

Towards a Functional Neuroanatomy of Speech Perception

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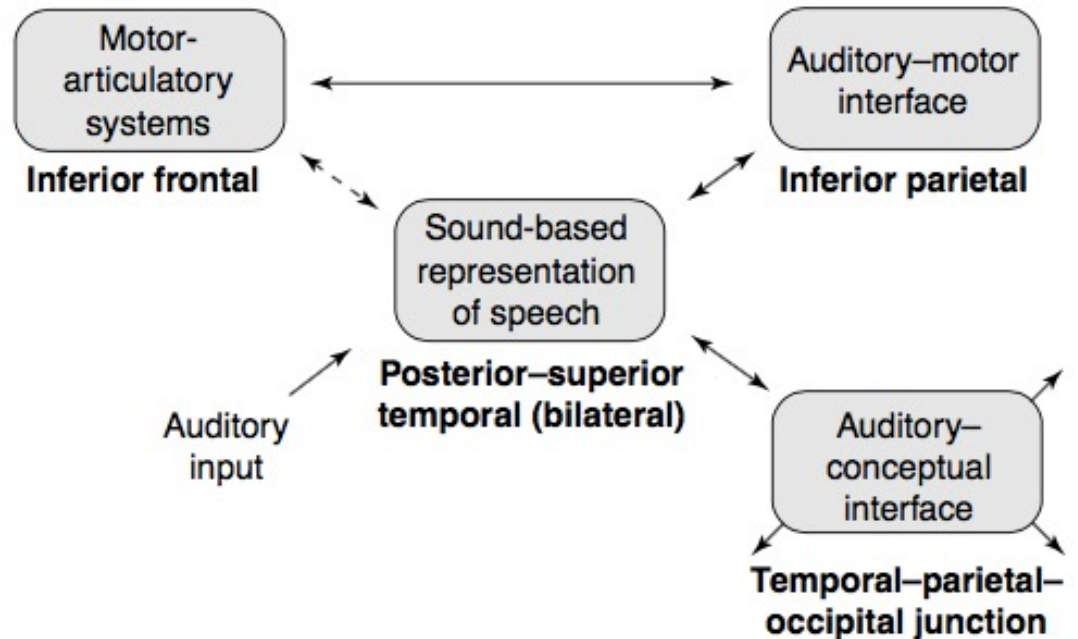
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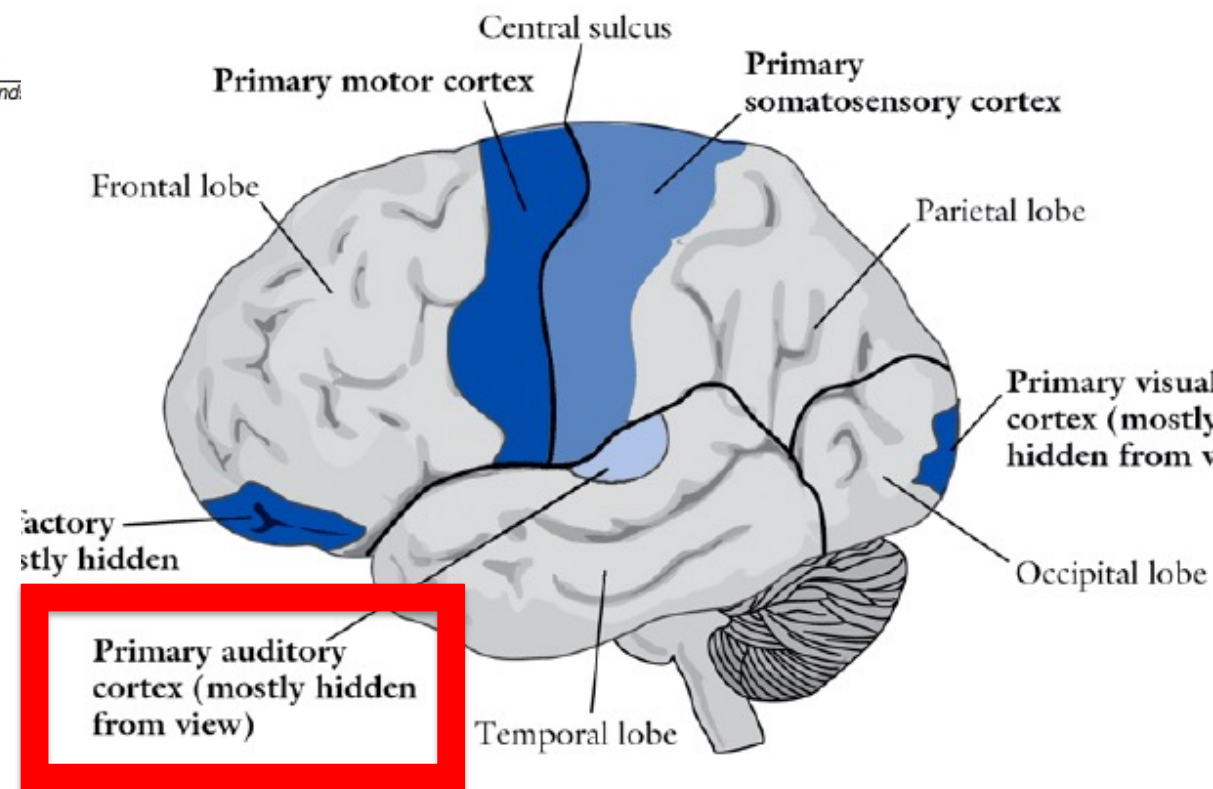
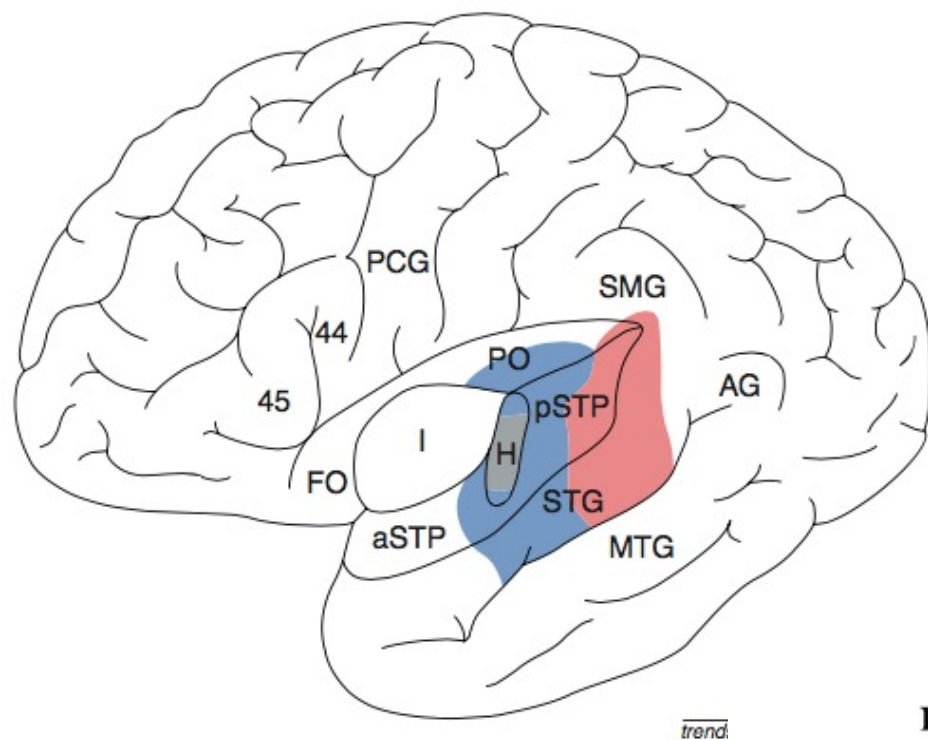
Argument

- Cortical fields in the **posterior-superior temporal lobe**, **bilaterally**, constitute the primary substrate for constructing sound-based representations of speech
- At least 2 distinct pathways that participate in speech perception in a task-dependent manner, with strong lateralization to the left hemisphere

2 Pathways

- Left temporal-parietal-occipital junction (auditory-to-meaning) → access mental lexicon
- Left frontal and parietal lobes (auditory-motor) → Access explicit speech segments





Aphasia

- Transcortical Sensory Aphasia (TSA) - Fluent
 - Associated with damage to TPO junction with most of pSTP/STG spared
 - Speech perception ability not affected b/c patients were able to repeat the heard speech
- Wernicke's Aphasia - Fluent
 - Associated with damage to the pSTP/STG, with extension either into MTG or TPO junction or both
 - Speech perception ability slightly affected/not severe.
 - Preserved speech perception is due to the right hemisphere's speech perception ability

Word Deafness

- Form of auditory agnosia
- They still have the ability to hear but speech perception is impaired.
- Bilateral lesion in the superior temporal lobe

The Isolated Right Hemisphere

- Split brain patients and amobarbital injection studies both indicate that in some cases, the isolated right hemisphere has the ability to understand simple speech
- There is also evidence of the right hemisphere performing speech discrimination tasks

Electrical interference evidence

- Boatman et al. proved involvement of the posterior superior temporal lobe.
- Used **electrical interference** to study the functional anatomy of speech perception in a series of 3 patients undergoing clinical evaluation for surgical treatment of epilepsy.
- Found stimulation sites along the **left pSTG** consistently compromised performance on speech perception tasks (i.e. syllable discrimination/identification and/or auditory comprehension)

Physiological Evidence

- fMRI, PET, MEG → all show **bilateral** activation in the **Superior Temporal Lobe**
- Intraoperative recordings for epilepsy treatment surgery show majority of speech-responsive cells in the **STG**.

Differing Contributions to Speech Perception by Left and Right Temporal Lobe

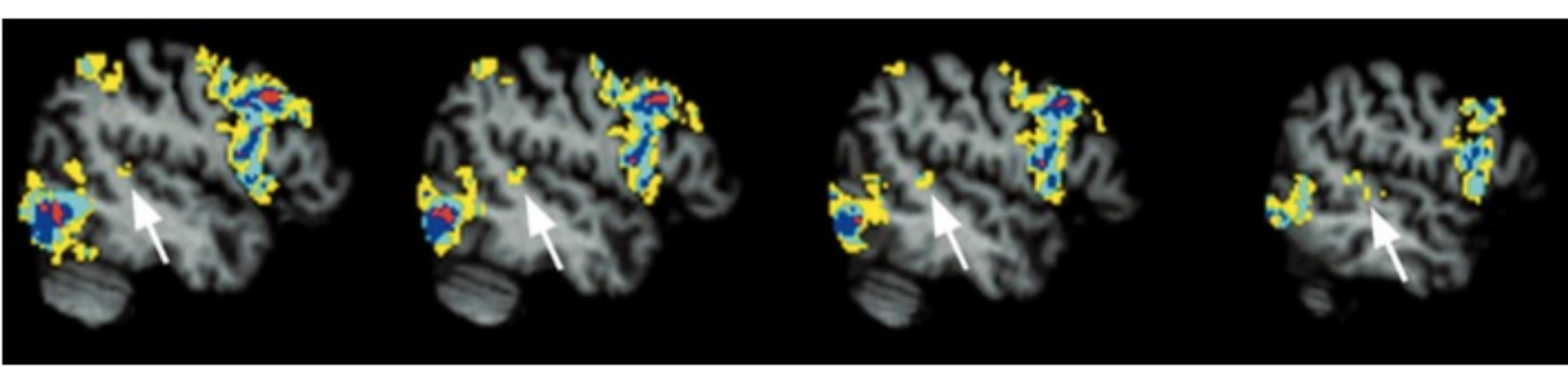
- Left and Right systems make different contributions to perceptual analysis
- In split brain patients, noise adversely affected right hemisphere performance than left
- Functional imaging techniques (PET, MEG) show response differences in the 2 hemispheres.

Speech Perception in Tasks Requiring Explicit Attention to Phonetic Structure

- Fronto-parietal network predominantly in the left hemisphere, functions to interface auditory and articulatory representations of speech.
- Activation in fronto-parital lobes during sub-lexical tasks (i.e. phoneme monitoring)
- Ability to repeat pseudowords (where semantic mediation is impossible) = evidence for auditory-motor interface system

A role for left auditory cortex in speech production

- Left auditory cortex (pSTP/pSTG) activated not only in speech perception but also during speech production!
- PET, MEG, fMRI



Take Home

1. The posterior-superior temporal lobe, bilaterally, constitutes the primary substrate for the construction of sound-based representations of speech.
2. While both hemispheres participate, they make different contributions to speech perception.
3. Left hemisphere frontal and parietal regions, may be understood in terms of a system that supports auditory-motor interaction (similar to visual-motor interaction)
4. Auditory cortex in the left pSTP/pSTG participates in aspects of speech production.