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

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Traditional views on morphological form

- 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
Sub-phonemic detail in morphological form

- 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
Predictability and sub-phonemic detail

- 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

<table>
<thead>
<tr>
<th>base</th>
<th>suffix</th>
<th>more predictable plural: shorter S</th>
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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

- *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
Research questions

- 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]
Methodology

- **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
Methodology

s duration by speaker

Density

Duration (ms)
Methodology

- Items
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    - female speaker does show systematic duration differences for [s] as found in previous studies
  - 2 recordings of each speaker-lemma-[s]-PRN combination
### Methodology

- **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
“Reading my book[s] inspired them so much.”
Methodology

“Reading my book[s] inspired them so much.”
“Their ship[s] appeared in numerous feature films.”
Methodology

“Their ship[s] appeared in numerous feature films.”
Ways to analyze eye-tracking data

- 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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Results & discussion: correctness of gazes

- 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*
Results & discussion: correctness of gazes

- plural [s] is overall more frequent than has-clitic [s]
- BOOK has a higher PL:SG ratio than SHIP
Results & discussion: correctness of gazes

- 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 interaction 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]
Results & discussion: correctness of gazes

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

his: low plural predictability
→ longer plural [s] expected
Results & discussion: correctness of gazes

- 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 interaction 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
Results & discussion: certitude of gazes

- **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]*
Results & discussion: certitude of gazes

- 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]
Conclusion

- 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.
On our to do list

- 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
Thank you for your attention!

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Selected references


