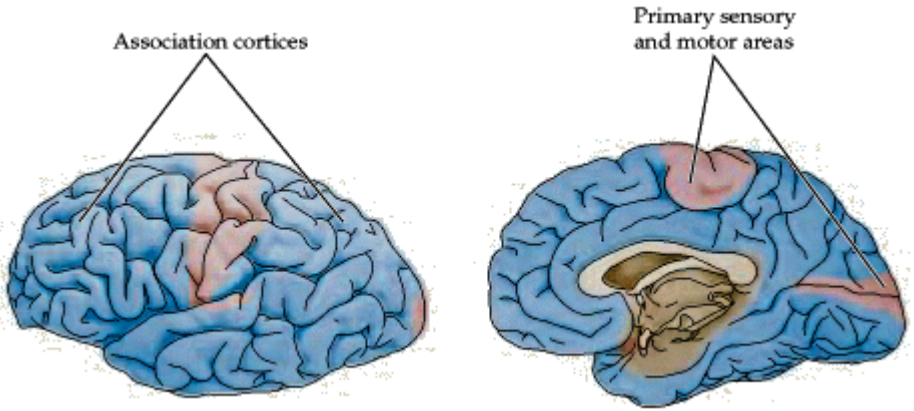
18

Neocortex II

Brain Cortex

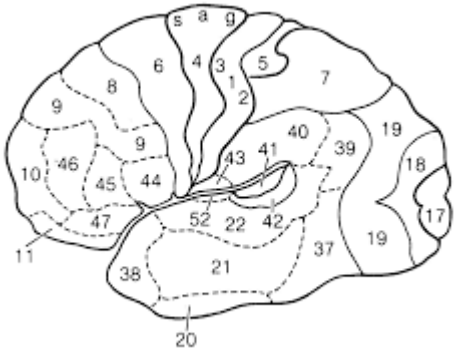


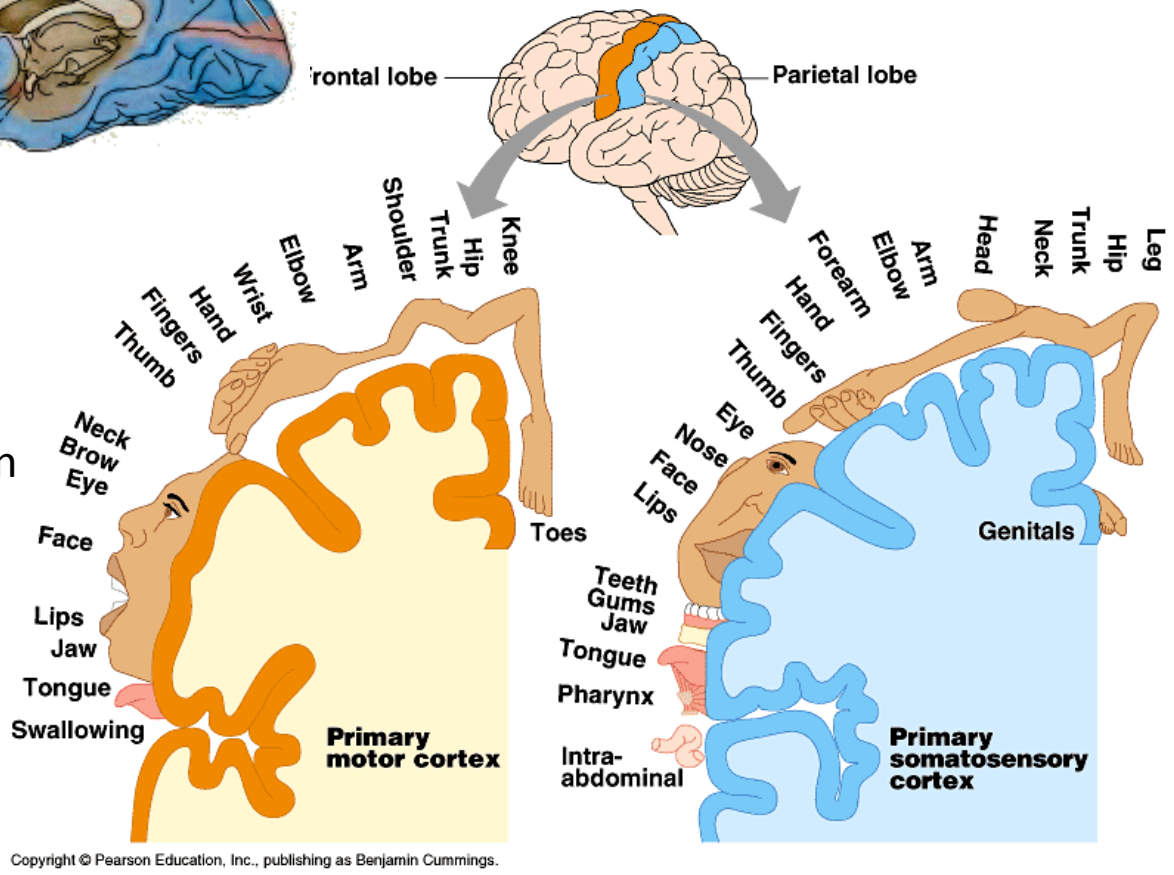
Primary areas

✓Somathotopic organization

Association areas

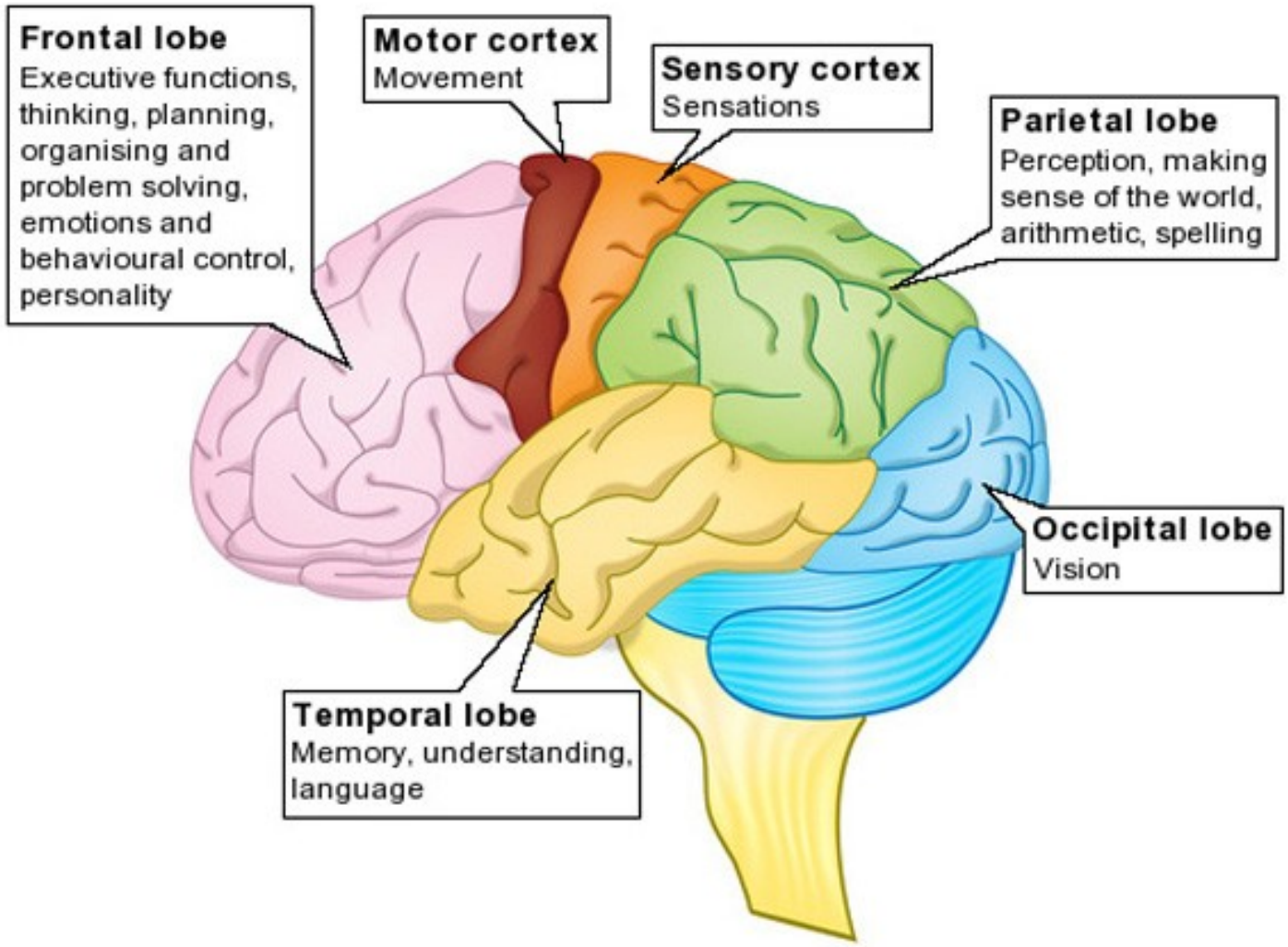
✓No somathotopic organization





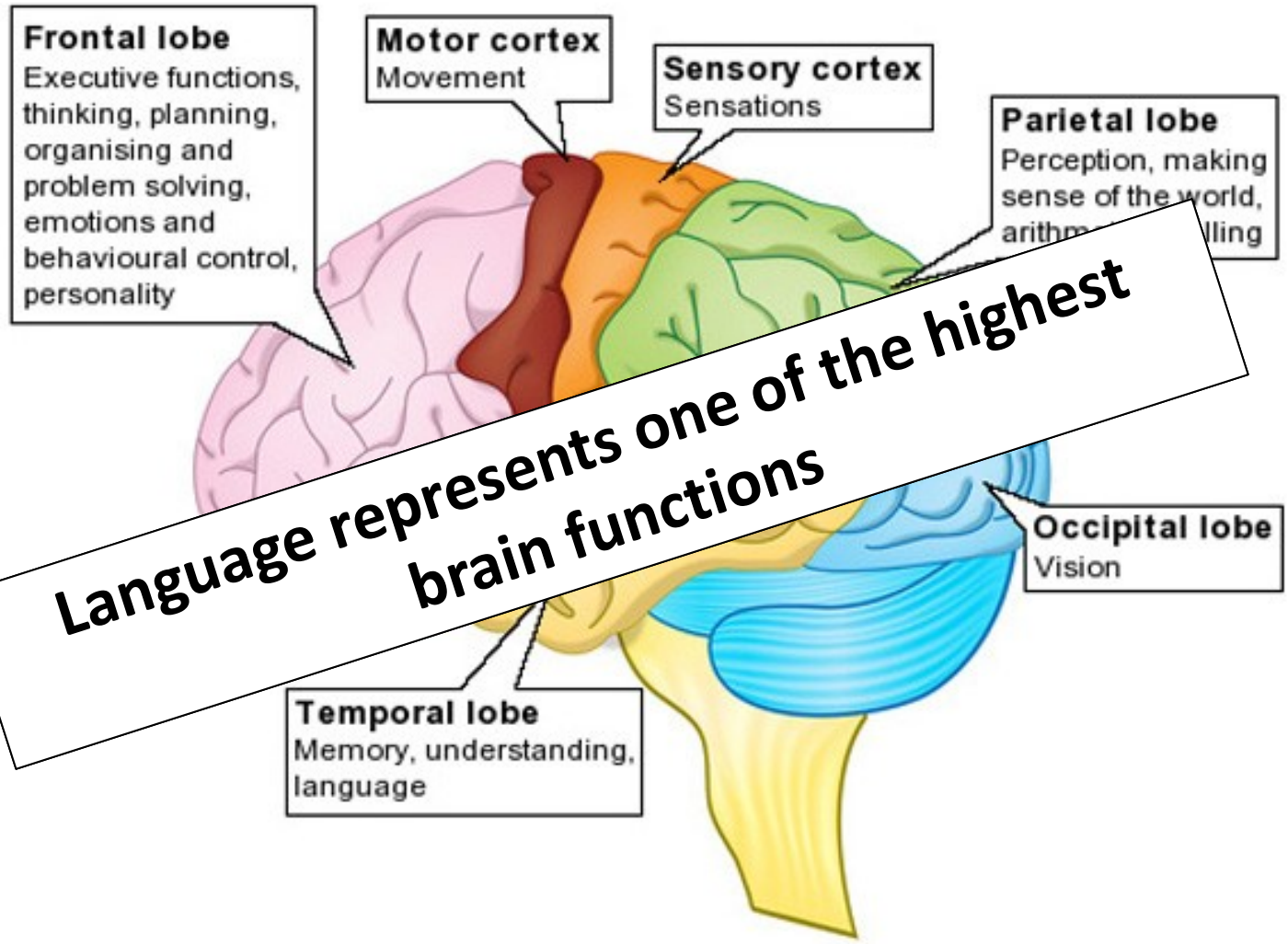
http://www.emunix.emich.edu

Brain Functions



http://www.modernfamilyideas.com

Brain Functions



Language represents one of the highest brain functions

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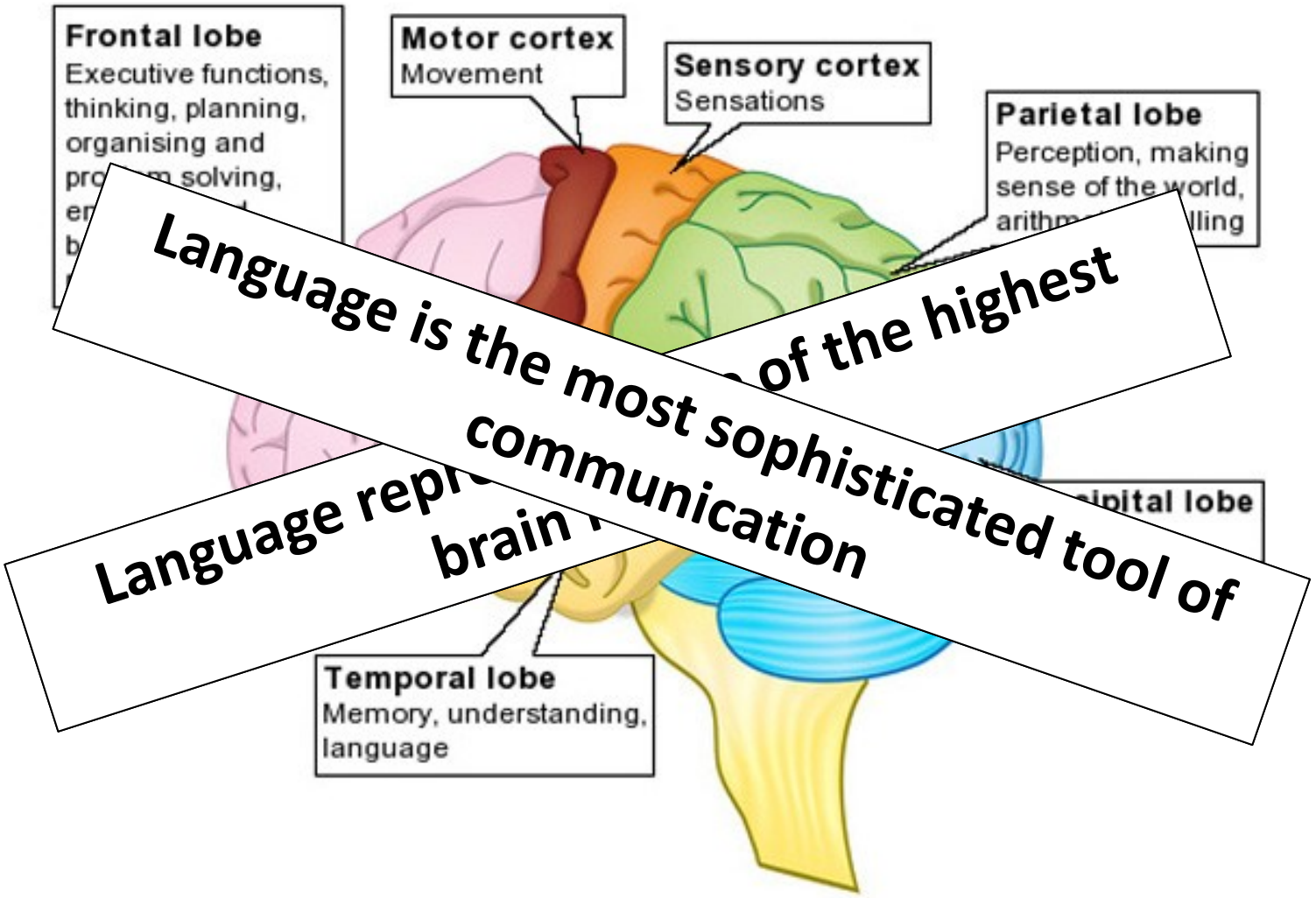
Brain Functions

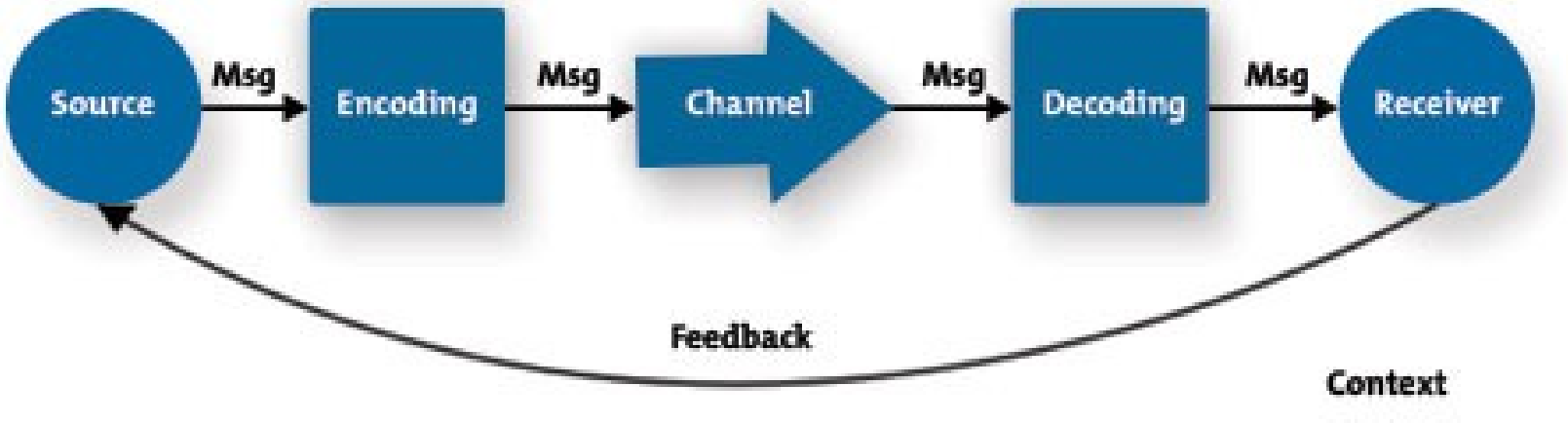


http://www.modernfamilyideas.com

Communication

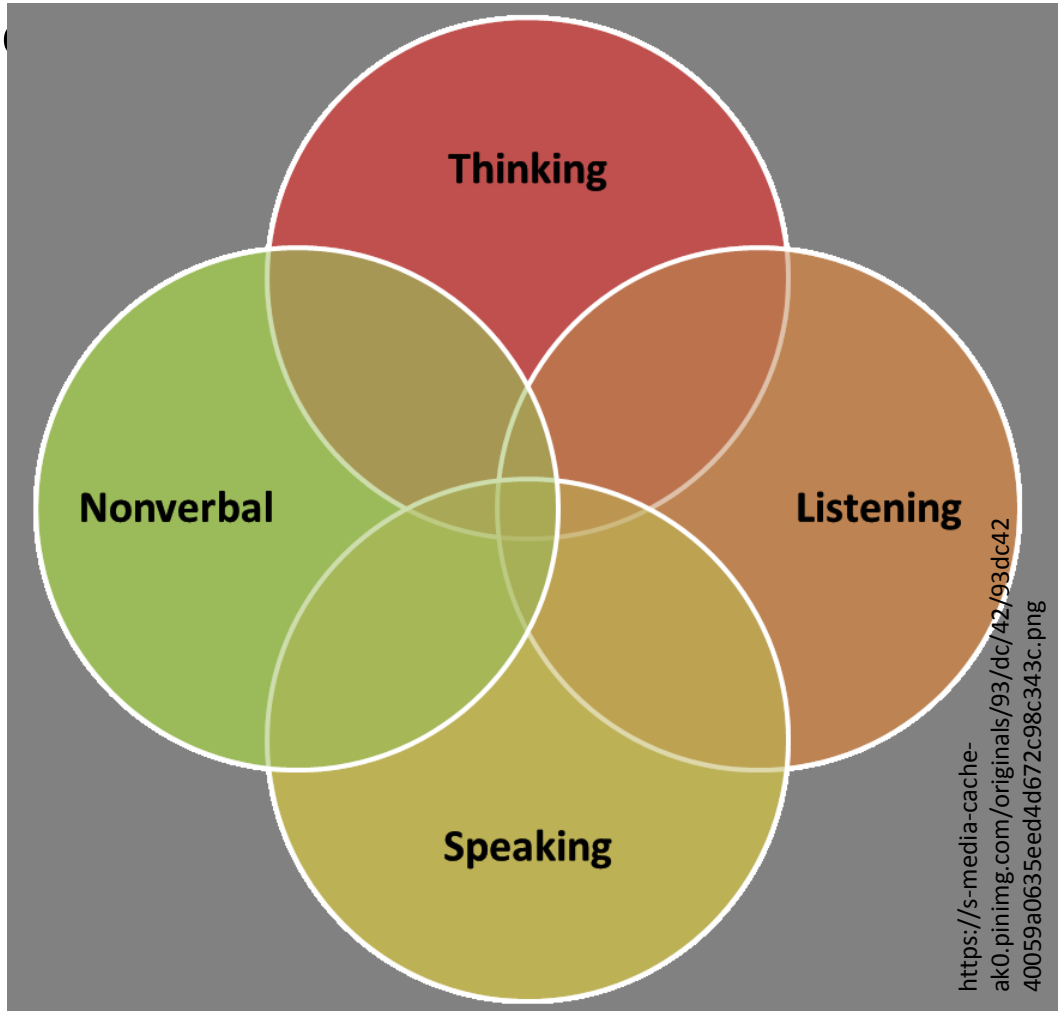
- Signal exchange
  - ✓ Smell
  - ✓ Visual
  - ✓ Acoustic
- Encoding
  - ✓ Simple – body size
  - ✓ Complex – dance of the honey bee
- Between individuals of
  - ✓ Same species
  - ✓ Different species

https://www.mindtools.com/media/Diagrams/CommunicationsProcess.jpg



Communication in human society

- Non-verbal
  - Hard to control
  - Influence of limbic syst
- Verbal
  - Fully controllable
  - Neocortex



Language

- The most sophisticated tool of communication

- Language is characteristic that defines the human species
  - No human society without language
  - No other species that have a language

- Language was a precondition for development of complex society and development of culture

http://www.zywave.com/wp-content/uploads/2015/08/culture1.jpg

Language

- The ability to acquire and use complex systems of communication, particularly the human ability to do so

- Complex hierarchic code

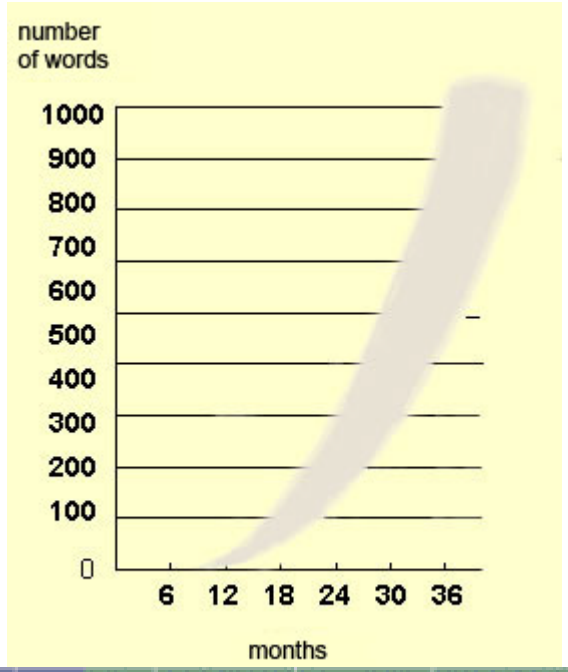
http://parsleysinmissions.org/images/postimages/language.jpg

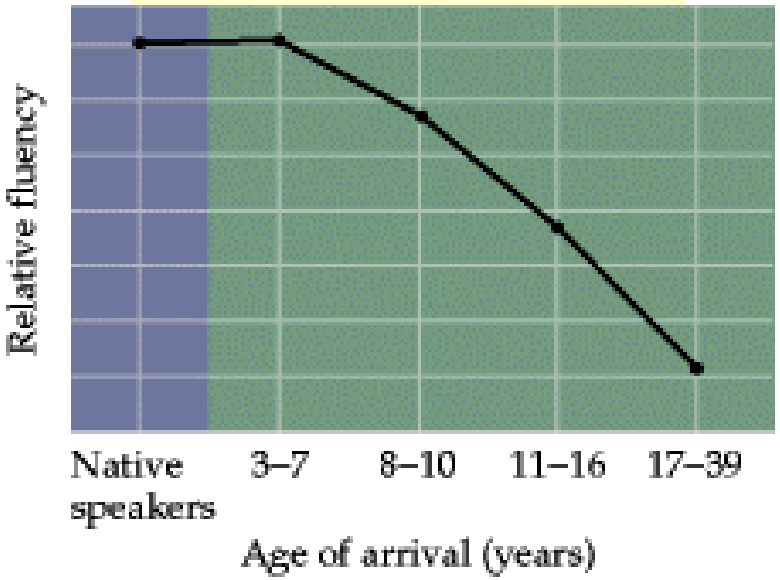
➢ Syllable
  - Unit of organization for
  a sequence of speech sounds

➢ Word
  - Symbol with a meaning

➢ Sentence
  - A group of words organized according to the rules of syntax

Learning to speak



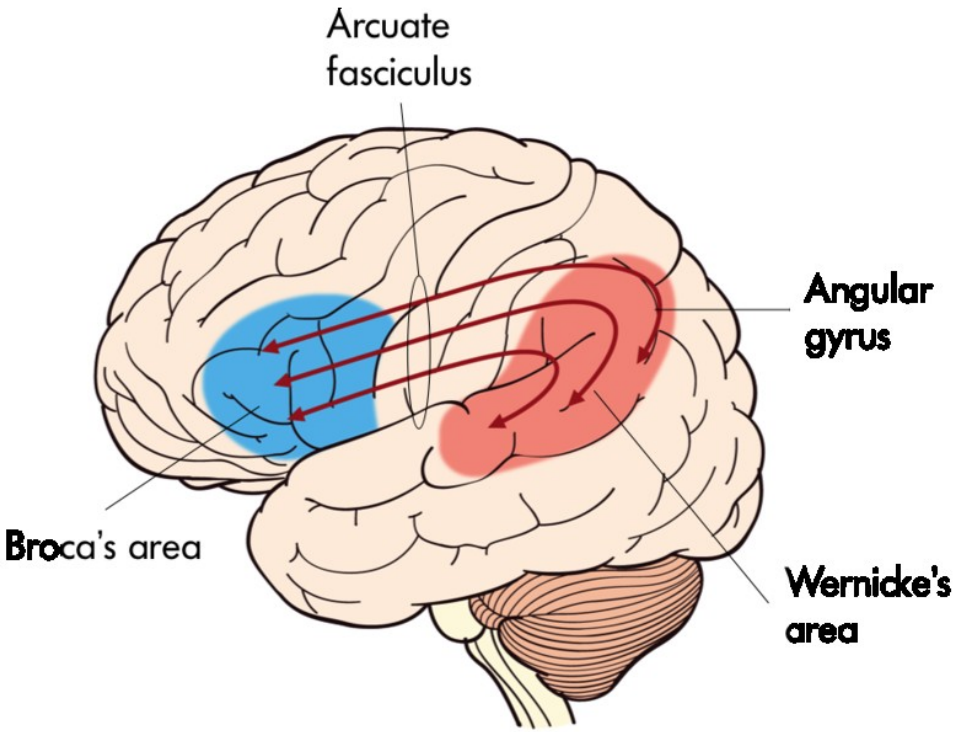


- Learning to speak takes a long time period
  - Understanding – „sensoric“
  - Speaking – „motor action“
- 7.-12. month – baby begins to understand simple orders
- 1. year – baby uses a couple of words
- 2.-5. years – baby maters syntax rules

6. years – child uses around 2500 words

Adult vocabulary
- Active: 3000 -10 000 words
- Passive: 3-6x higher than active v.

Language areas

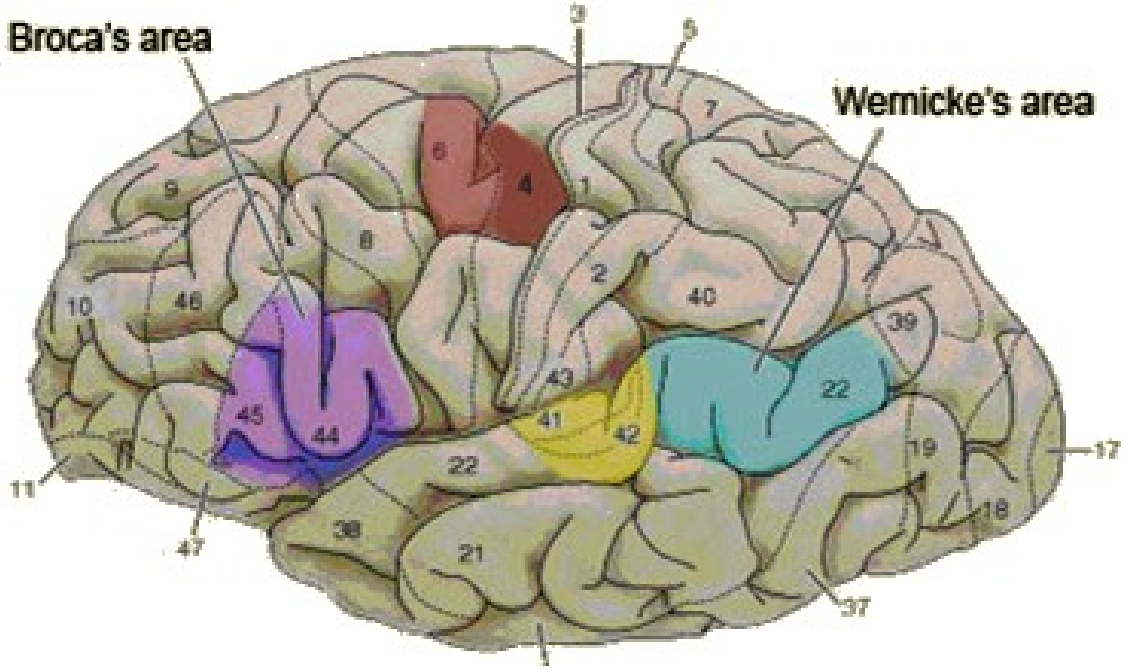


There are two main language areas

- Broca´s area (motor)
  - ✓ Close to motor cortex
- Wernicke´s area (sensor)
  - ✓ Close to auditory cortex
- Fasciculus arcuatus

- Conduction aphasia
  - ✓ Damage of fasc. arcuatus
  - ✓ Speech fluent, comprehension preserved
  - ✓ Problem with repeating words and sentences
- Dysarthria
  - ✓ Problem with articulation
  - ✓ For example, damage of vocal cord …

Broca´s area



Area 45

- ✓ Semantic processing

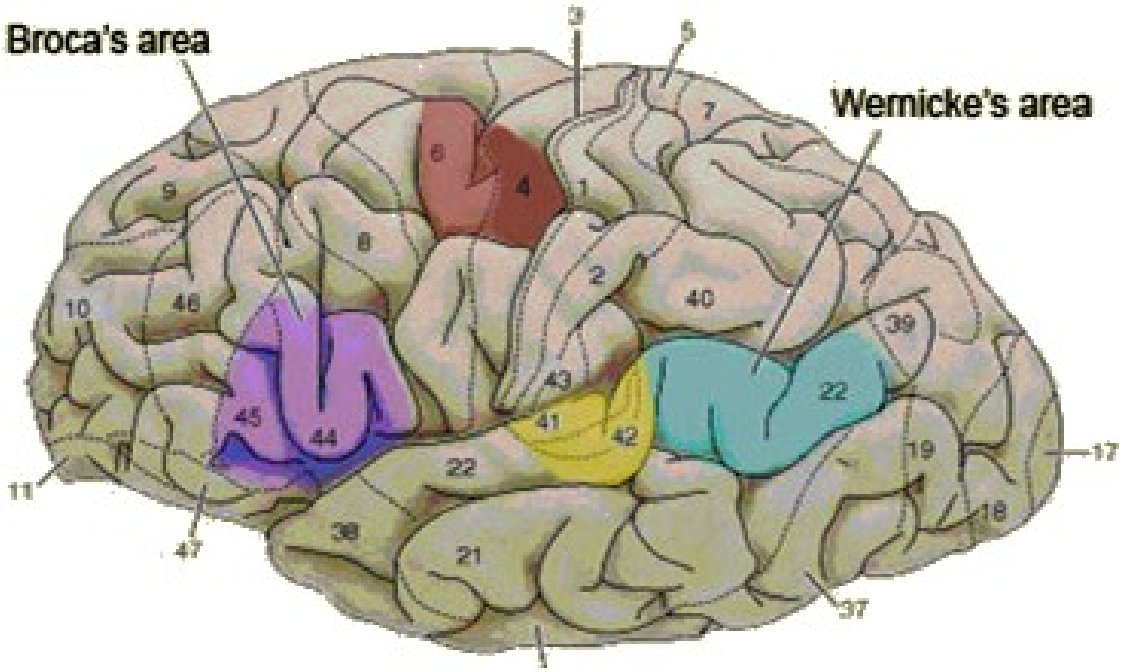
  „selection and manipulation with appropriate words“

Area 44

- ✓ Phonological processing and language production

  „selection and activation of particular motor centers“

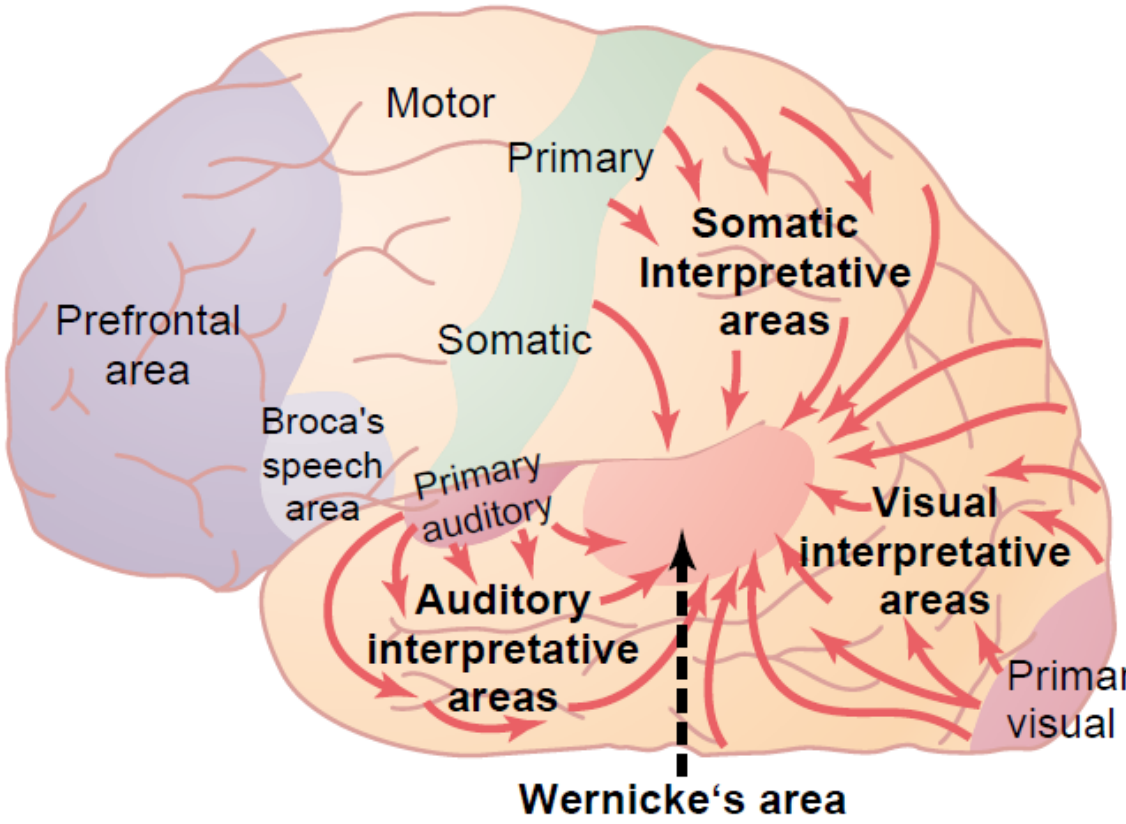
Wernicke´s area



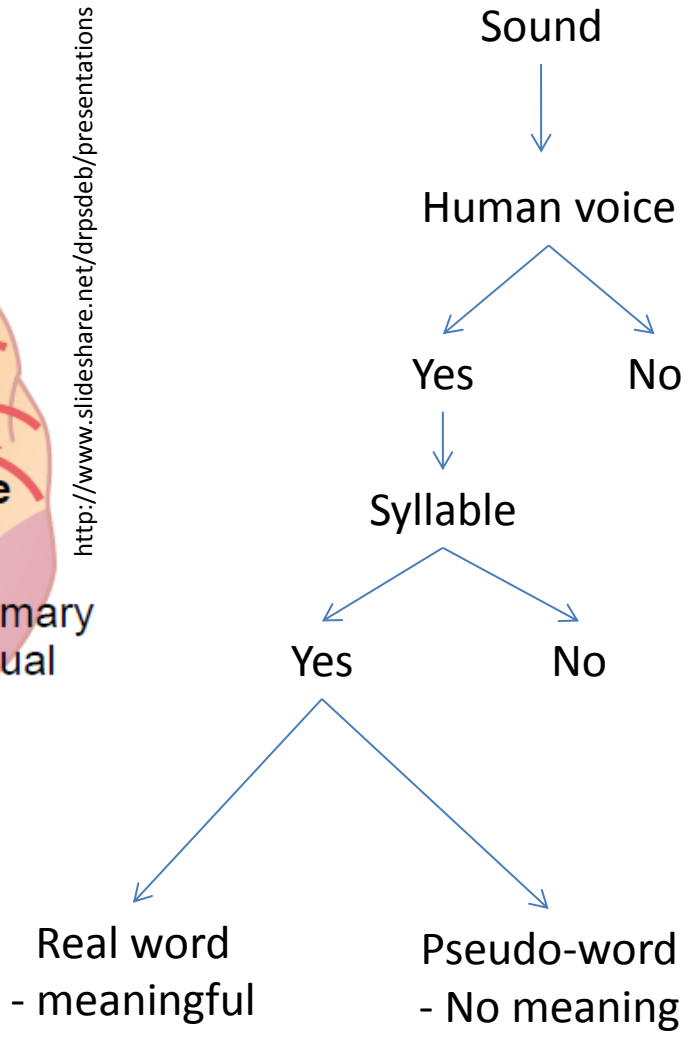
Area 22

- ✓ Three subdivisions
  1. The first responds to spoken words (including the individual's own) and other sounds
  2. The second responds only to words spoken by someone else but is also activated when the individual recalls a list of words.
  3. The third sub-area seems more closely associated with producing speech than with perceiving it

Algorithm of sound processing

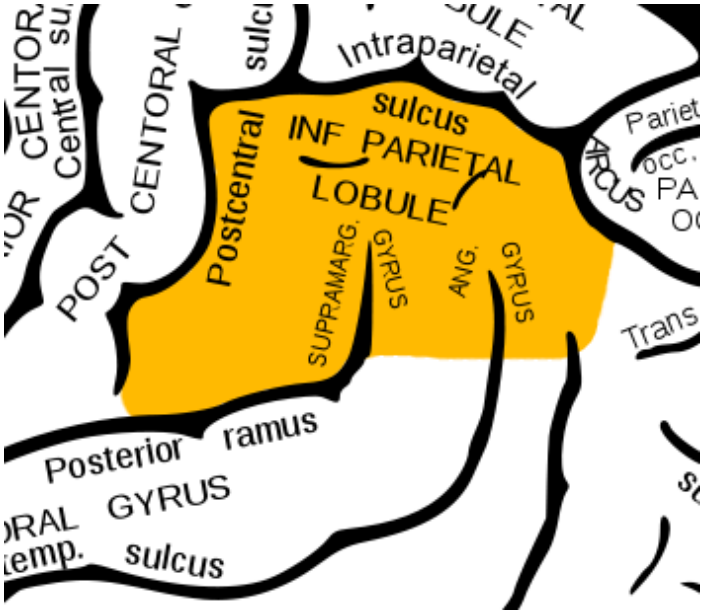


http://www.slideshare.net/drpsdeb/presentations

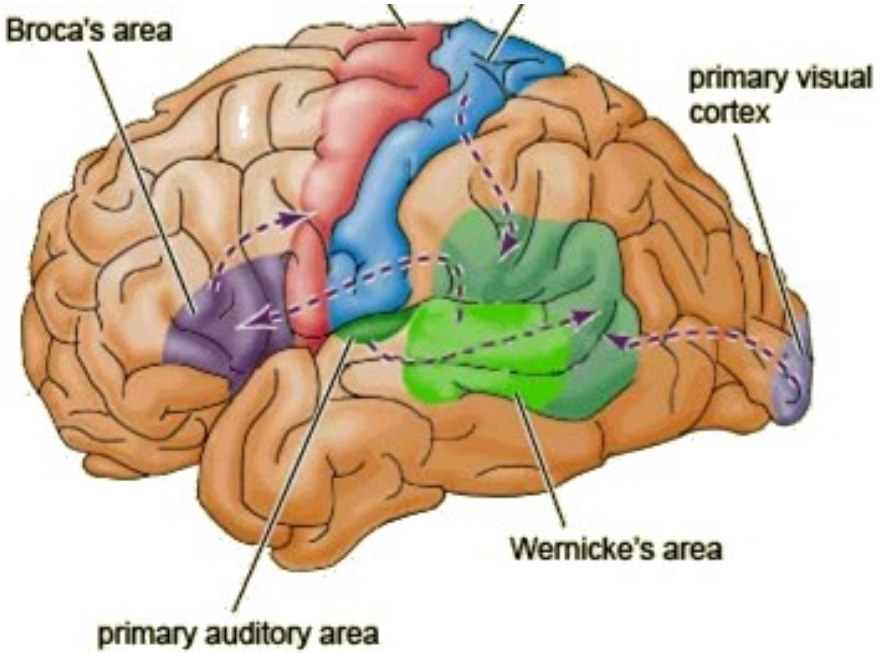


- ✓ **Wernicke´s area**
- ✓ **Broca´s area**
- ✓ **P-O-T association cortex**

Lobulus parietalis inferior



https://en.wikipedia.org/wiki/Inferior_parietal_lobule#/media/File:Gray726_inferior_parietal_lobule.png



http://www.slideshare.net/CsillaEgri/presentations

Gyrus supramarginalis

- ✓ Phonological and articulatory processing of words

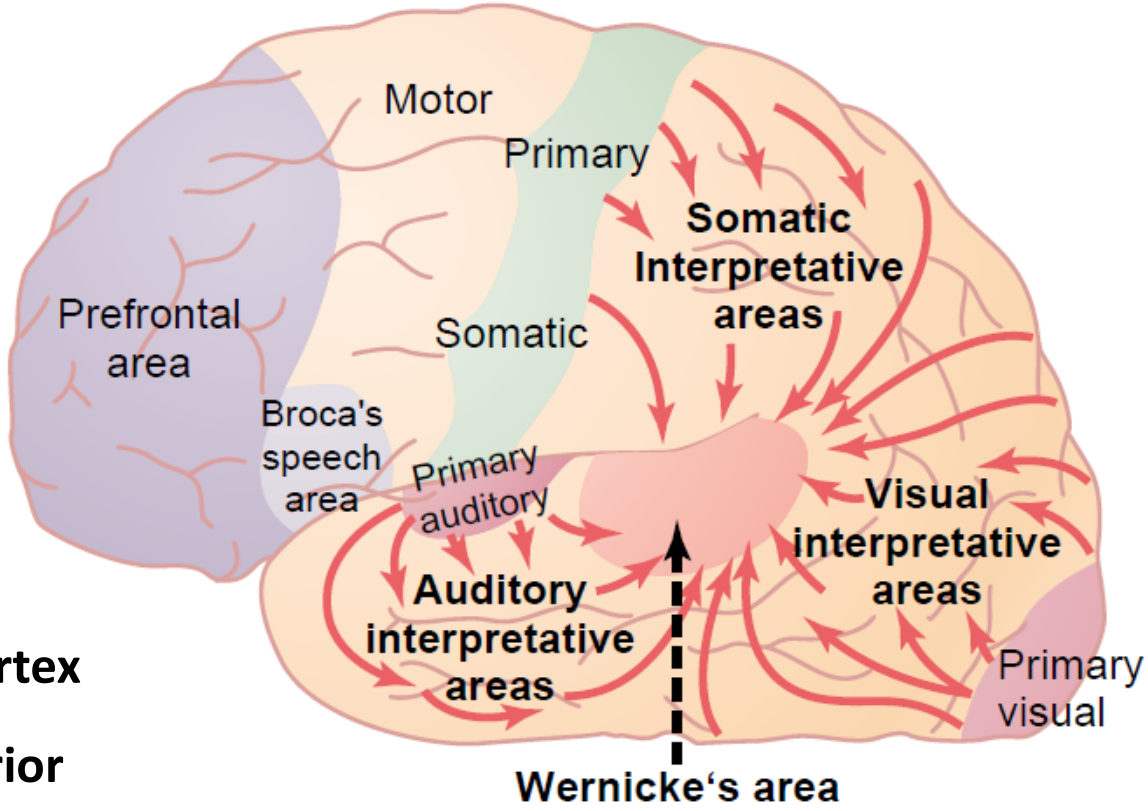
Gyrus angularis

- ✓ Semantic processing

Rich communication with Broca´s and Wernicke´s areas (triangular communication)

Integration of auditory, visual and somatosensory information

Integration of auditory, visual and somatosensory information



http://www.slideshare.net/drpsdeb/presentations

P - O - T association cortex

Lobulus parietalis inferior

- Interpretation of sound
- Interpretation of visual signal
- Interpretation of somatosensation
- Interpretation of spoken/read word

Categorization

Lobulus parietalis inferior

- Late evolutionary as well as ontogenic development
- Fully developed at the age of 5 – 6 years
  - Children usually cannot „actively“ read before this age (understand the meaning of the text which he/she reads)
- The language functions are also involved in complex „inner“ categorization
- The language („both spoken and inner“) enabled development of complex (abstract) thinking and development of culture

- The human society development is linked to information technology development
  - ✓ Spoken language
  - ✓ A system of writing
  - ✓ Printing
  - ✓ Internet

Language functions lateralization

- Broca´s and Wernicke´s area is localized in the left hemisphere in 97% of people

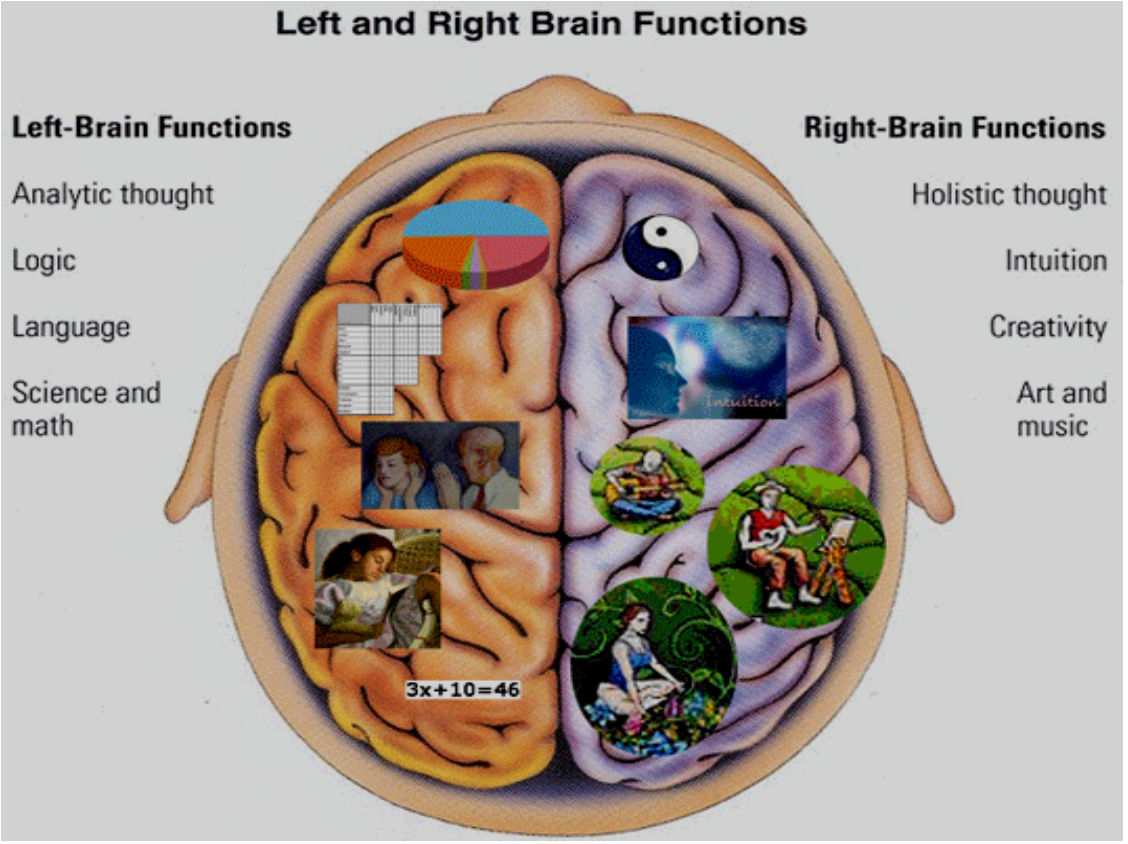
- Localization of B-W areas is not fully linked to left/right hand lateralization
  - ✓ 90% of people are right handed
  - ✓ 95% of right handed people have B-W area in the left hemisphere
  - ✓ The majority of left handed people has B-W areas also in left hemisphere

- Some scientists suggest that the left hemisphere dominance for language evolved from this hemisphere's better control over the right hand

- The language specialization develops in the left hemisphere, which matures slightly earlier

Right hemisphere language functions

- Non-verbal aspect of language
  - ✓ Prosody – intonation, stress…
- Non-literal language aspects
  - ✓ Irony
  - ✓ Metaphors
- Understanding to discourse / complex speech
  - ✓ Lecture, discussion



http://www.slideshare.net/drpsdeb/presentations

Women and language

- Females' speech is more fluid
  - they can pronounce more words or sentences in a given amount of time
- Women have the reputation of being able to talk and listen while doing all sorts of things at the same time
- Women language is more widespread in both hemispheres while in men more left lateralized
  - more nerve fibers connecting the two hemispheres of their brains, which also suggests that more information is exchanged between them.
- The males' higher levels of testosterone, which delays the development of the left hemisphere
  - 4 times more boys than girls suffer from stuttering, dyslexia

Functional diagnostic methods

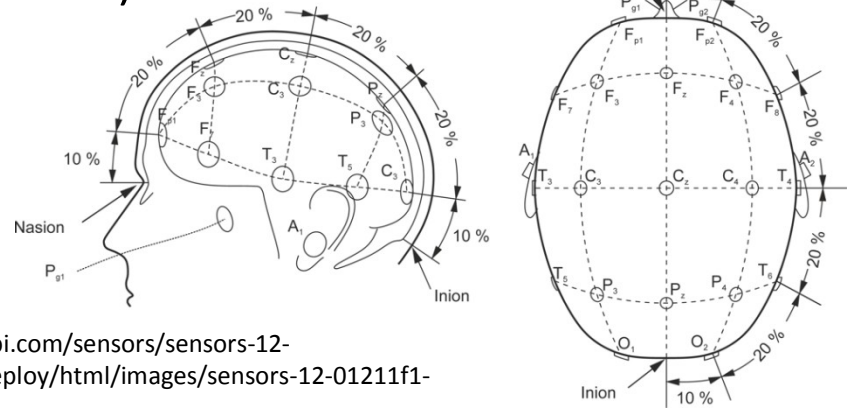
- Detection of electrical activity
  - Higher neuronal activity - higher electrical activity
  - Electroencephalography (EEG)

- Detection of regional blood flow
  - Higher neuronal activity – increased blod flw
  - Single photon emission tomography (SPECT)
  - Positron emission tomography (PET)
  - Functional magnetic resonance imaging (fMRI)

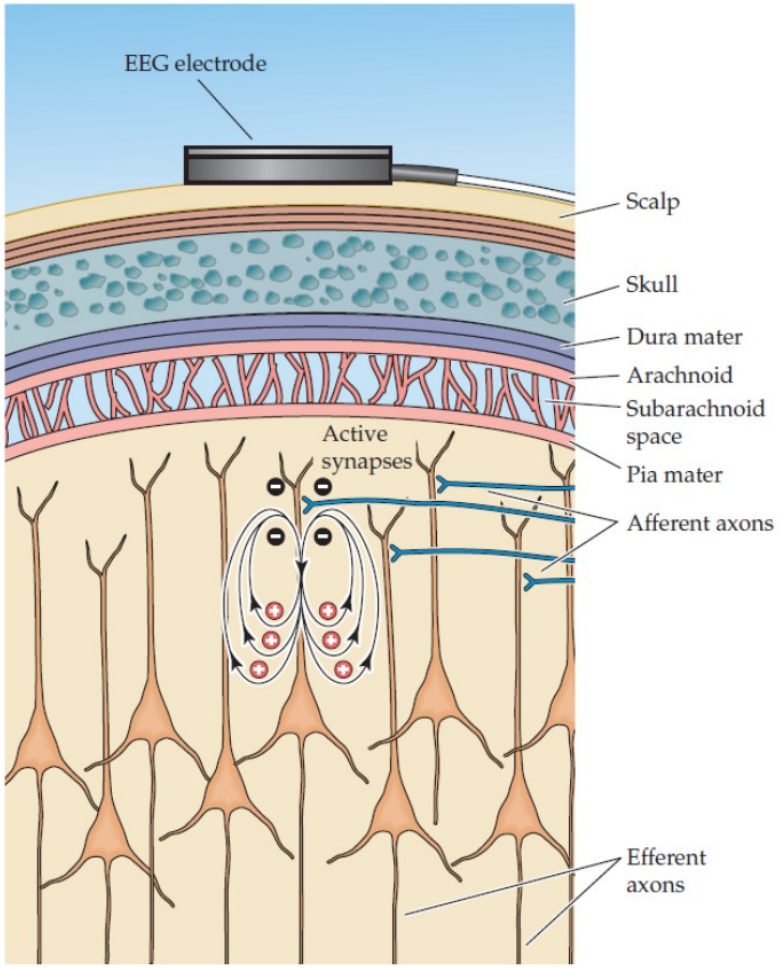
EEG

- Detection of neuronal electrical activity
- monopolar arrangement:
  - active electrode
  - indifferent electrode

  = referential recording
- bipolar recording
- lead (channel)
- ground electrode
- EEG voltage in microvolts (*vs.* in mV in neurons)

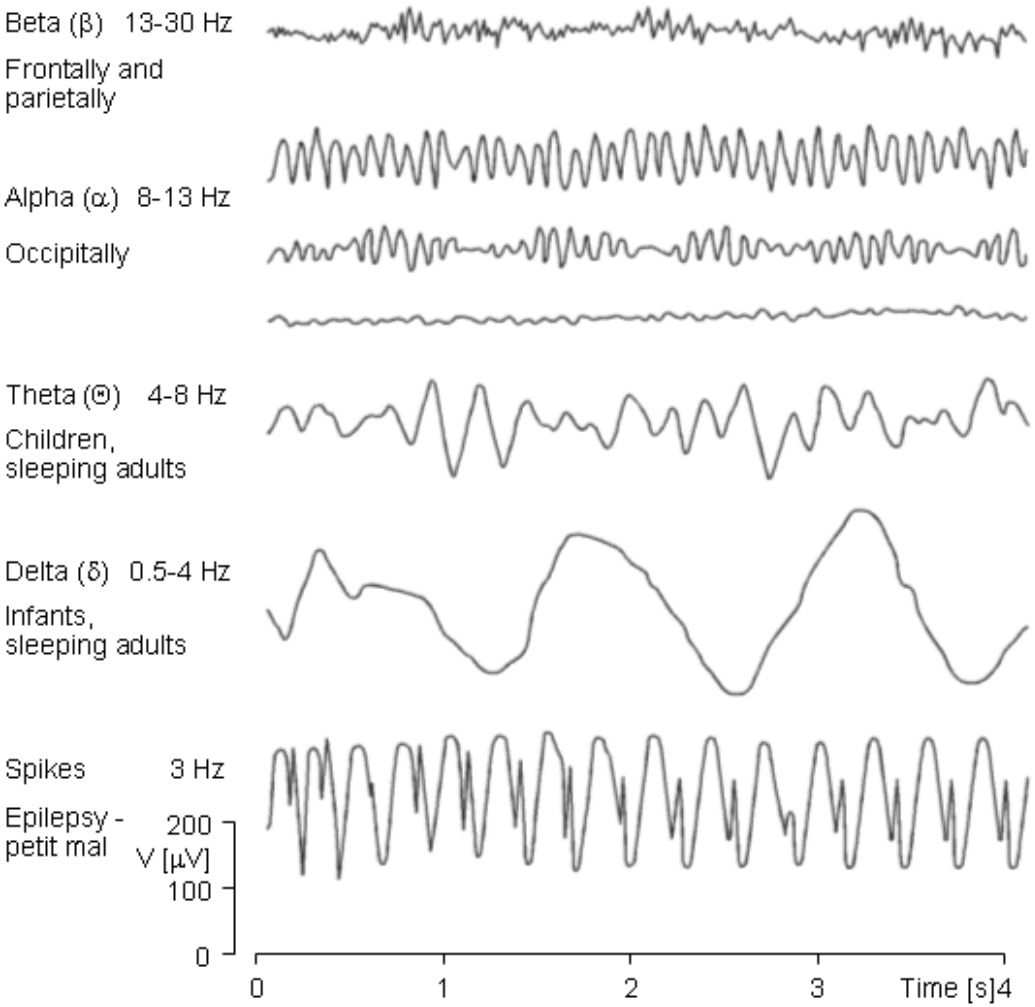


http://www.mdpi.com/sensors/sensors-12-01211/article_deploy/html/images/sensors-12-01211f1-1024.png



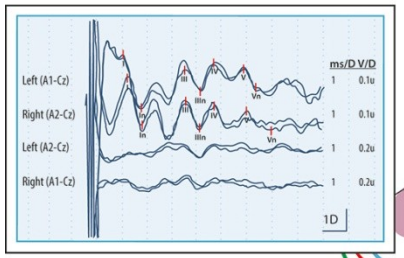
http://www.slideshare.net/kj_jantzen/biophysical-basis-of-eeg

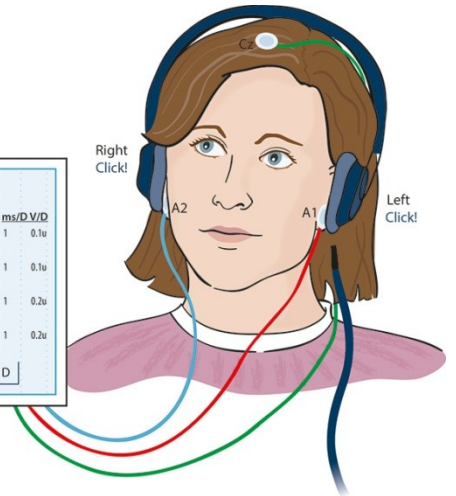
EEG



http://www.slideshare.net/akashbhoi12/eeg-53489764

Evoked potentials

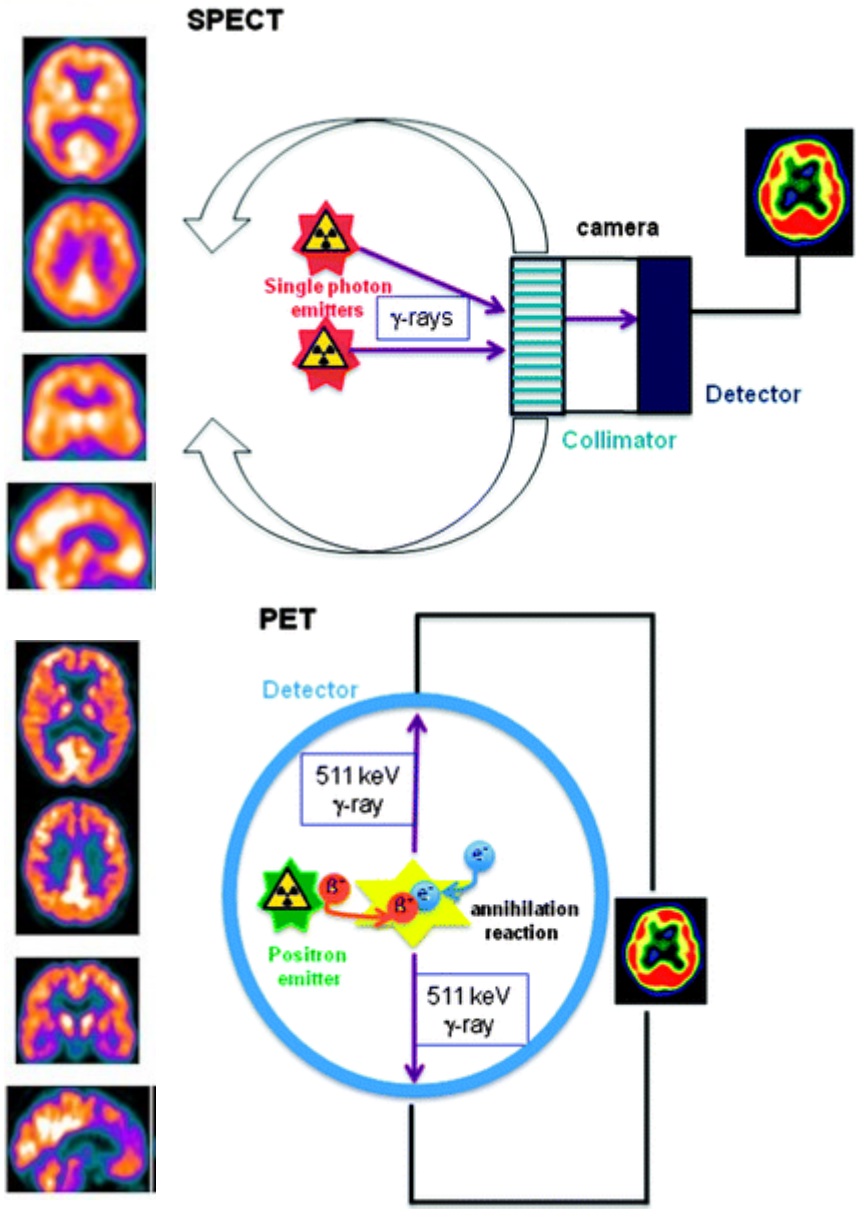




http://tidsskriftet.no/2013/05/evoked-potential-tests-clinical-diagnosis

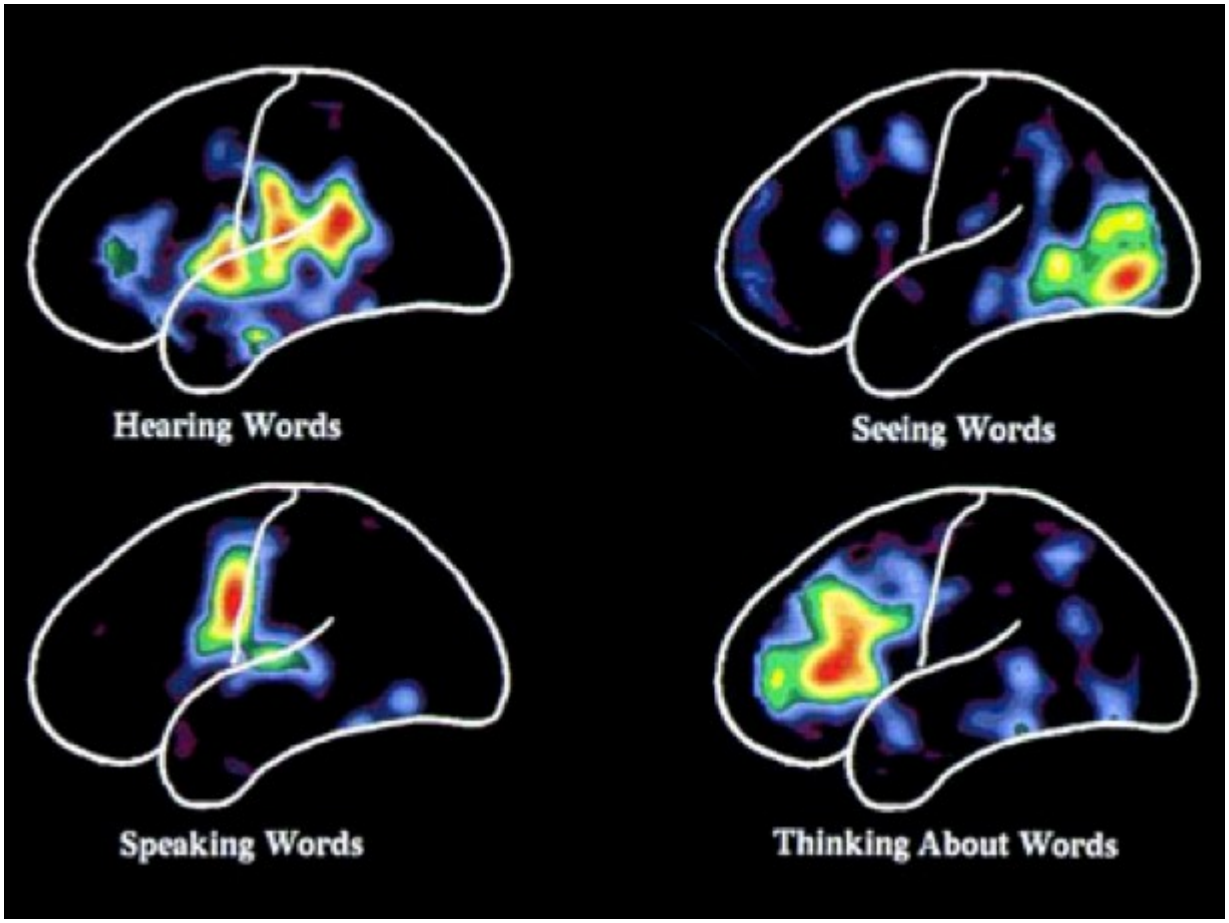
PET a SPECT

- Injection of radionuclide labeled substances
- Short half live of radionuclide
  - Necessary to prepare shortly before application
  - Nuclear medicine department
- SPECT
  - radionuclide is the source of gamma rays
  - Low resolution (around 1 cm)
- PET
  - radionuclide is the source of positrons
  - Positron annihilation produces two gamma photons – higher resolution (around 2mm)



http://pubs.rsc.org/services/images/RSCpubs.ePlatform.Service.FreeContent.ImageService.svc/ImageService/Articleimage/2013/CS/c3cs60086f/c3cs60086f-f4.gif

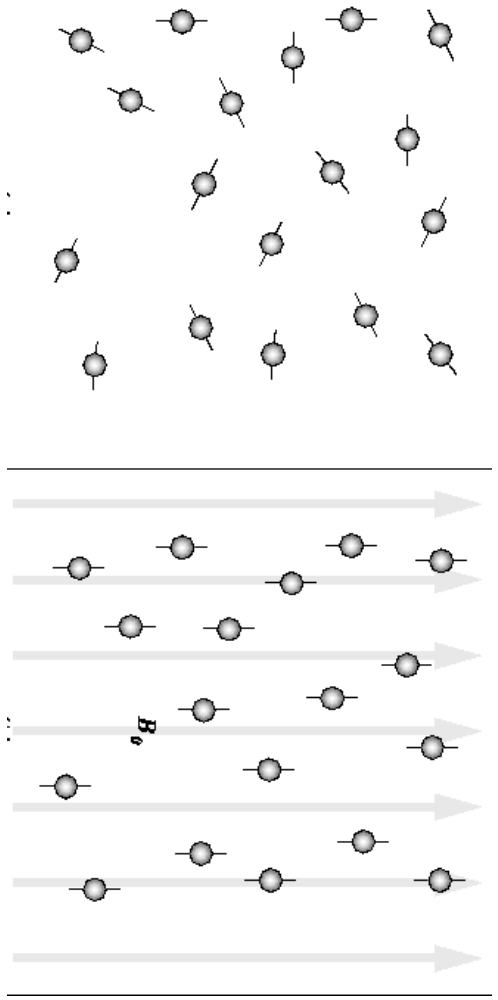
Functional regions of te brain



http://www.chroniclebooks.com/blog/wp-content/uploads/brain-scan.png

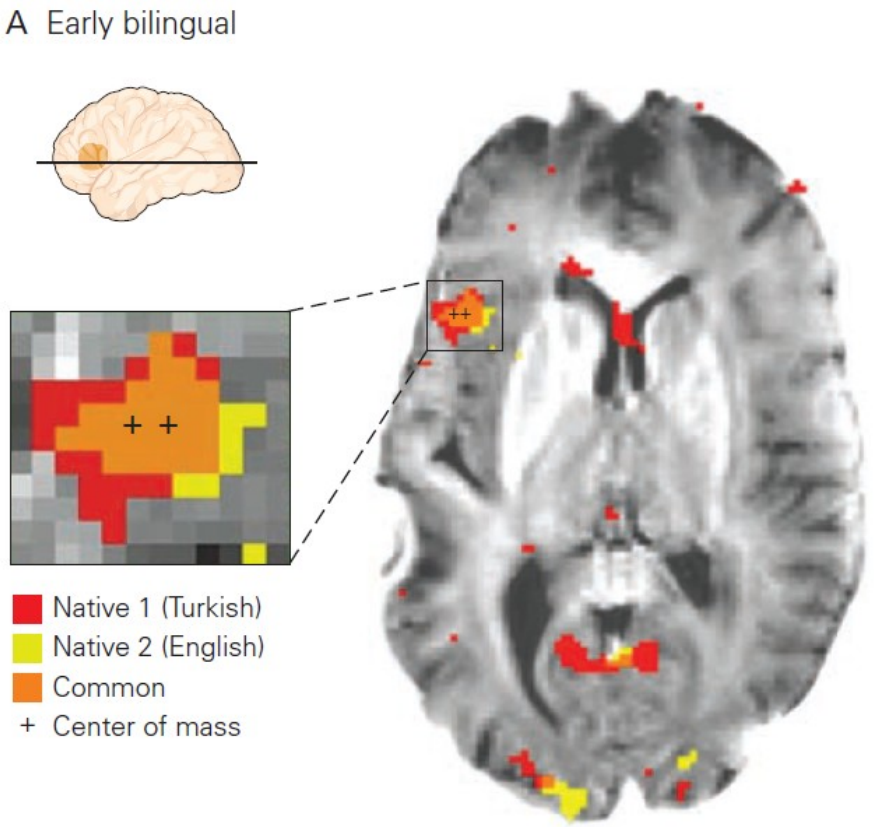
fMRI

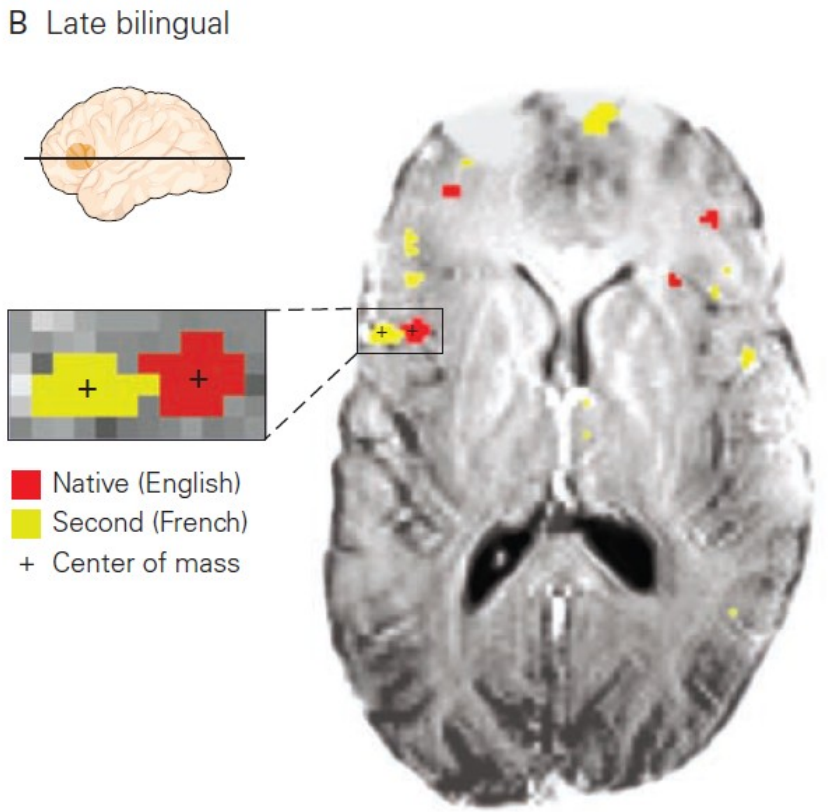
- Different atoms (nuclei) have various magnetic properties when exposed to strong magnetic field
- Hydrogen
- fMRI uses different magnetic properties of oxy- and deoxyhemoglobin
- reduced haemoglobin becomes paramagnetic, change the signal emitted by blood, we can measure the amount of oxy- and deoxyhaemoglobin as an indicator of the blood flow
- High resolution (up to1mm)
- No radiation



https://www.cs.sfu.ca/~stella/papers/blairthesis/main/node11.html

fMRI





Kim, K. H. S., Relkin, N. R., Lee, K.-M. & Hirsch, J. Distinct cortical areas associated with native and second languages. *Nature* **388,** 171–174 (1997).