

Higher Cognitive Functions - Reading

Reading

- Reading is an understanding of a written form of a language
- It is a complex cognitive process decoding symbols to create meaning
- It is the means of communication, language and communication

Genetic bases of reading

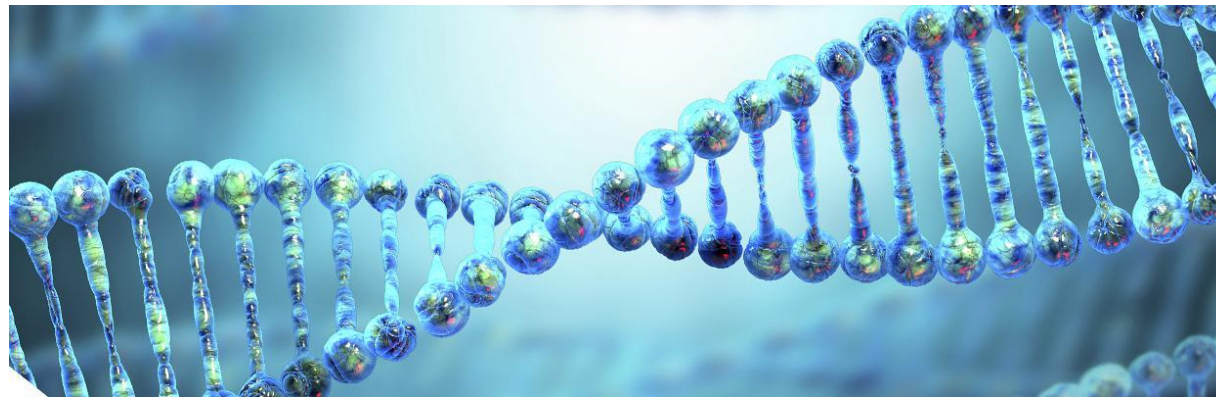
- While linguistic influence on forming speech and reading ability is undeniable, it has been very convincingly proven that language learning (both written and spoken) is subject to significant genetic influences
- For example, developmental dyslexia had little correlation with the home literacy environment, but instead is significantly impacted by gene transfer which increases a person's susceptibility

Genetic bases of reading

- Thanks to the GWAS (Genome Wide Association Scan) project, several single nucleotide polymorphisms (SNPs) have been found in genes influencing reading and language skills
- Namely, the linkage between the CCDC136, FLNC (Flamine C) genes on 7q32.1 and RBFOX2 to 22q12.3
- In connection with the expression of the recessive allele in RBFOX2, gray matter reduction in connection with the expression of the recessive allele in RBFOX2, gray matter reduction in the left parietal gyrus, right gyrus temporalis medius and pars opercularis and triangularis on lower frontal gyrus

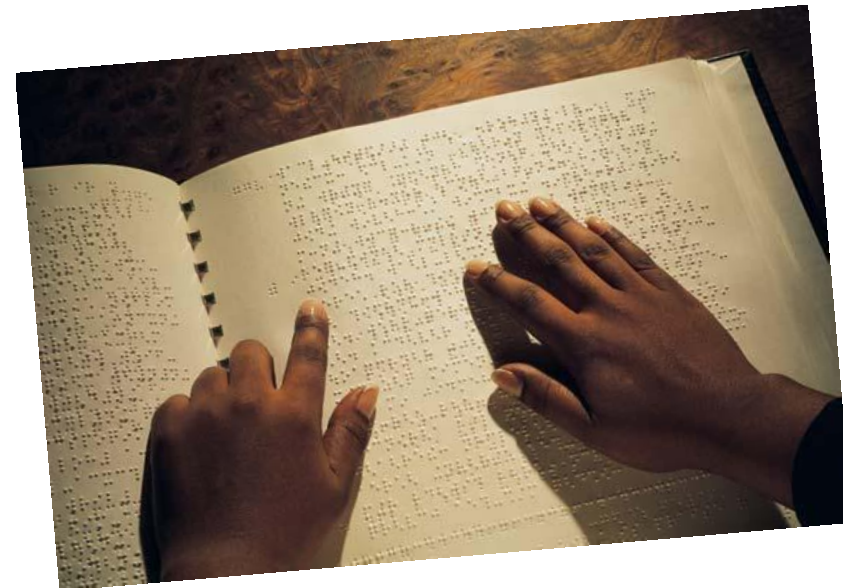
Genetic bases of reading

- So far there is no study that correlates gene alleles, gray matter findings in the brain, and language and reading abilities



Sight and reading

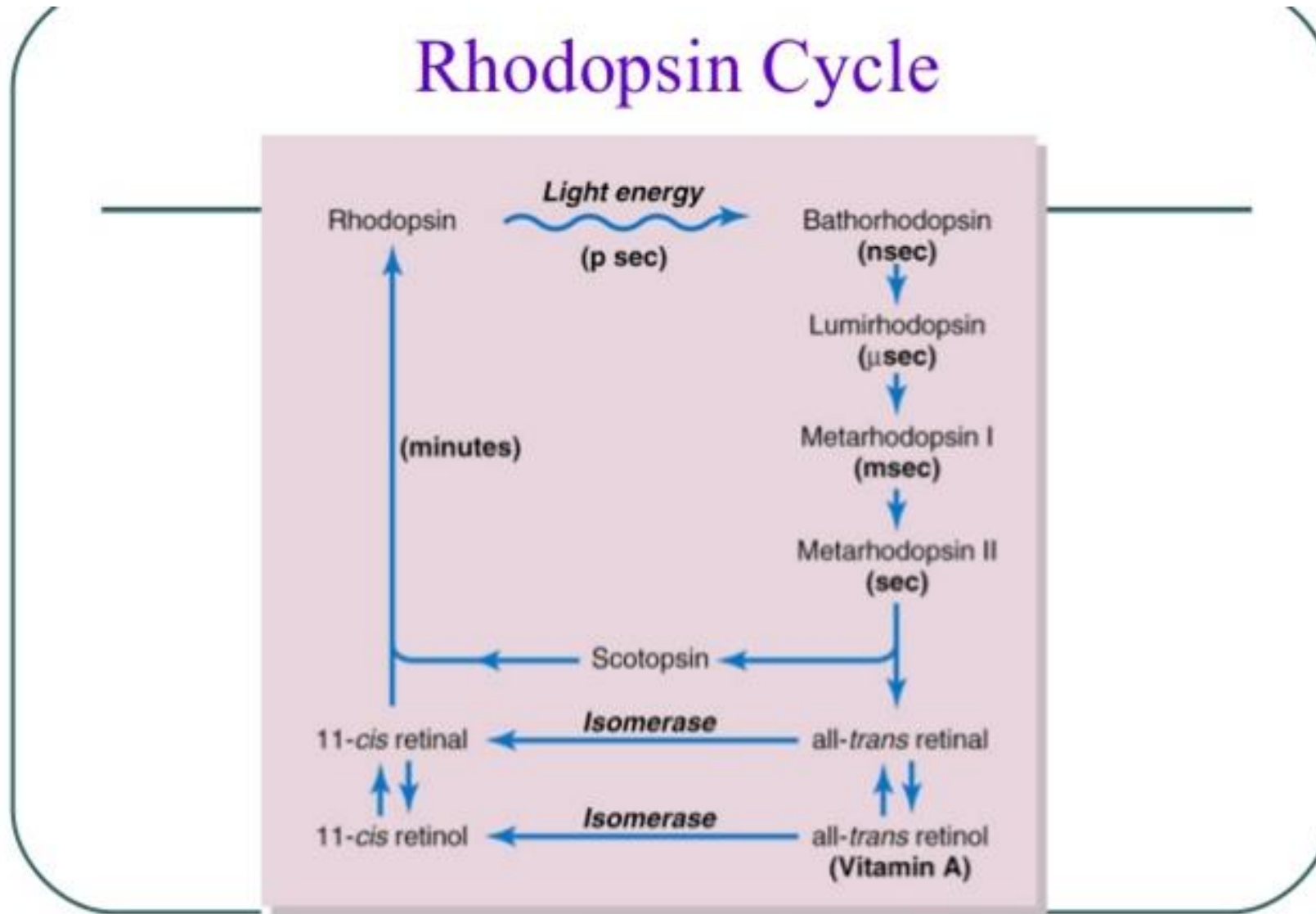
- Eye apparatus, eye tractus, primary and secondary vision centers, and other higher association areas are indispensable for reading ability
- With a variation for Braille where the cerebral cortex receives a tactile stimulus



Mechanism of light signal transformation into an electric

- Absorption of visible light photons and their transformation into an electrical signal in the photoreceptor is a key factor in the vision process
- The impact of a certain amount of light of certain wavelength on the external segment membrane disk system causes a breakdown of the photopigments
- The chemical process in the eye then leads to a voltage change - the generator potential - on the surface of the photoreceptor

Rhodopsin Cycle

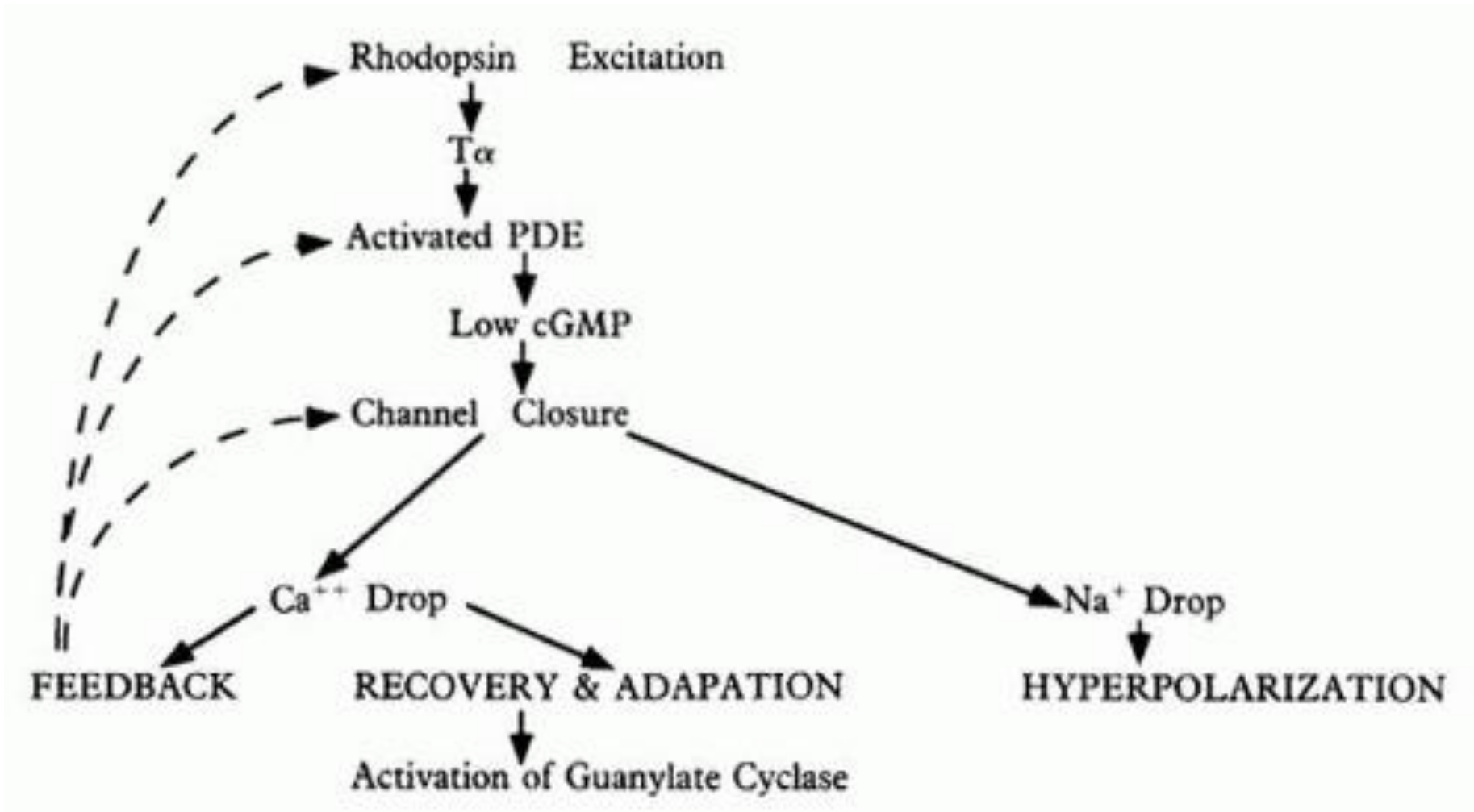


Mechanism of light signal transformation into an electric

- The generator potential has a character of hyperpolarization
- Light effect closes the Na⁺ channels in the outer photoreceptor segment -> increases the negative membrane voltage (-70 mV) towards the equilibrium potential for the K⁺
- Hyperpolarization occurs, voltage change spreads to the synaptic terminal where it mediates further local voltage changes on the membranes of bipolar and horizontal cells

Mechanism of light signal transformation into an electric

- The link between the decay of photopigmentation and the generation of the generator potential is cGMP
- Na⁺ channels are kept open in the dark due to the presence of cGMP
- Closure of Na⁺ channels when enhancing the retina is linked to a decrease in cGMP

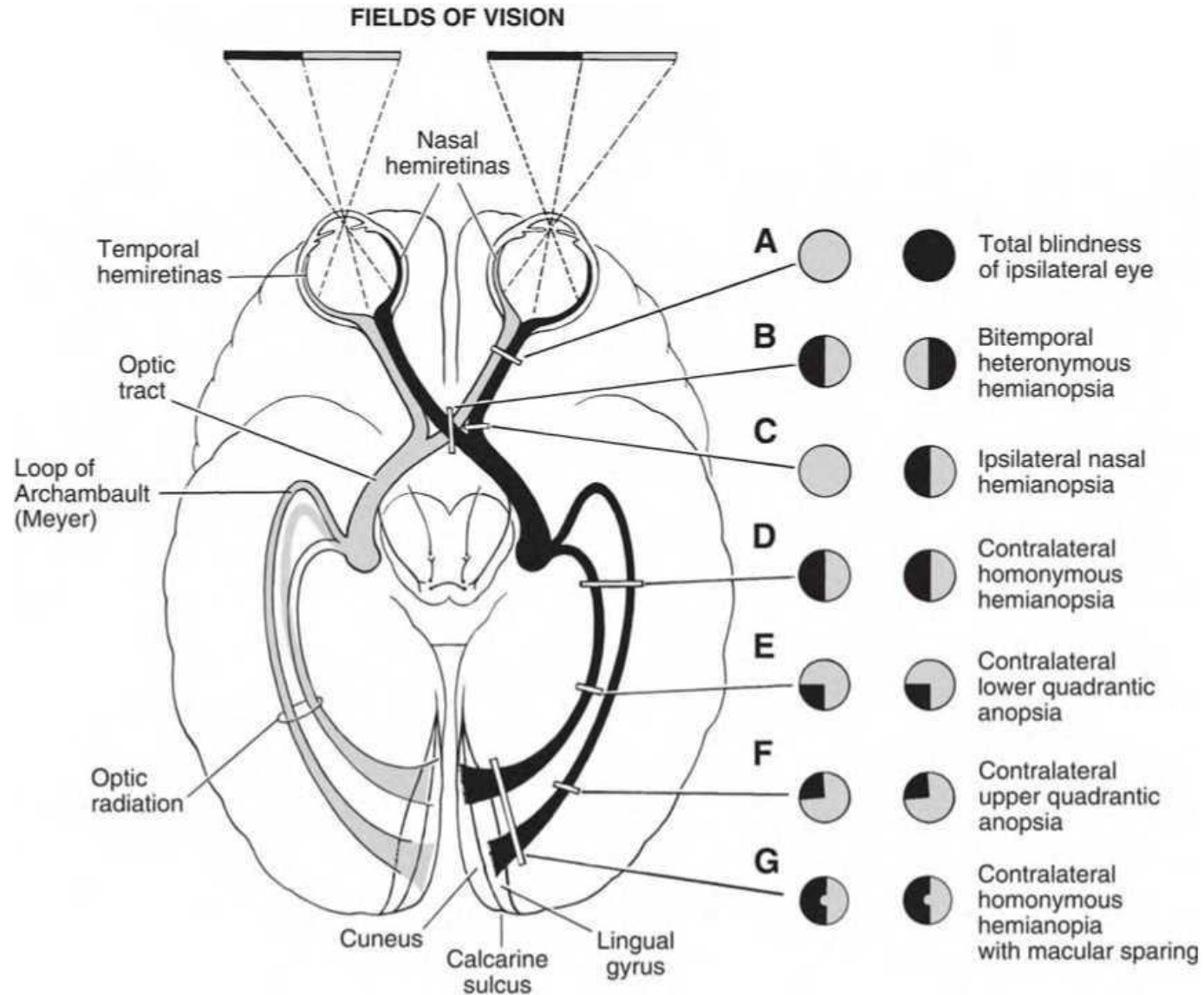


Visual pathway

- It is a sum of neurons that transmit visual information from the eye into the corresponding cortical projection area of the CNS
- The tract consists of four nerve cells
- The first neurons are photoreceptors, the second bipolar cells, the third multipolar retina neurons
- The neurites of the third neurons form the optic nerve that protrudes from the eyeball, some fibers cross in the chiasma opticum

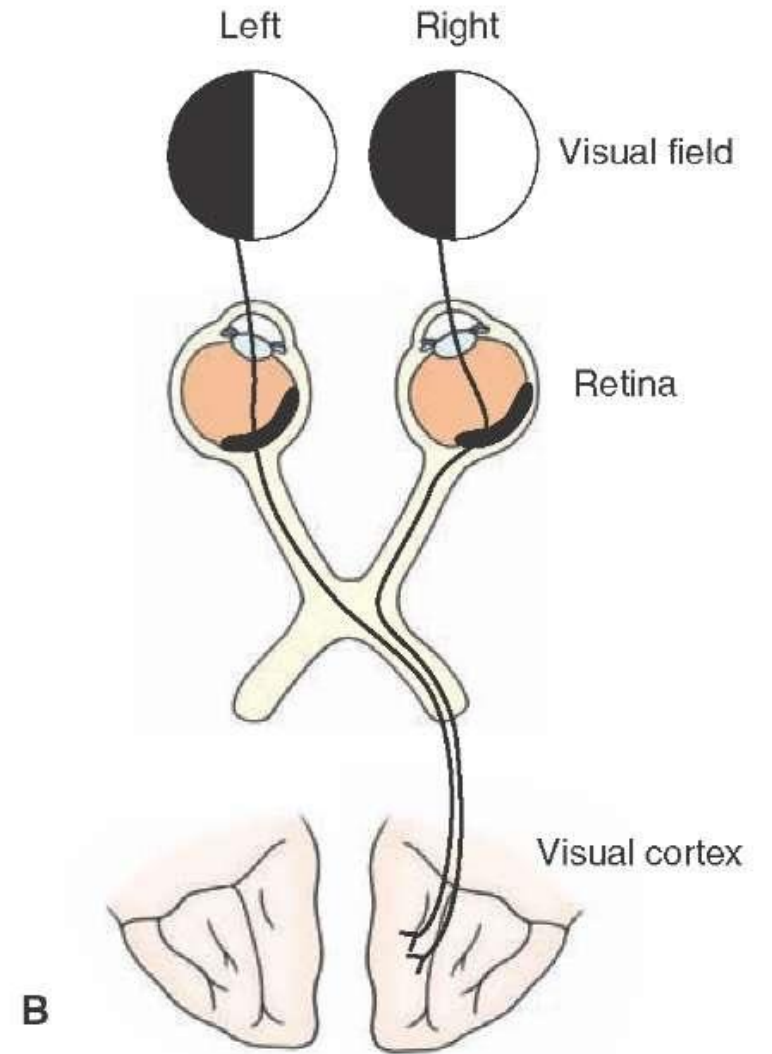
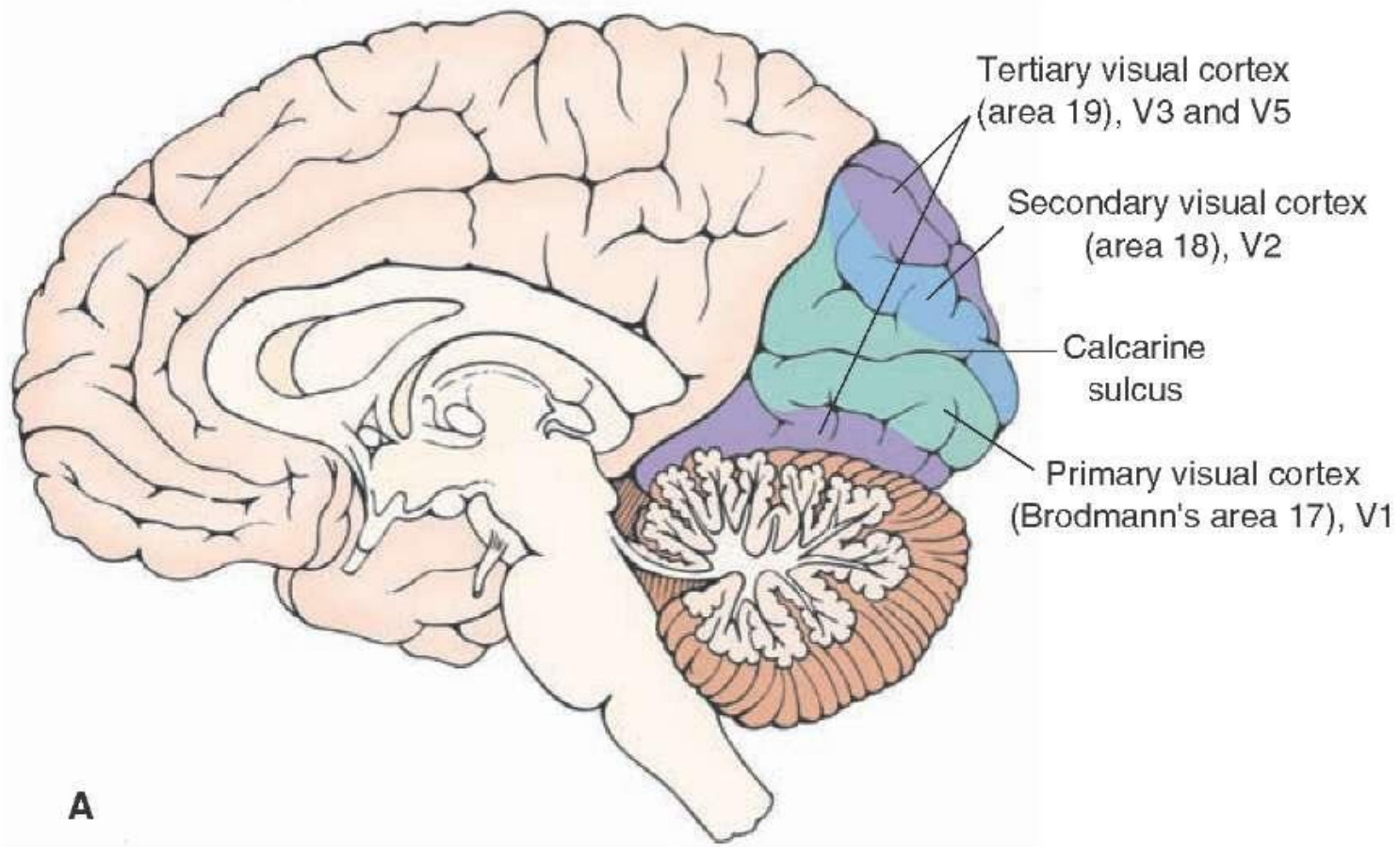
Visual pathway

- As trancus opticus it enters the CNS, where it ends on the fourth neurons in the nucleus corporis geniculati lateralis
- Neuritis of this nucleus extends through the internal capsule as radiation optic into the visual cortical region near sulcus calcarinus in lobus occipitalis



Secondary visual cortical regions

- Parastrial cortical region - cortical stripe encircling the primary visual cortex
- Mediotemporal visual cortical region - at the bottom and adjacent upper and lower quarter of sulcus temporalis superior
- Inferotemporal visual cortical region - on lateral of the temporal lobe under the anterior two-thirds of sulcus temporalis superior
- Rear parietal cortical region - localization roughly corresponds to the location of lobulus parietalis superior et inferior, the caudal part



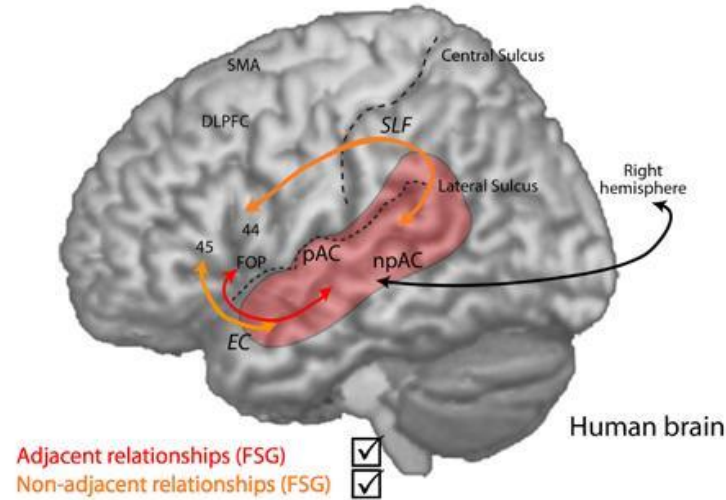
Reading and comprehension

- A number of brain centers are involved in the process of reading and understanding written text
- Temporal lobe, which is responsible for phonological awareness and decoding of different sounds
- The Broca area in the frontal lobe, which controls speech production and language comprehension

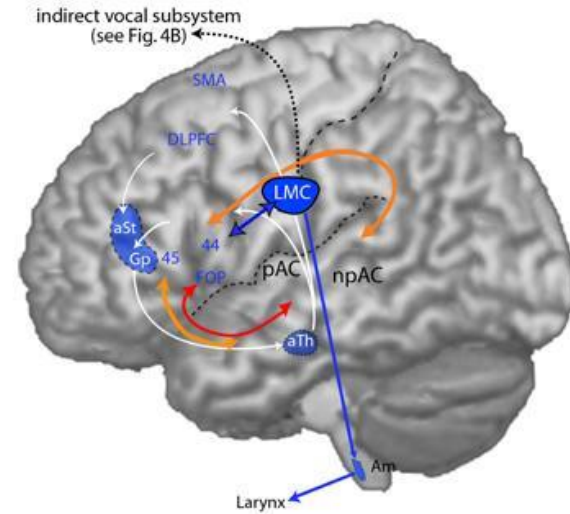
Reading and comprehension

- Gyrus angularis and supramarginalis, which connect different parts of the brain so that the letters can be combined into words
- Also important is the white matter, specifically the nucleus arcuatus, which connects the speech centers of the brain, and the fasciculus longitudinalis inferior, which connects the speech centers with the visual cortex

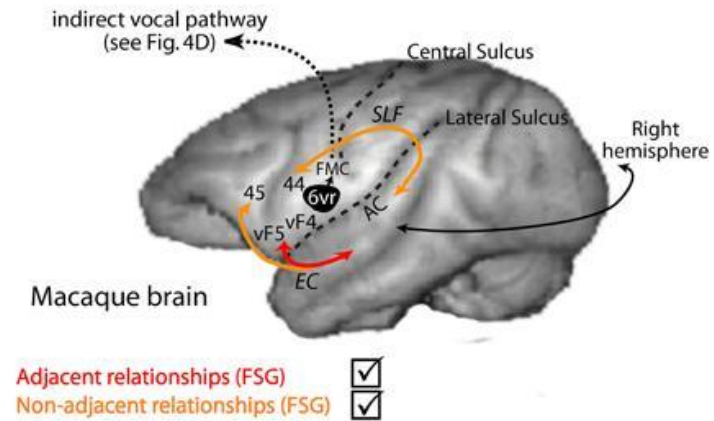
A Human syntax perceptual learning system



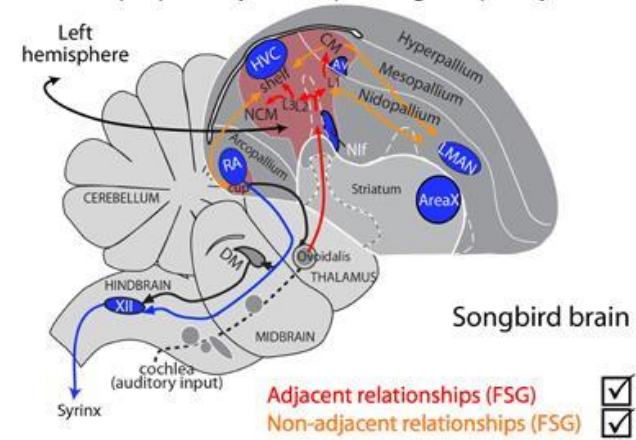
B Human learned vocal-production system



C Monkey 'proto-syntactic' sequencing hypothesis:
Multiple pathways for sequence learning complexity



D Songbird 'syntactic-like' sequencing hypothesis:
Multiple pathways for sequencing complexity



Theory of reading

- There are two basic theories of reading learning in the brain, recently there has been a synthesis between these two
- The first is a so-called lexical way, where the reader searches for words he/she sees in his/her mental dictionary and assigns a sound to them
- The second so-called sublexical way, says the reader analyzes the word letter by letter, assigns them a sound and reads the word

Theory of reading

- The lexical way works in the case of proficient readers in most words because they are very likely to have seen them before and are able to quickly recall them
- The sublexical path works primarily in children who learn to read, or in adults with new or made up words

Cognitive functions

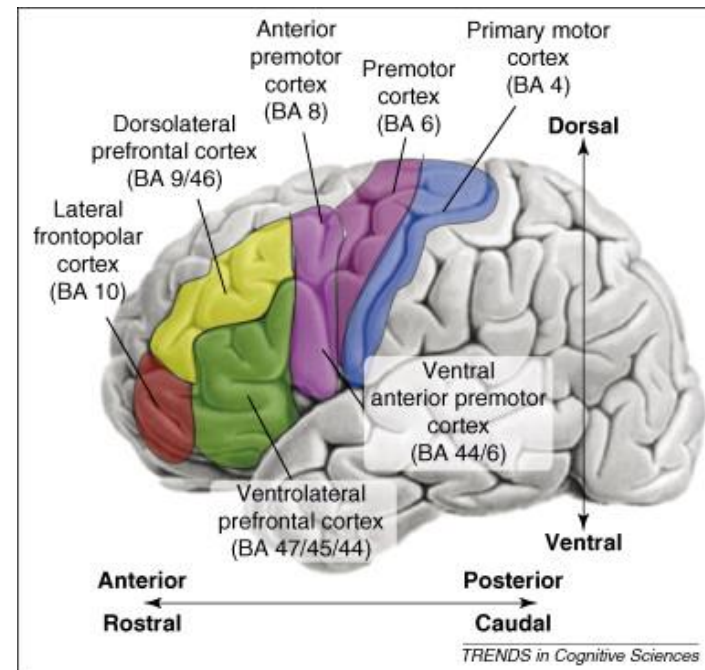
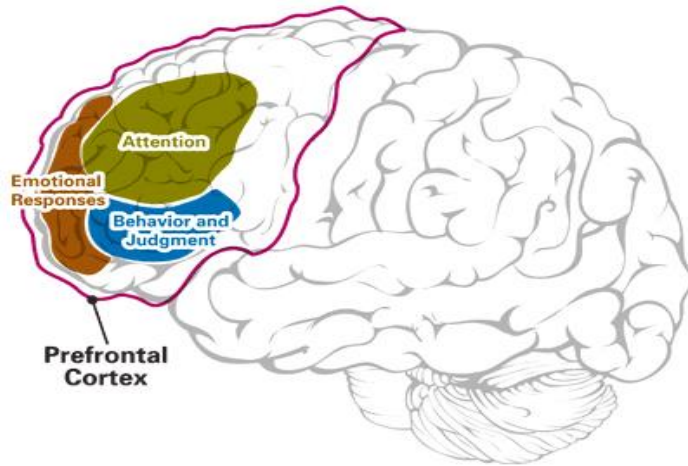
- Higher cognitive functions are the highest degree of cognitive (conscious) processes that are necessary to control thought and behavior
- They include, for example: thinking, attention, caution, memory, ability to speak, learn, read, plan, solve problems
- Cognitive functions are reduced with addiction, attention deficit deficiency (hyperactivity disorder) and a number of other CNS disorders

Cognitive functions

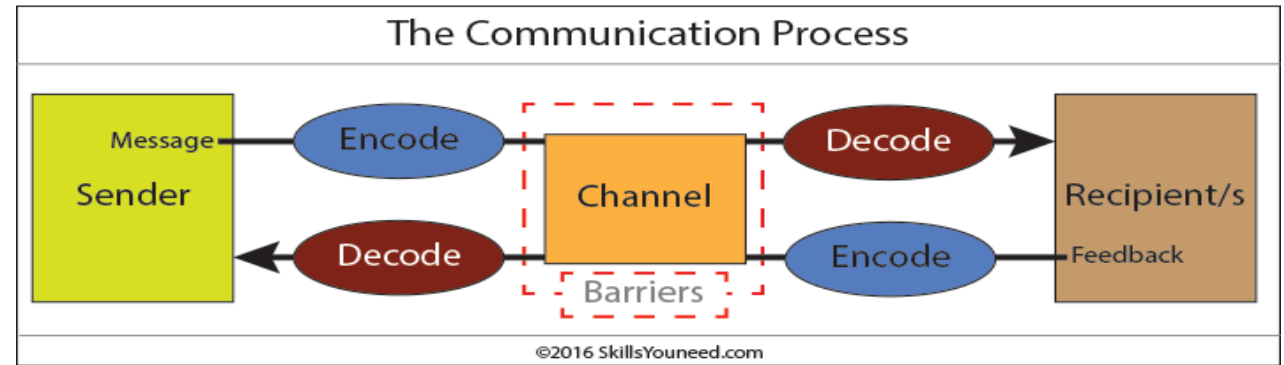
- From the neuroanatomical point of view, on the basis of modern neuroimaging methods and lesion studies, centers related to cognitive functions were identified primarily in the prefrontal cortex
- Dorsolateral prefrontal cortex processes information for planning, organizational skills, working memory, abstract thinking, etc.
- Cortex of the front cingulate is responsible for decision making, motivation-related behavior, inhibition of inappropriate behavior, etc.

Cognitive functions

- Orbitofrontal cortex monitors ongoing behavior, socially appropriate behavior, pulse control, etc.



Communication



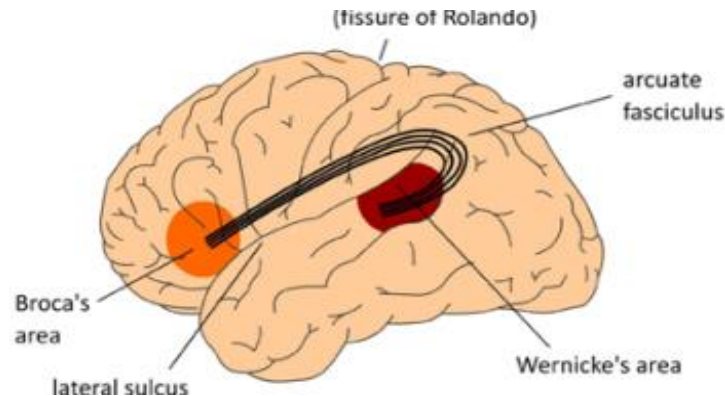
- Communication can take place in different ways, such as odor, visual, sound, tactile
- It is based on a pattern: source - encoding - channel - decoding - recipient
- In human society, communication can be non-verbal, which is difficult to control because it is under the influence of the limbic system
- Verbal communication is very manageable because it is under the control of the brain cortex

Speech

- Speech is an articulated manifestation of a person's thoughts serving for mutual understanding
- There is no human community that does not have a speech system
- Speaking, unlike reading, does not have to be taught
- Its acquisition is a complex process involving both sensory (understanding) and motor system (production)

Speech

- The main speech centers are Broca's center, which links to the motor cortex, and Wernick's center, which links to the hearing area and the fasciculus arcuatus
- 97% of people have Broca's and Wernick's areas located in the left hemisphere
- The right hemisphere evaluates the nonverbal aspects of speech, the conveyed meaning (irony, metaphor), and the understanding of a more complexly organized speech



Reading disabilities

- Developmental dyslexia is a congenital disorder characterized by difficulty in decoding written text and/or reading fluency
- Alexia is a reading disorder that has very similar symptoms as developmental dyslexia
- Hyperlexia is the ability to read much better than suggesting IQ or age, it is found in the spectrum of autism

THESE SENTENCES
WERE PRESENTED
TO SUBJECTS IN
A RANDOM ORDER
AND THEY HAD TO
READ THEM FROM
LEFT TO RIGHT
AND IDENTIFY THE
WORDS THAT WERE
PRESENT IN THE
SENTENCES

Individual improvement of reading capabilities

- Understanding the text is improved by increasing the reading range
- Reading in a pleasant environment - for someone library, another cafe, for another a train station
- Improve the speed of reading, for example, using rozectise.cz (also available in English)
- David Gruber' Speed Reading Courses - [website](#)
- Speed reading helps not only by increasing the reading speed but also increases the angle that the given eye is able to accept

**Thank you for paying attention and
completing these tasks!**