Automatic morpheme identification in reading development: MEG evidence from Fast Periodic Visual Stimulation

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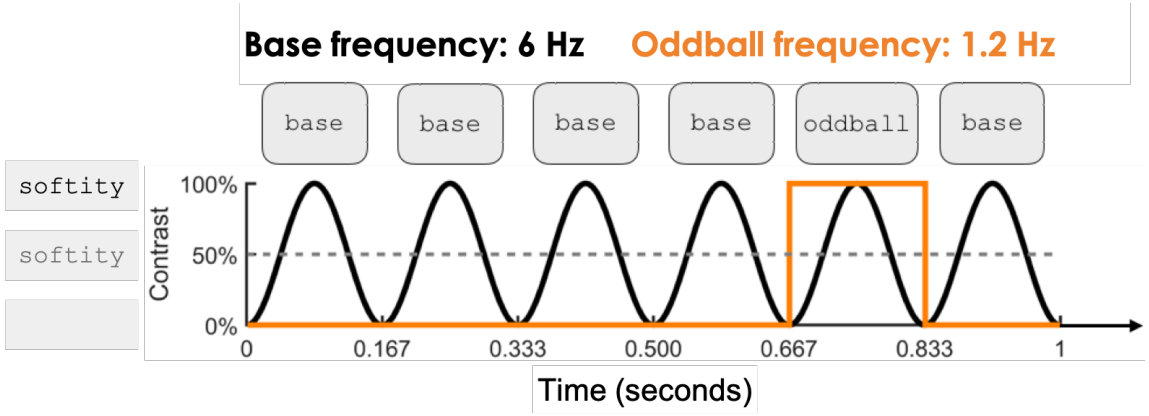
Background

- Morphemes: smallest linguistic units that carry meaning. *artist* = ***art-*** (stem) + ***-ist*** (suffix).
- Behavioural evidence for processing of complex written words via their constituent morphemes (Amenta & Crepaldi, 2012).
- Reading development → morphological structure of words, especially presence of stems (Grainger & Beyersmann, 2017).
- EEG evidence for selective word representation (Lochy et al., 2015).

AIM: investigate **selective neural responses to morphemes** embedded in pseudowords, at different stages of reading development.

Skilled adult readers
Methods

- **FPVS** with an **oddball** paradigm and **MEG** recording (160-channel Yokogawa system)



- **Stimuli:** 288 stimuli resulting from unique pseudoword combinations of: 12 stems (e.g., *soft-*),12 suffixes (e.g., *-ity*), 12 non-stems (e.g., *trum-*) and 12 non-suffixes (e.g., *-ust*).
- **Participants**: N=28 native English-speaking adults, monitoring a central fixation cross and responding to colour change.

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Design

Five 1-minute trials per condition

Stem detection

Condition 1:
stem+suffix in *non-stem+suffix*
*trumess joskive molpory firnure **softity** berfise*

Condition 2:
stem+non-suffix in *non-stem+non-suffix*
*trumust joskune molpute firnint **softert** berfere*

Suffix detection

Condition 3:
stem+suffix in *stem+non-suffix*
*stopust helpune parkute lastint **softity** townere*

Condition 4:
non-stem+suffix in *non-stem + non-suffix*
*trumust joskune molpute firnint **terpity** berfere*

Control condition:
words in *non-words*
*kltq rdsc fgnl pdrk **roll** tmkj*

Prediction: MEG response at oddball frequency if morpheme detection occurs

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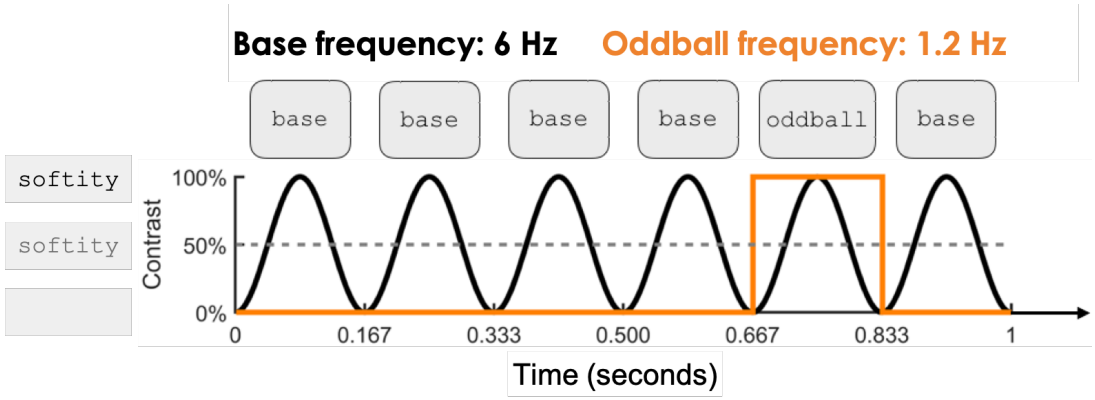
Methods



- **Stimuli**: 54 stimuli resulting from unique pseudoword combinations of: 6 stems (e.g., *soft-*), 6 suffixes (e.g., *-ity*), 6 non-stems (e.g., *trum-*) and 6 non-suffixes (e.g., *-ust*).
- **Participants**: N=17 native English-speaking children from Year 5 and 6, monitoring a central fixation cross and responding to colour change.

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Design

Six 1-minute trials per condition

Stem detection

Condition 1:

stem+suffix in *non-stem+suffix*

trumess joskive molpory firnure ***softity*** *berfise*

Suffix detection

Condition 3:

stem+suffix in *stem+non-suffix*

stopust helpune parkute lastint ***softity*** *townere*

Control condition:

words in *non-words*

kltq rdsc fgnl pdrk ***roll*** *tmkj*

Prediction: MEG response at oddball frequency if morpheme detection occurs

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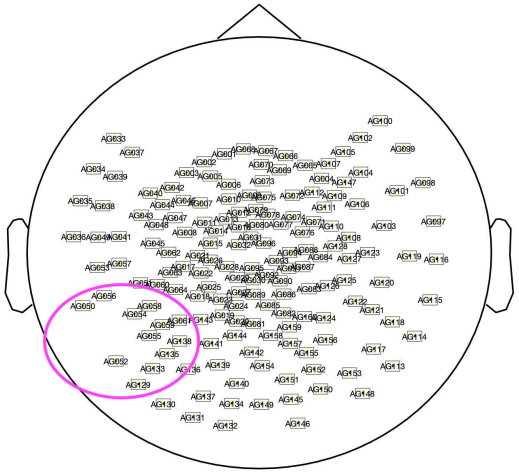
Sensor-level analysis

Sensor-level ROI definition

- A priori, theory-driven (see review by Leminen et al., 2019) definition of a sensor-level left occipito-temporal region of interest (ROI) of 12 channels, to map onto ventral occipito-temporal cortex (vOTC).
- Oddball response: quantified as the average signal-to-noise ratio (SNR) at the oddball stimulation frequency (1.2 Hz) and first three harmonics (2.4, 3.6, 4.8 Hz) for each condition, in the selected ROI. One-tailed *t*-test against noise level.



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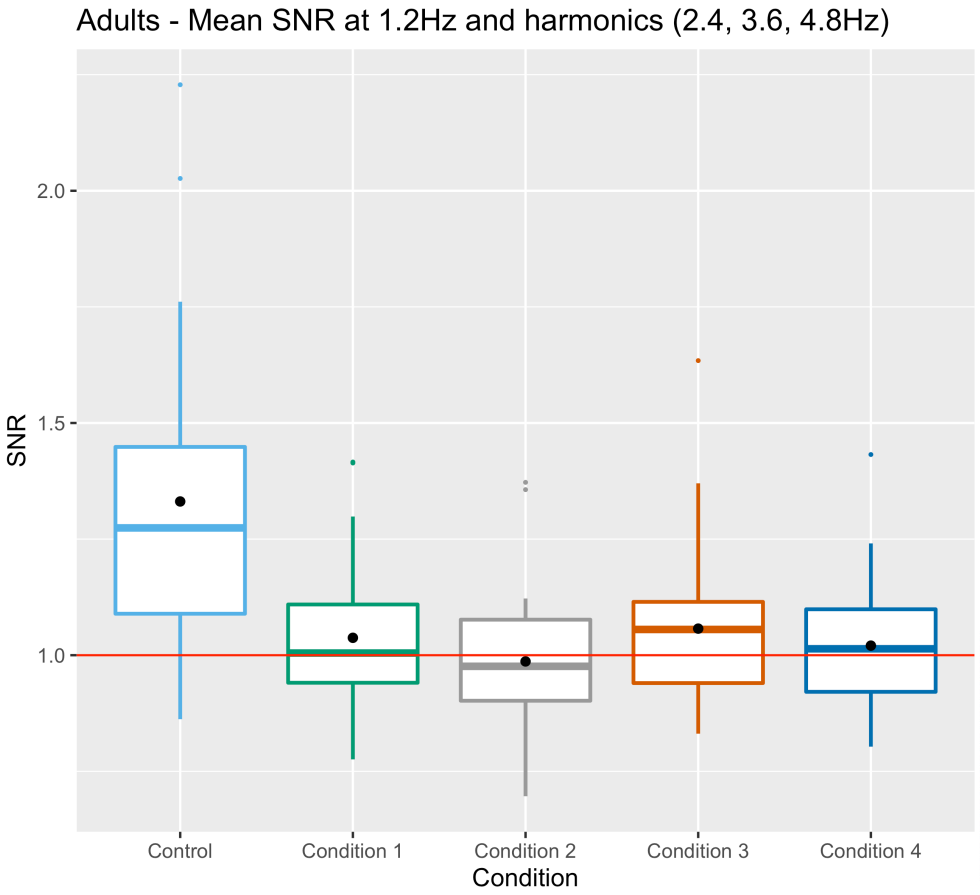
Results



Control: mean SNR = 1.331, $t(27) = 5.494$, $p < .001$
Condition 1: mean SNR = 1.037, $t(27) = 1.227$, $p = .115$
Condition 2: mean SNR = 0.987, $t(27) = -0.447$, $p = .671$
Condition 3: mean SNR = 1.057, $t(27) = 1.692$, $p = .051$
Condition 4: mean SNR = 1.027, $t(27) = 0.765$, $p = .225$

- roll in kltq (word detection)
- softity in terpity (stem detection with suffixes)
- softert in terpert (stem detection without suffixes)
- softity in softert (suffix detection with stems)
- terpity in terpert (suffix detection without stems)

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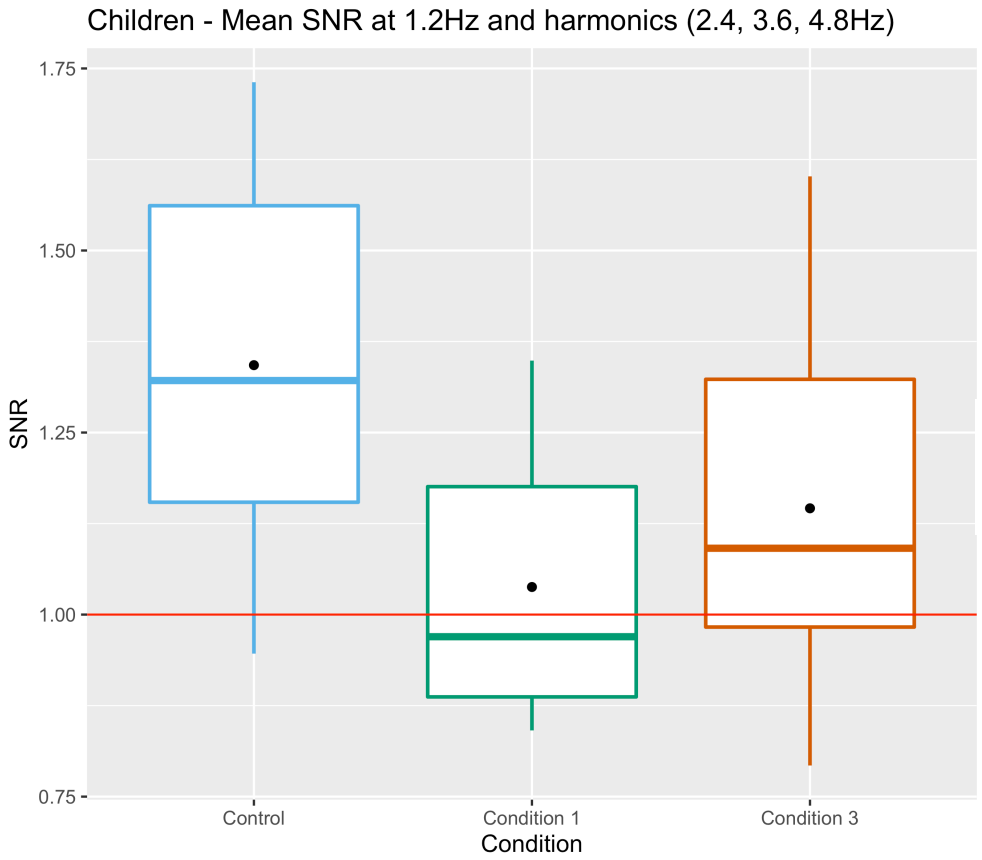
Results



Control: mean SNR = 1.342, $t(16) = 5.539$, $p < .001$
Condition 1: mean SNR = 1.038, $t(16) = 0.901$, $p = .190$
Condition 3: mean SNR = 1.146, $t(16) = 2.633$, $p = .009$

roll in kltq (word detection)
softity in terpity (stem detection with suffixes)
softity in softert (suffix detection with stems)

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Discussion

- **Morphemes** more easily identified when presented in **fully decomposable pseudowords**; specifically, significant response taken as suffix identification (condition 3) in a left occipito-temporal region.
- **Automatic morpheme identification** at relatively early stages of reading development, in line with accounts of morphological decomposition (e.g., Grainger & Beyersmann, 2017).
  Morpheme identification modulated by **context.**
- Next steps:
  - Cluster-based permutation at sensor level
  - Source-level analysis to provide more refined spatial information on the neural underpinnings of morpheme identification

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THANK YOU!

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