Introduction

First, we investigate how the cortical representation of speech is affected by noise. We record from human subjects listening to a narrated story using magnetoencephalography (MEG). The narrated story is presented in spectrally matched stationary noise at different signal-to-noise ratios (SNR). We find that the low frequency cortical activity that follows the speech envelope is robust to noise until about -9 dB SNR and is related to individual intelligibility score. Second, we compare the time and frequency domain analysis of the MEG response synchronized to the speech envelope.

Stimuli & Data Analysis

Stimuli

The speech materials were selected from a narrated story, and cut into 50-second duration segments. A spectrally matched stationary noise was mixed into speech with one of six SNRs, i.e., quiet (no noise added in), +6 dB, +2 dB, -3 dB, -6 dB, and -9 dB. All the sections were presented sequentially and then repeated twice (3 trials in total). The subjects had to answer a comprehension question after each section, and rate speech intelligibility during the first presentation of each section. The background noise reduces the dynamic range of the stimulus (as evident from the stimulus envelope), and distorts the spectro-temporal features of speech.

Data Analysis

MEG: 157-channel, whole-head MEG, 1 kHz sampling rate, resampled to 40 Hz. The neural source of MEG activity is localized using an equivalent current dipole model, one per hemisphere, 10 subjects participated in the experiment.

Temporal Response Function:

If the MEG response is modeled as the speech envelope processed by a linear system, the temporal response function (TRF) is the impulse response of the linear system. In other words, the neural response from a MEG sensor is modeled by the stimulus envelope convolved with a TRF. The TRF can be interpreted as the neural response evoked by a unit power increase of the stimulus. The TRF has two salient peaks, the M50TRF and M100TRF, which have opposite polarity. The source of the M100TRF is consistent with the source of the M100 evoked by a tone pip, which is a posterior association auditory cortex. The source of the M50TRF is more anterior than the source of the M100TRF, and is more close to core auditory cortex.

Coherence Spectrum

The coherence spectrum refers to the inter-trial correlation of the MEG response filtered into narrow frequency bands. It reflects how repeatable the MEG response is when the same stimulus is played multiple times, and is a measure of the degree of phase-locking of the MEG response. It is a non-parametric characterization of the neural response and does not explicitly model the relationship between the stimulus and response.

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