Suppressing Auditory Background Speech: a Link to Auditory Hallucination in Schizophrenia

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Introduction
Schizophrenia is a severe brain disorder, where a hallmark symptom is auditory hallucination. The origin of auditory hallucination, which dissociates auditory perception from acoustic stimuli, may be fundamentally a bottom-up problem, caused by erroneous processing of diverse external auditory inputs, or a top-down modulation problem, e.g., from attentional deficits or due to a failure to appropriately segregate/communicate internally-generated contents with the externally-oriented primary auditory pathway.

This study uses magnetoencephalography (MEG) to investigate the latter hypothesis using a “cocktail-party” listening paradigm: listeners attend to one speaker, suppressing the presence of another, again dissociating auditory perception from acoustic stimuli.

Methods
Participants
• 24 schizophrenia patients, age 21-61, 17 male
• 28 healthy controls, age 22-61, 20 male

Auditory Hallucination Index
• Evaluated for patients via Psychotic Symptom Rating Scales - AH (PSYRATS-AH)

Stimulus Paradigm
• 60 s duration segments of a story
• Narrated by separate male and female adults
• Digitally mixed into a single channel
• Presented diotically (identical stereo channels)
• “Listen to only one speaker at a time”

Switch to other speaker for next stimulus

MEG Recording
• 157 channel KIT/Eagle MEG Scanner
• 1 kHz sampling frequency
• Denoised by Time-Shift PCA (TSPCA),1
• Denoising Source Separation (DSS)2,3 enhances response reliability over trials (D=6).
• Neural responses bandpass filtered 2–8 Hz.

Temporal Response Function Analysis
• Temporal Response Function (TRF): a temporal measure that uses a stimulus acoustic envelope to optimally predict neural responses.
• Separate TRFs computed for Attended and Unattended speech stimuli.
• M50TRF and M100TRF (peaks with latency ~50 ms and ~100 ms respectively) tabulated

Results
Representative Attended & Unattended TRFs

Attended (upper) and Unattended (lower) TRFs from a representative schizophrenia patient. The amplitude and timing of the two M50TRFs are typically similar, regardless of attention. The Attended M100TRF, in contrast, is typically larger and earlier than Unattended.

Discussion
• Recent results from Puschmann et al. connect neural activity in right temporoparietal junction (TMJ) to successful selectively listening in speech, e.g., successful suppression of unattended speech.
• Auditory hallucinations are likewise connected to activity in both TMJ and auditory cortical areas whose activity strongly locks to speech.
• Deficits in speech-rate (delta band) auditory oscillations are associated with schizophrenia in general, and verbal working memory symptoms in particular.

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