Decoding bistable audio from EEG

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Introduction

Perception of auditory stimuli requires more than just audition. When someone is listening to sounds, non-auditory cues—such as visuals—can alter auditory perception (McGurk). With an ambiguous auditory stimulus, the brain turns to other sensory processes to refine the perception. Auditory illusions can illicit perceived visual stimuli that never existed (Auditory rabbit paper). Some stimuli are so ambiguous that there are two stable percepts, these are called bistable stimuli. A popular example of a bistable auditory stimulus is perceived as both “green needle” and “brainstorm” (See audio 1). It is unknown whether the processing of a bistable auditory percept occurs during encoding, or in higher processing.

Differences in perception of two similar auditory stimuli can be found by decoding fMRI, EEG, and MEG data (Beach et al., 2021). Decoding is a process of using brain data (e.g. EEG or fMRI) to reconstruct information collected by sensory systems. Decoding algorithms

Whole musical pieces can be decoded from EEG data (Bellier et al., 2023; Daly, 2023).

Currently, it is unclear whether a bistable stimulus can be decoded from EEG data. The main question derived from this is, does semantic priming lead to measurable differences in EEG for a bistable percept? If there is a difference in EEG output when perceiving different outcomes of a bistable auditory percept, then the EEG will be decodable.

Methods

PARTICIPANT INFORMATION

For the first study, participants were presented with stable versions of the bistable percept. Speech was generated with the speech generation AI Play HT (CITE). Intensity of generated speech was matched for root mean squares of each speech intensity (See fig 1)

A green needle spectrogram and a blue needle

Description automatically generatedA close-up of a brain storm spectrogram

Description automatically generatedA B

Figure 1: Spectrograms for generated speech. 1A, spectrogram for “Brain storm”. 1B, Spectrogram for “Green needle”

During a trial, participants would be presented with a fixation cross for 500ms. Then participants would be presented with five repetitions of the audio with jitters (0-200ms) between each presentation (Fig 2). Each block contained 40 trials and there were 6 blocks, 2 for each stable percept independently and 2 with both stable percepts randomly presented.

EEG INFORMATION

Results

Discussion