Neural Coding of Single and Simultaneous Talkers in Auditory Cortex

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Cocktail Party Problem

(Alex Katz)
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Magnetoencephalography (MEG)

(Alex Katz)
Experiment

• **Monaural speech**
  2 minute audio book excerpt

• **Dichotic speech mixture**
  a different audio excerpt in each ear
  attention on one ear

**MEG Recording**
Whole head MEG system
Response localized to bilateral auditory cortex in STG.
Neural Code of Temporal Modulations

Speech Stimulus

Frequency

Time

Auditory Model

MEG Response

Model Prediction
Spectro-Temporal Response Function (STRF)

STRF models how spectro-temporal features of speech are encoded into cortical neural activity.
Auditory Model: STRF

Speech Stimulus → STRF → STRF prediction
Auditory Model: STRF

STRF estimated by boosting with cross validation (David et al. 2007)
Neural Coding of Monaural Speech
The neural response tracks the slow temporal modulations of speech in a broad spectral region.

Left ear speech, right/contralateral hemisphere
STRF predicts neural response in low frequencies.
STRF prediction

- MEG measurement
- STRF prediction

2 seconds

Subject 1141
Stimulus envelope reconstruction

- MEG measurement
- STRF prediction

----- stimulus speech envelope
----- speech envelope reconstructed from MEG response

2 seconds

Subject 1141
Binaural STRF Model

Speech Stimulus

STRF

STRF prediction
Binaural STRF Model

Speech Stimulus  |  STRF  |  STRF prediction

Left

Right
STRF

Representative Subject

Attended

Unattended

Grand Average

Attended

Unattended

Left ear speech, right/contralateral hemisphere
Attentional Modulation

Contralateral Hemisphere  Ipsilateral Hemisphere

STRF amplitude

7 dB attentional gain in contralateral hemisphere
3 dB attentional gain in ipsilateral hemisphere
Binaural STRF Model

Speech Stimulus

STRF

STRF prediction

Left

Right

Attention
Summary

• Low frequency neural activity in human auditory cortex quantitatively encodes the slow temporal modulations of speech.

• Simultaneous speech signals are separately represented in auditory cortex, and the attended speech signal is encoded with larger gain.
Acknowledgement

• We thank David Poeppel & Stephen David for many insightful discussions!

Work supported by NIDCD.

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