KW11 : Lateralization

Case History: "MS"

- MS : 25 year old female
- long history of epilepsy (about 1 seizure/month)
- cause: cyst in L temporal lobe

- Surgery to remove it was success, but...
  - infection set it
  - caused widespread damage to LH

- Results:
  - unable to comprehend or speak language
    - except "I love you"
  - "Global Aphasia"
  - But could still sing songs and recognize right/wrong lyrics

Principles of Laterality

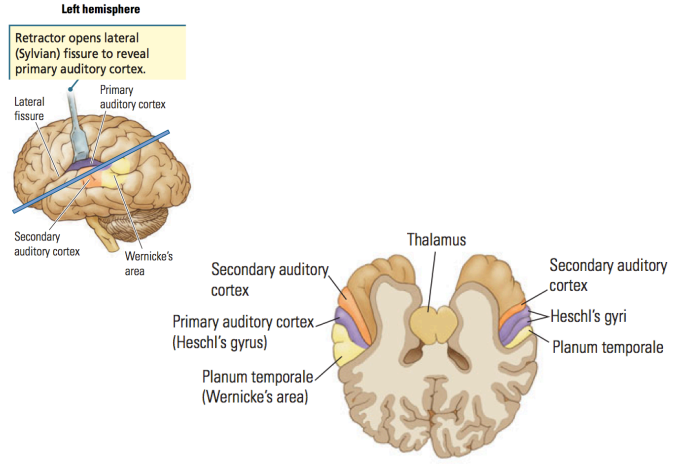
- Relative, not absolute:
  - both hemispheres active in most tasks
- Contralateral sites are more similar than different
  - "site is more important than side"
- Individual differences
  - genetics & environment, e.g. handedness

- Not just humans
  - animals show lateralization as well

History

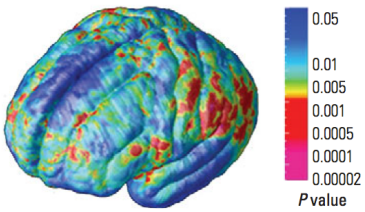
- Anatomic Asymmetry :
  - Pierre Gatiolet (1860s) noted LH develops gyri & sulci before RH
- Norman Geschwind & Walter Levitsky
  - asymmetry in *planum temporale* in temporal lobes
  - aka "Wernicke's Area"
  - average 1cm longer in LH than RH

Asymmetry in Auditory Cortex



Major anatomical asymmetry

- RH is slightly larger & heavier
- LH has more gray matter
- Temporal lobes : the most asymmetric
- Neurotransmitters show asymmetry too
- Details affected by sex & handedness

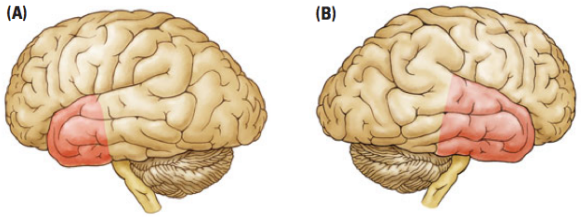


Forms of asymmetry

- Anatomic Asymmetry
- Neurotransmitter Asymmetry
- Genetic Asymmetry
  - gene expressions differ between LH and RH
- Behavioral / Functional Asymmetry

Double Dissociation Example

- Two patients, each had temporal lobe removed to help with intractable epilepsy
- (A) : patient PG - Left temporal lobectomy
- (B) : patient SK - Right temporal lobectomy

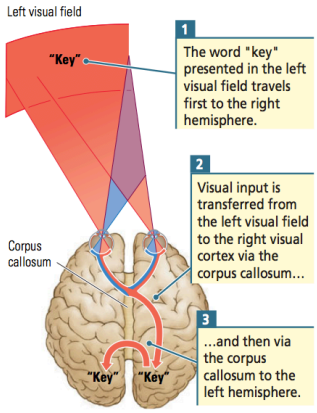


Double Dissociation : Test results

	Lobe Removed			
	LH		RH	
Test	Pre	Post	Pre	Post
FSIQ	123	109	114	103
VIQ	122	103	115	115
PIQ	121	114	110	**89**
Memory Quotient	**96**	**73**	121	101
Verbal Recall	**7.0**	**2.0**	16.0	12
NV recall	10.5	10.5	7.5	**5.5**
Drawing copy	94%	94%	86%	**78%**
Drawing recall	63%	63%	**31%**	**36%**

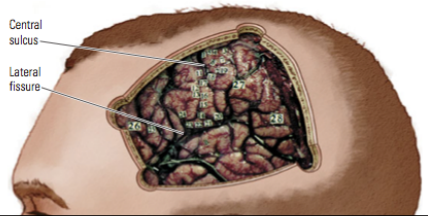
Split brain patients

- LH can read words from R visual field in normal patients due to connections via corpus callosum
- Commissurotomy: cutting both corpus callosum and anterior commisure



Direct brain stimulation : 4 effects

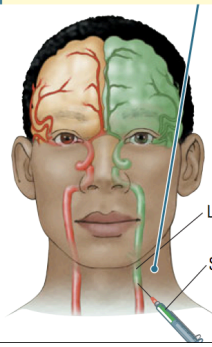
- somatosensory: movement, numbness, flashes of light, sounds
- experiential : fear, deja vu, dreaming states, memories
- increased action, e.g. LH : speech : increased talkativeness
- decreased action : LH, inhibition of behavior, e.g. inability to talk



Wada Test

- sodium amobarbital injection
-

When the left carotid artery is injected, the left hemisphere is briefly anesthetized; so the person cannot speak, move the right arm, or see on the right visual field. Although the right hemisphere is awake, for most people it is nondominant for speech, and the patient can neither speak nor later report on the experience.



Injection into the right side produces sensory and motor symptoms on the left but no speech disturbance, unless the patient's right hemisphere is domininant for speech.

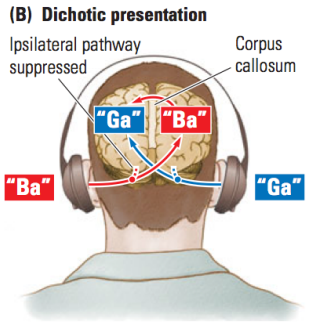
Video: Wada Test with Dr. Wada

Asymmetry in the Visual System

- Visual system : almost 100% perfectly crossed
- Methods:
  - Tachistoscope - presents stimuli to one visual *field* at a time
- Findings:
  - LH advantage for verbal stimuli
  - RH advantage for faces and other visuospatial stimuli

Asymmetry in the Auditory System

- Auditory system : not fully crossed - both hemispheres receive projection from both ears
- Methods:
  - Dichotic listening tasks
- Findings:
  - LH advantage for speech
  - RH advantage for melodies
  - inconsistent - greatly affected by individual Ss factors such as attention, practice



Asymmetry in the Somatosensory System

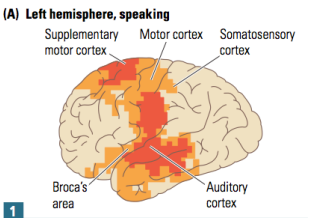
- Somatosensory system : almost 100% fully crossed
- Methods:
  - object identification by touch
- Findings:
  - LH disadvantage overall, but better at IDing letters
  - RH advantage overall

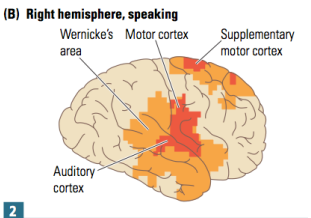
Asymmetry in the Somatomotor System

- Somatomotor system : almost 100% fully crossed
- Methods:
  - videotaping of face during speech
- Findings:
  - LH faster (right-side of mouth moves faster & more fully)
  - RH more expressive for emotions

Neuroimaging and Asymmetry

- Neural activation (from PET, fMRI…) consistent with localization / lateralization





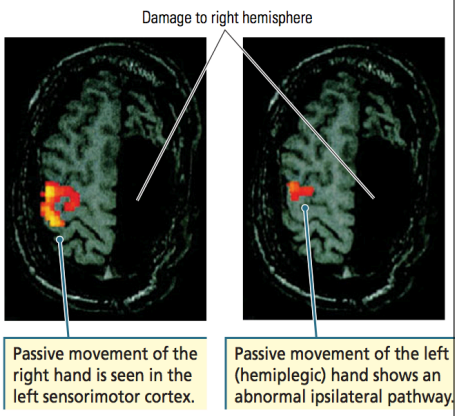
Asymmetry : Theory & Models

- Specialization models
  - LH and RH have unique abilities, not shared
  - LH : speech, language, motor movement, tracking information serially on short timeframes
  - RH : visuospatial, holistic, parallel, slower timeframes
  - viz “Stroke of genius” video?

- Interaction models:
  - LH and RH both capable of same abilities, but don’t
    - LH and RH work on different *aspect* of same task (e.g. speech meaning : LH, speech emotion : RH)
  - Each H inhibits the other
    - evidence : hemispherectomy can improve functioning

Asymmetry : Plasticity

- 17 hemispherectomy patients were examined
- in some patients, movement of left hand showed activation in the Left (ipsilateral) hemisphere



Preferred Cognitive Mode

- Given difference in LH and RH abilities
- Might individuals differ in strengths/weaknesses, and ability to choose or prefer one H to the other?