Slow brain activity reflects neural tracking of rhythmically regular versus irregular speech

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Background

Patterns of stressed and unstressed syllables provide a rhythmic scaffolding that facilitates language development and speech perception.

Sensitivity to speech rhythm is also predictive of later reading performance.

Electrophysiological (EEG) research shows that neural oscillations closely track the slow amplitude modulations in the speech signal, also known as the **speech envelope**.

Previously revealed using **Cerebro-Acoustic Coherence (CAC)**, which measure cortical responses across the time course.

The precision in which the brain tacks the speech envelope correlates with individual differences in language comprehension and reading ability.

Research Question

How does speech envelope tracking differ between rhythmically regular speech and rhythmically irregular speech?

Which phonemic feature best predict speech envelop tracking?

Methods

26 participants (21 F), 18-22 yrs (M =18.8), neurologically healthy and Native English speakers.

EEG recorded while listening to two 6-minute audio recordings of children's stories: one with rhythmically regular structure (fig. 1, left panel) and one with irregular rhythm (fig. 1, right panel).

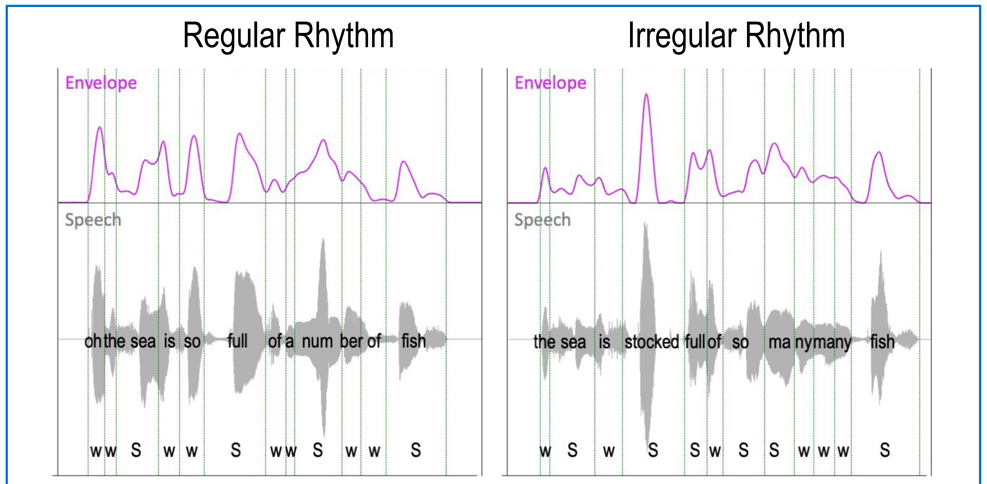

Figure 1: Example of auditory stimuli and & speech envelop

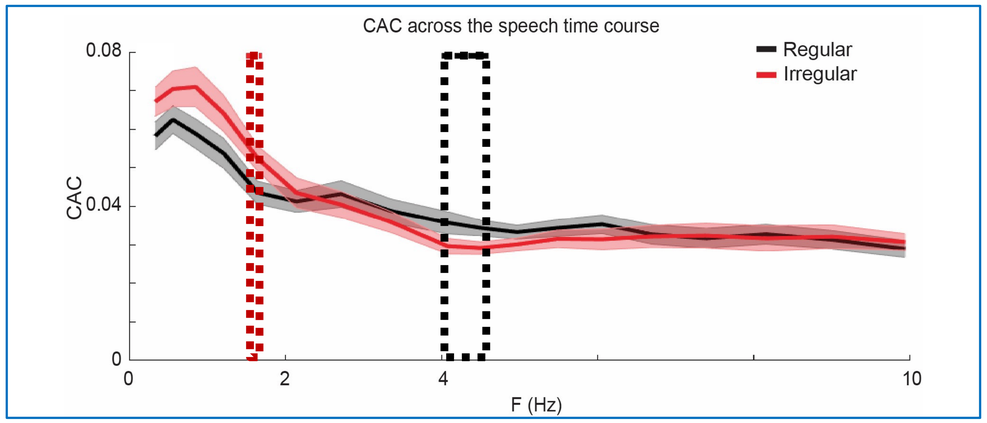

Figure 2: Preliminary EEG results

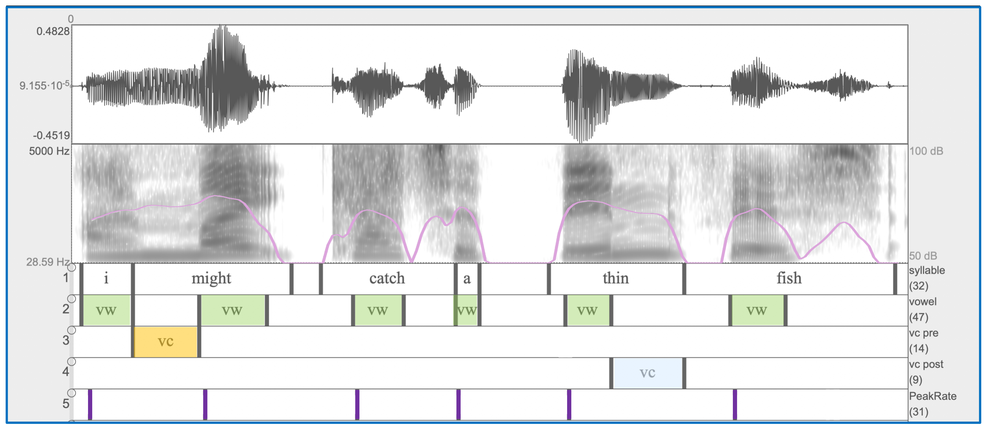

Figure 3: Speech segmentation & identification of voicing acoustic edges

Preliminary Findings

Neural analysis showed key differences between processing of naturalistic speech with metrically regular and irregular prosody (fig. 2).

Stronger neural engagement was seen with regular speech at higher frequencies (4-5 Hz), across the time-course of the stories.

Conversely, at lower frequencies (1-2 Hz), stronger neural engagement was seen with irregular speech.

Results suggest increased neural engagement with phrase-level cues in irregular speech, potentially contrasting with engagement with metrically predictable syllable patterns in regular speech.

Next Steps

Manually segment and annotate each phoneme in the stories (fig. 3).

Identify acoustic edges, defined as peaks in the rate of change (i.e., peakRates) in the speech envelope.

Select acoustic edges closest to onset of voicing in each syllable.

Calculate inter-event phase coherence (IEPC), which measure cortical responses to selected acoustic edges.

Do CAC & IEPC responses differ between rhythmically regular and irregular speech?

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