Morphological processing is affected by subphonemic detail

FOR 2373 Spoken Morphology
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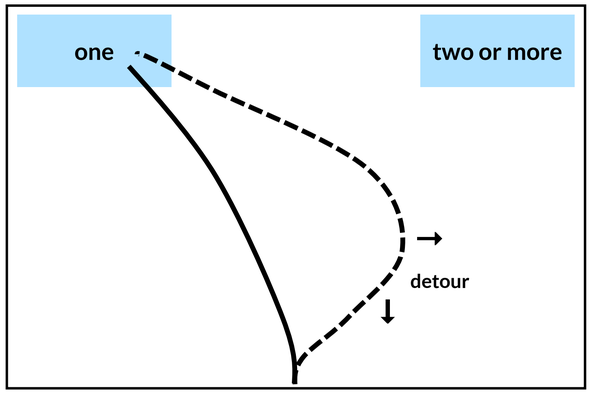
Motivation

- Research has shown that seemingly homophonous elements, e.g. **words** (e.g. [1], [2]), **stems** (e.g. [3], [4]), **prefixes** (e.g. [5], [6]), and **suffixes** (e.g. [7]) differ in their acoustic duration
- A prominent case for subphonemic durational differences is word-final /s/ in English; studies (e.g. [8], [9], [10], [11]) show that: **non-morphemic > suffixes > clitics**
- Recent studies have shown that such subphonemic durational differences are apparently also perceivable (e.g. [7])
- **Research question:** Do listeners make use of such subphonemic detail in morphological processing?
- **Expectation:** If durational information is used in comprehension, a mismatch of durations should show an effect on comprehension

Method

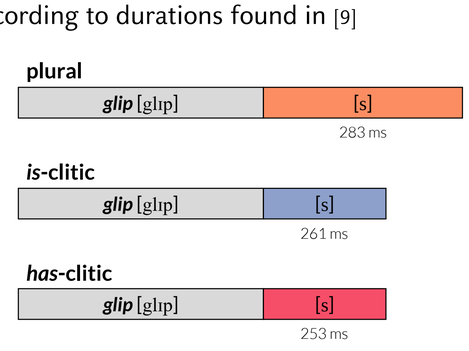
- Number-decision task in a mouse-tracking paradigm



- **Pseudowords** from a previous production study ([11]) were used to rule out potentially confounding lexical and contextual effects (e.g. [12], [13], [14], [15])

ɪ	iː	uː	ʌ	aʊ	eɪ
glips	*pleeps*	*cloops*	*prups*	*bloups*	*glaips*
glits	*pleets*	*cloots*	*pruts*	*blouts*	*glaits*
gliks	*pleeks*	*clooks*	*pruks*	*blouks*	*glaiks*
glifs	*pleefs*	*cloofs*	*prufs*	*bloufs*	*glaifs*

- For each pseudoword, **three audio stimuli** were created by manipulating the /s/ duration according to durations found in [9]



- To allow for disambiguation of plural and clitic /s/, items were embedded into real word **contexts**, for example:

Plural
The [glɪps]/[glɪpsˈ]/[glɪpsʰ] *ate their lunch together.*

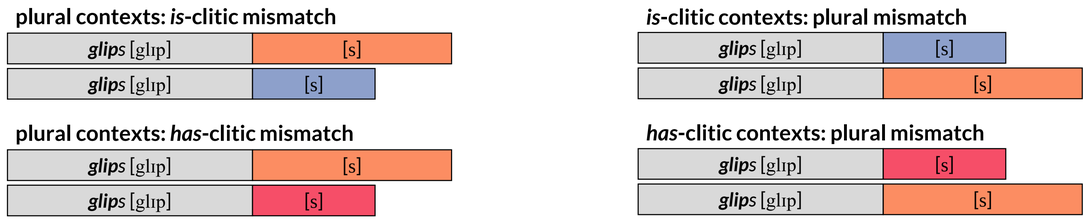
is-clitic
The [glɪpsˈ]/[glɪpsʰ] *eating cake with the bloup.*

has-clitic
The [glɪpsʰ]/[glɪps] *eaten the bloup's lunch.*

match *mismatch*

Analysis

- Data were analysed using QGAMs – Quantile Generalised Additive Mixed models ([16]) – for a detailed insight into the independent variables' effects across conditional quantiles
- QGAMs were fitted for quantiles 0.1, 0.3, 0.5, 0.7, and 0.9 with
  - **response variables**: X coordinates & Y coordinates
  - **smooth term**: order of coordinates per trials
  - **parametric term**: match vs. mismatch
  - **random smooth terms**: item, participant
- QGAMs were fitted for four subsets



Results

- A significant effect of match vs. mismatch is found across all sets of QGAMs

	plural contexts				clitic contexts			
	is-clitic mismatch		*has*-clitic mismatch		*is*: plural mismatch		*has*: plural mismatch	
Q	X	Y	X	Y	X	Y	X	Y
0.1			→	↑		↓	←	
0.3				↑		↓	←	↓
0.5				↑		↓	←	↓
0.7	←	↑	←	↑	→	↓		↓
0.9	←	↑	←		→			↓

- Where a significant effect is found, arrows indicate the position of mismatched coordinates relative to the position of matched coordinates

Discussion

- Subtle morpho-phonetic differences need to be taken seriously in both production and comprehension and pertinent theoretical approaches
- Abstractionist (e.g. [17], [18], [19], [20]) and feature-based approaches (e.g. [21], [22]) cannot account for the present findings
- Exemplar-based models (e.g. [23]) can potentially account for our findings as they assume fine phonetic detail to be stored in the lexicon

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Welcome to our poster on morphological processing being affected by subphonemic detail.

Recent research has shown that seemingly homophonous elements differ in their acoustic realizations. Pertinent evidence was found for words, stems, prefixes, and suffixes.

A prominent case for suffixes is word-final /s/ in English, which depending on its morphological make-up shows different acoustic durations.

Recently, it has been found that such durational differences in word-final /s/ also are perceptible.

Grounding our work in such findings, we ask whether listeners not only perceive such subphonemic differences but make use of them in morphological processing.

If durational information is used in comprehension, a mismatch of durations should show an effect on comprehension.

To answer this question, we conducted a number-decision task in a mouse-tracking paradigm.

As indicated by the figure, participants were to click on either ‘one’ or ‘two or more’ while listening to an audio stimulus.

We will come back to the illustrated mouse-tracks is a moment.

As items, we used pseudowords from a previous study on the production of word-final English /s/ to rule out potentially confounding lexical and contextual effects.

All pseudowords are listed in the given table.

As is illustrated, for each pseudoword, three audio stimuli were created by manipulating their word-final /s/ duration according to the prototypical durations found in a previous study.

To allow for disambiguation of plural and clitic /s/, items were embedded into real word contexts, such as the ones given here.

To allow testing of our expectation, stimuli of matched and mismatched conditions were created.

We speak of matched condition when real word context and word-final /s/ duration match up; while we speak of mismatched condition when real word context and word-final /s/ duration do not match up.

For plural /s/, one matched and two mismatched conditions were created.

For both clitic /s/s, one matched and one mismatched condition were created.

Coming back to the mouse-tracks given here, our expectations predict mouse-tracks of matched condition to resemble the solid track, while mouse-tracks of mismatched condition should resemble the dashed track being further to the right and lower down.

That is, the tracks of mismatched contexts should show a general detour away from the final answer.

Mouse-tracking data were analysed using Quantile Generalised Additive Mixed models to obtain a detailed insight into the independent variables' effects across conditional quantiles.

Models were fit for quantiles 0.1, 0.3, 0.5, 0.7, and 0.9 with the response variable being either X or Y coordinate values.

As parametric term, our variable of interest – match vs. mismatch – was included.

The order of coordinates per trial was included as smooth term, while item and participant ID were included as random smooth terms.

Models were fitted to four subsets as is illustrated. Within each subset, a matched condition was compared to its counterpart mismatched condition.

Analysing the data of 40 participants, we found a significant effect of match vs. mismatch across all sets of models.

Let's take a closer look at the nature of the found significant effects as given in this table.

Starting with plural contexts and mismatched is-clitic /s/ durations, we find coordinates of mismatched trials to be further to the left and higher up.

Recalling our expectations for mismatched trials, these results are of opposite nature.

Moving on to plural contexts and mismatched has-clitic /s/ durations, we again find tracks of mismatched trials to be higher up.

For the horizontal dimension we find a mixed picture, as tracks are further to the right in the 0.1 quantile, but further to the left in the two highest quantiles.

Again, these results are – partially – the opposite of what was expected.

Let's move on to the clitic contexts.

For is-clitic contexts, we find tracks of mismatched trials to be further to the right and lower down.

This pattern is what we expected to find.

Finally, considering the results for has-clitic contexts, we similarly find that mismatched tracks are lower down.

However, such tracks are further to the left – contrary to what we expected.

Overall, we find a rather mixed picture with only some patterns.

That is, mismatches caused by clitic /s/ durations come with higher Y coordinate values, while mismatches caused by plural /s/ duration come with lower Y coordinate values.

For X coordinates, no such clear pattern is found.

Most importantly, however, we found that subphonemic durational differences show an effect on comprehension.

Thus, such subtle morpho-phonetic differences need to be taken seriously in both production and comprehension and pertinent theoretical approaches.

Yet, most theories such as abstractionist models or features-based approaches cannot account for our findings, while only some such as exemplar-based models potentially can.

In sum, our results add to the literature that calls for more adequate models of speech production and comprehension.