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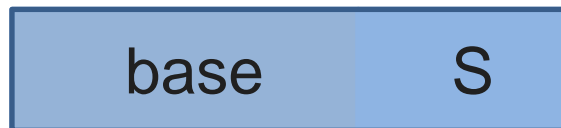University of Central Lancashire

# *The Role of Predictability and Sub-Phonemic Detail in Speech Perception: English has-Clitic [s] vs. Plural [s]*

Julia Zimmermann, Darcy Rose,

Daniel Bürkle, Kevin Watson

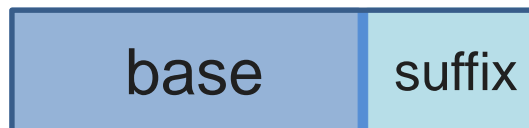Te Kāhui Roro Reo · New Zealand Institute of
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- morphemes are represented at the phonological level

- no phonetic difference between different English /s/ morphemes

- homophony of: plural, genitive, genitive plural, 3rd sg, clitics of *has, is, us*

- no systematic phonetic difference between different instances of one allomorph of a certain morpheme
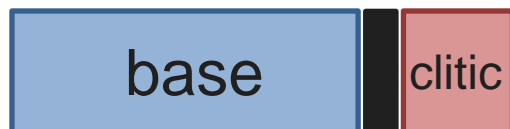
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- Does the type of morphological boundary preceding a word-final S have an effect on its duration?

- Plag et al. (2015) AE, Zimmermann (2016) NZE:

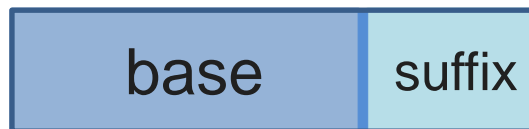| base | S |
|---|---|

no boundary: longest

| base | suffix |
|---|---|

morphological boundary: medium

| base | | clitic |
|---|---|---|

word/clitic boundary: shortest

3

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- Does morphological predictability affect the phonetic realization of bound morphemes?

- Rose (2016) on NZE plurals:

    - calculated plural predictability based on preceding word

    - duration of plural S shorter when plural is more predictable

| base | suffix |
|------|--------|

more predictable plural: shorter S

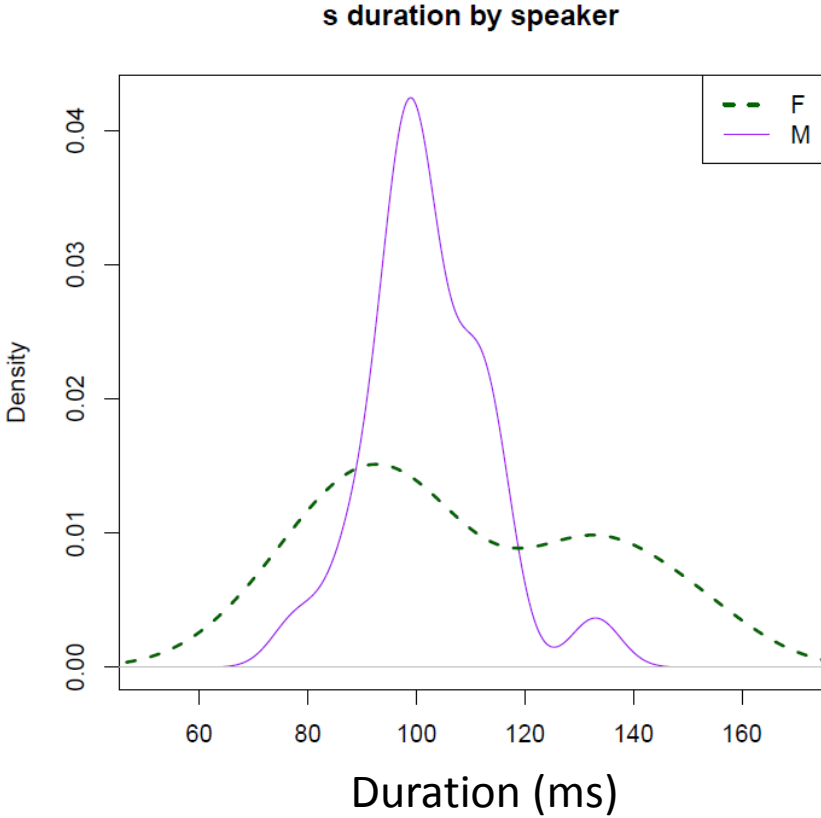| base | suffix |
|------|--------|

less predictable plural: longer S

4

- Kemps et al. (2005a, 2005b) found that listeners can distinguish free bases from bound bases followed by a suffix, e.g. BAKE in *bake* vs. BAKE in *baker*

- Shatzman & McQueen (2006) found that listeners can use [s] duration as a cue for word boundaries in Dutch

  - e.g. *een spot* ('one spot') vs. *eens pot* ('once pot')

- Derrick & Bürkle (2016) used a visual-world eye-tracking experiment to investigate the perceptibility of anticipatory tongue movements in VrVrV-sequences like *editor* vs. *edit a*

  - participants were able to distinguish the sequences before the rhotic/non-rhotic final vowel was reached

- Can listeners use duration differences of [s]  to distinguish plural and *has*-clitic  [s] in ambiguous contexts?

  - plural [s] is longer than has-clitic [s] in production, with some duration differences exceeding 70ms

- Does predictability play a role in the distinction of plural and *has*-clitic [s] in ambiguous contexts?

  - plural [s] duration differs in production based on preceding context's plural predictability

  - shortest plural [s] could be shorter than longest *has*-clitic [s]

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- Items
  - 2 target lemmas as bases: BOOK and SHIP
  - 2 types of [s]: *has*-clitic and plural
  - 3 different plural predictabilities: his, my, their
  - 2 carrier sentences:
    - Reading PRN book[s] inspired them so much
    - PRN ship[s] appeared in numerous feature films
  - 2 native speakers of NZE: male and female
    - male speaker does not show systematic duration differences for [s]
    - female speaker does show systematic duration differences for [s] as found in previous studies

s duration by speaker

Duration (ms)

- ## Items

  - 2 target lemmas as bases: BOOK and SHIP

  - 2 types of [s]: *has*-clitic and plural

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  - 2 carrier sentences:

    - Reading PRN book[s] inspired them so much

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  - 2 native speakers of NZE: male and female

    - male speaker does not show systematic duration differences for [s]

    - female speaker does show systematic duration differences for [s] as found in previous studies

  - 2 recordings of each speaker-lemma-[s]-PRN combination

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- **Experimental setup**

  - 20 participants (9 female, 11 male), native speakers of NZE, compensated with $10 shopping voucher

  - visual-world-like eye-tracking paradigm

    - participants listen to recordings over headphones

    - two words displayed on screen, e.g. *books* and *book's*

    - instructed to look at word they think they heard in recording

    - tracking of eye-movements while participants identify words, using a Tobii X120 head-free near-infrared eyetracker

    - 48 unique test items, each played twice

    - 96 unambiguous control items

    - four blocks of 48 items each, fully randomized

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books          X          book's

*"Reading my book[s] inspired them so much."*

books        X        book's

*"Reading my book[s] inspired them so much."*

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ship's            X            ships

*"Their ship[s] appeared in numerous feature films."*

14

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ships          X          ship's

*"Their ship[s] appeared in numerous feature films."*

- **gaze points**
  - target areas determined for each participant using control items
  - percentage on-target vs. off-target (vs. neutral)
  - majority of gazes interpreted as response

- **trajectory length**
  - short trajectory = direct gaze
  - long trajectory = back-and-forth gazes
  - interpreted as measure of certainty

- **fixations**
  - on-target vs. off-target
  - time course (first, last, longest)

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- ▪ **gaze points**

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  - ▪ interpreted as measure of certainty

- ▪ fixations

  - ▪ on-target vs. off-target

  - ▪ time course (first, last, longest)

- percentage of on-target vs off-target gazes

- more on-target gazes for plural items

  - interaction with base: even more on-target gazes for *books* vs. *ships*

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## type of [s] and base interaction
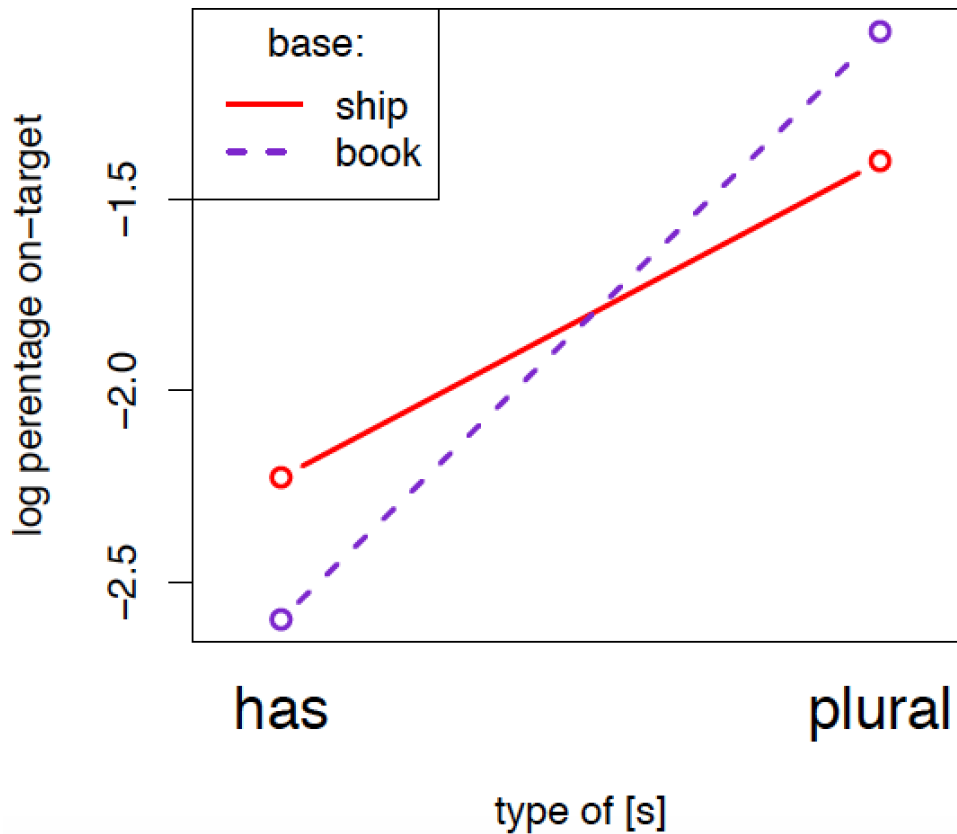


- plural [s] is overall more frequent than *has*-clitic [s]
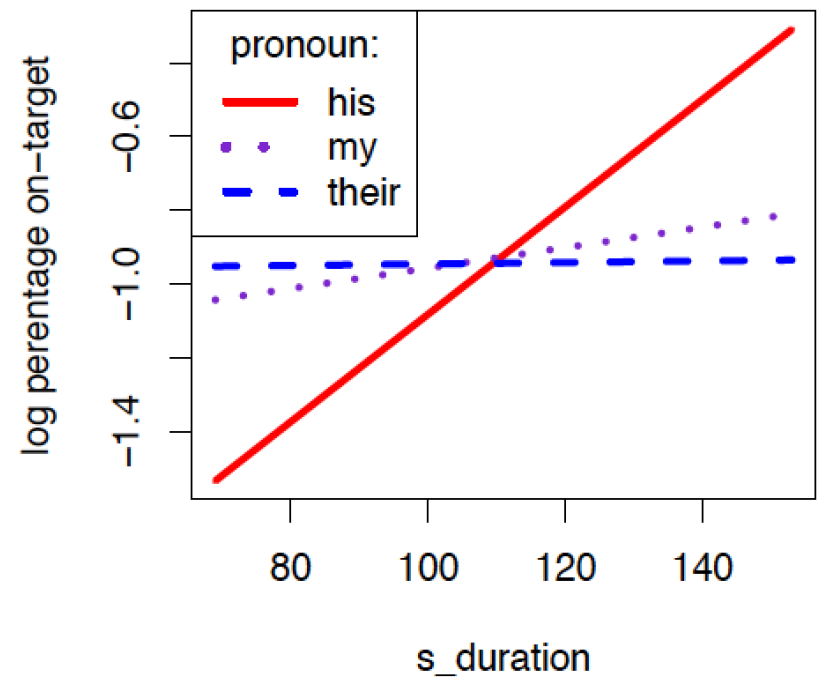
- BOOK has a higher PL:SG ratio than SHIP

- percentage of on-target vs off-target gazes

- more on-target gazes for plural items

    - interaction with base: even more on-target gazes for *books* vs. *ships*

- three-way interacation of plural type, pronoun, [s] duration

    - their + *has*-clitic: more on-target gazes for longer [s]

    - his + plural: more on-target gazes for longer [s]

**[s] type: has**
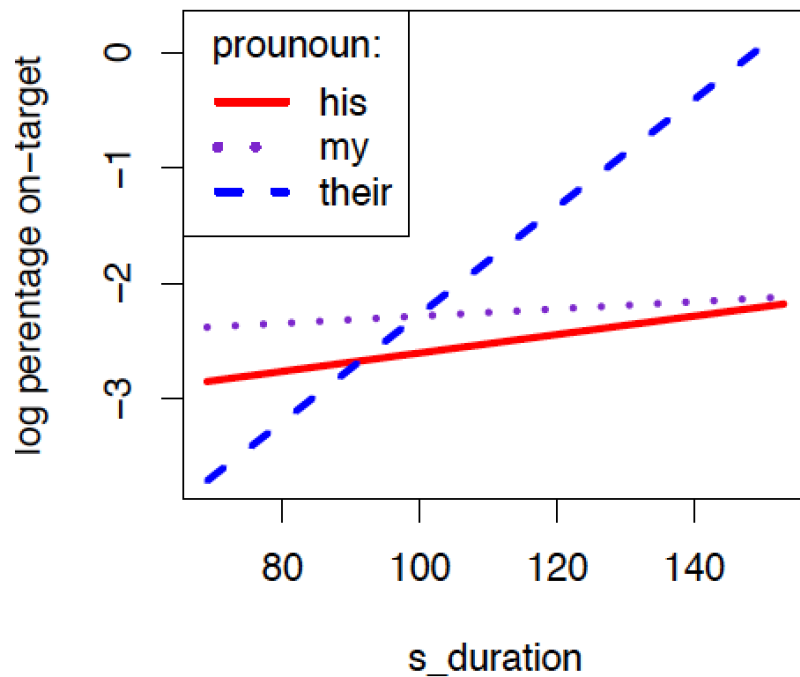
**[s] type: plural**

*their*: high plural predictability
→ shorter plural [s] expected

*his*: low plural predictability
→ longer plural [s] expected

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- percentage of on-target vs off-target gazes

- more on-target gazes for plural items

  - interaction with base: even more on-target gazes for *books* vs. *ships*

- three-way interacation of plural type, pronoun, [s] duration

  - his + plural: more on-target gazes for longer [s]

  - their + *has*-clitic: more on-target gazes for longer [s]

- no effect of speaker

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- interpretation: the longer the gaze trajectory, the more unsure the participant is in their categorization

- linear mixed effects regression modelling

  - participant as random effect

  - response = majority of gazes

- interaction of speaker, base, pronoun, response, [s] duration

  - for the male speaker, they are more unsure about responding with

    - has for *his ship[s]* vs. plural for *my ship[s]/their ship[s]*

    - has for *my book[s]* vs. plural for *my book[s]*

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- interaction of speaker, base, pronoun, response, [s] duration

  - for the female speaker, they are more unsure about responding with

    - plural for *my ship[s]* vs. plural for *their ship[s]*

    - has for *their ship[s]/my ship[s]* vs. has for *his ship[s]*

    - has for *their ship[s]* vs. plural for *their ship[s]*

    - plural for *my ship[s]* vs. has for *my ship[s]*

    - plural for *his book[s]* vs. has for *his book[s]*

  - for the female speaker, they are more unsure upon longer [s] when responding

    - has for *their ship[s]*

    - plural for *their ship[s]*

    - has for *my ship[s]*

    - plural for *his book[s]*

- Does predictability play a role in the distinction of plural and *has*-clitic [s] in ambiguous contexts?

  - Yes. There are effects of predictability on percent correct gazes.

  - Predictability interacts with [s] duration in the expected way.

- Can listeners use duration differences of [s]  to distinguish plural and *has*-clitic  [s] in ambiguous contexts?

  - In a certain way. There are effects of [s]-duration on the certainty with which participants respond, given a high/low plural predictability.

  - These effects mostly go in the expected direction.

  - However, this does not necessarily go together with correctness of responses. For *his* + has-clitic and *their* + plural, it does.

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- analyze fixation patterns in depth

- use more sophisticated modelling to account for non-linear data

- further acoustic analysis of test items, considering other aspects besides [s] duration

  - base duration / relative [s]-duration

  - onset of following word

26

*Thank you for your attention!*

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