Understanding The Brain Through Language:
A Window Into Cognition
Announcements

• Quiz B – on Week 2 material will be administered during sections this week.
• You must go to section to take the quiz.
• Remember – no make up quizzes.
• Lowest quiz will be dropped.
• Make sure you go to a section this week!
• Review questions for Week 2 material are posted under the “lecture” tab on the website. 😊
• Quiz C – on Week 3 material will be administered during sections next week.
• You must go to section to take the quiz.
• Midterm 1 will cover all material from weeks 1-3 (readings and lectures.)
• Midterm 1 review – next Friday in lecture 😊
• Midterm 1 exam – Monday week 5 in lecture.
How does the brain understand and produce language?
Warm up Quit!
The motor homunculus:

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<tr>
<td>A</td>
<td>Is a pictorial representation of the brain regions which control the body.</td>
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<tr>
<td>B</td>
<td>Shows that humans have a great emphasis on controlling mouth and hand movement</td>
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<td>C</td>
<td>Diagram on the right indicates the location and amount of cortex devoted to each part of the body.</td>
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<tr>
<td>D</td>
<td>All of the above are true.</td>
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The Wada test is a procedure ....

A. that assesses which side of the patient’s brain is dominant for language function.

B. in which one hemisphere is put to sleep (anesthetized) by injecting an anesthetic into the carotid artery.

C. that clinicians use to mitigate unwanted functional damage during brain surgery by learning which areas of the brain are essential for speech.

D. All of the above
Language dominance (LH) vs. spatial visualization (RH)
sign language has different sensory and motor modalities

sign for drink
spoken language vs signed language

?? Is language set up in the brain the same for hearing and speaking as for signed language?
Frontal lobe
central sulcus
Primary Motor Cortex (M1)
Motor Homunculus
Broca’s Area
Lateral sulcus

Temporal Lobe

Primary Auditory Cortex (A1)

Wernicke's Area
Broca's area:

Primary Auditory Cortex (A1)

Primary Motor Area (M1)

Wernicke's Area
Retina
Lateral Geniculate Nucleus (Thalamus)
Primary Visual Cortex (V1)
Occipital Lobe
Parietal Lobe
Spatial Visual Information (Where)
Object Visual Information (What)
Are the same areas of the brain used for spoken language as for signed language?

What happens to language processing when a hemisphere is damaged?
Is language set up in the brain for hearing and speaking?

- **Broca’s area**: mouth articulation and speech production
- **Wernicke’s area**: speech comprehension auditory area
The region associated with language comprehension is typically associated with:

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<tbody>
<tr>
<td>A</td>
<td>Broca’s area</td>
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<td>B</td>
<td>Wernicke’s area</td>
</tr>
<tr>
<td>C</td>
<td>Primary Motor Cortex (M1)</td>
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<tr>
<td>D</td>
<td>Primary Visual Cortex (V1)</td>
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What happens to deaf signers that have hemispheric damage?

1. Signers with (LHD) left hemisphere brain damage have sign-language deficits.
2. Wernicke’s area damage → comprehension problems.
3. Broca’s area damage → production problems.
What happens to signer's with right hemisphere damage (RHD)?

Drawings (right) depict maintenance of a spatial framework for an extended discourse in American Sign Language.

(Left) Many signers with RHD make mistakes in their spatial organization of a discourse.

Using brain lesions to infer a structure-function relationship

1. How systematic is the consequence of the damage across the patient population?
2. A localization-function map has been generated using patients with brain injuries.

What is the relationship between brain region and functionality?
Broca’s Aphasics:
Have difficulties in producing speech but have relatively good comprehension

Can utter well-learned phrases perfectly
Limited ability to express oneself
No function words (e.g. “the”, “if”)
Use gesture and nodding to communicate
Does not destroy all ability to communicate

Bottom Line:
The inferior front (anterior) part of the LH may be critical for producing spoken language, especially for building sentences.
Wernicke’s Aphasics:
Can speak ‘fluently’ but fail to understand speech sounds.

Bottom Line:
LH upper temporal lobe area is necessary for language comprehension.

From research in LHD/RHD deaf patients – language processing is not determined by the auditory input modality.
This is not the complete story, but spoken and signed languages appear to depend on the same cortical substrates.
Additional Readings
Sign Language and the Brain: A Review

How are signed languages processed by the brain? This review briefly outlines some basic principles of brain structure and function and the methodological principles and techniques that have been used to investigate this question. We then summarize a number of different studies exploring brain activity associated with sign language processing especially as compared to speech processing. We focus on lateralization: is signed language lateralized to the left hemisphere (LH) of native signers, just as spoken language is lateralized to the LH of native speakers, or could sign processing involve the right hemisphere to a greater extent than speech processing? Experiments that have addressed this question are described, and some problems in obtaining a clear answer are outlined.
Why Broca’s Area Damage Does Not Result in Classical Broca’s Aphasia

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Keywords: Broca’s area, Broca aphasia, Broca complex, Broca’s area aphasia, fMRI