High Frequency Time Locking in Auditory Cortex to Continuous Speech

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Introduction

The neural processing of natural sounds, such as speech, changes along the ascending auditory pathway, and is often characterized by a progressive reduction in representative frequencies. This is observed in two well known neural responses:

1. The Frequency Following Response (FFR): – Thought to originate in the auditory brainstem. – Frequencies of ~100 Hz to several hundred Hz. – Time-lock to fast acoustic envelope and waveform.

2. The cortical low frequency Temporal Response Function (TRF): – Frequencies of ~1-20 Hz. – Time-lock to slow acoustic envelope.

Recent studies have shown that the FFR may not have a purely subcortical origin (Coffey et al. 2016). Recent studies have also shown a continuous speech generated FFR-like response in brainstem (Maddox and Lee 2015) and that brainstem responses are modulated by attention (Forst et al. 2017).

Age-related differences, of opposite direction, have been observed for the FFR and the slow cortical TRF. – FFR response is stronger in younger subjects (Anderson et al. 2012). – cortical low frequency TRF response is stronger in older subjects (Brodbeck et al. 2018). Does the cortex time-lock to high frequency components of connected speech stimuli? Are there age differences in high frequency responses in the cortex?

Methods

MEG data was collected from 17 younger and 23 older subjects while they listened to 6 minutes of speech from an audistick. Earlier analysis of dataset published as Presacco et al. (2016a, 2016b).

Statistical significance was tested using permutation tests on the model prediction accuracy and the spatially and temporally smoothed right-sided TRFs.

Stimulus Representation

Two separate high frequency aspects of the speech stimuli were considered:

1. The waveform of the speech bandpassed 80-300 Hz.

2. The source frequency (300-4000 Hz) components of the speech stimulus, bandpassed 80-300 Hz. – Compute the envelopes of the auditory spectrum (Yang et al. 1991).

– Filter the 300-4000 Hz components of the spectrogram envelope at 80-300 Hz.

– Average the resulting spectrogram envelope across frequency.

Source Localization

The 157 MEG sensors were transformed to current source space using the MNE software (Gramfort et al. 2014).

1. Volume source space – The brain volume is divided into 10mm³ voxels. Current dipole vectors with 3D orientation and magnitude placed at each voxel. ROI: voxels closest to a) the temporal lobe and b) the brainstem.

References


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