Stereo EEG Mapping of Sensorimotor Responses to Self-Generated Speech

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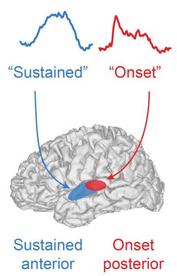
Introduction and motivation

· A key component of speaking is integration of sensory information[1].

· Speaker-induced suppression occurs when internally generated speech generates less of a neural response than externally generated speech[2].

· Superior temporal gyrus (STG) exhibits onset and sustained responses to speech perception[3] – are both these response profiles present during speech production?

· Is speaker-induced suppression related to speech production being more predictable (via efference copy) than perception[4]?



Methods

· n=6 patients at Dell Children's Medical Center in Austin, Texas.

· sEEG (stereoelectroencephalography) seizure monitoring for medically intractable epilepsy.

· 776 total electrodes across participants.

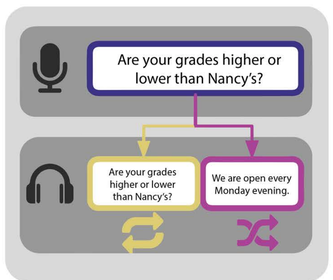
· Dual perception-production task, where participants read a sentence aloud, then listened to playback of themselves reading

· Playback was either predictable (immediately repeated) or unpredictable (random previous trial)

· Conditions have identical acoustic stimuli (perception stimuli generated from production)

Participant	Age	Sex	Coverage
S0004	16	F	RH: STG, ITG, insula
S0006	14	M	RH: STG, MTG, insula, IFG, cingulate
S0007	19	M	RH: STG, MTG, insula, IFG, OFC
S0014	13	M	LH: STG, MTG, insula, IFG, OFC, cingulate
S0015	18	F	RH: STG, MTG, insula, IFG, OFC, SPL
S0017	14	F	RH: STG, MTG, insula, IFG, MFG, occipital, SMG

Participant information



Task schematic

Anatomically distinct onset and sustained response profiles for speaking and listening

· Nonnegative matrix factorization[5] was used to cluster electrodes from all participants into anatomically distinct response profiles.

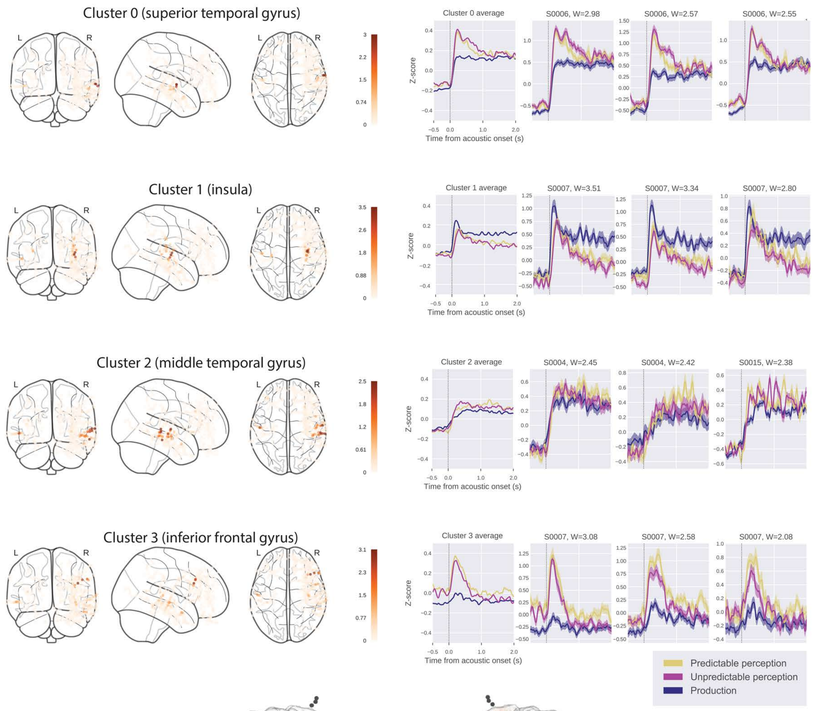
· Cluster 0 (STG): selective suppression of onset responses during **speech production.**

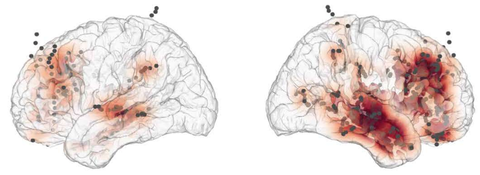
· Cluster 1 (Insula): responses to both speaking and listening, but production responses occurred on a faster timescale than perception.

· Cluster 2 (MTG): Sustained responses to all behavioral conditions.

· Cluster 3 (IFG): Onset responses to speech perception; no response to production.

· **Predictable** and **unpredictable** speech perception did not elicit different pattterns of responses across any cluster.





Anatomical distribution of 776 electrodes warped to template brain.
Color represents density of coverage.

Phonological feature tuning during speaking and listening is similar

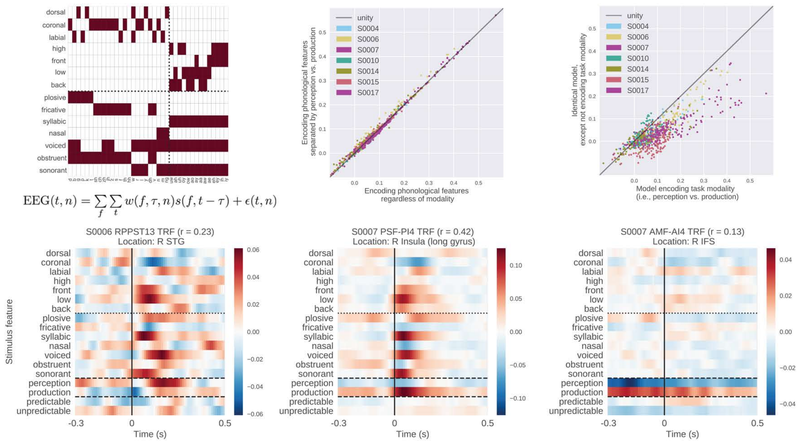
· Top left: mTRF[6] encoding models were fit to examine phonological feature tuning.

· Top middle: models that encode phonological conditions during speaking and listening separately, and those that don't, performed similarly.

· Top right: omitting task condition (i.e., whether a phoneme occurred during speaking or listening) severely impaired model performance.

· Bottom left, center: STG and insula electrodes showed strong phonological feature tuning.

· Bottom right: IFG electrodes do *not* model phonological features well, suggesting the IFG plays a different role in speech perception than STG and insula.



$$\mathrm{EEG}(t,n) = \sum_f \sum_\tau w(f,\tau,n)s(f,t-\tau) + \epsilon(t,n)$$

Conclusions

· Speaker-induced suppression appears to be the suppression of onset responses, not differences in phonological feature tuning.

· Perceptual electrodes in the inferior frontal cortex do not encode phonological features well and likely play a different role in the processing of speech.

· The insula responses to both speaking and listening, and may serve as an interface between these functions.

References & Acknowledgements

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