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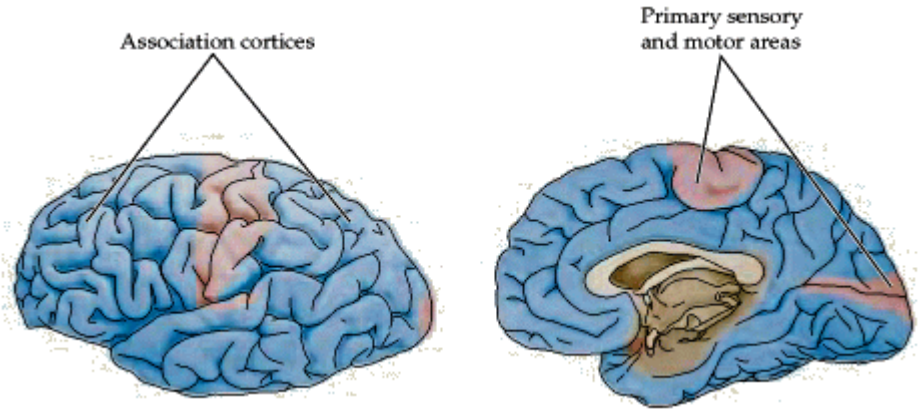
16

Neocortex II

Neocortex

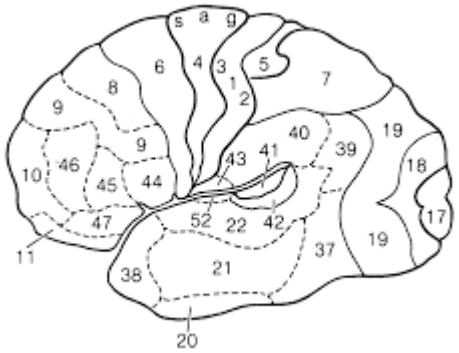


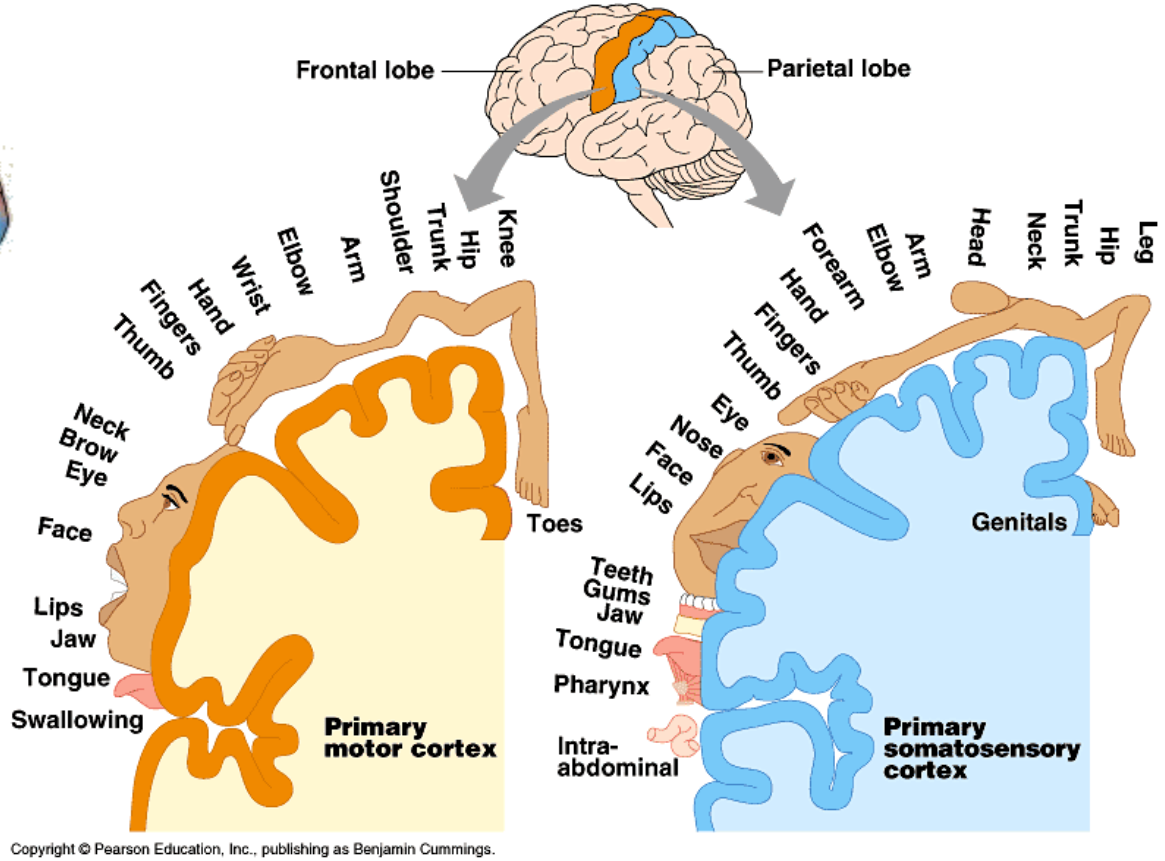
Primary areas

✓Somathotopic organization

Association areas

✓No somathotopic organization





http://www.emunix.emich.edu

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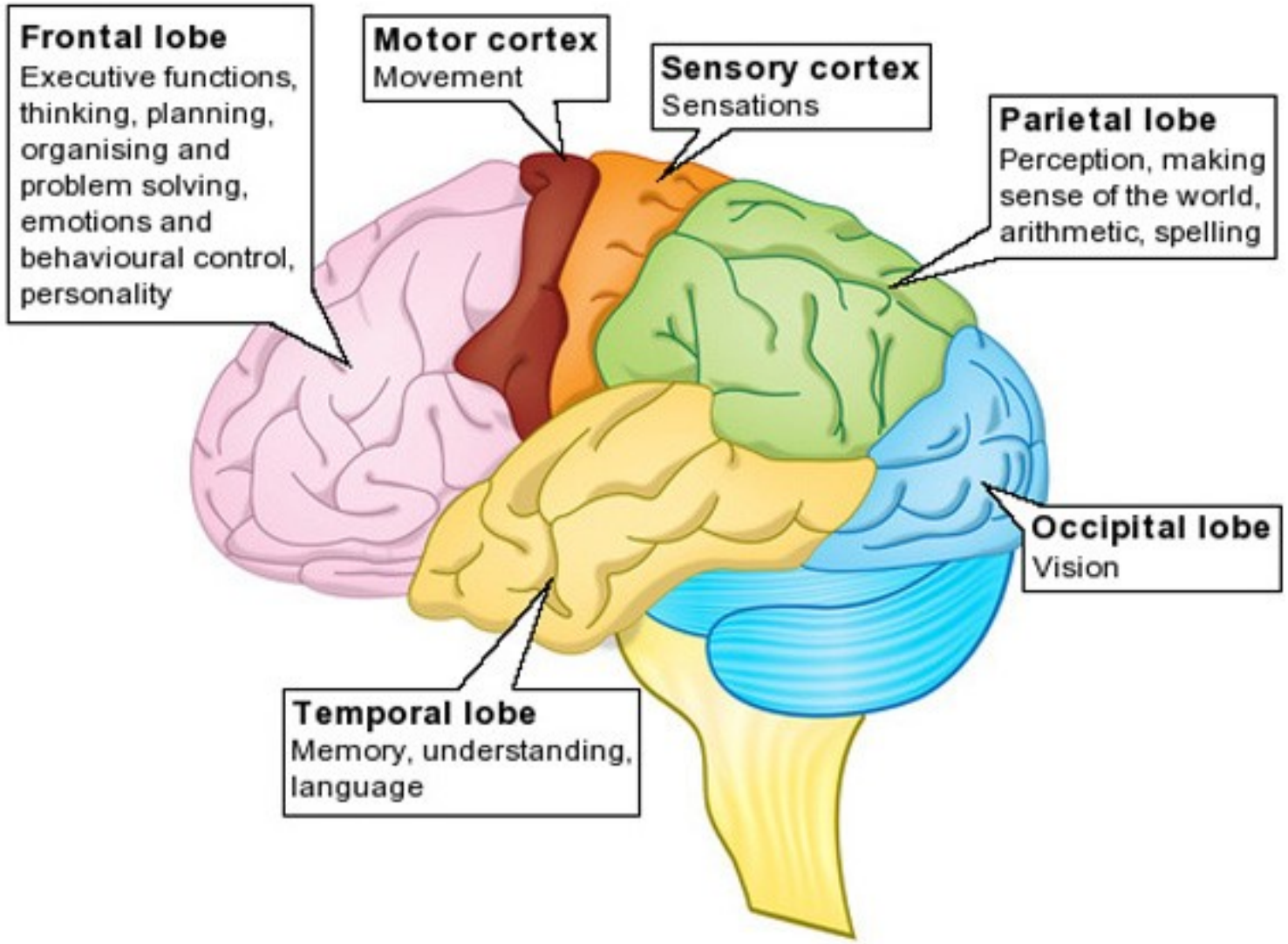
Cortical functions



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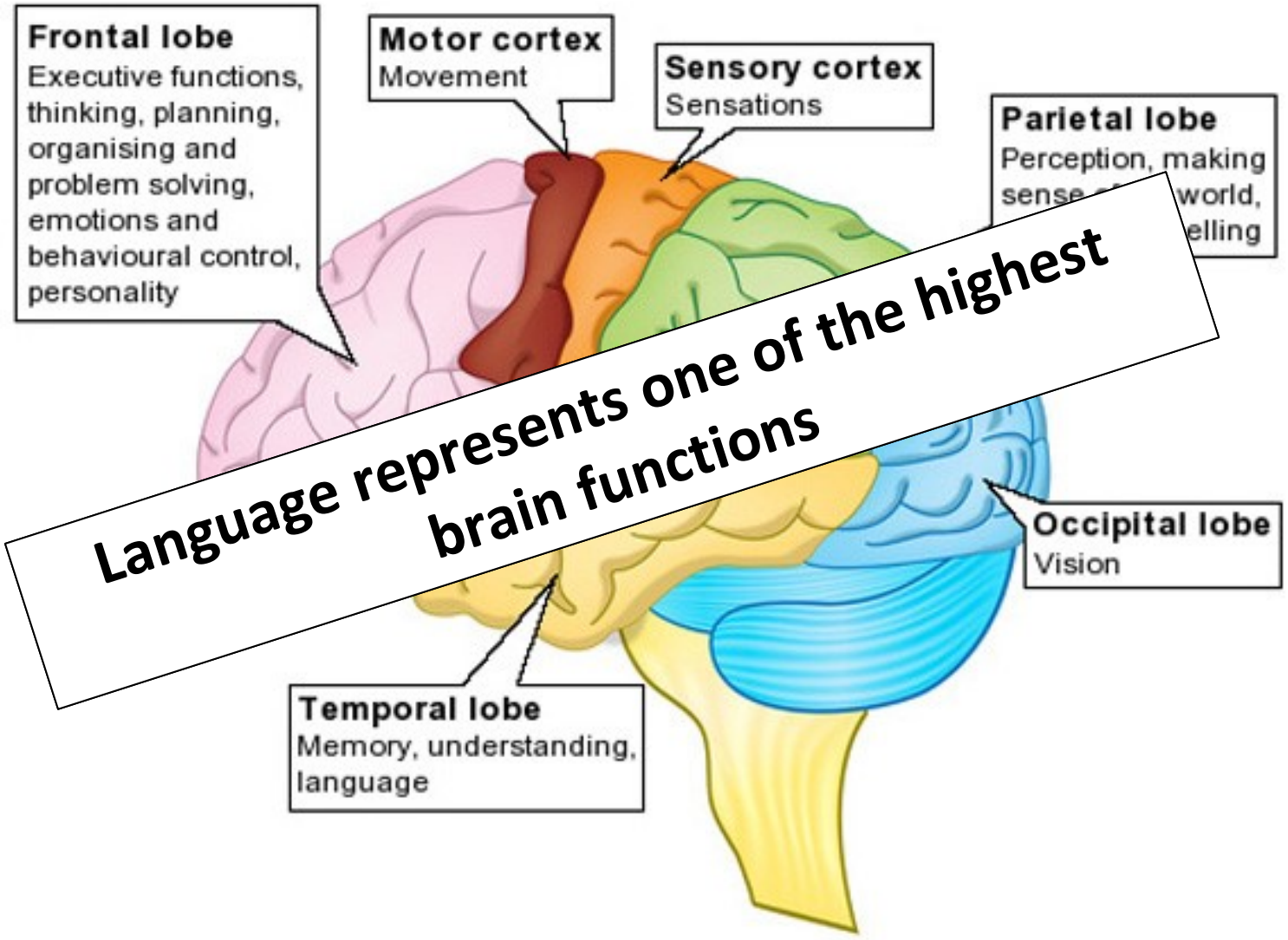
Cortical functions



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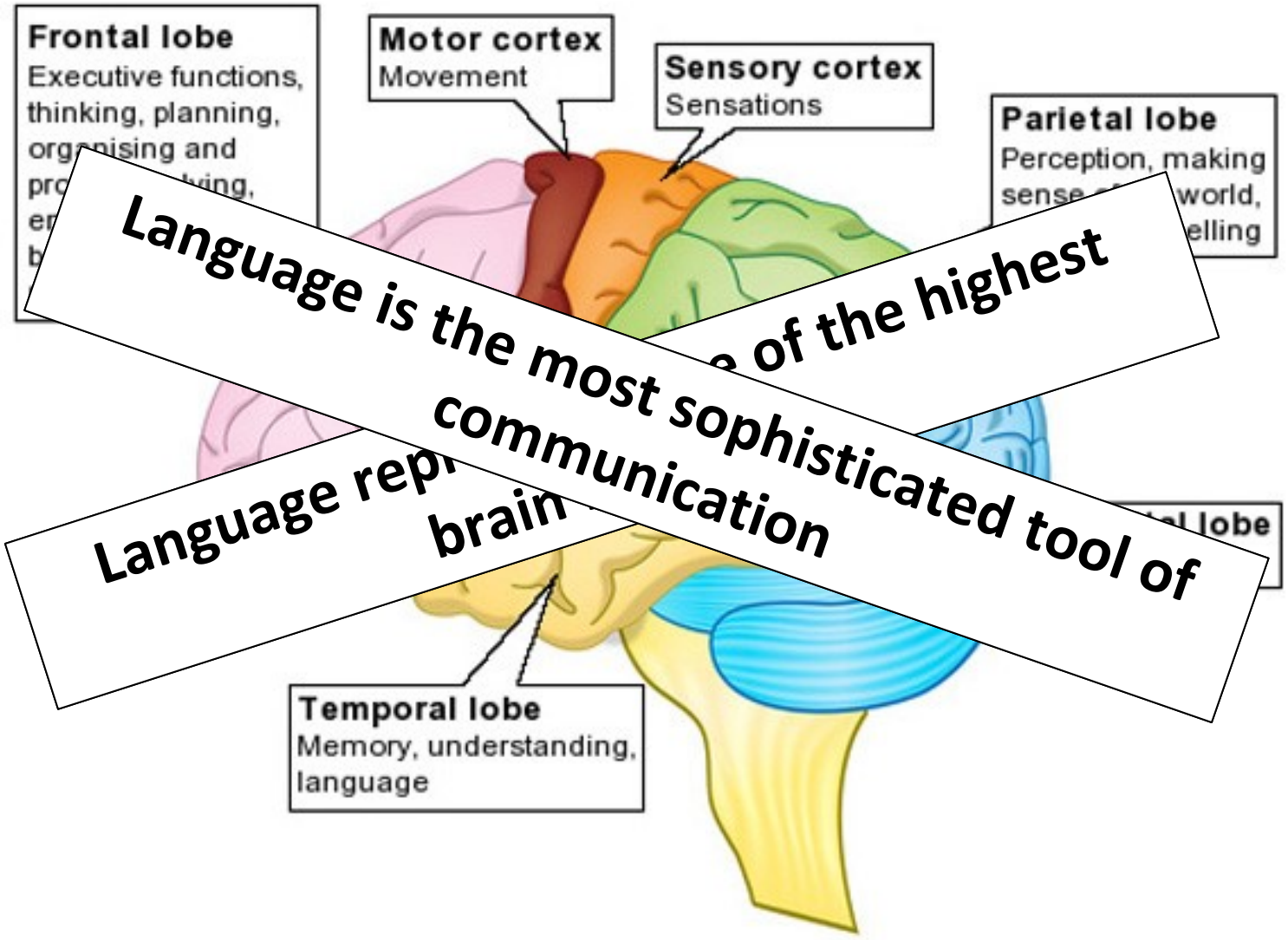

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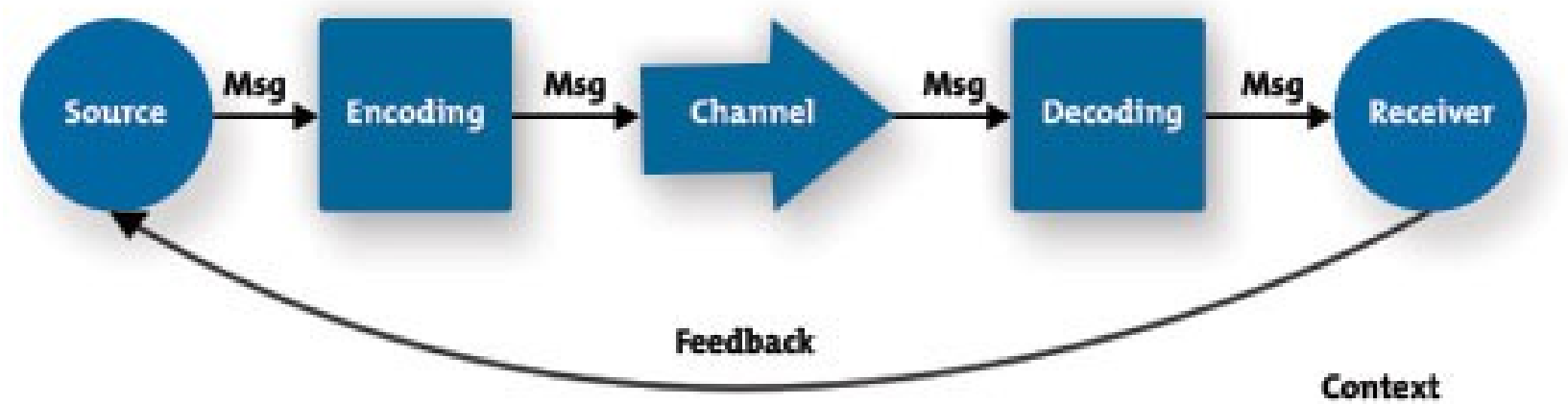
Communication

- Signal exchange
  - ✓ Smell
  - ✓ Visual
  - ✓ Acoustic
- Between individuals of
  - ✓ Same species
  - ✓ Different species

- Encoding
  - ✓ Simple – body size
  - ✓ Complex – dance of the honey bee



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

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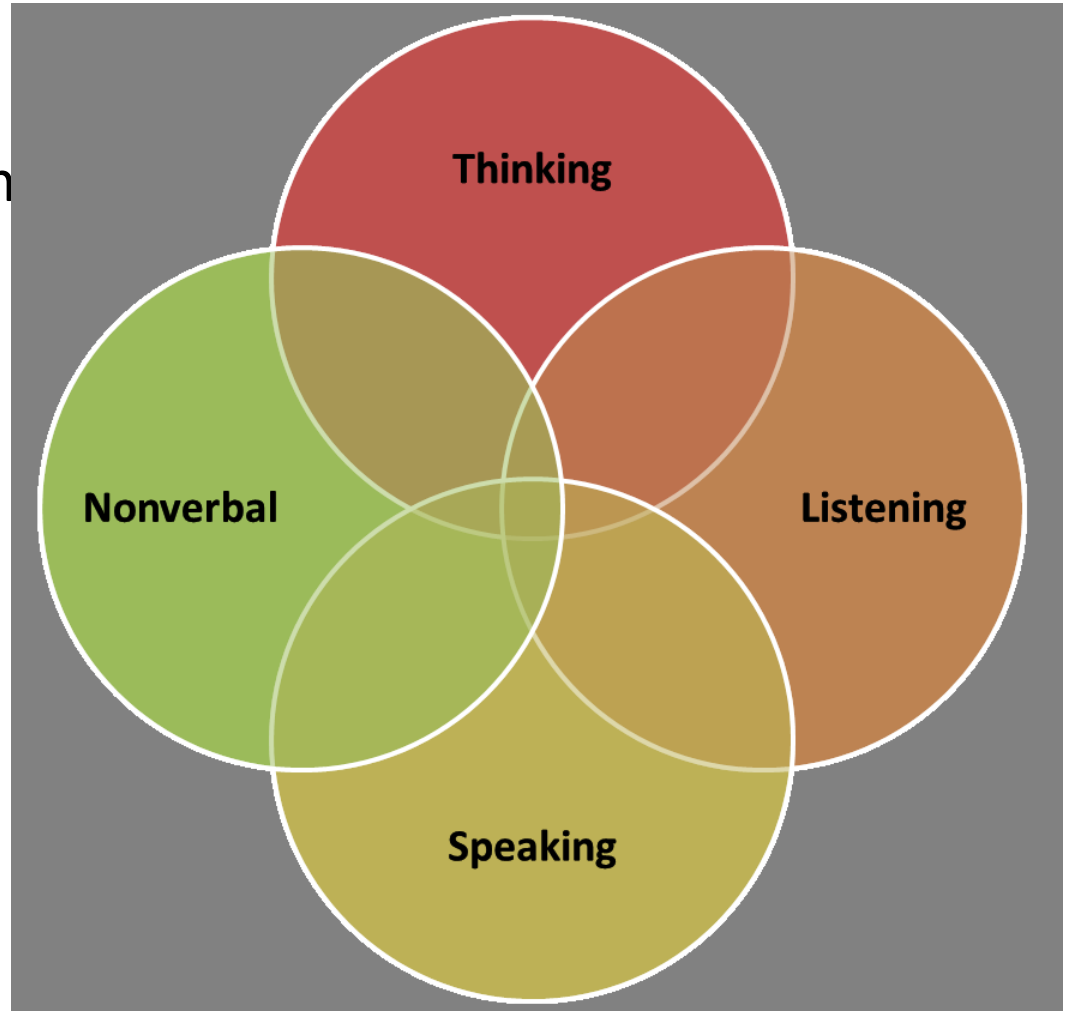
Communication in human society

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



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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

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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

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

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Language

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

- Complex hierarchic code

➢ Syllable

- Unit of organization for

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- Symbol with a meaning

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➢ Word

- Symbol with a meaning

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➢ Sentence

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

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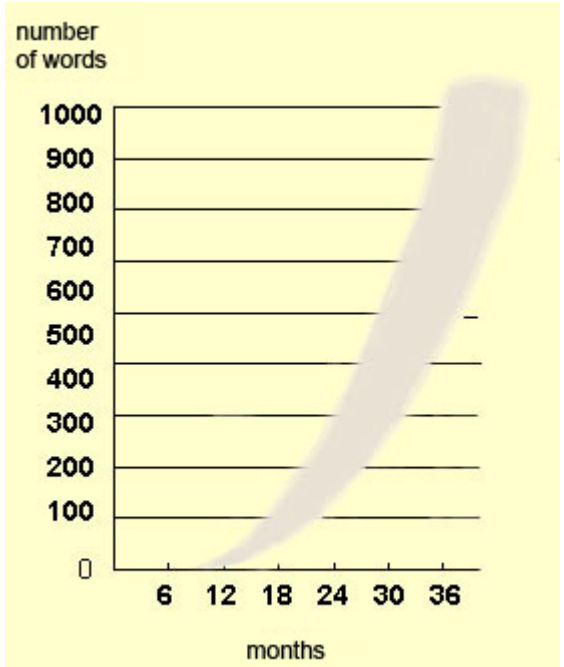
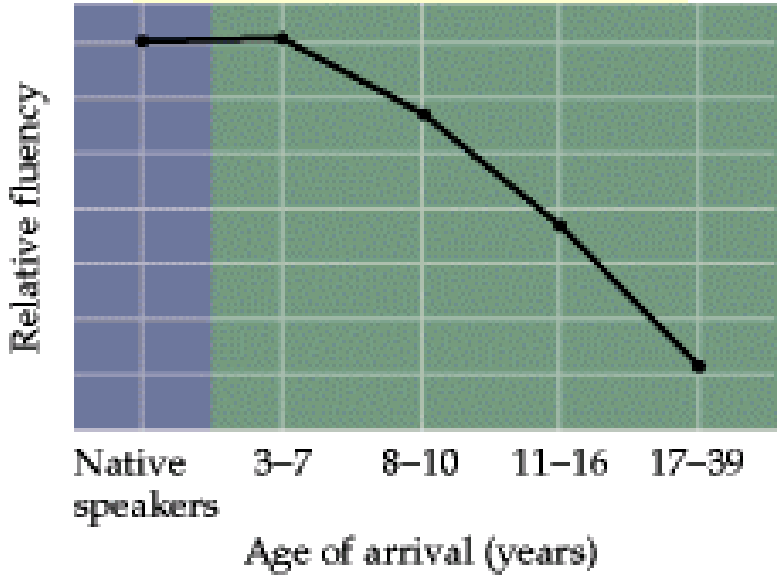
Learning to speak

- Learning to speak takes a long time period
  - Understanding – „sensoric“
  - Speaking – „motor action“





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

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- 1. year – baby uses a couple of words
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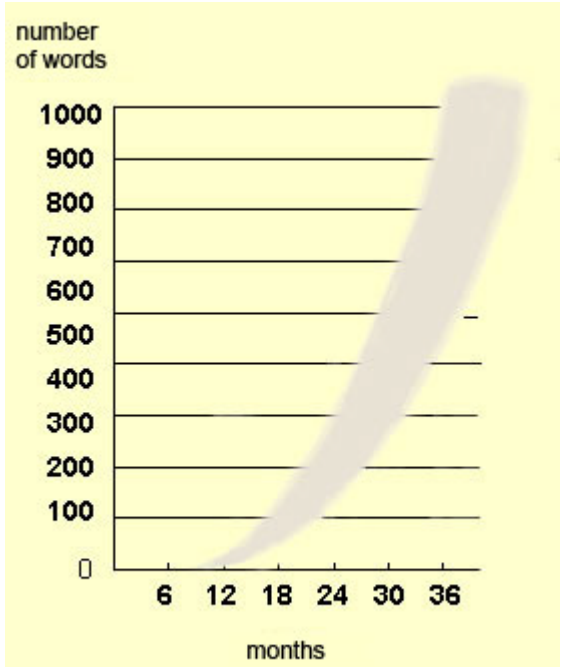
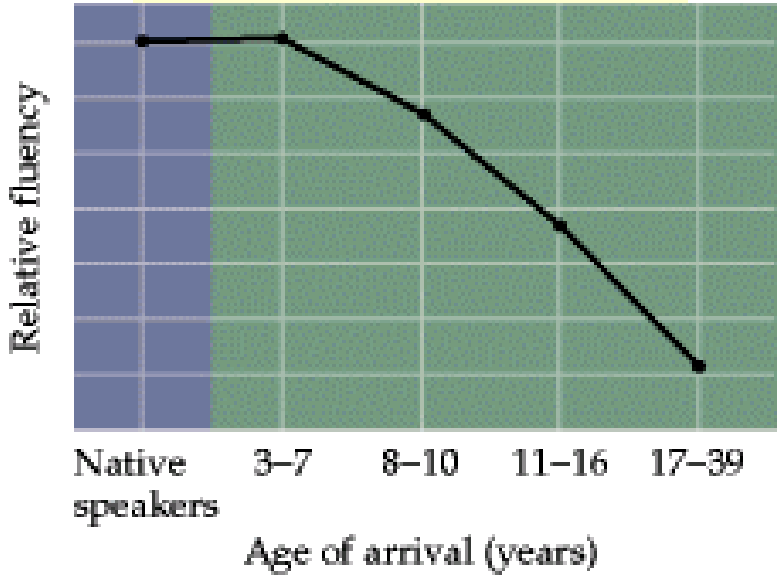
- 6. years – child uses around 2500 words





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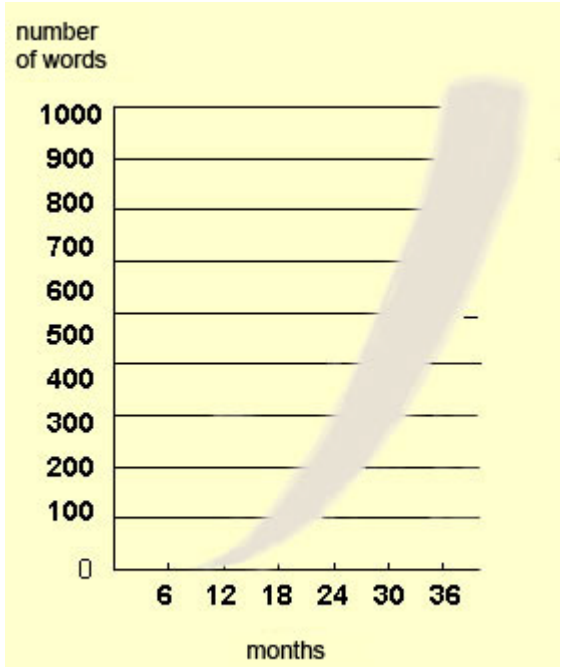
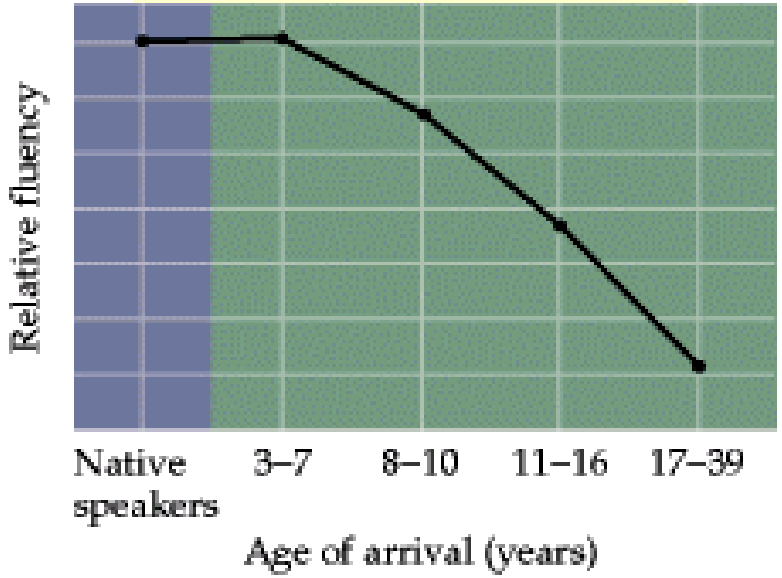
- Adult vocabulary
  - Active: 3000 -10 000 words
  - Passive: 3-6x higher than active v.





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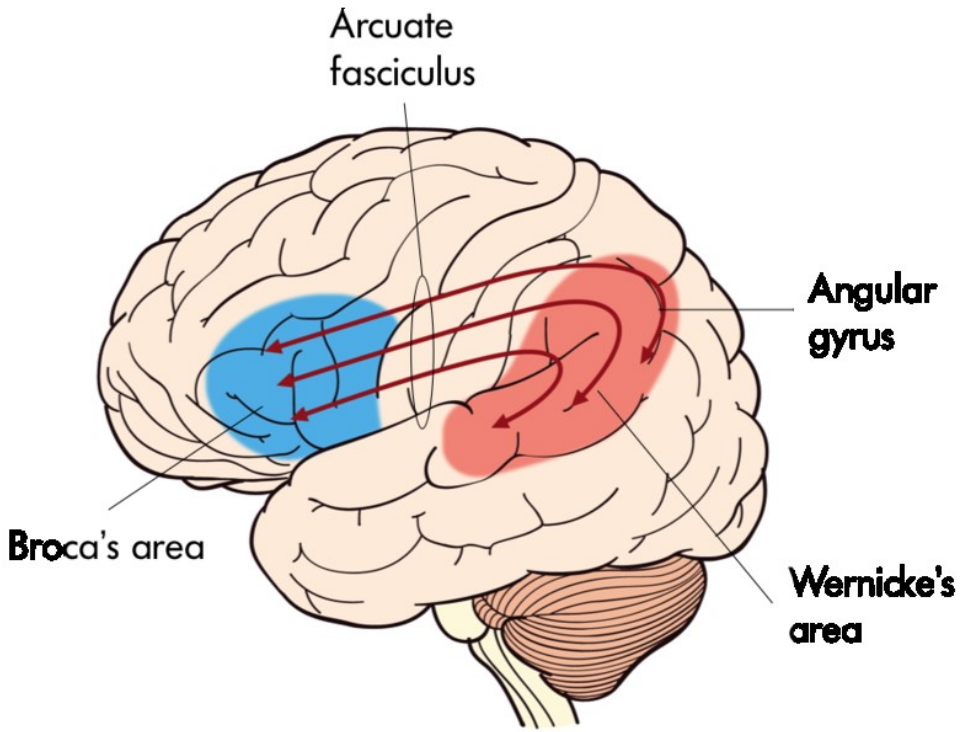
.anguage areas



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

There are two main language areas

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

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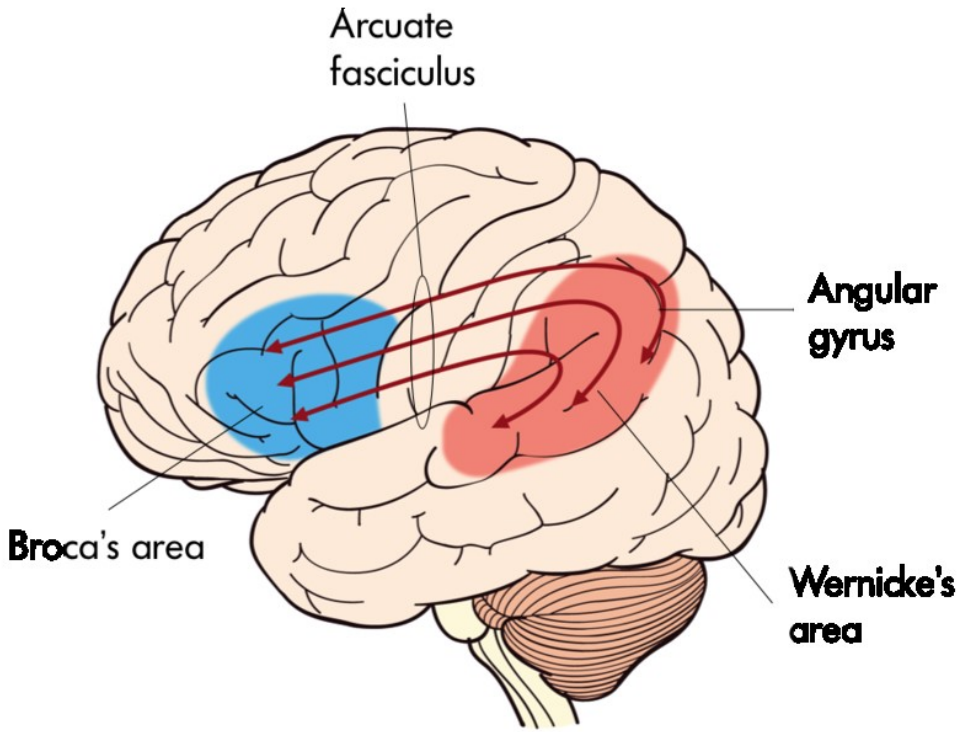

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- Broca´s aphasia
  - ✓ Motor, expressive
  - ✓ Comprehension preserved, speach unarticulated
- Wernicke´s aphasia
  - ✓ perceptive, sensor
  - ✓ Comprehension damaged, speech fluent, but not meaningful

- 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 …

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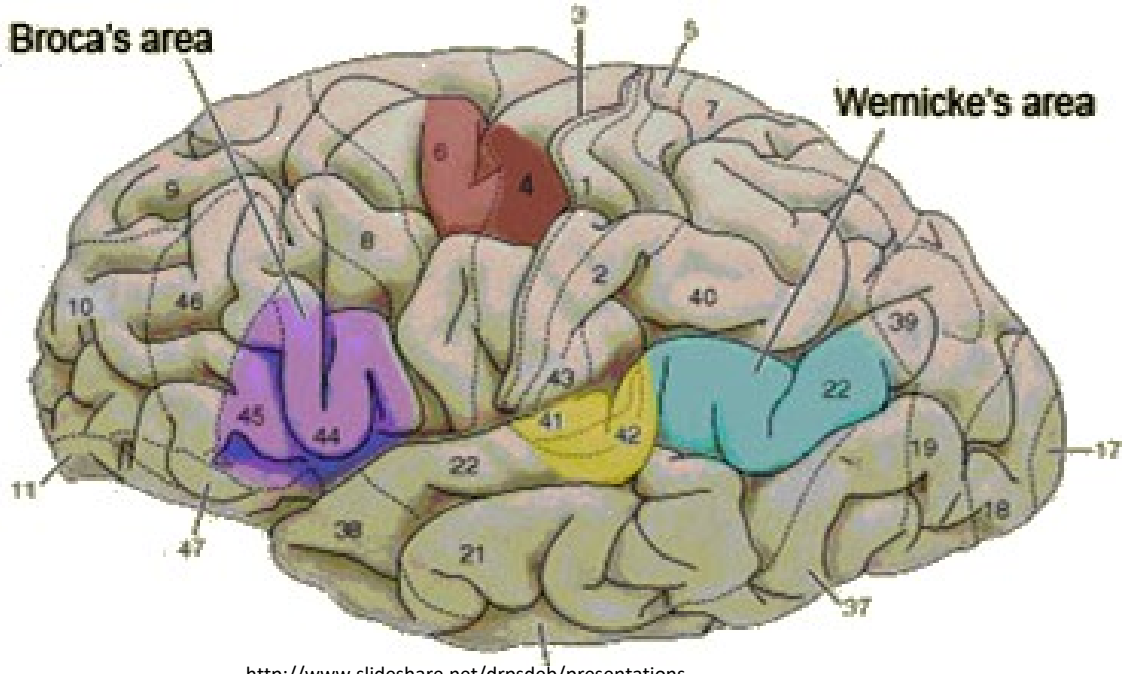
Broca´s area



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

Area 45

- ✓ Semantic processing

„selection and manipulation with appropriate words“

Area 44

- ✓ Phonological processing and language production

„selection and activation of particular motor centers“

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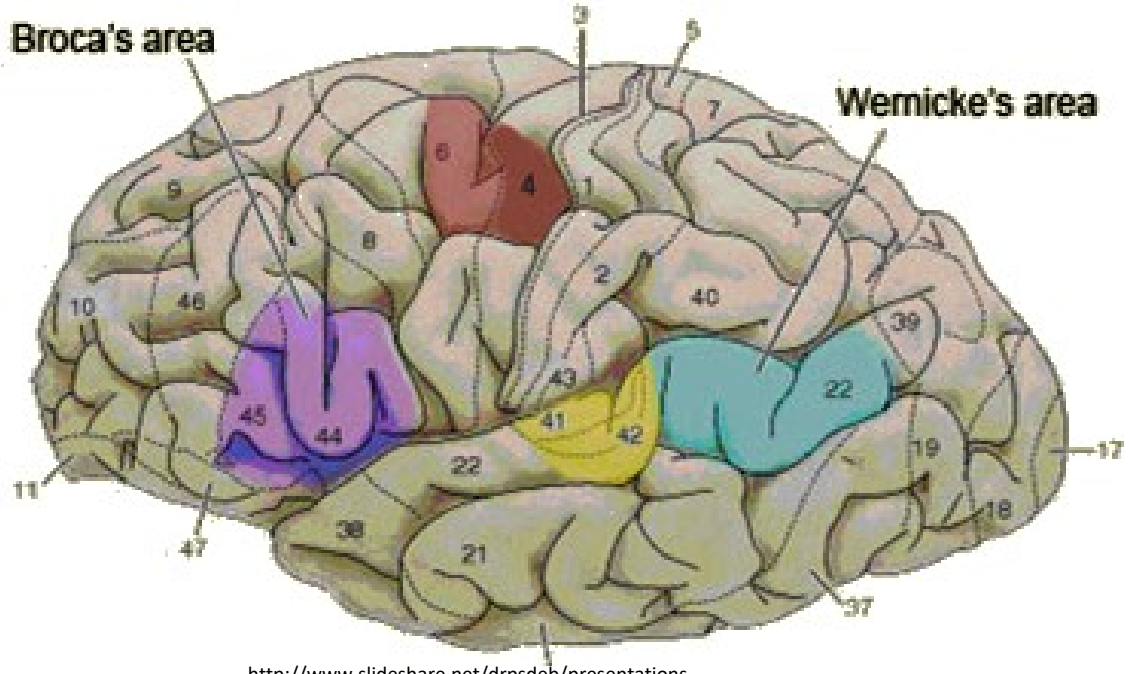
Wernicke´s area



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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

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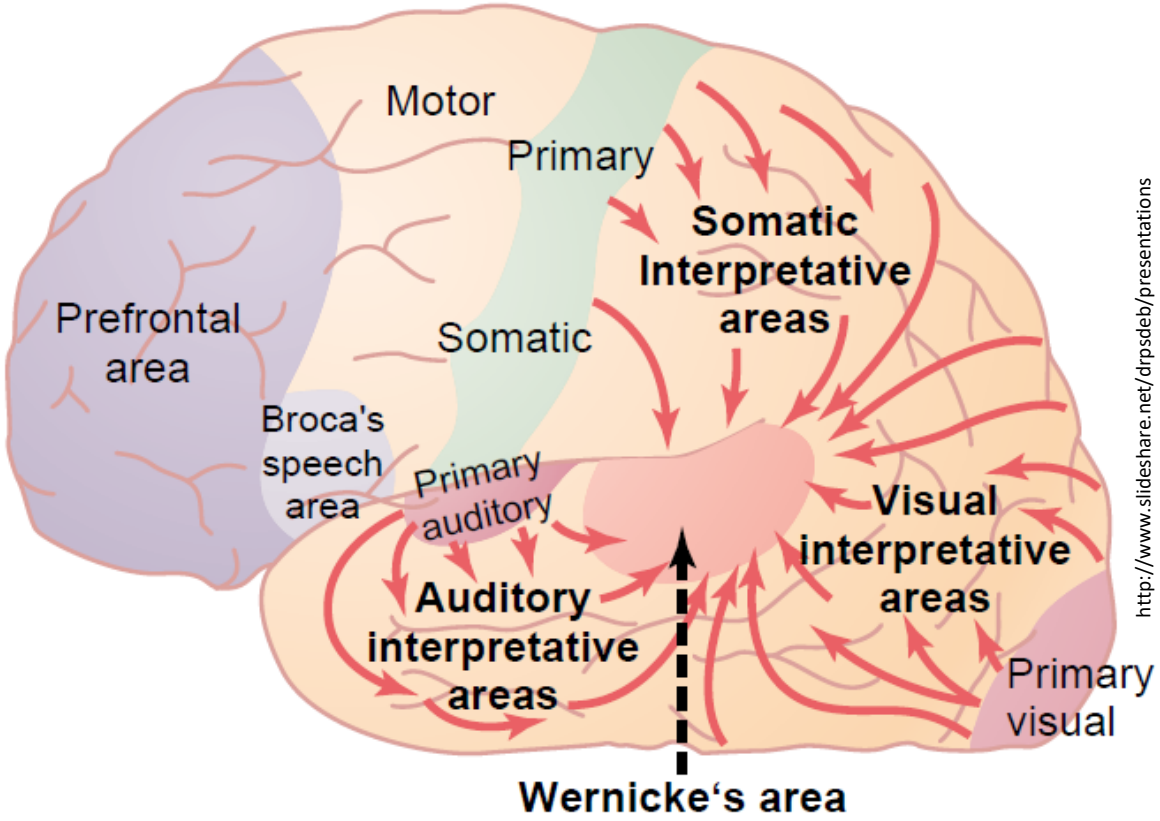
Algorithm of sound processing



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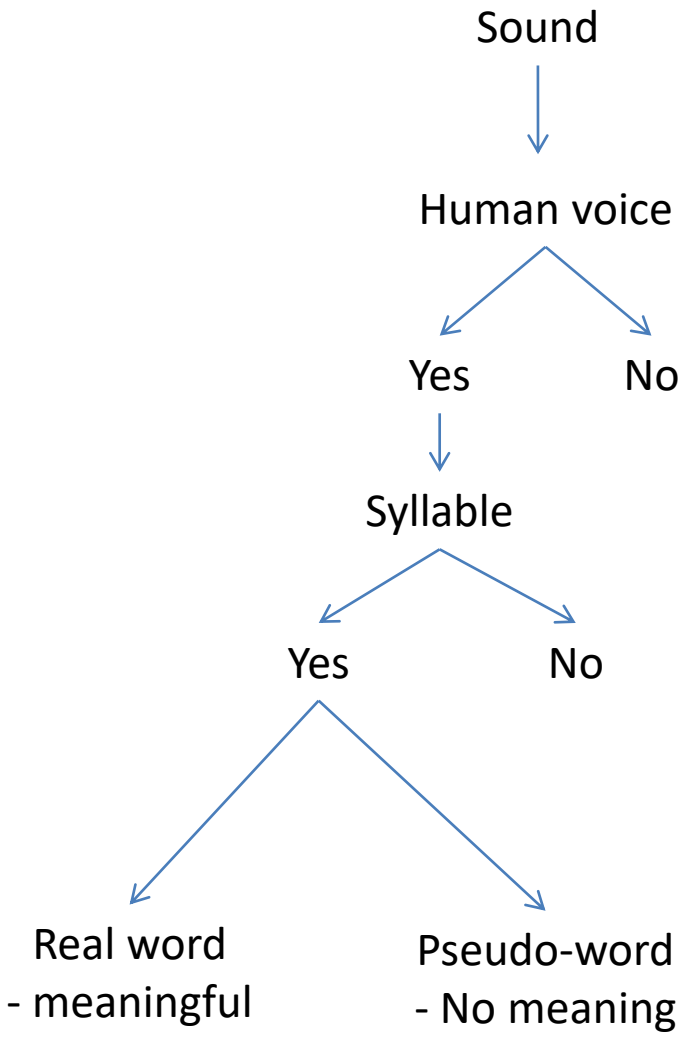
- ✓ **Wernicke´s area**
- ✓ **Broca´s area**
- ✓ **P-O-T association cortex**



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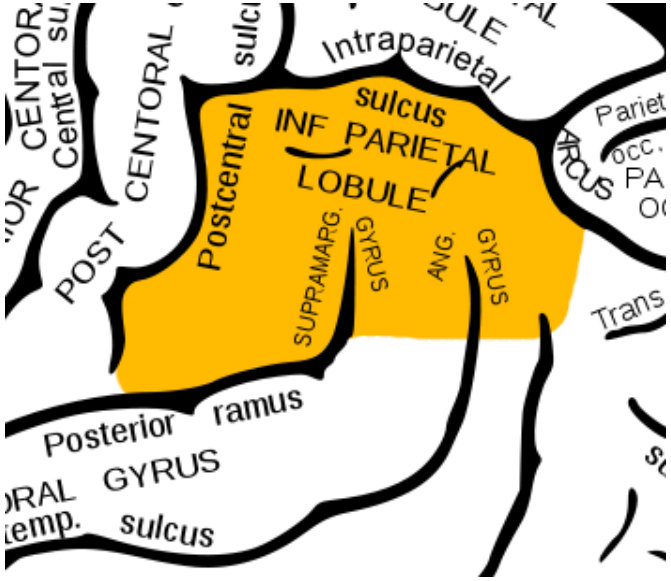
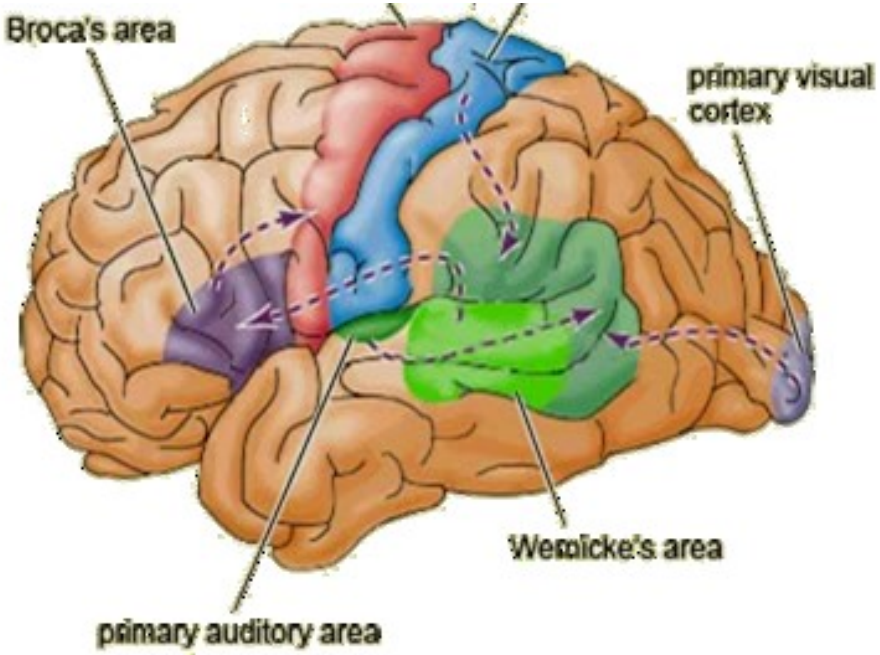
Lobulus parietalis inferior

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





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

Gyrus supramarginalis (Area 40)

- ✓ Phonological and articulatory processing of words

Gyrus angularis (Area 39)

- ✓ Semantic processing

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

Integration of auditory, visual and somatosensory information

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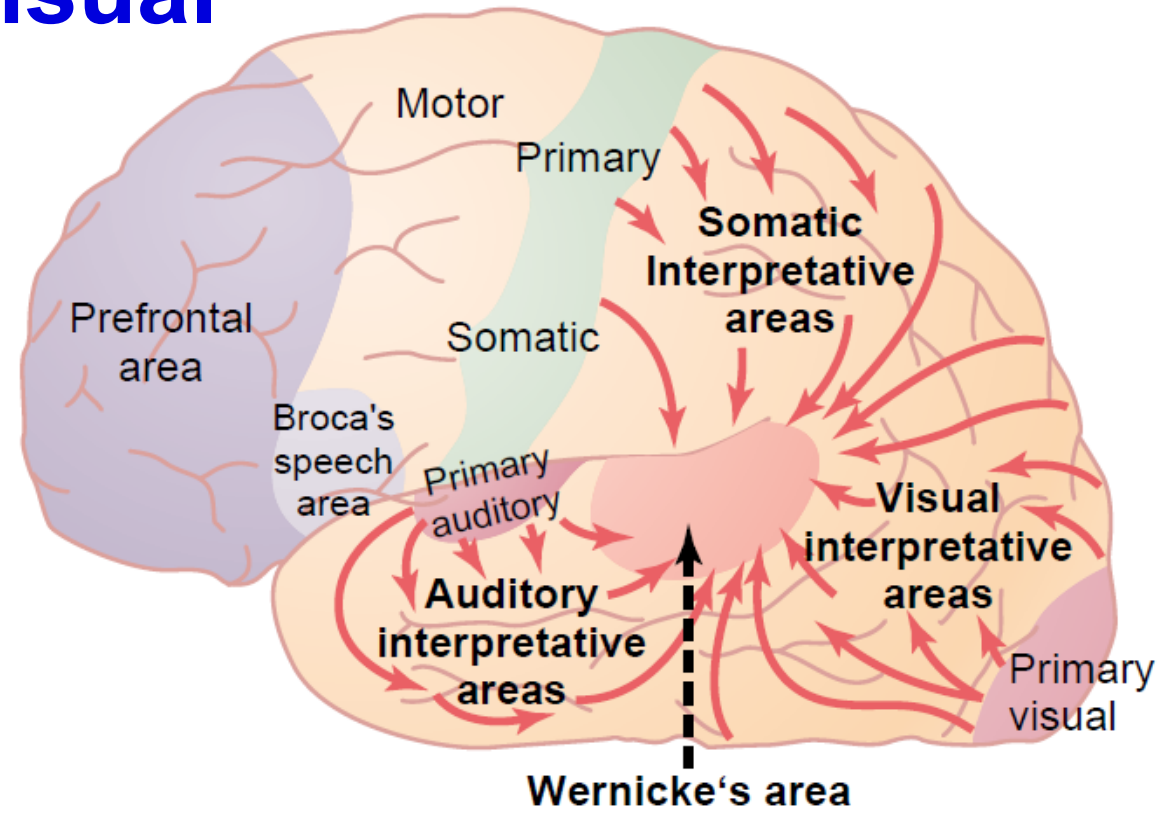
Integration of auditory, visual and somatosensory information



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

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Lobulus parietalis inferior

- Late evolutionary as well as ontogenic development
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  - Children usually cannot „actively“ read before this age (understand the meaning of the text which he/she reads)

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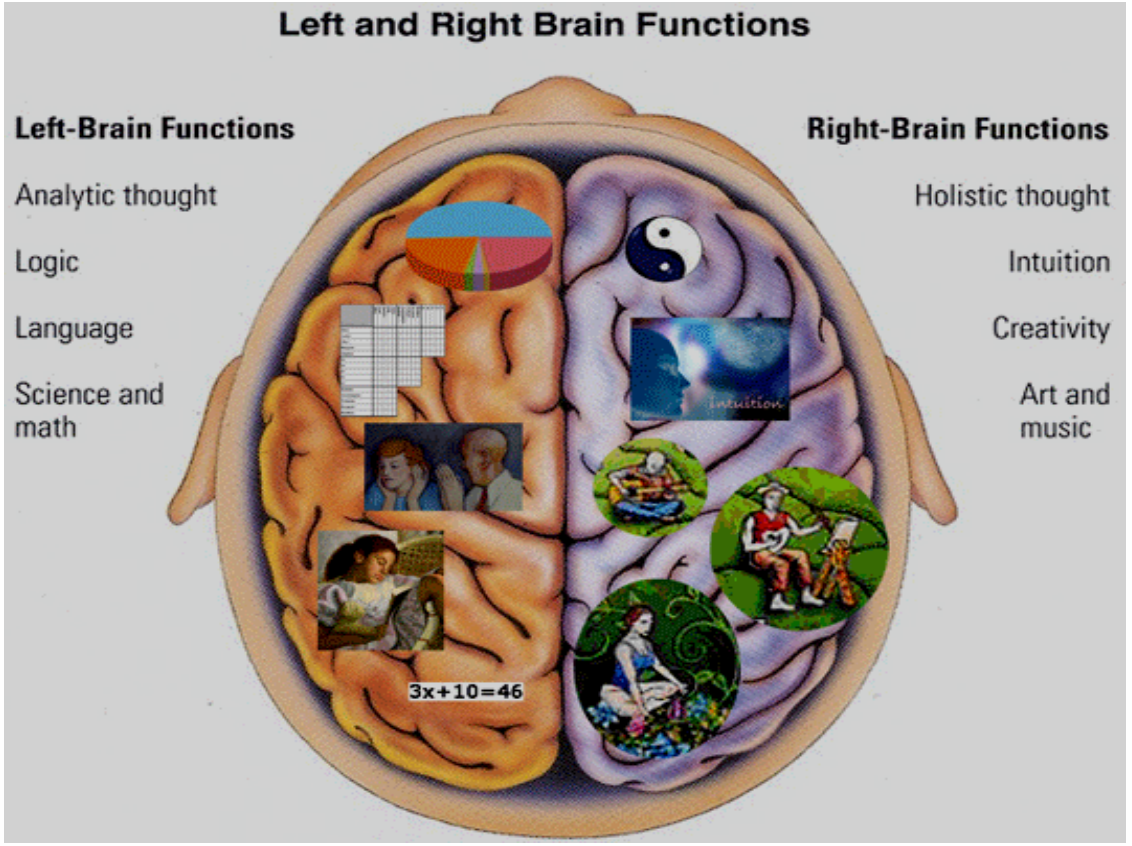
- Some scientists suggest that the left hemisphere dominance for language evolved from this hemisphere's better motor control

- 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



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Women and language

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- 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

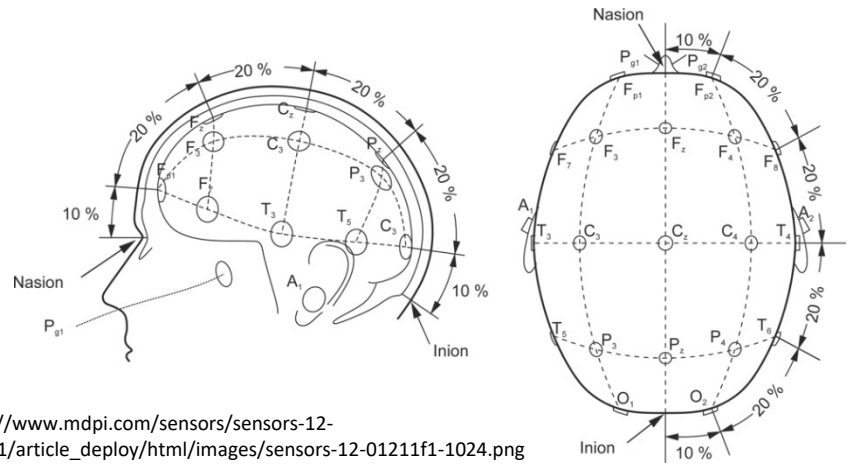
- Detection of electrical activity
  - Higher neuronal activity - higher electrical activity
  - Electroencephalography (EEG)

- Detection of regional blood flow
  - Higher neuronal activity – increased blod flow
  - 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)



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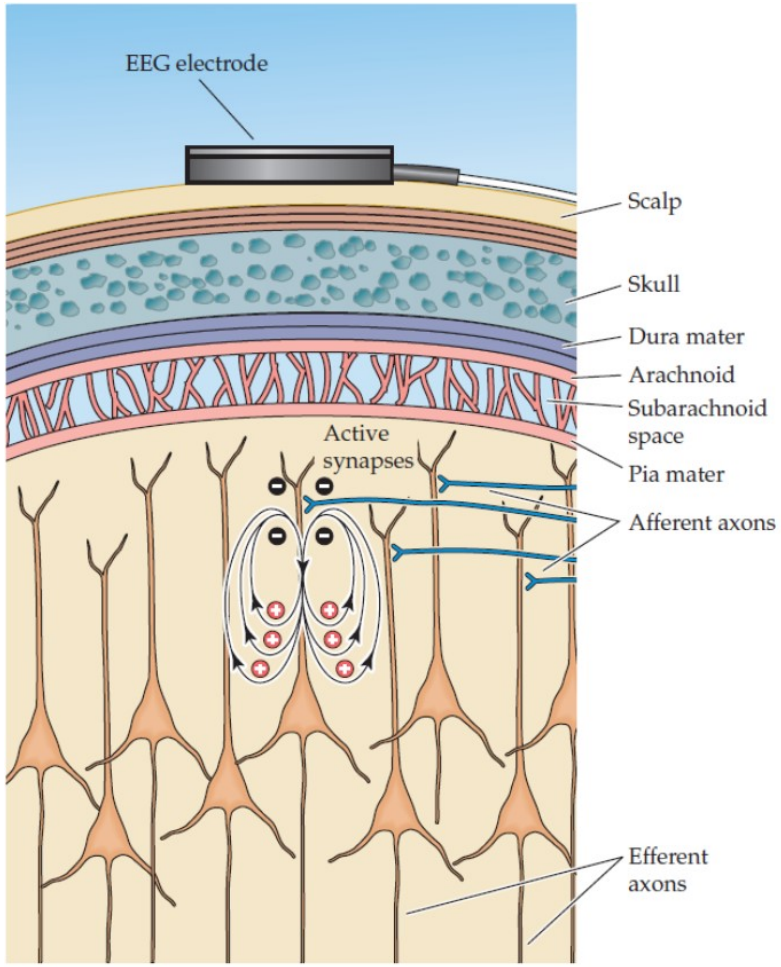

http://www.slideshare.net/kj_jantzen/biophysical-basis-of-eeg

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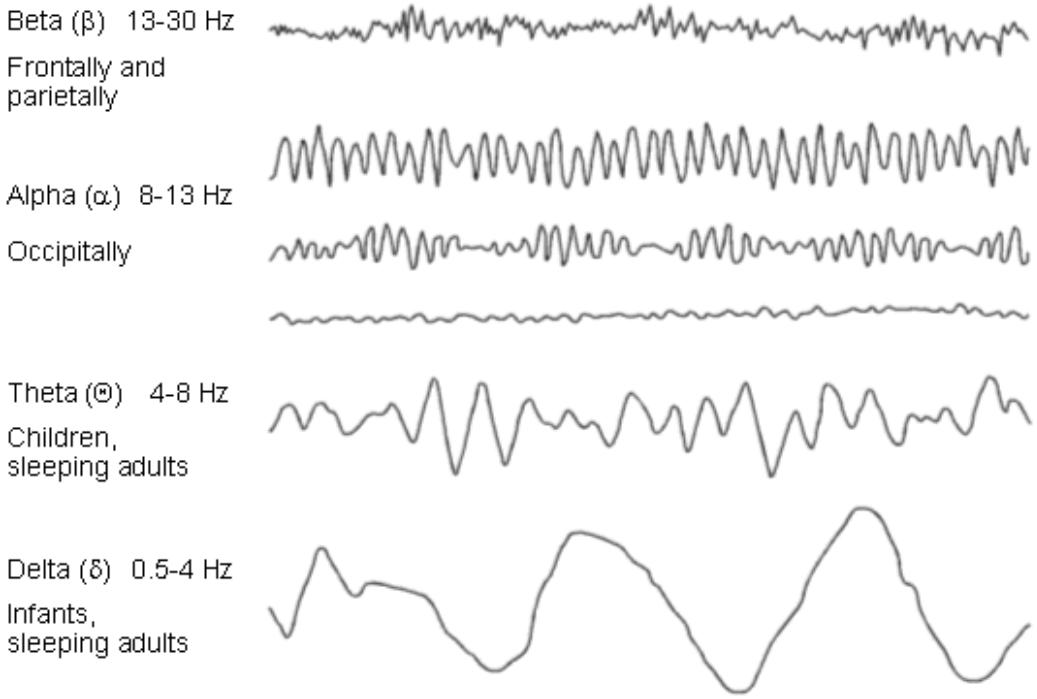
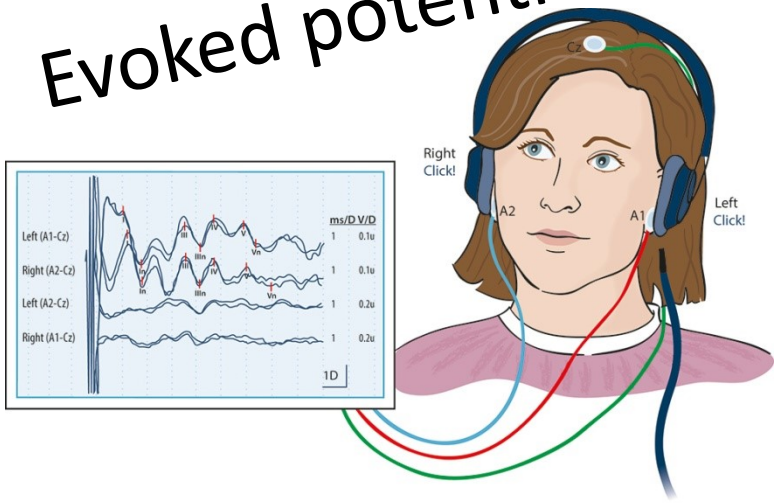
EEG

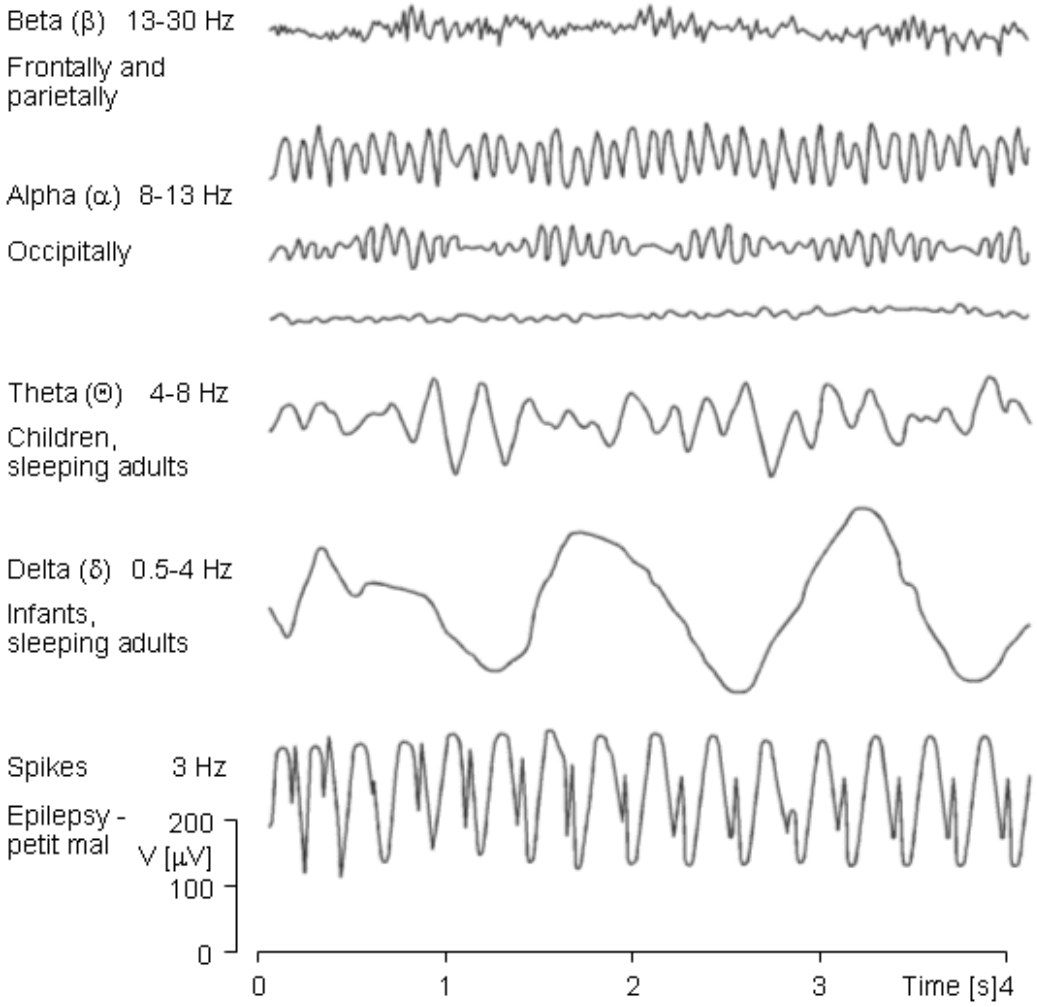


Evoked potentials



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

EEG



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

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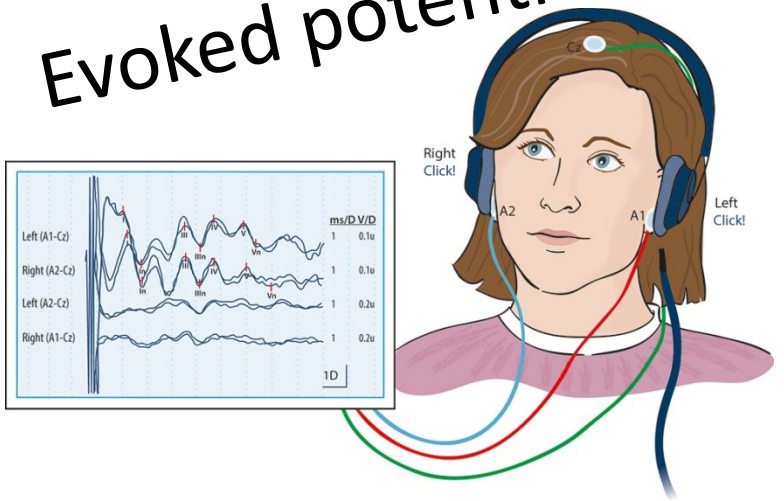

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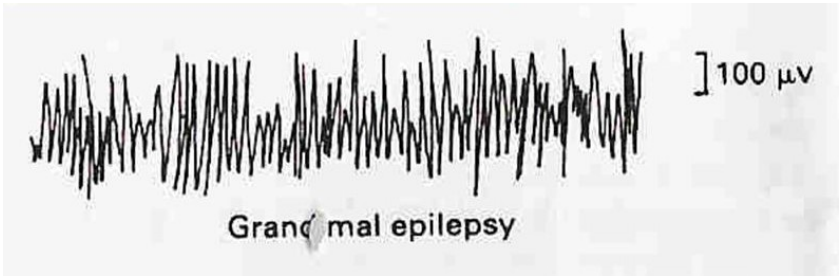

https://www.google.com/search?q=GRAND+MAL+EEG&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjyr82Im6veAhUliaYKHfquClkQ_AUIDigB&biw=1222&bih=574#imgrc=nCNGCX88H3K7ZM:

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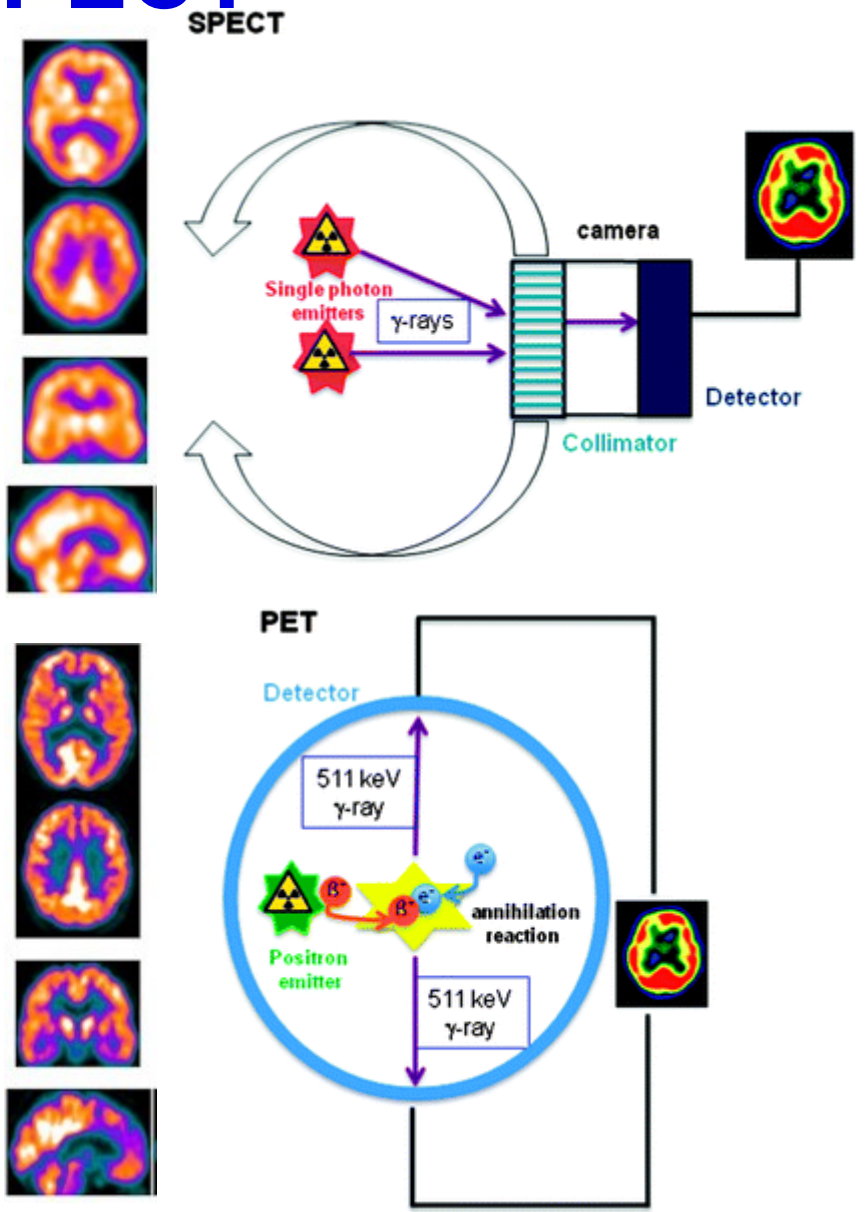
PET a SPECT

- Injection of radionuclide labeled substances
- Short half live of radionuclide
  - Necessary to prepare shortly before application
  - Nuclear medicine department
- SPECT
  - Single photon emission computer tomograhy
  - radionuclide is the source of gamma rays
  - Low resolution (around 1 cm)
- PET
  - Positron emission tomography
  - 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

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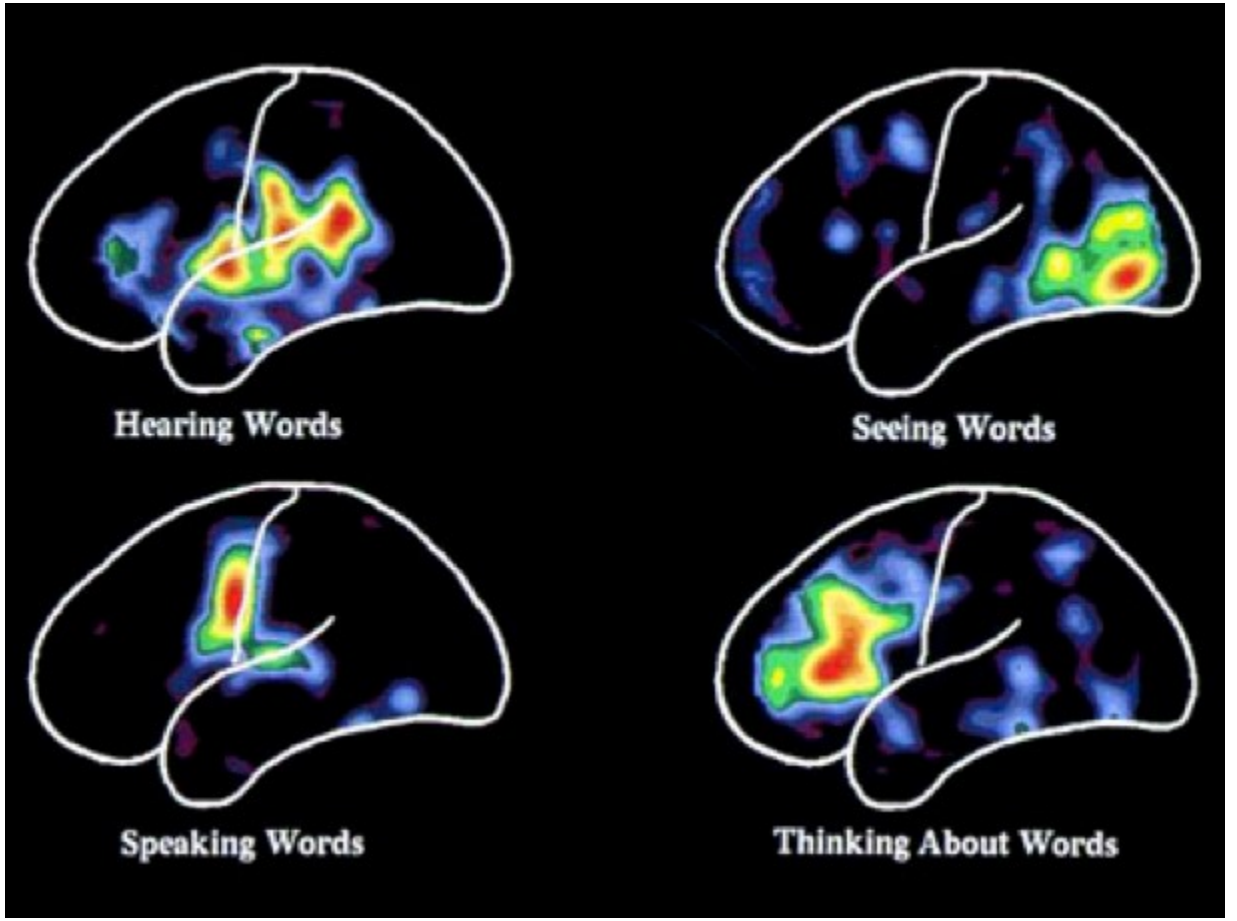
Functional regions of te brain



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

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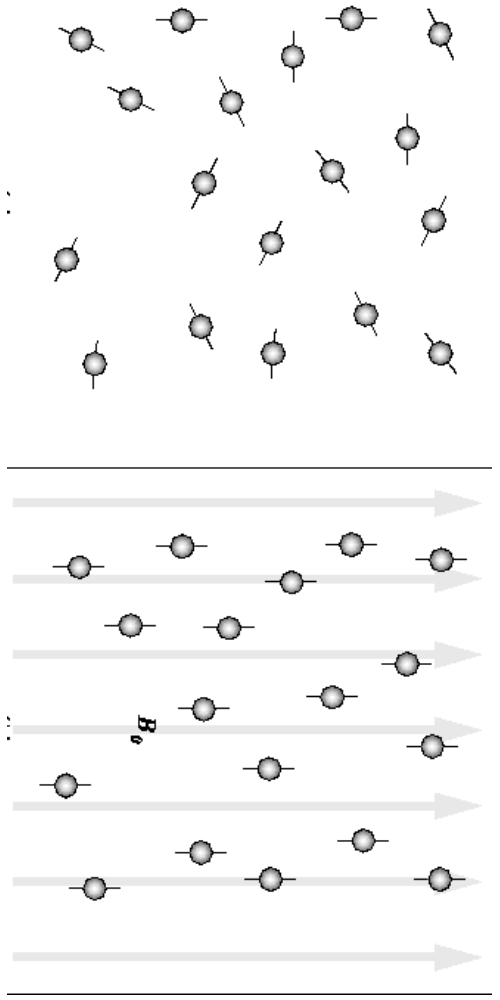
fMRI

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



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

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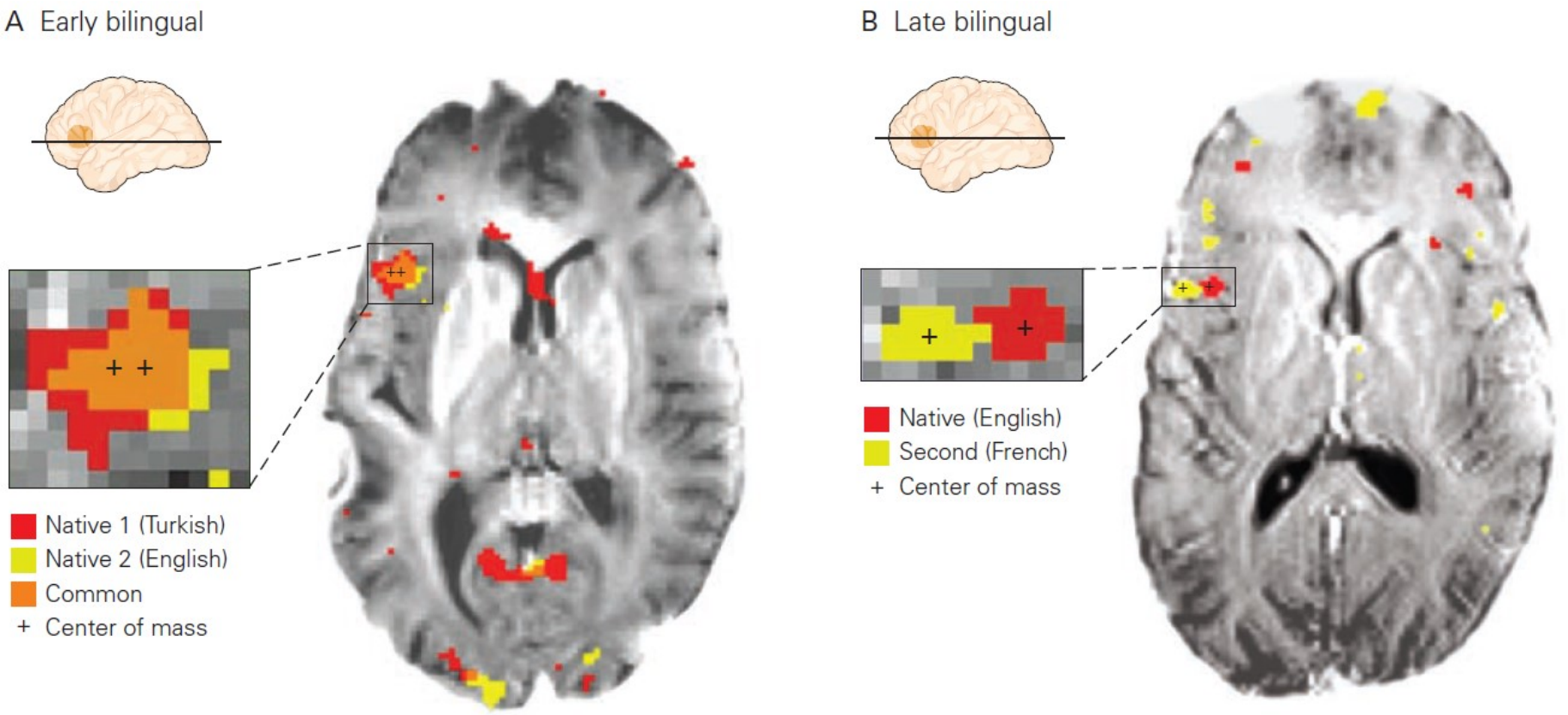
fMRI



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).

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86. The basic characterization of neocortical functions – language and social brain, basic overview of functional diagnostic methods used in neurology

- Communication and language
  - Language areas – localization and fuctuion including lobulus parietalis inferior, aphasia…
  - Lateralization of language functions, gender differences
- Social brain
  - Human is a social beeing, so the brain has to be designed accordingly
  - Frontal lobe and limbic system in behavioral control
  - Triune brain theory, whole brain model, mentalization, dehumanization
- Functional diagnostic methods (EEG, SPECT, PET , fMRI)

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