Recovery and lexical effects in the perception of lenited (and missing) Spanish approximants

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Introduction

The scope of lenition
Introduction

Lenition can be defined as reduction process that often results in deletion.
(Escure, 1977)

Some examples: spirantization of stops, degemination, debuccalization and deletion.
(Kirchner, 1998; Kingston, 2008)

Lenition is very common in connected/informal speech.
(e.g., Ingram, 1989; Fosler-Lussier & Morgan, 1999; Johnson 2004; Torreira & Ernestus, 2011)

What do listeners do about it?

Coping with lenition
Introduction

Listeners often recover lenited units effortlessly, provided that complementary cues are available.
(e.g., Liberman, 1963; Samuel, 1981; Samuel, 1987; Samuel, 1996; Mitterer & Ernestus, 2006)

For instance, listeners are able to recover missing segments from highly reduced forms, but only when presented in a semantic and syntactic context.
(Kemps et al., 2004; see also Ernestus et al., 2002)

> Dutch derivational suffix “-(e)lijk” [(ə)lək], often reduced to [ək] or [k] in spontaneous speech. Full recovery of [l] when additional cues are presented.

When does recovery begin?
Introduction

Listeners recover units if sufficient additional cues are presented: categorical increases in the amount of available cues have already showed that.
(Kemps et al., 2004; see also Ernestus et al., 2002)

But, what acoustic evidence is required for listeners to start reporting recovery?

Is it possible to observe how recovery unfolds instead of just determining its presence or absence?

Our proposal
Introduction

Limitations from previous studies: in most studies, recovery is observed after categorical increments of available cues.
(e.g., Ernestus et al., 2002)

Our proposal: investigating recovery by using continua from presence of Spanish spirant approximants[1] to absence.

> For instance, a continuum from callado (“silent”) [ka.ˈʝ̞a.ð̞o] to Callao (“Callao”, the Peruvian port) [ka.ˈʝ̞a.o].

These continua will be presented in several conditions varying in the amount of acoustic and semantic cues available to listeners, and in three perception tasks.

[1] More details about approximants below.

Aims
Introduction

Observe whether listeners recover underlying approximants under some conditions.

Explore whether lexical effects (e.g., Ganong, 1980) seem to affect speech perception of our continua.

Explore whether any of this is modulated by what listeners experience as normal in the production domain.

Chilean Spanish approximants

Testing ground

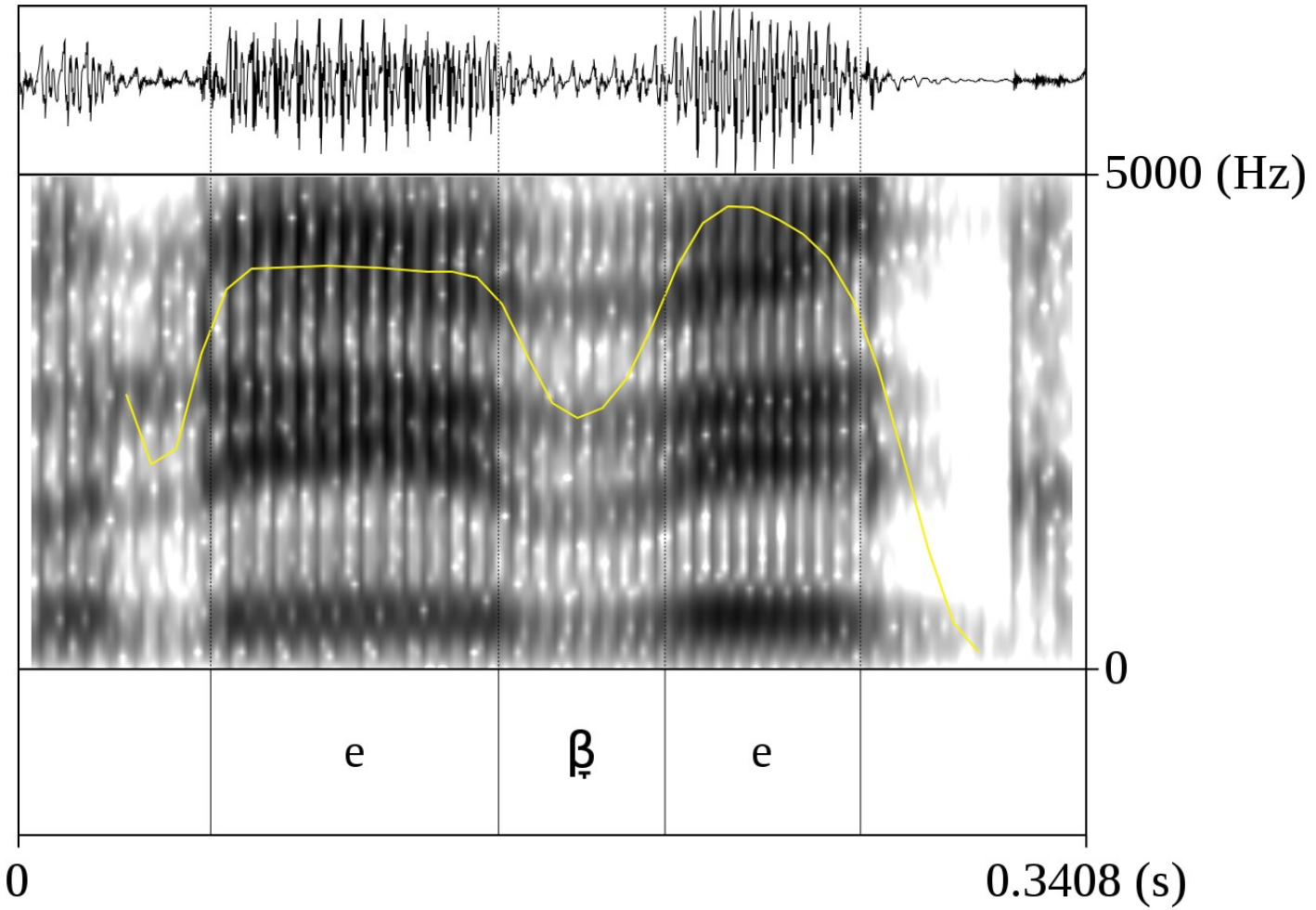
Traditional account for /b d g/ in Spanish: plosives are found after pause, nasals and /l/ in the case of /d/; elsewhere, they are articulated as the approximants [β̞ ð̞ ɣ̞].
(Hualde, 2005)

A natural continuum of variation from approximants to elided variants exists for the three places of articulation.
(e.g., Cole et al., 1999; Hualde, Simonet, Shosted, & Nadeu, 2010; Hualde, Shosted, & Scarpace, 2011; Carrasco et al., 2012)

Chilean Spanish differs in some regards from this general trend: is particularly lenited, and differences exist between /b/, /d/ and /g/ regarding how they are affected by lenition (extremes: /d/ and /g/),
(e.g., Pérez, 2007)

Chilean Spanish approximants

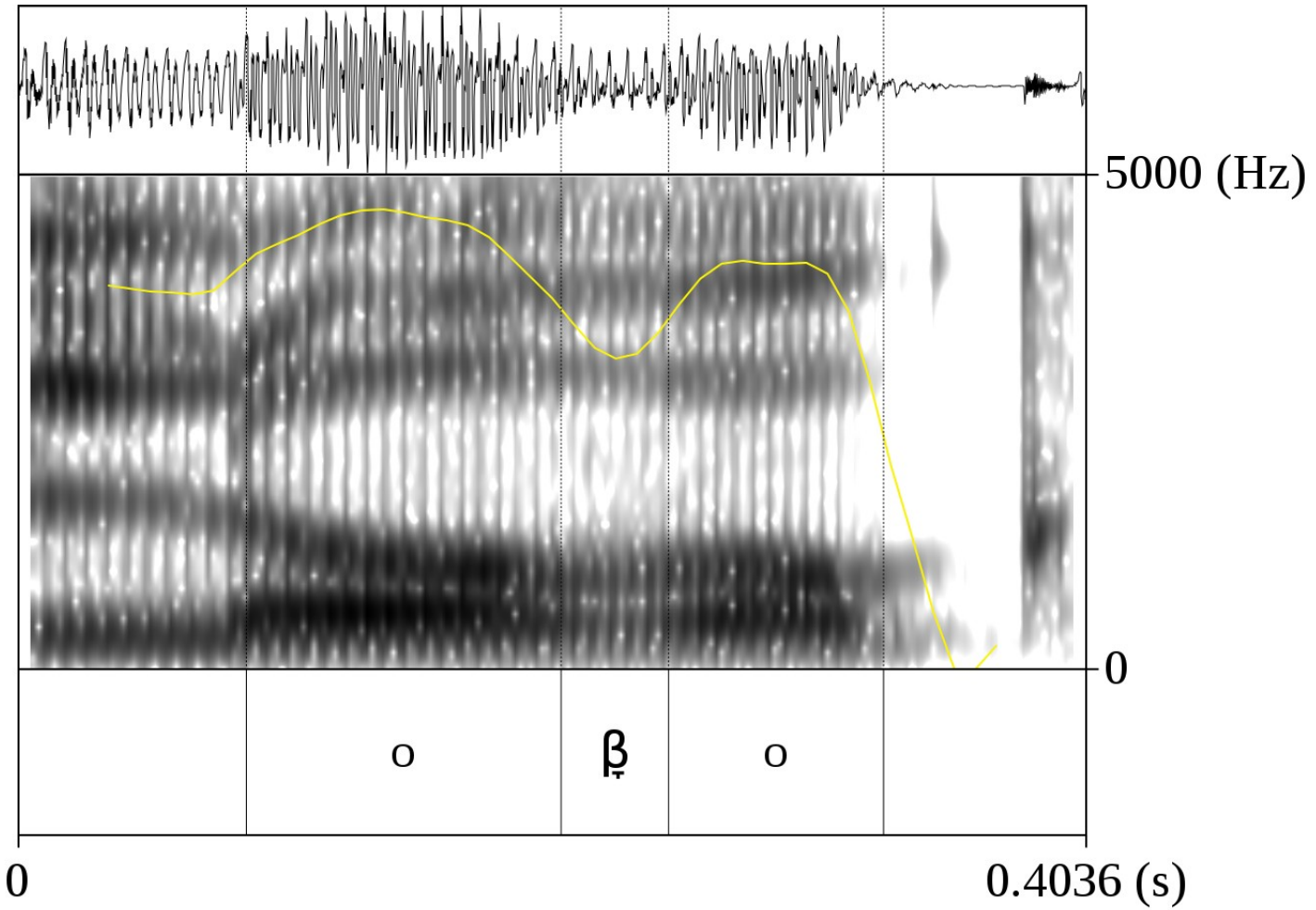
Testing ground



Example of an open approximant from /b/ for the word ['bɾe.β̞e] (breve, “brief”).

Chilean Spanish approximants

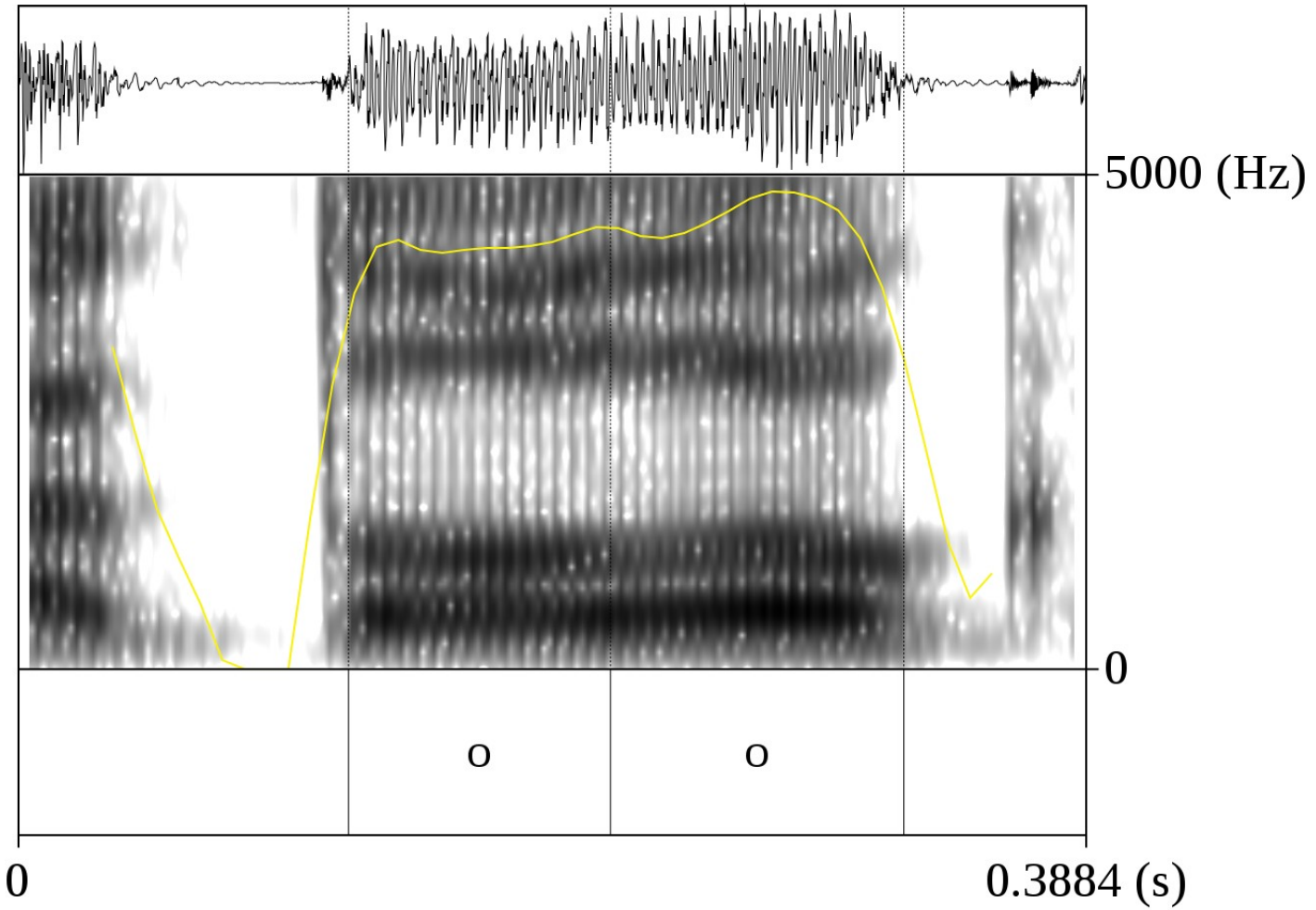
Testing ground



Example of a vocalic approximant from /b/ for the word ['lo.β̞o] (lobo, “wolf”).

Chilean Spanish approximants

Testing ground



Example of an elided variant from /d/ for the word ['to.ð̞o] (todo, “all”).

General methods

General methods

Stimuli

Minimal pairs from consonant presence to absence were selected.

Lexical frequency was homogenized within pairs, to control for lexical effects on categorical perception.

Semantic associates were found for each pair member, to use in semantic priming conditions (their relative strength comparable, as judged by native Chilean speakers).

The minimal pairs were recorded, and then segmented manually.

General methods
Stimuli

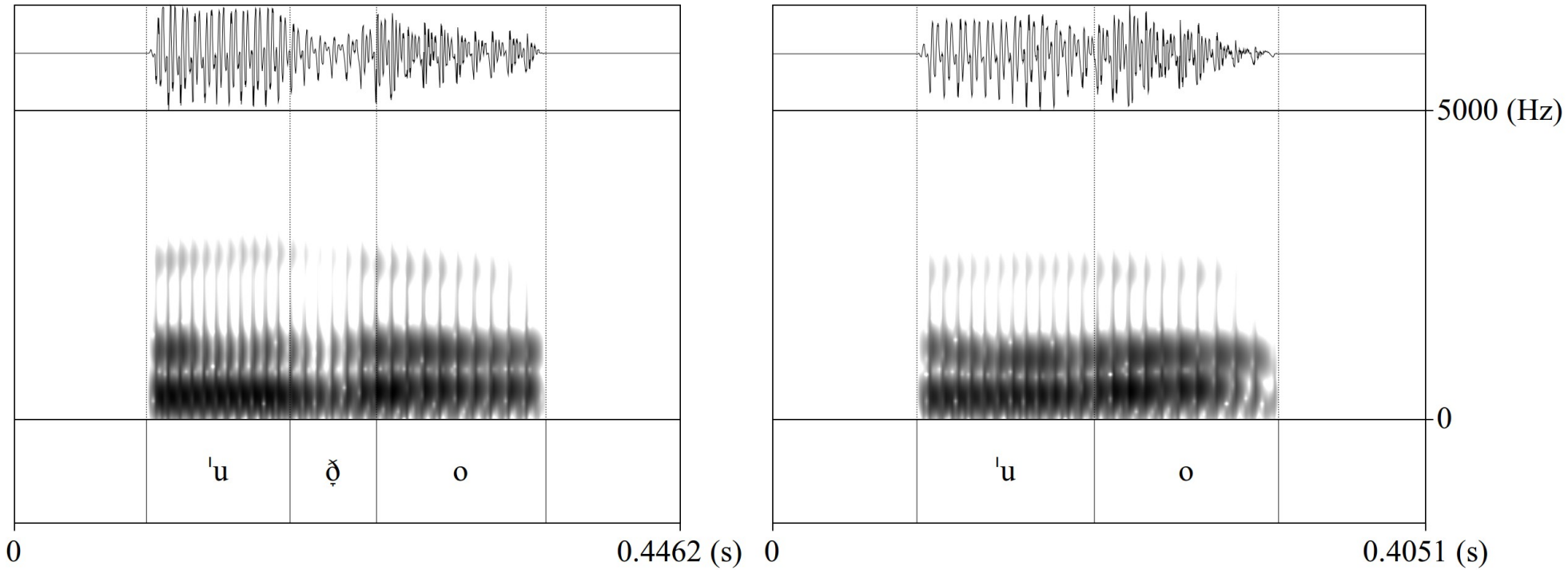
An acoustic model was built for the VCV section from the full approximant end (e.g., “dudo”), and for the VV section of the elided variant end (e.g., dúo).

Variables included (besides duration): fundamental frequency, intensity, formants from F1 to F3 and bandwidths from F1 to F3.

KlattGrid objects were created and populated for the two endpoints, and for 8 equally-distanced intermediate steps. The resulting 10 steps were synthesized using Klatt synthesis.
(Klatt & Klatt, 1990; Weenink, 2009)

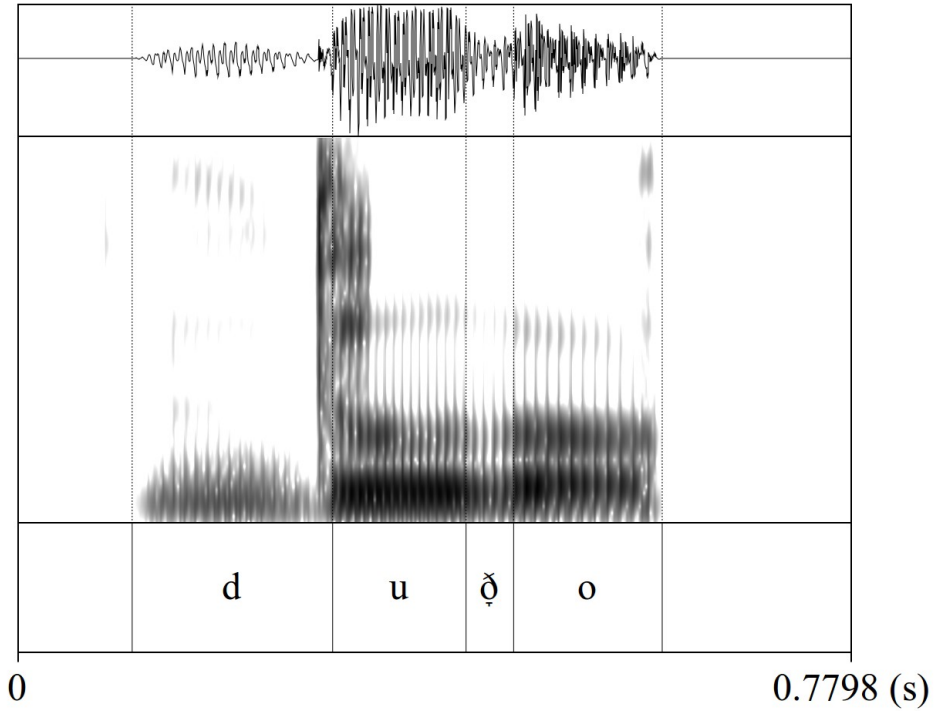
General methods

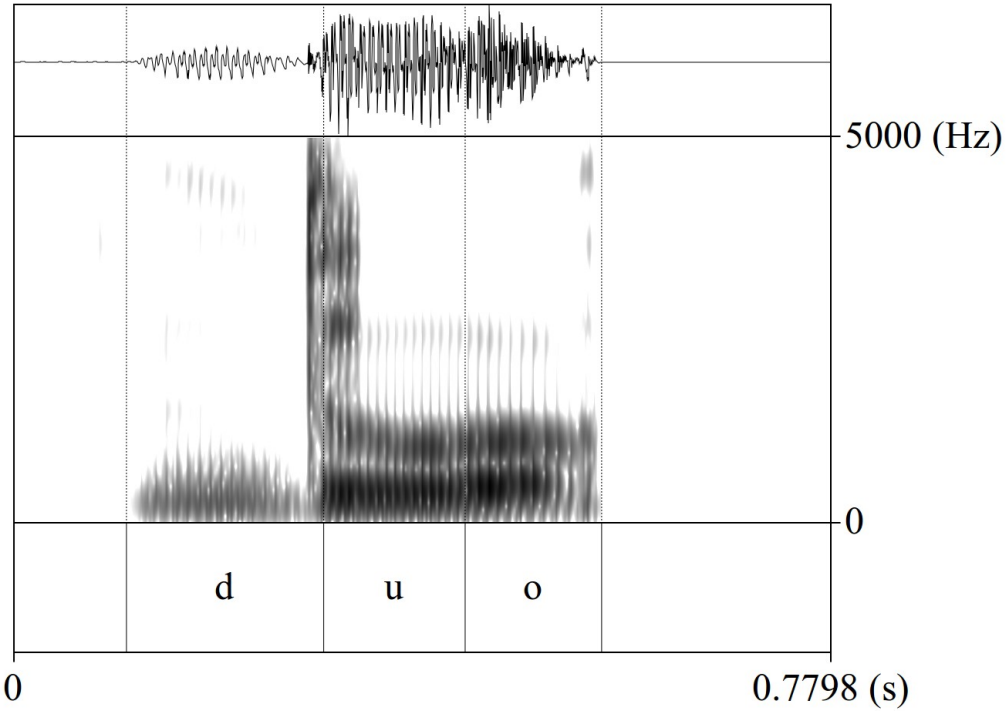
Segmental condition continuum



General methods

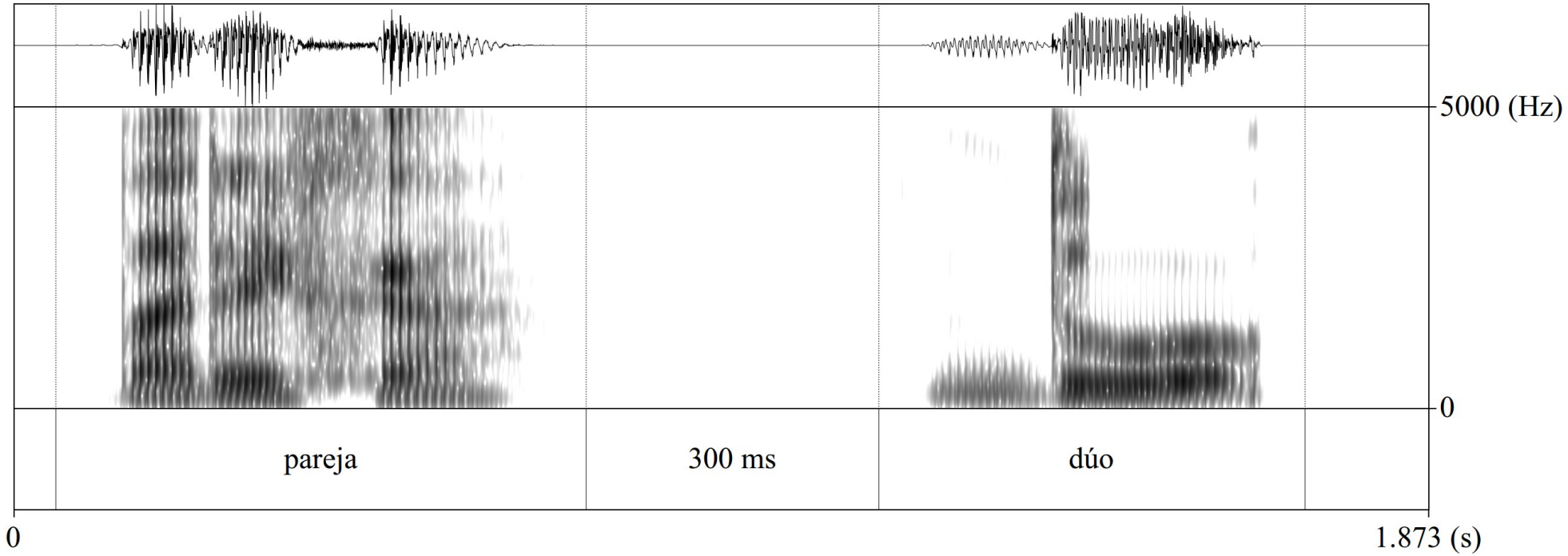
Word-level condition continuum





General methods

Semantic priming condition: elided variant



Experiment 1: Phoneme monitoring

Phoneme monitoring: methods

Experiment 1

Modified version of the phoneme monitoring task (no RT).

Participants: 61 native monolingual listeners.

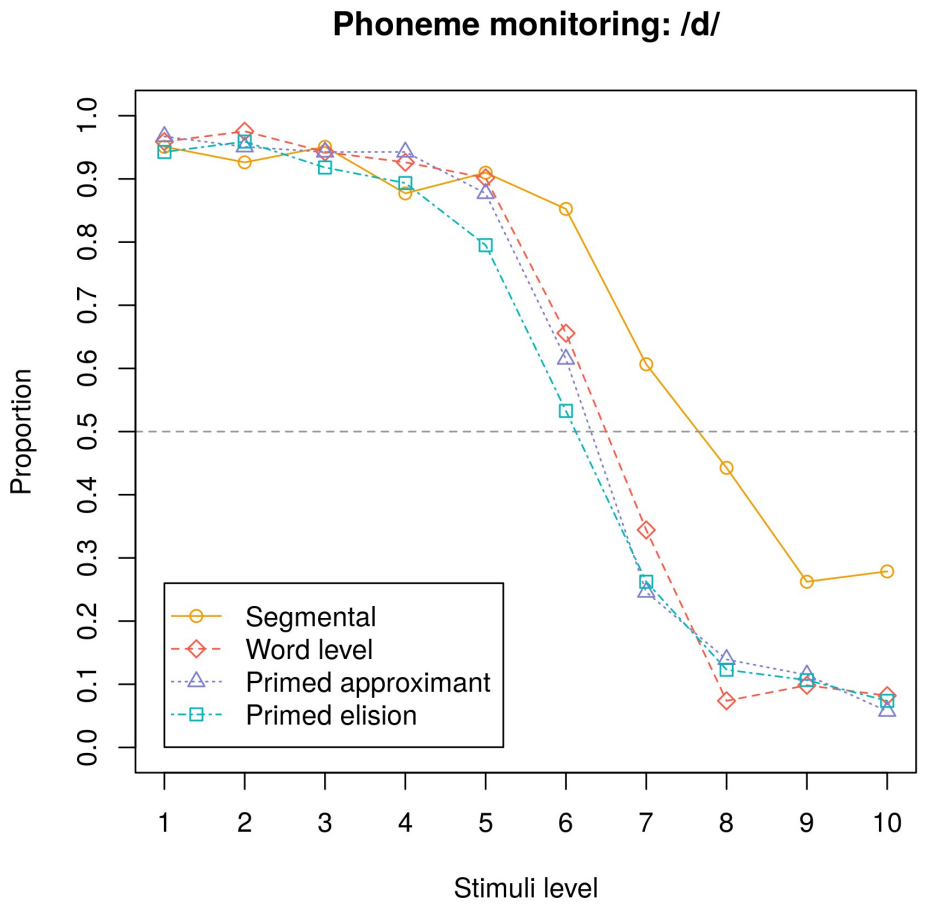
Stimuli: synthetic 10-step continua from open approximants to elided variants (Klatt synthesis), modelled after natural examples.

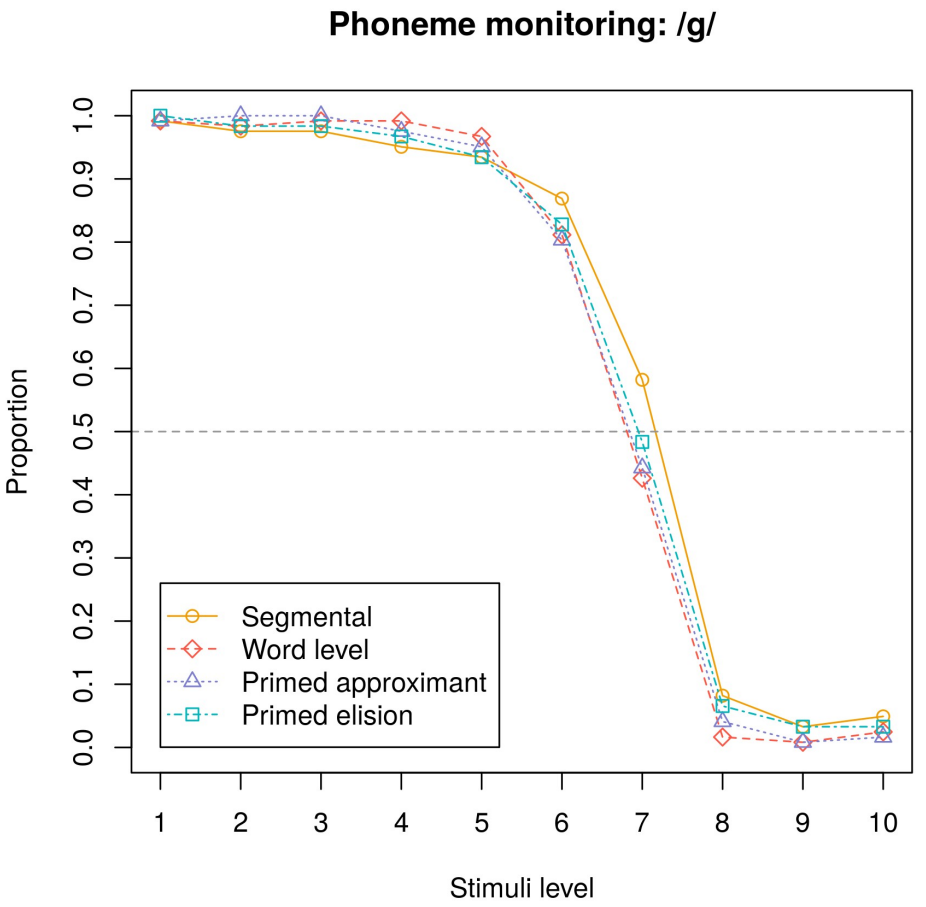
For each continuum, the endpoints constitute Spanish words, with similar lexical frequencies (as in the callado vs. Callao example).

Conditions: segmental, word-level, primed approximant and primed elided.

Phoneme monitoring: results

Experiment 1





Generalized linear mixed models analyses (GLMM): significant main effect of stimulus level, significant main effect of condition and interaction only for /d/. Wald z post-hoc analyses: segmental condition significantly different from all others only for /d/.

Experiment 2: Identification

Identification: methods

Experiment 2

Identification task: mandatory lexical processing due to labels from response categories.

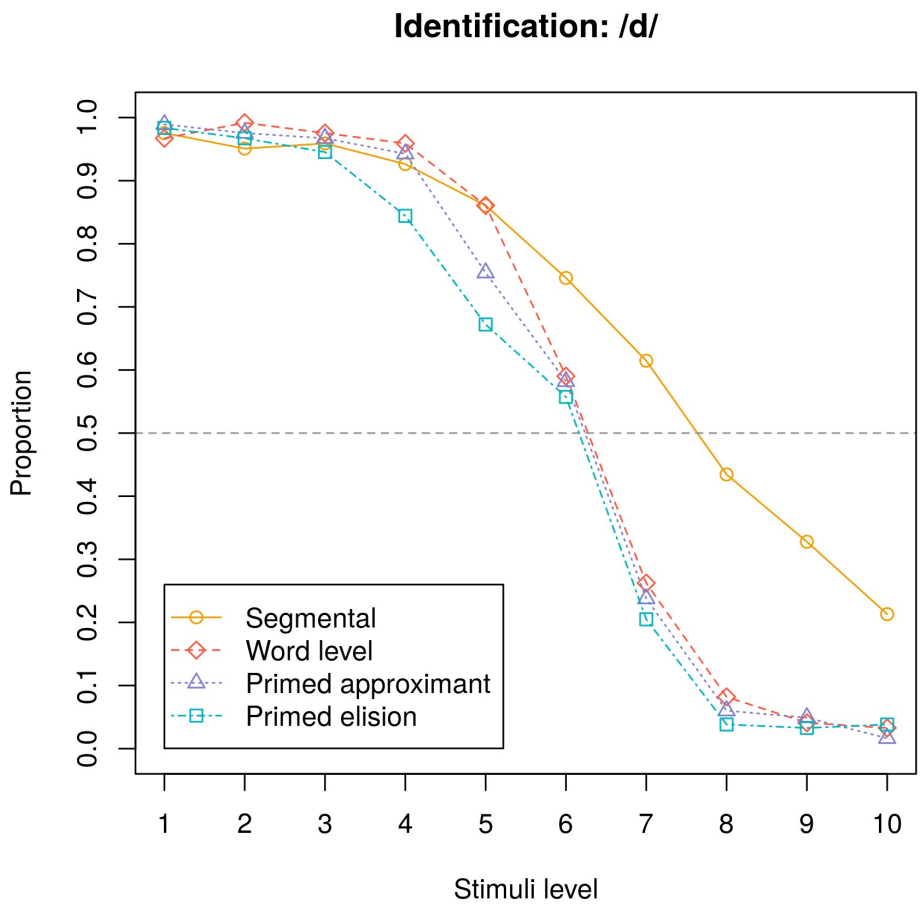
Participants: same as above.

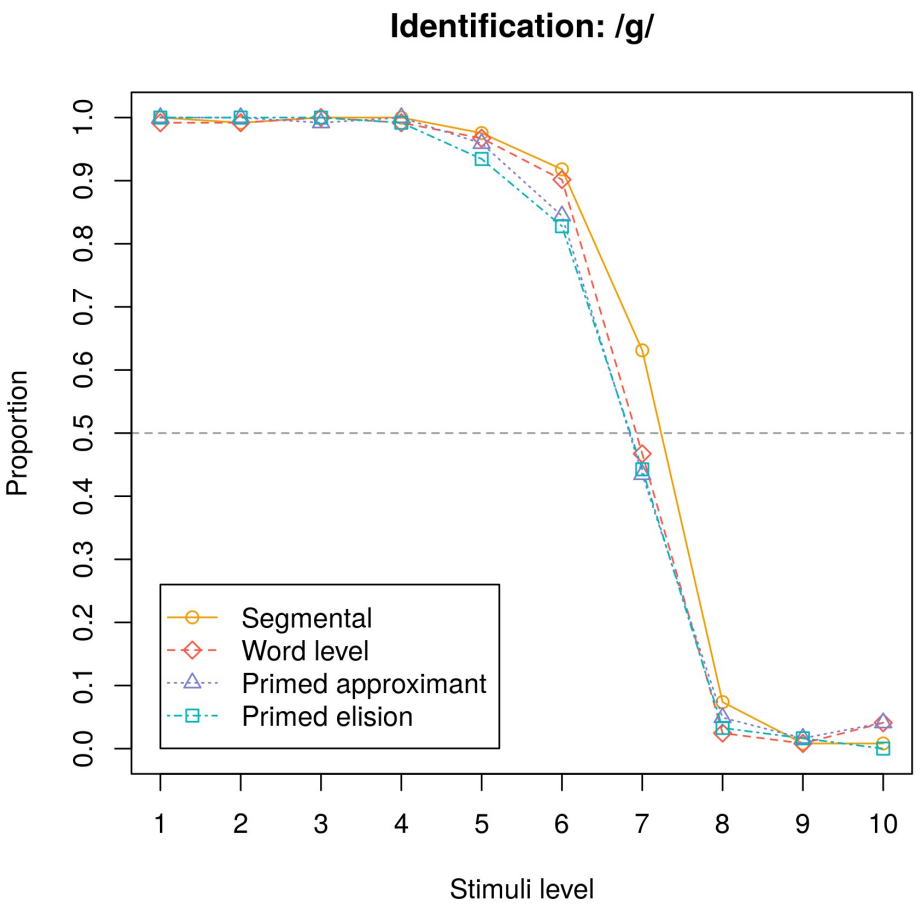
Stimuli: same as above.

Conditions: same as above.

Identification: results

Experiment 2





GLMM: significant main effect of stimulus level and condition for both consonants, significant interaction only for /d/. Wald z post-hoc analyses: segmental condition significantly different from all others, for both consonants.

Experiment 3: Discrimination

Discrimination: methods

Experiment 3

Discrimination task, aiming to measure sensitivity to stimuli differences.

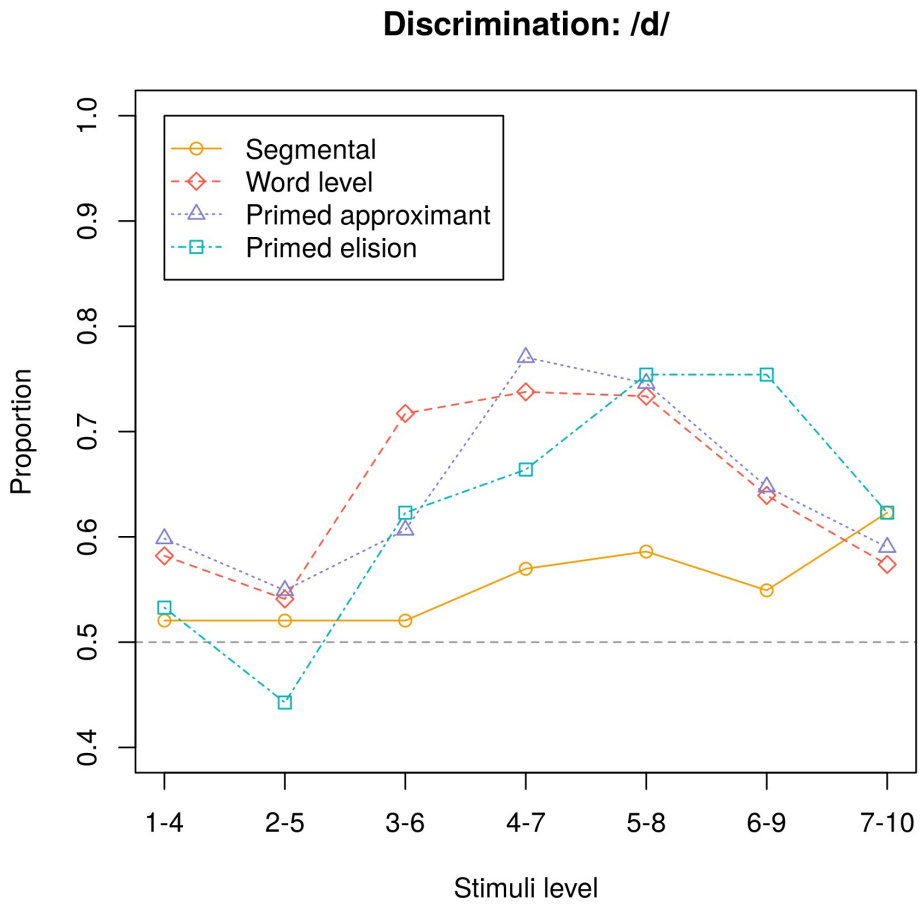
Participants: same as above.

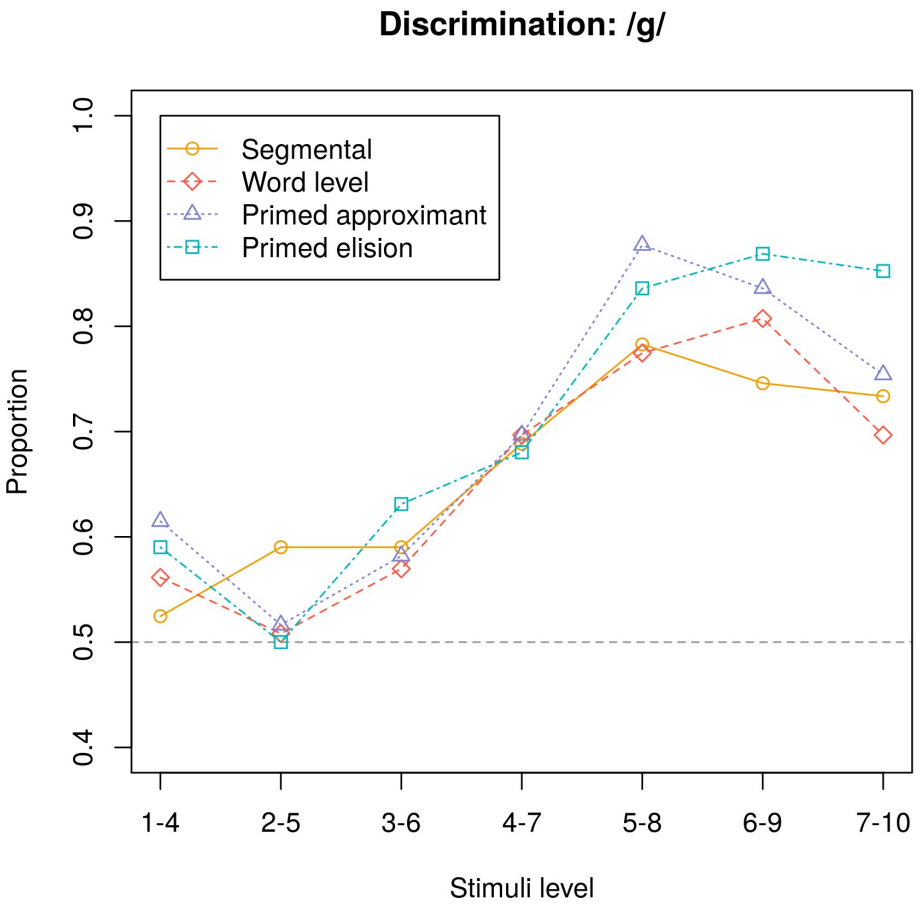
Stimuli: stimuli was presented in an ABX format (all permutations); each 10 step continuum was converted into 7 discrimination pairs with a 2-step inter-stimulus distance.

Conditions: same as above.

Discrimination: results

Experiment 3





GLMM: significant main effect of stimulus level for both consonants; significant main effect of condition for /d/; significant interaction of stimulus level and condition for both.

Experiment 4: Follow-up semantic priming

Follow-up semantic priming: methods

Experiment 4

Modified version of the phoneme monitoring task (no RT).

Participants: 30 native monolingual listeners.

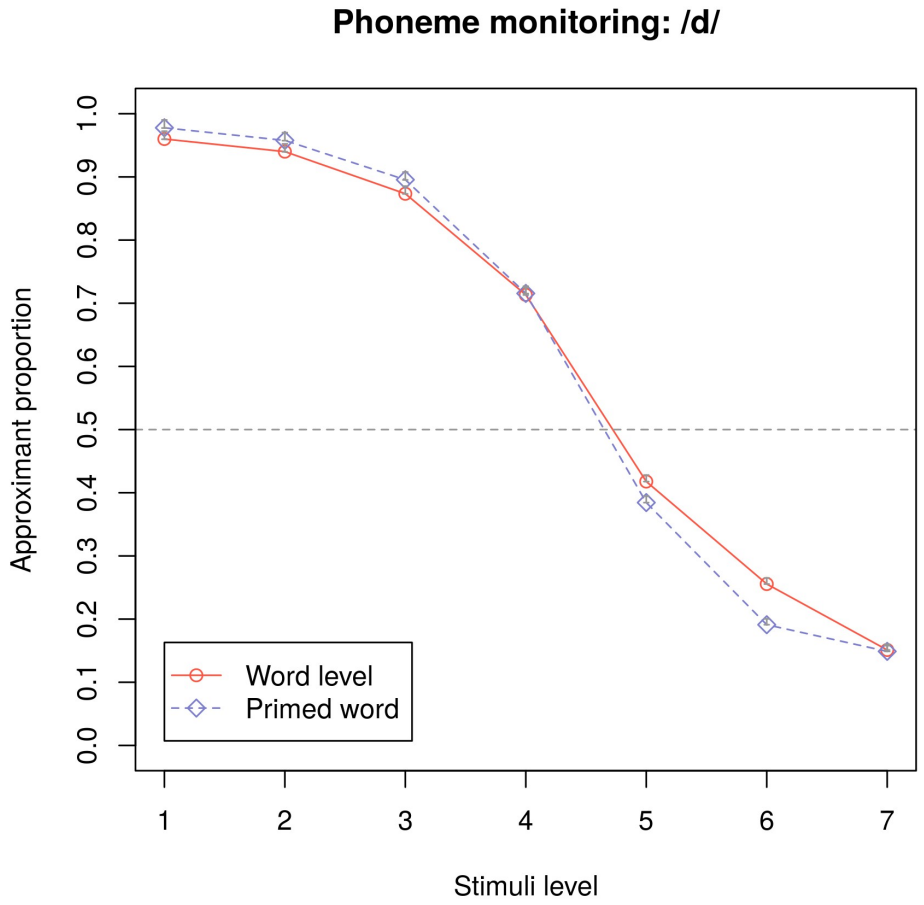
Stimuli: synthetic 7-step continua from open approximants to elided variants (Klatt synthesis), modelled after natural examples (now including F4 and F5).

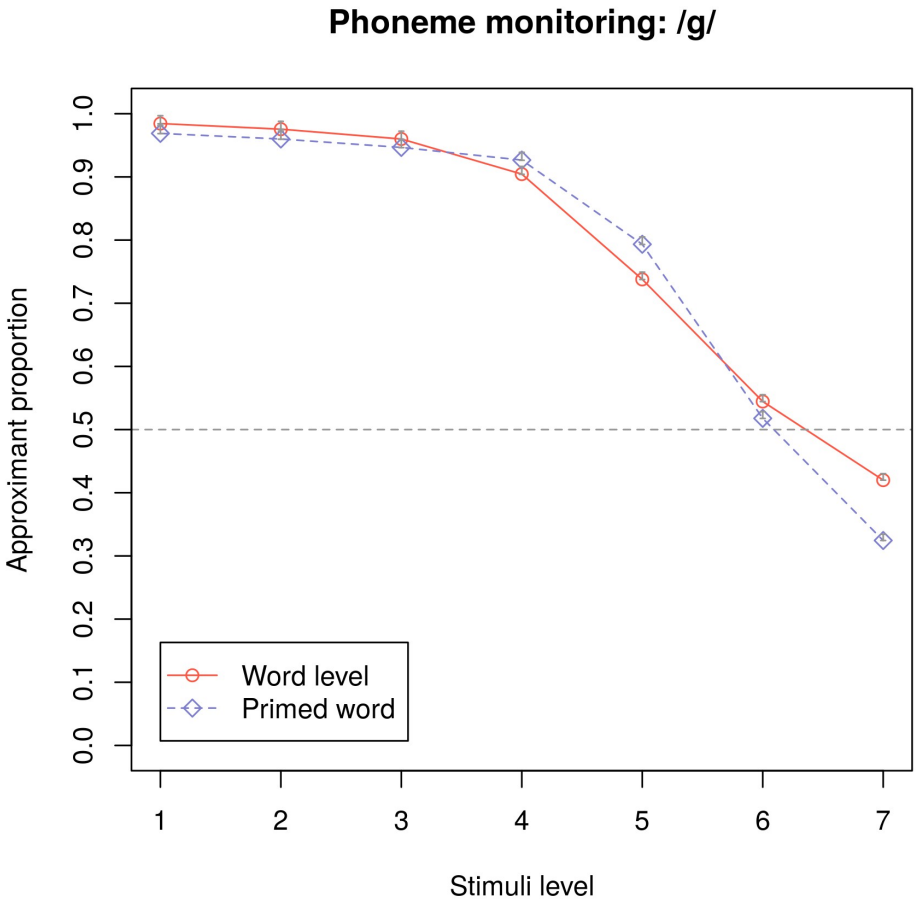
For each continuum, only the full approximant endpoint constitutes a Spanish word (e.g., from “Adán” [a.ˈð̞an], Adam, to *“aán” [a.ˈan]). High frequency words only and strong primes.

Conditions: word-level and primed approximant.

Follow-up semantic priming: results

Experiment 4





GLMM: only a significant main effect of stimulus level.

Summary of results

Summary of results

Experiment 1: phoneme monitoring

Generally speaking, more acoustic evidence equals to more perception.

The segmental condition is different for /d/: recovery.

Semantic level information triggers lexical effects and categorical perception.

Experiment 2: identification

Categorical perception is enhanced by a task in which lexical processing is mandatory

Summary of results

Experiment 3: discrimination

In the case of /g/, discrimination sensitivity peaks are aligned with category boundary crossings.

In the case of /d/, almost chance level discrimination in the segmental condition.

For both, but more clearly for /d/, adding semantic cues boosts discrimination sensitivity: higher levels of lexical processing seem to have a role.

Summary of results

Experiment 4: follow-up semantic priming (monitoring)

No detectable semantic priming effect: we are probably using a weak priming technique.

Differences in lexical effects due to expectations: stronger for /g/ and weaker for /d/.

General discussion

Recovery, lexical effects and lenition

General discussion

Evidence from phonological recovery and lexical effects on speech perception.
(Liberman, 1963; Ganong, 1980)

Some approximant consonants seem to be unreliable; they can be considered low bearing informational units.

Results consistent with a view of lenition as degradation of the informational complexity of the speech signal or a means to increase intensity in order to reduce the amount by which the segmental unit interrupts the speech flow.
(Harris & Urua, 2001; Kingston, 2008)

Lexical access in spite of elision

General discussion

The fact that listeners are able to recover elided units challenges the assumptions of some lexical access models[2].

Why? Given that the acoustic input is not entirely reliable, higher levels of lexical processing ought to be involved.

Strong bottom-up abstractionist models such as Shortlist find it difficult to account for effects from higher levels of lexical processing in speech perception.
(Norris, 1994; Mitterer & Ernestus, 2006)

[2] Models attempting to describe the stages and components involved between the reception of an acoustic input and the formation of a lexical representation.

Back to lexical access

General discussion

Taken together, results suggest at link between production and perception.

Listeners take into account what is expectable in natural production in prelexical processing.

Results are consistent with both interactive episodic models of lexical access, e.g., Minerva 2, and interactive hybrid models, e.g., POLYSP and Goldinger's CLS.
(Hintzman, 1984, 1986; Goldinger, 1998; Hawkins & Smith, 2001; Hawkins, 2003; Goldinger, 2007)

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Abstract

Chilean Spanish spirant approximants [β̞ ð̞ ɣ̞] display particularly high degrees of lenition in production, which often leads to elision in several phonetic contexts. The fact that listeners experience no problems recovering these units raises a number of questions regarding the reliability of acoustic information cueing for approximants, the use of complementary cues in perception, and how the variability originating from lenition is taken into account during lexical access. In order to address these issues, synthetic continua from approximant consonant to elision in which both ends were legal Spanish words were prepared (e.g., from *releva* –"to take over", [re.ˈle.βa]– to *relea* –"to re-read", [re.ˈle.a]), and presented in conditions which varied in the amount of acoustic and semantic cues available, in three perception tasks. Results suggested that listeners' expectations regarding what is normal in natural production and perception had an effect on how each continuum was perceived, with responses closer to categorical perception for those consonants in which the acoustic evidence is more reliable in natural settings, and recovery for those in which it is particularly unreliable. Adding semantic cues brought all responses closer to categorical distributions, suggesting lexical effects on speech perception. Overall, these results provide evidence for the use of episodic memory in tasks requiring only prelexical processing, and top-down feedback from post-lexical levels of processing in those tasks in which lexical access is mandatory.

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