Engagement of the Cingulo-Opercular System Enhances Future Word Recognition

KI Vaden, SE Kuchinsky, SL Cute, JB Ahlstrom, JR Dubno, MA Eckert
Department of Otolaryngology-Head and Neck Surgery
Medical University of South Carolina, Charleston, SC

Introduction
The engagement of attention systems is critical for successful communication, particularly when difficult listening conditions diminish speech intelligibility. Speech recognition requires more effort in noise and elicits increased activity in frontal cortices that are collectively referred to as the cingulo-opercular network [CO; 1,2].

The CO network responds to difficulty, response uncertainty, and errors across a range of experimental tasks [3]. Neuroimaging studies involving non-linguistic tasks have shown that CO activity also can predict behavioral adjustments on subsequent trials [4].

The goal of the current study was to assess the extent to which CO network activity predicts word recognition on subsequent trials in a normative sample of young adults.

Predictions:
1. Elevated CO activity provides a word recognition benefit.
2. Coherent CO network engagement improves word recognition.

Method
Participants: 18 young, normal hearing adults [20-38 years, m = 29.2, sd = 5.8; 10 females; native English speakers; right-handed distribution (m = 68.3, sd = 50.3; 7)]. Mean pure tone thresholds (200 Hz to 8000 Hz) were less than 9.2 dB HL.

Task: Listen, then repeat the word aloud, or say “nope” if it was not recognizable.

Stimuli: 120 consonant-vowel-consonant words in multi-talker babble.
- Multi-talker babble: 82 dB SPL; speech: 85 dB SPL (60 words, +3 dB SNR).
- Multi-talker babble: 92 dB SPL (60 words, +10 dB SNR).

Words were presented in alternating SNR-blocks of 4-6 trials, 60 trials per epoch.

Word recognition: Correct if the word was repeated exactly as it was presented.

Trial Design

Experiment Design

Word Recog.: poorer in the +3 dB SNR (66.1 ± 7.6%) than in the +10 dB SNR (90.9 ± 3.9%), Z = 11.34, p < 0.001.

Conclusion: Correct the word recognition increases following errors (red bar height denotes mean error for each trial) and during +3 dB SNR trials (dark blue bars) compared to +10 dB SNR trials (light blue bars).

BOLD Associated with Improved Subsequent Word Recognition

Connectivity: Task

Connectivity: Rest

Results

Word Recognition: CO network activity increased before correct responses, after controlling for SNR effects on activity. Connectivity between CO regions increased during word recognition compared to rest epochs, Z = 4.93, p < 0.001. Correct responses were more likely after more CO regions exhibited elevated activity, Z = 2.03, p = 0.04

Conclusions
Elevated CO activity is frequently observed when speech recognition requires greater effort [1-2, 7-10].

Our results show that CO engagement increases the likelihood of correct word recognition on the next trial, similar to findings in visuospatial studies [4,11]. Furthermore, the trial-level connectivity analysis demonstrated that correct word recognition increased when all regions in the CO network exhibited elevated activity on the previous trial.

These findings are consistent with the premise that the CO network is important for adaptive control, including during word recognition.

References
6. E-Prime presented scanner-synched stimuli with Sensimetrics piezoelectric insert earphones and recorded responses with a Resonance Technology microphone.

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