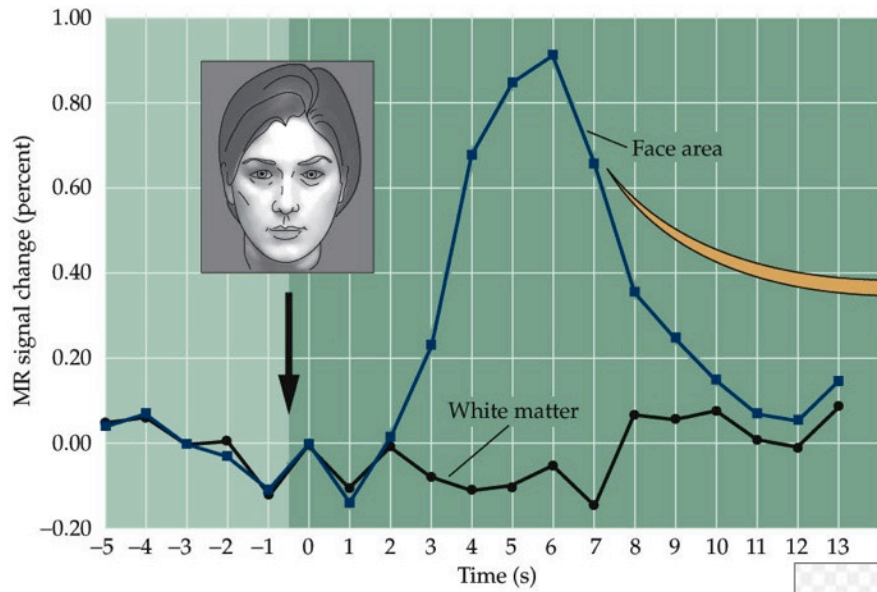


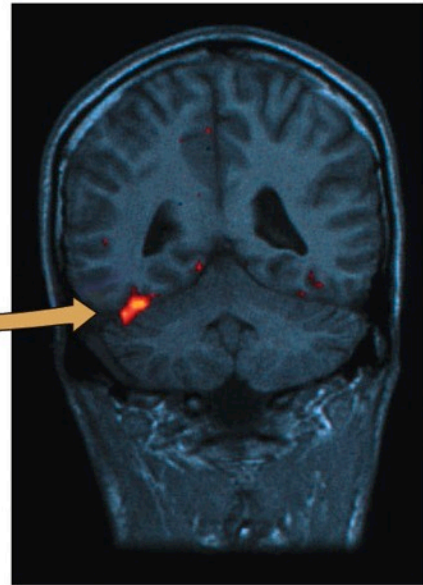
# Class 11: Language and Lateralization

11/16/13

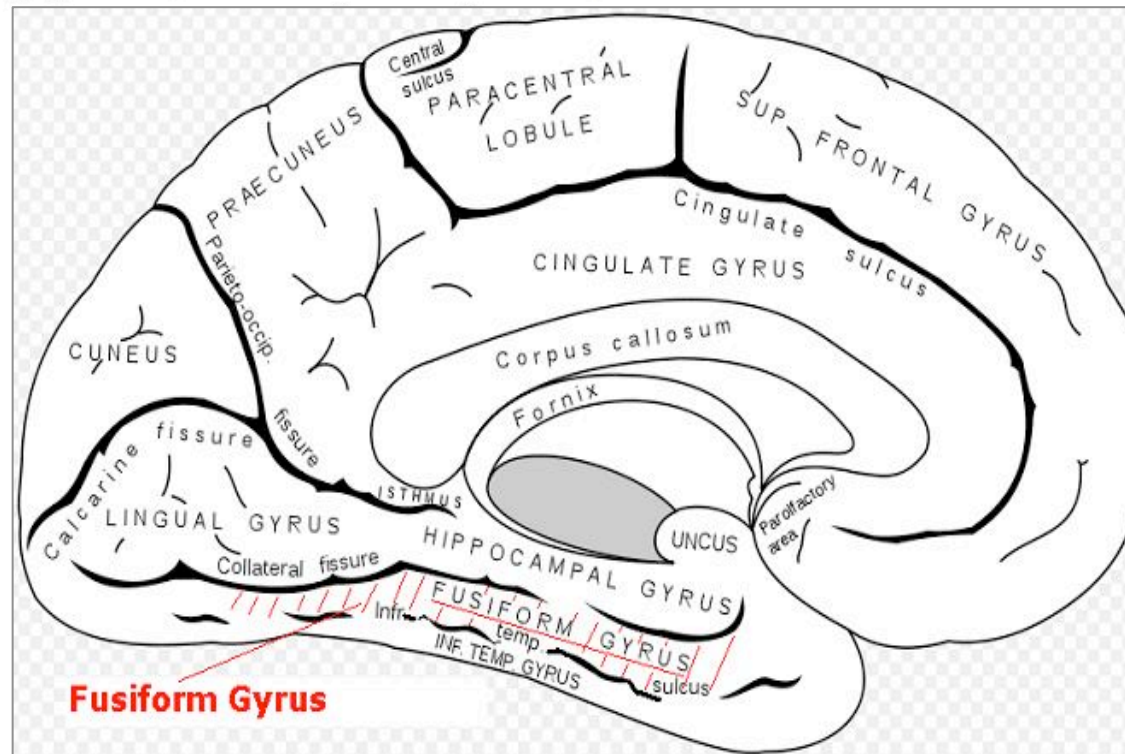
(A)



(B)

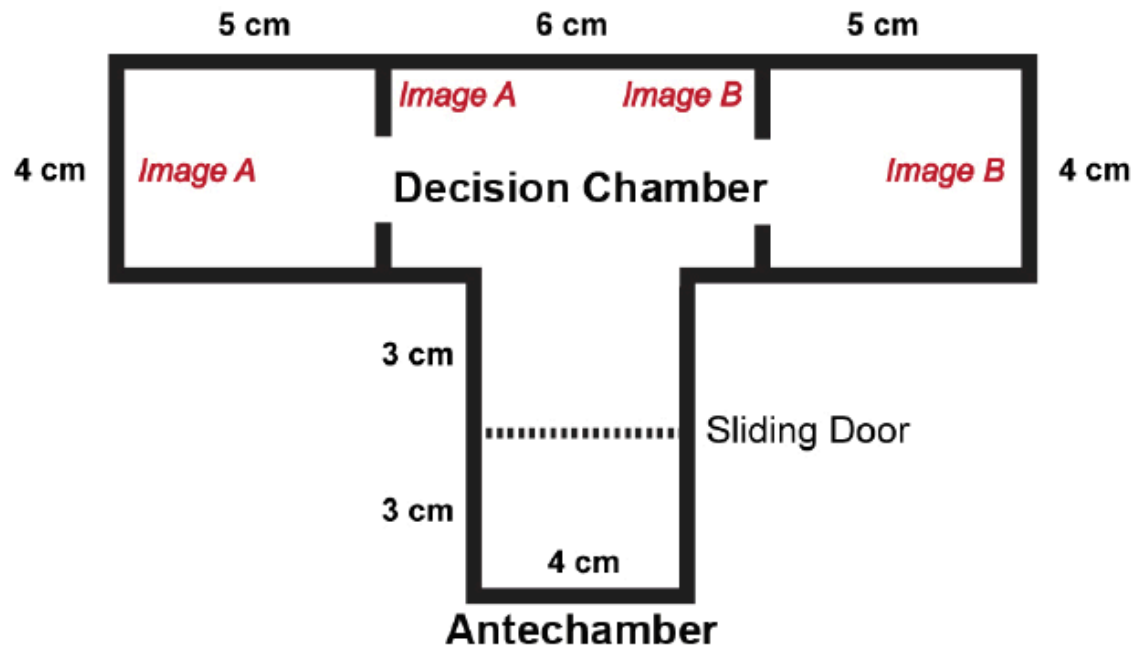


**NEUROSCIENCE, Fourth Edition, Figure 26.8**



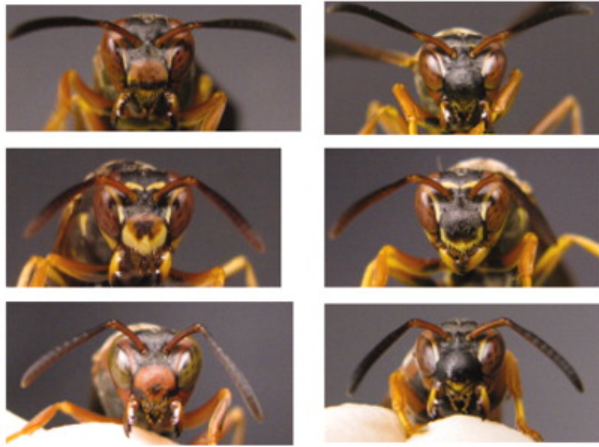
# Wasp brains!

- Two species:
  - *Polistes fuscatus*
  - *Polistes metricus*



# The cues

***P. fuscatus* faces**



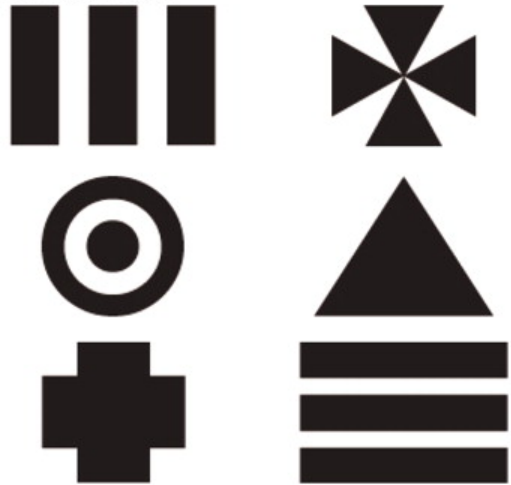
**Antenna-less faces**



**Rearranged faces**



**Patterns**



**Caterpillars**

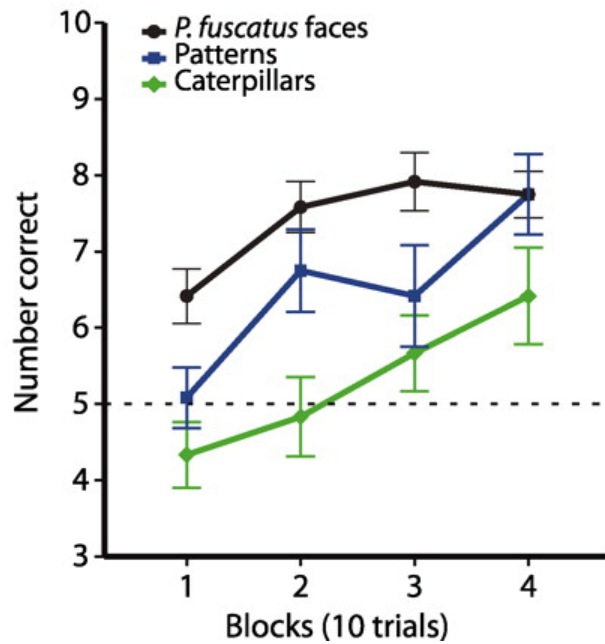


***P. metricus* faces**

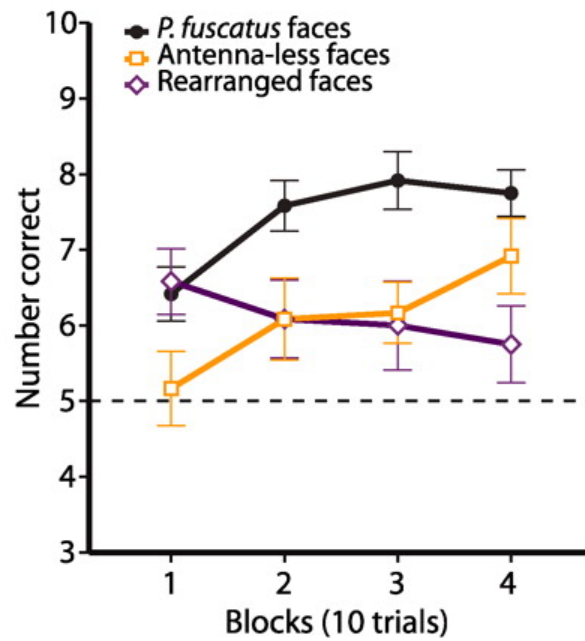


# Can wasps discriminate between faces, patterns, or caterpillars?

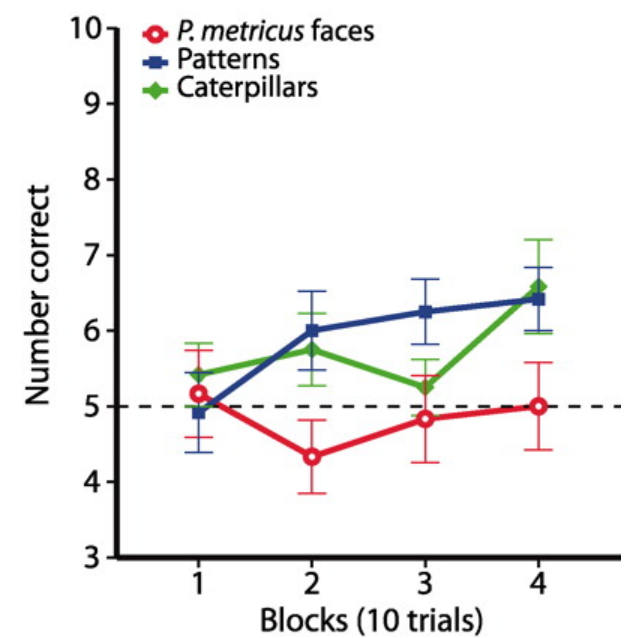
**A** *P. fuscatus* faces v. non-faces



**B** *P. fuscatus* faces v. manipulated faces

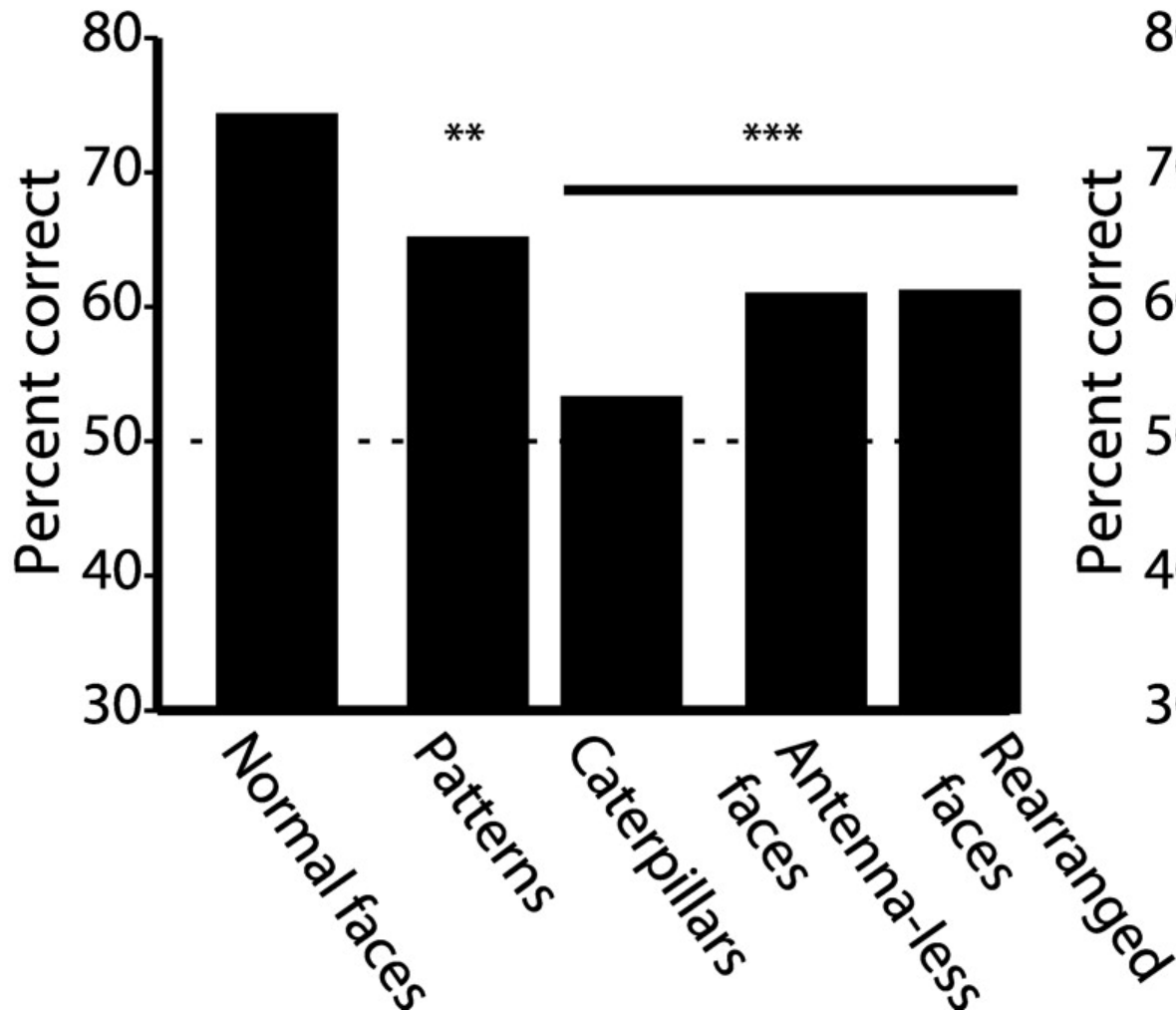


**C** *P. metricus* faces v. non-faces

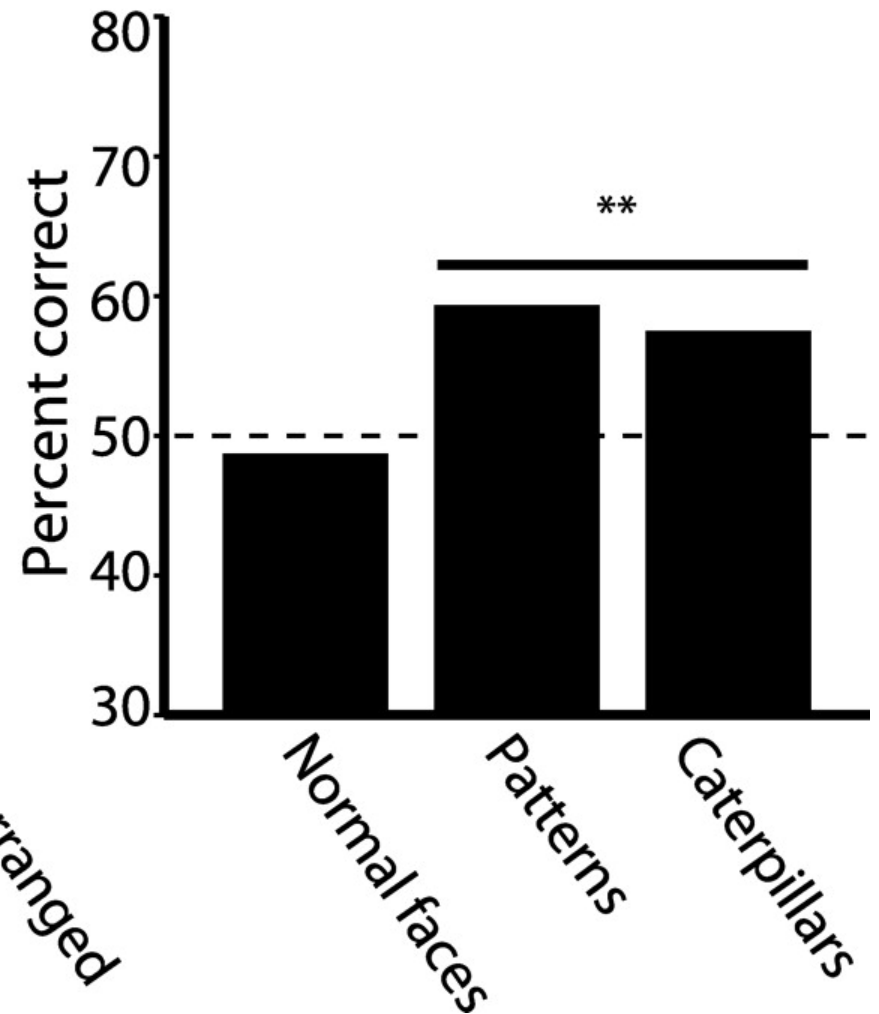


# Is this real? Rearrange the faces:

**A** *P. fuscatus*



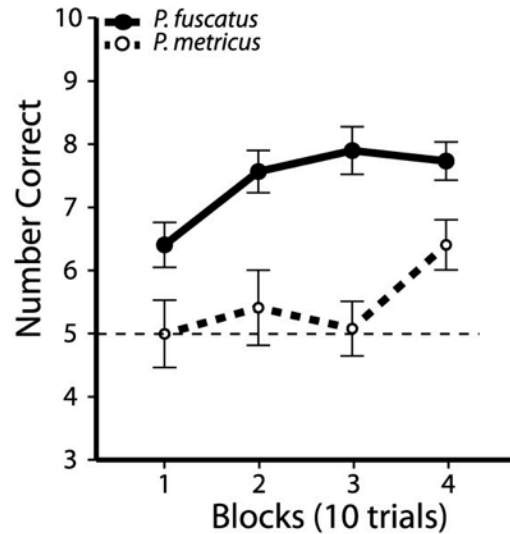
**B** *P. metricus*



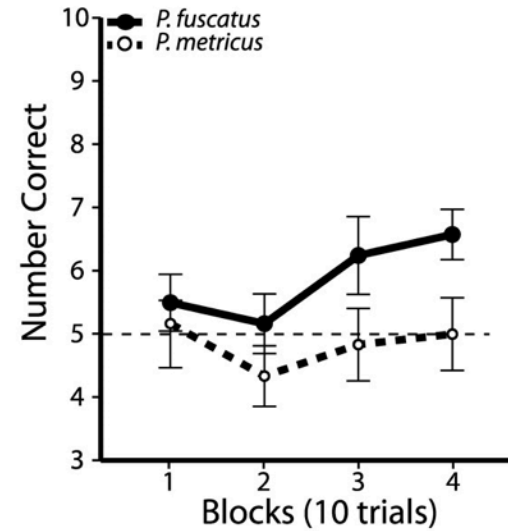


# Can they learn each other's faces?

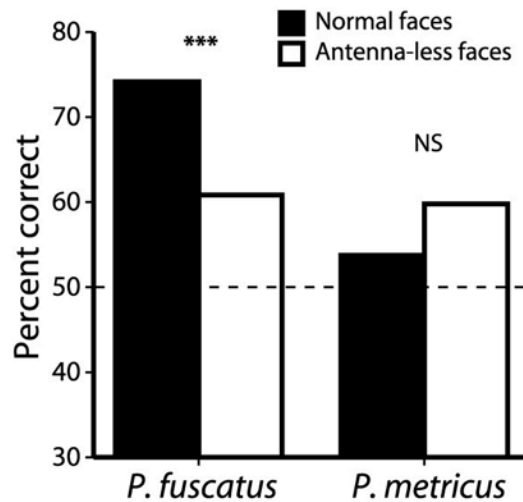
**A** *P. fuscatus* faces



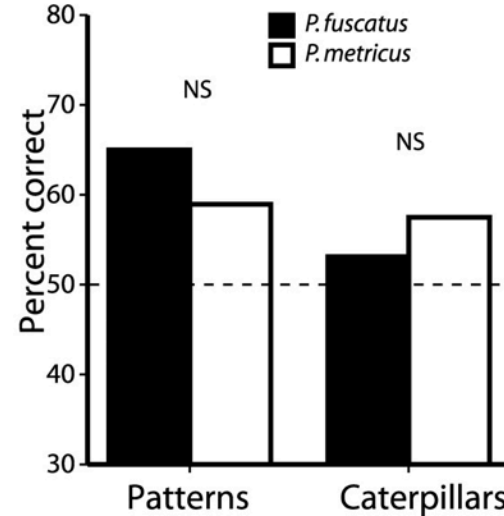
**B** *P. metricus* faces



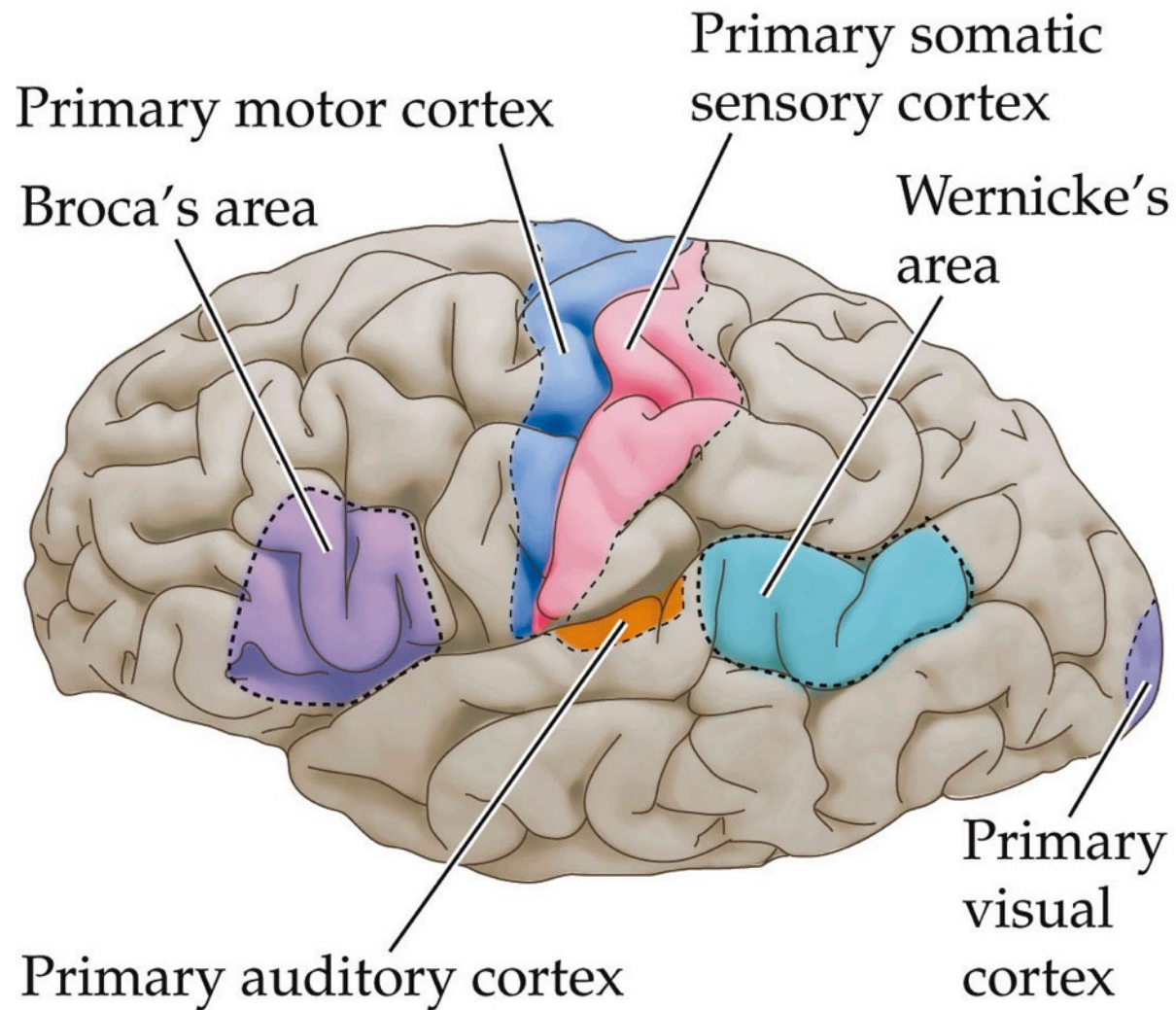
**C** Normal and antenna-less faces



**D** Non-faces

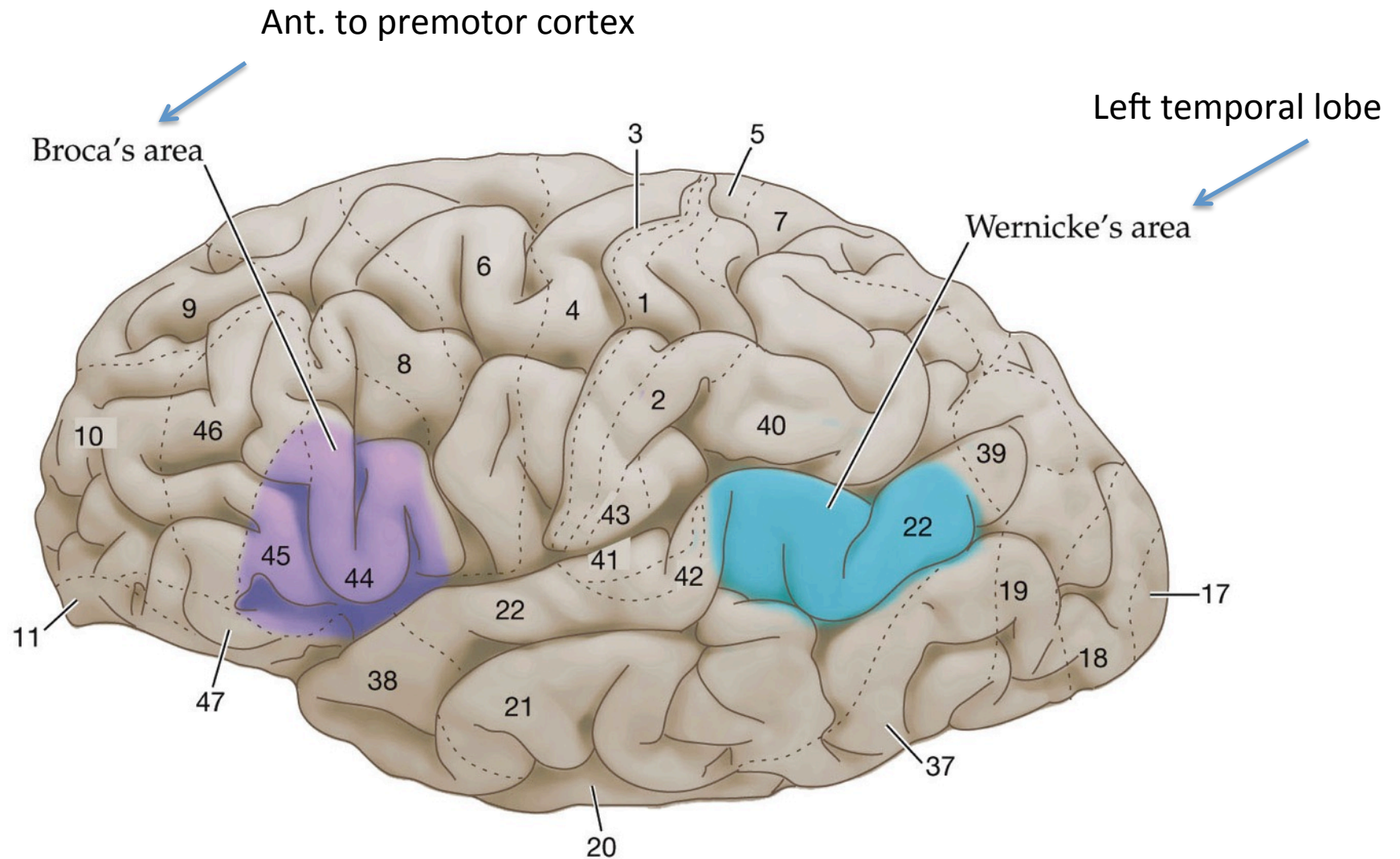


# The major language areas of the brain





# The major language areas of the brain



# The short description

**Broca's area:** Generation of language

**Wernicke's area:** Interpretation of language

# Broca's area: a closer look



His patient could understand language perfectly well and was otherwise normal, but the only sound he could make was the syllable “Tan”

After he died, Broca looked at his brain and saw a lesion in Brodmann areas 44 and 45- now known as Broca's area

Area 44: phonological processing and in language production as such- makes sense because this area is right by the motor cortex

Area 45: seems to be involved in the semantic aspects of language (verbal memory role?)

# Aphasias

Acquired communication disorders that impairs a person's ability to process language

# Global Aphasia

- – Most severe form
  - Produce few recognizable words
  - Understands little or no spoken speech
  - Can neither read or write
    - Usually seen after patient has suffered a stroke and may rapidly improve if the damage has not been too extensive. Greater brain damage, more severe and lasting disability.

# Wernicke's Aphasia – fluent aphasia

- ability to grasp the meaning of spoken words is chiefly impaired
- Speech is produced easily but doesn't make sense
  - Sentences do not hang together and irrelevant words intrude-sometimes to the point of jargon, in severe cases. Reading and writing are often severely impaired.

[Wernicke's aphasia](#)



# Broca's Aphasia

- Speech output severely reduced limited mainly to short utterances of less than four words
  - Vocabulary access limited
  - Formation of sounds often laborious/clumsy
  - May understand speech and be able to read but limited in writing
  - Halting and effortful quality of speech

[Broca's aphasia](#)

**TABLE 27.1** Characteristics of Broca's and Wernicke's Aphasias

Broca's aphasia <sup>a</sup>	Wernicke's aphasia <sup>b</sup>
Halting speech	Fluent speech
Tendency to repeat phrases or words (perseveration)	Little spontaneous repetition
Disordered syntax	Syntax adequate
Disordered grammar	Grammar adequate
Disordered structure of individual words	Contrived or inappropriate words
Comprehension intact	Comprehension not intact

<sup>a</sup> Also called motor, expressive, or production aphasia.

<sup>b</sup> Also called sensory or receptive aphasia.

# What causes Aphasia

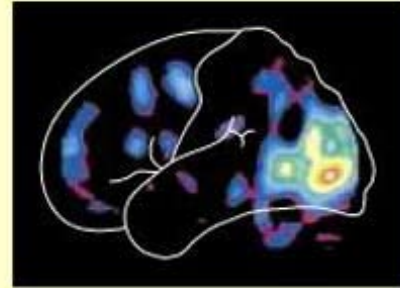
- Most common cause of aphasia is stroke – about 23 – 40% of stroke survivors acquire aphasia.
- It is estimated that about one million people in the United States have acquired aphasia, or 1 in 250 people.

# Language in the brain

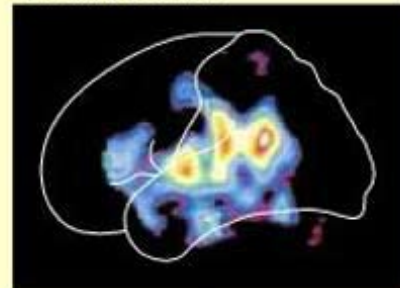
- [AMNH language in the brain](#)

Different aspects of language are processed in different regions

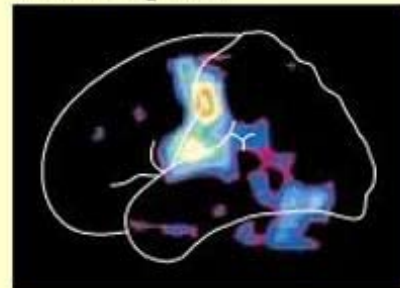
Seeing words passively



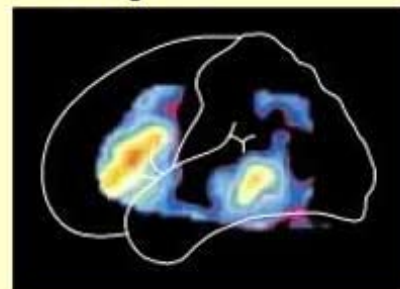
Listening to words



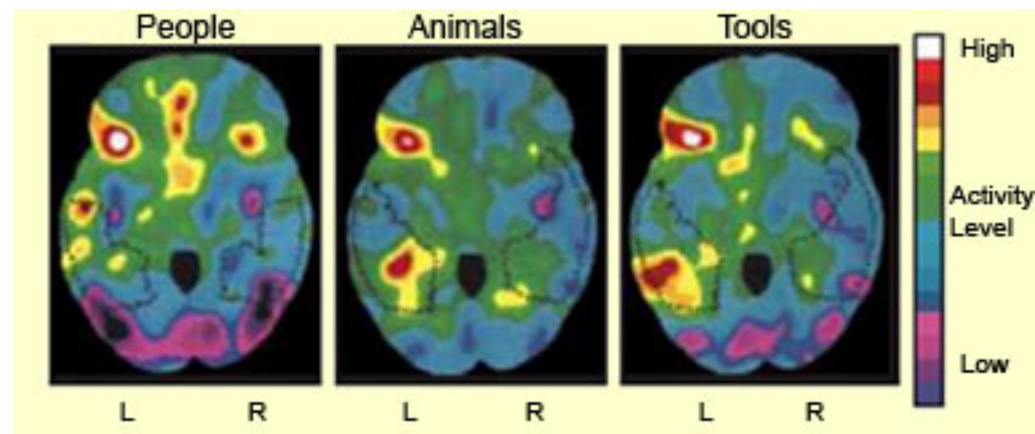
Pronouncing words



Generating words



# Different categories of meaning seem to be stored in different locations



Famous people:  
Ant. end of temp  
lobe

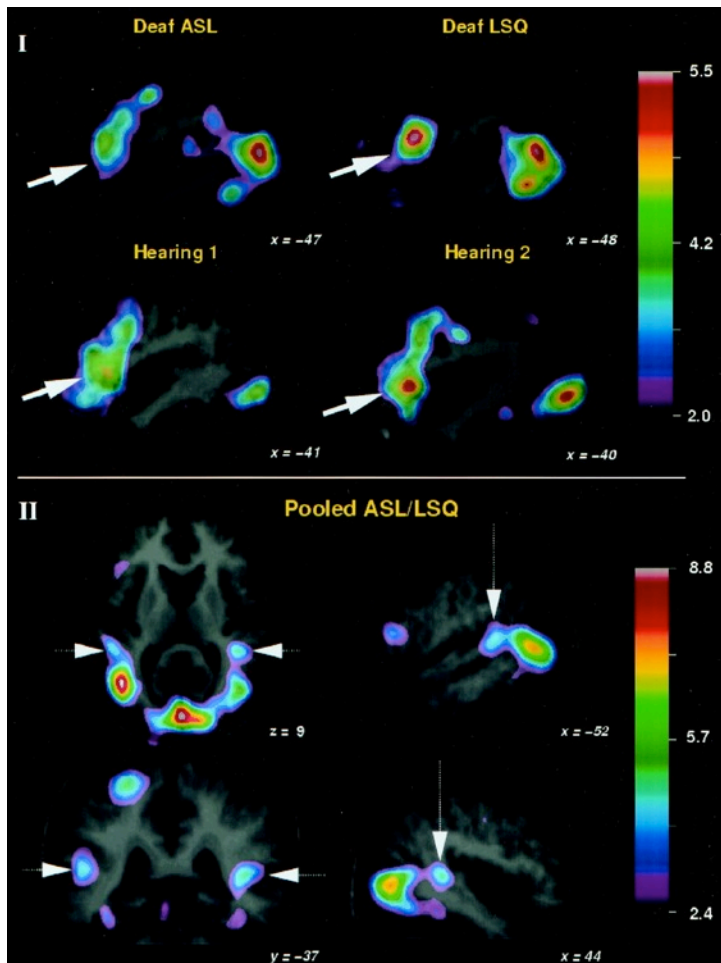
Animals: inf  
temporal lobe

Frontal premotor areas  
activated while *naming*  
tools

Naming animals activated  
visual areas



# Is sign language like spoken language?



**Yes:** many of the same brain regions are involved

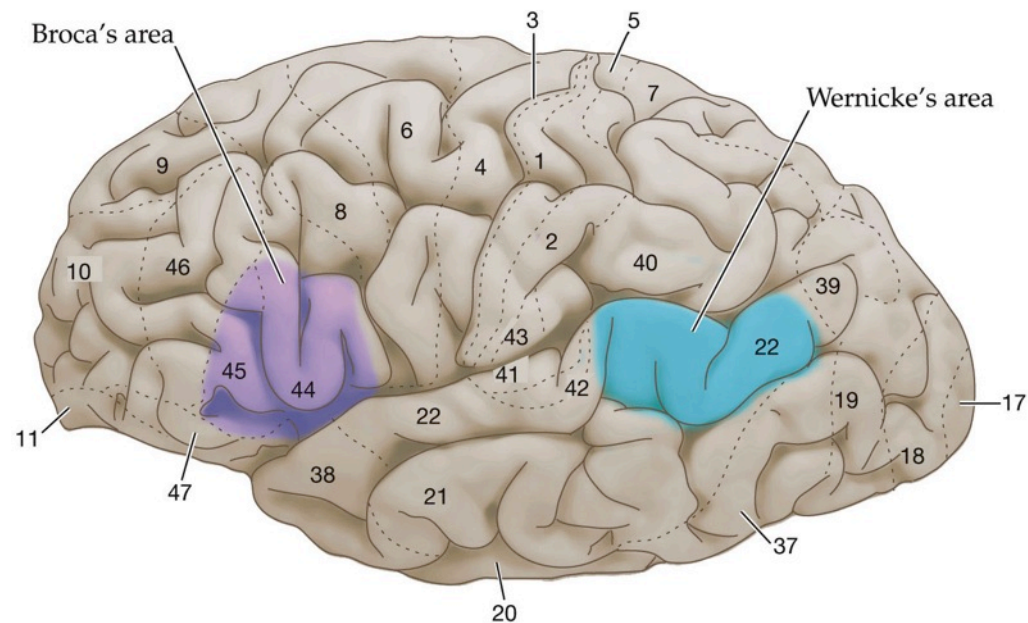
Including Broca's area and Wernicke's area

Why language?

# Gesture and language

Think about where Broca's area is in the brain

Ant. to premotor cortex

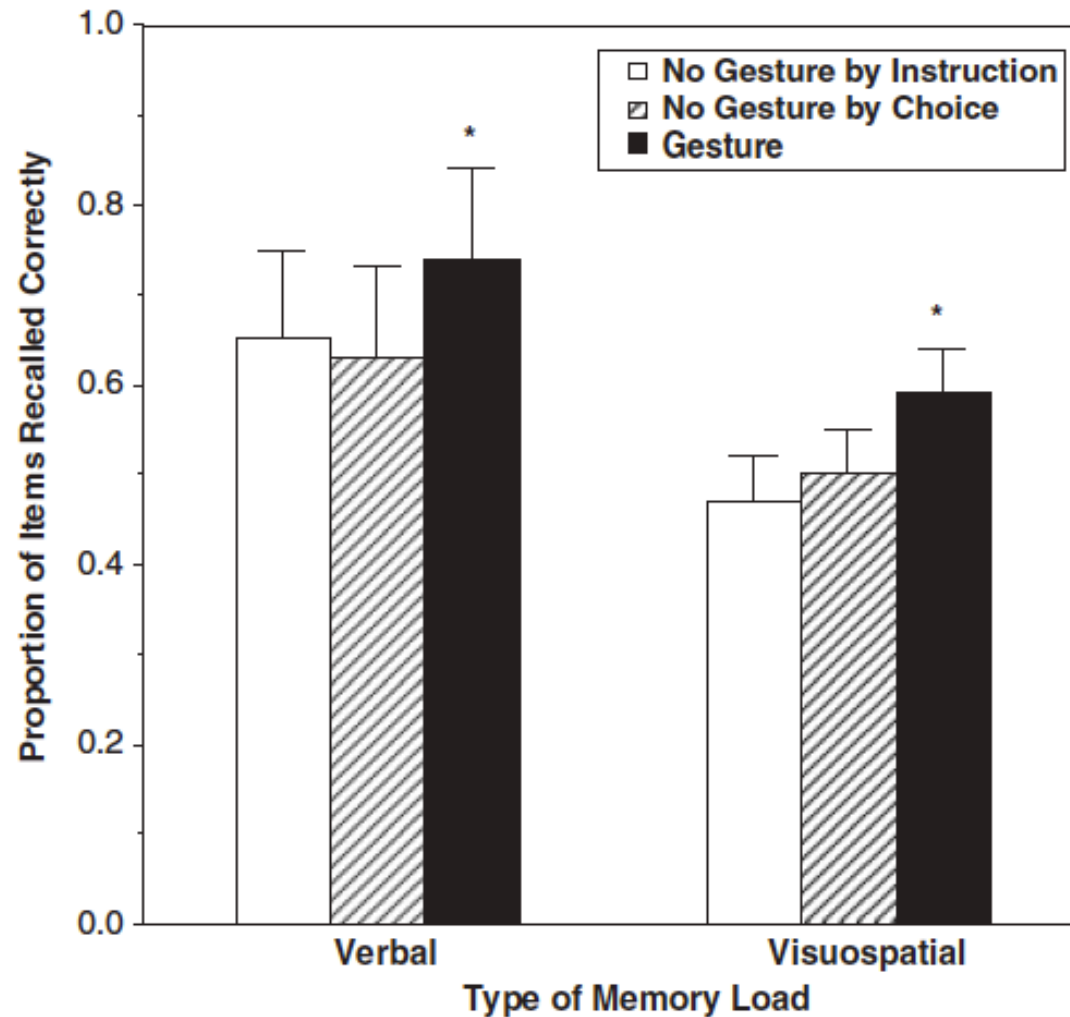


*NEUROSCIENCE, Fourth Edition, Figure 27.2*

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Is there a sort of synesthesia between spoken language and gesture?

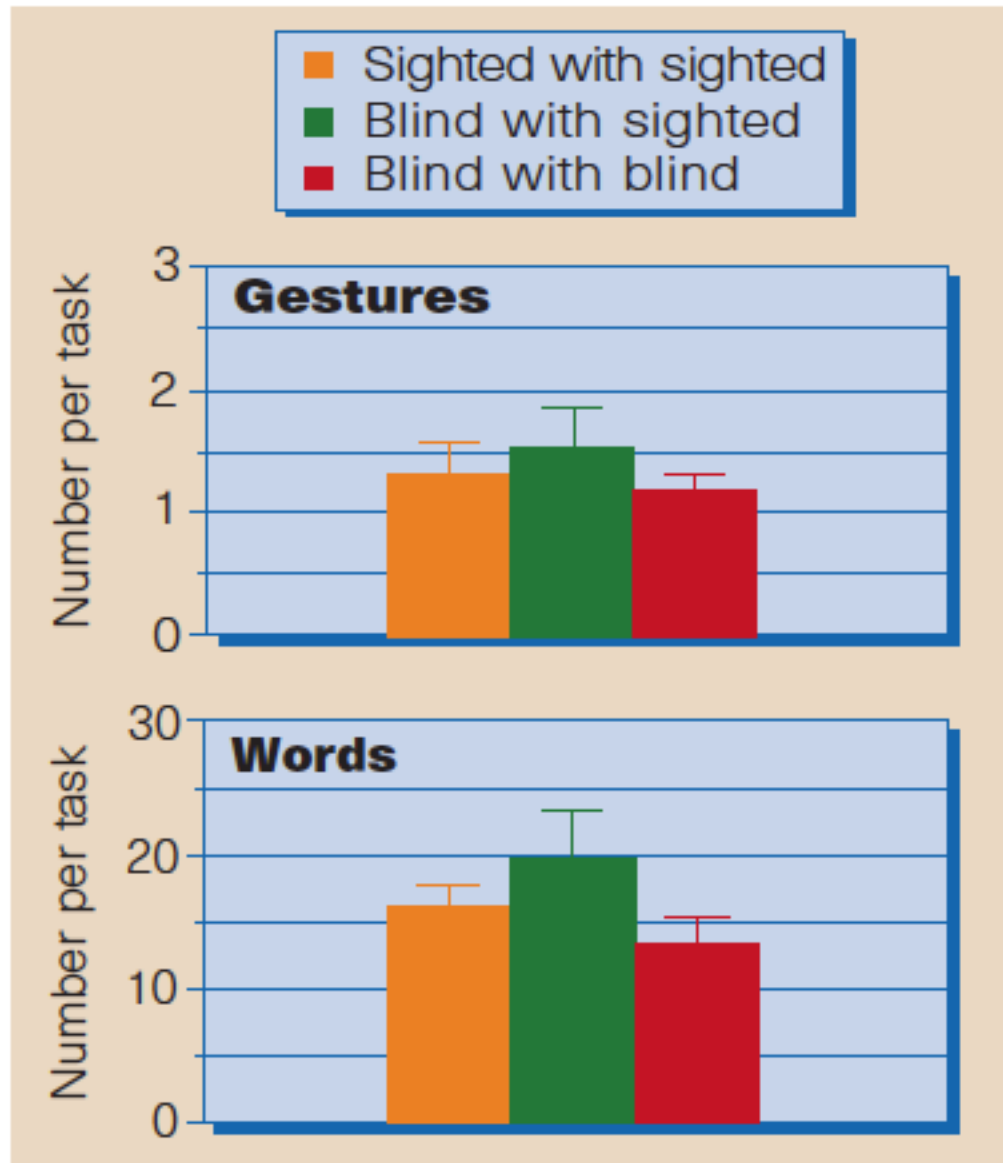
# People remember more when they gesture



\* $p < .05$ , Gesture vs. No Gesture by Instruction; Gesture vs. No Gesture by Choice

Here people were asked to explain how they solved a math problem when they did or did not gesture (either by choice or by instruction)

# People born blind still gesture



# Theories of language origin

**Gestural:** We started walking on two legs, our hands were free to use for gestural communication, then we started talking and using our hands for other things

Gesture came first



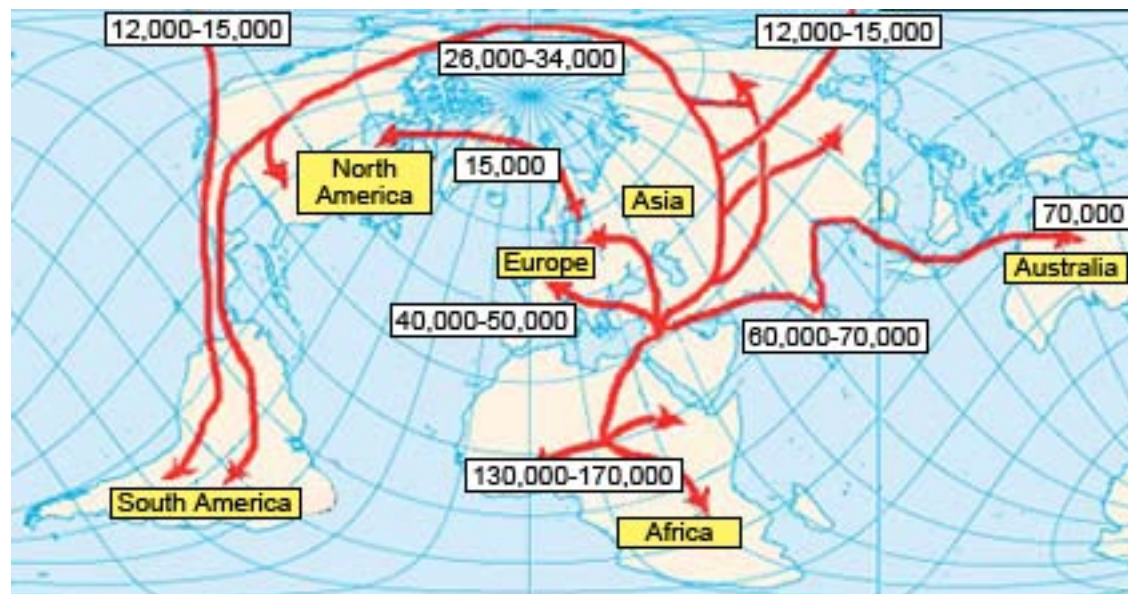
# Theories of language origin

**Social complexity/gossip:** exchanging information is really useful (hunting strategies for example). Robin Dunbar proposed that most of the info we exchange is social (gossip)- who is trustworthy, who is allied with whom

**Vocal:** certain changes in the mouth and the pharynx combined with an increased brain volume to give human beings voluntary control over vocal outputs that up to then had been more like instinctive cries. Lots of variations of this.

And many, many, many more...

Did language evolve once (monogenism) or many times (polygenism)?



Map of human migrations based on mtDNA

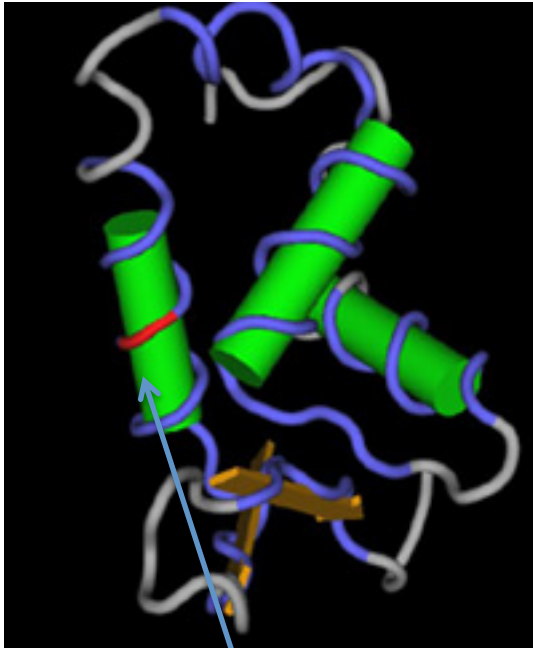
# Monogenism: two main schools of thought

*Adaptation:* A mutation happened some 100,000 years ago that re-organized the brain that created a language instinct  
-Influenced by Chomsky's universal grammar ideas

*Exaption:* Language was an accidental byproduct of natural selection (a spandrel- see S.J. Gould) for homo sapiens' increased cognitive abilities

These theories could also apply to polygenist theories too

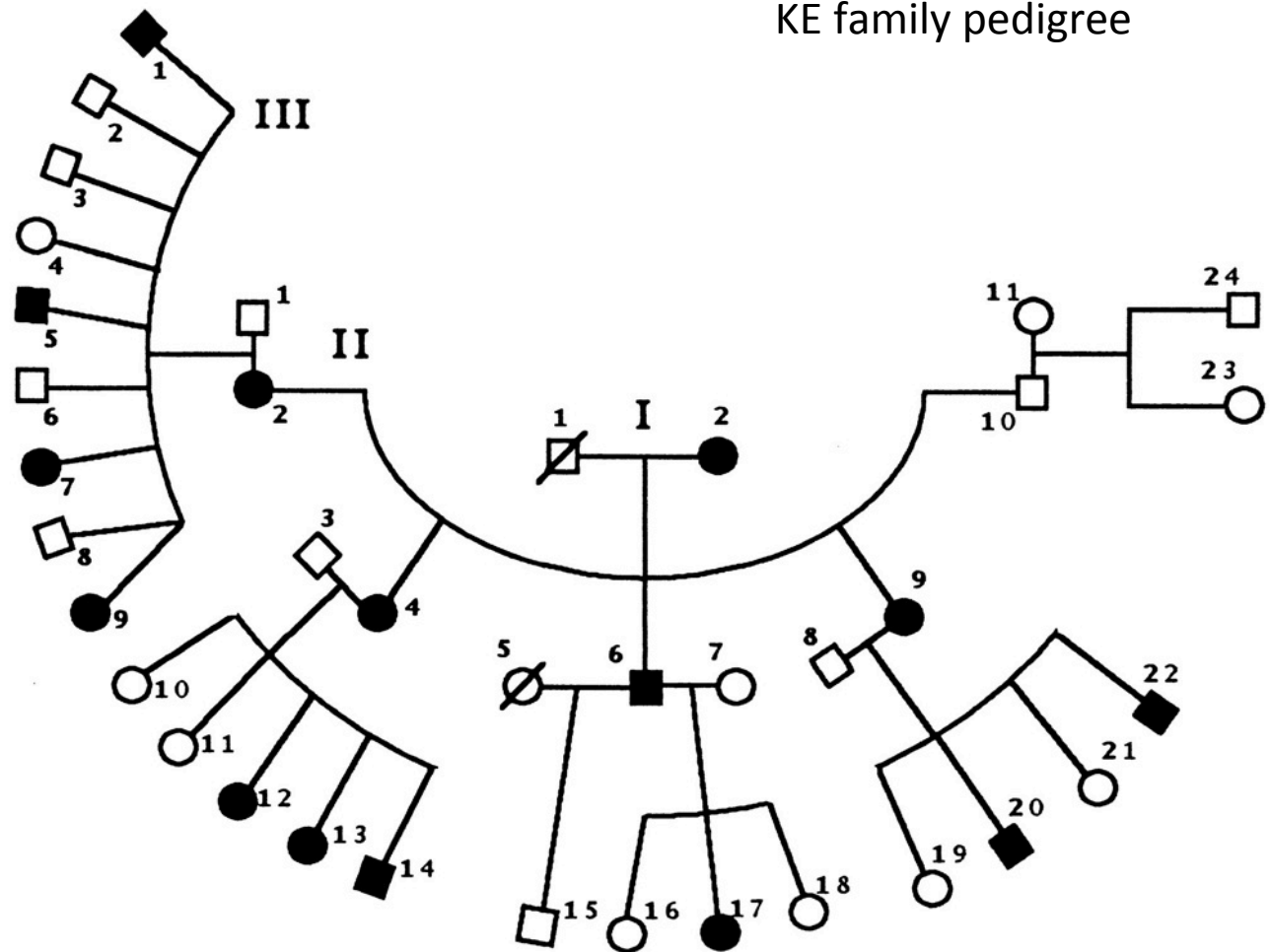
# How did language evolve in humans?



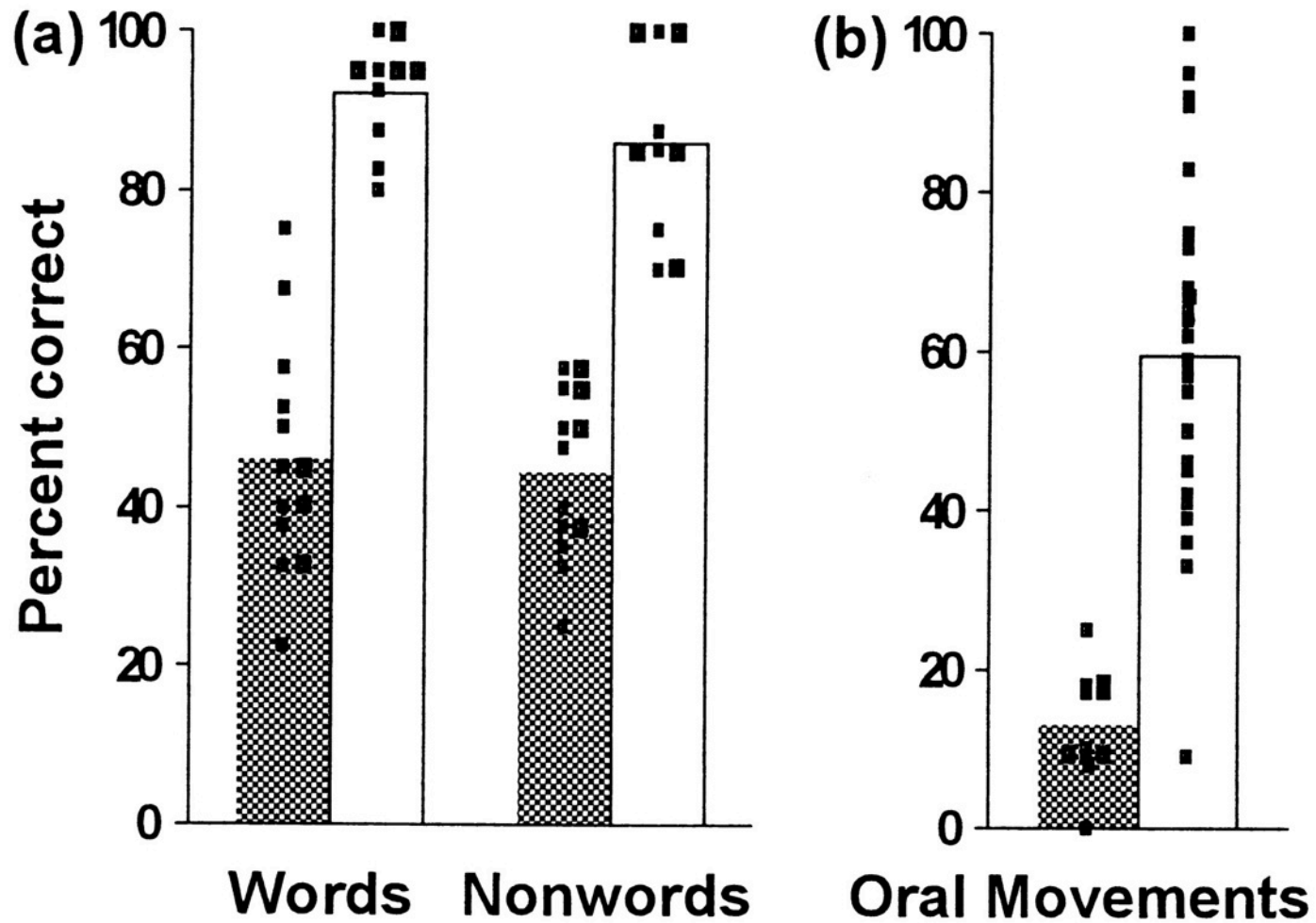
**FOXP2**

Severe speech and language problems in affected individuals

KE family pedigree

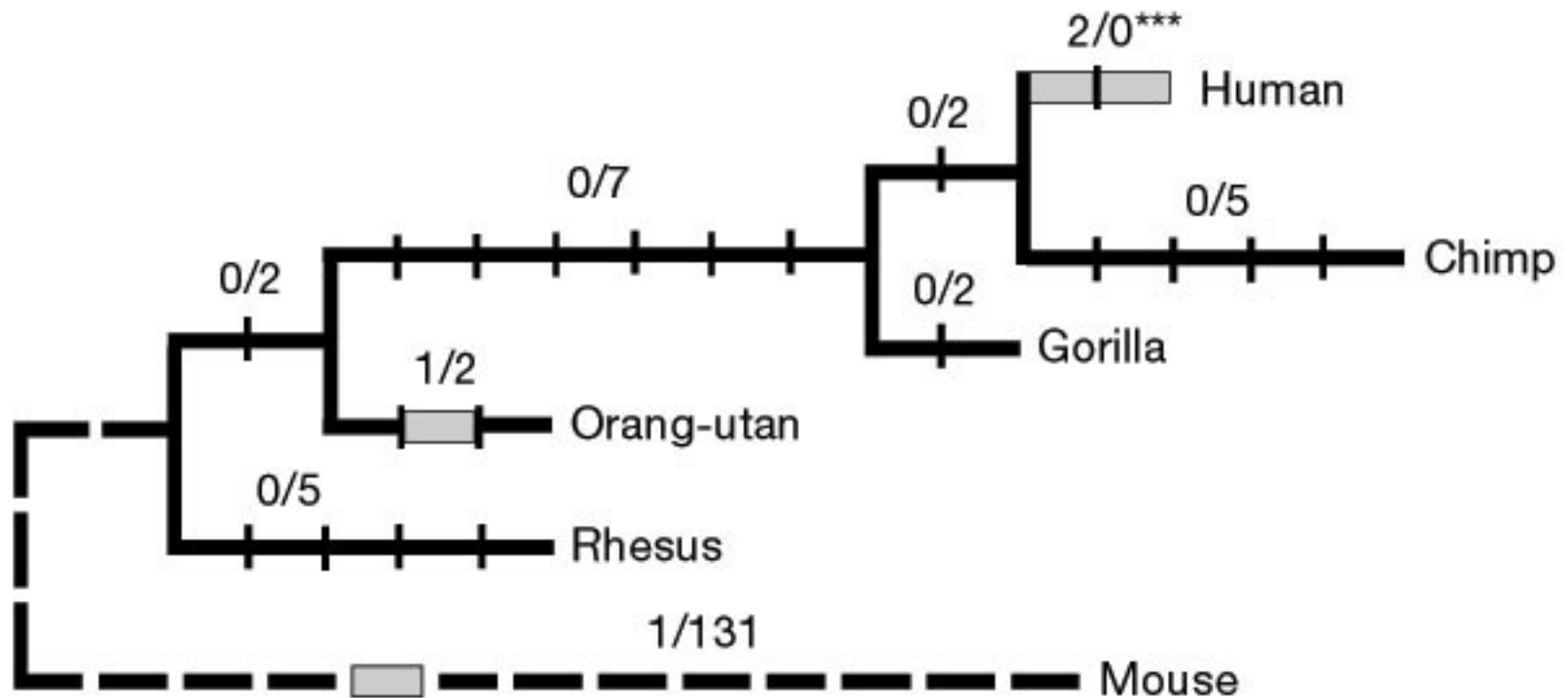


(a) Word and nonword repetition.



Vargha-Khadem F et al. PNAS 1998;95:12695-12700

# Evolution of FOXP2 gene

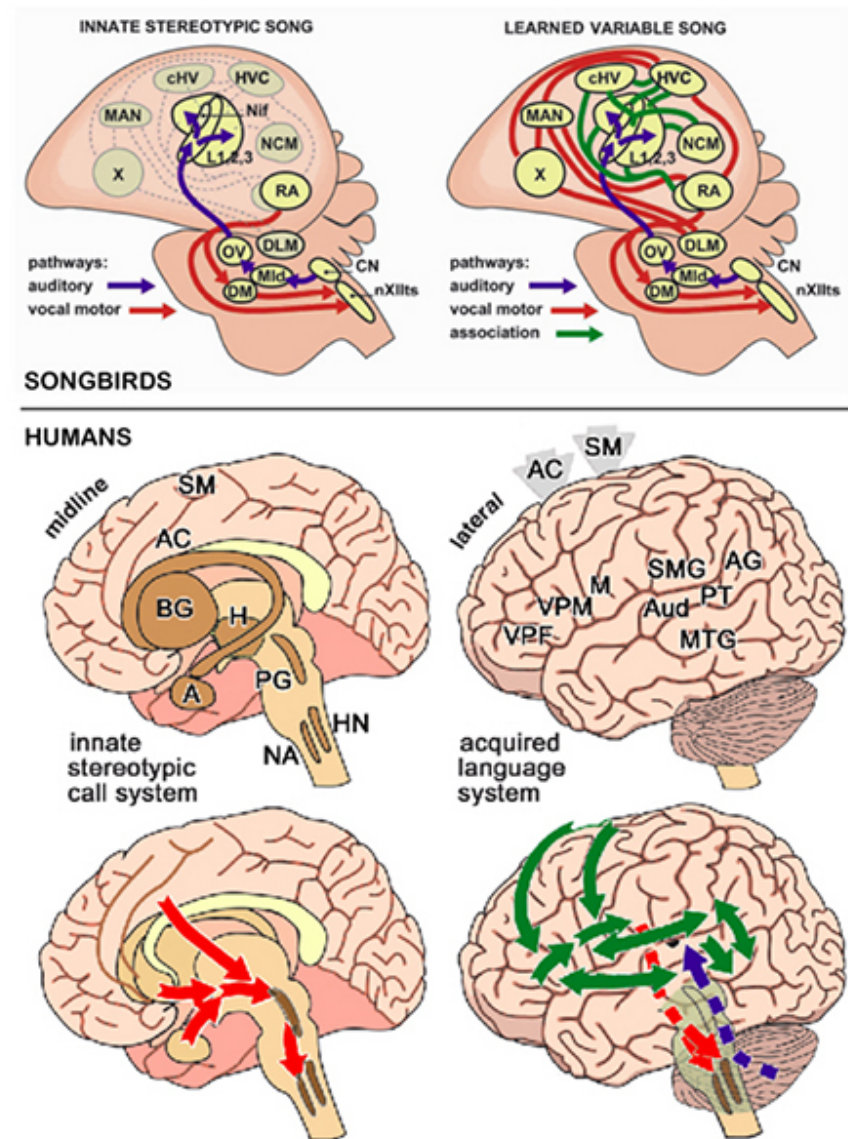


Bars represent nucleotide changes. Grey bars indicate amino-acid changes.

# Do other animals have language

Alex the African Grey

[Alex video](#)



What is this?



# Humpback whales



Whalesong has regional dialects and accents

There are some universal songs- 5 regular call in sperm whales

# Are whales smarter than us?

Sperm whale brain: 8,000 cm<sup>2</sup>.

Human brain: 1300 cm<sup>2</sup>

Humans gyrification index\*:1.75

Dolphins: 2.7,

Orca: >3

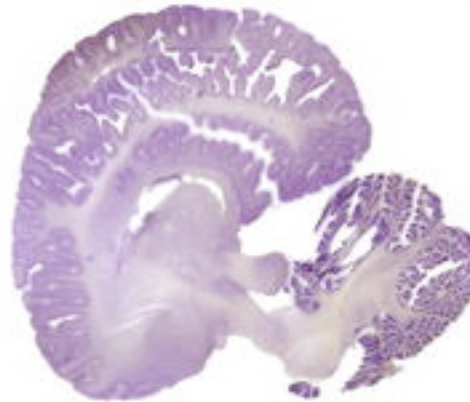
\*Cortical surface area/total brain weight

Human neocortical surface: 2,275 cm<sup>2</sup>

Common dolphin neocortical area: 3,745 cm<sup>2</sup>

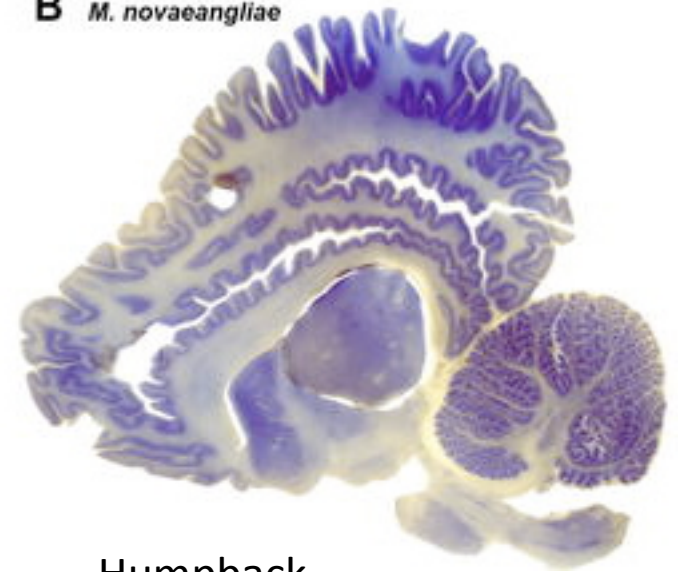
Sperm whale: Unknown, but much bigger than that!

A *T. truncatus*



Dolphin

B *M. novaeangliae*

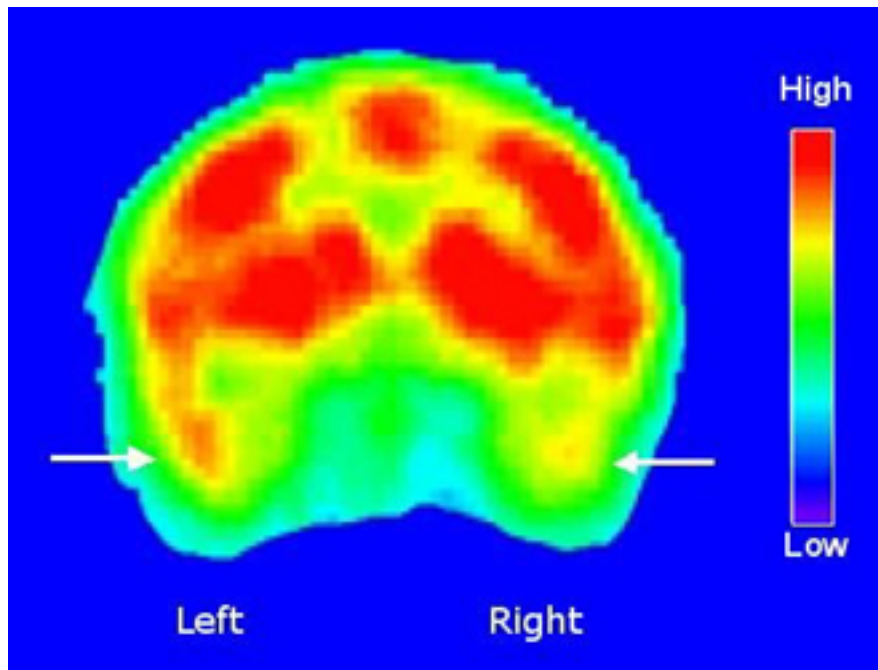


Humpback

See the Scientific American article "Are Whales Smarter Than We Are?"

Why are humans brains fancier than  
fruit fly brains?

# Look again...



What do you notice?

This is a brain scan of a monkey listening to monkey vocalizations

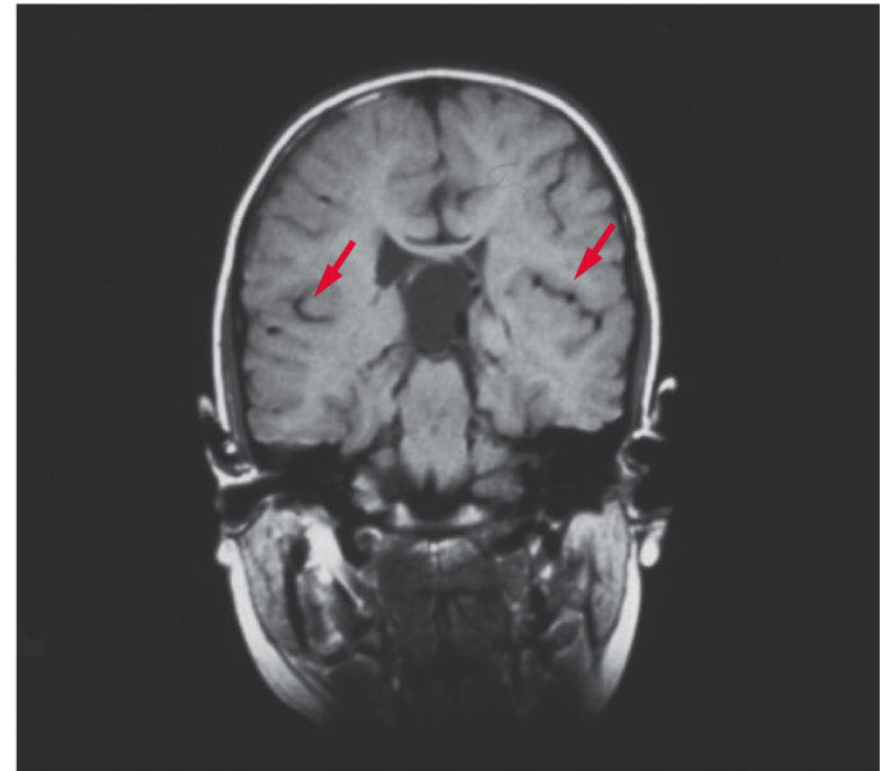
# The human brain is asymmetric

(B)

Planum temporale measurements of 100 adult and 100 infant brains		
	Left hemisphere	Right hemisphere
Infant	20.7	11.7
Adult	37.0	18.4

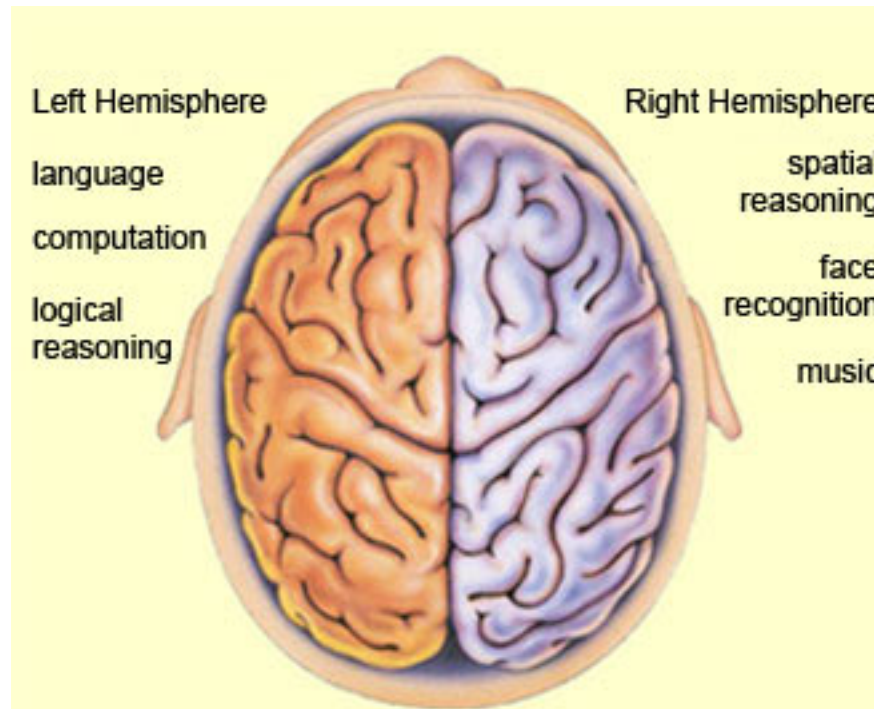
(C) Right side

Left side



# Lateralization

Specialization of the two hemispheres



## LEFT BRAIN FUNCTIONS

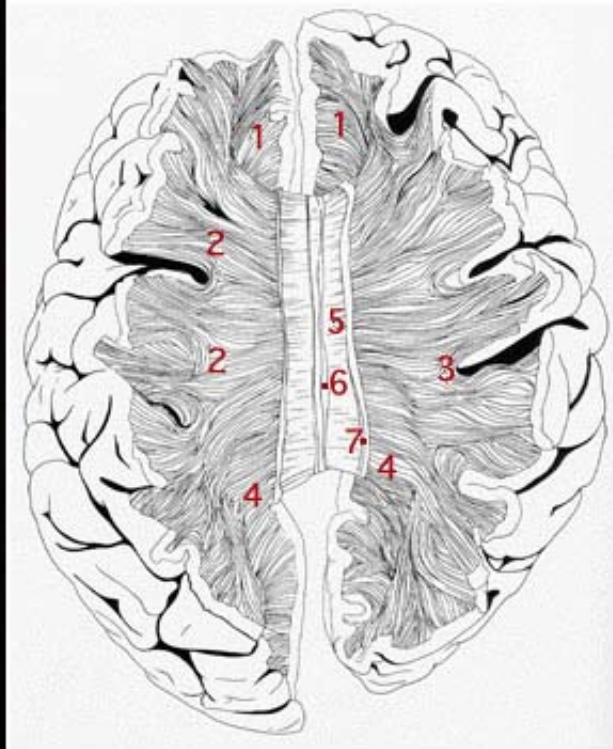
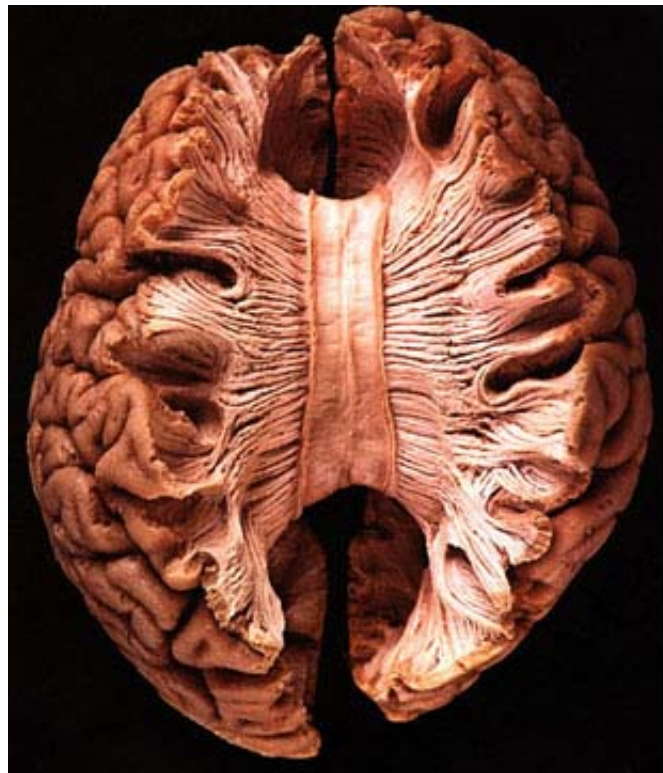
uses logic  
detail oriented  
facts rule  
words and language  
present and past  
math and science  
can comprehend  
knowing  
acknowledges  
order/pattern perception  
knows object name  
reality based  
forms strategies  
practical  
safe

## RIGHT BRAIN FUNCTIONS

uses feeling  
"big picture" oriented  
imagination rules  
symbols and images  
present and future  
philosophy and religion  
can "get it" (i.e. meaning)  
believes  
appreciates  
spatial perception  
knows object function  
fantasy based  
presents possibilities  
impetuous  
risk taking



# The link between the hemispheres: The Corpus Callosum





So what happens when the two hemispheres aren't connected?

Split brain patients