Neuropsychological perspectives on the assessment and management of visual-perceptual deficits following brain injury

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Outline

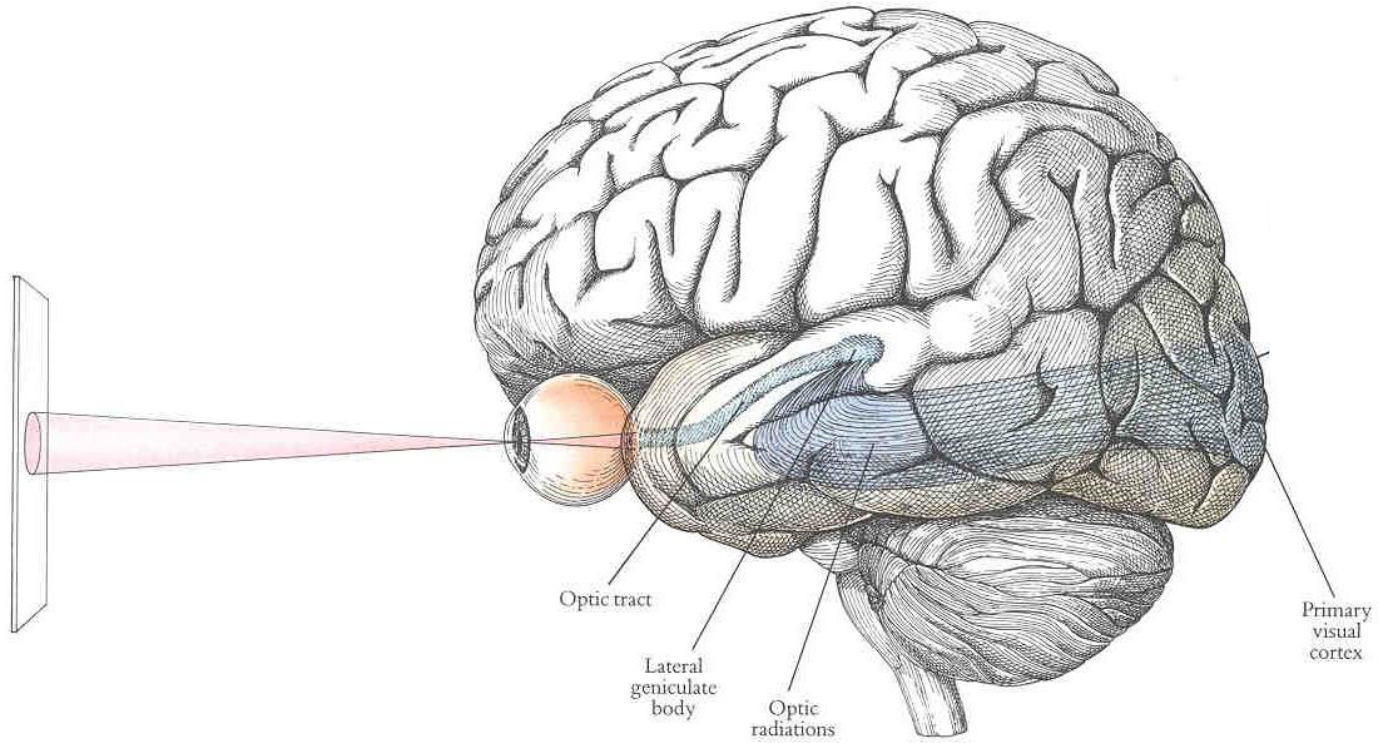
- How the brain processes vision
- Deficits in visual perception after brain injury
- Other consequences of brain injury
- Challenges related to assessment and rehabilitation og visual impairments following brain injury
- Mapping strengths and weaknesses

Warm-up:
How the Brain Processes Vision

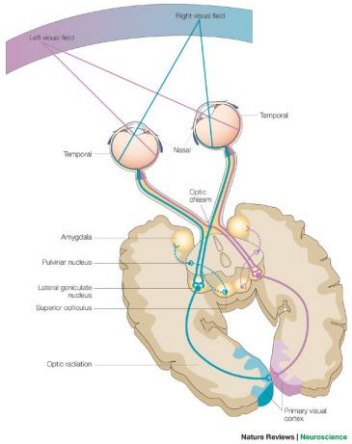
Registration of visual information

Slide from Christian Gerlach

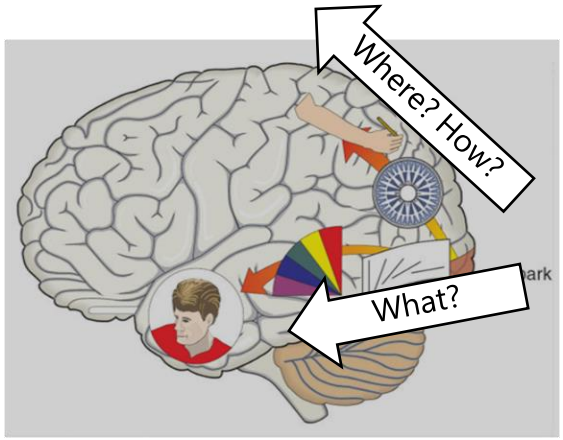
How we recognize a mug



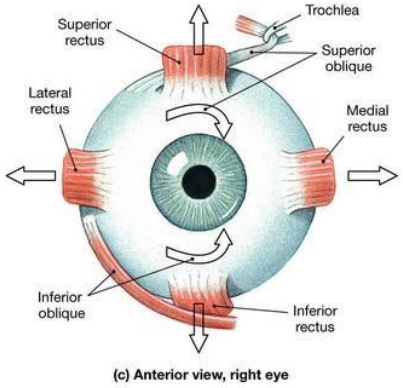
Overview

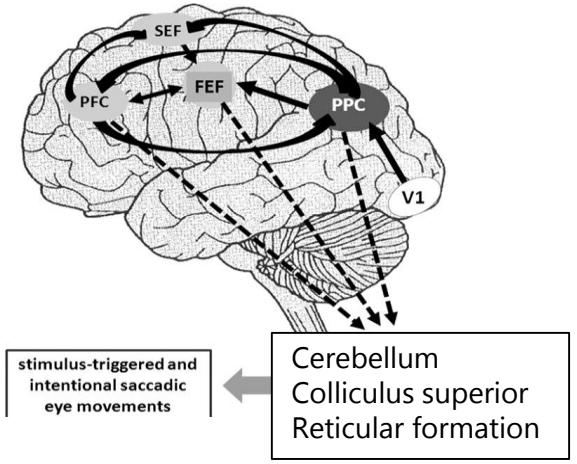


Part I: **The sensory visual system**



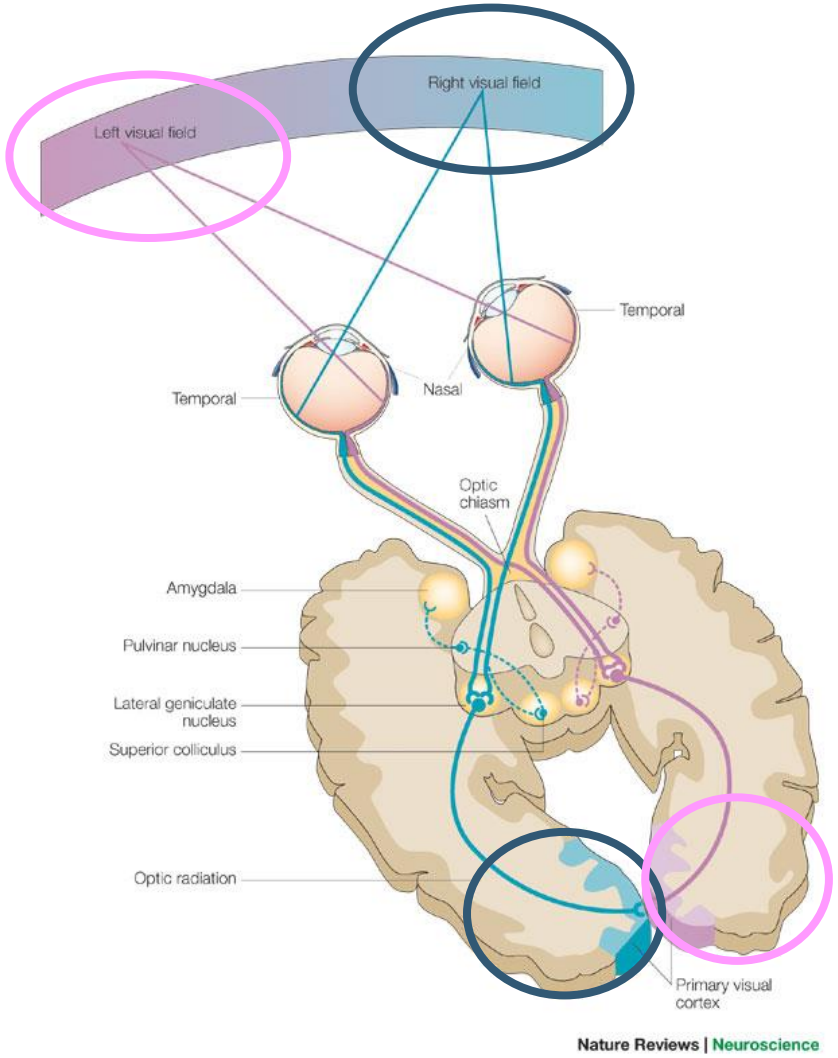
Part II: **The visuo-cognitive system**





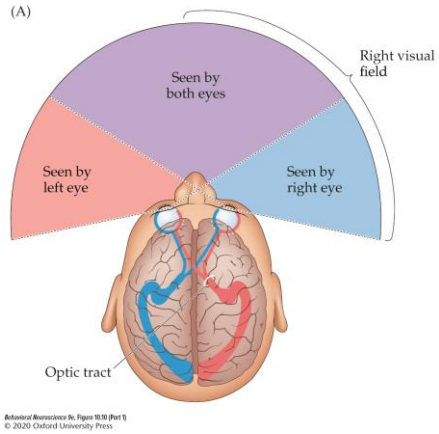
Part III: **The oculomotor system**

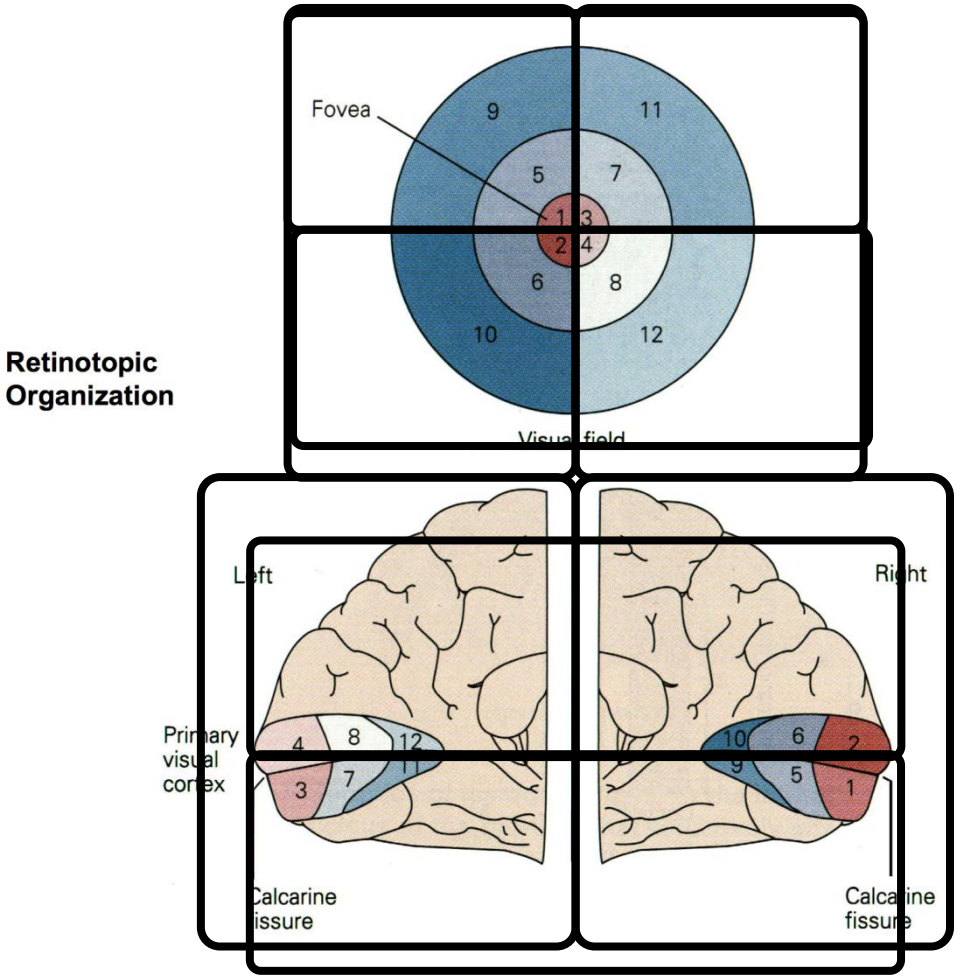
I: The visual sensory system



Lesion in left/right **cerebral hemisphere** of the brain leads to visual field deficit in the **contralateral hemifield**

Retintopic organisation of primary visual cortex (V1)



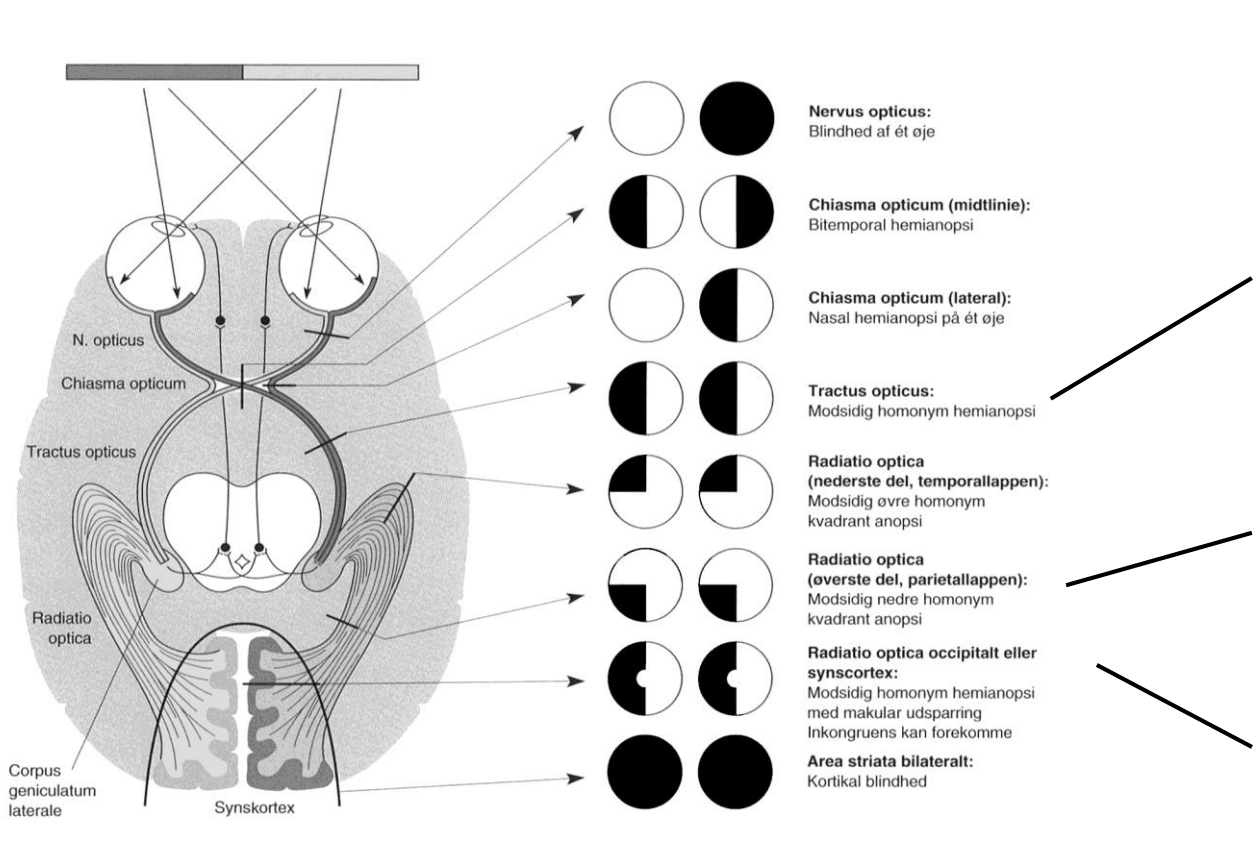


- Left visual hemifield processed by contralateral (right) cerebral hemisphere
- Right visual hemifield processed by contraletaral (left) cerebral hemisphere

- Lower visual field processed by area above calcarine fissure
- Superior visual field processed by area below calcarine fissure

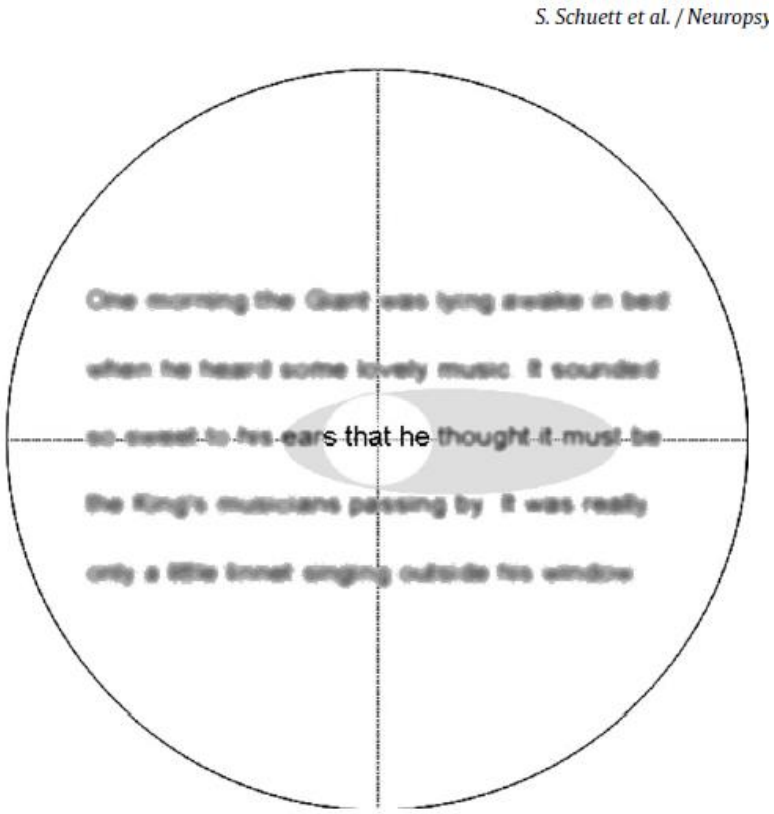
Figur fra: https://commons.wikimedia.org/wiki/File:Retinotopic_organization.png

Damage to the visual sensory system can give visual field deficits



Gerlach, C. & Martstrand, L. (2009). Kapitel 6: Visuelle perceptions-forstyrrelser og agnosi. Modificeret efter Sørensen & Gjerris, 2004. In: Gade, A., Gerlach, C., Starrfelt, R., & Pedersen, P.M. (Ed.) Klinisk Neuropsykologi. Frydenlund: København.

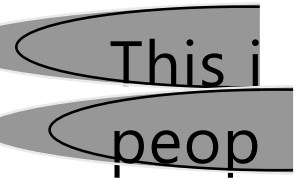
Consequence of homonymous hemianopia on reading:



Reading in neurotypical individuals

Illustration: Neurotypical readers

Illustration: Right homonymous hemianopia

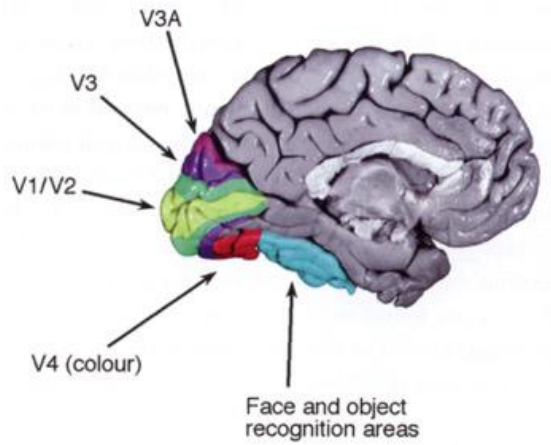


- Problems with planning fixations, so more fixations and regressions than normal.
- No problems when changing line.

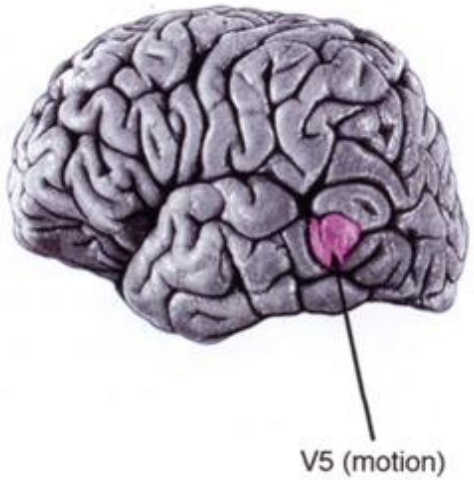
Illustration: Left homonymous hemianopia

- Problems when changing line.
- No problems with planning fixations.

Other low-level visual perceptual functions: Perception of colour and motion



Akromatopsia

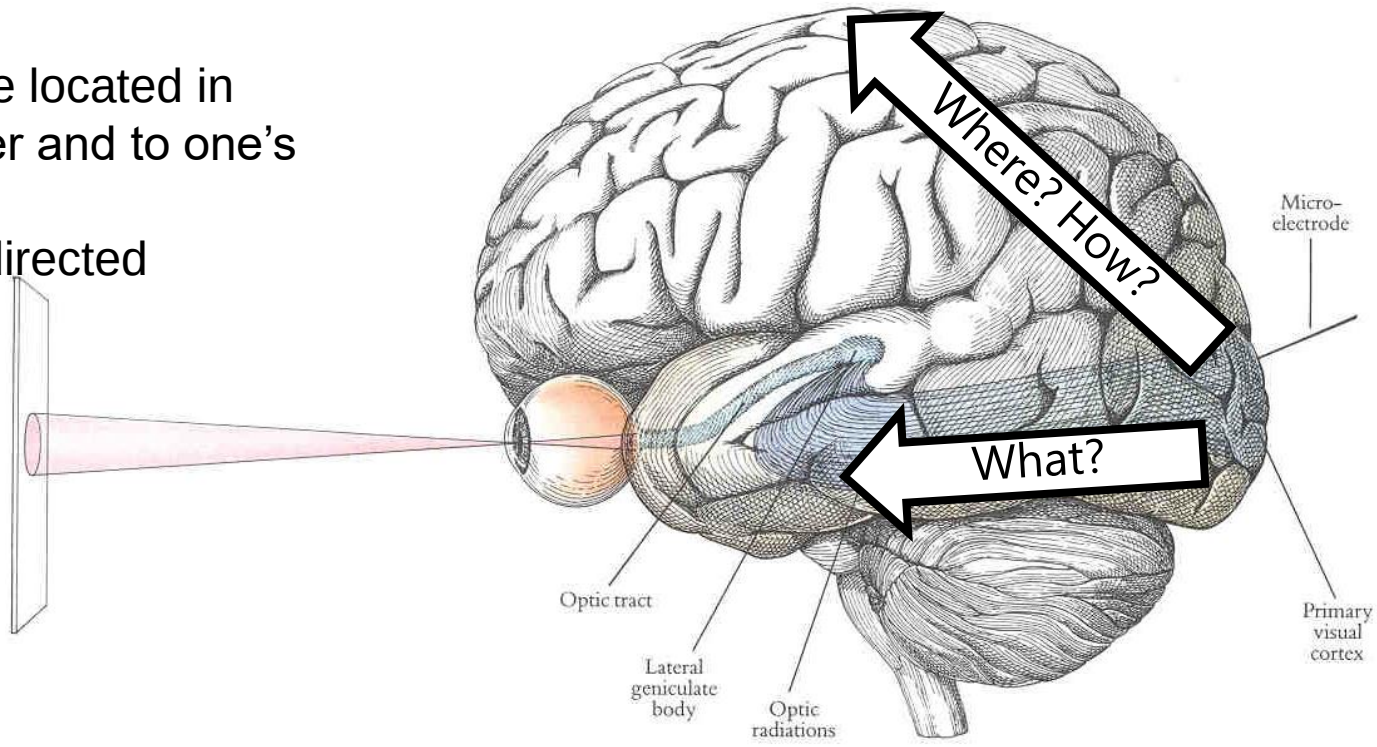


Akinetopsia

II: The visuo-cognitive system

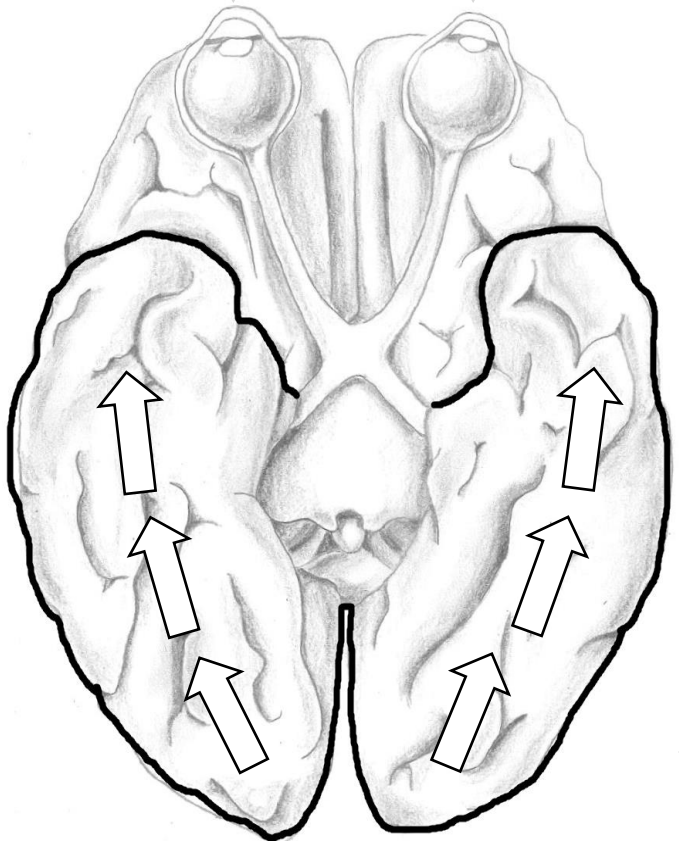
Dorsal stream (Where? How?)

- Visuospatial abilities
- Determining where stimuli are located in space in relation to each other and to one's own body
- Visually guided movements directed towards the use of objects



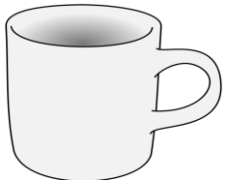
Ventral stream (What?):

- Processing of color, shape
- Recognition of objects, faces and words



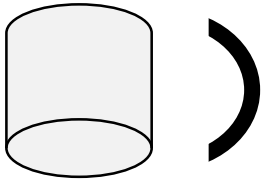
Semantic knowledge

Complex visual processing



= “Mug”

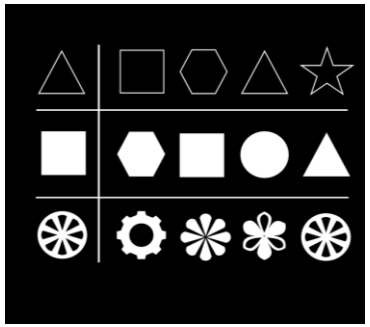
Intermediate visual processing
- Edges
- Contours



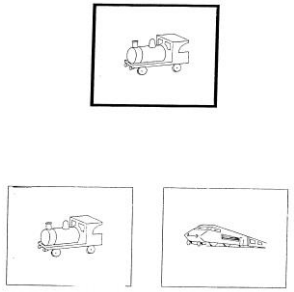
Low-level visual perceptual processing:
- Colours
- Movements

Consequences of lesions in the ventral stream

- **Problems in recognising**



Shapes



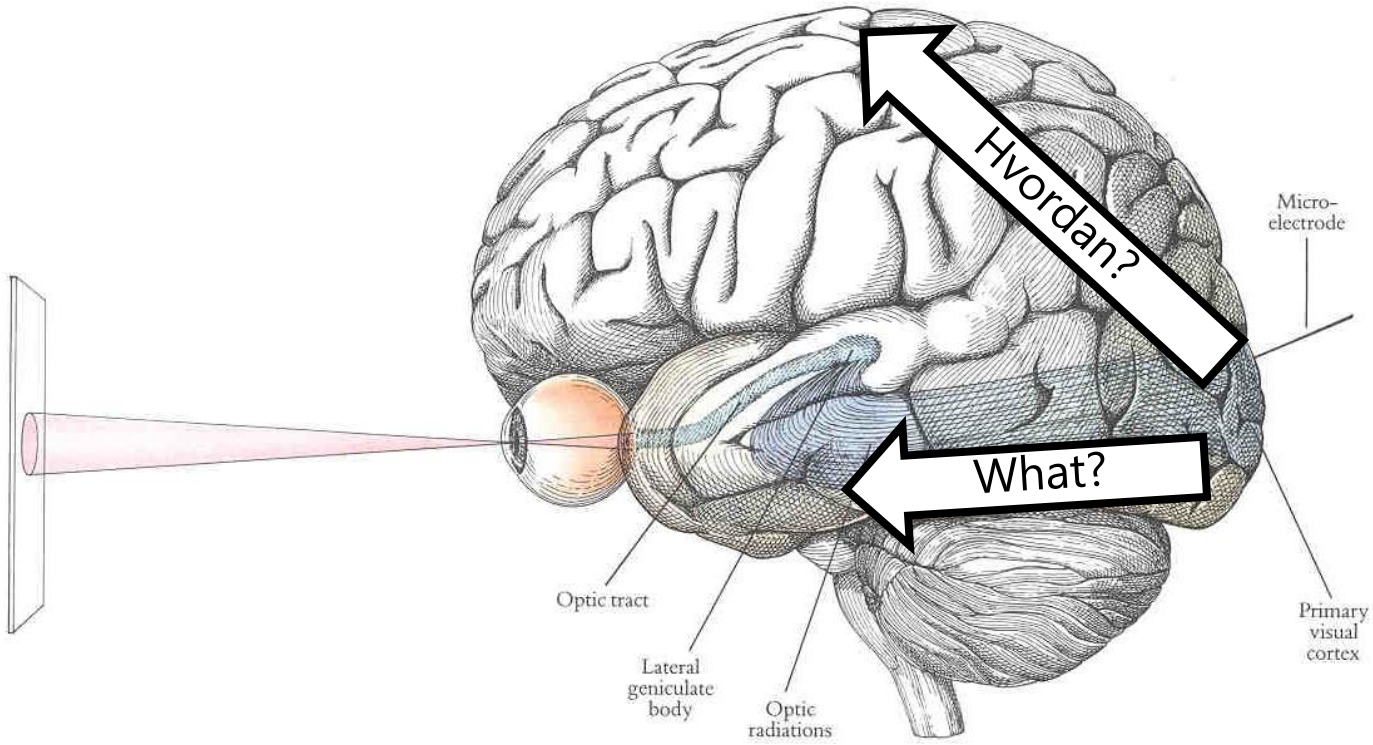
Objects

Faces

TABLE

Words

Consequences of lesions in the dorsal stream

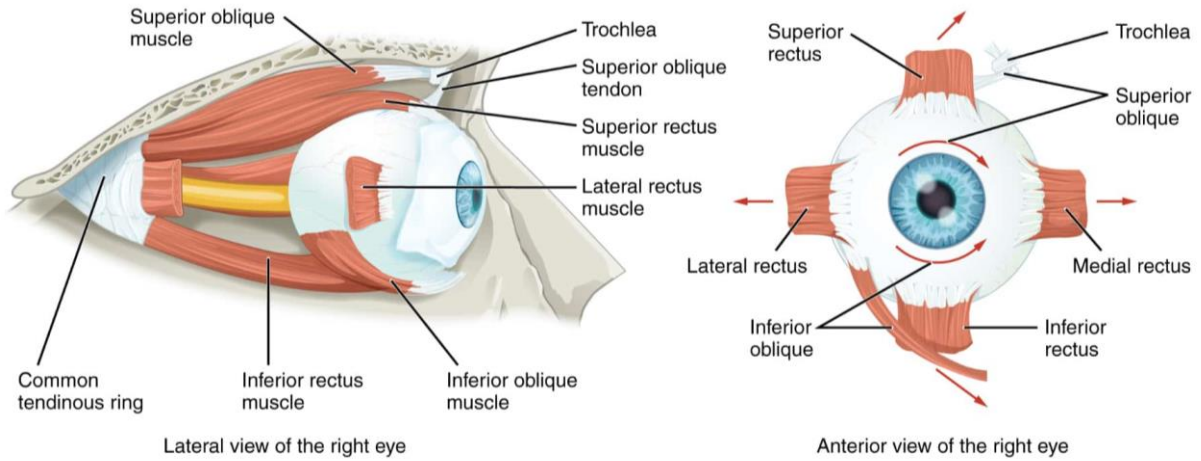


- Problems in determining where things are in my environment
- Problems in reaching out for objects in the visual field when the movement is guided by vision (optic ataxia).
- Problems in making voluntary eye movements (oculomotor apraxia)
- Problems in seeing more than one thing at a time (simultaneous agnosia)

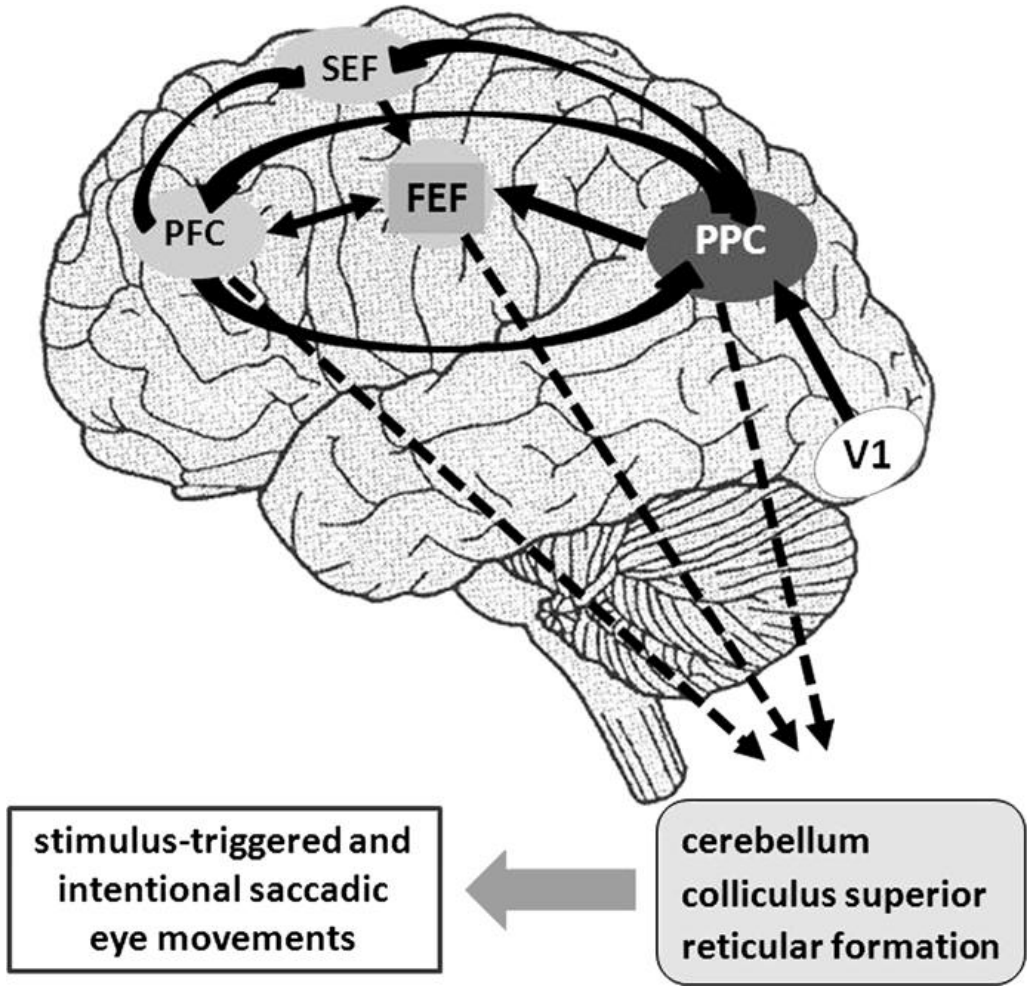
→ Seen after bilateral parieto-occipital lesions

III: The oculomotor system

- Enables:
  - Maintaining visual stability
  - Controlling eye movements to focus the fovea on stationary or moving targets.
- 1 disjunctive system (eyes move in different directions)
  - **Vergence**
- 4 conjugate eye movement system (eyes move in same direction):
  - **Vestibular**
  - **Optokinetic**
  - **Saccadic**
  - **Smooth pursuit**



Example: saccadic system and cerebral areas involved

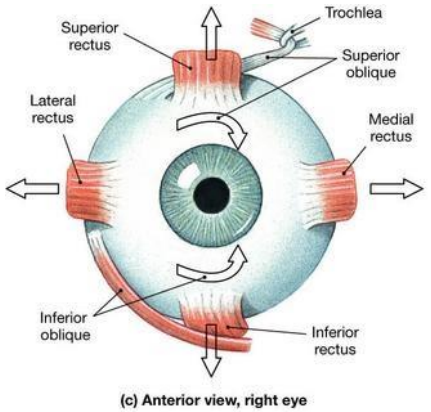


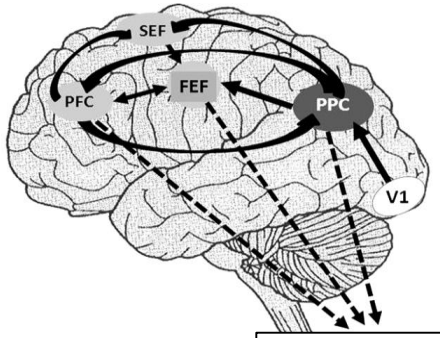
- **PFC: Prefrontal cortex**
- **FEF: Frontal eye fields**
- **SEF: Supplementary eye fields**
- **PPC: Posterior Parietal cortex**
- **V1: Primary Visual Cortex**

→ Large brain network involved

Modified after Pierrot-Deseilligny et al. 1995, in Zihl & Dutton, (2015). Cerebral Visual Impairment in Children Visuoperceptive and Visuocognitive Disorders. Spinger: London

Damage to areas involved in the oculomotor system





Eye movements

Cerebellum
Colliculus superior
Reticular formation

The oculomotor system

Problems with:

- Vergence
- Voluntary and reflexive saccadic eye movements
- Sustaining fixation
- Smooth pursuit

Zihl & Dutton (2015)

The oculomotor system is highly complex and precise and involves a large network og brain areas.

→ Can easily be affected by a brain injury

Summing up

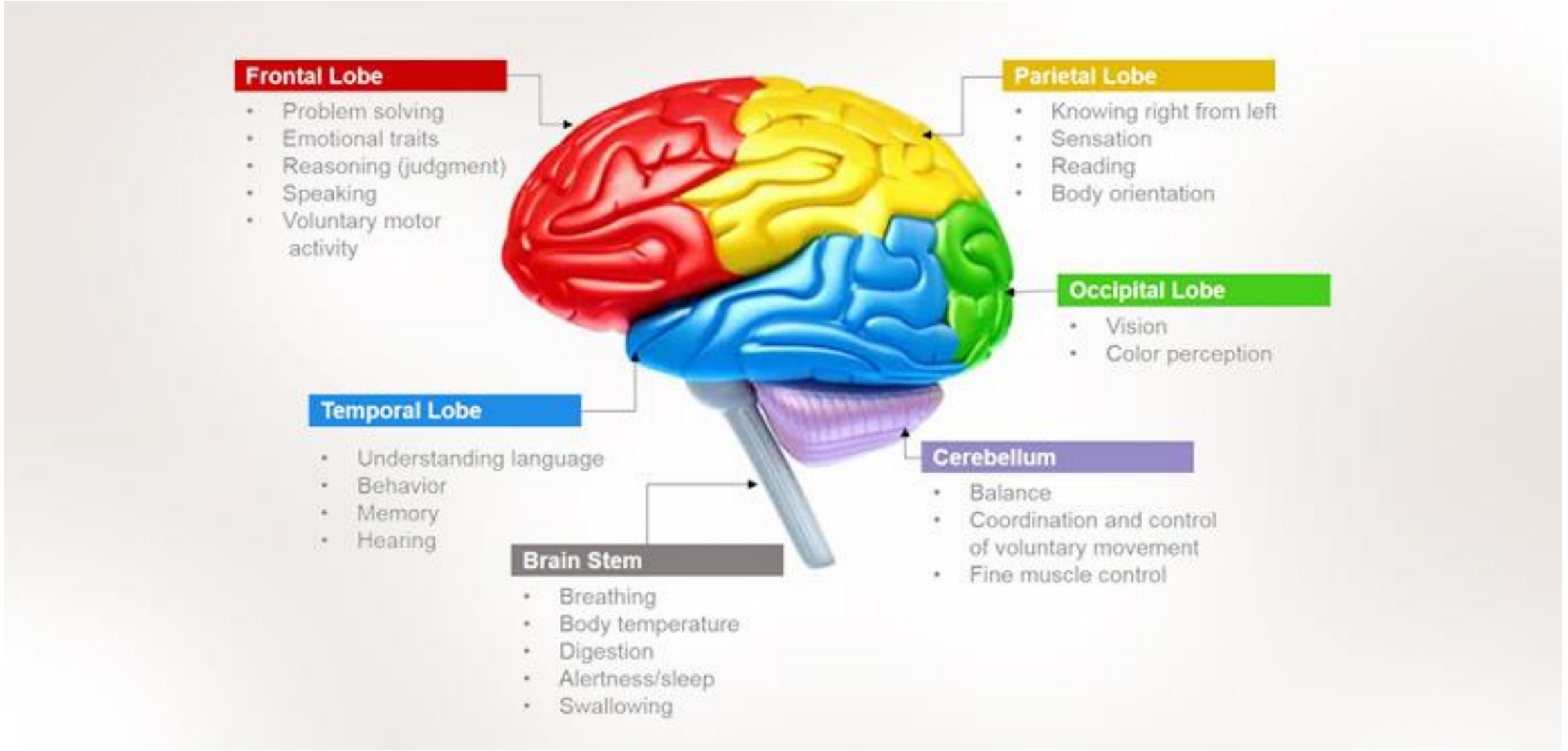
- Visual system is highly complex
- Visual system involves many cortical and subcortical structures

→ Easily compromised following brain injury or in relation to atypical brain development

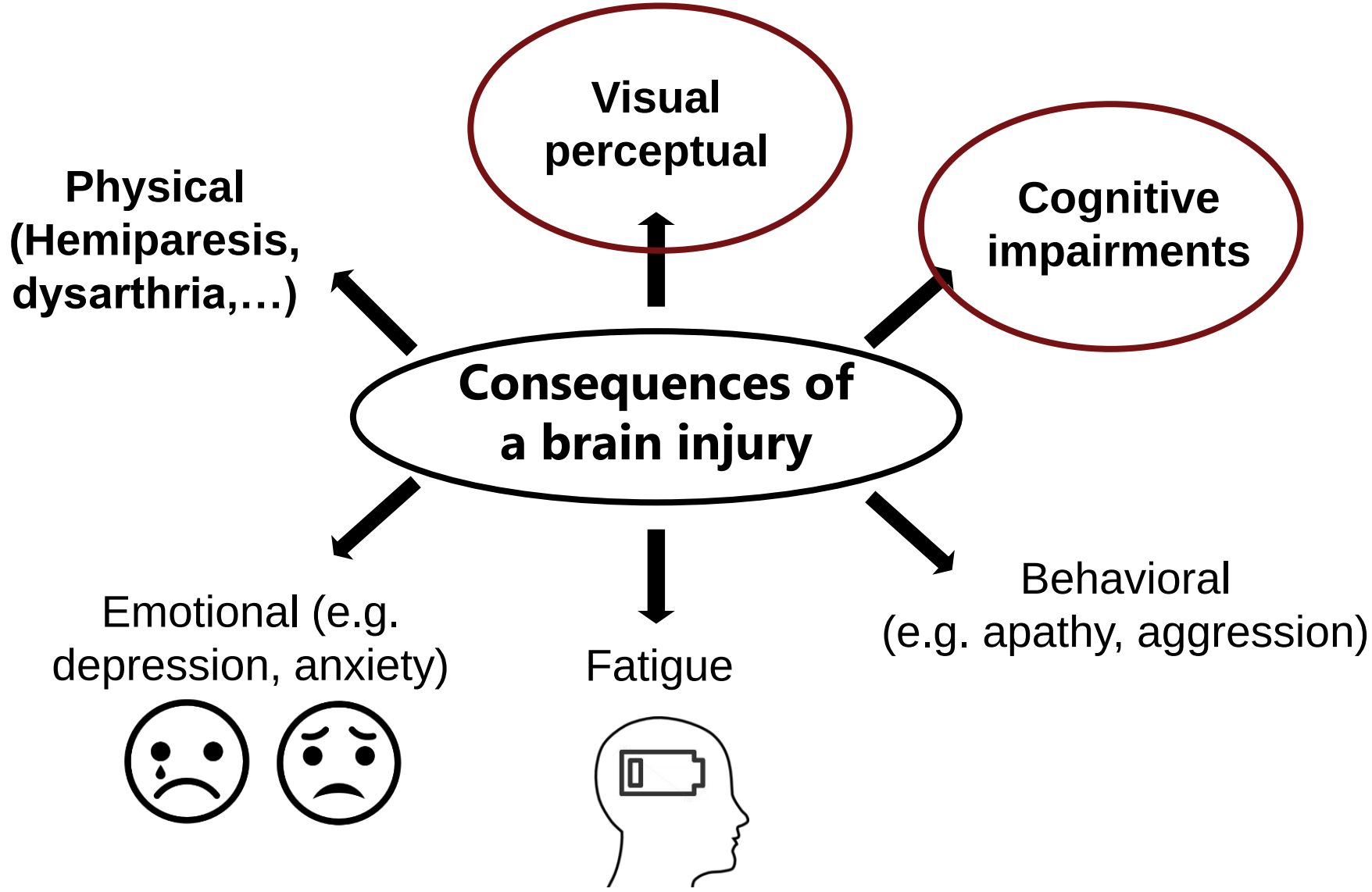
→ Visual impairments after a brain injury will nearly always be accompanied by other impairments

Other consequences of a brain injury

"Draw a cross on a piece of paper"



Consequences of a brain injury



Cognitive impairments

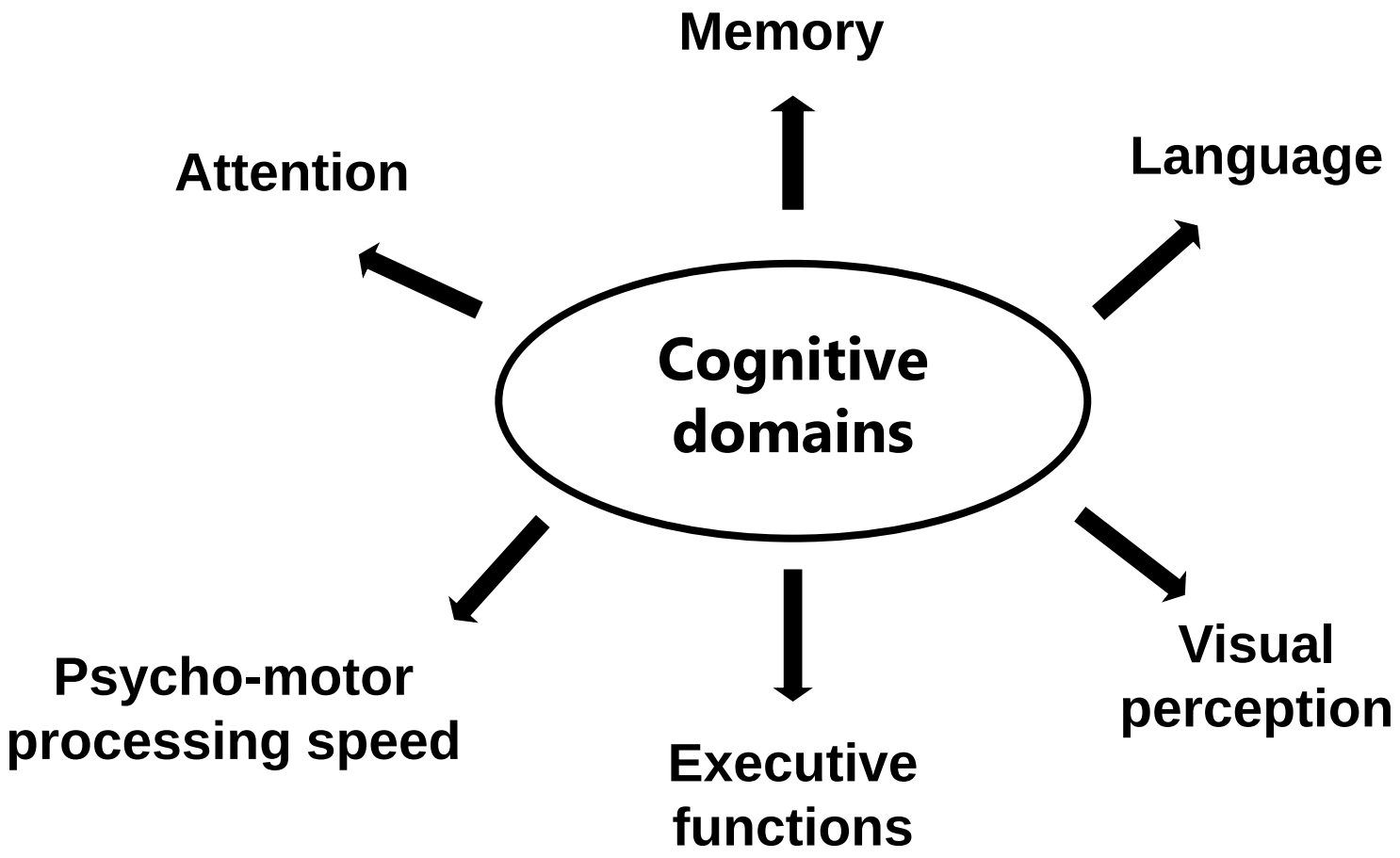
Cognitive impairments are impairments in **cognition**

Cognition

Cognition is the scientific term for “thought processes”

https://da.wikipedia.org/wiki/Kognition d.15.05.2019

Cognitive domains



Vogel, A. & Gerlach, C. (2015) Kapitel 6: Neuropsykologiske forstyrrelser. I: Paulsen, O.B., Gjerris, F. & Sørensen, Per, S. (Red.) Klinisk Neurologi og Neurokirurgi (6. udgave). Fadl's forlag, København. Sider 136-159.

Challenges related to assessment and rehabilitation of visual impairments following brain injury when there are other impairments

Memory

Procedural (implicit)

How we do things

Deklarative (eksplicit)

Episodic

Memory for things that can be placed in time and space

Semantic

Knowledge about things, how they are used and what they are for

= fish
= lives in water

Memory impairments and visual perceptual impairments

Challenge:

- When teaching new adaptive or compensatory strategies, the patients may forget what they have been told and will forget to use them

Advice:

- Often episodic memory is impaired but procedural is preserved, so patients will be able to learn new habits → Try to implement new strategies as habits in daily routines.
- Take (record) notes of advice that is given and make them accessible
- Limit the amount of information that is given and repeat it many times

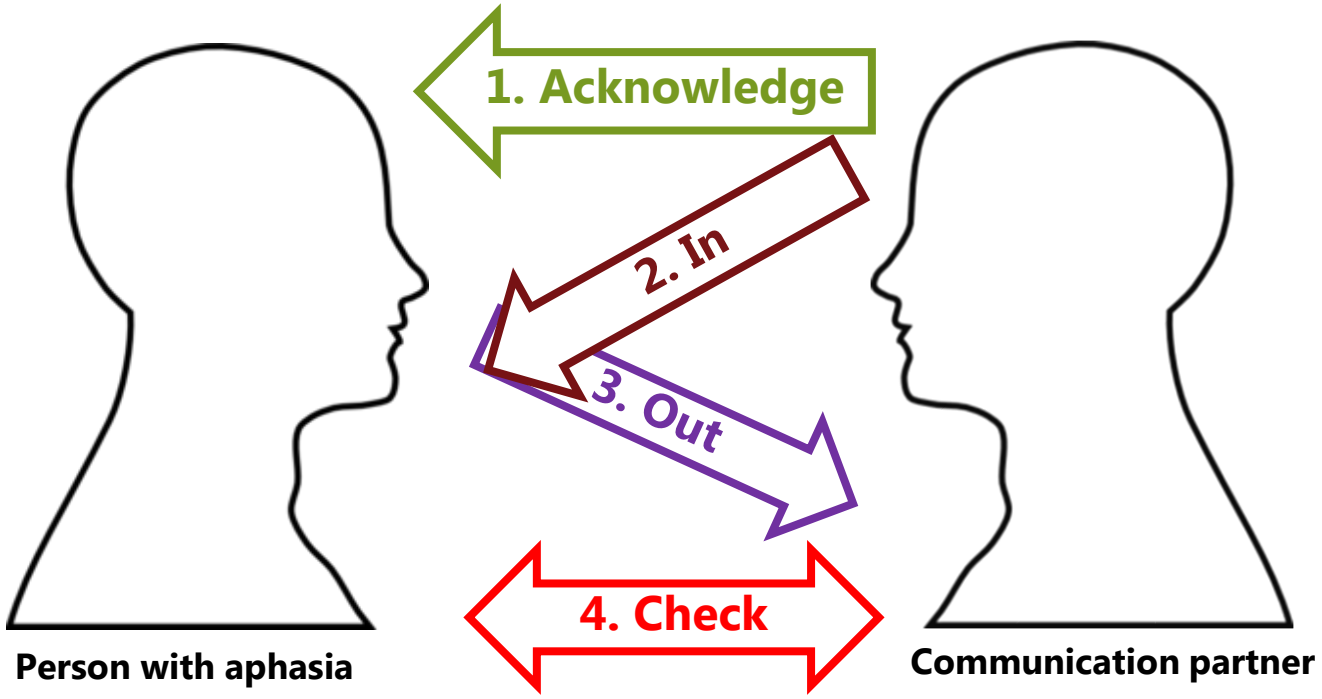
Language deficits after brain injury - Aphasia

- The following can be impaired to larger or lesser degree:
  - Producing speech or written language
  - Understanding speech or written language
- Can vary from difficulty to find some specific words to total loss of language production and understanding

<u>Challenge:</u>

Often if someone has a visual impairment we rely more heavily on communicating verbally

Communicating with people with aphasia



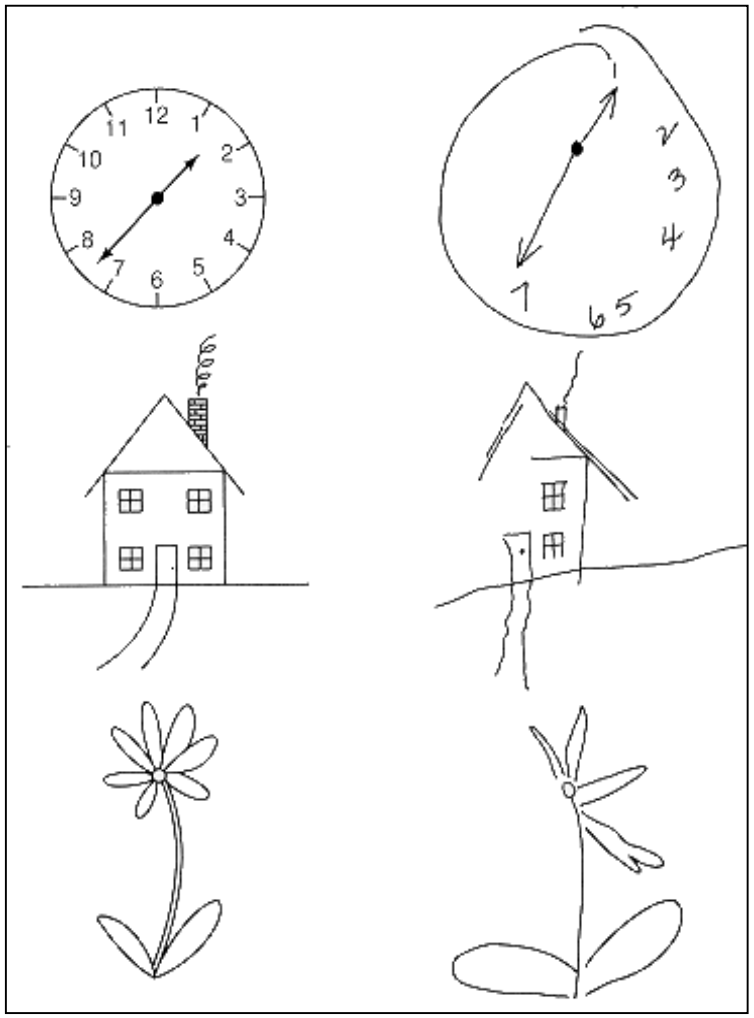
Acknowledge: "I am aware that it is difficult for you to produce words. That must be frustrating."

In: Only ask one thing at a time. Supplement your speech with keywords and gestures. Use drawings and images to aid communication.

Out: Help the individual in expressing themselves by encouraging them to write, draw, show or by giving them multiple choice options. Use pointed material.

Check: Reformulate/repeat what you have understood from the interaction so that the individual can correct misunderstandings.

Neglect



- An attentional disorder in which a patient is unable to attend to stimuli presented in one side of the visual space or one side of the body.
- Most often after right hemisphere lesion. The patient will overlook stimuli to the left.

→ It is **not** caused by a sensory or motor deficit. The brain can process input but is not interested.

Examples of neglect behavior

- Forgets to put on their left shoe
- Forgets to release left wheel of wheelchair
- Bumps into things to the left
- Doesn't eat food on the left side of the plate
- Forgets to wash/shave left side of face/body
- Does not react when talked to from the left side
- Reduced insight in impairments

Not the same as a visual field impairments but can be difficult to distinguish clinically

Visual impairments and neglect

Challenge:

- Patients with neglect will often have bad insight into their difficulties and will struggle to learn and implement compensatory strategies.
- It can be difficult to differentiate between visual field impairments and neglect

Advice:

- When talking to the individual, sit on the non-neglected side of the patient.
- For reading tasks, draw a think colorful line next to the side of the text that is neglected.
- Help directing the person's attention towards the neglected side via verbal guidance.

Anosognosia and visual impairments

- Symptom that is common after brain injury, where the person is unaware of their symptoms after brain injury.

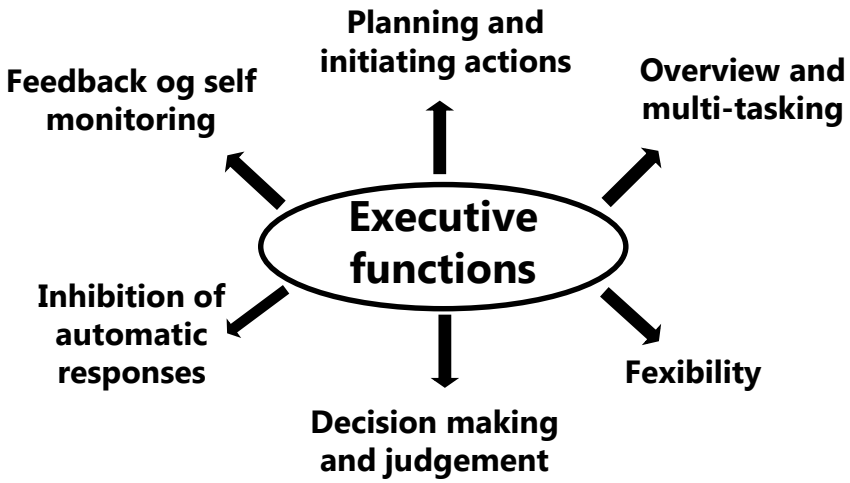
Challenge:

- Assessment: May not report visual impairments
- Rehabilitation: May not cooperate as they don't think they have a problem

Advice:

- Involve relatives as much as possible
- Include rehabilitation in daily activities and make use of routines

Executive functions



Start – monitor – stop - check = control functions

Executive functions and visual impairments

Challenges in rehabilitation:

- Often the person will struggle to remember to do exercises due to a lack of structure
- It can be difficult to break a large rehabilitation goal into smaller manageable sub-goals.

Advice:

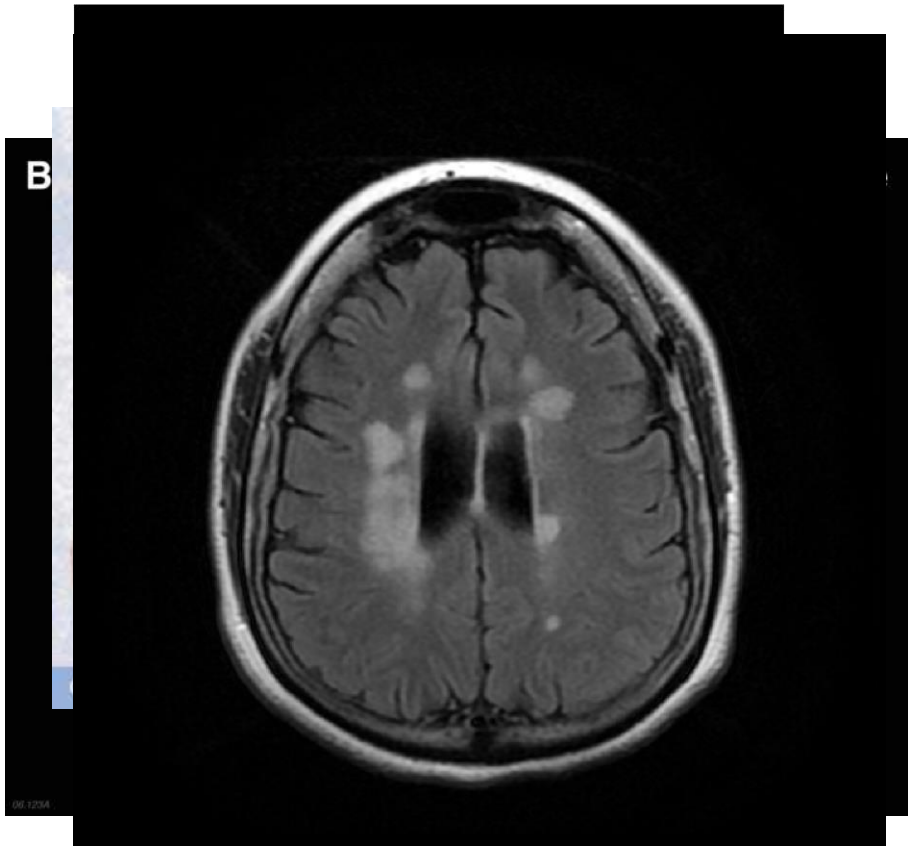
- Make a concrete rehabilitation plan (e.g. a day/week plan)
- Make a list of tasks at the start of a session and tick them off the list once completed.
- Help the individual divide complex tasks and complex goals into smaller manageable tasks and goals.
- When completing tasks, make it a habit for the patient to: ”Start – monitor – stop – check and adjust”.

Motor impairments and visual impairments

- Motor impairments can be more or less severe.
- Increased risk of falling
- Often use vision to guide our movements, especially when our motor system is affected and our movements are less precise.
- When someone has visual impairments, we often encourage using the sense of touch to search and investigate the physical environment. This can be challenging when someone has sensory-motor impairments.

Advice: Remember to check whether the individual you are working with has a preserved sense of touch and preserved motor system.

Different types of brain injury have different types of consequences



Case courtesy of Dr Bruno Di Muzio, Radiopaedia.org, rID: 42765

Stroke in the visual areas

→ Impairments depend on location and size of lesion

Dementia (Posterior Cortical Atrophy)

→ Atrophy distributed over large area so wide range of problems

Tumor

→ Mixture of selective deficits and also diffuse symptoms

Traumatic brain injury

→ Often diffuse impairments and many executive problems

Multiple sclerosis

→ Often a series of impairments but can start with very specific impairment of visual field

Early brain injury (e.g. cerebral visual impairment)

→ Often impairments across many domains

Mapping strengths and weaknesses

What to consider when working with **rehabilitation** of individuals with brain-related visual impairments

- The cause of, or the type of brain injury:
  - Does the individual likely also have other challenges (cognitive, motor, emotional)?
  - Do we expect recovery or progression? (e.g. stroke vs dementia)
  - What does this mean for the potential for improvement with rehabilitation?

- The full motor, cognitive and emotional profile of the individual:
  - Which impairments does the individual have after their brain injury?
  - How do we expect the impairments to interact?
  - How can this be taken into account when implementing compensatory strategies?
  - Focus on identifying strengths in the individual

What to consider when **assessing** vision in individuals with brain-related visual impairments

- When selecting tests/assessment tools to assess vision, take into account the person's preserved functions (e.g. if motor impairments do not test requiring fine motor skills).
- Make sure to assess/evaluate the different visual systems
- Careful when interpreting performance on visual perceptual tasks:
  - Can the poor performance be explained by a motor deficit (e.g. task requiring use of a pen), by psychomotor slowing (in timed tasks), by neglect (e.g. poor performance on perimetry), by language problems (did not understand instructions), etc.
- When asking about challenges try and involve a close relative or friend.
  - Many people after brain injury have limited insight into their difficulties.
- Pain, fatigue, medicine and emotional challenges can all affect performance during assessment.

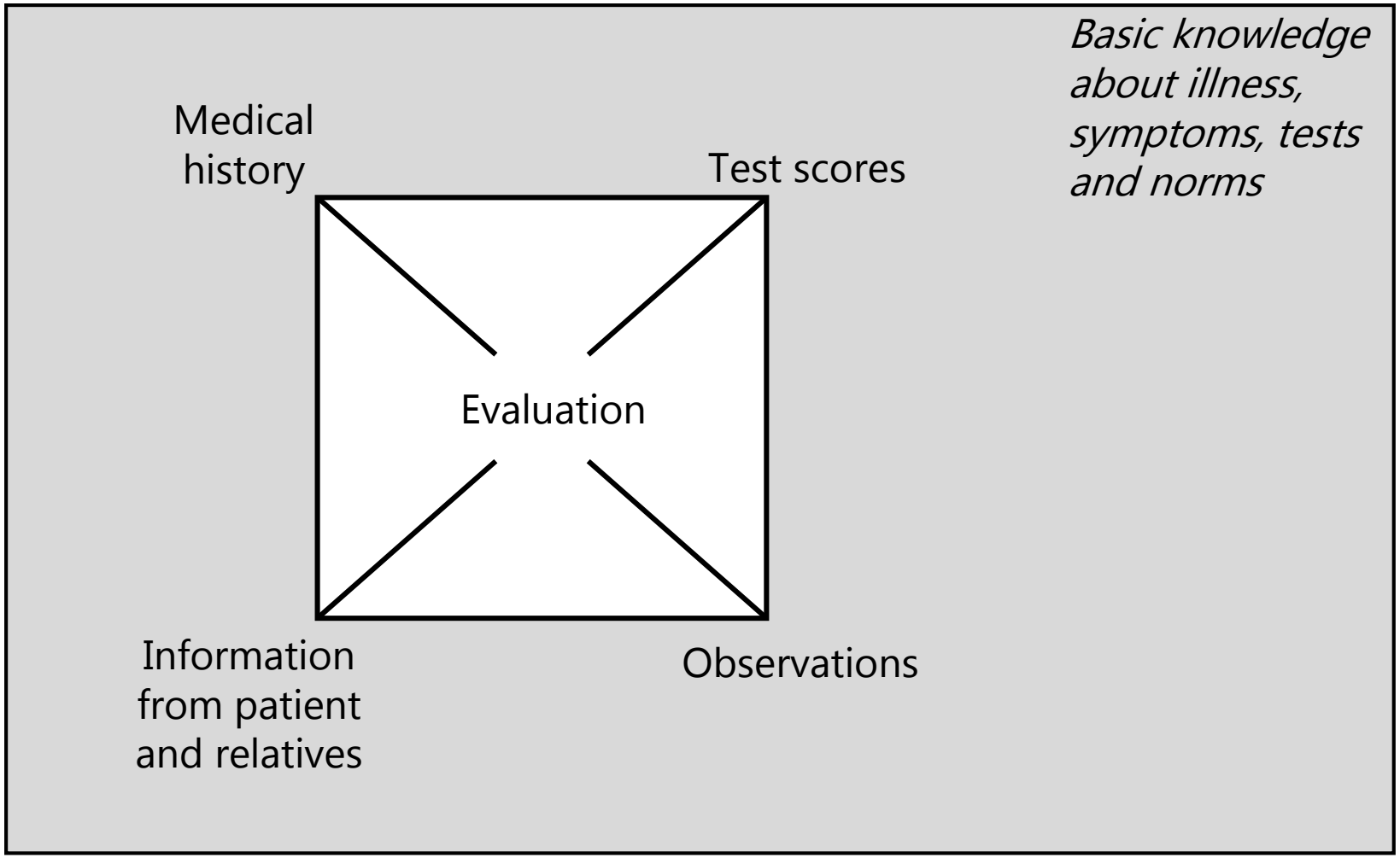
When assessing **brain based visual perceptual deficits**

- Ensure test environment is as visually plain as possible (table, walls, etc.)
- The individual being assessed should be placed with their back against the window
- Present each stimuli from test material individually (unless assessing attention)
- If the individual struggles to keep head in a stable position provide support for the head.
- If the individual has a visual field deficit, place stimuli in the preserved field.
- The assessor should constantly ensure that the individual's attention is directed towards the task.

Assessment and rehabilitation of brain injury: **It's complicated**!

- Work in interdisciplinary teams to identify the patients strengths and weaknesses across functional domains (involve speech therapists, neuropsychologists, occupational therapists, physiotherapists, etc. when relevant).
- Impairments in different functional domains can interact and make assessment and rehabilitation of individuals with brain injury highly complex.
- There is no "one-size-fits-all" so assessments and interventions must be individually designed.

Neuropsychological approach to assessment



Thank you for your attention!