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Neural Correlates of Auditory Comprehension

Juliana Baldo[1], Sandy Lwi[1], Brian Curran[1], Nina Dronkers[1,2], Timothy Herron[1], and Krista Schendel[1]

[1]VA Northern California Health Care System, [2]University of California, Berkeley

For information/reprints, email jvbaldo@gmail.com

INTRODUCTION

Debate exists as to the neural basis of auditory comprehension. Traditionally, it was associated with Wernicke's area, which includes left posterior superior temporal cortex and sometimes inferior parietal cortex.[1] Newer data from our group suggests an important role for the left posterior middle temporal lobe and underlying white matter in auditory comprehension.[2-5] Some discrepancy in the literature is likely due to the use of different types of comprehension tasks across studies. In the current study, we used lesion-symptom mapping (LSM) to identify critical brain regions underlying auditory comprehension in three distinct tasks: Yes/No question comprehension, sequential command comprehension, and single word comprehension. This retrospective study included 168 chronic left hemisphere stroke patients with a wide range of auditory comprehension impairment.

PARTICIPANTS

168 single, left hemisphere stroke patients

- 138 male, 30 female
- chronic phase (> 12 months post-stroke)
- right-handed
- native English speaking
- no neurologic/severe psychiatric history
- mean time post-stroke: 51.4 months (range 12-271)
- mean age: 61.2 (range 31-86)
- mean education: 14.9 years (range 8-20)

Aphasia Classification on Western Aphasia Battery

- Transcortical motor (n=1)
- Transcortical sensory (n = 3)
- Global (n = 4)
- Conduction aphasia (n =6)
- Wernicke's (n = 14)
- Broca's (n = 45)
- Anomic aphasia (n = 47)
- Within normal limits (n = 48)

PROCEDURE

Auditory Comprehension Tests

Auditory comprehension subtests were taken from the Western Aphasia Battery (WAB), a speech and language test battery that measures multiples areas of language (e.g., comprehension, speech fluency, naming)

Yes/No Questions (20 items)

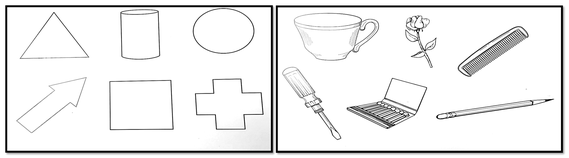
- "Am I a woman?"
- "Is this a hotel?"
- "Do you cut the grass with an ax?"
- *Average score: 92% correct; range 0-100%*

Sequential Commands (11 items)

- "Point to the chair"
- "Point to the pen and the book"
- "Point to the comb with the pen"
- *Average score: 58% correct; range 0-100%*

Single-Word Recognition (60 items)

- real and pictured objects
- shapes
- letters and numbers
- colors
- furniture
- body parts
- *Average score: 85% correct; range 13-100%*



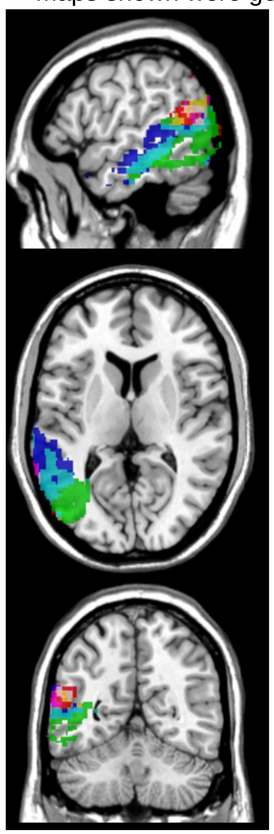
Stimuli pages from recognition task

RESULTS

Neural Correlates of Auditory Comprehension Subtests

Lesion-Symptom Mapping of Auditory Comprehension in 168 patients

- critical *t*-value cutoff scores based on permutation-testing and minimum of 5 patients in each voxel
- covariates: lesion volume, age, education, gender, log months post-stroke, and overall aphasia severity
- maps shown were generated with univariate LSM and confirmed with multivariate LSM analyses



Yes/No Question Comprehension (in blue)

- left mid - to posterior middle temporal gyrus (*t*-max at -66,-22,-16)
- small portions of left posterior superior temporal and inferior temporal gyri

Sequential Command Comprehension (in red)

- left posterior middle temporal gyrus (*t*-max at -64,-54,14)
- small portions of left superior temporal and angular gyri

Single Word Comprehension (in green)

- left mid- to posterior inferior temporal gyrus (*t*-max at -60,-38,-14)
- left posterior middle temporal gyrus
- small portions of left angular and inferior-middle occipital gyri and underlying white matter

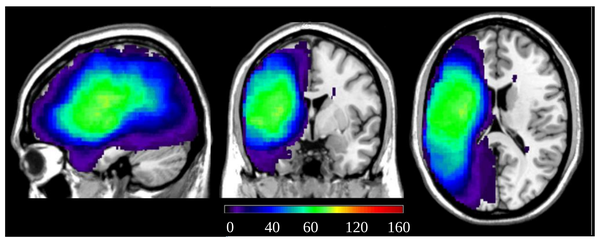
Common overlap for Yes/No Questions and Single Word Comprehension (in aqua)

- left mid- to posterior middle temporal gyrus

Common overlap across 3 subtests (in black)

- small region of left posterior middle temporal gyrus

LESION COVERAGE MAP



Overlay of patients' lesions showing voxels included in the LSM analysis. Color bar indicates number of patients with lesion overlap.

SUMMARY

The current study used lesion-symptom mapping to identify the neural correlates of 3 different aspects of auditory comprehension in a large sample of 168 stroke patients. All 3 tasks overlapped in a small portion of left posterior middle temporal cortex, but there was substantial divergence as well: Single-word auditory comprehension was additionally associated with inferior temporal cortex and underlying white matter, as well as posterior temporo-occipital regions; Yes/No questions was associated primarily with mid - to posterior middle temporal gyrus; and comprehending sequential commands was associated with the left posterior middle temporal gyrus, with some involvement of left superior temporal and angular gyri. These findings provide context for discrepant results in the literature on auditory comprehension that may arise from the use of different types of tasks. Based on our results and perhaps not surprisingly, tasks involving picture/object stimuli are associated with more inferior temporal cortical regions, while sentence-level tasks (which likely engage verbal working memory) tap more superior temporal and inferior parietal cortices. The only region common to all 3 subtests was a small region of posterior middle temporal gyrus, a highly-interconnected region that we and others have shown to be a critical hub for lexical-semantics.[5-7]

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