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Presentation to the MSU Retirees

September 27, 2016

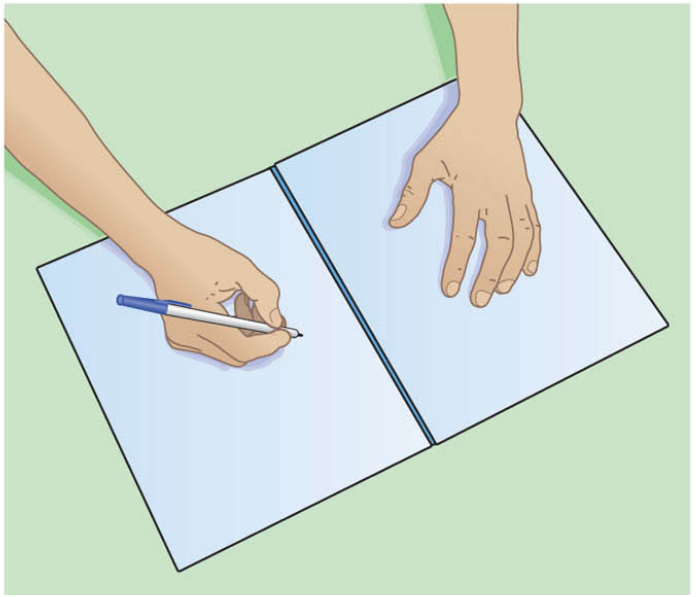
About 88 - 90% of humans are right-handed

Apes: Recent evidence for right-handed bias,
Other animals: MANY examples of laterality.

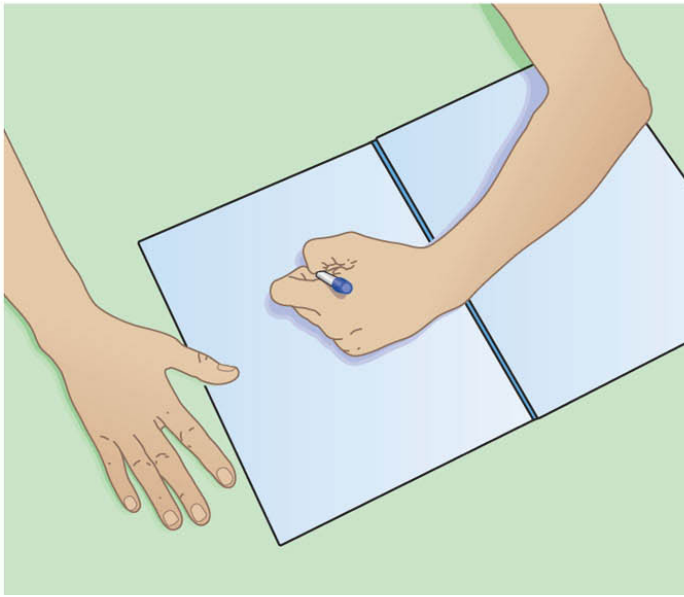
Right-handed

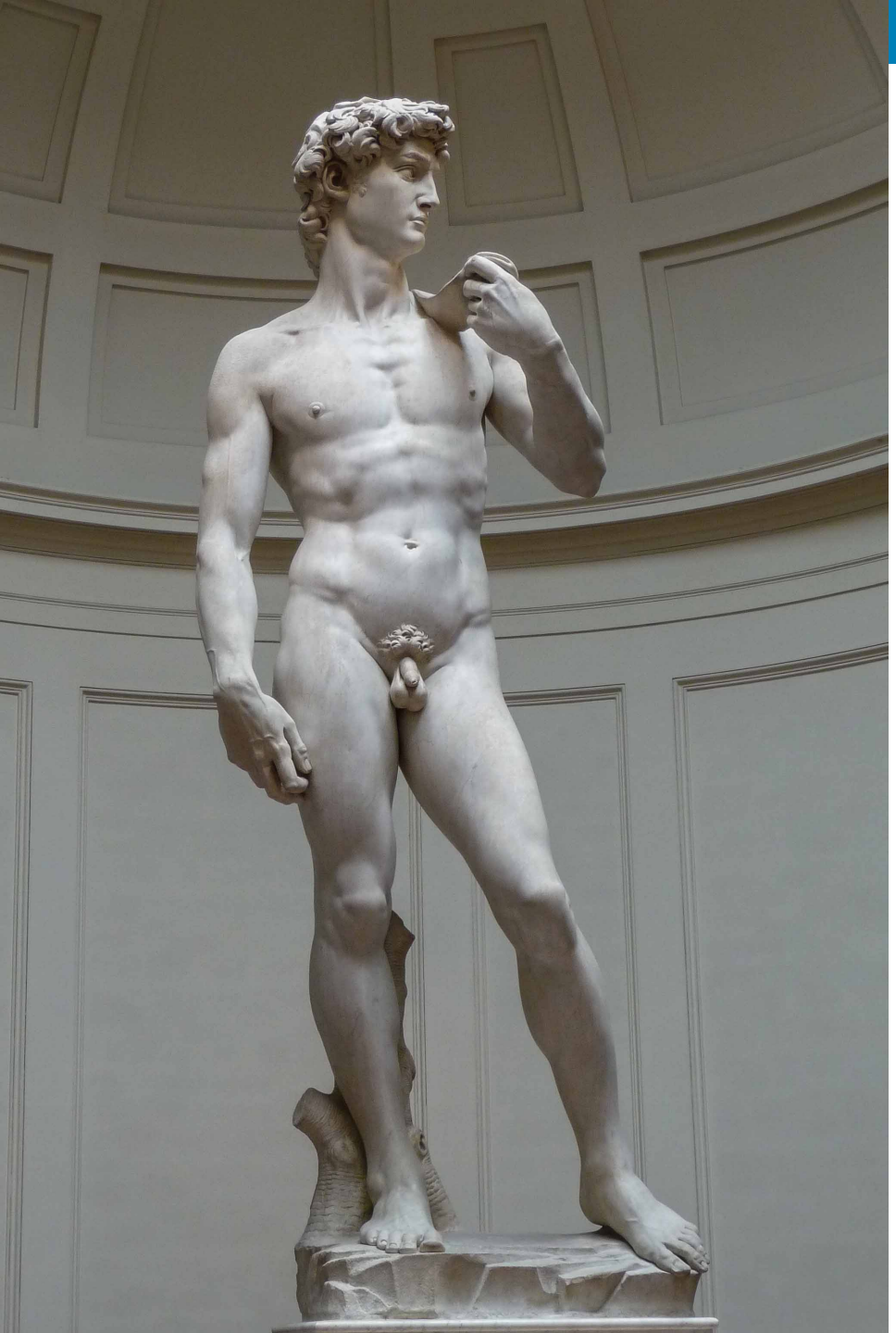
Left-handed

Right-handed writing



Left-handed writing





Michelangelo was a lefty!

Other famous left-handed artists:

Leonardo da Vinci
Durer
Rembrandt
Rubens
Klee
Picasso

Some general statistics on laterality:

Approximate statistics for motor and sensory laterality:

- Favoring right hand: 88%
- Favoring right foot: 81%
  - *Favoring same hand and foot: 84%* *(> 16% are "goofy")*
- Favoring right eye: 71%
- Favoring right ear: 59%

> Eye-hand crossed dominance:

Right-handers who are left eyed: 29%
Left-handers who are right eyed: 4%

> Ear-hand crossed dominance:

- Favoring ear on the same side as the dominant hand: ~70%
- Favoring ear on the opposite side as the dominant hand: ~24%
- No preference: ~6%

> Ear-eye crossed dominance:

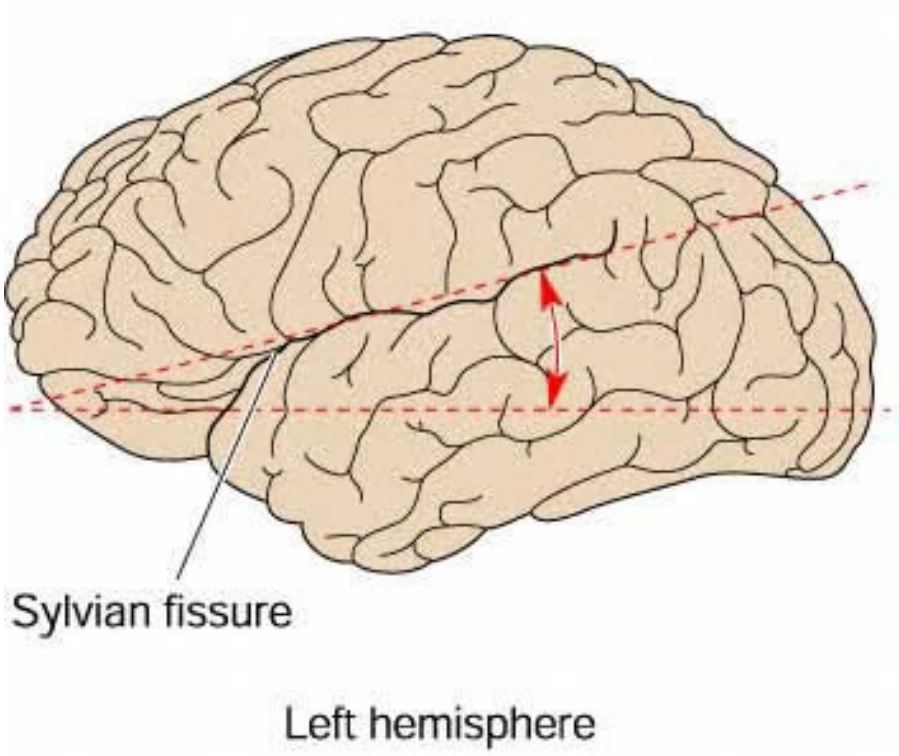
- *Those who use same ear and eye: 62%*

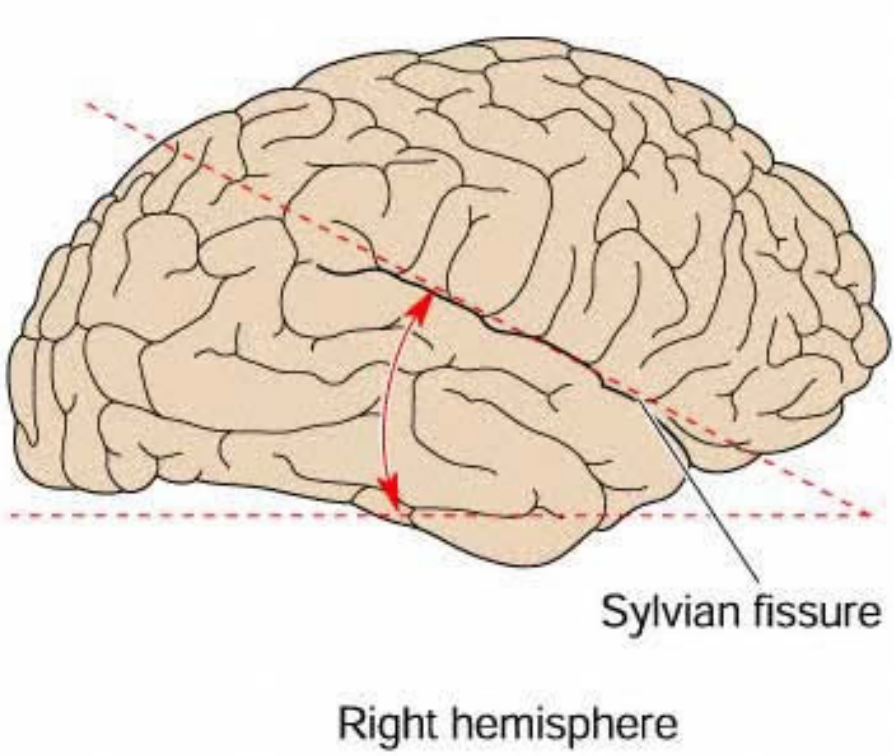
Approximate statistics for language laterality:

- Left hemispheric for grammar (> right hemispheric for prosody): ~ 80%
  - *Right-handers who are left hemispheric for grammar: 90%*
  - *Left-handers who are right hemispheric for grammar: 50%*

Functional asymmetry > Anatomical Asymmetry?

Left lateral (Sylvian) fissure longer and less steep than right

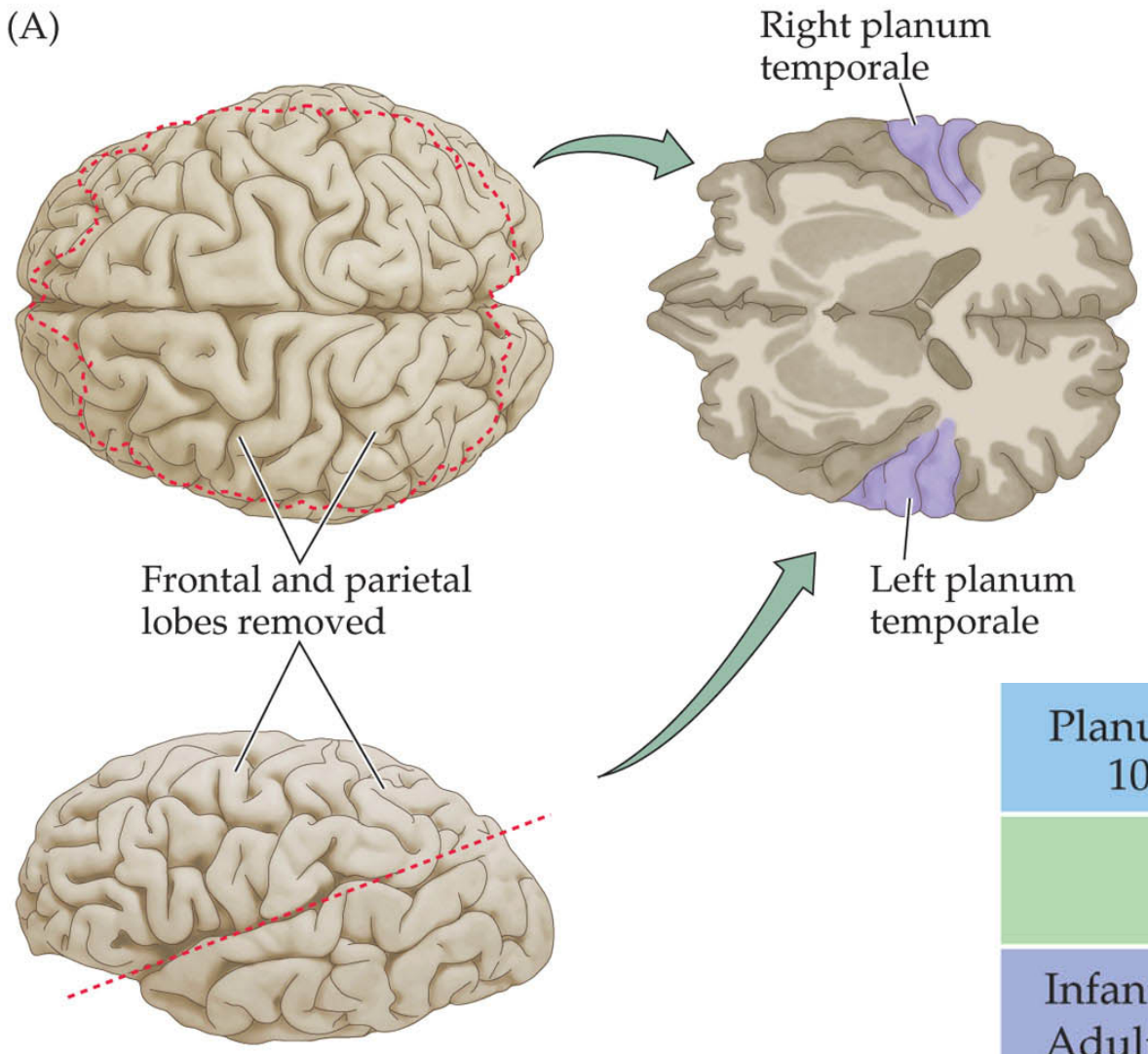


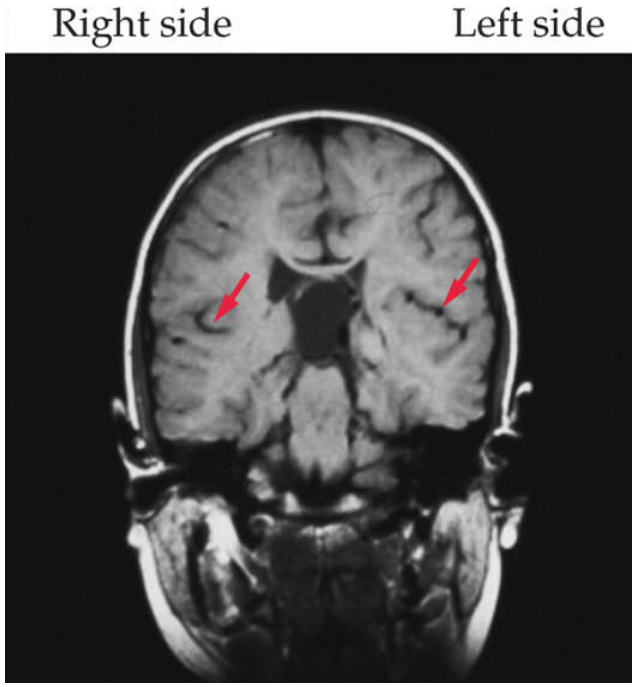


Anatomical Asymmetry > Functional asymmetry?

Left planum temporale larger than right in 65% of all cases

(Planum T. overlaps a major language area)





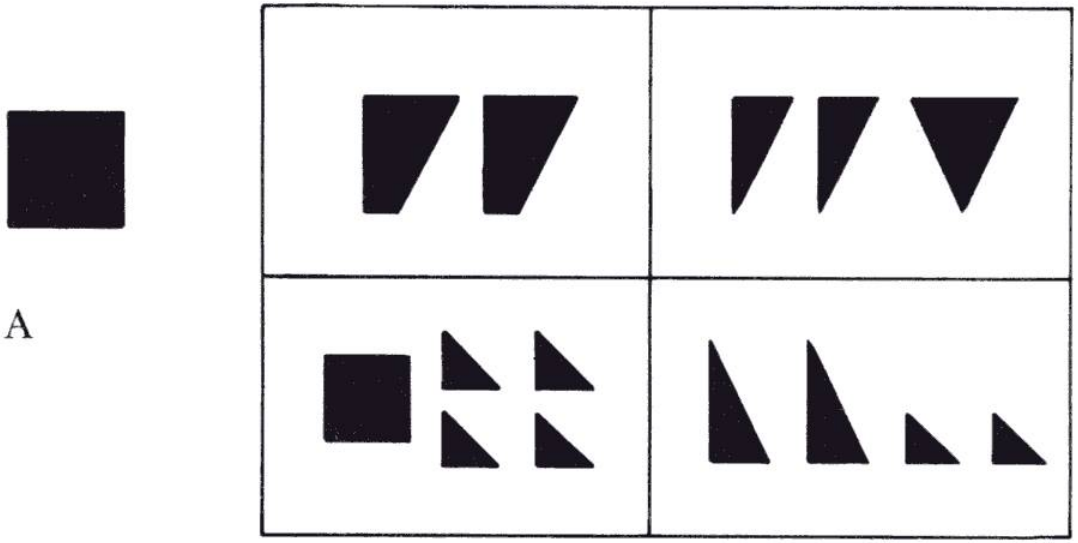
Planum temporale measurements of 100 adult and 100 infant brains

	Left hemisphere	Right hemisphere
Infant	20.7	11.7
Adult	37.0	18.4

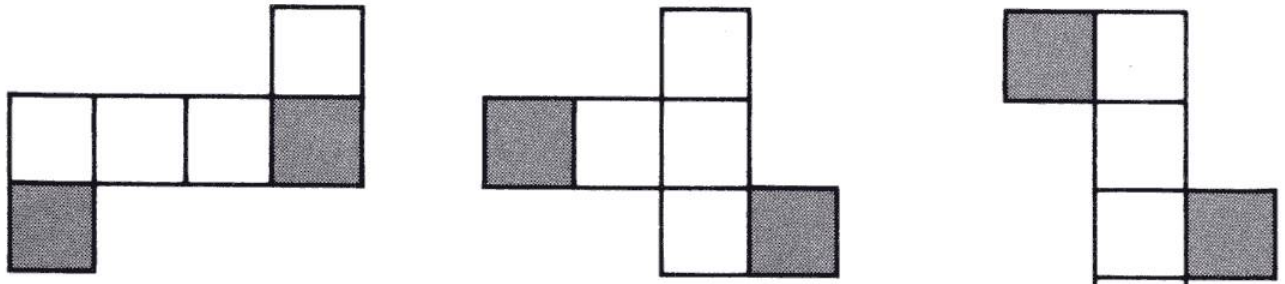
Generalizations on characteristics of the two different hemispheres

LEFT HEMISPHERE:	**RIGHT HEMISPHERE:**
articulate, verbal: syntactic	involved in detecting and controlling prosody, "nuance" and emotional valence in language
Analytical: good at complex reasoning and analysis required when a problem must be broken down into sequential elements; recognition of your own face	Wholistic: limited in ability to do complex reasoning or analysis, better at tasks like pattern recognition; face recognition of familiar people
Best at tasks related to "declarative" (AKA "explicit" or "episodic") memory: storage of information based on specific facts accessible to conscious awareness	Best at tasks related to "reflexive" (AKA "implicit", "procedural") memory: storage of information that is not generally accessible to conscious awareness
Modeling relations between events across time and trains of analytical thinking, successions of complex physical movements, ***perception and generation of rhythmic patterns in music***: "temporal sequencer"	Modeling relations between simultaneously occurring events, spatial relations, body position, relations among concurrent sounds (e.g., ***chords, short melodic patterns***)
Damage: Motor: Right-side paralysis Language: aphasias Music: arrhythmia	Damage: Motor: Left-side paralysis Language: aprosodia Music: amelodia, tone deafness

Example of a “right hemisphere” task



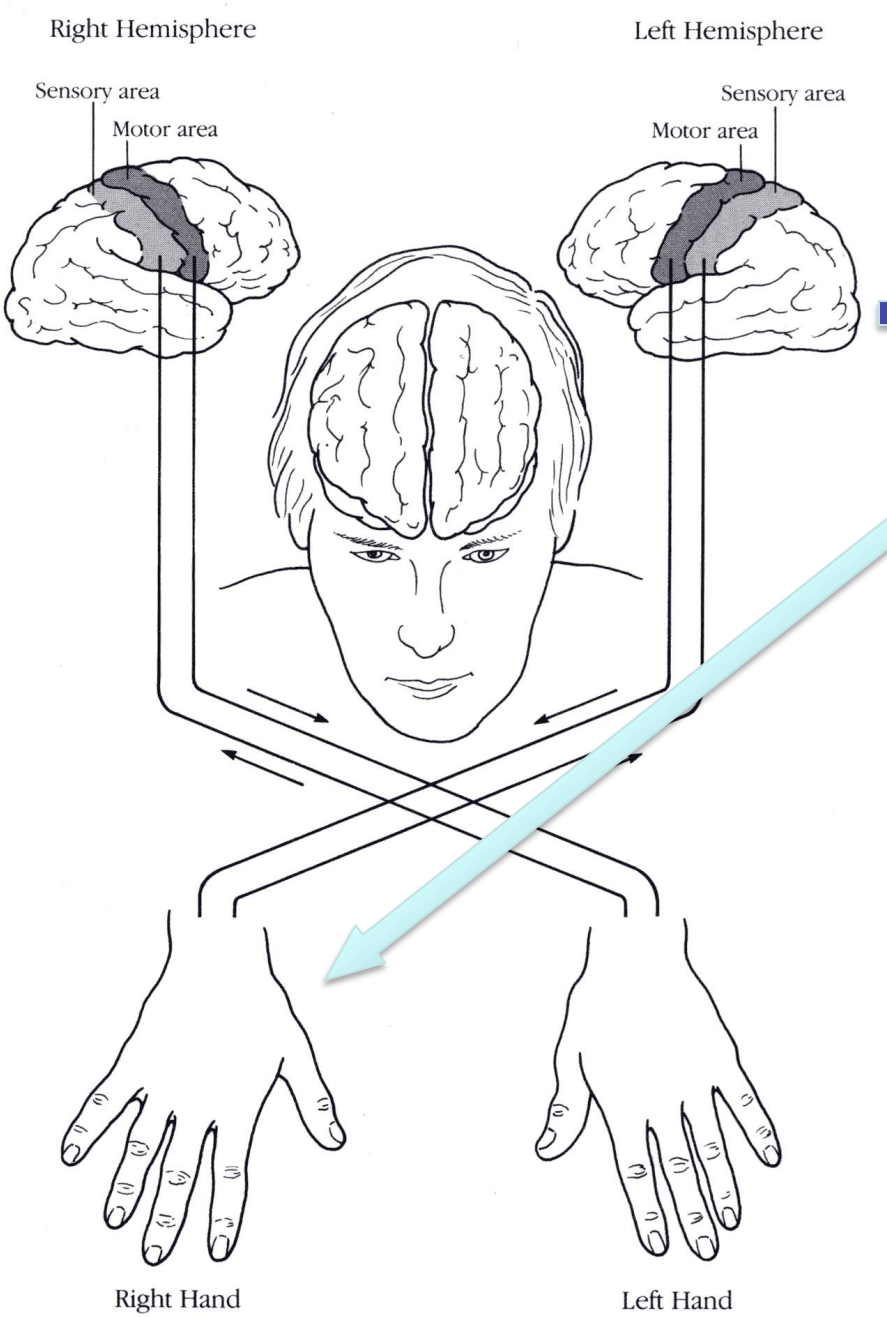
A

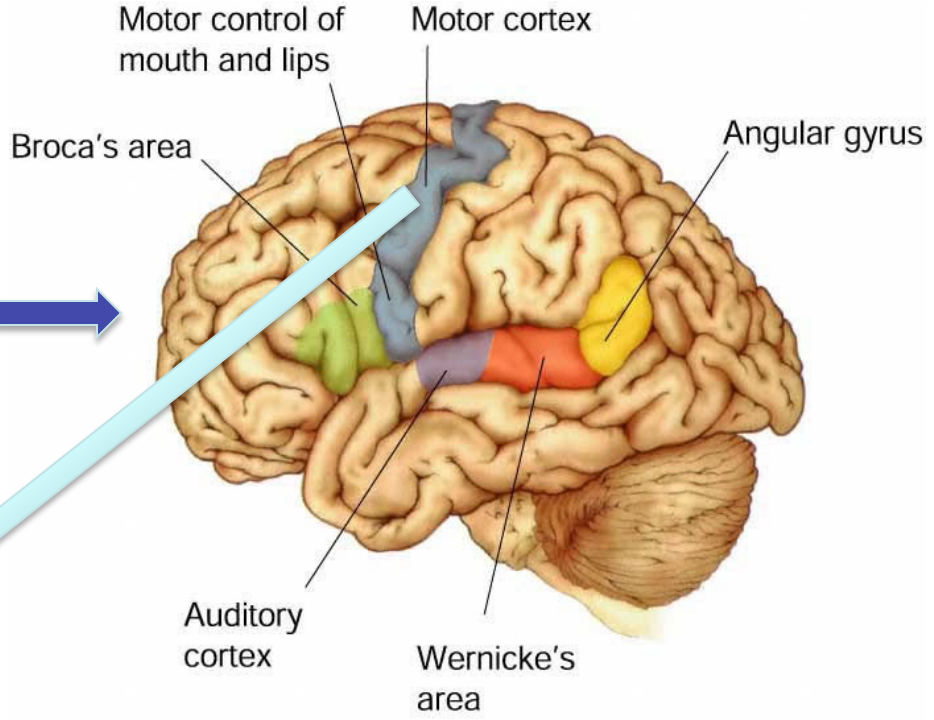


B

1.4 Visuo-spatial tasks. A. Which of the boxed set(s) can form the square on the outside? B. If you fold these patterns into cubes, in which cube(s) will the dark sides meet at one edge?

Motor pathways are “crossed”: your right hand is controlled by your *left* brain





Syntactical language processing is also lateralized to the ***left*** brain (in most of us)

Why are most of us right-handed?

Handedness is a natural consequence of the lateralization of language tasks.

Why are different functions lateralized?

Understandable from computational considerations!

- Optimization of different computational architectures: *CPUs, GPUs, APUs*
- Minimization of communication overhead

But given that it is better to lateralize functions,
why is ***right*** handedness better than ***left*** handedness?

Answer: ***it ISN'T,*** *from any fundamental standpoint…*

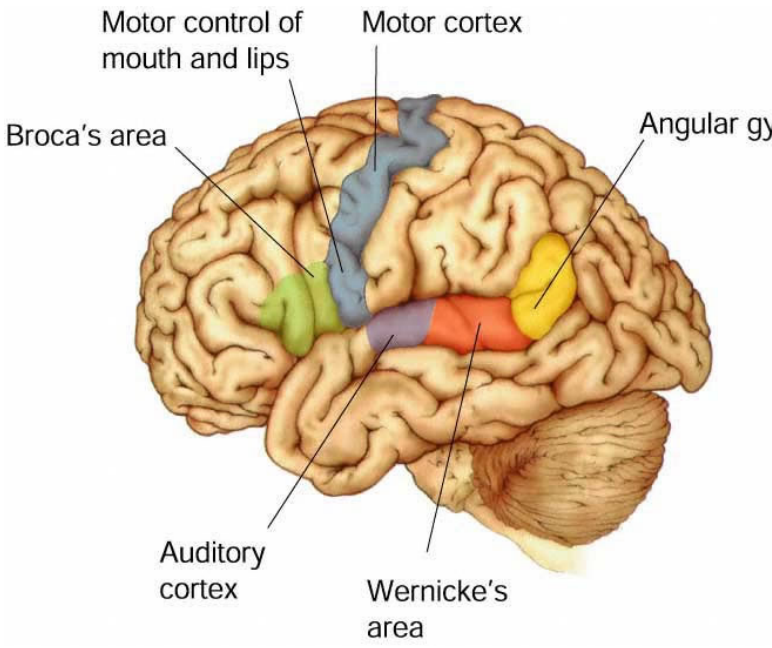
>>> But that's just the way it turned out, because:

a) syntactical language processing ended up emerging in the **left hemisphere**, and

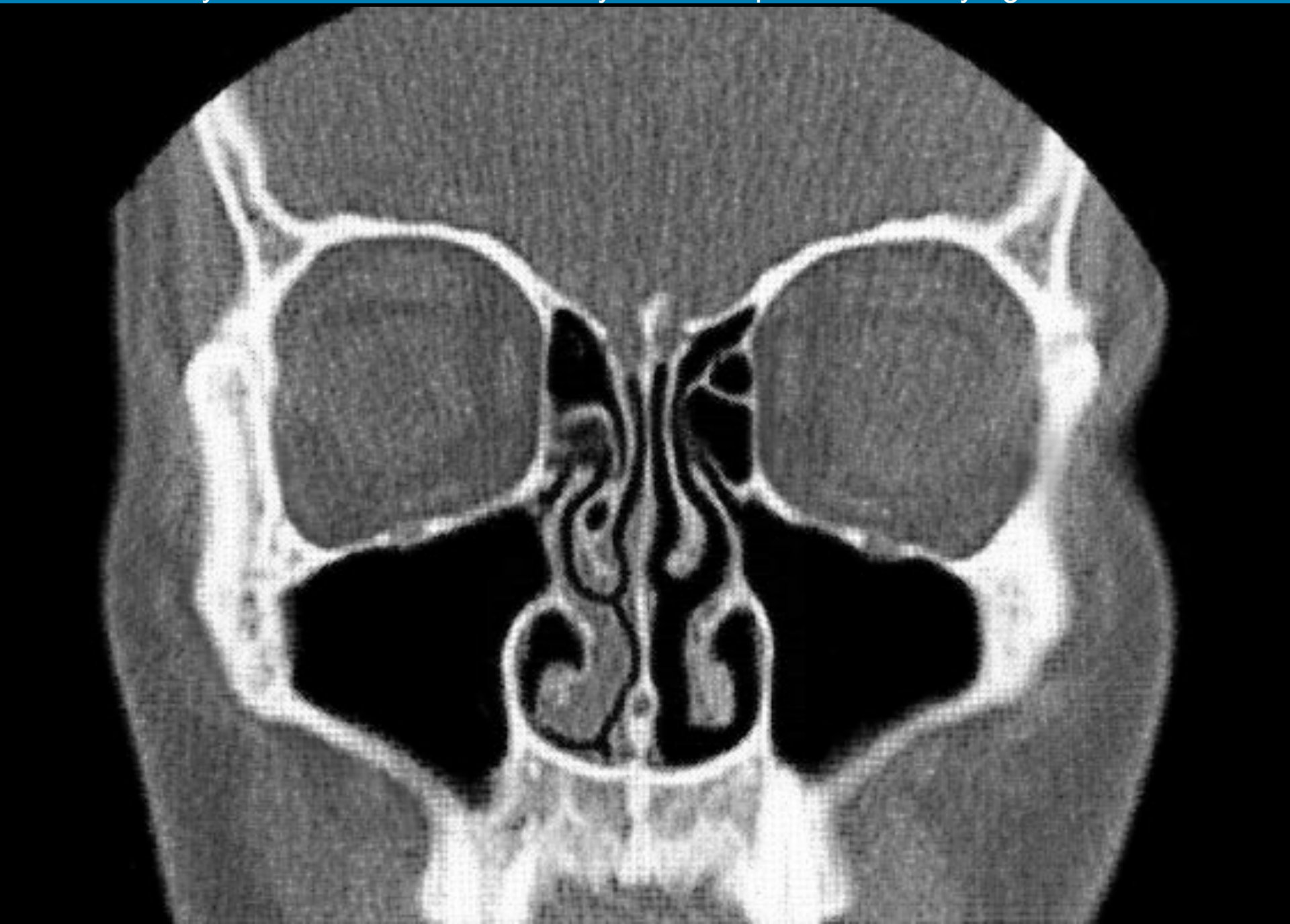
b) gesturing first evolved as a language enhancer.

c) since language task was already in left hemisphere, then the left motor area (right hand!) developed control of gestural communication.

d) As language capabilities evolve, gesturing became less essential, and the right hand is freed up for other tasks that involved object manipulation and motor recognition / motor thinking.



The nasal cycle: what is the balance of your hemispherical activity right now?

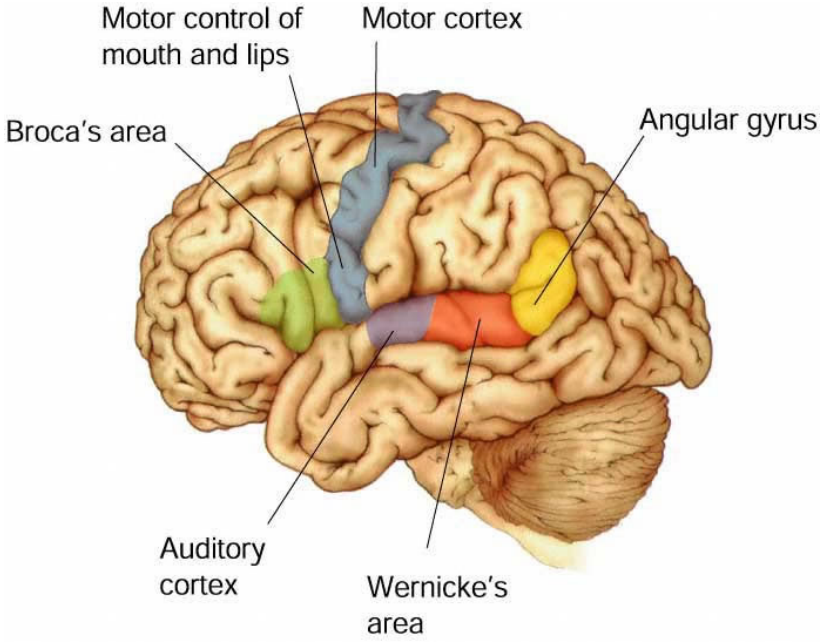


Language and the brain…

Innateness – the Fox P2 and other genes (www.nature.com/articles/srep22157)

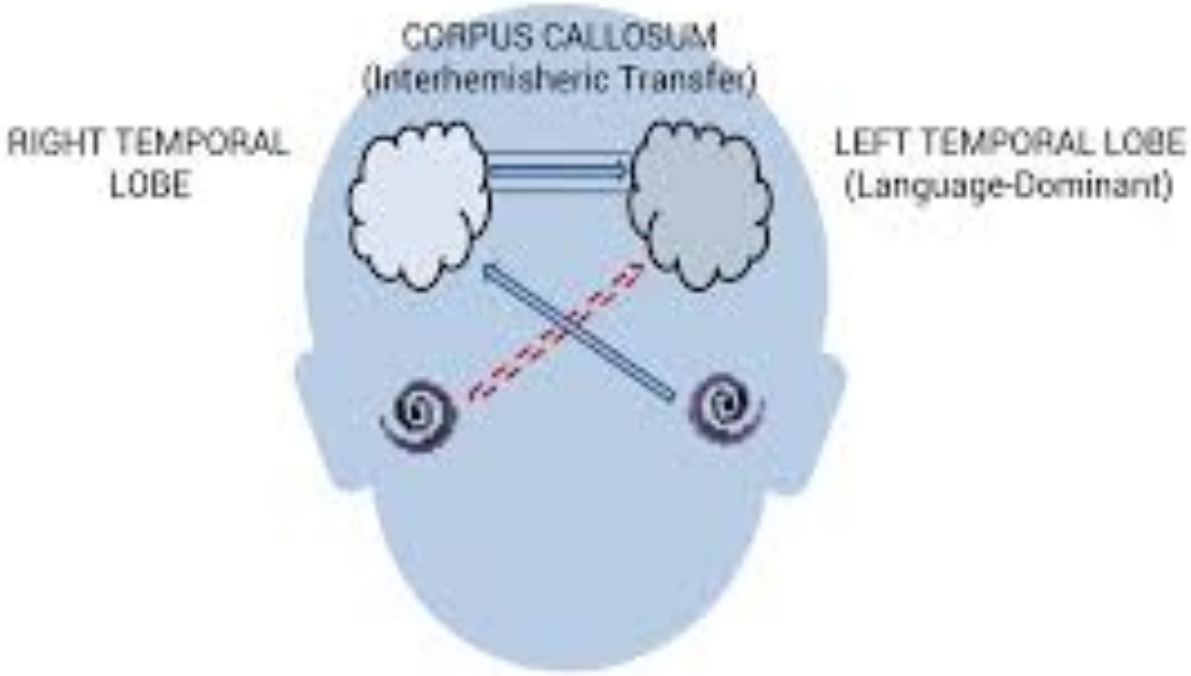
Handedness and Language

91% right handed and left hemisphere dominant for language
3% left handed and left hemisphere dominant for language
3% left handed and right hemisphere dominant for language
3% left handed and bilateralized for language



How can you test for which hemisphere is dominant for syntactical processing?

Dichotic Listening Test



IDichotic - itunes.apple.com/no/app/idichotic/id487280424?mt=8

Wada Experiments - https://www.youtube.com/watch?v=sBbilBZ46Eg

What we have learned learn from Stroke victims:

Aphasia Studies

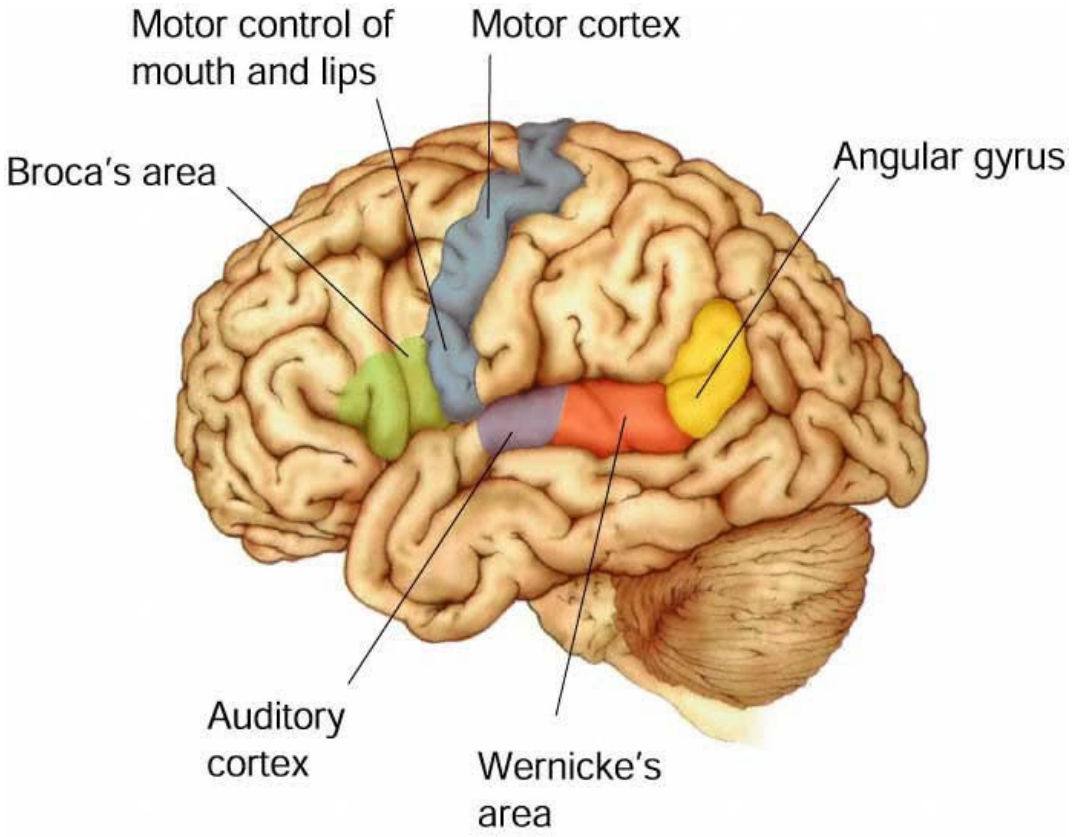
Global Aphasia – productive and receptive disturbances

Broca's Aphasia – phonological disturbances, word retrieval, other problems

Wernike's Aphasia – word salad

Heschel's Aphasia – word deafness, gyrus in primary auditory cortex

Bilingual Aphasia



Other important aspects of language acquisition:

Brain Health and Dementia – exercise, learning and playing a musical instrument, learning a foreign language all are very helpful in maintaining brain health and in delaying the onset of dementias.

Critical Age Theory

Primary Critical Age (age 4-5) – first language acquisition

Secondary Critical Age (the onset of puberty) – second language acquisition

Some cool links from ScienceDaily.com we will post:

Being bilingual wards off symptoms of dementia

Bilingualism delays Alzheimer's manifestation by more than four years

EEG recordings prove learning foreign languages can sharpen our minds

First physical evidence bilingualism delays onset of Alzheimer's symptoms

Language juggling rewires bilingual brain in a good way

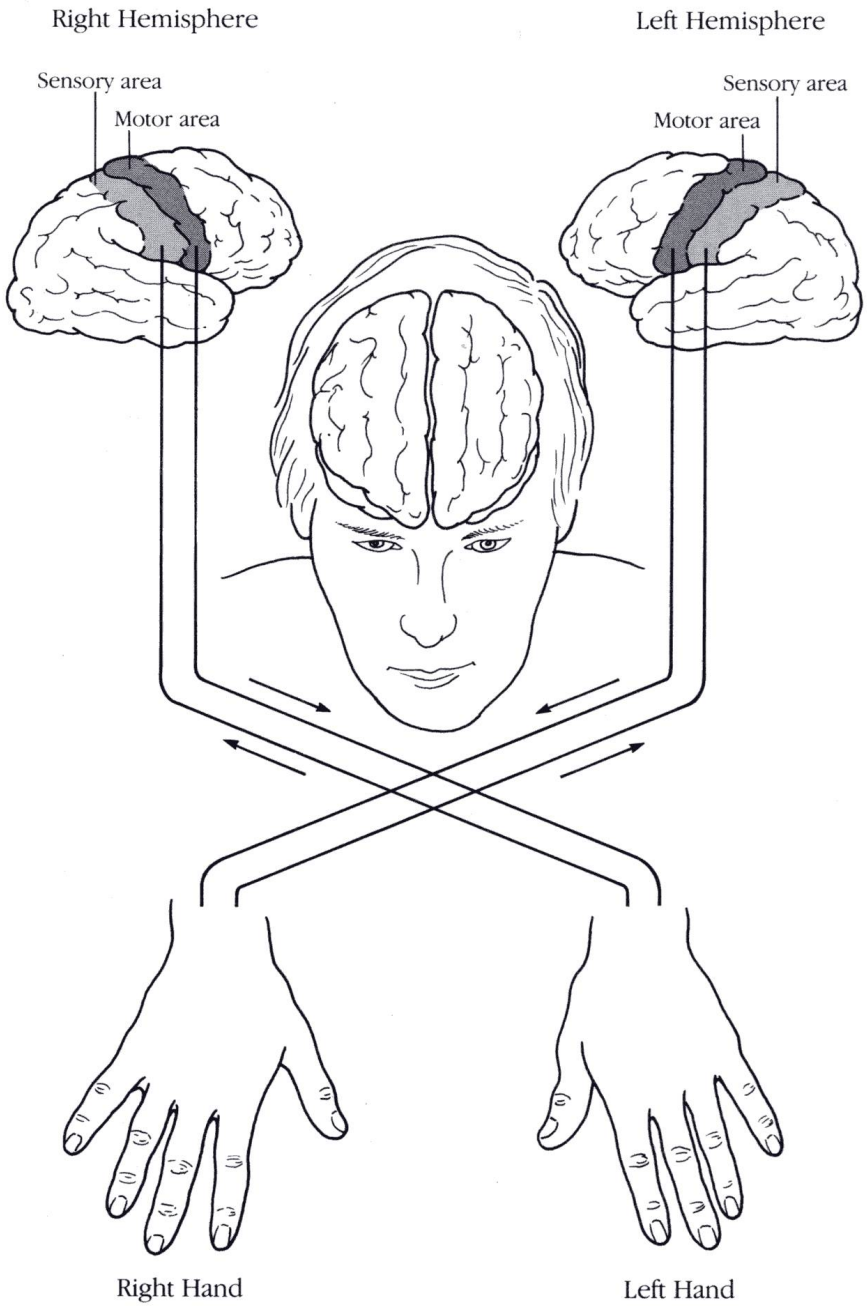
Language learning makes the brain grow, Swedish study suggests

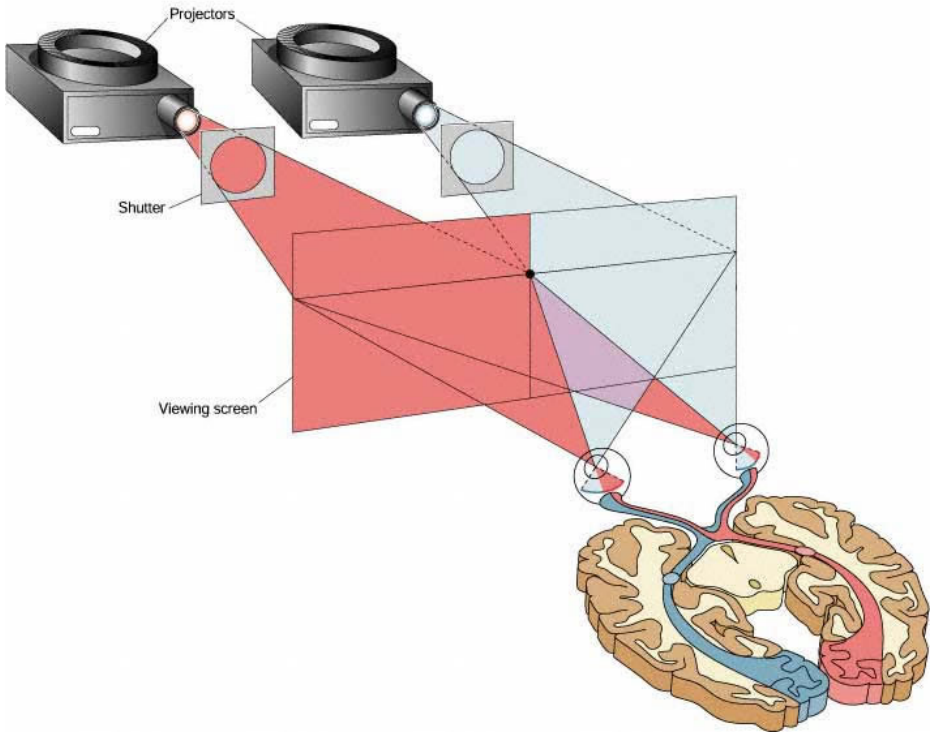
Speaking a second language may delay different dementias

Fini

Following: extra slides on split-brain studies…

Motor and sensory pathways are“crossed”

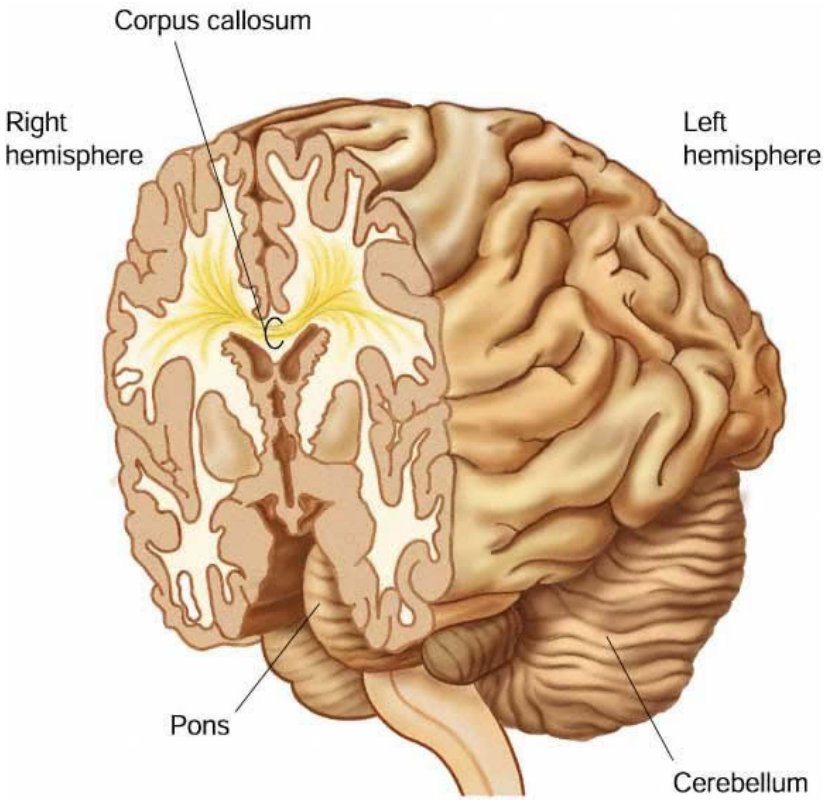


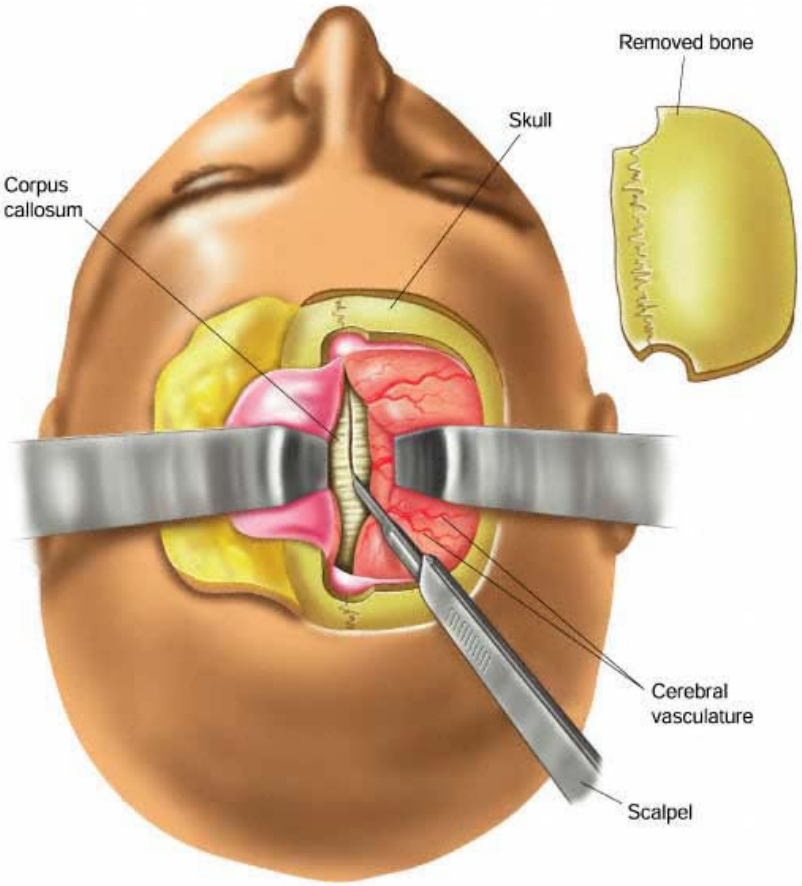


Cutting the Corpus callosum splits the two hemispheres

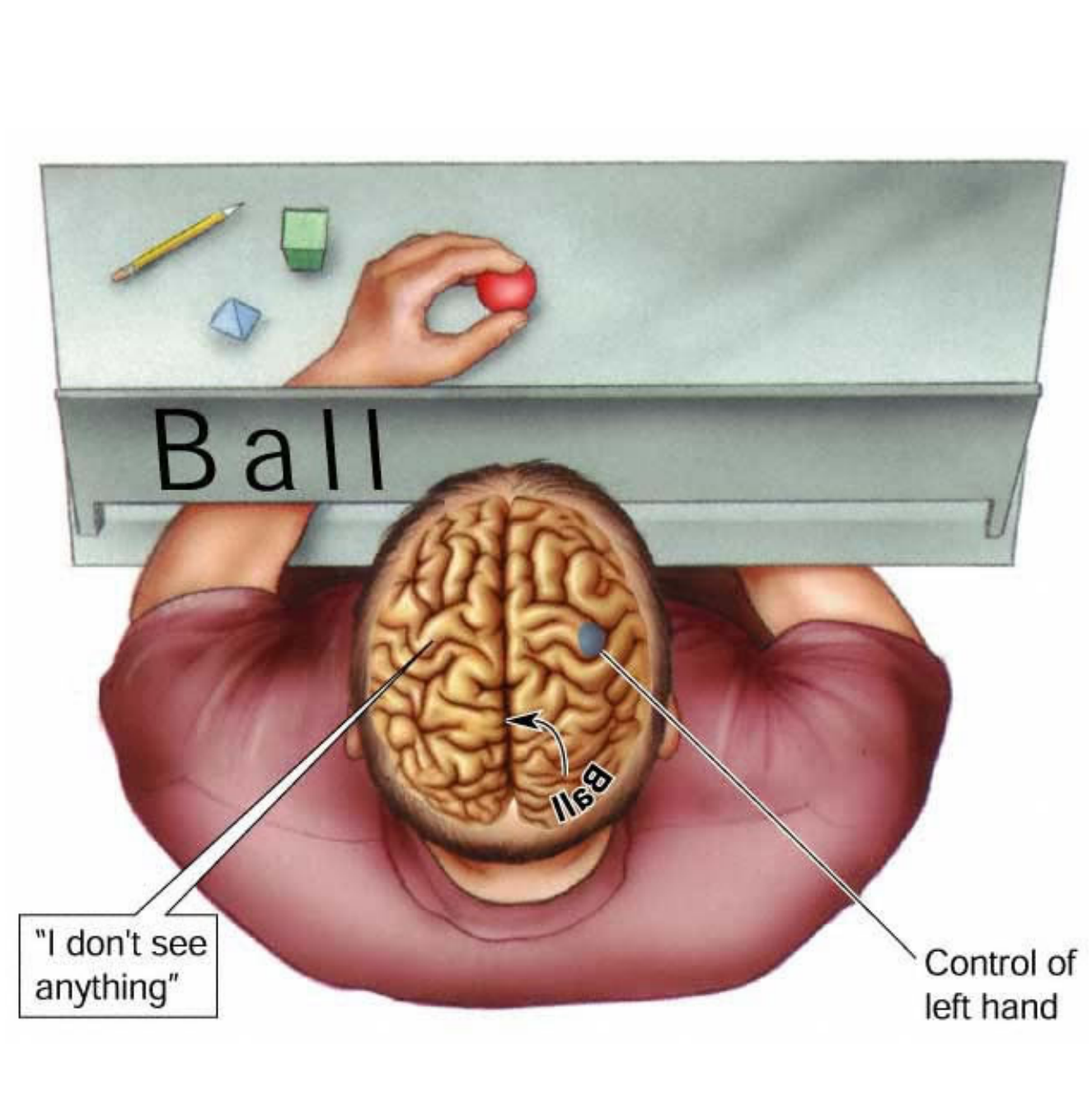
Roger Sperry (1950s)

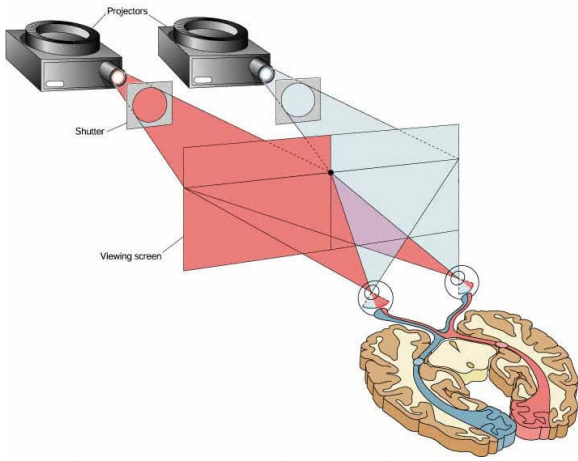
- Split-brain procedure:
- Sever axons making up the corpus callosum
  - No major deficits
  - With proper experiments, animals behaved as if they had 2 brains

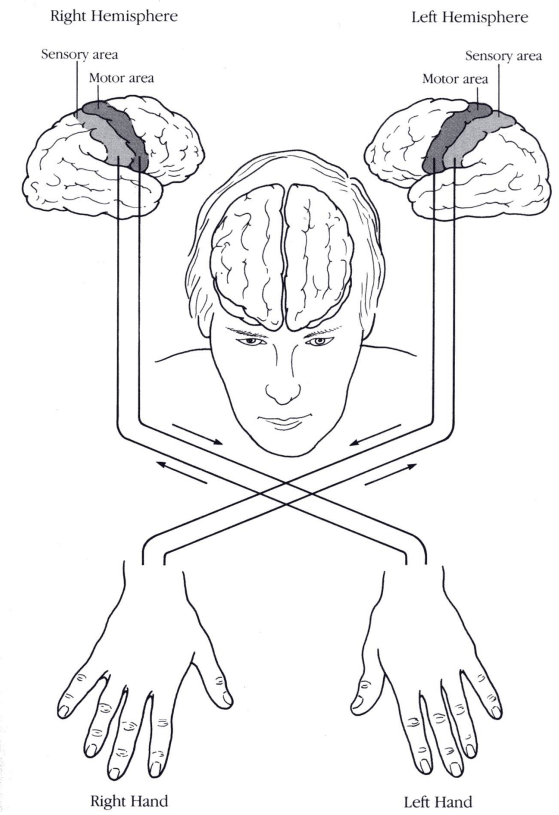




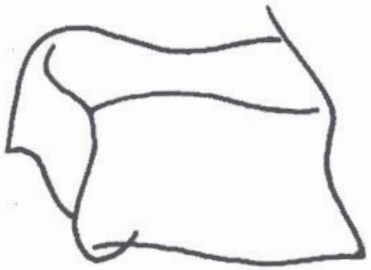
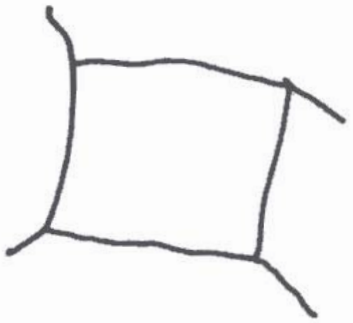
Different hemispheres see different things!





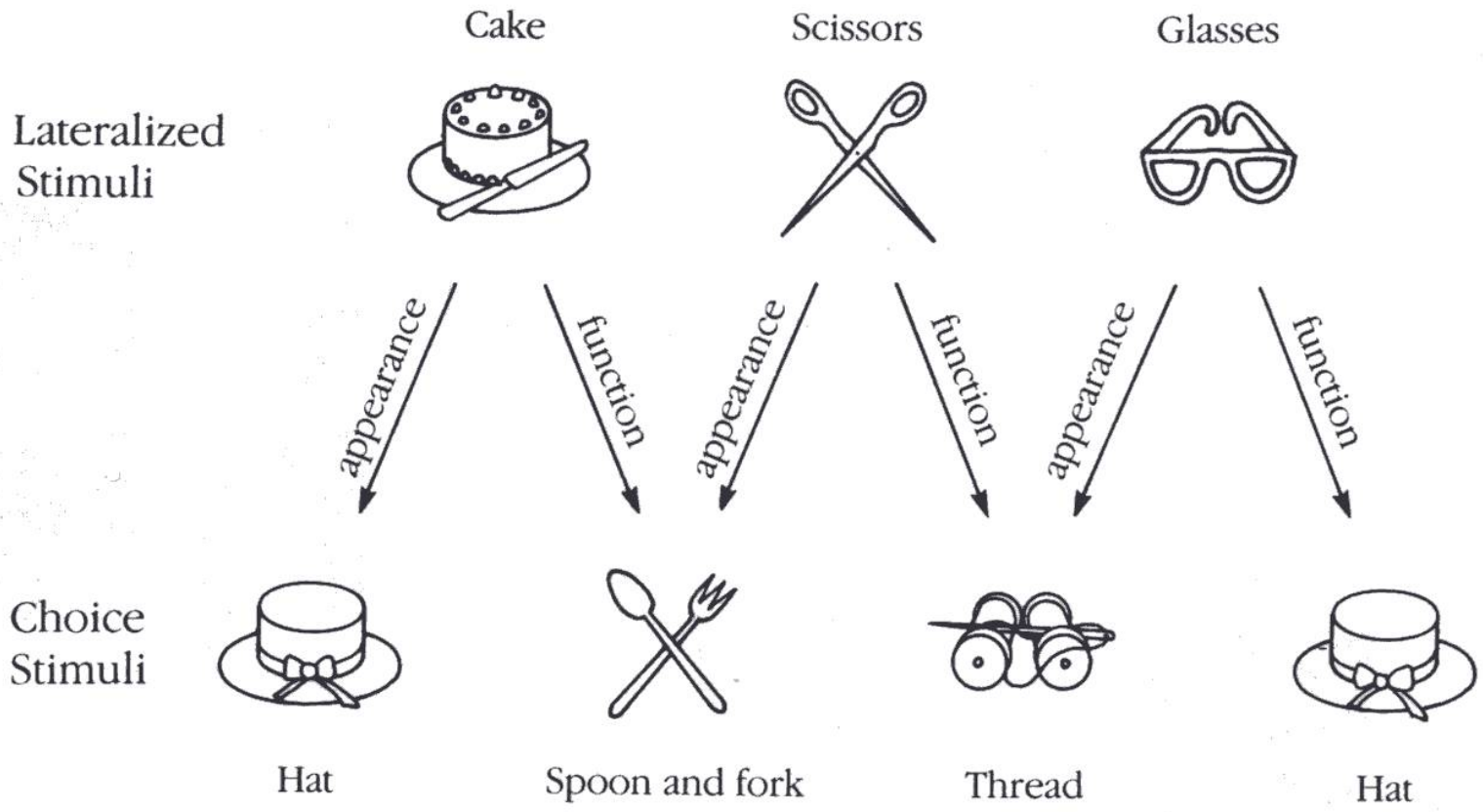


Before and after a commissurotomy

	Left hand	Right hand
Preoperative		
Postoperative		

Cube drawings before and after commissurotomy. Preoperatively, the patient could draw a cube with either hand. Postoperatively, the right hand performed poorly. The patient was right-handed. (From M. S. Gazzaniga and J. E. Le Doux, *The Integrated Mind,* Fig. 18, p. 52. New York: Plenum Press, 1978.)

Different hemispheres have different "cognitive points of view"



Function and appearance matches by split-brain patients. The stimuli in the top row are visually presented to one hemisphere at a time. The patient is instructed to pick the best "match" from the choice stimuli. When the left hemisphere sees the stimuli, it tends to match by function. When the right hemisphere sees the stimuli, it tends to match by appearance. (Adapted from J. Levy and C. Trevarthen, "Metacontrol of Hemispheric Function in Human Split Brain Patients," *Journal of Experimental Psychology,* Fig. 1, p. 302. 1976. Copyright © 1976 by the American Psychological Association. Reprinted by permission.)

The nasal cycle: which of your hemispheres is more active right now?

- The autonomic nervous system (**ANS**) is viewed as the "housekeeping" nervous system, and is regulated primarily by the hypothalamus. The **ANS** is divided into two divisions:
  - ***sympathetic nervous system (SNS)***
  - ***parasympathetic nervous system (PNS)***
- Most organs, ***including the cerebral cortex***, are innervated by fibers from both divisions that have opposing effects.
  - The **SNS** helps prepare for ***increased levels of activity and the fight or flight response***, which includes an increase in heart rate, blood pressure, cardiac output, a diversion of blood flow from the skin and splanchnic vessels to those supplying skeletal muscle, increased pupil size, bronchiolar dilation, contraction of sphincters, and metabolic changes utilizing fat and glycogen.
  - Activity in the **PNS** leads to ***rest, conservation, and restoration of energy*** and, thus, to a reduction in heart rate, blood pressure, and a facilitation of digestive processes and the elimination of waste products.
- An interesting feature of the **ANS** is that it is active in lateralized "ultradian" rhythms:
  - one branch of the **SNS** dominates one side of the body, and one branch of the **PNS** dominates on the opposite side, and then the two systems switch dominance on the two sides.
  - The period for this switching is variable, but averages at about 2-3 hours.

Studies have shown that the nasal cycle is tightly coupled to this rhythm of alternating cerebral hemispheric activity!!!

- The **nasal cycle** is the alternating congestion and decongestion of the nostrils in humans.
  - The turbinates in one fossa become engorged with blood while the opposite turbinates decongest.
- It is a physiological congestion of the nasal concha due to selective activation of one half of the autonomic nervous system by the hypothalamus.

Several publications (and anecdotal personal experience!) support the hypothesis that differential efficiency and/or ability for task performance correlates with nostril dominance!!!