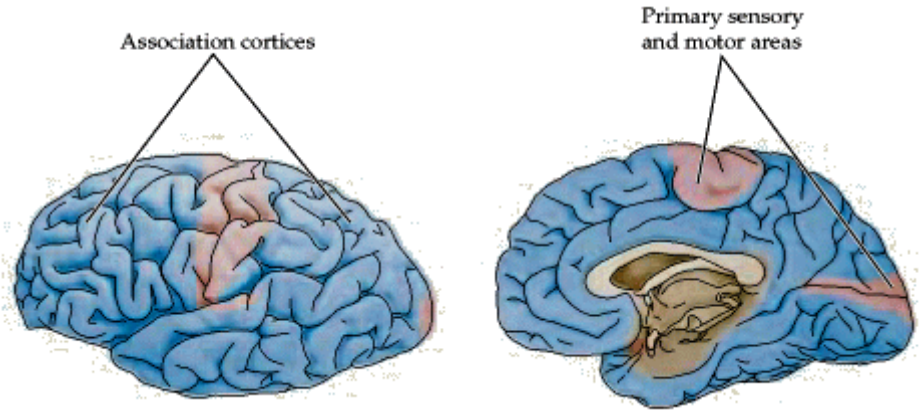
MUNI
MED

MUNI
MED

16

Neocortex II
The Highest Level of Cerebral Activity

Neocortex

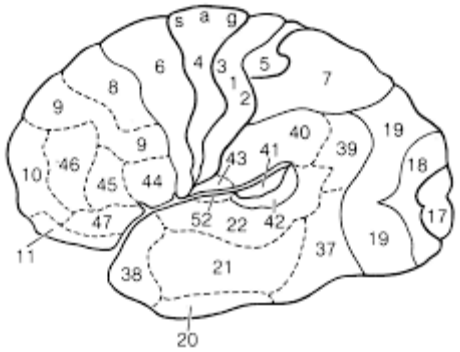


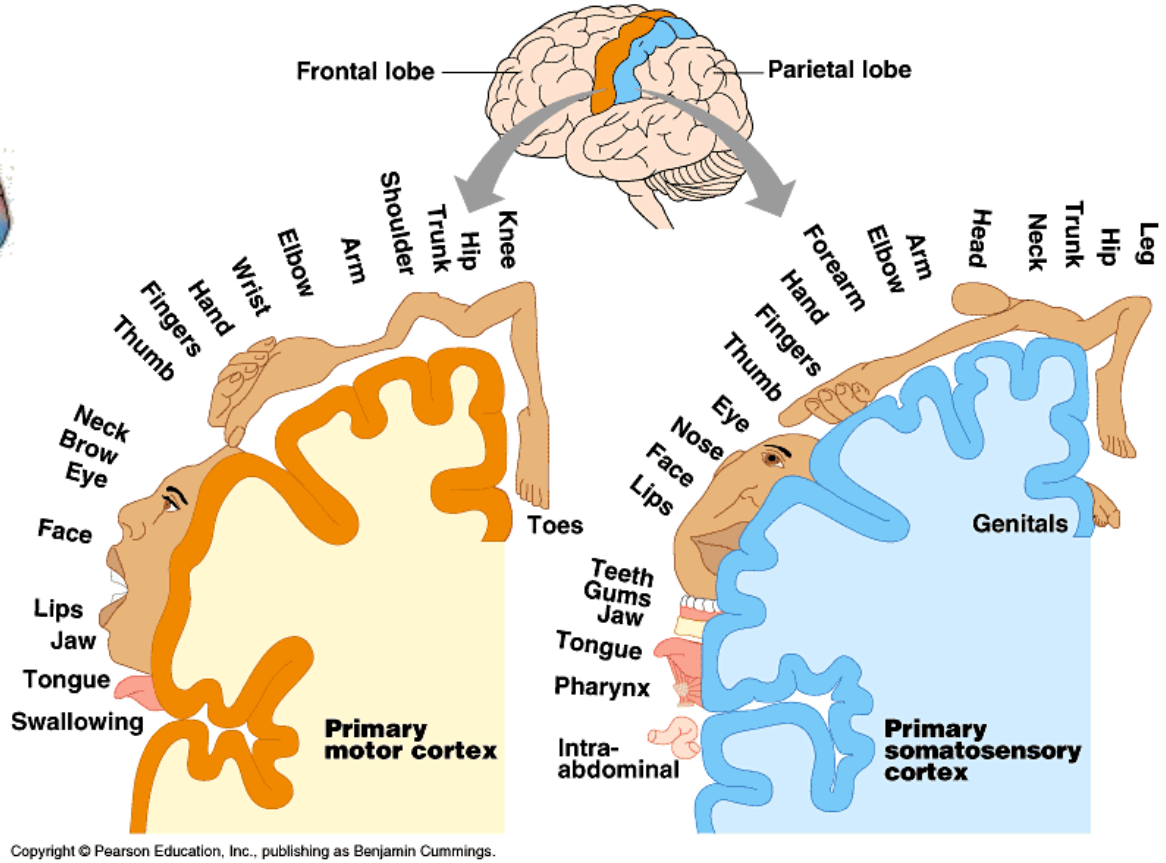
Primary areas

✓Somathotopic organization

Association areas

✓No somathotopic organization

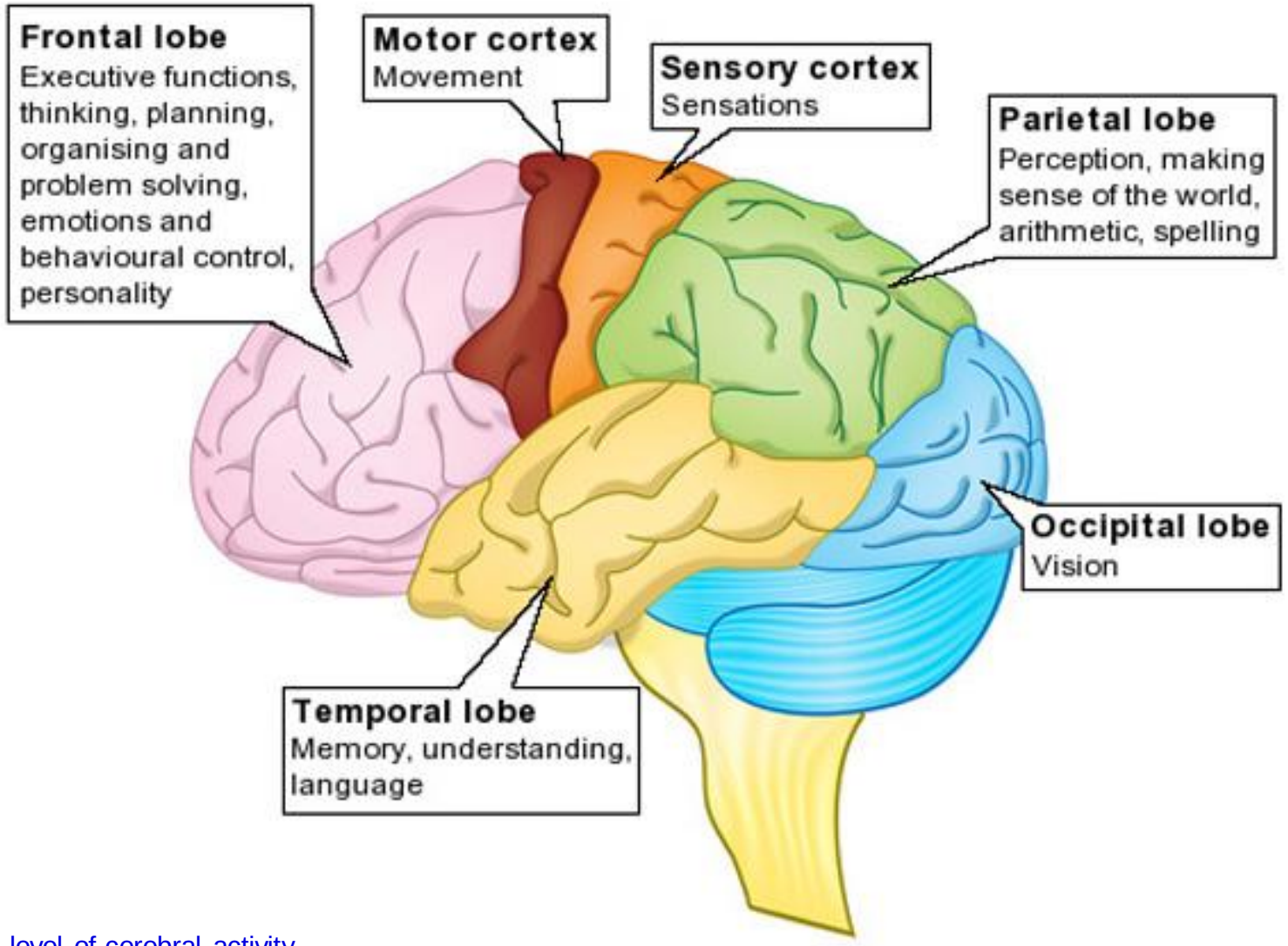




http://www.emunix.emich.edu

MUNI MED

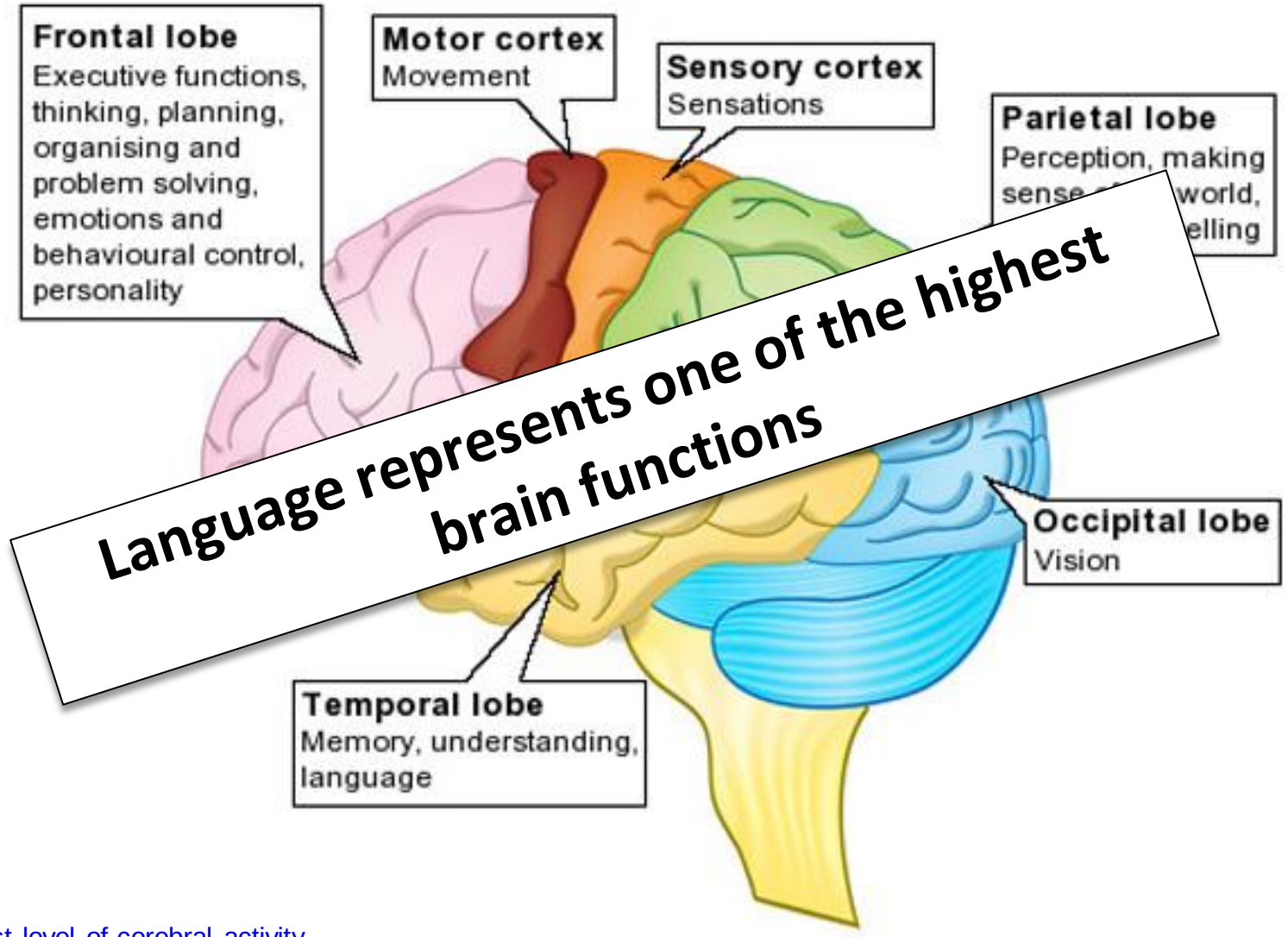
Cortical functions



http://www.modernfamilyideas.com

MUNI MED

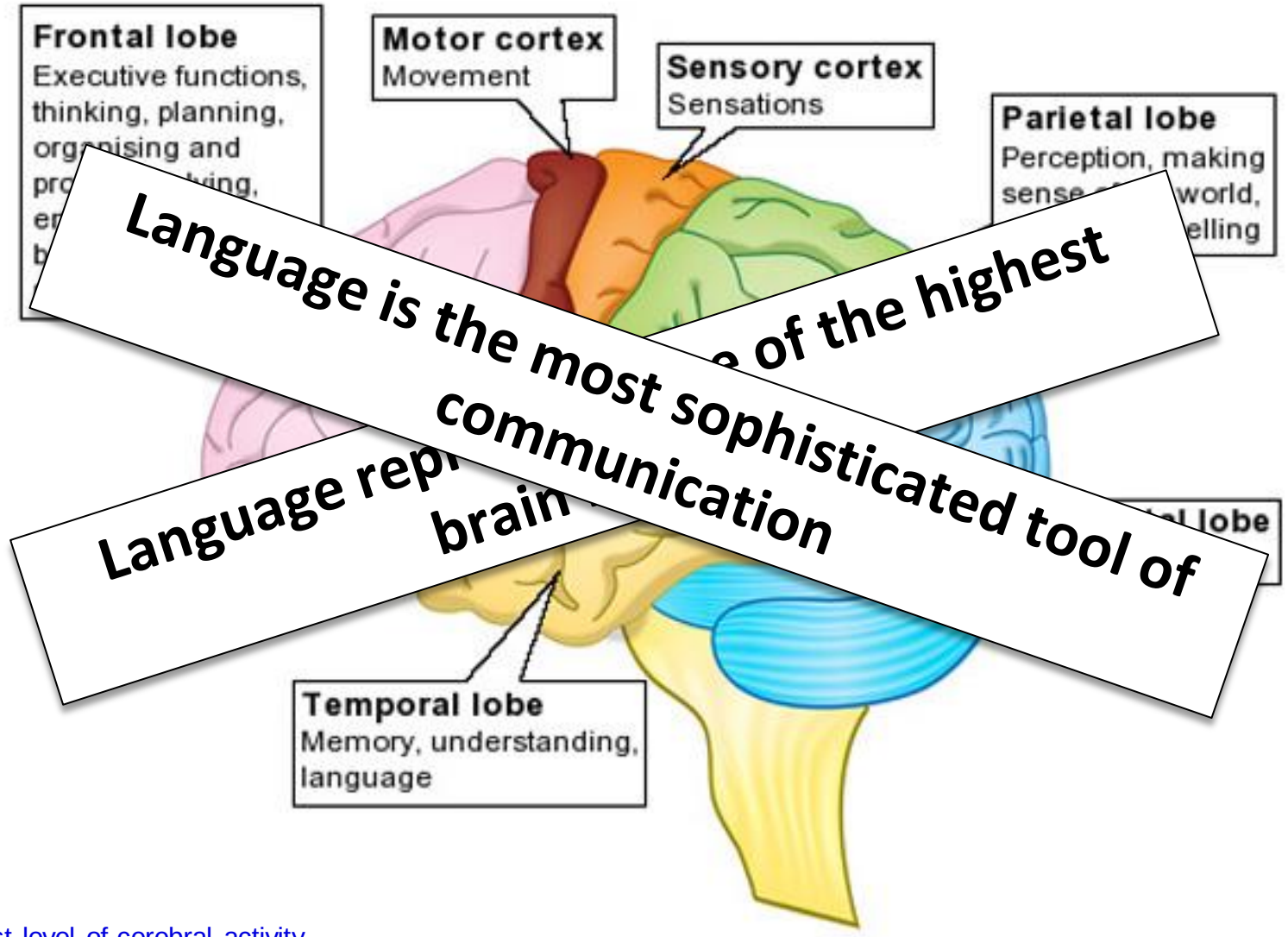
Cortical functions



http://www.modernfamilyideas.com

MUNI MED

Cortical functions



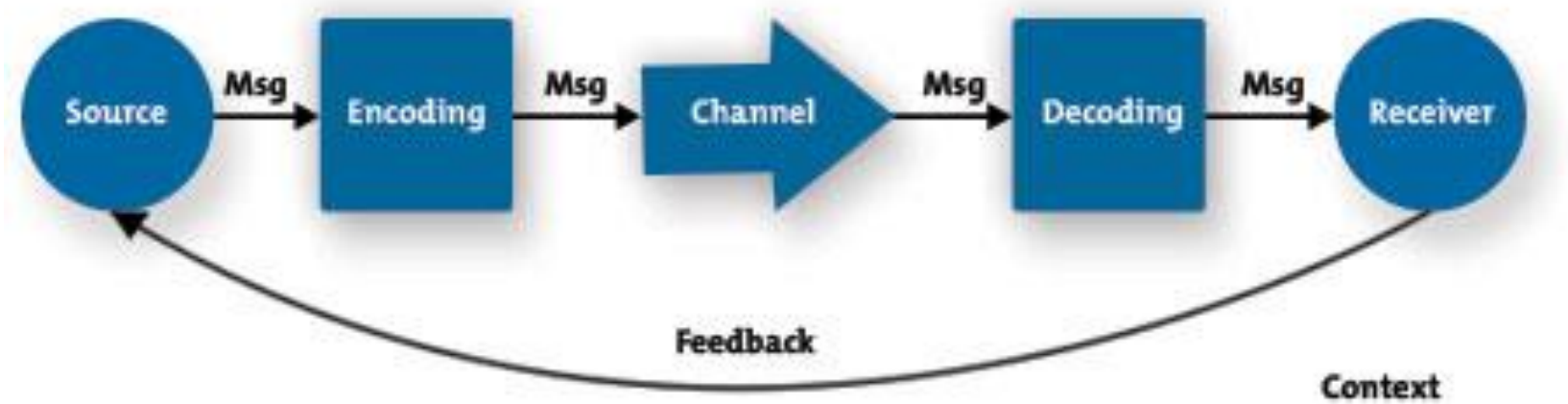
http://www.modernfamilyideas.com

MUNI MED

Communication

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

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

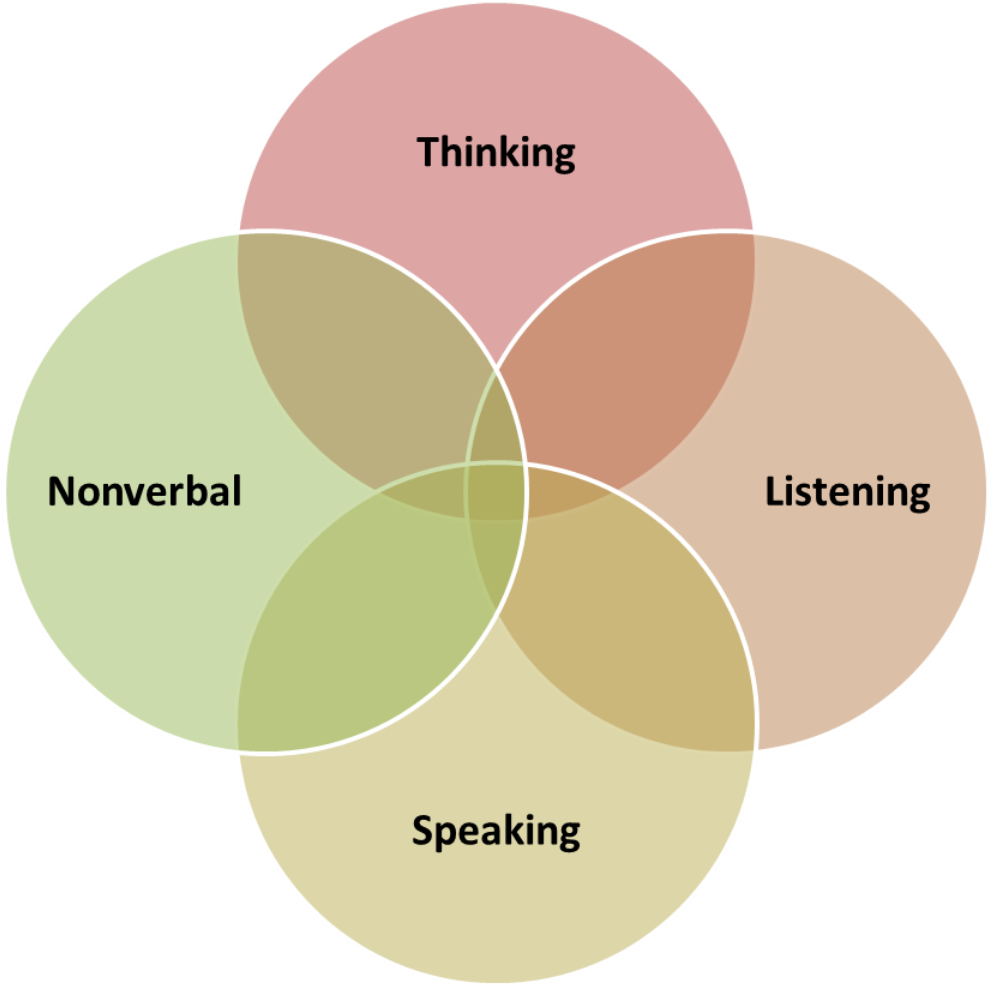


https://www.mindtools.com/media/Diagrams/CommunicationsProcess.jpg

MUNI MED

Communication in human society

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



https://s-media-cache-ak0.pinimg.com/originals/93/dc/42/93dc4240059a0635eed4d672c98c343c.png

MUNI MED

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

MUNI MED

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

MUNI MED

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

a sequence of speech sounds

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

➢ Word

- Symbol with a meaning

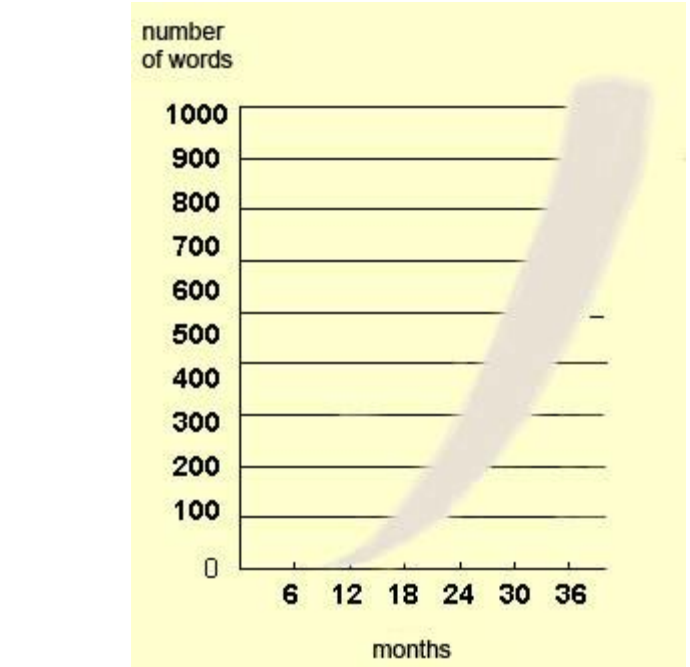
➢ Sentence

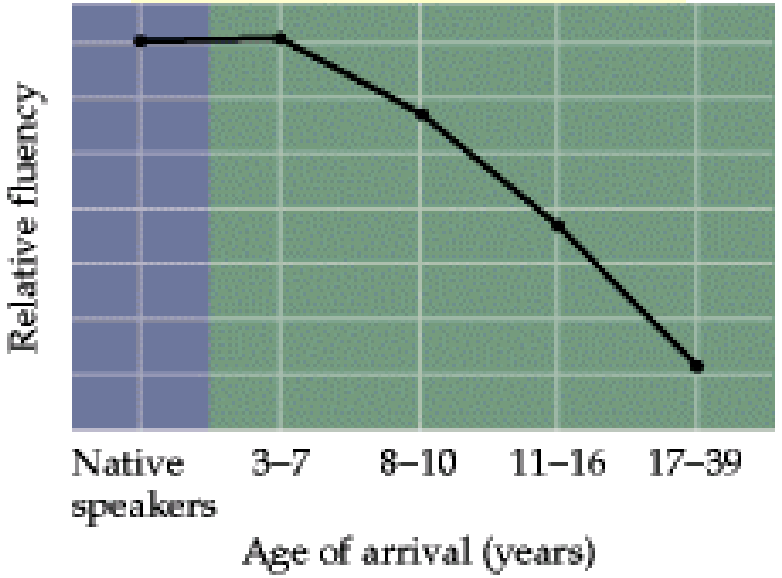
- A group of words organized according to the rules of syntax

MUNI MED

Learning to speak

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



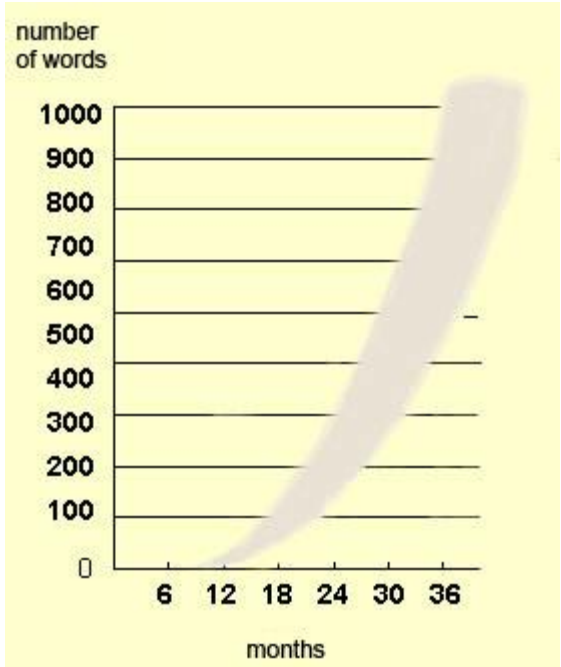


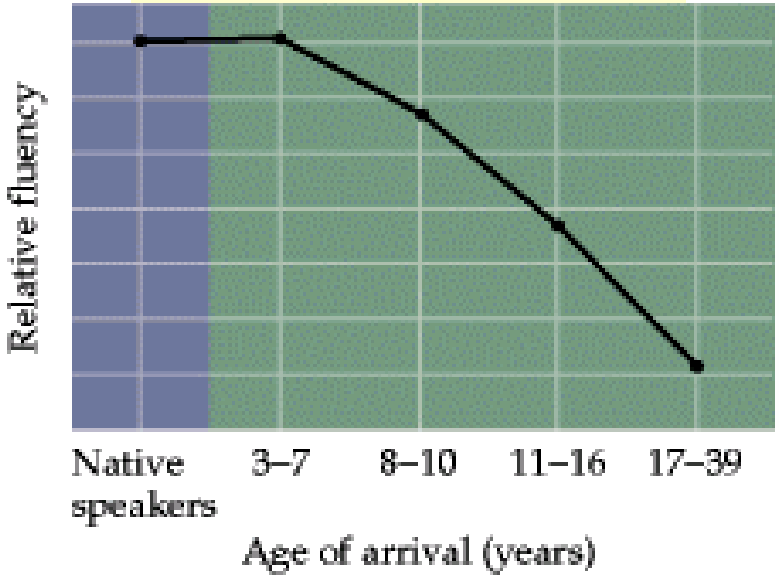
http://www.slideshare.net/drpsdeb/presentations

MUNI MED

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



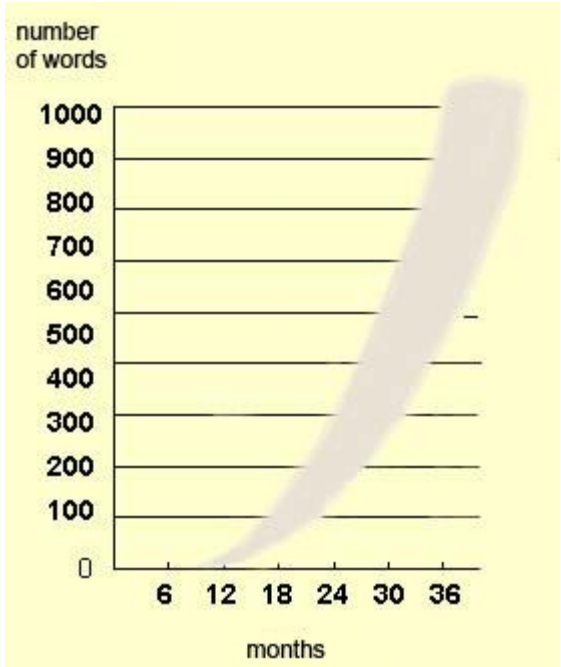


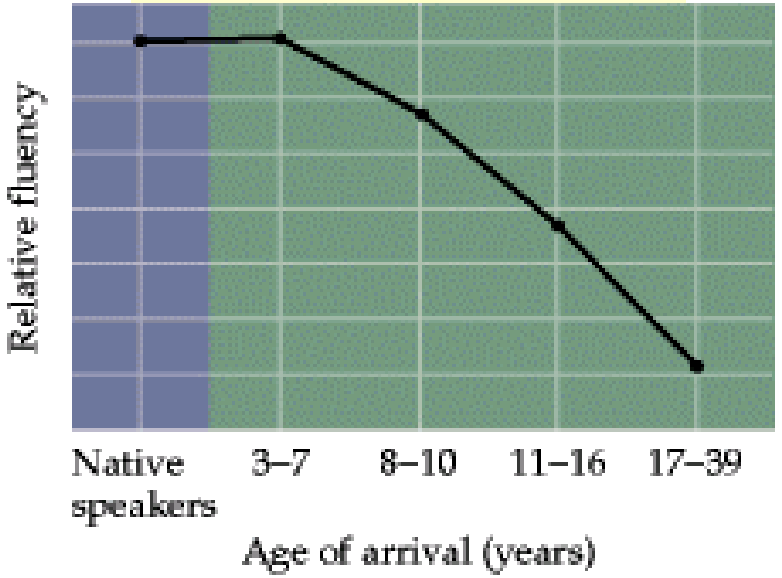
http://www.slideshare.net/drpsdeb/presentations

MUNI MED

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.

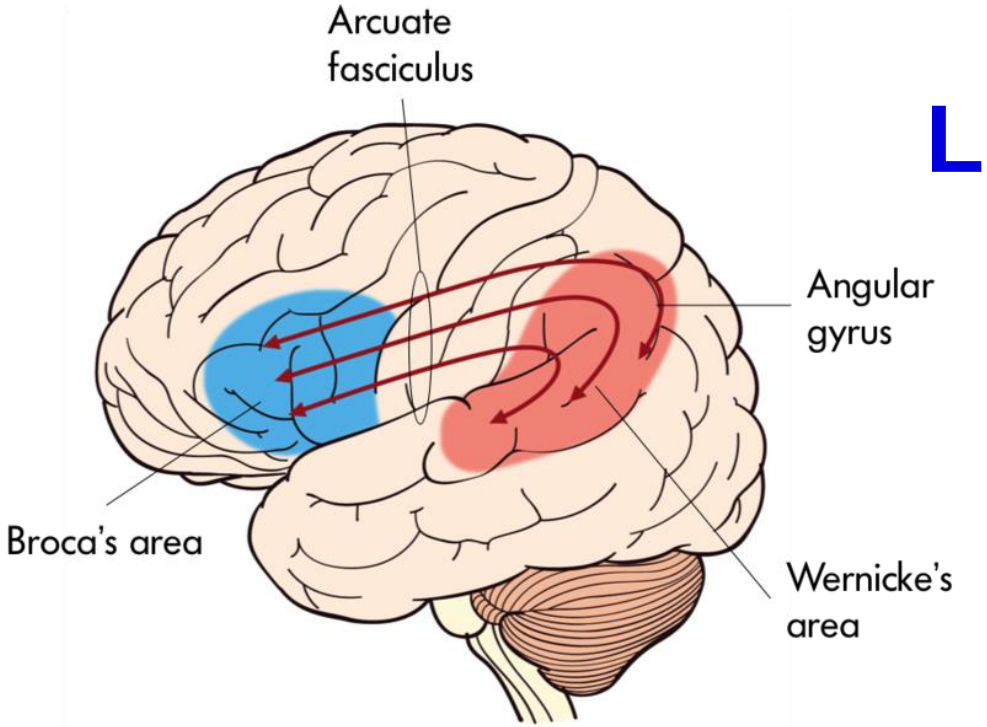




http://www.slideshare.net/drpsdeb/presentations

MUNI MED

Language areas



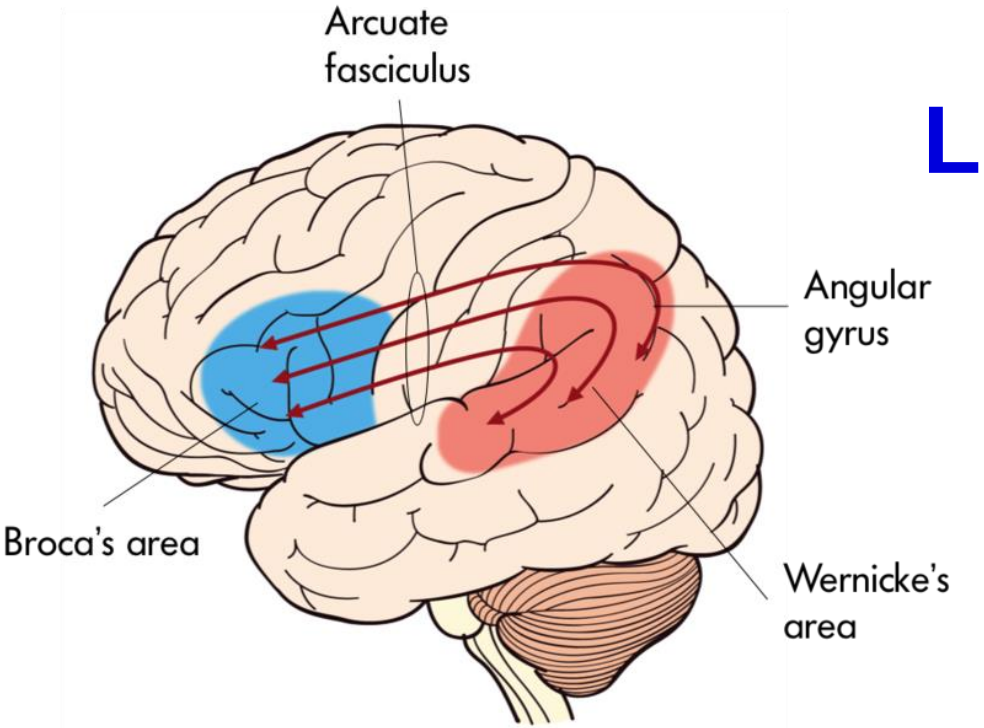
http://www.slideshare.net/CsillaEgri/presentations

There are two main language areas

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

MUNI MED

Language areas



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

There are two main language areas

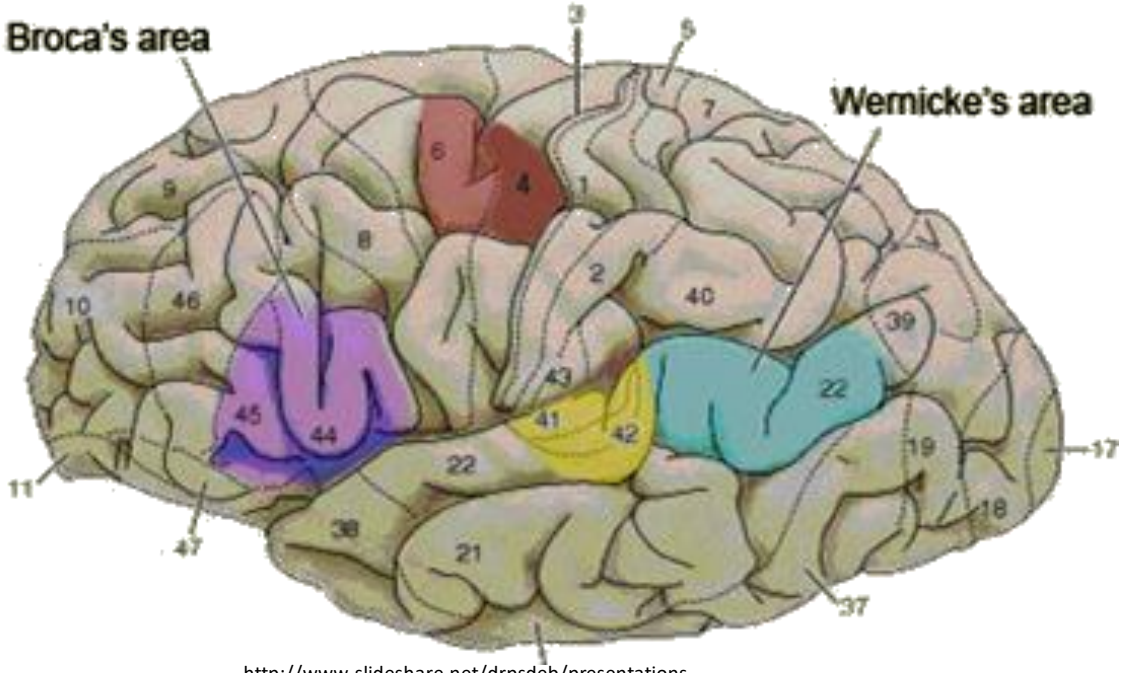
- Broca´s area (motor)
  - ✓ Close to motor cortex
- Wernicke´s area (sensor)
  - ✓ Close to auditory cortex
- Fasciculus arcuatus

- 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 …

MUNI MED

Broca´s area



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

Area 45

- ✓ Semantic processing

„selection and manipulation with appropriate words“

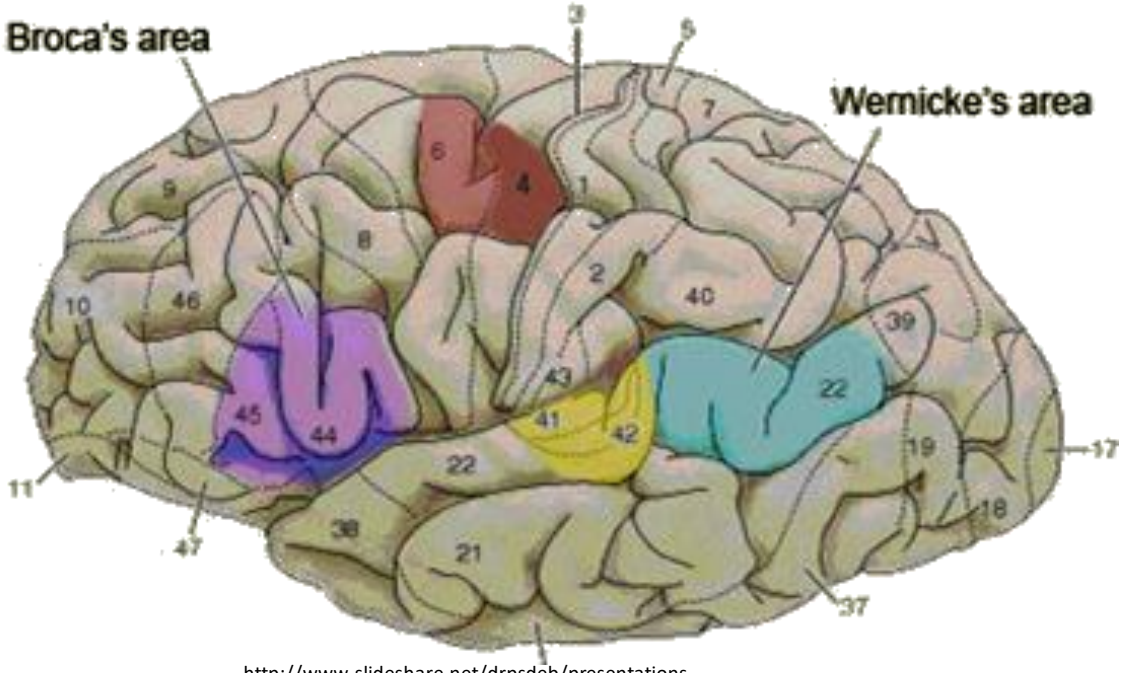
Area 44

- ✓ Phonological processing and language production

„selection and activation of particular motor centers“

MUNI MED

Wernicke´s area



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

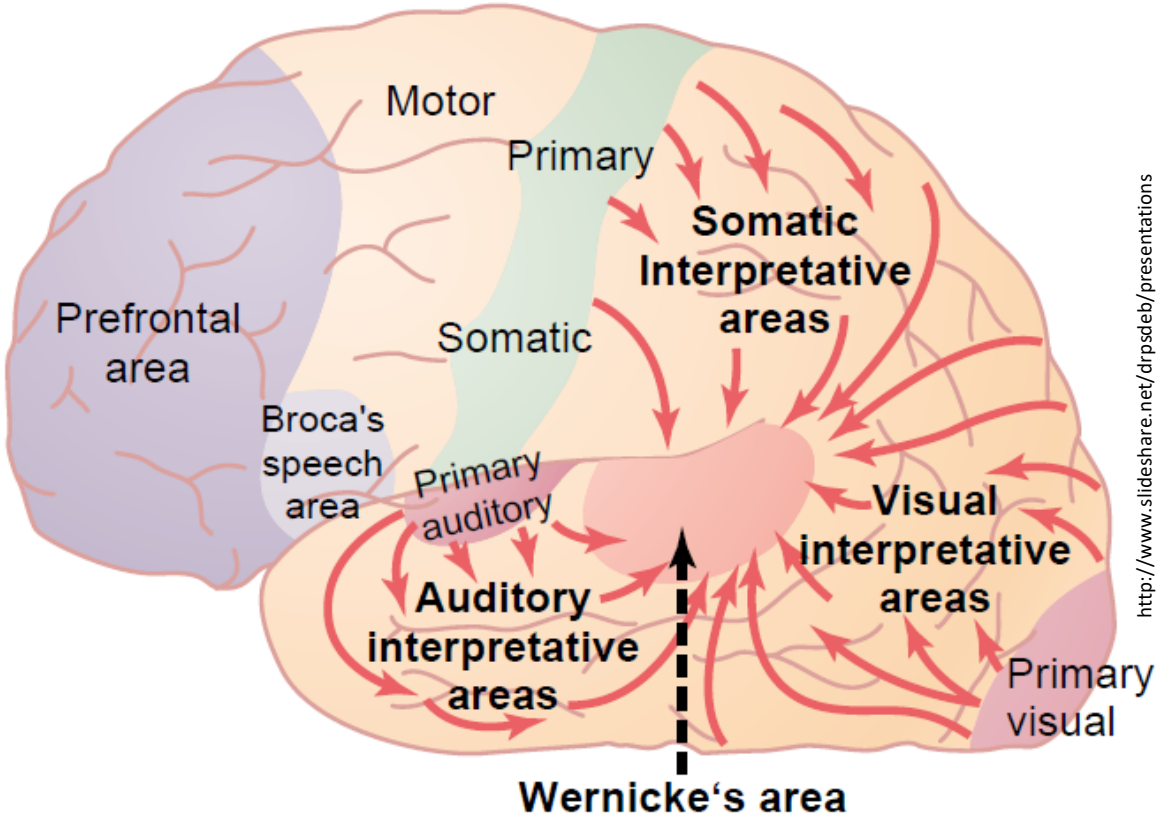
Area 22

✓ 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

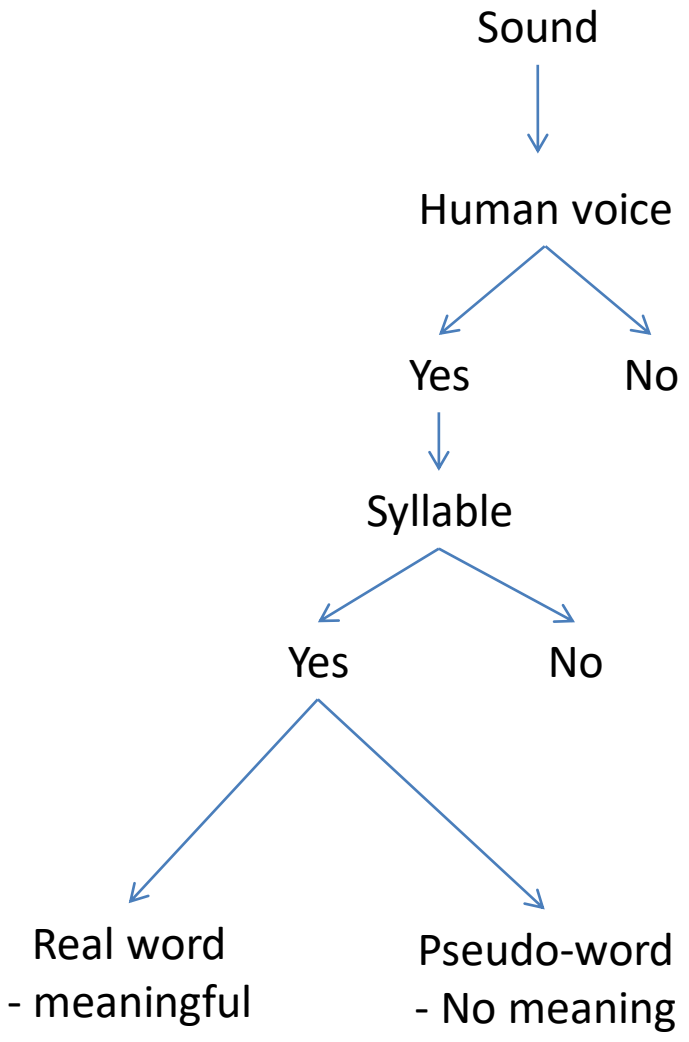
MUNI MED

Algorithm of sound processing



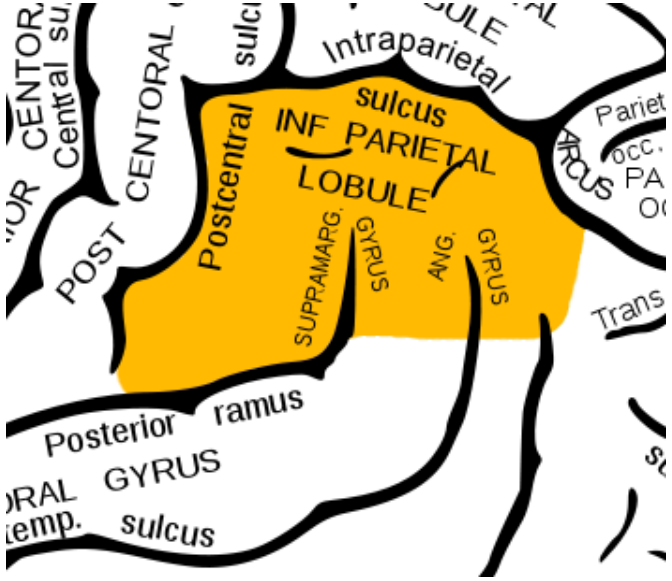
http://www.slideshare.net/drpsdeb/presentations

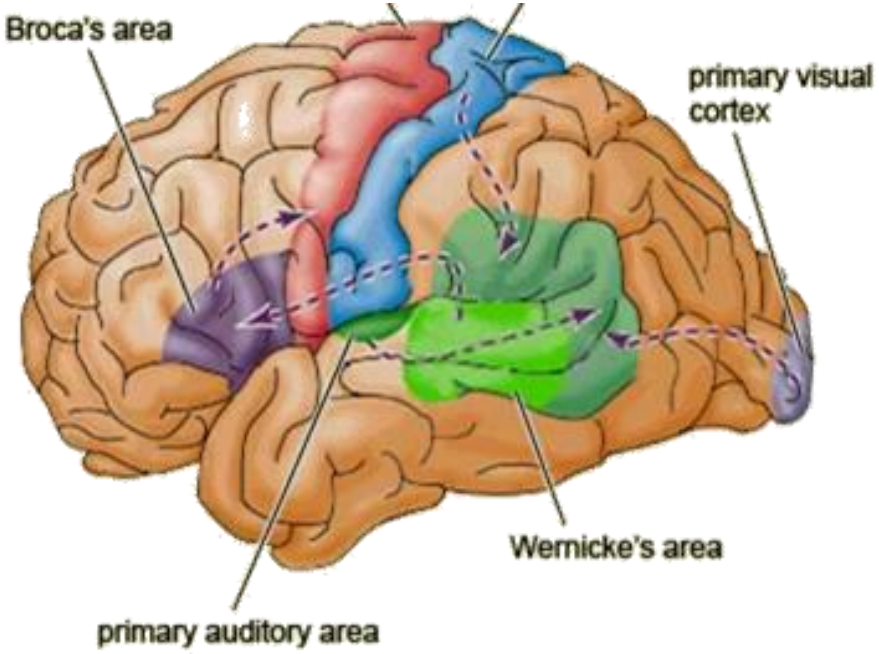
- ✓ **Wernicke´s area**
- ✓ **Broca´s area**
- ✓ **P-O-T association cortex**



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 (Area 40)

- ✓ Phonological and articulatory processing of words

Gyrus angularis (Area 39)

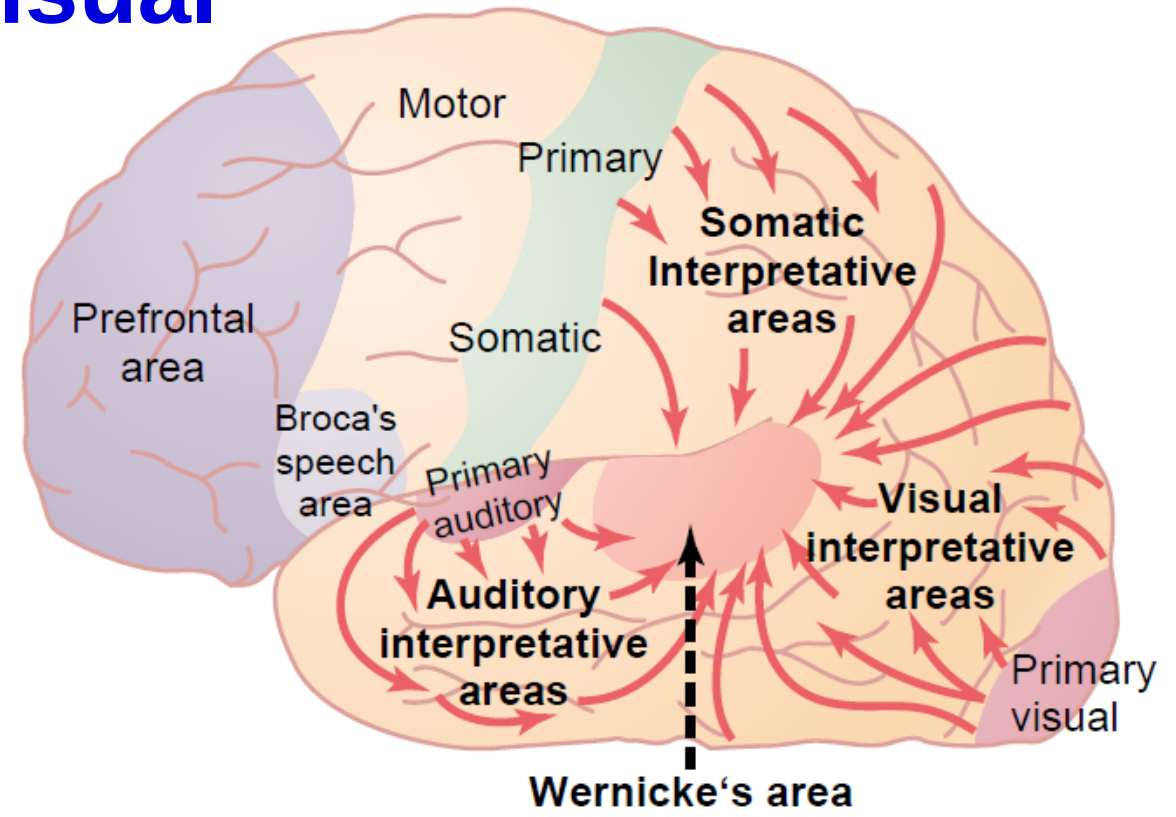
- ✓ Semantic processing

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

Integration of auditory, visual and somatosensory information

MUNI MED

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

MUNI MED

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)

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 algorythms are also involved in complex „inner“ categorization
- The language („both spoken and inner“) enabled development of complex (abstract) thinking and development of culture

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 algorythms 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

Language functions lateralization

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

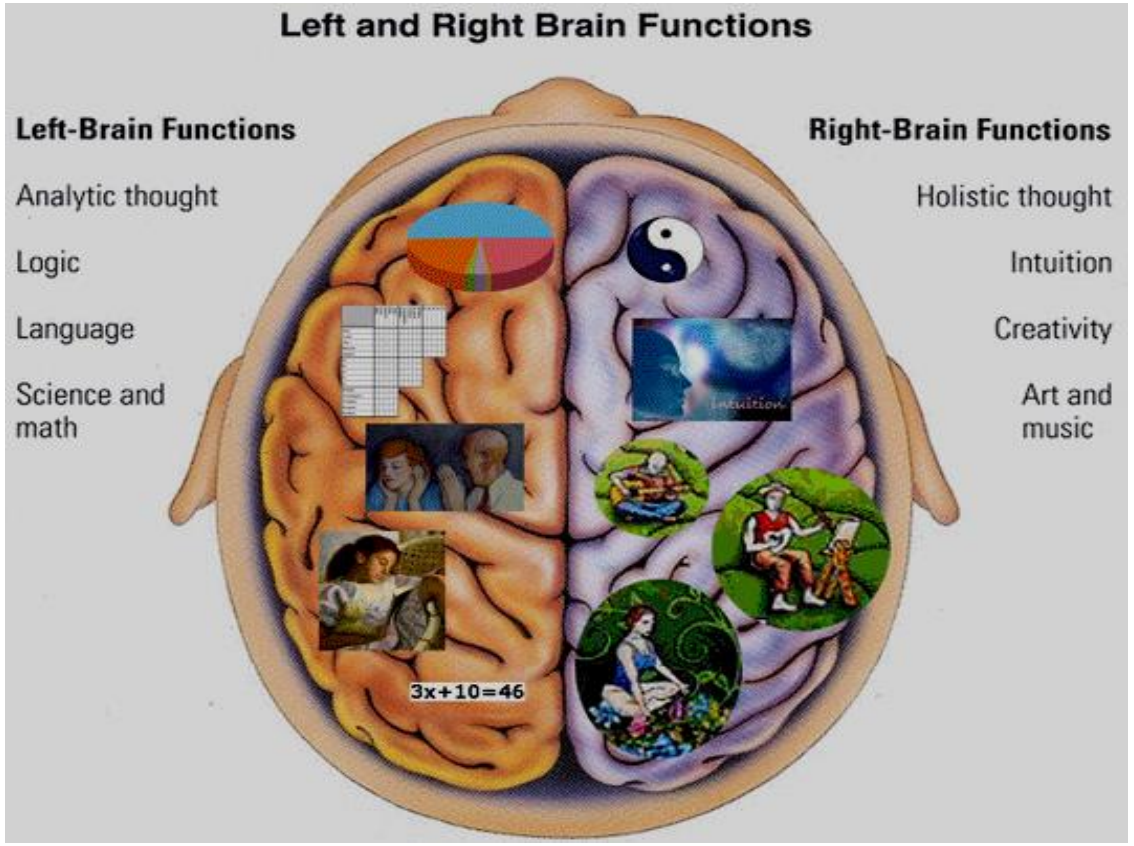
- Localization of B-W areas is not fully linked to left/right hand lateralization
  - ✓ 90% of people are right handed
  - ✓ 95% of right handed people have B-W area in the left hemisphere
  - ✓ The majority of left handed people has B-W areas also in left hemisphere

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



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

MUNI MED

Women and language

- Females' speech is more fluent
  - they can pronounce more words or sentences in a given amount of time

Women and language

- Females' speech is more fluent
  - 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.

Women and language

- Females' speech is more fluent
  - 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

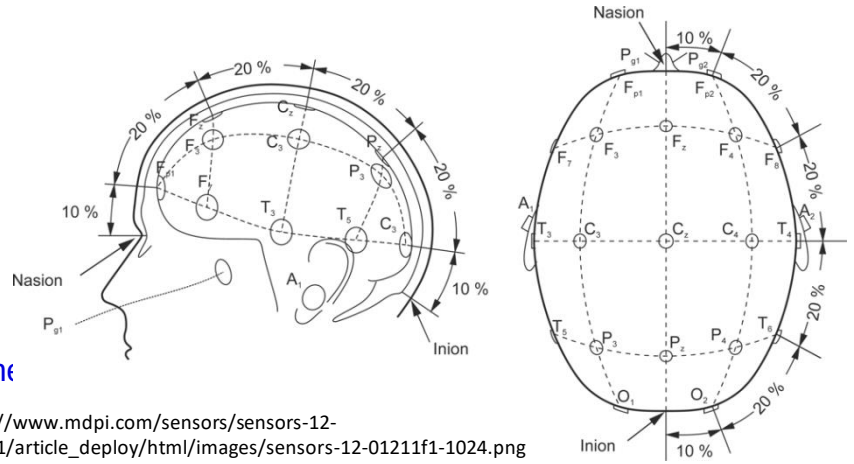
- Detection of electrical activity
  - Higher neuronal activity - higher electrical activity
  - Electroencephalography (EEG)

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

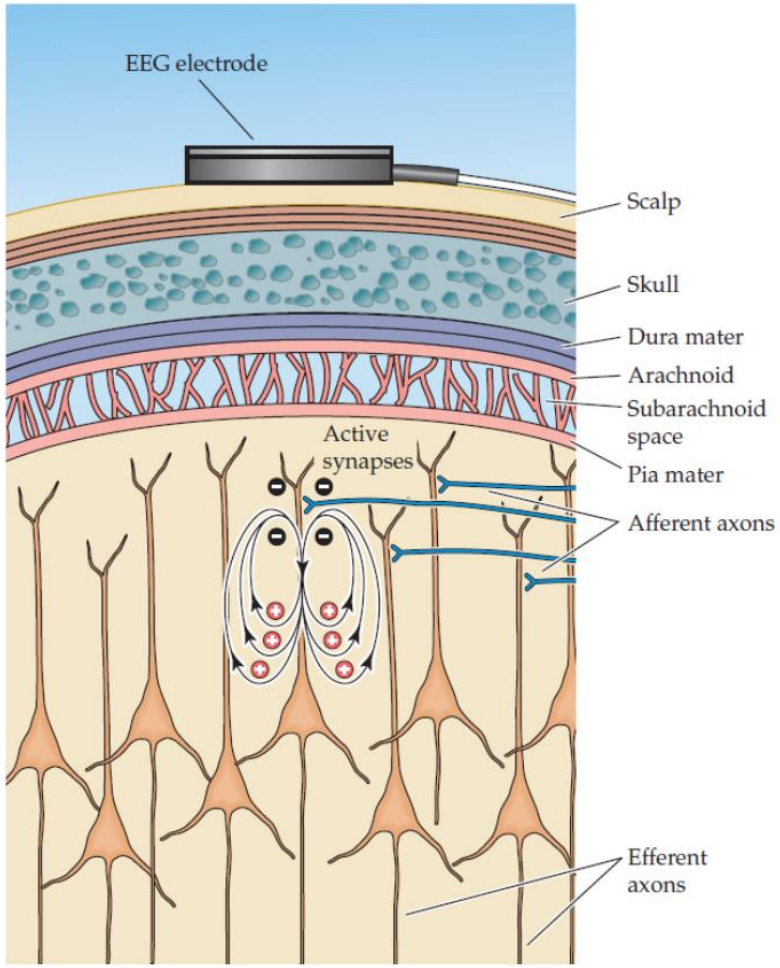
EEG

- 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)



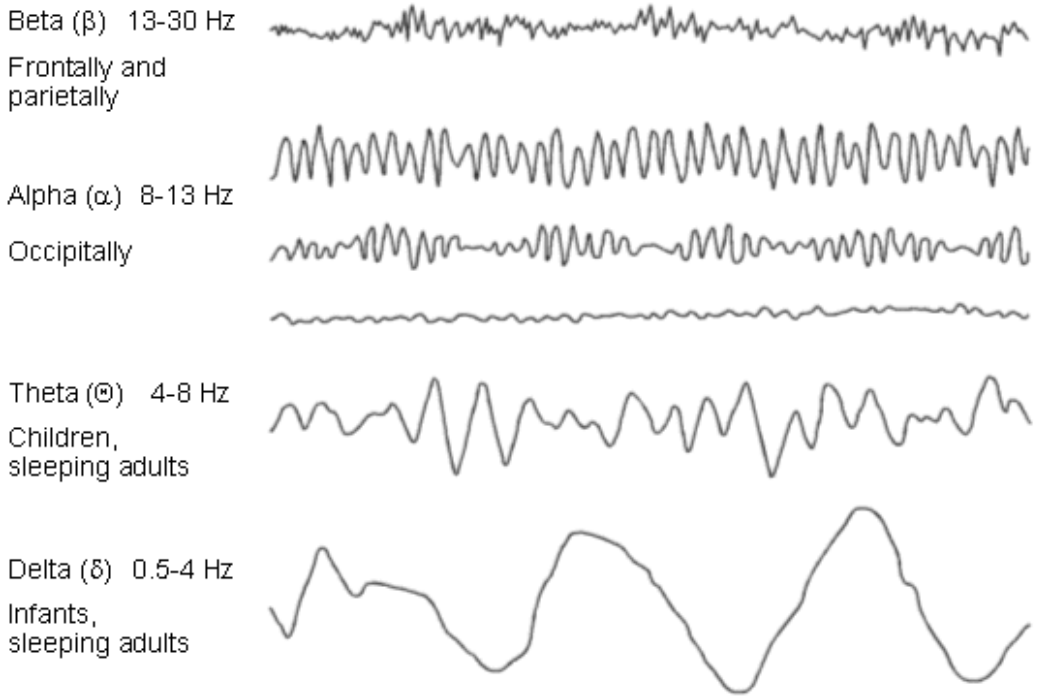
http://www.mdpi.com/sensors/sensors-12-01211/article_deploy/html/images/sensors-12-01211f1-1024.png



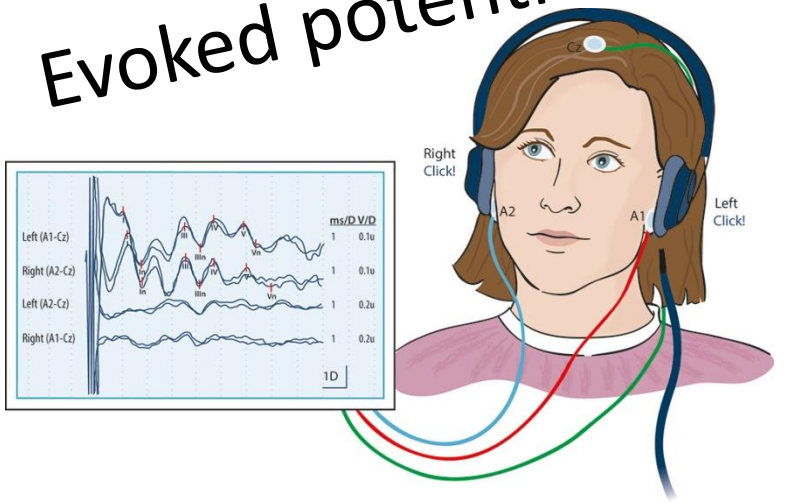
http://www.slideshare.net/kj_jantzen/biophysical-basis-of-eeg

MUNI MED

EEG



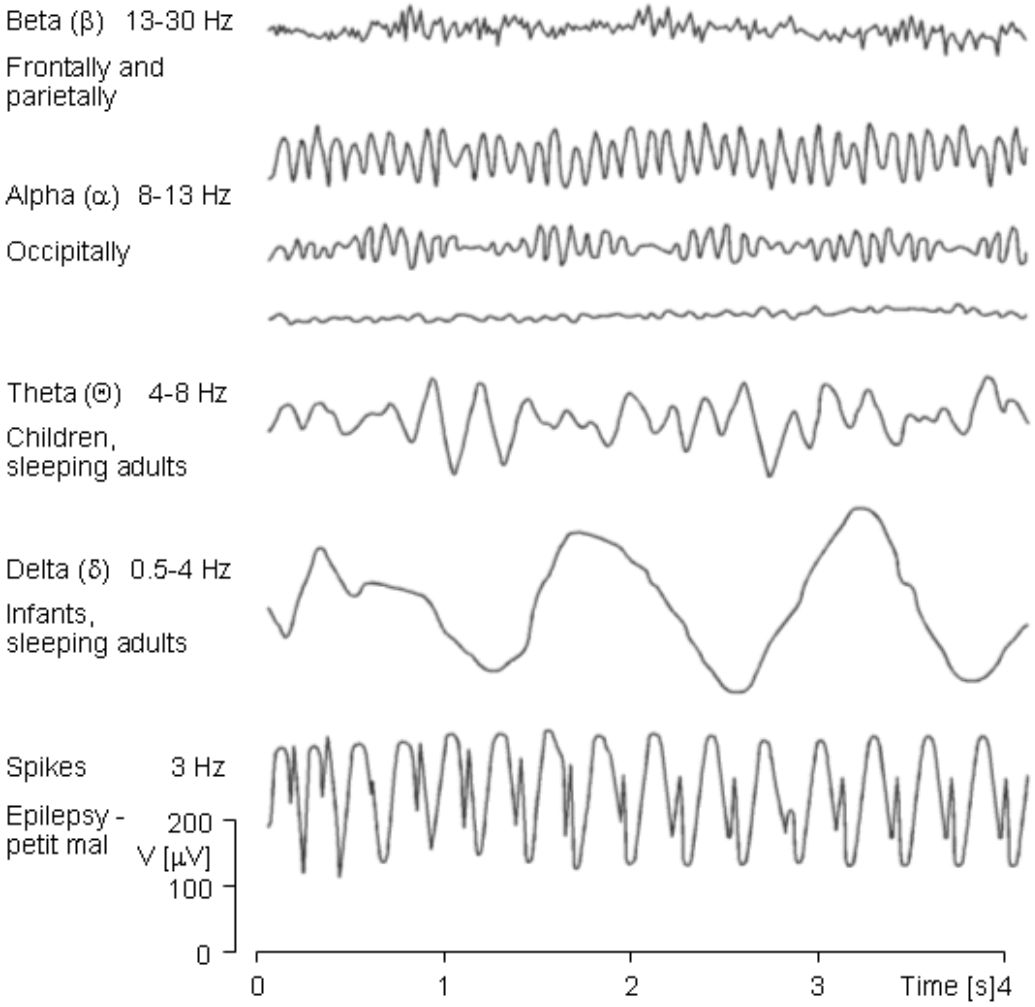
Evoked potentials



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

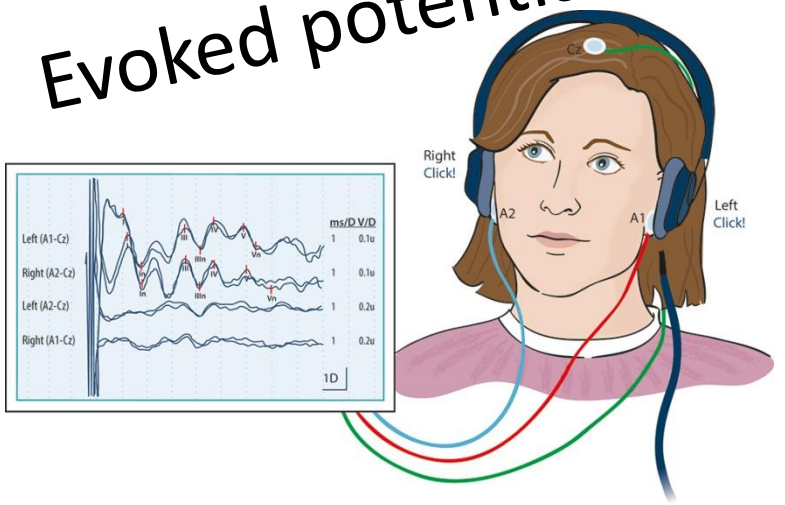
MUNI MED

EEG

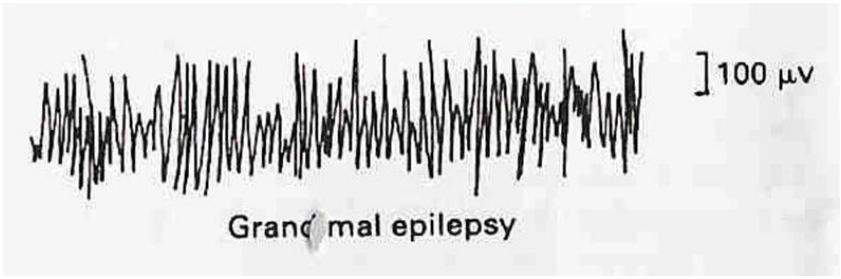


http://www.slideshare.net/akashbhoi12/eeg-53489764

Evoked potentials



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

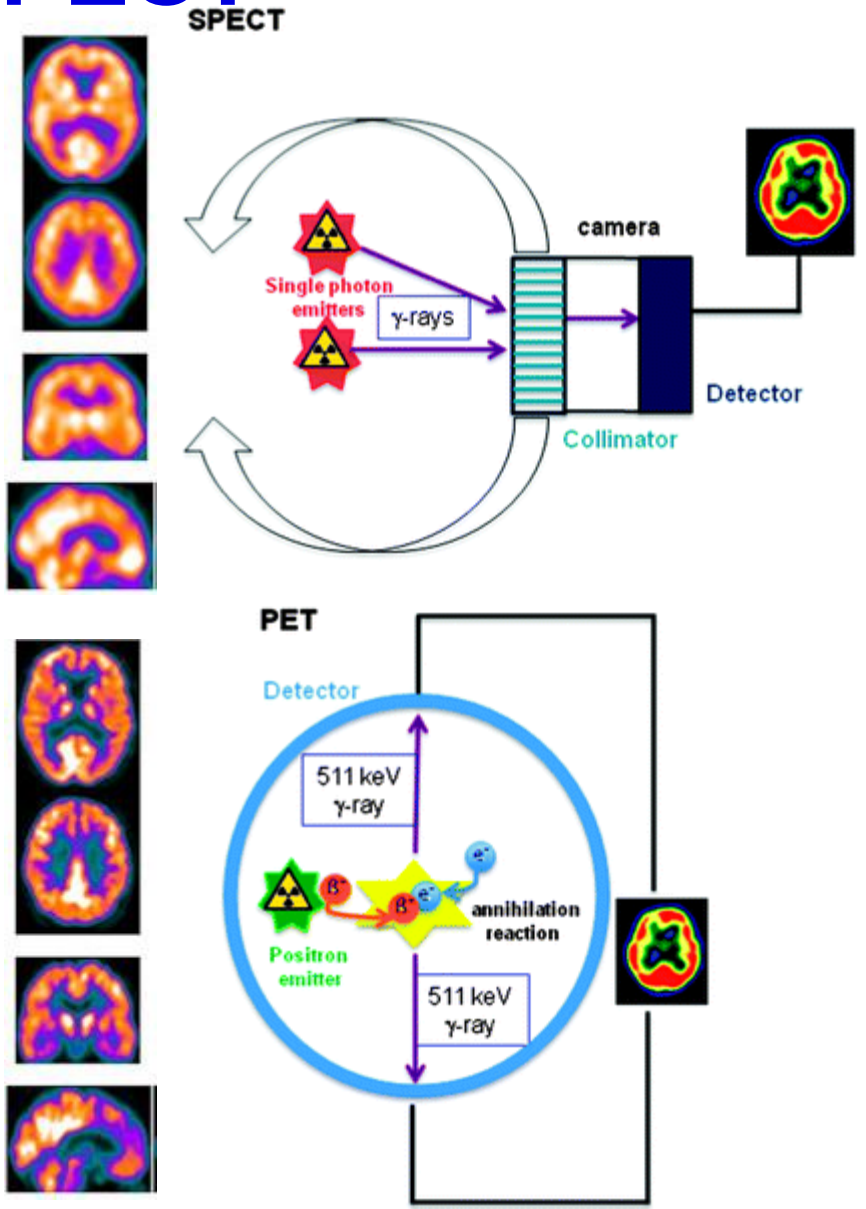


https://www.google.com/search?q=GRAND+MAL+EEG&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjyr82Im6veAhUliaYKHfquClkQ_AUIDigB&biw=1222&bih=574#imgrc=nCNGCX88H3K7ZM:

MUNI MED

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)

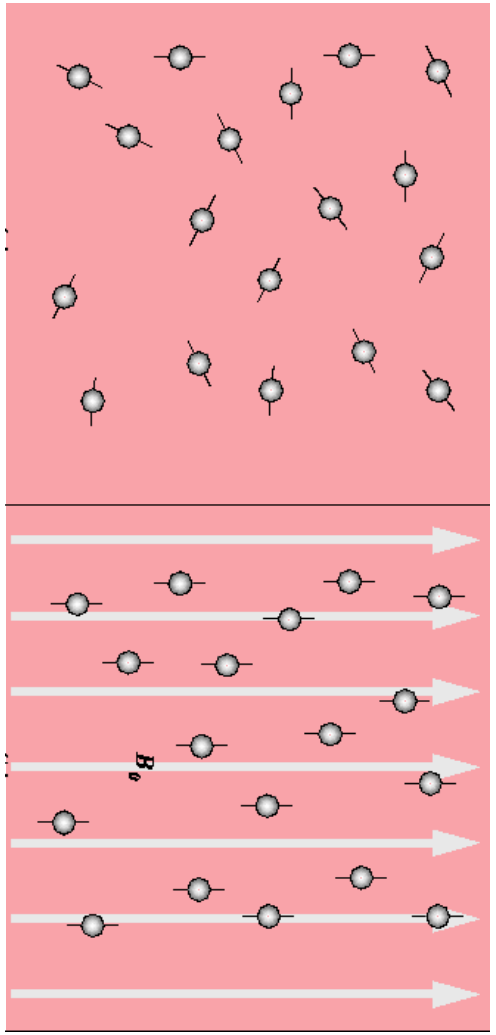


http://pubs.rsc.org/services/images/RSCpubs.ePlatform.Service.FreeContent.ImageService.svc/ImageService/Articleimage/2013/CS/c3cs60086f/c3cs60086f-f4.gif

MUNI MED

fMRI

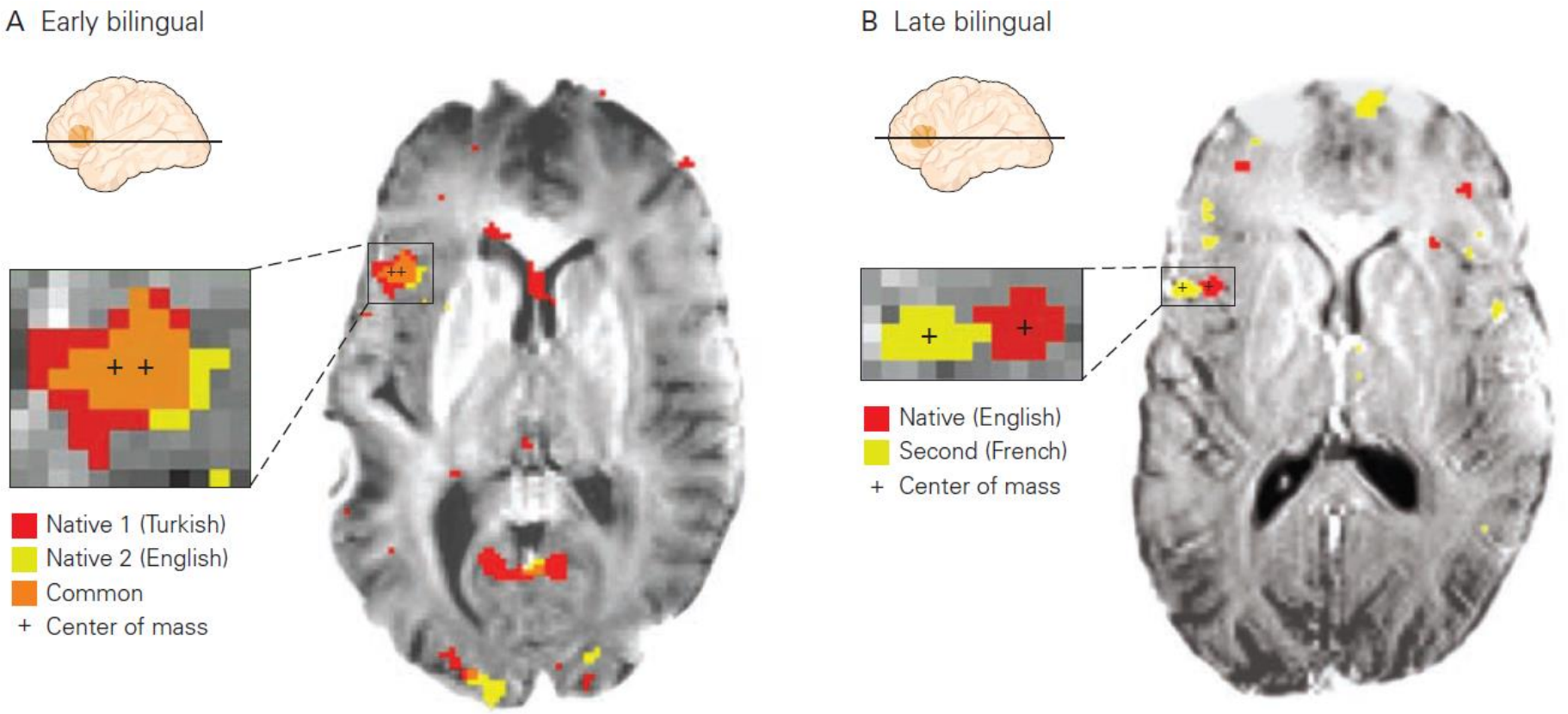
- Different atoms (nuclei) have various magnetic properties when exposed to strong magnetic field
- Hydrogen
- fMRI uses different magnetic properties of oxy- and deoxyhemoglobin
- reduced hemoglobin becomes paramagnetic, change the signal emitted by blood, we can measure the amount of oxy- and deoxyhemoglobin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



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

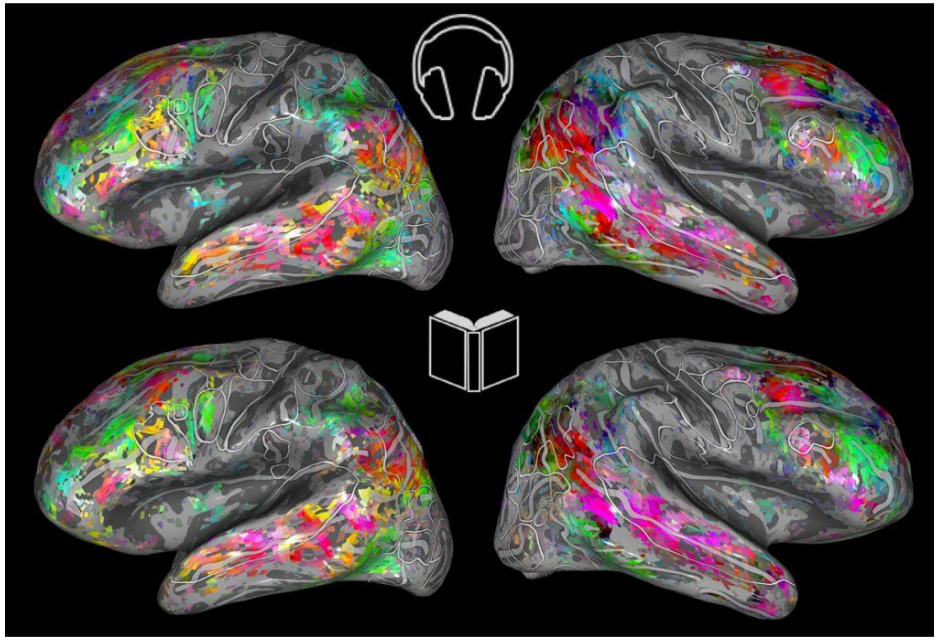
MUNI MED

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).

MUNI MED



http://blogs.discovermagazine.com/d-brief/2019/08/22/reading-listening-activate-same-brain-regions/#.XbhBsppKi00

J Neurosci. 2019 Sep 25;39(39):7722-7736. doi: 10.1523/JNEUROSCI.0675-19.2019. Epub 2019 Aug 19.

The Representation of Semantic Information Across Human Cerebral Cortex During Listening Versus Reading Is Invariant to Stimulus Modality.

Deniz F[1,2,3,4], Nunez-Elizalde AO[1], Huth AG[1], Gallant JL[5,3].

Author information

Abstract

An integral part of human language is the capacity to extract meaning from spoken and written words, but the precise relationship between brain representations of information perceived by listening versus reading is unclear. Prior neuroimaging studies have shown that semantic information in spoken language is represented in multiple regions in the human cerebral cortex, while amodal semantic information appears to be represented in a few broad brain regions. However, previous studies were too insensitive to determine whether semantic representations were shared at a fine level of detail rather than merely at a coarse scale. We used fMRI to record brain activity in two separate experiments while participants listened to or read several hours of the same narrative stories, and then created voxelwise encoding models to characterize semantic selectivity in each voxel and in each individual participant. We find that semantic tuning during listening and reading are highly correlated in most semantically selective regions of cortex, and models estimated using one modality accurately predict voxel responses in the other modality. These results suggest that the representation of language semantics is independent of the sensory modality through which the semantic information is received. **SIGNIFICANCE STATEMENT** Humans can comprehend the meaning of words from both spoken and written language. It is therefore important to understand the relationship between the brain representations of spoken or written text. Here, we show that although the representation of semantic information in the human brain is quite complex, the semantic representations evoked by listening versus reading are almost identical. These results suggest that the representation of language semantics is independent of the sensory modality through which the semantic information is received.

KEYWORDS: BOLD; cross-modal representations; fMRI; listening; reading; semantics

PMID: 31427396 PMCID: PMC6764208 [Available on 2020-03-25] DOI: 10.1523/JNEUROSCI.0675-19.2019

MUNI MED

MUNI
MED

The Highest Level of Cerebral Activity

Three States of Cognition

Philosophy : Mind behind Mind

PS Deb

Neuroscience: Brain

Psychology : Mind

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

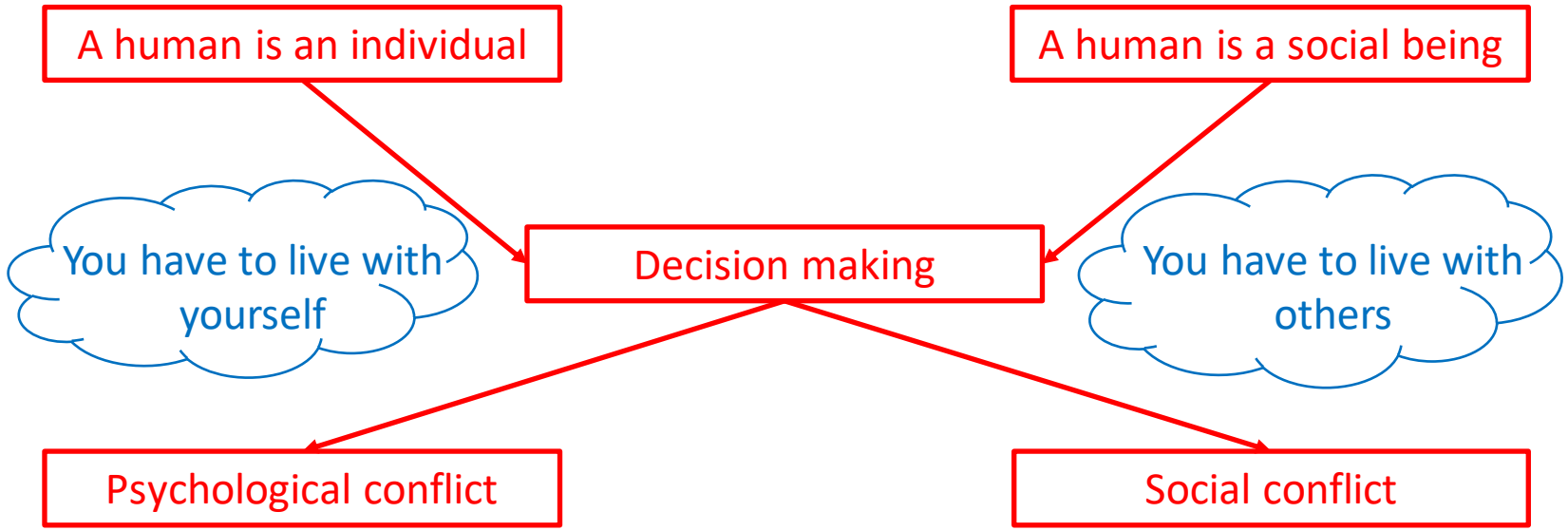
MUNI MED

Why?


A human is an individual
A human is a social being
Decision making

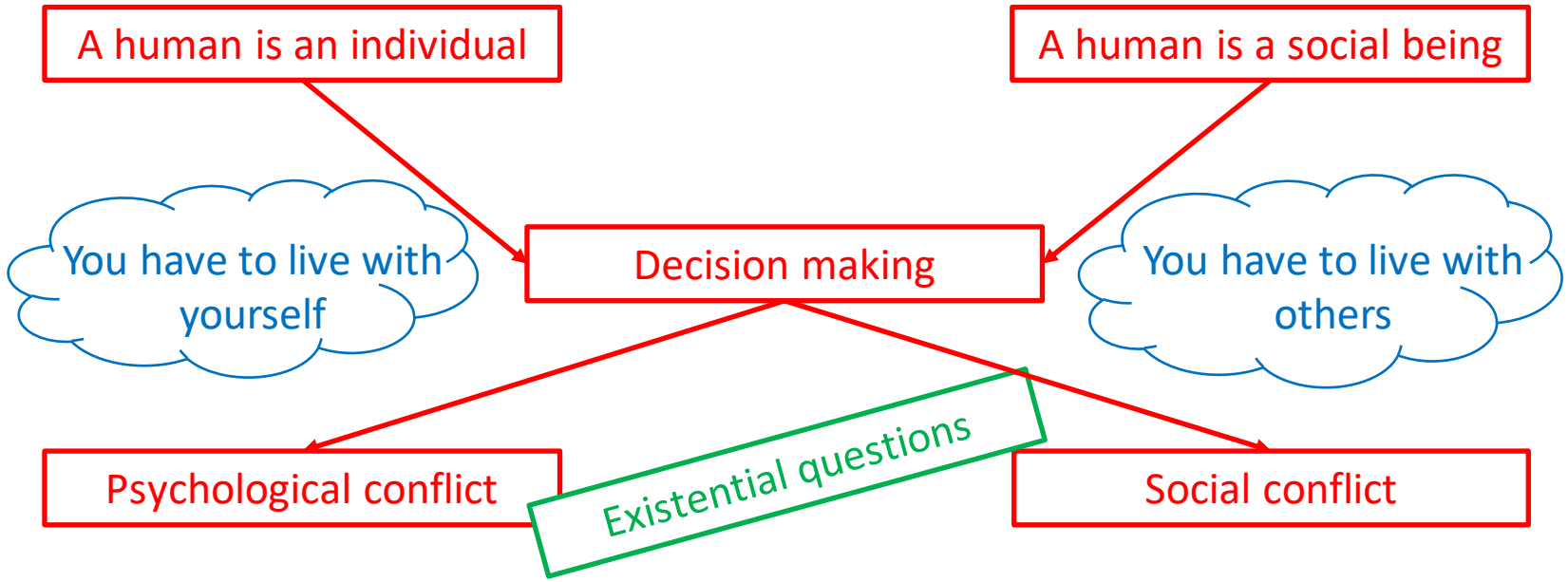
MUNI MED

Why?


A human is an individual
A human is a social being
You have to live with yourself
Decision making
You have to live with others
Psychological conflict
Social conflict

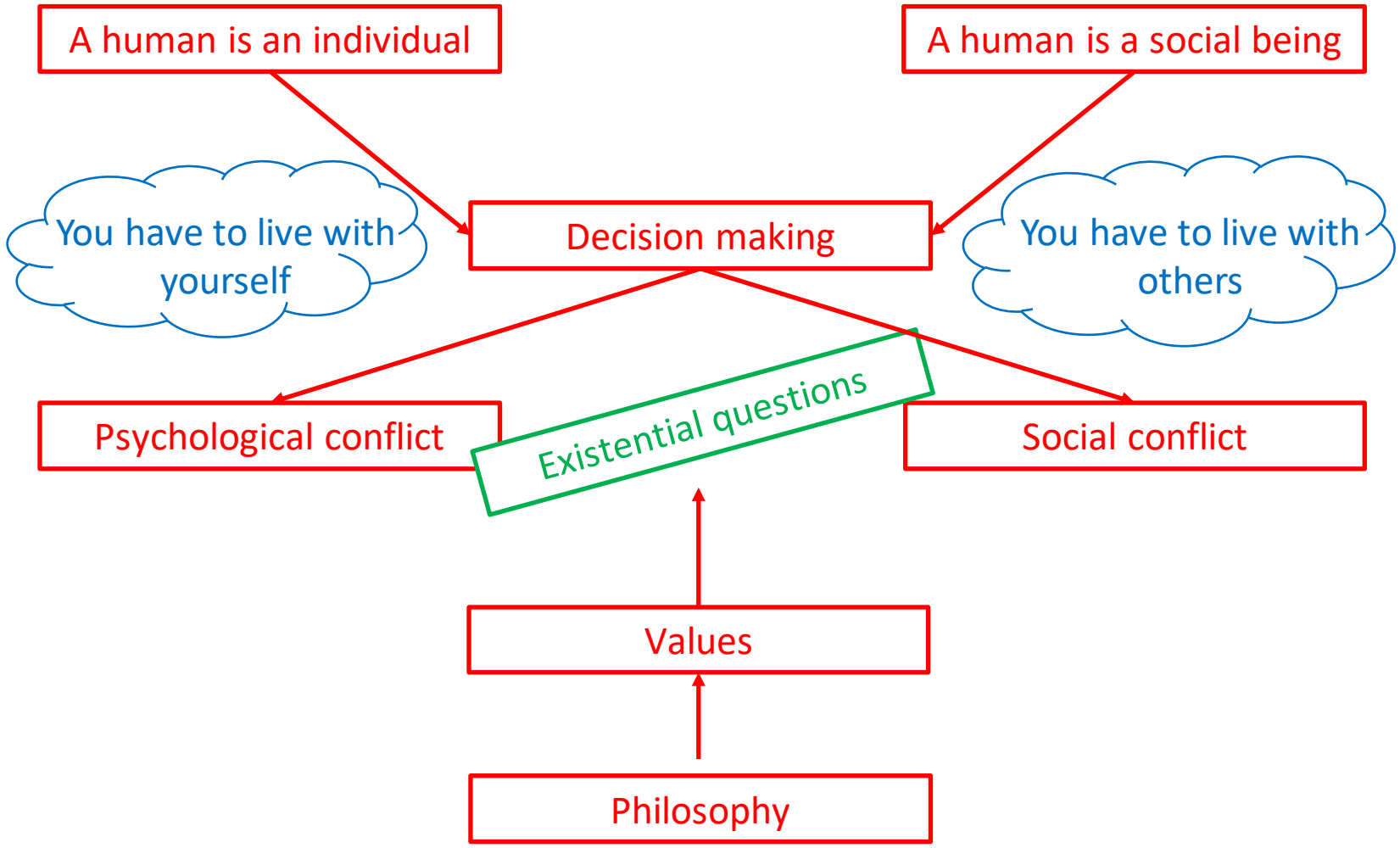
MUNI MED

Why?


A human is an individual
A human is a social being
You have to live with yourself
Decision making
You have to live with others
Psychological conflict
Existential questions
Social conflict

MUNI MED

Why?


A human is an individual
A human is a social being
You have to live with yourself
Decision making
You have to live with others
Psychological conflict
Existential questions
Social conflict
Values
Philosophy

MUNI MED

Philosophy

Philosophy of life is a personal philosophy, whose focus is **resolving the existential questions** about the human condition.

Wikipedia

MUNI MED

Philosophy

FORMAL PHILOSOPHY

Philosophy is the study of **general and fundamental problems** concerning matters such as existence, knowledge, values, reason, mind, and language.

Wikipedia

INFORMAL PHILOSOPHY

Philosophy of life is a personal philosophy, whose focus is **resolving the existential questions** about the human condition.

Wikipedia

MUNI MED

Philosophy

FORMAL PHILOSOPHY

Philosophy is the study of **general and fundamental problems** concerning matters such as existence, knowledge, values, reason, mind, and language.

Wikipedia

INFORMAL PHILOSOPHY

Philosophy of life is a personal philosophy, whose focus is **resolving the existential questions** about the human condition.

Wikipedia

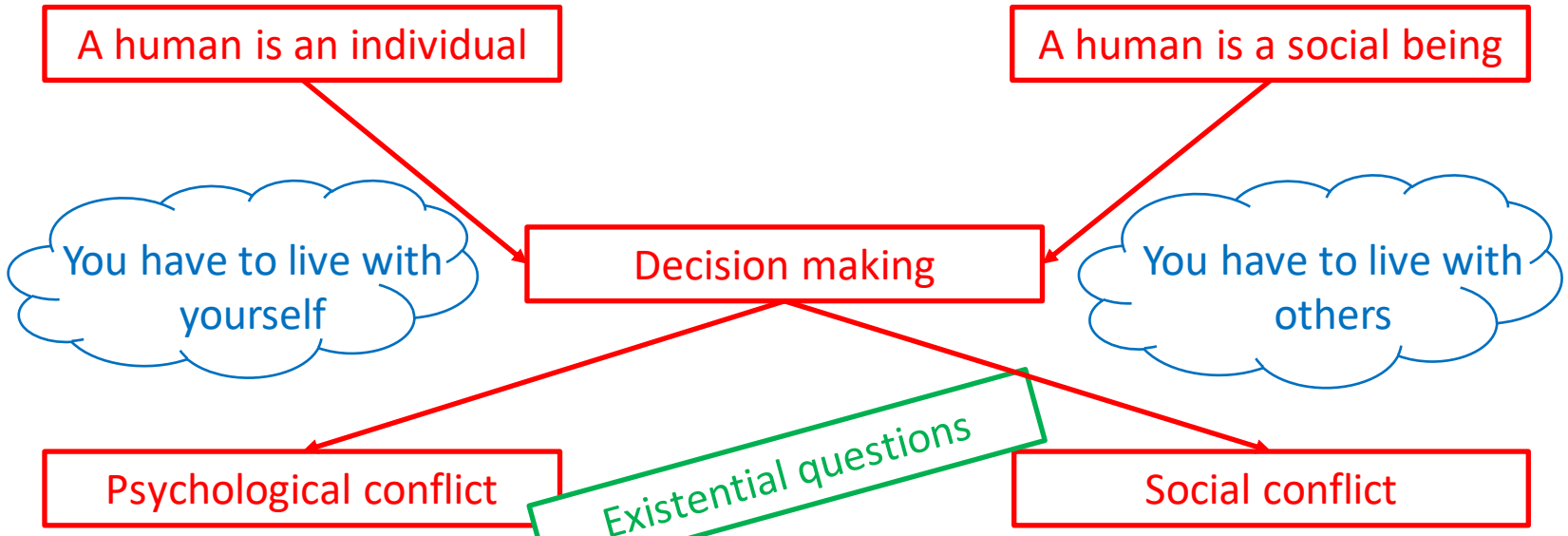
COLLECTIVE CONSCIOUSNESS

Collective consciousness or collective conscio us is the **set of shared** beliefs, ideas and moral attitudes which operate as a **unifying force within society.**

Wikipedia

MUNI MED

Why?



Philosophy of life is a personal philosophy, whose focus is **resolving the existential questions** about the human condition.

Wikipedia

Values

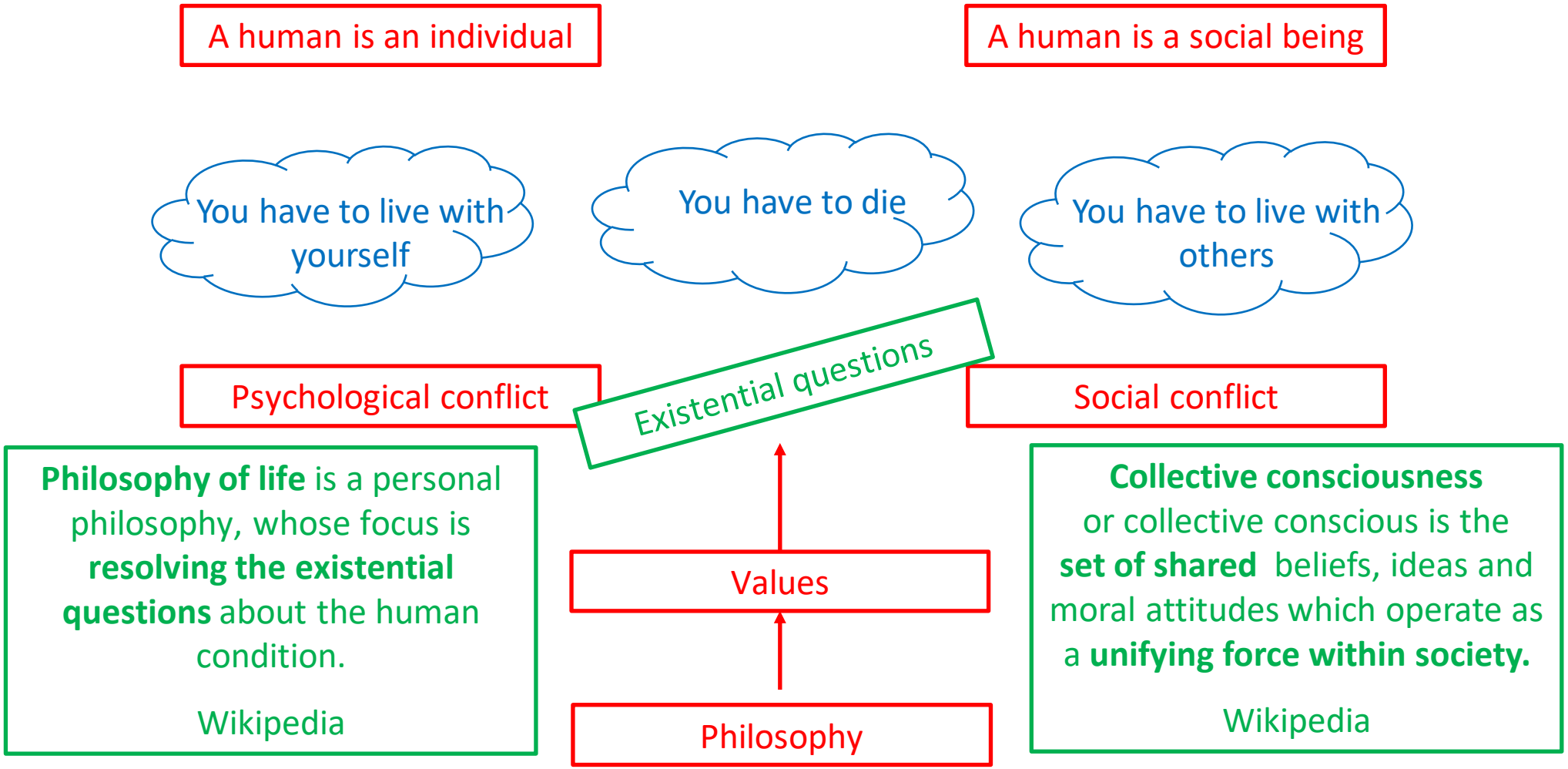
Philosophy

Collective consciousness or collective conscious is the **set of shared** beliefs, ideas and moral attitudes which operate as a **unifying force within society.**

Wikipedia

MUNI MED

Why?


A human is an individual
A human is a social being
You have to live with yourself
You have to die
You have to live with others
Psychological conflict
Existential questions
Social conflict
Philosophy of life is a personal philosophy, whose focus is resolving the existential questions about the human condition.
Wikipedia
Values
Philosophy
Collective consciousness or collective conscious is the set of shared beliefs, ideas and moral attitudes which operate as a unifying force within society.
Wikipedia

MUNI MED

Jan Sokol

http://www.jansokol.cz/2014/03/civilizace-kultura-a-nabozenstvi/

Three levels of life in society

Civiliztion level

- Everyday activities, user
- „Manual“ is sufficient, imitation

MUNI MED

Jan Sokol

http://www.jansokol.cz/2014/03/civilizace-kultura-a-nabozenstvi/

Three levels of life in society

Civiliztion level

- Everyday activities, user
- „Manual“ is sufficient, imitation

Cultural level

- Creativity
- Knowldege and technique are needed

MUNI MED

Jan Sokol

http://www.jansokol.cz/2014/03/civilizace-kultura-a-nabozenstvi/

Three levels of life in society

Civiliztion level

- Everyday activities, user
- „Manual“ is sufficient, imitation

Cultural level

- Creativity
- Knowldege and technique are needed

Religious level

- Inspiration of creativity
- Awareness of meaning is needed

MUNI MED

Culture

– the sum of knowledge

- ✓ Material
- ✓ Spiritual

https://cdn.nexternal.com/tjb/images/FC-11.jpg

https://s-media-cache-ak0.pinimg.com/564x/9a/86/da/9a86da32052973bb085dc1511d4b7102.jpg

http://previews.123rf.com/images/dja65/dja651107/dja65110700341/10025966-Stone-age-axe-Stock-Photo-tools-ancient-stone.jpg

http://www.thebushcraftstore.co.uk/ekmps/shops/bduimportsltd/images/condor-greenland-pattern-axe-[2]-12105-p.jpg

https://en.wikipedia.org/wiki/File:Mary16thC.jpg

https://www.wikiart.org/en/leonardo-da-vinci/the-madonna-of-the-carnation

https://pixels.com/featured/1-madonna-and-child-peter-paul-rubens.html

https://www.wikiart.org/en/m-h-maxy/madonna

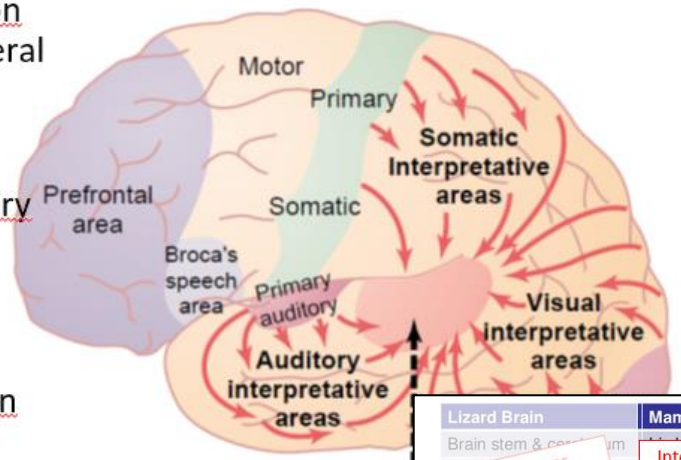
MUNI MED

Complementary ways of thinking

Analytical functions

Parieto-occipito-temporal association area

- Linking and interpretation of information from several sensory modalities
- Visual – acoustic – sensory analysis
- Object recognition and categorization
- Language comprehension
- Attention

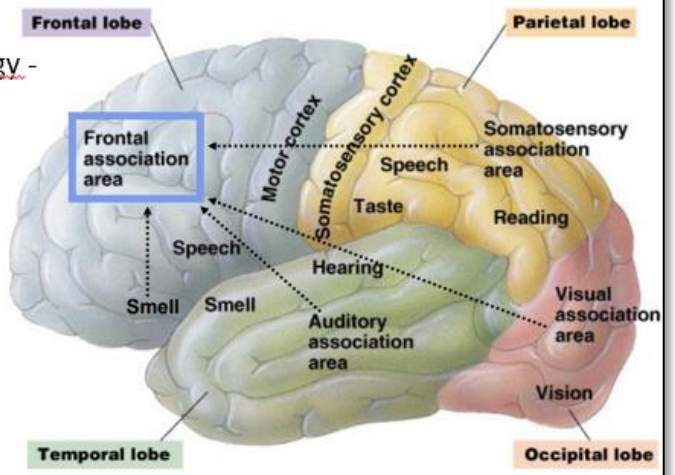


http://www.slid

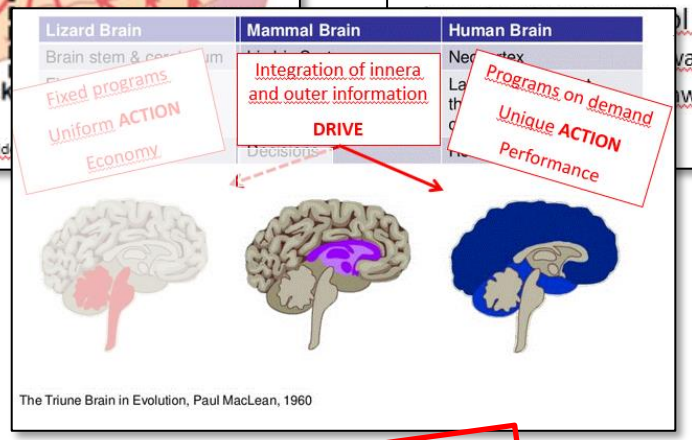
Executive functions

Frontal association area

- Motor/non-motor planning/organization - strategy - anticipation
- Thinking – mental models processing
- Attention – „information filtering“



https://www.slideshare.net/thelawofscience/cns-13256395



The Triune Brain in Evolution, Paul MacLean, 1960

Analysis
Categorization

Drive

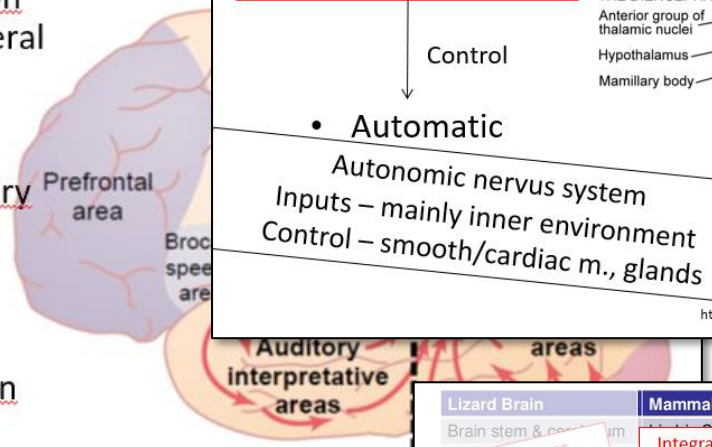
Anticipation
Expectation

MUNI MED

Comp…inking

Parieto-occipito-tempora…

- Linking and interpretation of information from several sensory modalities
- Visual – acoustic – sensory analysis
- Object recognition and categorization
- Language comprehension
- Attention



http://www.slid…

Concept of the limbic system

Somatic nervous system
Inputs – mainly from outer environment
Control – skeletal muscle

- Voluntary

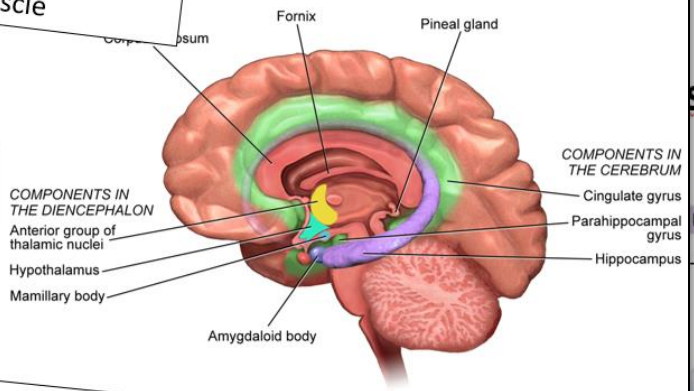
Modulation

Limbic system

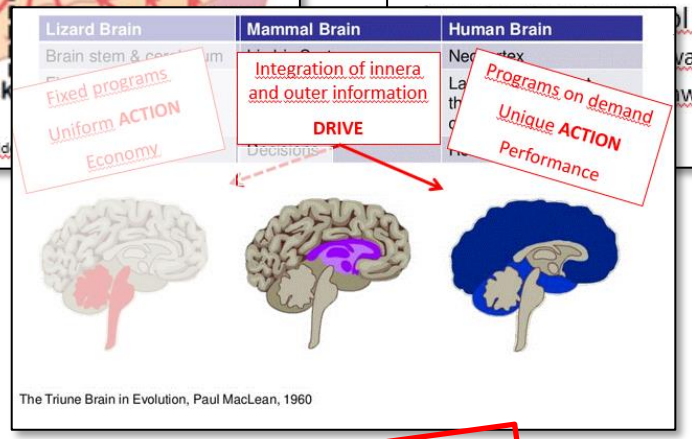
Control

- Automatic

Autonomic nervus system
Inputs – mainly inner environment
Control – smooth/cardiac m., glands

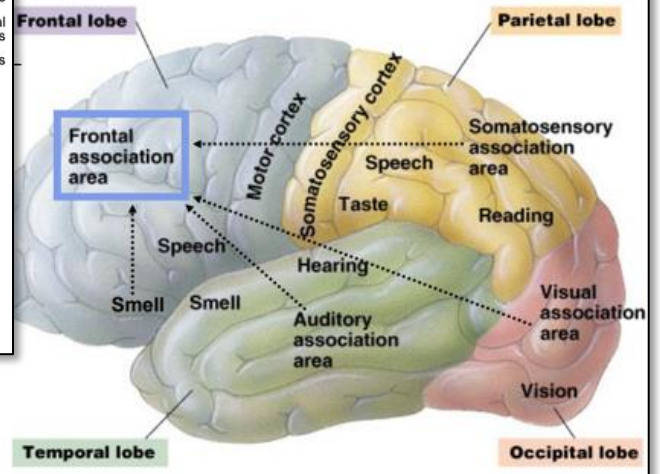


https://upload.wikimedia.org/wikipedia/commons/d/d1/Blausen_0614_LimbicSystem.png



…ssociation area

Executive functions



https://www.slideshare.net/thelawofscience/cns-13256395

Analysis Categorization

Drive

Anticipation Expectation

MUNI MED

Limbic system and neocortex

Instinctive behavior

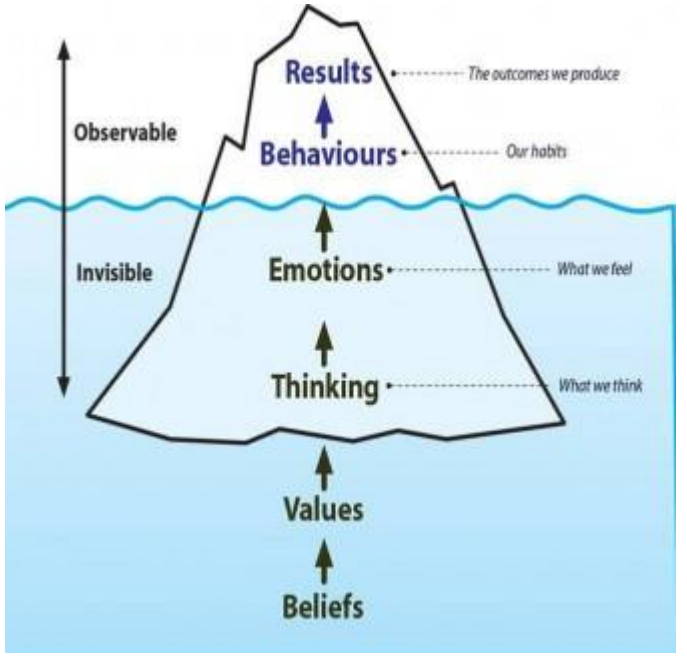
- ➢ Limbic system
- ✓I see a nice thing, so why not to steel it?

Socially enforced behavior

- ➢ Legal behavior
- ➢ Neocortex – limbic system
- ✓Theft is a crime, and punishment may come

Moral behavior

- ➢ Legitime behavior
- ➢ Limbic system
- ✓Stealing is a bad thing



http://www.coaching.net.nz/wp-content/uploads/2013/06/Iceberg-for-blog-from-J-e1371521135440.jpg

MUNI MED

Limbic system and neocortex

Instinctive behavior

- ➢ Limbic system
- ✓I see a nice thing, so why not to steel it?

Socially enforced behavior

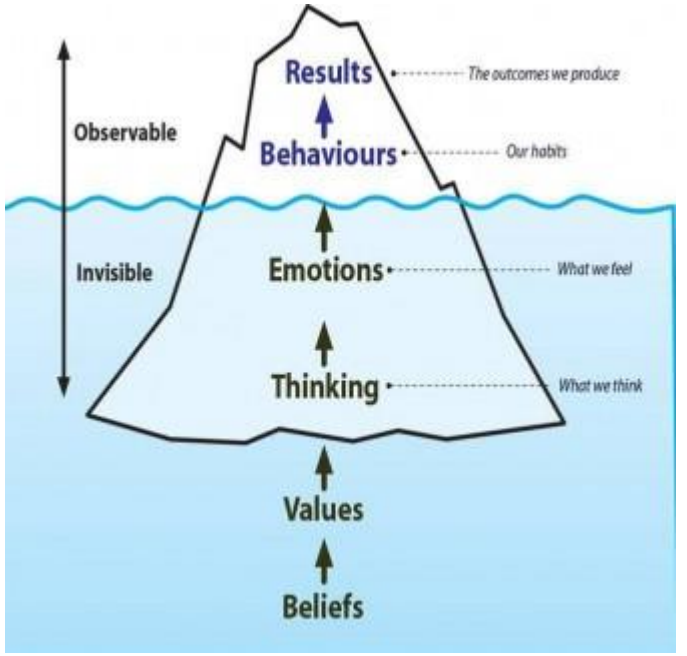
- ➢ Legal b… r
- ➢ …mbic system
- ✓ …is a crime, and punishment may come

Fear of punishment

Moral behavior

- ➢ L… …avior
- … …tem
- ✓ Stealing is a bad thing

Moral stance



http://www.coaching.net.nz/wp-content/uploads/2013/06/Iceberg-for-blog-from-J-e1371521135440.jpg

MUNI MED

Limbic system and neocortex

Information

NEOCORTEX

vs

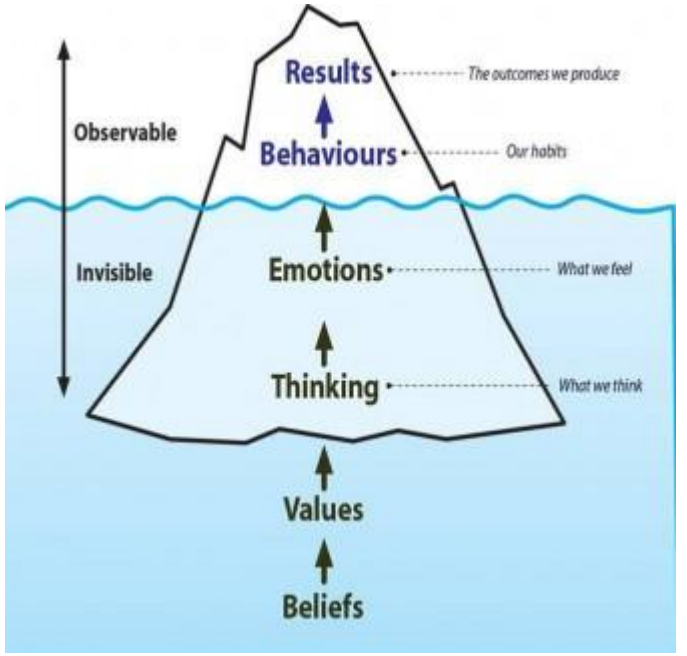
Complex information

NEOCORTEX/limbic system

vs

Values/Philosophy/Faith

Neocortex/LIMBIC SYSTEM



http://www.coaching.net.nz/wp-content/uploads/2013/06/Iceberg-for-blog-from-J-e1371521135440.jpg

MUNI MED

Cognitive maps

Type of **mental representation** which serves an individual to acquire, code, store, recall, and decode information about the **relative locations and attributes** of phenomena in their everyday or metaphorical spatial environment.

Wikipedia

- Origins of endbrain: Structures underlying olfaction
- Two major links between olfactory system and the motor systems of the midbrain

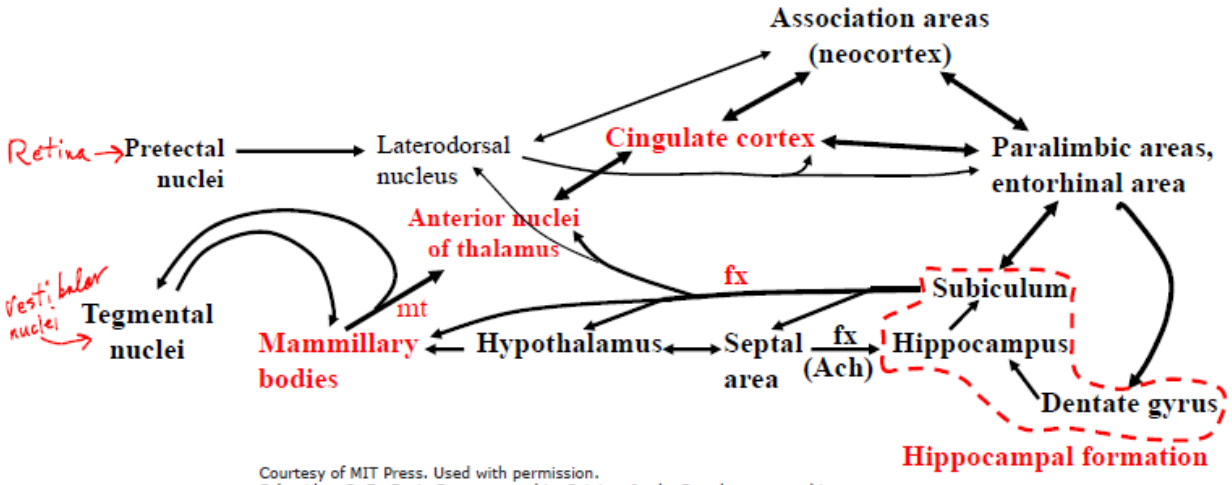
1) Through the ventral endbrain, which became corpus striatum and basal forebrain (including much of the septal area)
   - Outputs to hypothalamus, (epithalamus, subthalamus), midbrain
   - These outputs affected locomotion and orienting movements
   - The links were plastic, so habits were formed according to rewarding effects mediated, e.g., by taste effects.

2) Through the medial part of the dorsal endbrain, which became medial pallium—the hippocampal formation
   - **Outputs to ventral striatum, hypothalamus, epithalamus**
   - **The links were plastic, but the "habits" formed were different: The association of place with good or bad consequences of approach.**

✓ Object oriented
✓ Implicite

✓ **Location oriented**
✓ **Explcite**

mt = mammillothalamic tract
fx = fornix bundle



http://www.slideshare.net/drsunilsuthar/neurobiology-of-emotion

Prof. Gerald Schneider

MUNI MED

Learning and memory

- Connections of striatum and hippocampus are plastic
- Plasticity is a base of learning
- Learning is a forming of long- term memory

- Declarative memory (explicit)
- Based on hippocampus
- Explicit information is stored and later recollected
- „Construction of the maps (relationships)“ – spatial or abstract

Location oriented:
Where am I and what has happened here?

- Procedural memory (implicit)
- Based on striatum
- Habitual learning – motor skills, but also social habits
- „Construction of the algorithms“

Object oriented:
Can I eat it and how to eat it?

MUNI MED

Cognitive map term definition

Edward C. Tolman

1948

https://en.wikipedia.org/wiki/Edward_C._Tolman

Anatomical correalte?

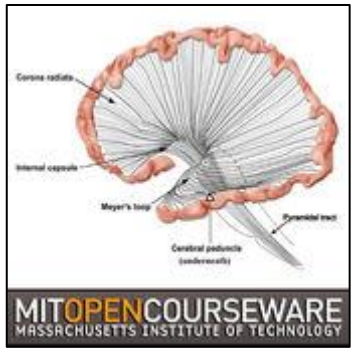
Gerald Schneider

O´Keefe and Nadel
´70s
And others

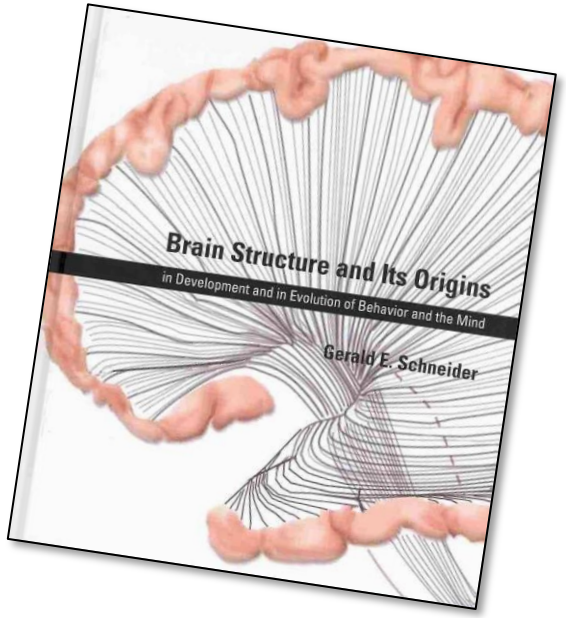
2009

https://itunes.apple.com/us/podcast/brain-structure-and-its-origins-2009/id385157530?mt=2

2014



https://itunes.apple.com/us/podcast/brain-structure-and-its-origins-2014/id944293984?mt=2



2014

MUNI MED

Cognitive maps

Type of **mental representation** which serves an individual to acquire, code, store, recall, and decode information about the **relative locations and attributes** of phenomena in their everyday or metaphorical spatial environment.

Wikipedia

Later generalized to refer to a kind of **semantic network** **representing** an individual's personal **knowledge or schemas**.

Wikipedia

MUNI MED

Cognitive maps

Type of **mental representation** which serves an individual to acquire, code, store, recall, and decode information about the **relative locations and attributes** of phenomena in their everyday or metaphorical spatial environment.

Wikipedia

- ✓ Complex
- ✓ Unique
- ✓ Egocentric, but multiple points of view

Later generalized to refer to a kind of **semantic network** **representing** an individual's personal **knowledge or schemas**.

Wikipedia

MUNI MED

Cognitive maps

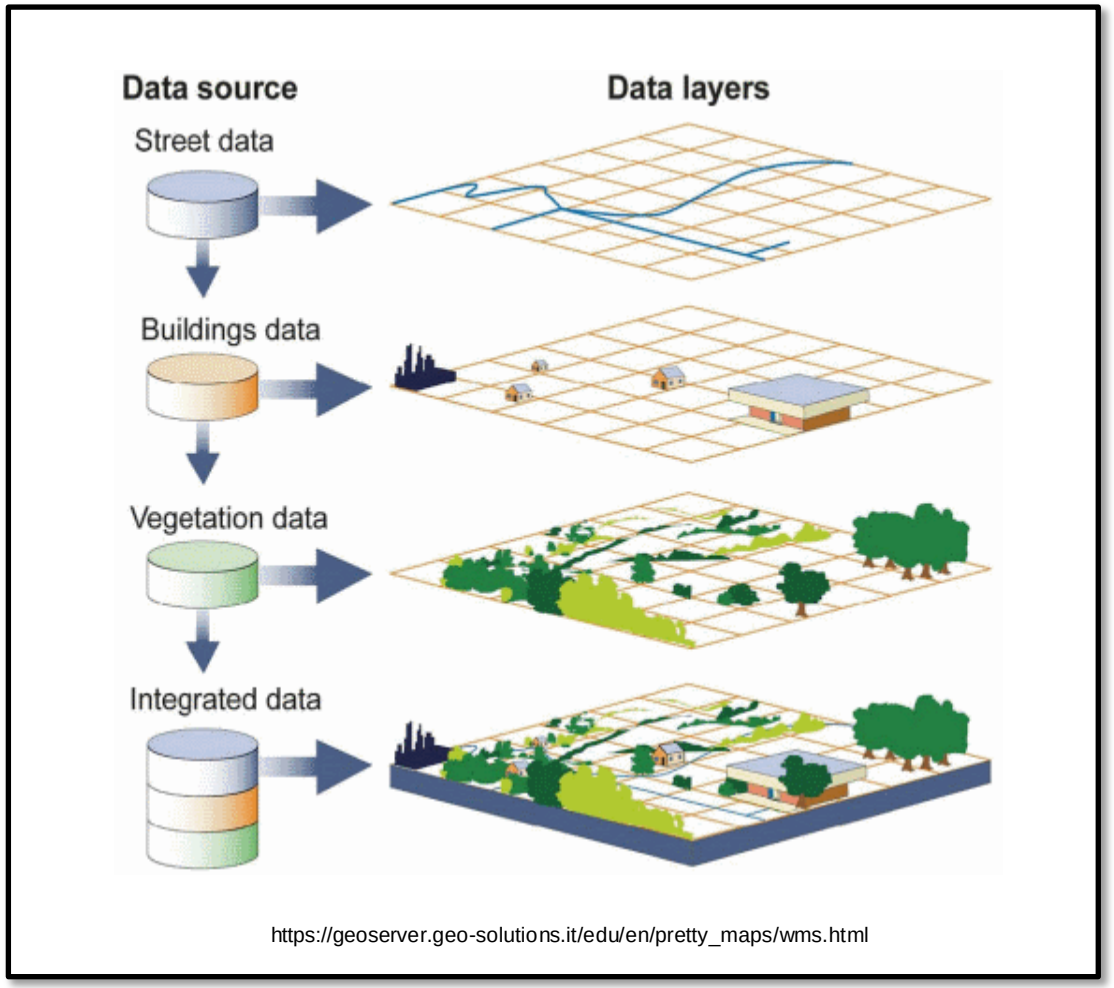
Type of **mental representation** which serves an individual to acquire, code, store, recall, and decode information about the **relative locations and attributes** of phenomena in their everyday or metaphorical spatial environment.

Wikipedia

- ✓ Unique
- ✓ Egocentric, but multiple points of view
- ✓ Complex

Later generalized to refer to a kind of **semantic network representing** an individual's personal **knowledge or schemas**.

Wikipedia



https://geoserver.geo-solutions.it/edu/en/pretty_maps/wms.html

MUNI MED

MUNI
MED