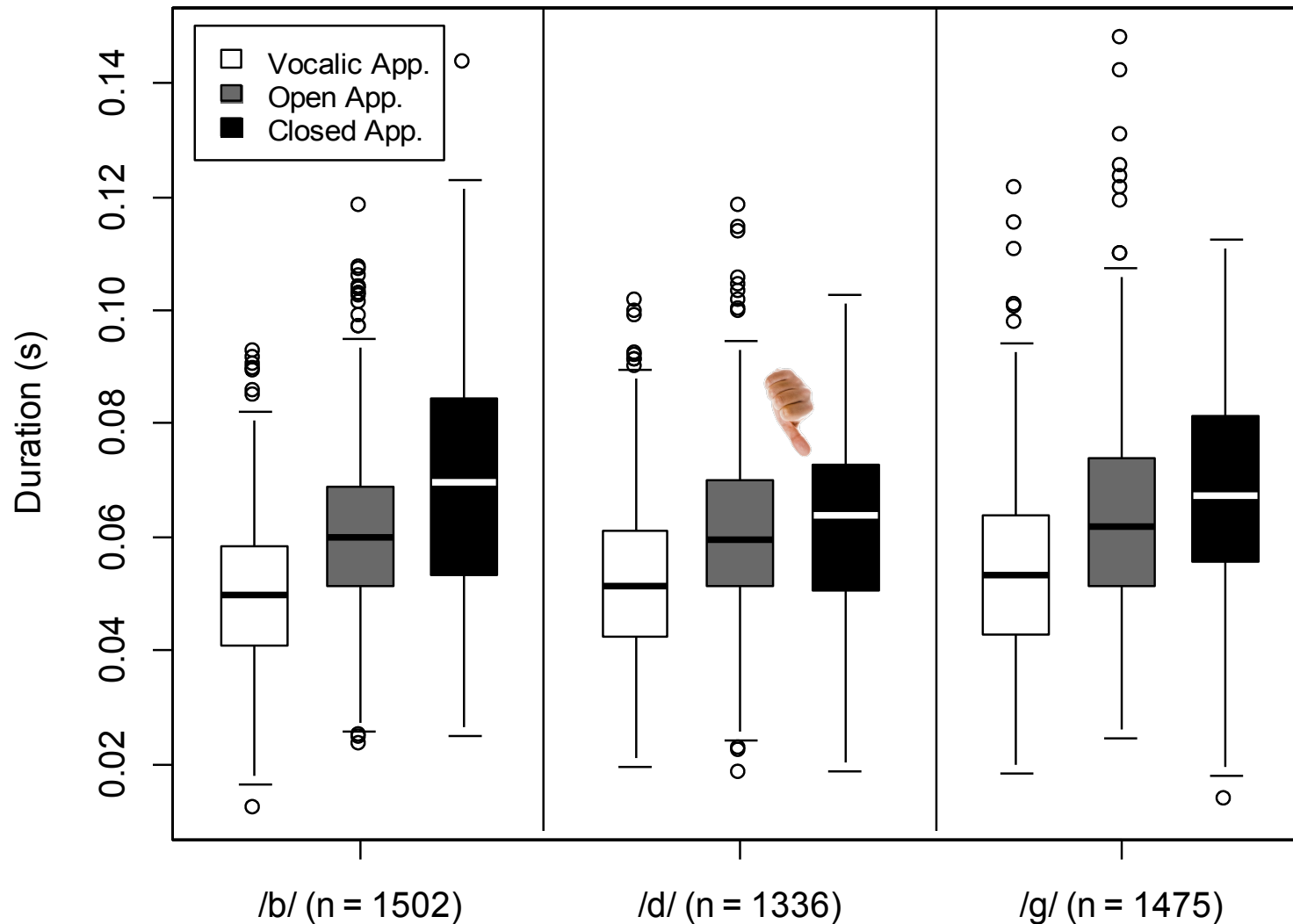
In total, 6808 tokens were examined: 32.55% corresponded to /b/, 41.36% to /d/, and 26.09% to /g/.

Regarding type of approximant, 28% of were VA, 29% OA, 6% CA, 24% elision and 13% were classified as 'other' (e.g., fricative, occlusive, etc.).



Study I: Production

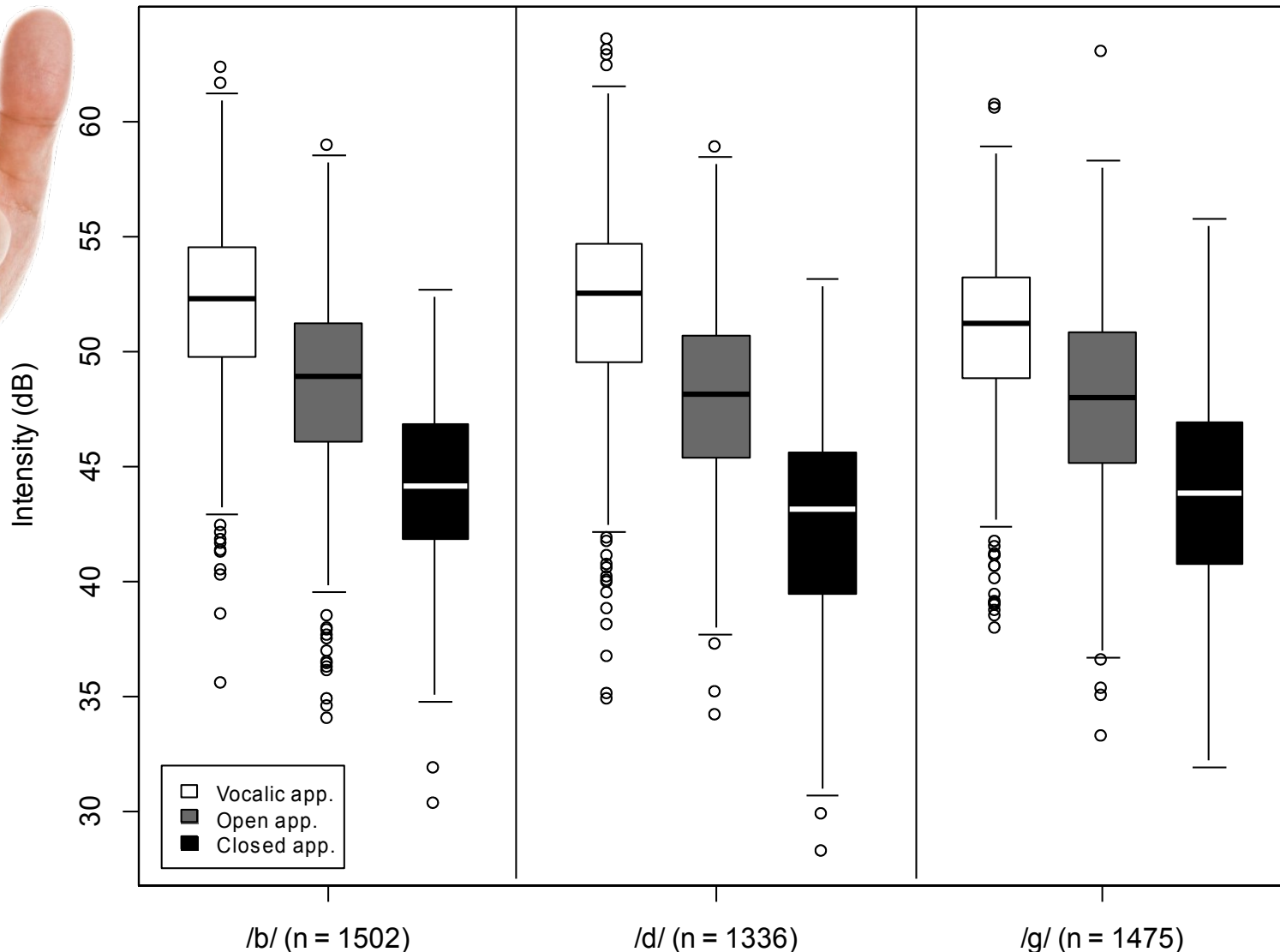
Differences exist from lenition to elision



Duration values for each approximant variant of /b/, /d/ and /g/. An increase of duration is observed within each phoneme category as the variant becomes more closed.

Study I: Production

Differences exist from lenition to elision

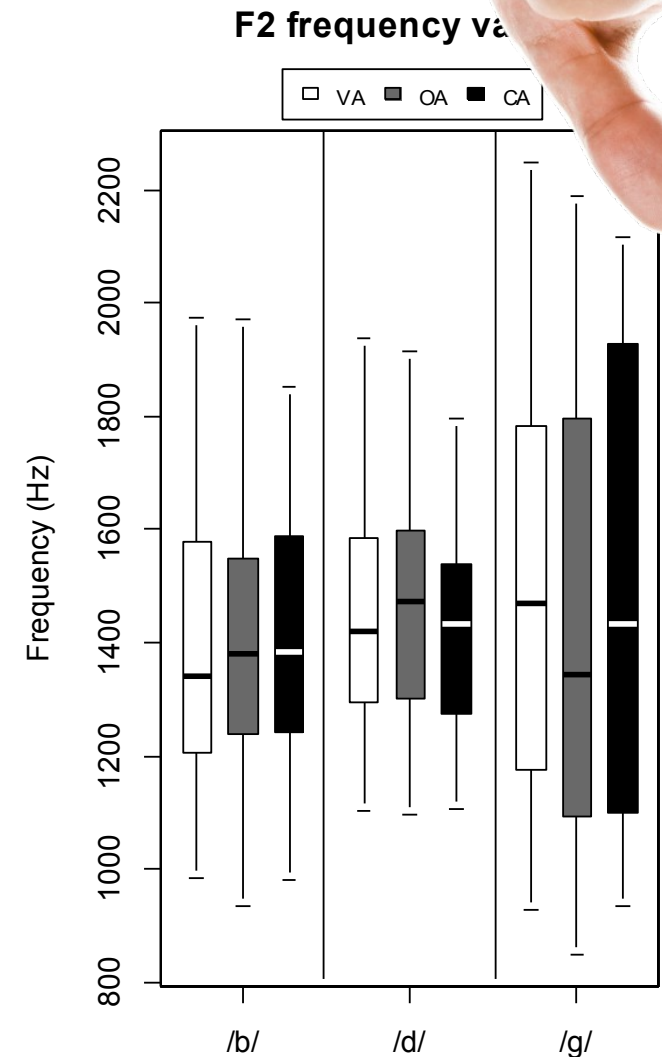
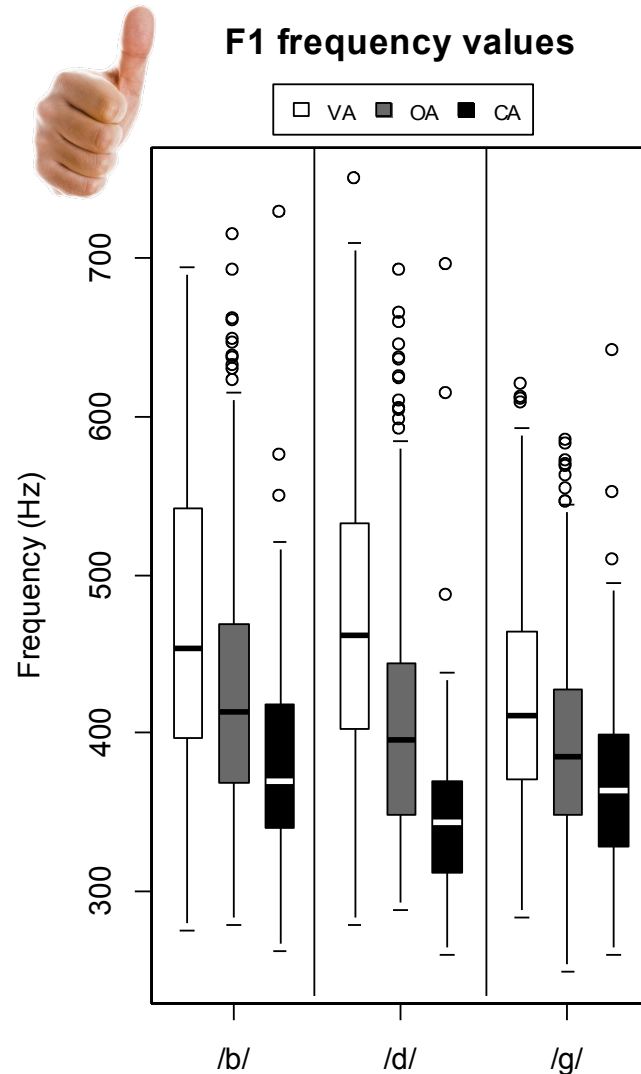


Intensity values for each approximant variant of /b/, /d/ and /g/. A decrease in intensity is observed within each phoneme category as the variants become more closed.

Study I: Production

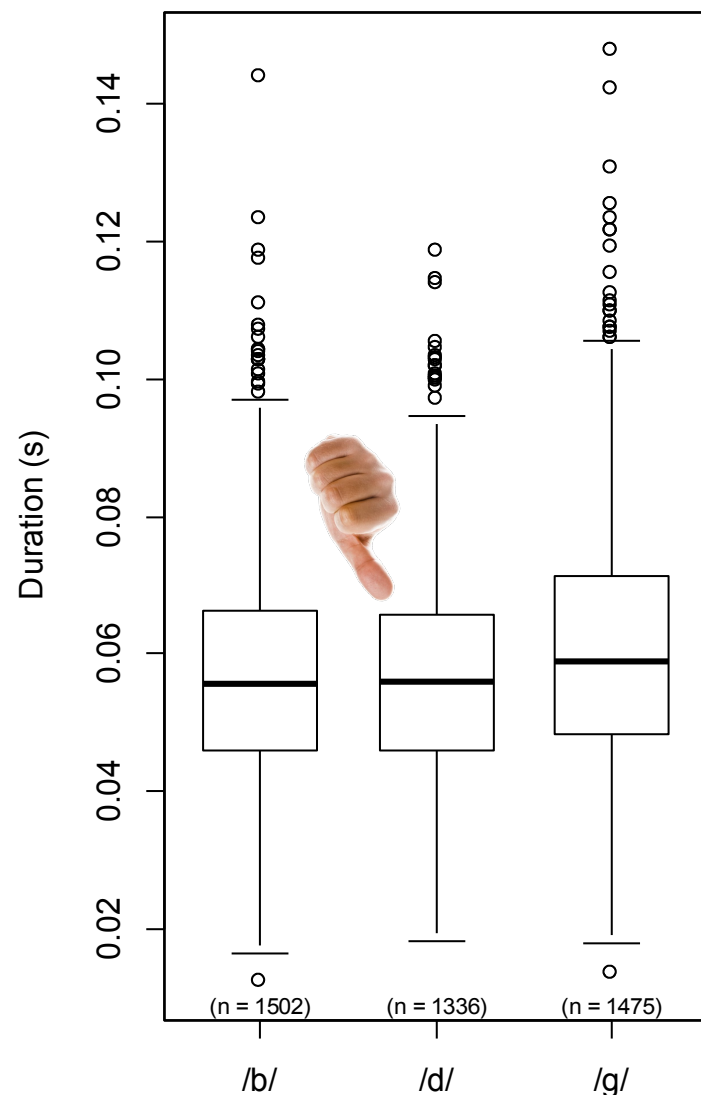
Differences exist from lenition to elision

Normalised and scaled F1 and F2 values for each approximant variant of /b/, /d/ and /g/. A decrease in F1 can be observed for more closed variants within each phoneme category. A higher similarity between variants within phoneme category is observed for F2.



Study I: Production

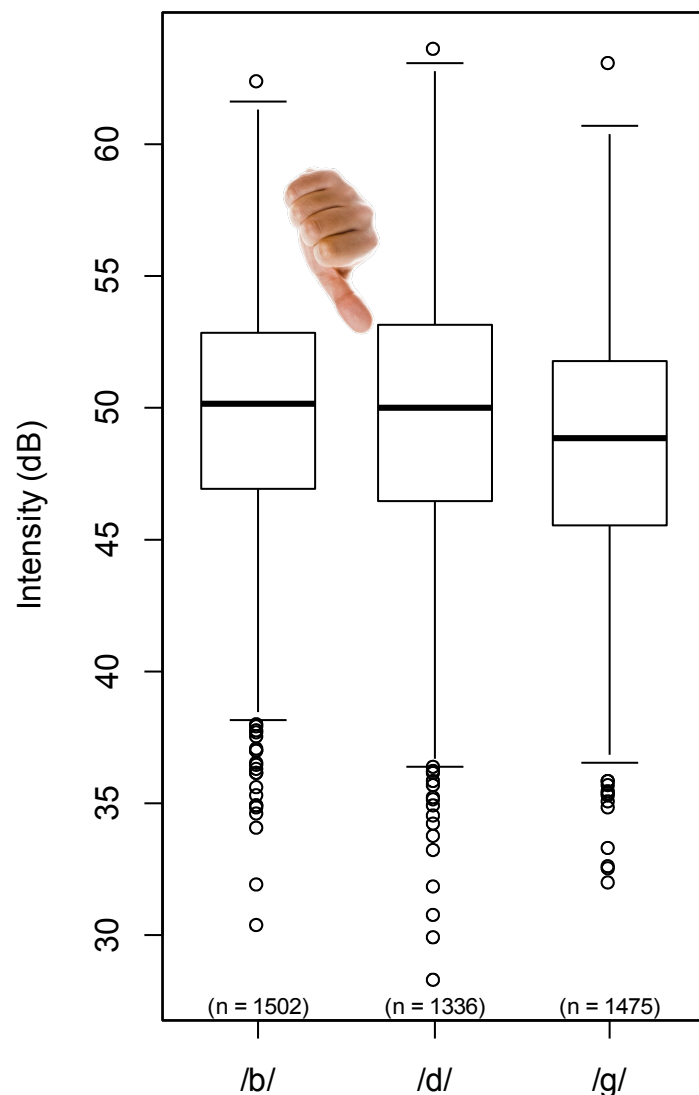
/b, d, g/ do not seem that different, though...



Duration values of the approximant variants of /b/, /d/ and /g/. Each phoneme category includes the duration values for VA, OA and CA.

Study I: Production

/b, d, g/ do not seem that different, though...

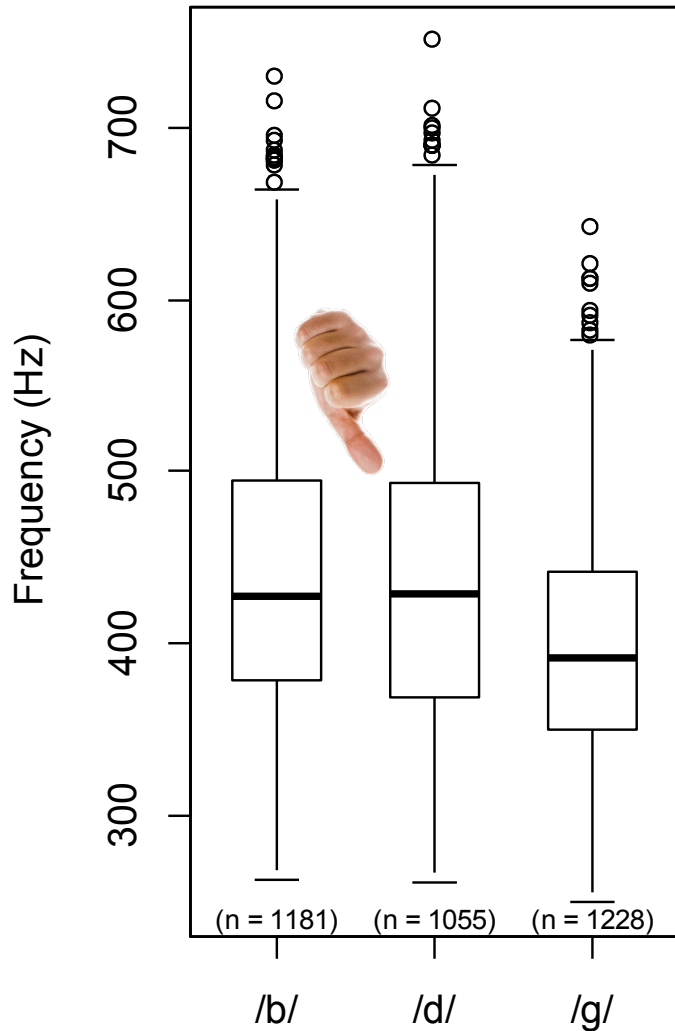


Intensity values of the approximant variants of /b/, /d/ and /g/. Each phoneme includes the intensity values for VA, OA and CA.

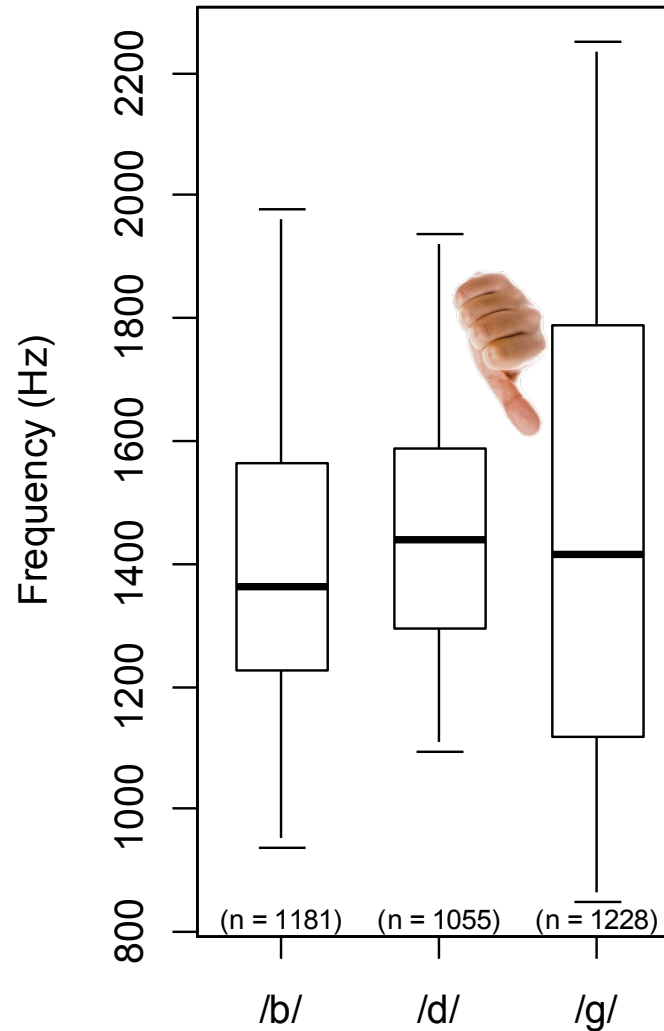
Study I: Production

/b, d, g/ do not seem that different, though...

F1 frequency values



F2 frequency values



Normalised and scaled F1 and F2 values of the approximant variants of /b/, /d/ and /g/. Each phoneme category includes the values for VA, OA and CA.

Study I: Production

Can listeners rely solely on acoustic cues?

Elision is particularly frequent in Chilean Spanish, even more than previously reported.

(Pérez, 2007)

Highly lenited forms (VA) are also very frequent. When combined with elision they reach between 45% – 55%.

This evidence suggests that the perception of /b, d, g/ is likely aided by non-segmental cues, particularly given what the acoustic data shows about /b/ vs. /d/.

Study I: Production

Can listeners rely solely on acoustic cues?

The acoustic differences between /b/ and /d/ might be more context-dependent.

All the acoustic variables (but F2) are indicative of degree of lenition.

Closed variants are longer, less intense and have lower F1 values than open variants.

Study II: Perception

(Ongoing)

Cue weighting of acoustic and linguistic variables in the perception of the approximant variants of /b, d, g/.

Study II: Perception

Cue weighting of acoustic variables

Access to the lexical level is mediated by the information conveyed in the speech signal.

This information is coded through acoustic cues, which stand for phonetic categories.

(Chandrasekaran, Sampath & Wong, 2010)

Acoustic variables that cue a segmental or suprasegmental phenomenon can be determined experimentally.

Study II: Perception

Cue weighting of acoustic variables

Continua ranging from elision to intervocalic approximants were constructed using Klatt copy synthesis in Praat.
(Klatt, 1980) || (Weenink, 2009)

The continua were built from 48 good examples of VCV sections containing approximant consonants from /b, d, g/.

Within /b, d, g/, each continuum contains a unique combination of duration, intensity, and formants.

Study II: Perception

How well can we distinguish /b, d, g/?

For each approximant end of the continuum, there is the natural, the synthesized and the manipulated stimuli.

An online identification experiment was conducted with the three types of stimuli.

The idea was to verify the identifiability of the stimuli and to determine how it is affected by a decrease in acoustic information.

In total, 29 adult native Chilean Spanish speakers participated in the experiment (10 male, 19 female).



Study II: Perception

How well can we distinguish /b, d, g/?

Original stimuli: 82.76%. Copy-synthesized: 71.12%. Manipulated stimuli: 62.28%.

Response	Reference (%)								
	Original			Copy-synthesized			Manipulated		
	/b/	/d/	/g/	/b/	/d/	/g/	/b/	/d/	/g/
/b/	81.47	22.07	6.69	68.75	30.11	7.30	67.46	29.20	24.34
/d/	4.09	75.86	3.25	4.96	54.02	4.26	14.44	58.85	15.21
/g/	14.44	2.07	90.06	26.29	15.86	88.44	18.10	11.95	60.45

A mix-model analysis showed a significant effect of type of stimuli on the identifiability of /b, d, g/ ($F(2) = 124.279$, $p > .001$). A significant effect of phoneme ($F(2) = 81.527$, $p > .001$) and a significant interaction between type of stimuli and phoneme ($F(4) = 84.754$, $p > .001$).

Future directions

Exploring perception and integrating results with production.

Study II: Perception

Cue weighting of acoustic variables

The results of the production study suggest that no variable is, by itself, a good correlate for /b/, /d/ and /g/.

It is expected that smaller values of each acoustic variable are needed to perceive a consonant when the acoustic variables are combined.

Probably, the weight of particular variables will be phoneme-dependent (e.g., /d/).

The results from the identification experiment suggest that /b/ should require less acoustic information to be perceived, followed by /g/.

Study II: Perception

Cue weighting of linguistic variables

Aim: to determine how certain categorical non-segmental linguistic variables (stress, morphology and word status) cue the perception of approximant consonants.

Does the weight from acoustic cues shift to other type of linguistic cues when lenition and elision exist?

A continuum of variants from elision to OA for /b/, /d/ and /g/ will be inserted in pairs of synthesized structures that have or lack stress, morphology [sic], or word status.

The differences observed in the perceptual boundaries between the structures with or without these variables will allow to determine whether they can cue for approximant consonants independently of other acoustic cues.

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