

Psych 56L/ Ling 51:
Acquisition of Language

Lecture 4
Biological Bases of Language II

Announcements

Be working on HW1 (due 1/24/13)

Be working on bio bases review questions - remember that collaboration is strongly encouraged

Check out the reference material on the webpage

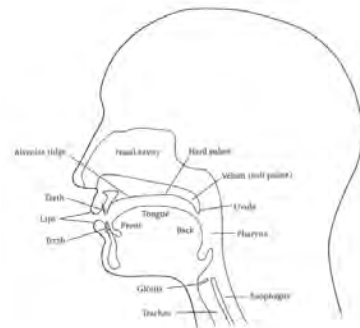


Anatomy & Language



The Human Vocal Tract:
A Finely Honed Instrument

Speech is produced when air from the lungs exits the larynx and is filtered by the vocal tract above the larynx: glottis, pharynx, uvula, velum, hard palate, tongue, nasal cavity, alveolar ridge, teeth, lips.



Methods of Neurolinguistic Investigation

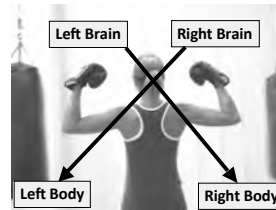
Lesion studies: correlate missing bits of brain (lesions) with missing bits of psychological functioning.

One very interesting kind of missing brain bit: split or damaged corpus callosum, found in split brain patients



Methods of Neurolinguistic Investigation

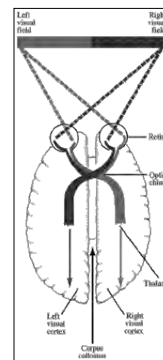
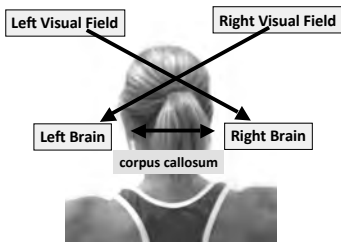
- Contralateral connections in the 1860s: investigators apply electric currents to brains of anesthetized animals and made an interesting discovery.



Note on connections:

Contralateral: across
Ipsilateral: same side

Hemispheres & Visual Field



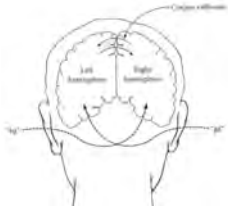
Information Flow:

LVF → RH → LH

RVF → LH → RH

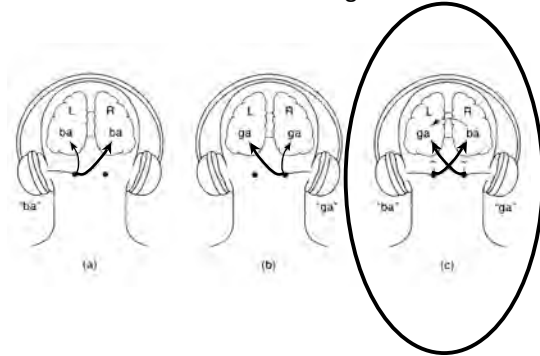
Methods of Neurolinguistic Investigation

Dichotic listening tasks: use the fact that contralateral connections from the ears to the brain are stronger than ipsilateral connections. Experimenters present two tasks at the same time, one to each ear, and ask subjects which one is perceived.



If subjects say the left ear's stimulus, then the right side of the brain processes that signal. If subjects say the right ear's stimulus, then the left side of the brain processes that signal.

Dichotic Listening



Methods of Neurolinguistic Investigation

ERPs: Event-related brain potentials, gauged via electrode caps. The location of ERPs associated with different mental activities is taken as a clue to the area of the brain responsible for those activities.



Good: non-invasive, relatively undemanding on the subject, provide precise timing on brain events

Bad: poor information on exact location of ERP since just monitoring the scalp

Methods of Neurolinguistic Investigation

Brain-imaging techniques: gauge what part of the brain is active as subjects perform certain tasks

PET scans: Positron emission topography scans

- subjects inhale low-level radioactive gas or injected with glucose tagged with radioactive substance
- experimenters can see which parts of the brain are using more glucose (requiring the most energy)



<http://www.youtube.com/watch?v=5KXIDUo18aA>
[Language Processing in the Brain: 6:26 long]

Methods of Neurolinguistic Investigation

Brain-imaging techniques: gauge what part of the brain is active as subjects perform certain tasks

fMRI scans: functional magnetic resonance imaging

- subjects have to be very still inside MRI machine, which is expensive to operate
- experimenters can see which parts of the brain are getting more blood flow or consuming more oxygen

Methods of Neurolinguistic Investigation

Brain-imaging techniques: gauge what part of the brain is active as subjects perform certain tasks

MEG: Magnetoencephalography

- subjects have to be very still
- experimenters can see which parts of the brain are active



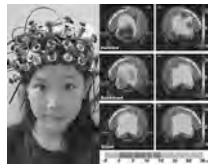
Video of word recognition in brain (10 sec long):
<http://www.mrc-cbu.cam.ac.uk/facilities/meg/>

Methods of Neurolinguistic Investigation

Brain-imaging techniques: gauge what part of the brain is active as subjects perform certain tasks

Optical Topography: Near-infrared spectroscopy (NIRS)

- transmission of light through the tissues of the brain is affected by hemoglobin concentration changes, which can be detected



Where is language located? Left hemisphere evidence

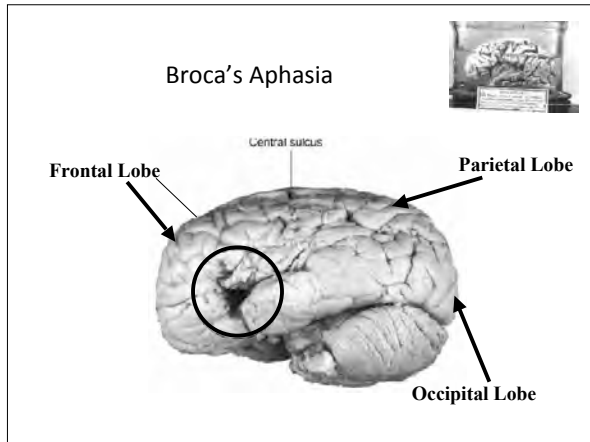
From brain injury and aphasia (when language is severely impaired):

Paul Broca's lesion studies

- "Tan", who had left hemisphere lesion and loss of language abilities



Functional asymmetry: damage to the left hemisphere seems to cause language problems (whether it is spoken or signed) while damage to the right hemisphere seems to cause non-linguistic visual-spatial information processing problems.



Broca's Aphasia

Patients have trouble producing speech, mostly content words (nouns and verbs) with few grammatical morphemes

"Yes... ah... Monday... er... Dad and Peter H... [his own name], and Dad.... er... hospital... and... ah... Wednesday... Wednesday, nine o'clock..."

Video of sample speech from a Broca's aphasic:
<http://www.youtube.com/watch?v=f2liMEbMnPM>

However, there are also issues with understanding more complex grammatical forms.


http://www.learner.org/vod/vod_window.html?pid=1574 [7:40 long]
 (especially 2:43-6:16)

Broca's Aphasia

Broca's aphasics & comprehension:

Relatively good comprehension of some sentences:
 Can understand sentences like these:

The dog bit the woman.
 The apple that the boy is eating is red.

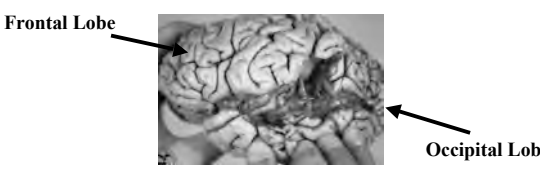


...but not these (because their meaning can't be inferred from the meaning of the nouns and verbs alone):

The car is pushed by the truck.
 The girl whom the boy is pushing is tall.

Wernicke's Aphasia

- Patients with posterior lesions in the left hemisphere
- Speech is fluent
- But comprehension is impaired



Frontal Lobe Occipital Lobe

Wernicke's Aphasia

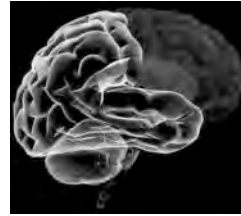
Patients have speech that is "syntactically full but semantically empty"
"I feel very well. My hearing, writing been doing well. Things that I couldn't hear from. In other words, I used to be able to work cigarettes I didn't know how..."

Videos of sample speech from Wernicke's aphasics:
<http://www.youtube.com/watch?v=B-LD5jzXpLE>
<http://www.youtube.com/watch?v=aVhYN7NTIKU>

Comprehension is very low.

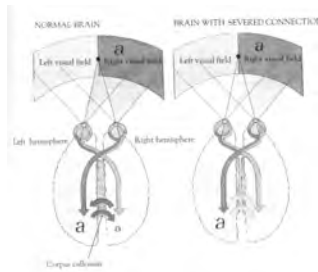
Also, see http://www.learner.org/vod/vod_window.html?pid=1574 from about 6:20 through 7:40.

Where is language located?



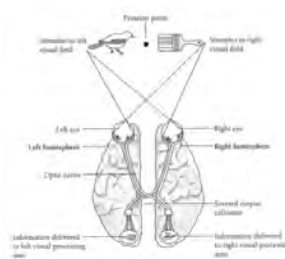
Where is language located? Left hemisphere evidence

From split-brain patients (with severed corpus callosum - no communication between hemispheres)



Where is language located? Left hemisphere evidence

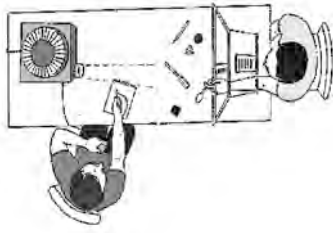
From split-brain patients (with severed corpus callosum - no communication between hemispheres)



Can't say what they saw on the left side, but can draw with their left hand.

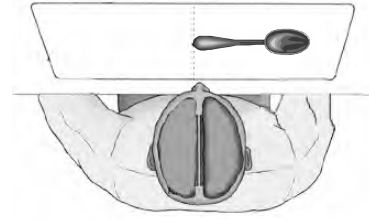
Testing Split Brain Patients

General Testing Setup



Testing Split Brain Patients

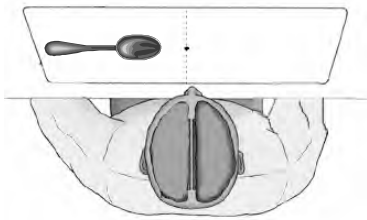
Name that object
(picture in RVF)



Patient says: "Spoon!"

Testing Split Brain Patients

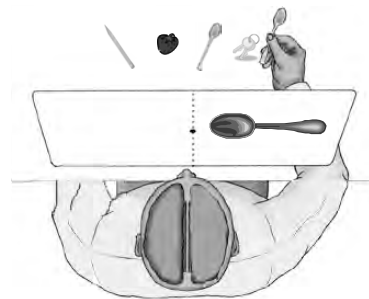
Name that object
(picture in LVF)



Patient: *(says nothing)*
Researcher: "Did you see anything?"
Patient: "Nope."

Testing Split Brain Patients

Pick up the
object
displayed
(picture in
RVF)



Right Hand: Pulls out spoon
Left Hand does nothing

Testing Split Brain Patients

Pick up the object displayed (picture in LVF)

Left Hand: Pulls out spoon!
Right hand does nothing

Left Hemisphere rationalizing behavior of Right Hemisphere

Figure 1. Communication continues down the left hemisphere.

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Typical Split Brain Patient

- **Left Brain:**
 - Normal language use
 - No easily detectable deficits.
- **Right Brain:**
 - Some rudimentary word recognition.

Extremely useful walkthrough of a split-brain study

http://ebooks.bfwpub.com/psychinquiry/shell.php?activity=simulate_splitbrain

Simulate a Split-Brain Experiment

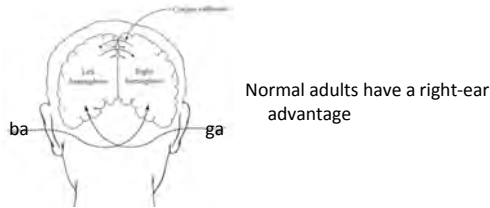
Simulate a Split-Brain Experiment

By Thomas E. Lubwig, Moor College

This activity will take about 15 minutes to complete.

Where is language located? Left hemisphere evidence

From normal adults: dichotic-listening experiments



Evidence for Left Hemisphere Lateralization from American Sign Language

- Deaf Signers with Left Hemisphere Damage:
 - Language Deficit. Aphasic.
- Deaf Signers with Right Hemisphere Damage:
 - Visuo-Spatial Deficits.
 - No easily detectable language deficits.
- Left Hemisphere implicated in language

Poizner, Klima, & Bellugi (1987)

Hickok et al. 1998: ASL lateralization evidence

Left hemisphere damage leads to language damage while right hemisphere damage does not

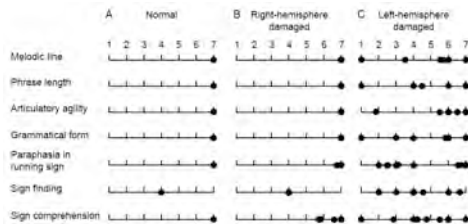


Fig. 1 Group data showing the effects of left versus right hemisphere damage on American Sign Language (ASL) ability in deaf life-long signers. Note that, relative to normal subjects (A) and subjects with right-hemisphere damage (B), left-hemisphere hemispheric patients show (C) greater deficits in a range of ASL skills. The 7-point rating scales the each measure of performance are as follows: Melodic line, 'absent' (1) through 'limited to short, stereotypical phrases' (7); Phrase length, 'from single signs' (1) to 'short strings of signs' (8); Articulatory agility, 'from 'absent' responses' (1) through 'verbal only in familiar signs and phrases' (8); Grammatical form, 'from 'verbal' (1) through 'limited to simple declaratives and phrases' (8); Paraphasia in turning signs, 'from 'absent phrases' (1) through 'verbal phrases of various lengths' (8); Sign finding, 'from 'verbal without information' (1) through 'informational (prosodic) to musical' (8); Sign comprehension, 'from 'absent' to 'verbal'.

Why the left hemisphere?

Left hemisphere may process information more analytically.

Trained musicians process music in the left hemisphere. Normal (untrained) people process it on the right.



Left hemisphere may be better at executing well-practiced routines, while right is better at responding to novel stimuli.

Language, for adults, is a well-practiced routine.

Where is language located? Not-just-left hemisphere evidence

Sometimes, aphasia doesn't result when there is left hemisphere damage.
Sometimes, aphasia does result when there is right hemisphere damage.

In some people (usually left-handed people), language is controlled by the right hemisphere.



Where is language located? Not-just-left hemisphere evidence

Right hemisphere contributions to language: tone contour, emotional tone, jokes, sarcasm, figurative language interpretation, following indirect requests (much of this falls under pragmatics)

Evidence: right hemisphere lesion patients

Right hemisphere activated by semantic processing, while left hemisphere activated primarily by syntactic processing

Evidence: ERP studies

Evidence: late language learners who aren't as proficient with syntax, and have language located primarily in right hemisphere

How does a left hemisphere specialization for language develop?

Equipotentiality hypothesis: left and right hemispheres have equal potential at birth

Prediction: dichotic listening and brain injury in children show less specialization for language than adults

Invariance hypothesis: left hemisphere specialization available at birth

Prediction: dichotic listening and brain injury data from children should look like the corresponding data from adults

How does a left hemisphere specialization for language develop?

fMRI studies: newborns and 3-month-old infants show greater left-hemisphere than right-hemisphere activation in response to speech stimuli (as do adults)

- But also greater left-hemisphere activity in response to non-speech sounds, suggesting general bias to process sounds in left hemisphere (older children [10-month-olds] and adults process non-speech sounds with right hemisphere)



How does a left hemisphere specialization for language develop?

Summary from experimental studies:

Language processing appears to be specialized to the left hemisphere as early as researchers can test it.

But the infant brain is not the same as the adult brain - specialization/lateralization continues to increase as the brain matures.

Recap

Researchers interested in the functional architecture of the brain with respect to language are interested in how the brain is organized to accomplish the function of language.

Broca's and Wernicke's aphasics, as well as split brain patients, indicate that certain areas of the brain seem to be integral for processing and producing language.

Many aspects of language seem to be lateralized in the left hemisphere on many people (such as syntax), though some language processing may be done in the right hemisphere (such as semantics/lexical meaning).

Questions?



You should be able to do up through question 6 on HW1 and up through question 24 on the bio bases review questions.