

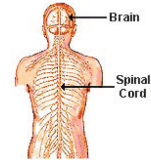
## Lateralization of Function



Dr. Coulson  
Cognitive Science Department  
UCSD

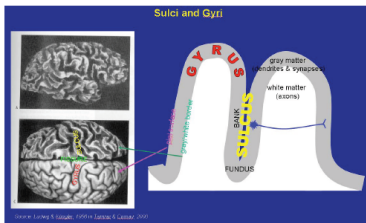
## Human Brain

- An extension of the spinal cord

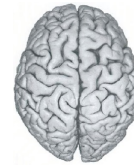


## Cortex

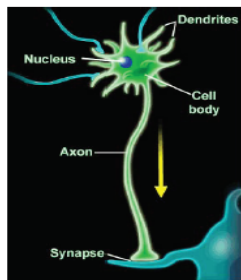
- Two millimeters thick and has area of 1.5 square meters



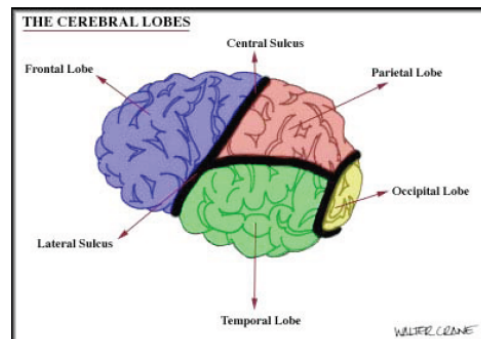
## Cerebral Hemispheres



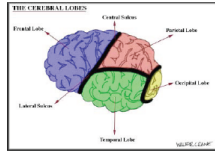
## Corpus Callosum



## Cerebral Lobes

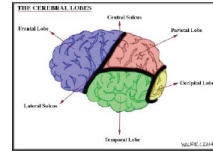


## Cartoon View: Frontal Lobe



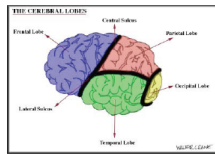
- In front of central sulcus
- Motor control
- Decisions, judgments, emotions
- Language production

## Cartoon View: Parietal Lobe



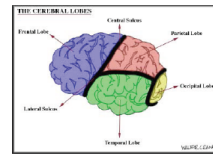
- Behind central sulcus
- Perception of stimuli related to touch, pressure, temperature, pain
- Spatial cognition
- Spatial attention

## Cartoon View: Temporal Lobe



- Below lateral fissure
- Visual perception, object recognition, auditory processing
- Memory
- Language comprehension

## Cartoon View: Occipital Lobe



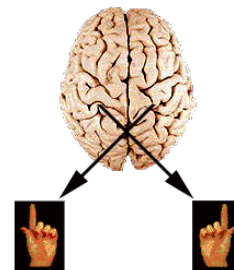
- Located at back of brain, behind the parietal lobe and temporal lobe
- Vision

## Lateralization of Function

- One side of the brain is more crucial for a given function and/or more efficient at the underlying computational tasks
- Typically a matter of degree
  - Strongly vs. Weakly Lateralized
- Motor control a good example of a lateralized function



## Motor Control



## Sensorimotor Cortex

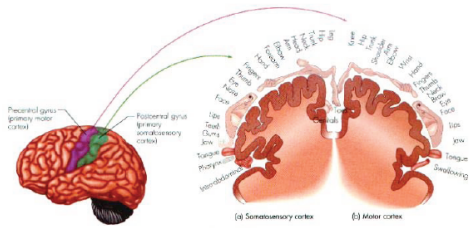


Figure 4.21 Approximate representation of sensory and motor information in the cortex. (a) Each location in the somatosensory cortex represents sensation from a different body part. (b) Each location in the motor cortex regulates movement of a different body part. (Source: After Penfield & Rasmussen, 1950)

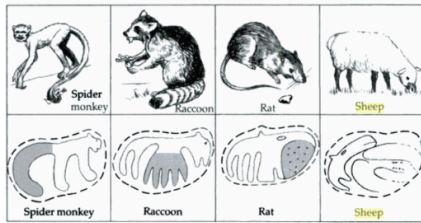
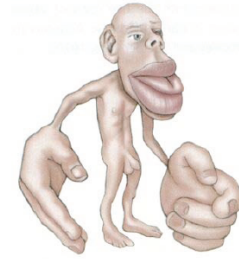
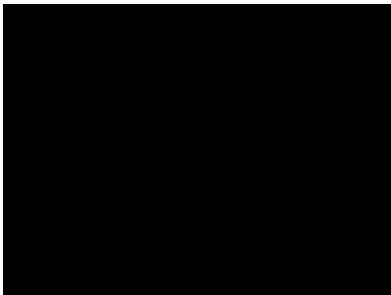


Figure 8.19 Within the modality of touch, in animals that are “feelers” the behaviorally most used and sensitive area of the body touch sense (upper panel) is much expanded in its representation on the somatic sensory area of the cerebral cortex (lower panel). The spider monkey explores with its tail, the raccoon with its forepaws, the rat with its whiskers, and the sheep with its lips and tongue.

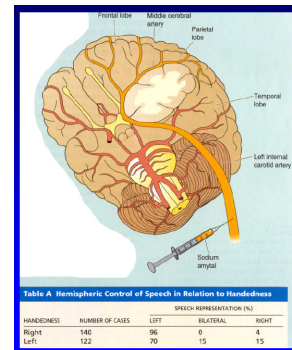
## Are there other lateralized functions?

- Speech is a paradigmatic example of a strongly lateralized cognitive phenomenon

## Wada Test



## Wada Test



## Lateralization of Function

- Historically, evidence of lateralized brain function has come from observing how brain damage affects behavior on various sorts of cognitive tasks



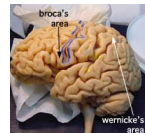
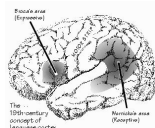
## Paul Broca



- 19<sup>th</sup> century French neurologist
- Star patient: Leborgne
- Understood most of what was said to him
- Able to eat, drink (move mouth and tongue)
- Only utterance was "tan"

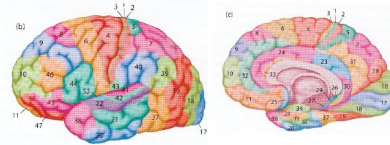
## Broca's Discovery

- Leborgne's brain had damage to the lower rear portion of frontal lobe, lower front portion of parietal lobe, and upper part of the temporal lobe
- Broca deemed frontal lobe damage most important
- Aphasia** – partial or total loss of ability to articulate ideas due to brain damage
- Broca's Area – lower rear portion of frontal lobe, adjacent to motor cortex
  - Inferior frontal gyrus
  - Brodman's Areas 44/45



## Brodman's Areas

- Korbinian Brodmann examined brain cells with various stains designed to detect chemical differences between areas
- Brain areas defined by cytoarchitectonic characteristics known as Brodmann's Areas
  - 52 areas in the human brain (though some subdivided into a, b, etc)



## Broca's Aphasia

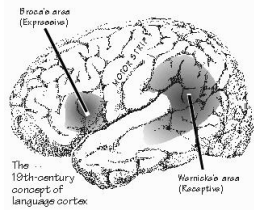
- M.E.* Cinderella...poor...um 'dopted her...scrubbed floor, um, tidy...poor, um...'dopted...Si-sisters and mother...ball. Ball, prince um, shoe...
- Examiner* Keep going.
- M.E.* Scrubbed and uh washed and un...tidy, uh, sisters and mother, prince, no, prince, yes. Cinderella hooked prince. (Laughs.) Um, um, shoes, um, twelve o'clock ball, finished.
- Examiner* So what happened in the end?
- M.E.* Married.
- Examiner* How does he find her?
- M.E.* Um, Prince, um, happen to, um...Prince, and Cinderella meet, um met um met.
- Examiner* What happened at the ball? They didn't get married at the ball.
- M.E.* No, um, no...I don't know. Shoe, um found shoe...

## Broca's Aphasic



## Wernicke's Aphasia

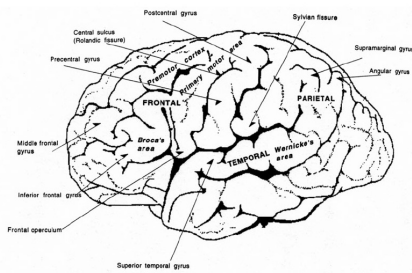
- 1871 Karl Wernicke reported a different sort of language disorder
- Symptoms
  - Talk fluently, excessively
  - Use made up words
  - Don't understand, in spite of intact hearing



## Wernicke's Area

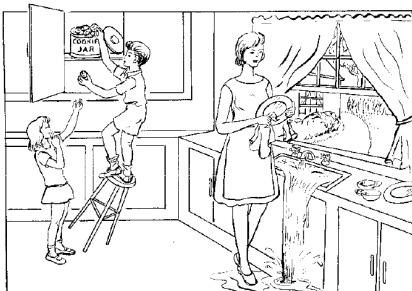


## Wernicke's Area



## Wernicke's Aphasic

- C.B. Uh, well this is the ... the /dodu/ of this. This and this and this and this. These things going in there like that. This is /sen/ things here. This one here, these two things here. And the other one here, back in this one, this one /gesh/ look at this one.
- Examiner: Yeah, what's happening there?
- C.B. I can't tell you what that is, but I know what it is, but I don't know where it is. But I don't know what's under. I know it's you couldn't say it's ... I couldn't say what it is. I couldn't say what that is. This shu-- that should be right in here. That's very bad in there. Anyway, this one here, and that, and that's it. This is the getting in here and that's the getting around here, and that, and that's it. This is getting in here and that's the getting around here, this one and one with this one. And this one, and that's it, isn't it? I don't know what else you'd want.
- Describing a picture of a child taking a cookie



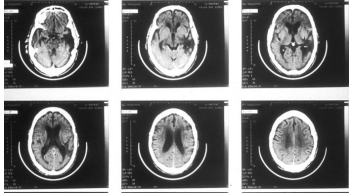
Copyright © 1972 by Lee & Fabinger

Goodglass "cookie theft" picture

## Wernicke's Aphasic

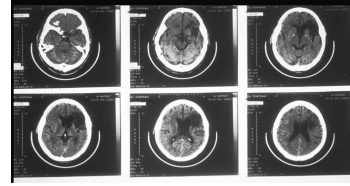


## Pop Quiz



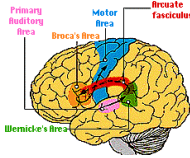
Wernicke's Aphasia (Temporal Lobe Lesions)

## Pop Quiz

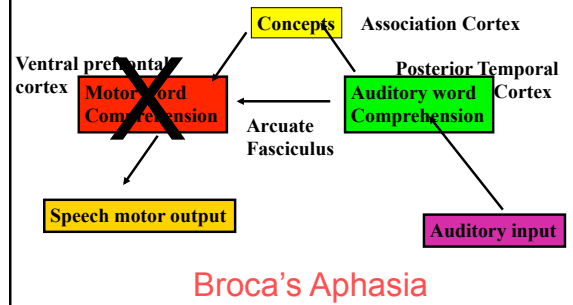


Broca's Aphasia (Frontal Lobe Lesions)

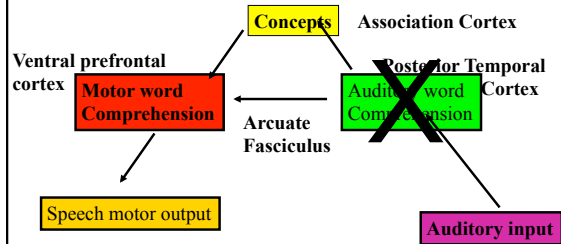
## Wernicke-Geschwind Model



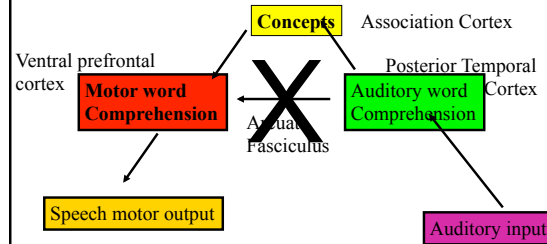
- Broca's Area stores motor representation of speech
- Wernicke's Area stores auditory representation of speech sounds
- Connected by fiber tract known as arcuate fasciculus
- Considered an oversimplified model



psychology.rutgers.edu/~rypma/



psychology.rutgers.edu/~rypma/



psychology.rutgers.edu/~rypma/