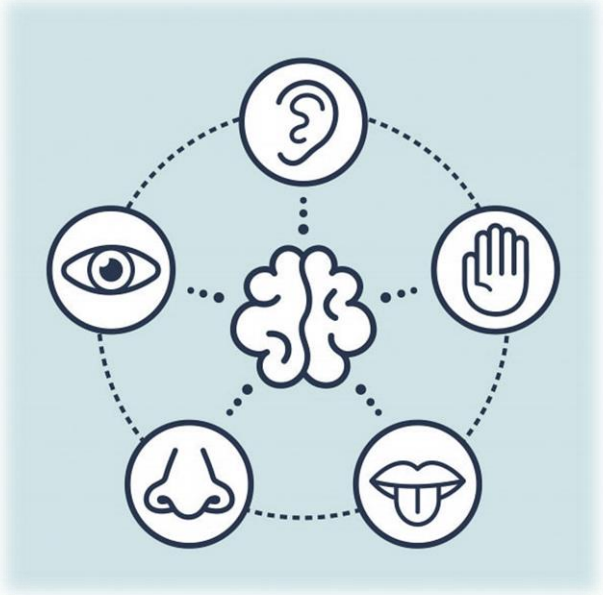
106508.
Cognitive Processes
Perception and Attention



Contents

1 Basic processing

Sensation and perception, our senses, top-down and bottom-up processes

2 Object and face recognition

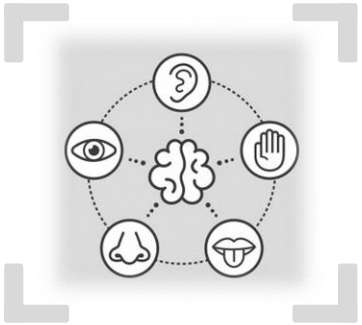
Pattern recognition, face recognition, imagery

3 Motion perception

Perception of human motion, visually guided action

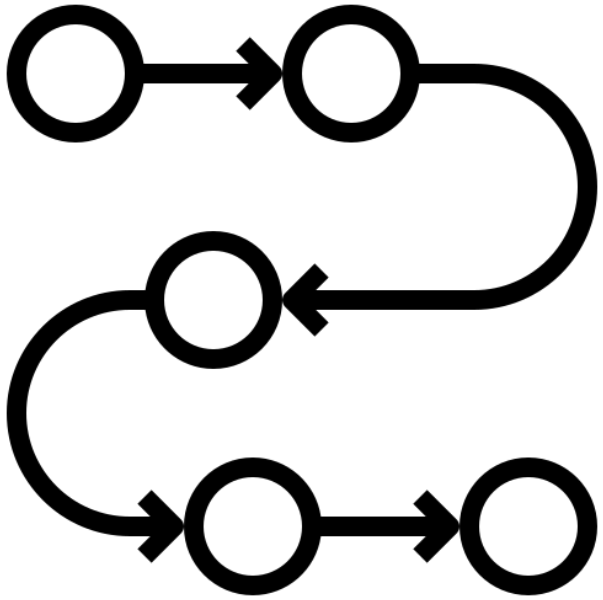
4 Attention and performance

Multi-modal perception, divided attention, automatic processing



Goals

- Understand fundamental elements of human perception and attentional processes
- Find out what is “human” in human perception
- Understand the difference between bottom-up and top-down processes
- Evaluate the applicability of human attentional functioning



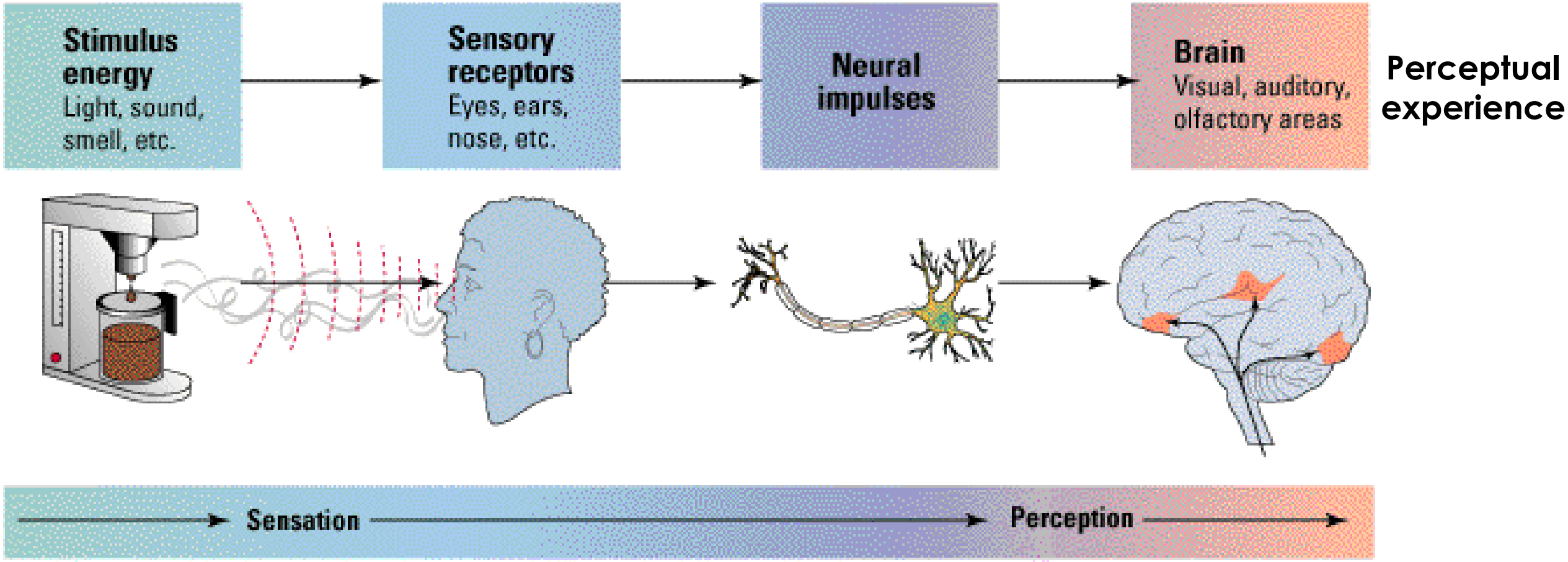
Basic Processing

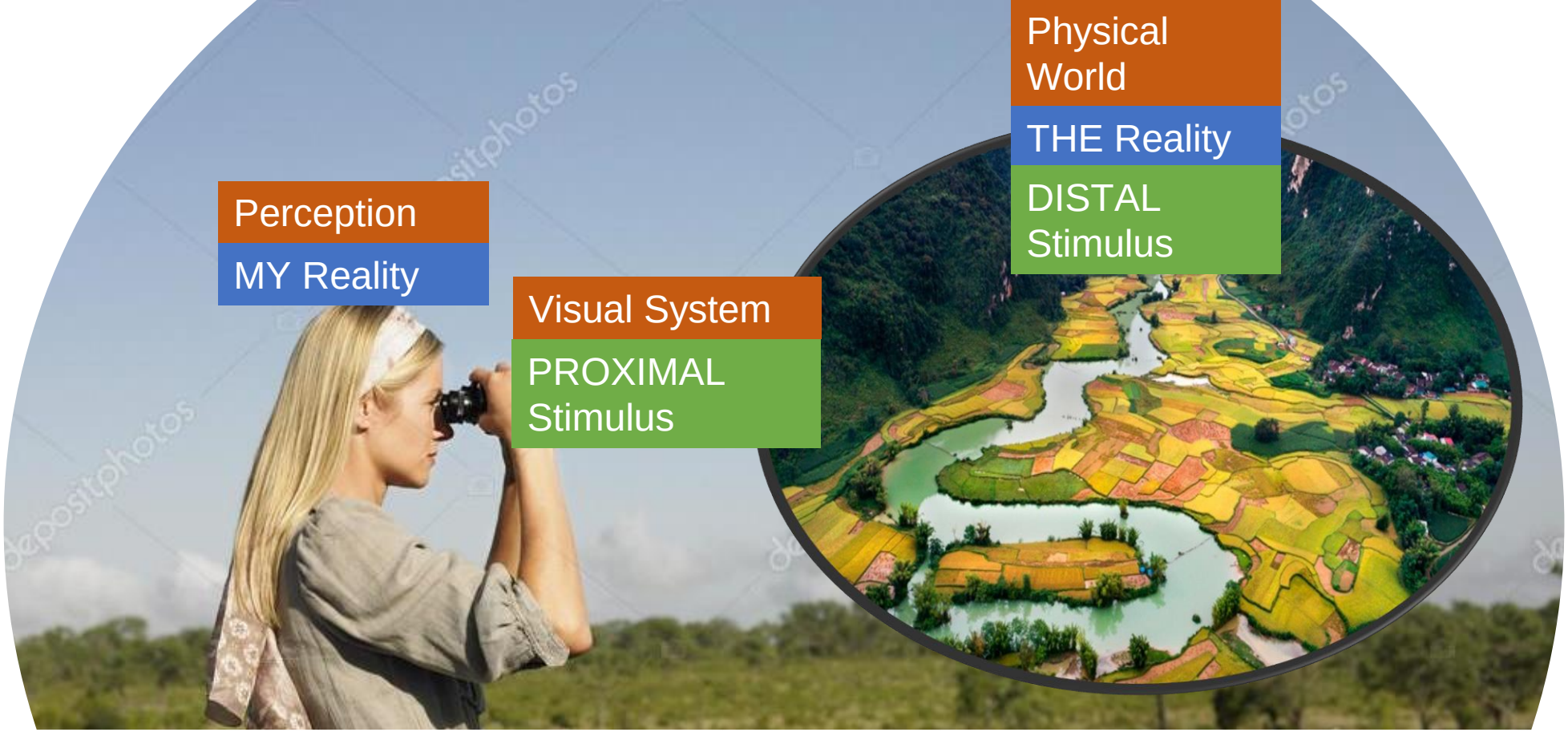
Sensation and perception

- **Sensation**: Refers to the way in which our sensorial receptors represent physically our outer reality
  - Entry systems: Allow the individual relation with the environment
  - Conscious Experiences: detection of the stimulus but without meaning
- **Perception:** Refers to the way in which we organize, integrate and interpret *mentally* this information
  - Provides meaning and allows the recognition of stimuli
  - Facilitates our adaptation to the environment

From stimulus to experience

Environment → **Detection** → **Transduction** (physical to electrical energy) → **Transmission** → **Processing** (Integration & Interaction)





Proximal stimulus works with incomplete information: (a) perception completes information + (b) we perceive beyond reality

Perception is rather more **information processing** than **reflecting the physical reality**

Automatic or intentional

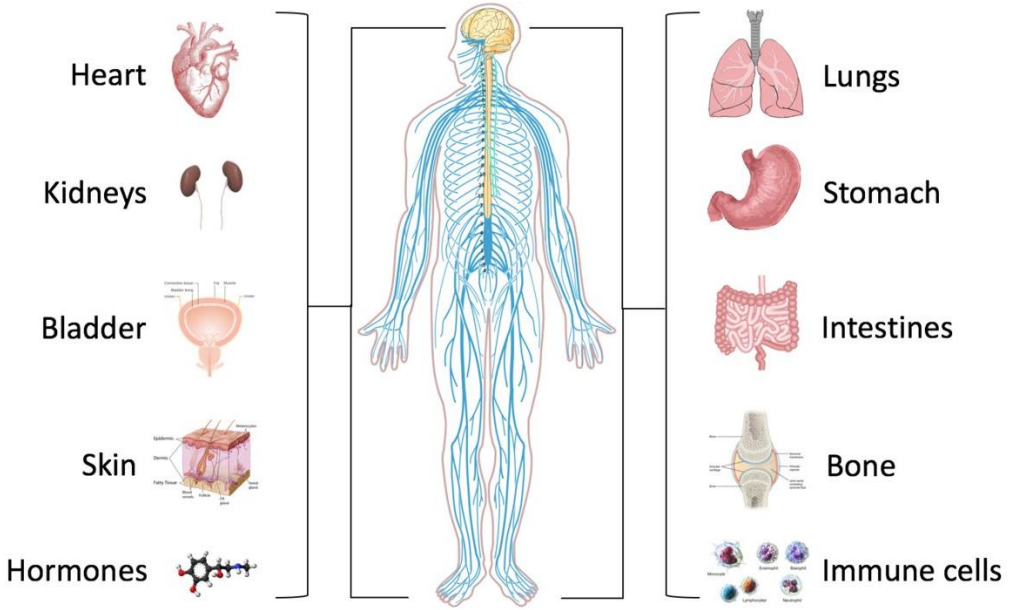
- Perception is a process that **reduces uncertainty** based on previous experience
- Perception is a **volitional/intentional** process
- Perception is suboptimal in terms of **accuracy** but adaptative in terms of **survival**

- Attention is a process of **perceptual focus** that increases one's own clear awareness central number of stimuli around which there are others more diffusely perceived
  - **Primary attention (reflex):** physiological response that the body has to a stimulus that attracts our attention
  - **Secondary attention (selective attention):** implies that our mechanism attention consciously "selects" the stimuli in which focus our attention

Our senses

Systems and sensory modalities

Interoceptive sensory systems

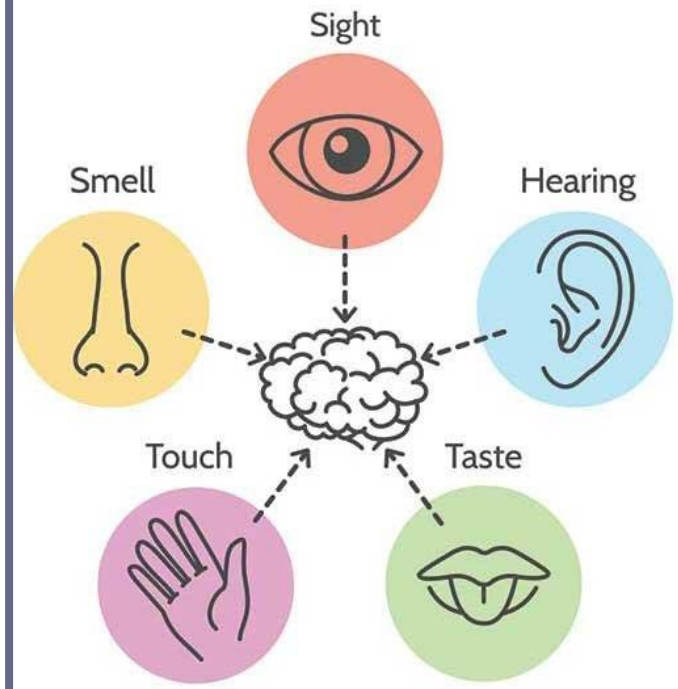


State of the bodies and information system of internal changes of the body

Proprioceptive sensory systems

Information about the position in space and the movement of the different parts of the body (joints and muscles)

Exteroceptive sensory systems



Five senses that allow us to relate to the outside world

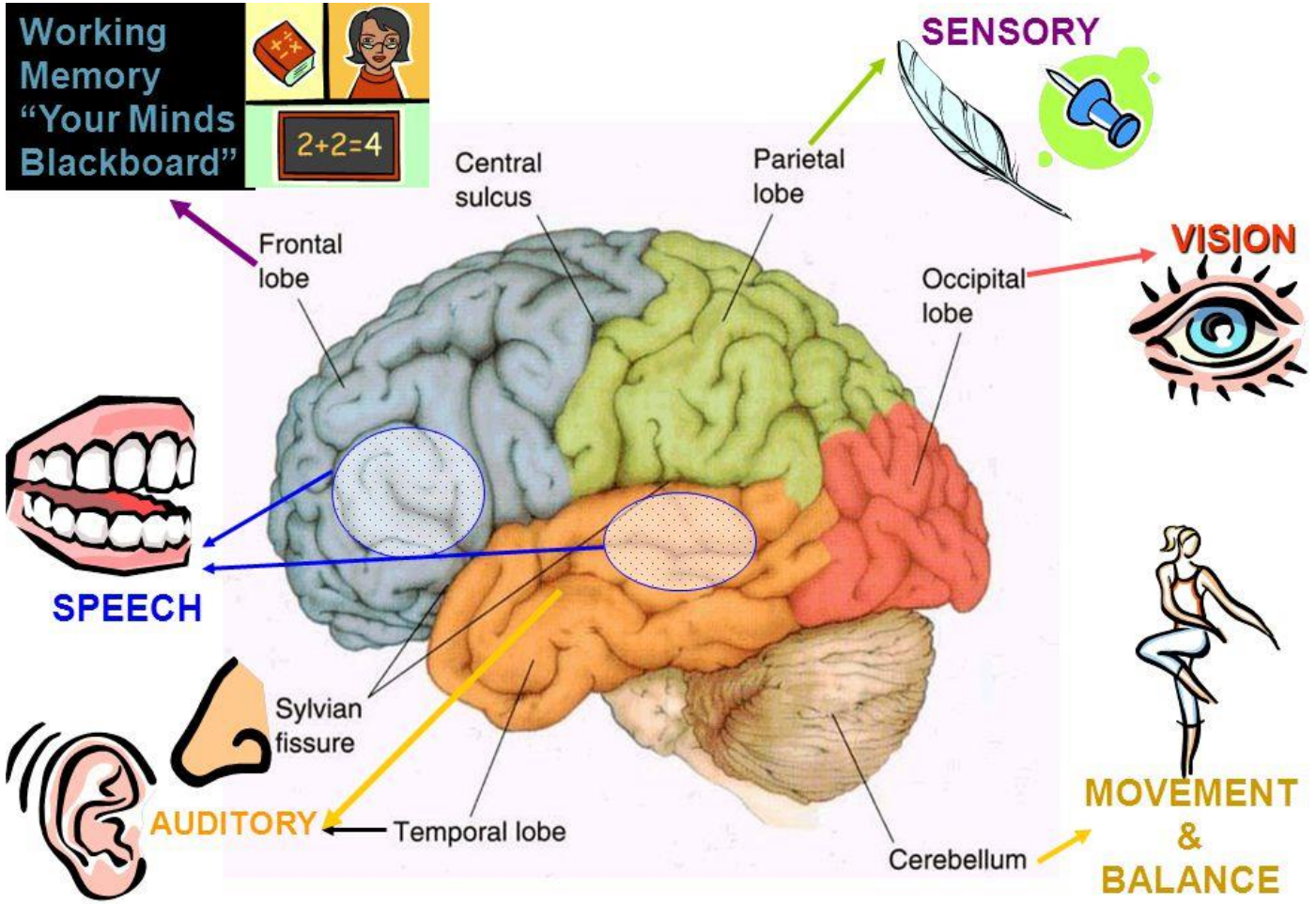
Receptors

- Our senses mainly detect (with receptors) energy or matter

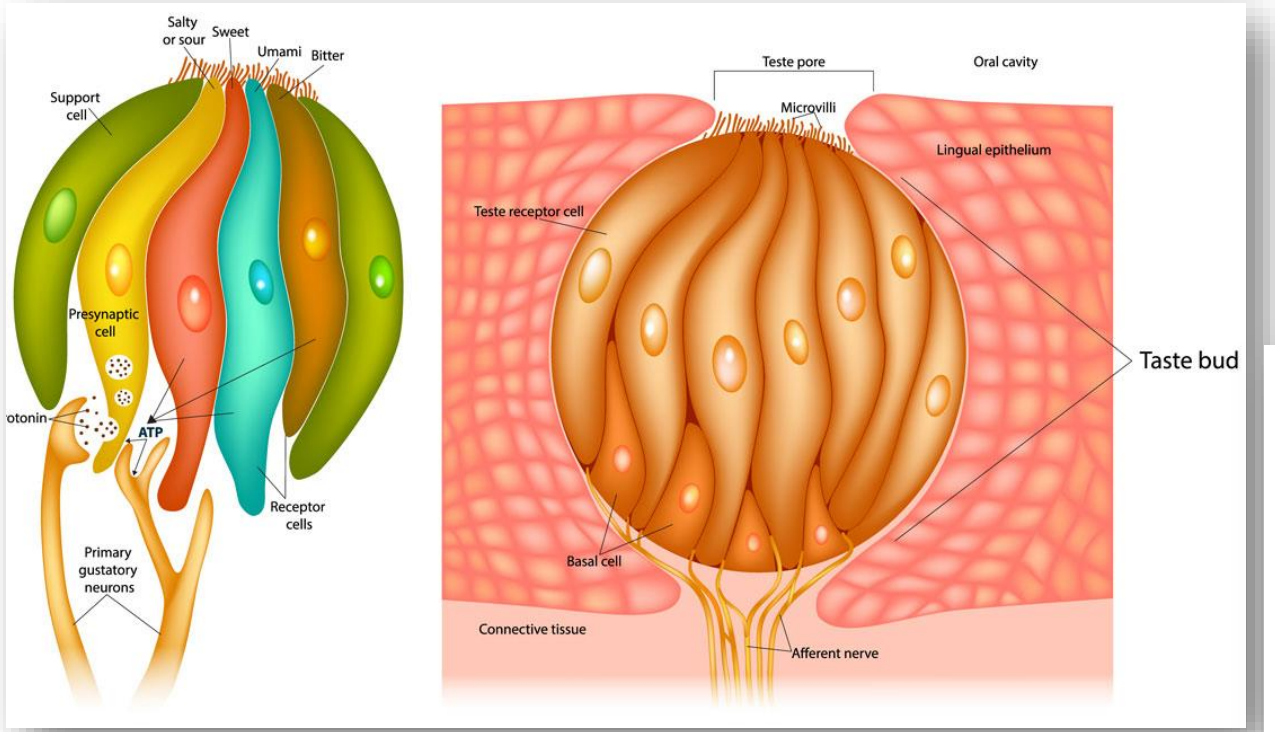
1. **Chemoreceptors:** Sensors of chemical molecules in the air or water → **Taste and smell**
2. **Touch receptors:** Sensors of mechanical pression on the skin → **Touch** (pression and vibration)
3. **Mechanical receptors:** Sensors of the pression derived from sound waves in the tympanum → **Audition**
4. **Photoreceptors:** Sensors of the electromagnetic radiation → **Vision**

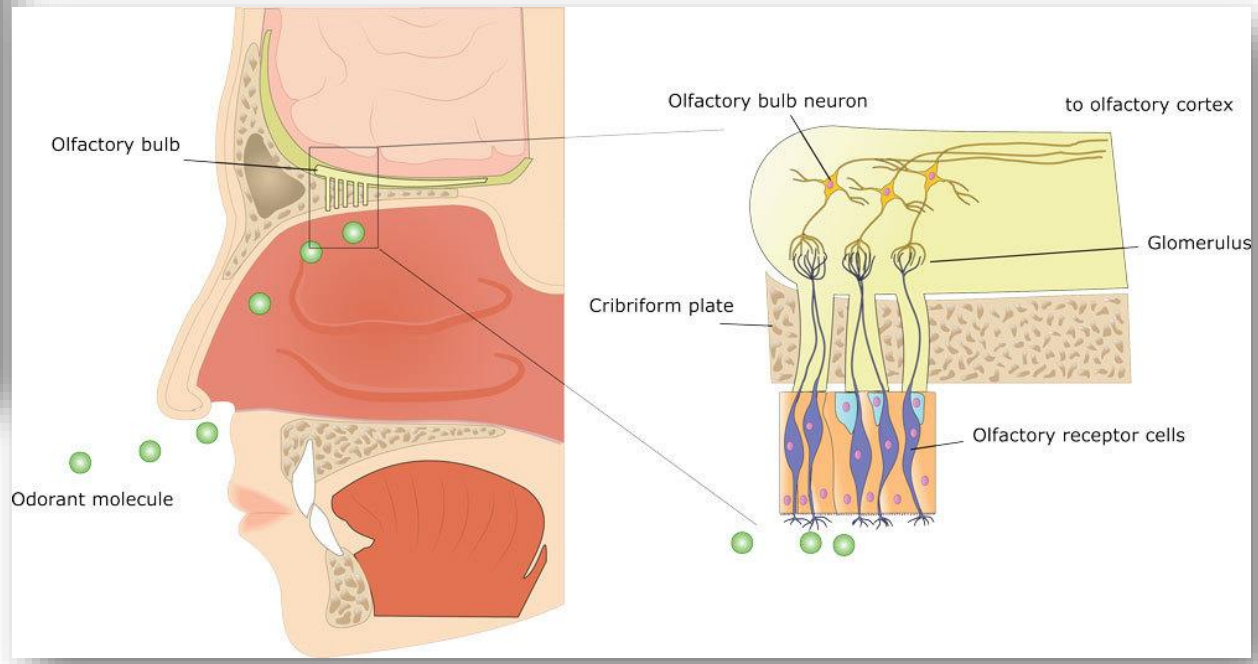
Cerebral cortex

Where does perceptual experience occur?

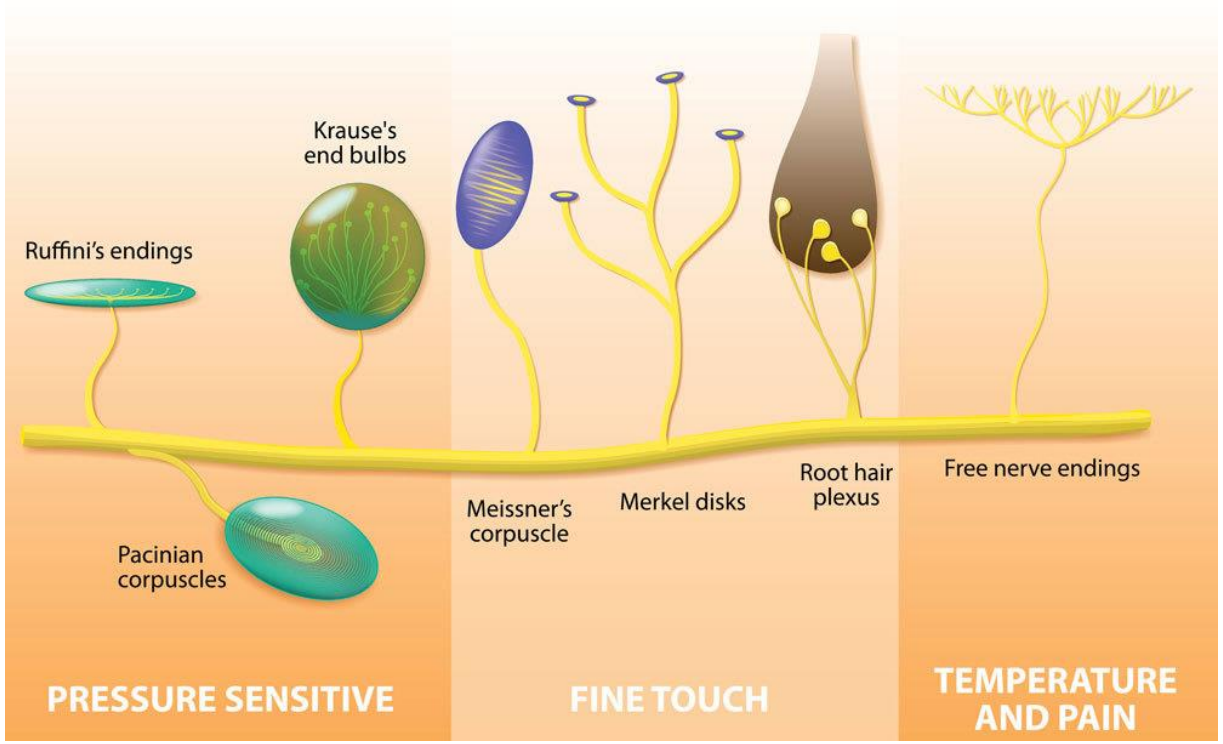


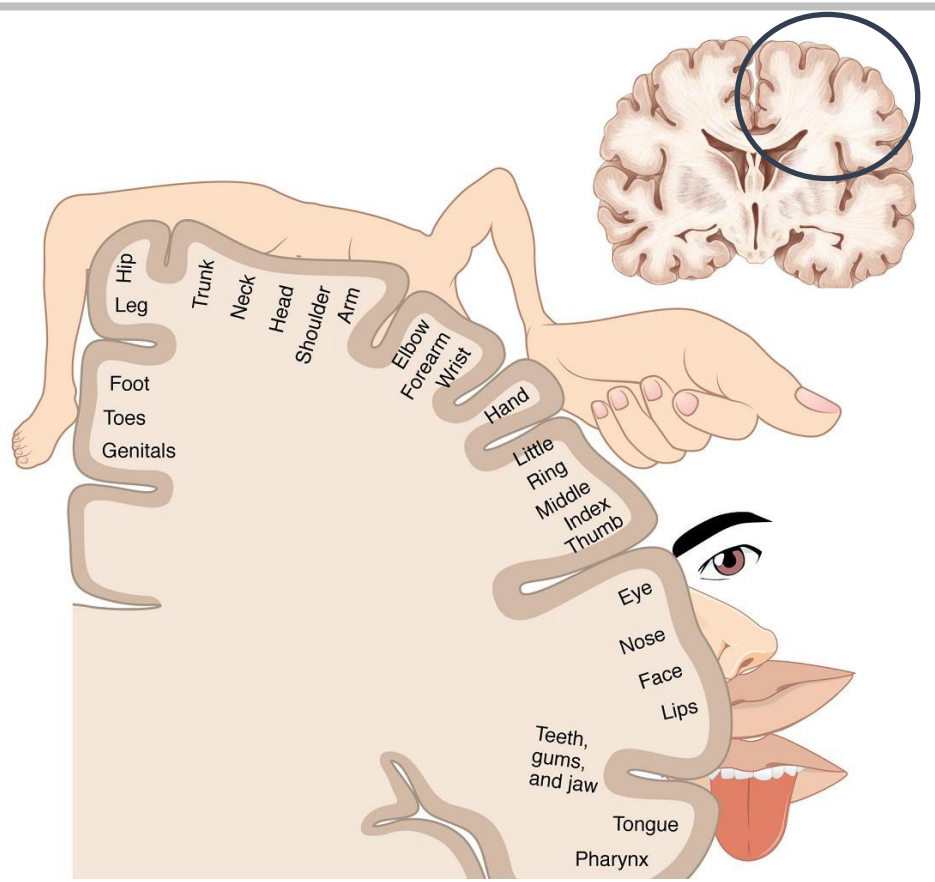
Taste and smell





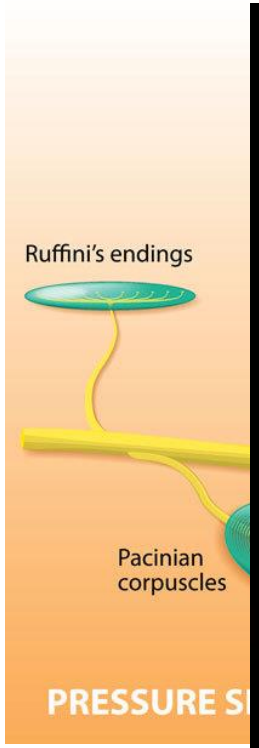
Touch

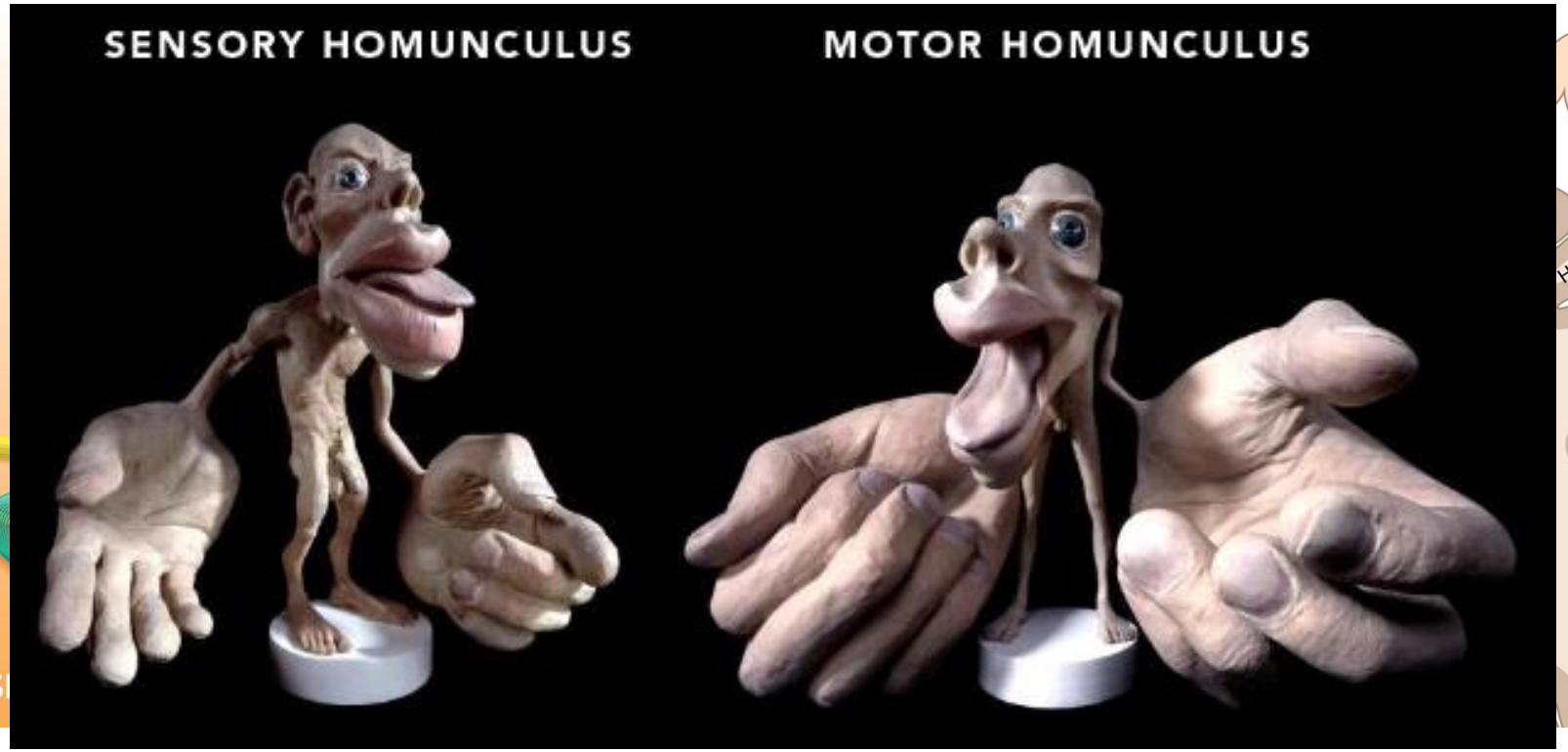


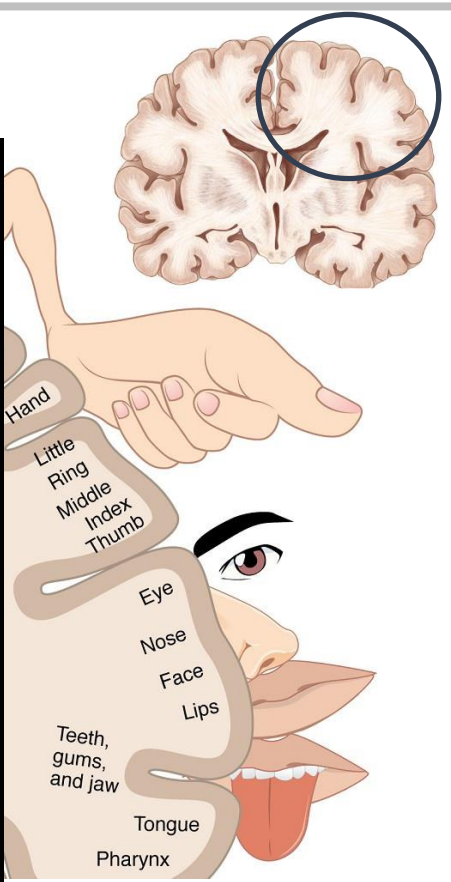


Touch

Penfield Homunculus





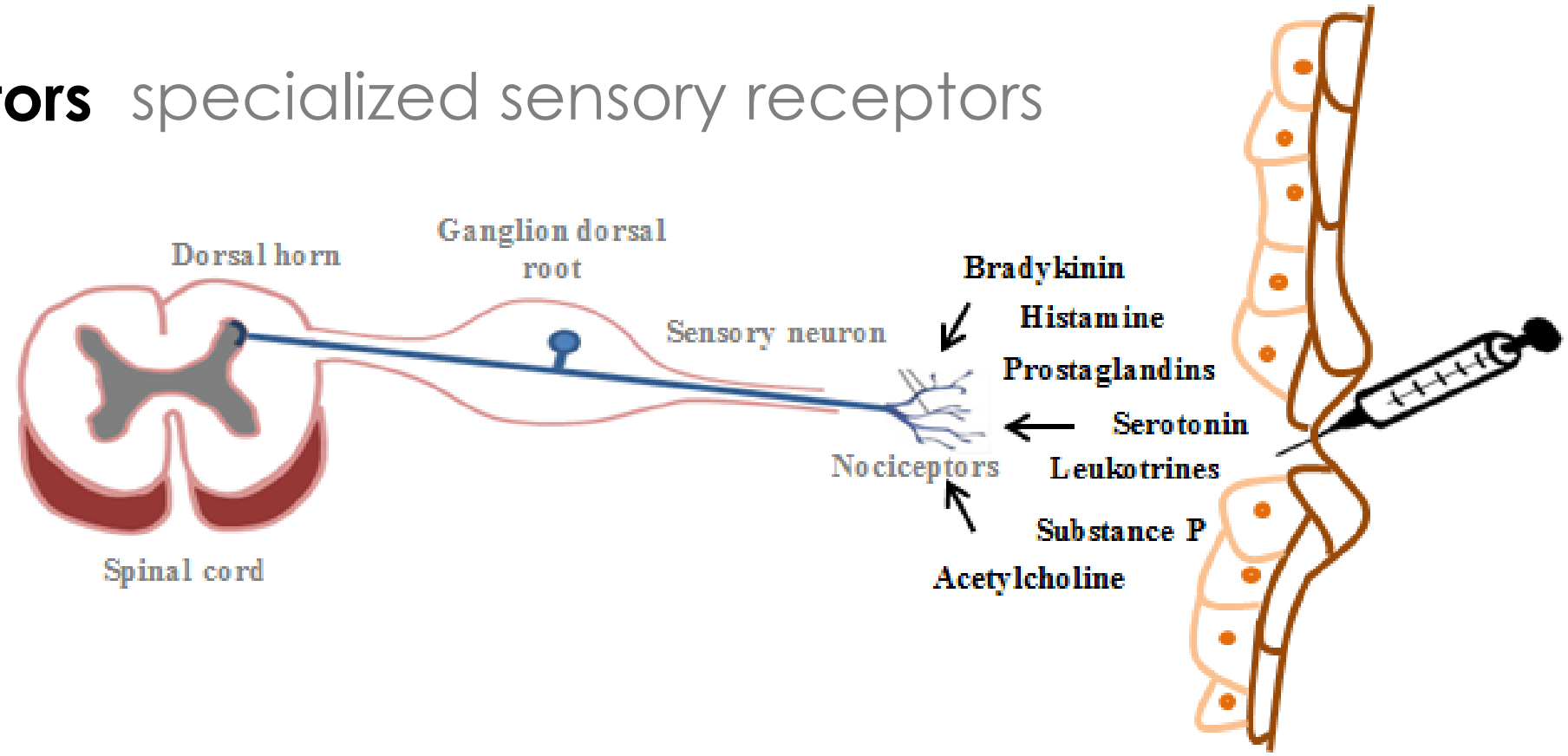


How many nerves are involved?

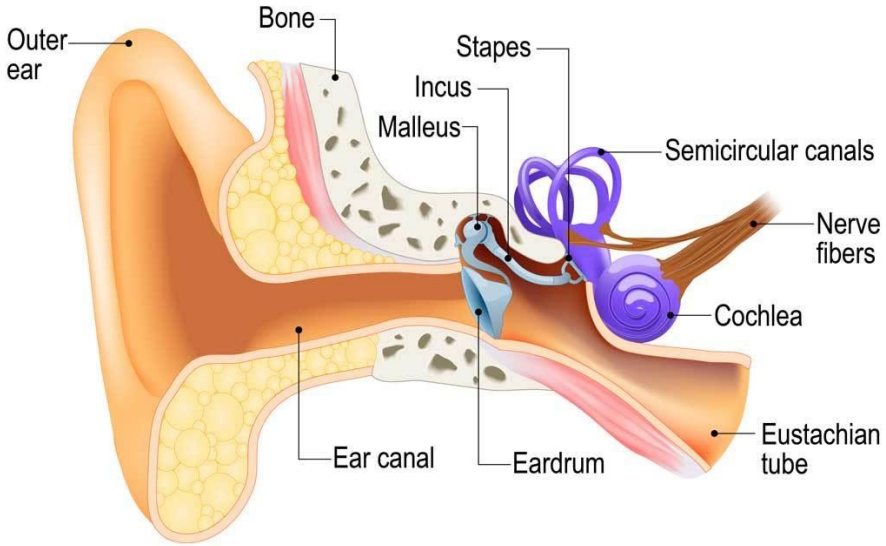
Pain is different!

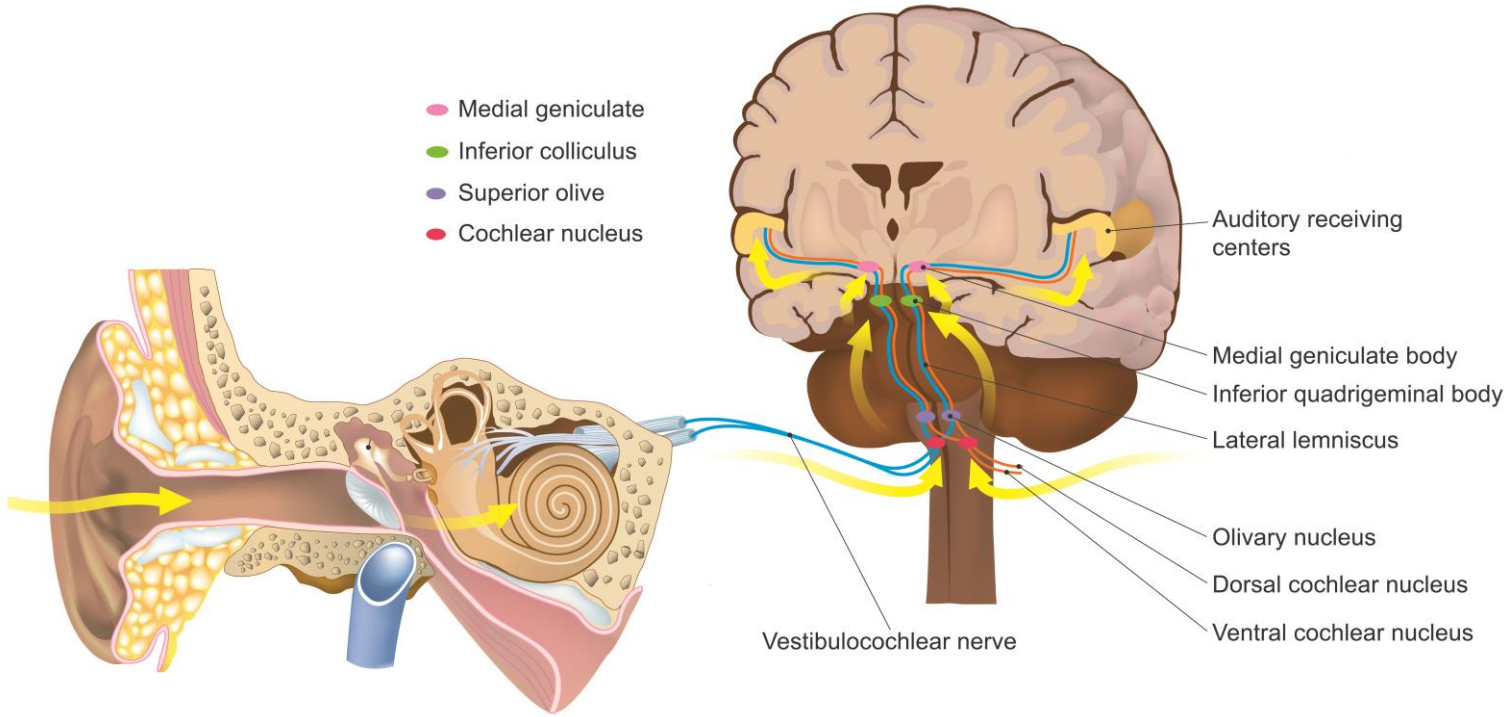
PAIN essential function for survival

Nociceptors specialized sensory receptors

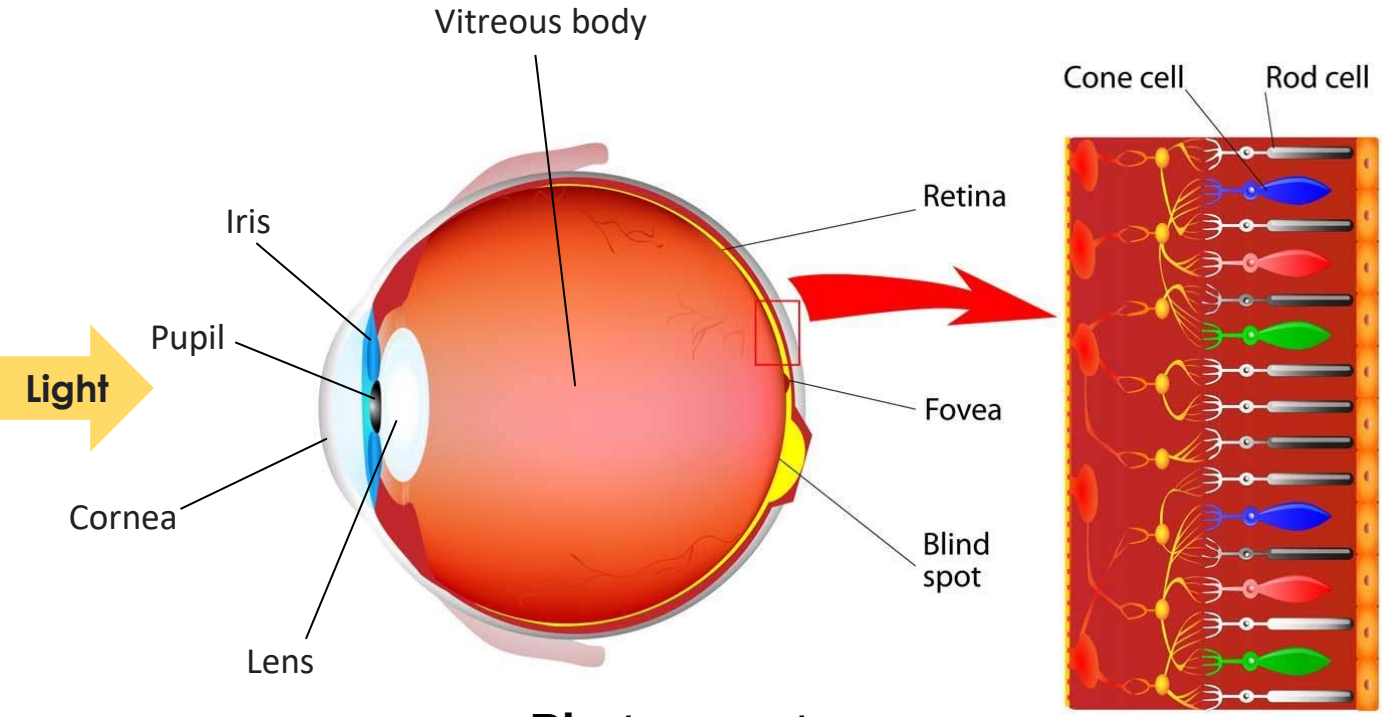


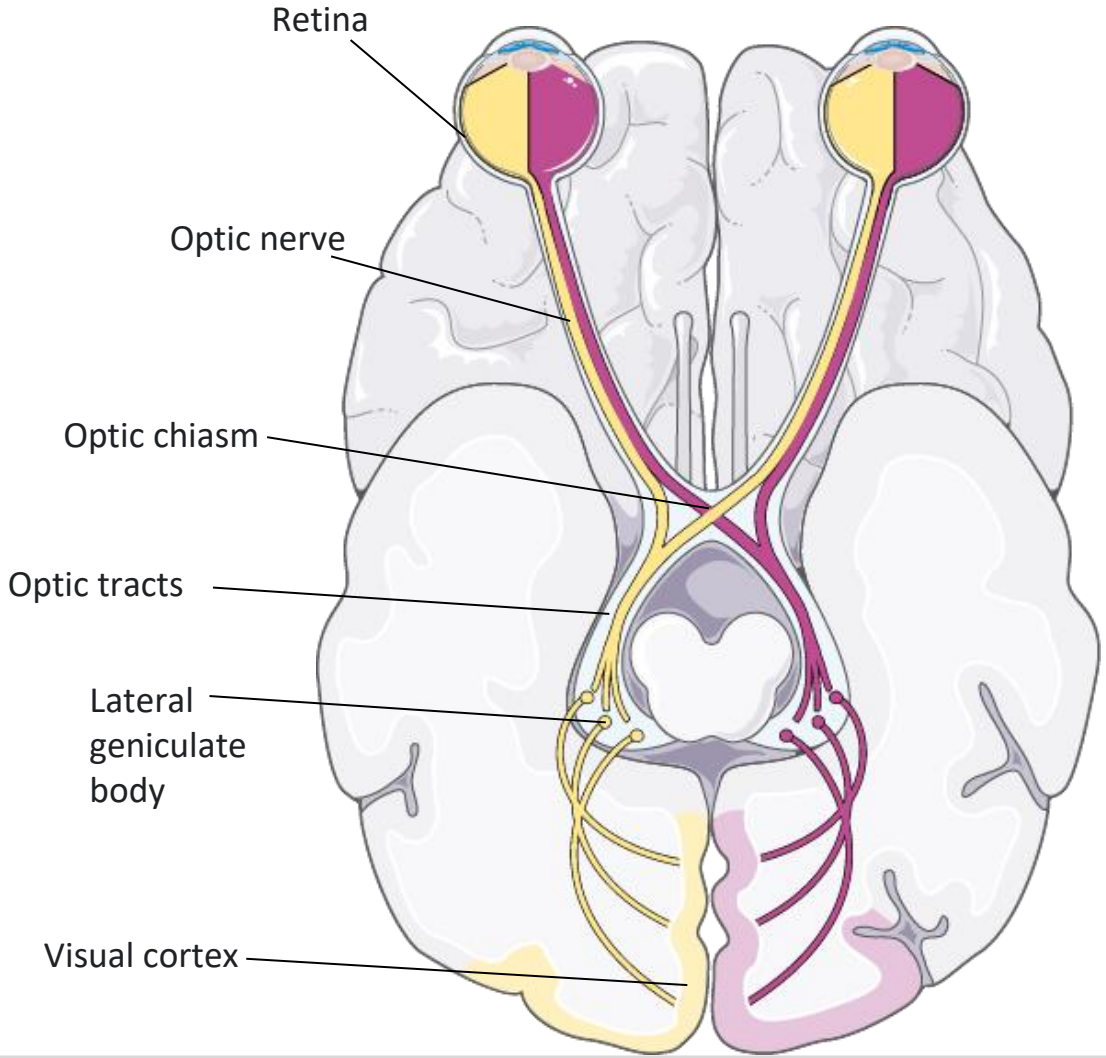
Audition





Vision





Photoreceptors

Rods are responsible for vision at **low light levels**

Cones are responsible for vision at **higher light levels**

Bottom-up & Top-down

BOTTOM-UP

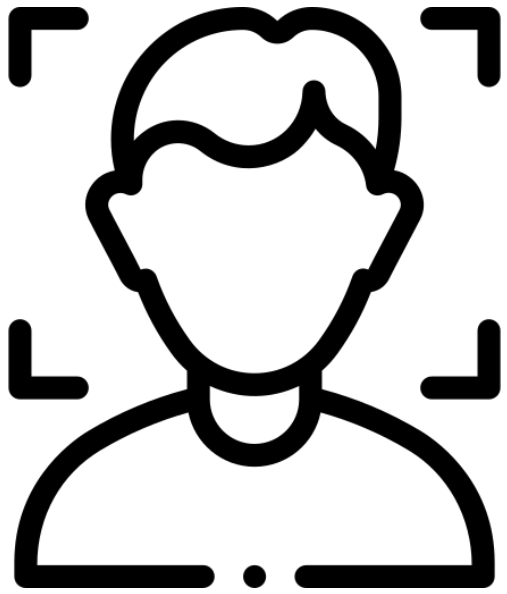
- **Start: receptors stimulation**

No context to give it a specific meaning

TOP-DOWN

- **Start: knowledge (conceptually driven)**

Two different context:
your perception is driven by your cognitive expectations

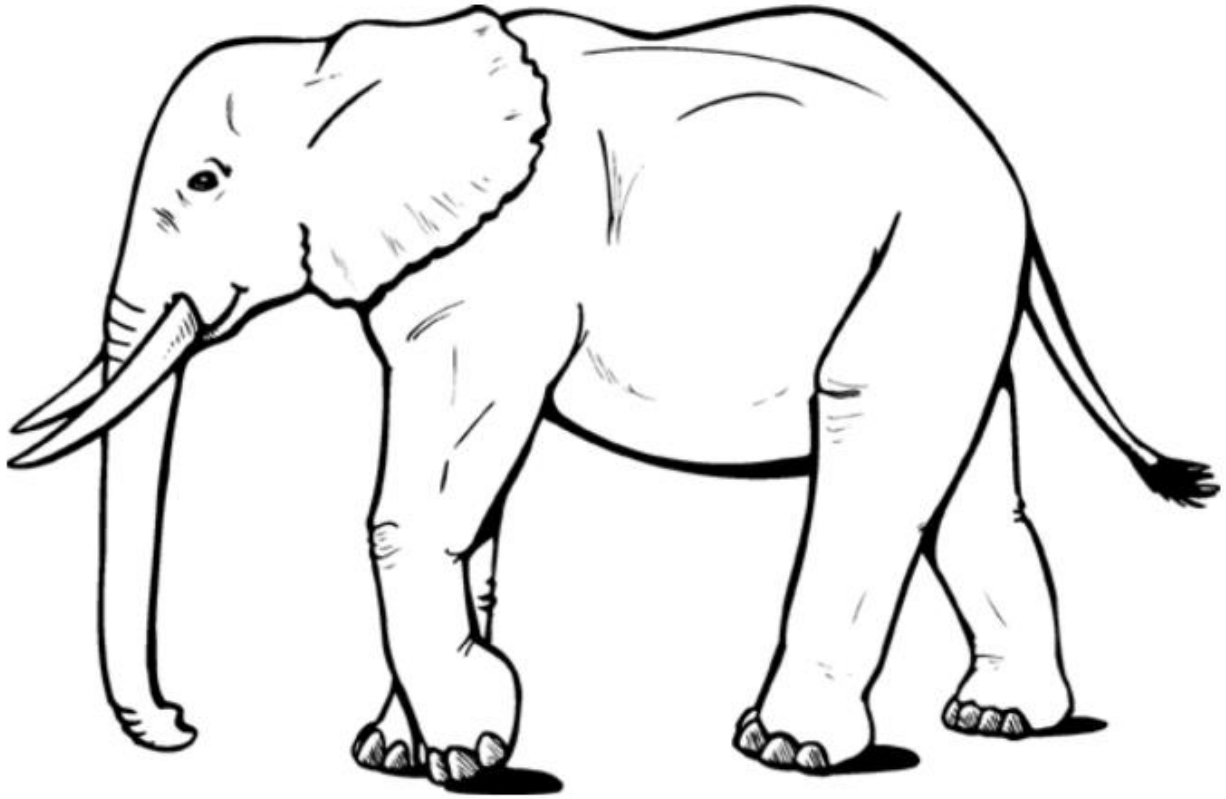


Object and face recognition

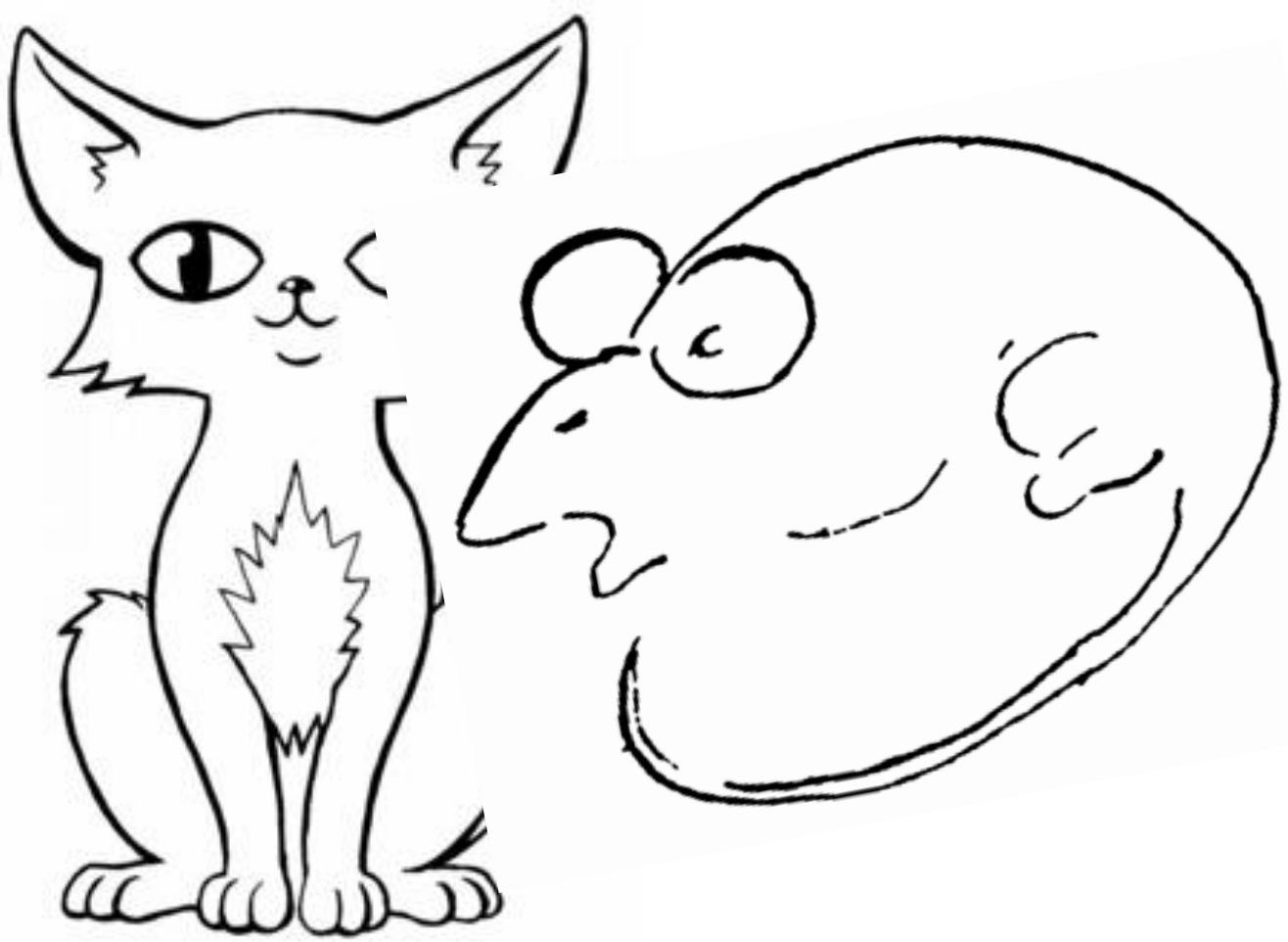
Bottom-up & Top-down experiment

Half a class: close your eyes

Bottom-up & Top-down experiment



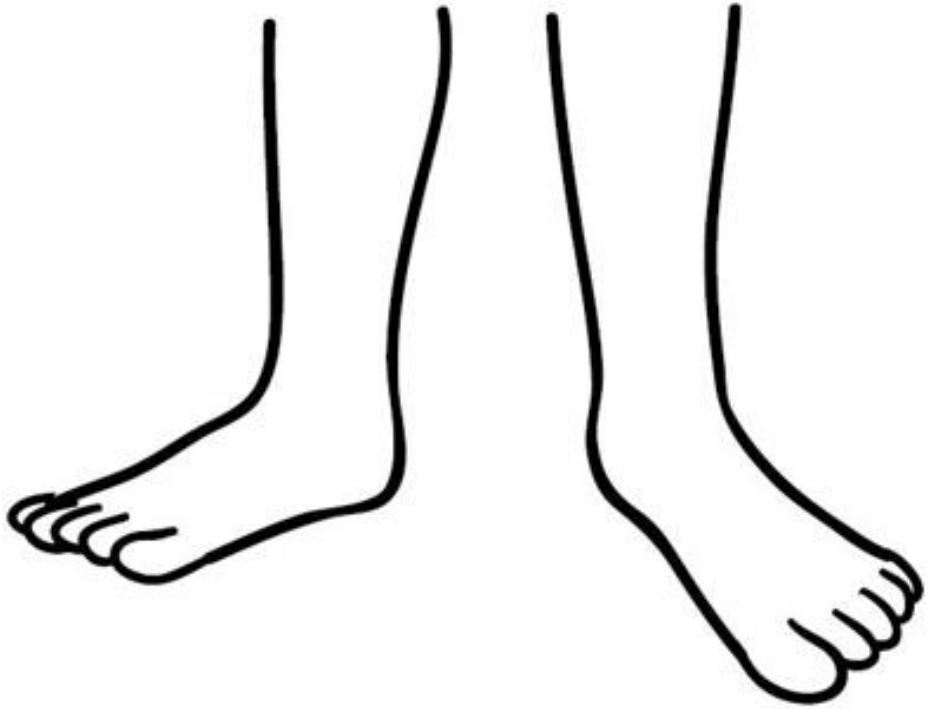
Bottom-up & Top-down experiment



Bottom-up & Top-down experiment

Half a class: close your eyes

Bottom-up & Top-down experiment



Bottom-up & Top-down experiment

Bottom-up & Top-down experiment

what is this?

Recognition processes

01 Pattern Recognition

02 Perceptual Organisation

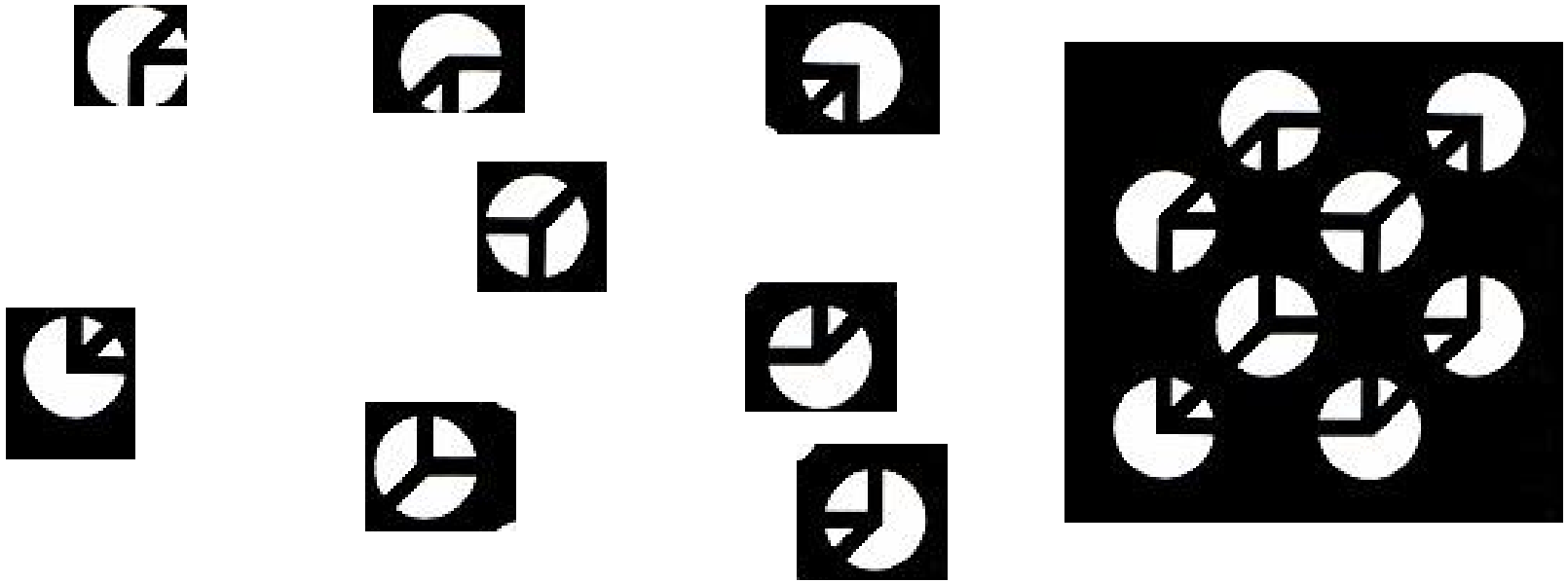
03 Object Recognition

04 Face Recognition

Perceiving is organizing information

- World provides us with too much information
  - Coherence
  - Structure
  - Essential information
  - Selective attention

What do you see?

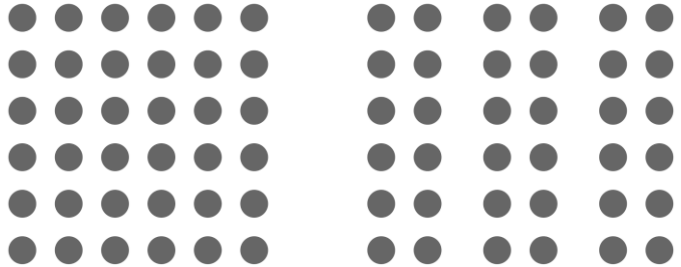


Gestalt Principles

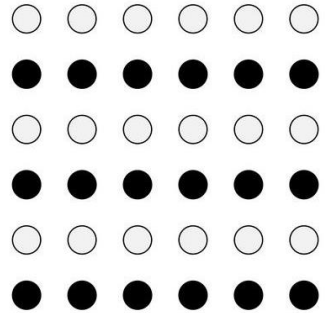
- Our brains go through a process of information restructuration and try to find a shape (*Gestalt*)
- This shape does not really meet the a "trigonometric analysis" but rather tries to meet some sort of known pattern
- Gestalt principles, and perception in general, tries to find a normal relation between the figure and the background
- Perception: "the whole is greater than the sum of its parts"

GESTALT Perceptual Organization

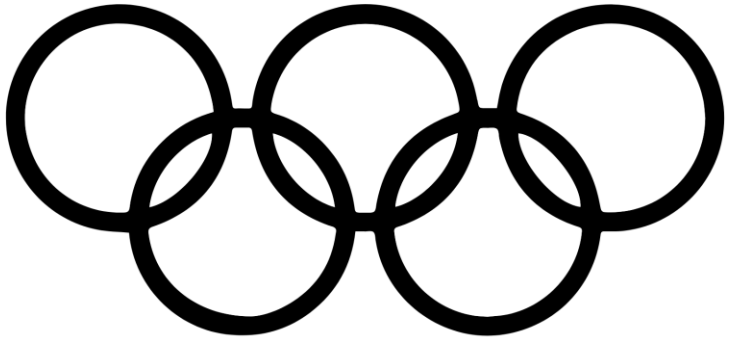
- Proximity



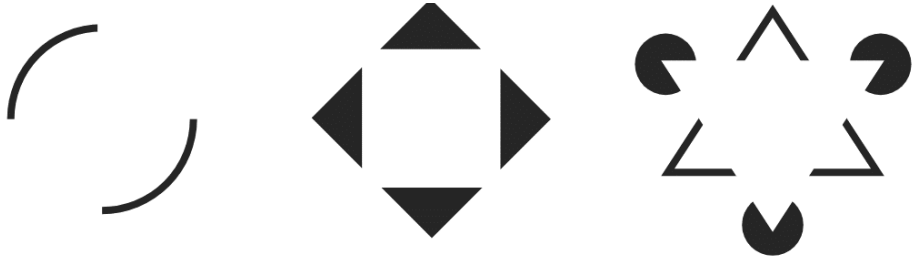
- Similarity



- Continuation



- Closure

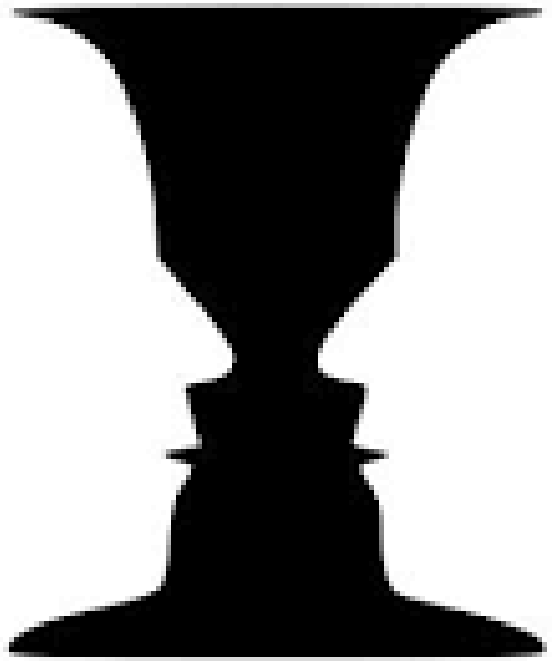


Exercise. Find examples in real life of:

- Proximity
- Similarity
- Continuation
- Closure

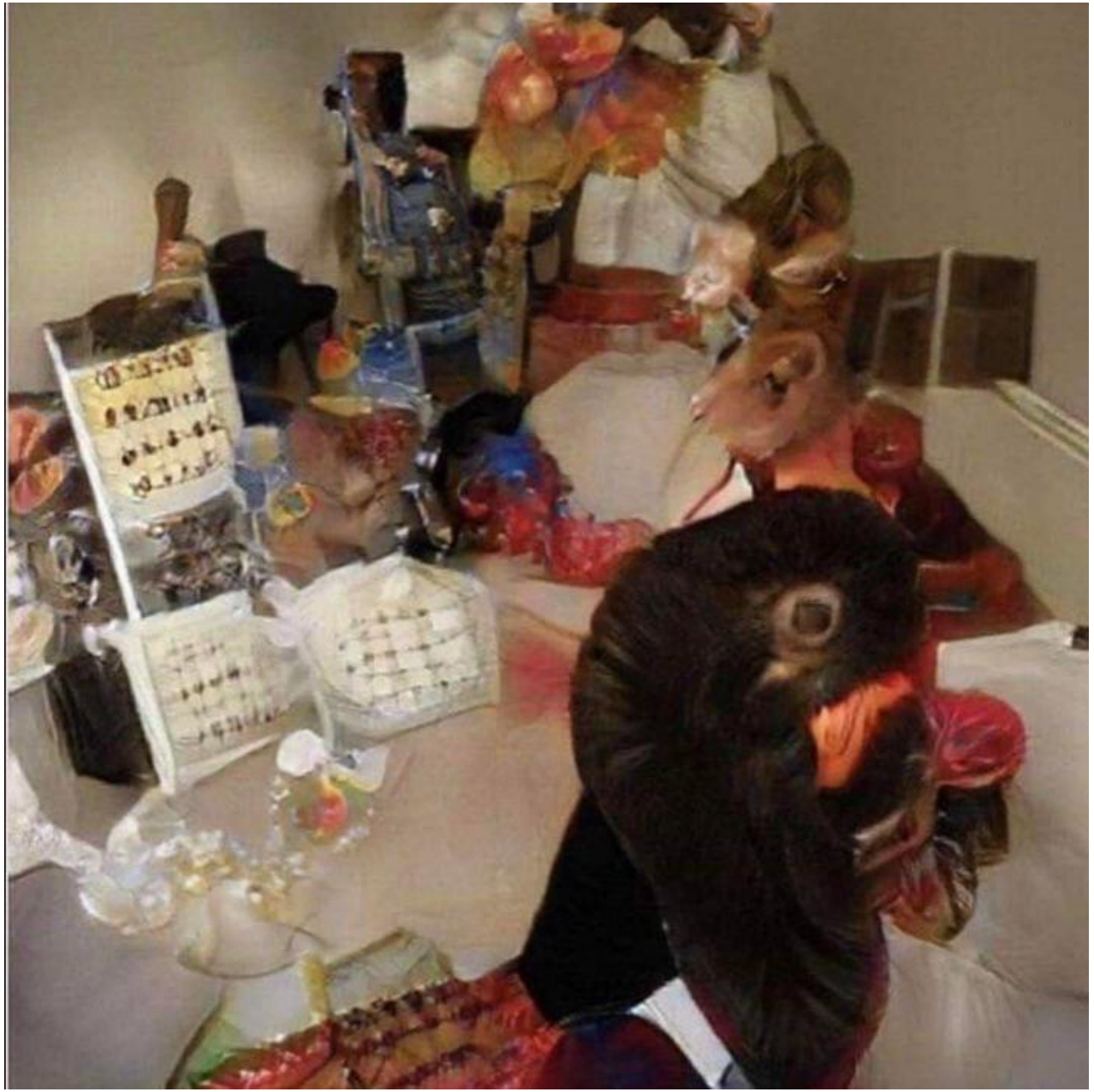
Perceptual organization: Figure & ground

- The most elementary perceptual organization
- It might include ambiguity
- This organization exists only on our minds, not in the stimulus
- It can exist also in other perceptual modalities



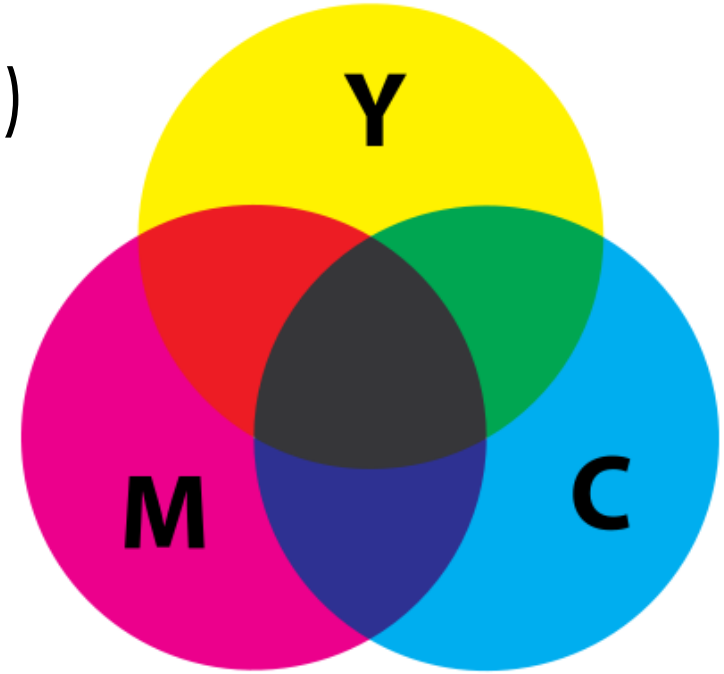
Completely Automated Turing Test to tell Computers and Humans Apart

- Why do you think is so difficult for a computer to recognize this?
- What does it say about our pattern recognition ability?
- How does this relate to Gestalt principles?



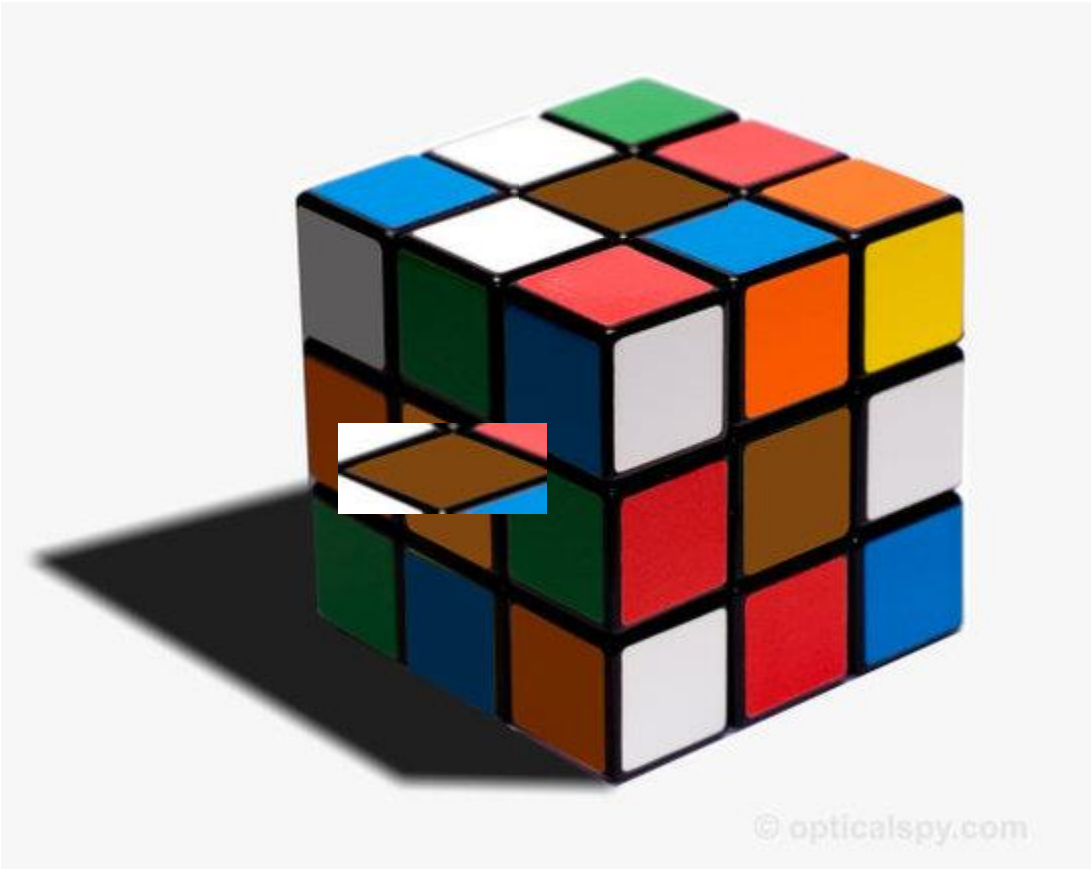
Colour Representation

- Our eyes can only perceive three colours
  - Light or dark (rods)
  - Red, blue and green (cones)
- The combination of these 4 elements (CMYK) allows the perception of all possible colours:
  - Cyan – Yes / No
  - Magenta – Yes / No
  - Yellow – Yes / No
  - Black (light) – Yes / No



Colour constancy

- Colour perception depends not only on wavelengths
- Our brains correct the light in order to obtain the most likely interpretation
- Otherwise, our world would be changing constantly



Colour Constancy

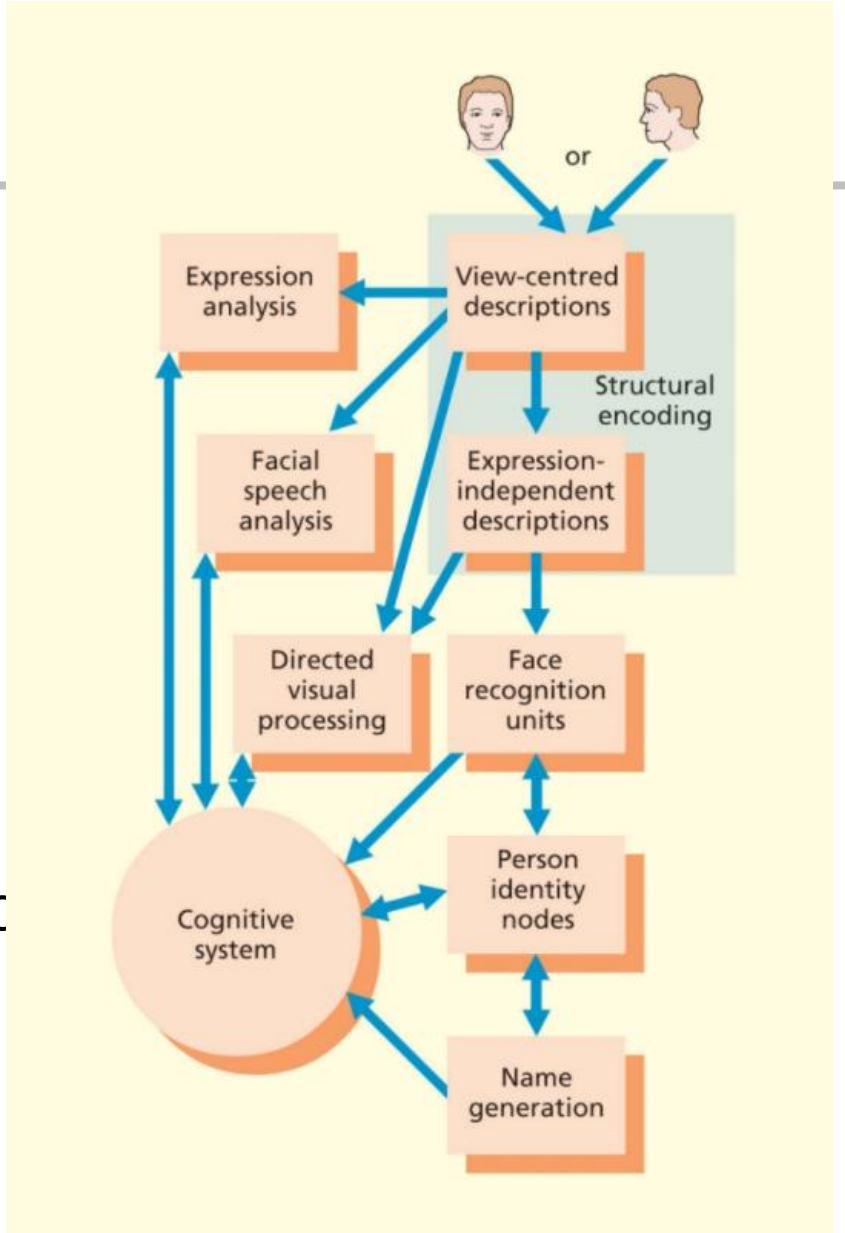
Face recognition

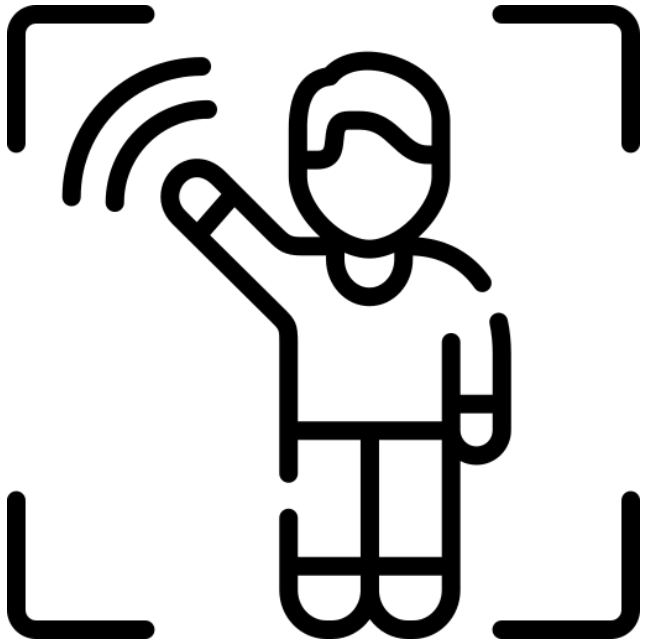
- One of the first social competences acquired
- Even before developing completely their visual perception, children prefer looking to faces than to other patterns and forms
- This has relation to our survival but is based on social bindings

Face recognition

Face recognition model

- **Structural encoding:** Face representation
- **Expression analysis:** Emotional state
- **Facial speech analysis:** Lip reading
- **Direct visual processing:** Specific facial informatio
- **Face recognition units:** Structural information of known faces
- **Person identity nodes:** Information about individuc
- **Name generation:** Different storage
- **Cognitive system:** Additional information





Motion Perception

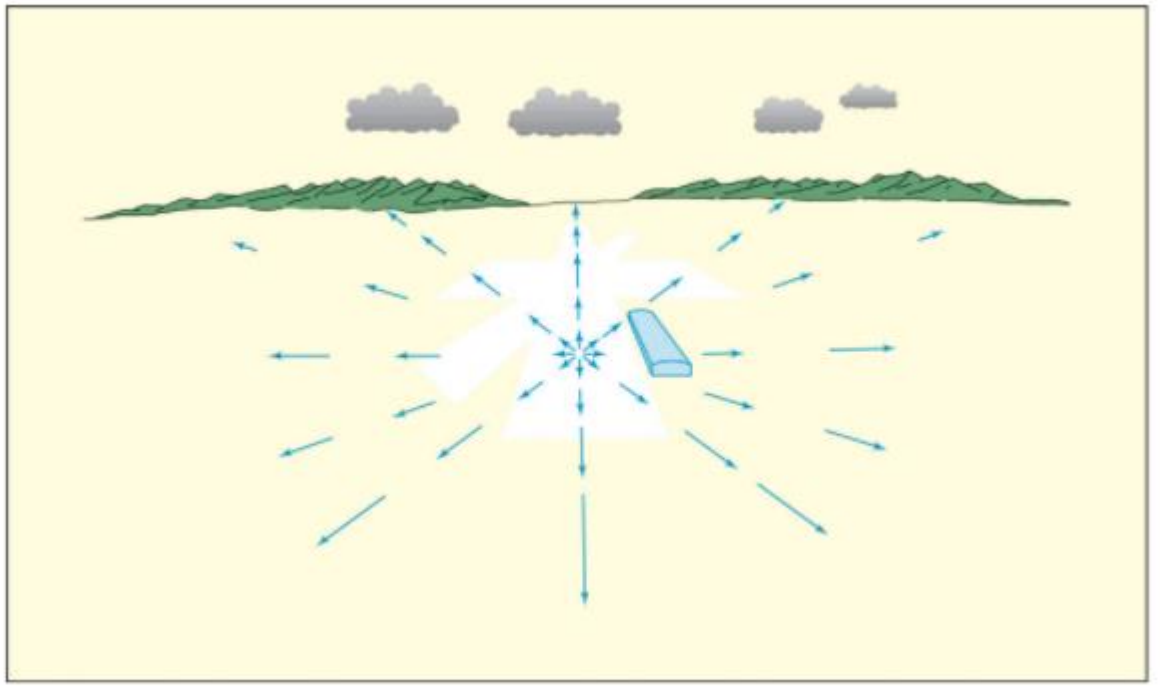
Gibson's Direct Perception

- Perception involves keeping in touch with our environment
  - **Optic array:** Pattern of light containing all visual information from the environment
  - It provides unambiguous or invariant information about the layout of objects: optic flow patterns, affordances, texture gradients.

When I assert that perception of the environment is direct, I mean that it is not mediated by *retinal* pictures, *neural* pictures, or *mental* pictures.
Direct perception is the activity of getting information from the ambient array of light. I call this a process of *information pickup* that involves, looking around, getting around, and looking at things. (Gibson, 1979)

Gibson's Direct Perception

- **Invariants**: Elements that remain unaltered as observers move around the environment
- **Optic flow** is fundamental in order to assess focus
- **Affordances**: Potential use of objects. Opportunities for action



Depth and distance perception

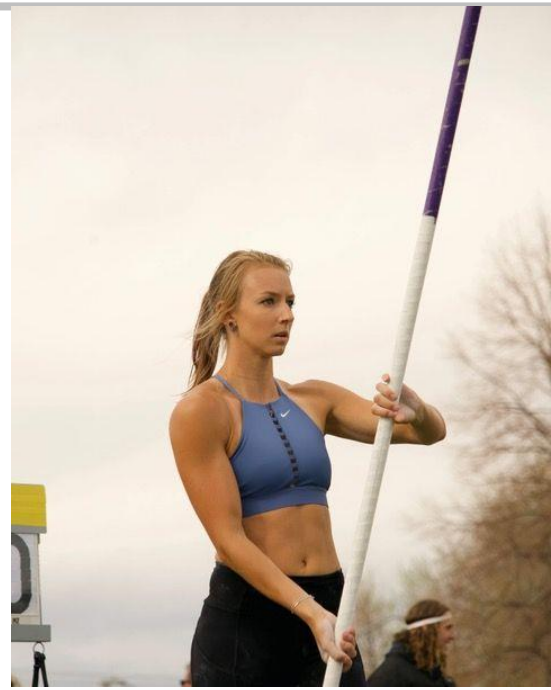
- Beyond the physiological keys…
- Visual keys
  - Static:
    - Interposition
    - Size
    - Perspective
  - Dynamic
    - Relative speed of objects depending on distance

Affordances

- The potential actions are directly perceivable in objects
  - E.g. climbable / graspable

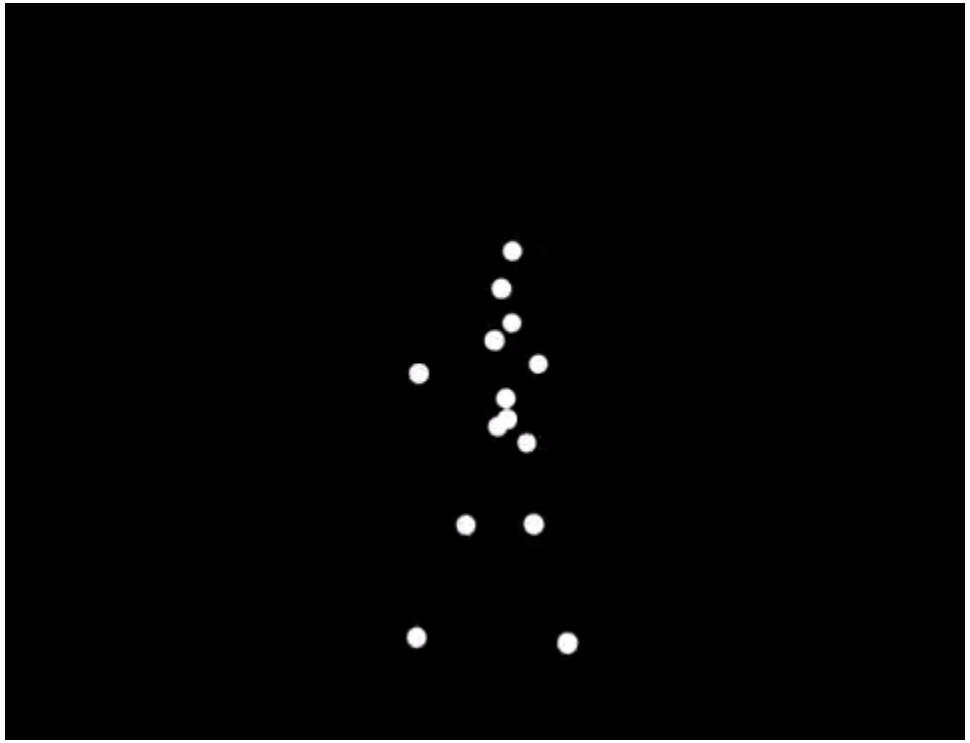
- These affordances are activated even before recognition of the object
  - Motor priming is activated even below the level of conscious awareness

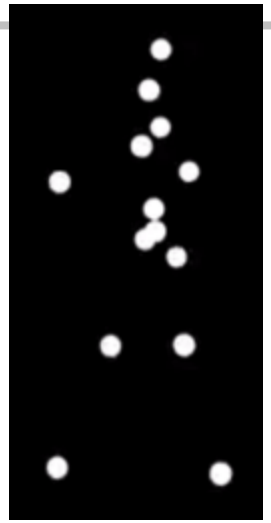
Visually Guided Action: Planning control model

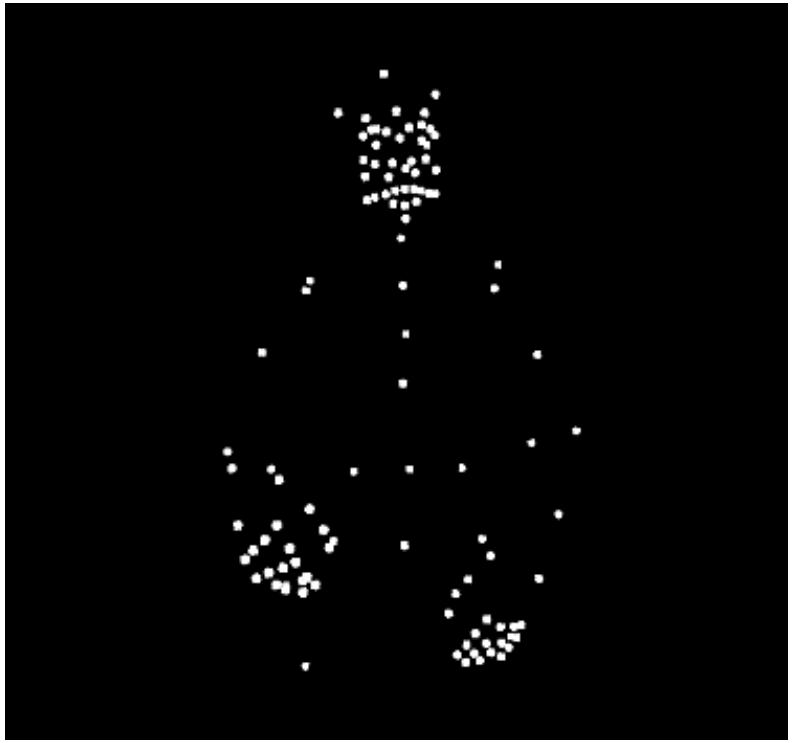


- **Planning system**
  - Before initiating the movement
  - Selection of appropriate target and how to interact
  - Mediated by intentions and motivations and the visual context
  - Slow as it uses a lot of information
- **Control system**
  - During the movement
  - Ensures accuracy, adjusts based on visual feedback. Involves proprioception
  - Influenced by target characteristics (e.g., size, orientation), not by context
  - Fast as it uses little information

Motion perception







Human (biological) motion perception

- Innate ability to perceive biological motion (1-3 days)
- Bottom-up process… but requires attention
- We perceive better motions that resemble or own repertoire (i.e., Human > Dog > Seal; Cohen, 2002)
- Only perception that we can produce as well as perceive
- Great source of social and emotional information
- Parkinson's and paraplegic individuals have lesser ability to detect human motion

Mirror neurons

- Our premotor cortex includes a so-called mirror neuron system
- This system presents the same activity when we perform an action than when we see someone else performing it
- It allows imagery practice of abilities or even muscle and skeletal recovery from injuries

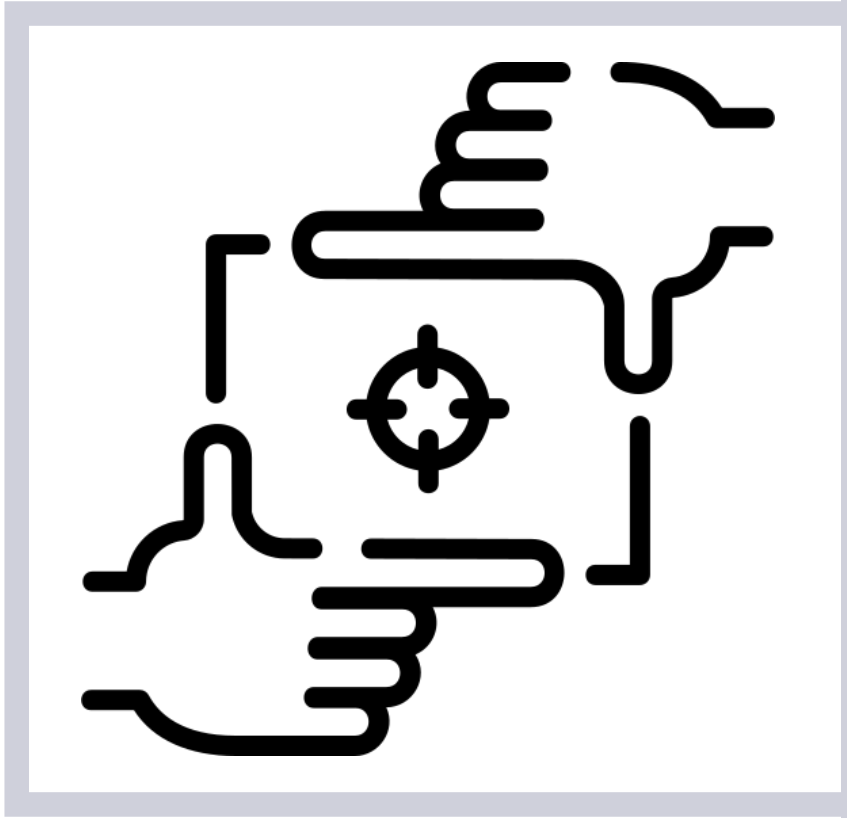
Change blindness / Inattentional blindness

- **Change blindness**: Inability to detect changes in visual scenes

- **Inattentional blindness:** Failure to detect an unexpected object in the visual environment

Inattentional blindness

- Attentional test:



Attention and Performance

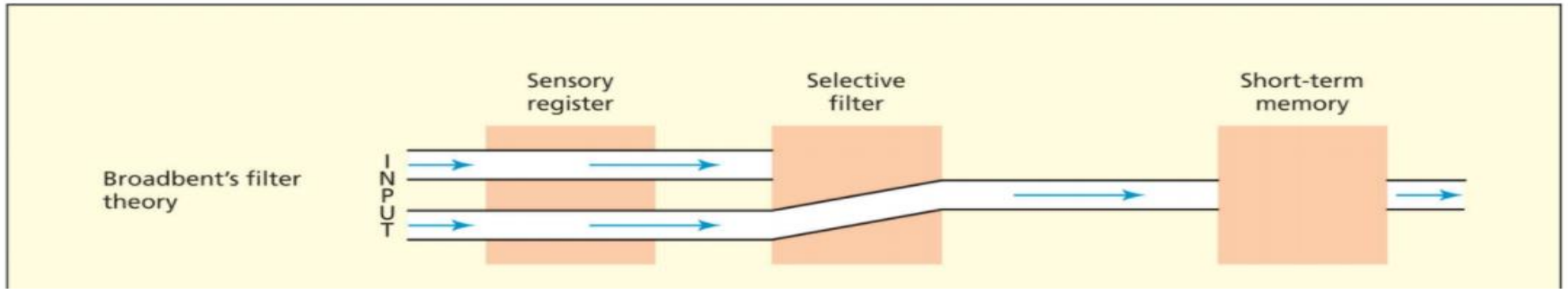
Attention

- **Definition:**

  "Central mechanism of limited capacity whose function is to control and orient the conscious activity of the organism towards a specific objective"

(Tudela,1992)

Filter theories

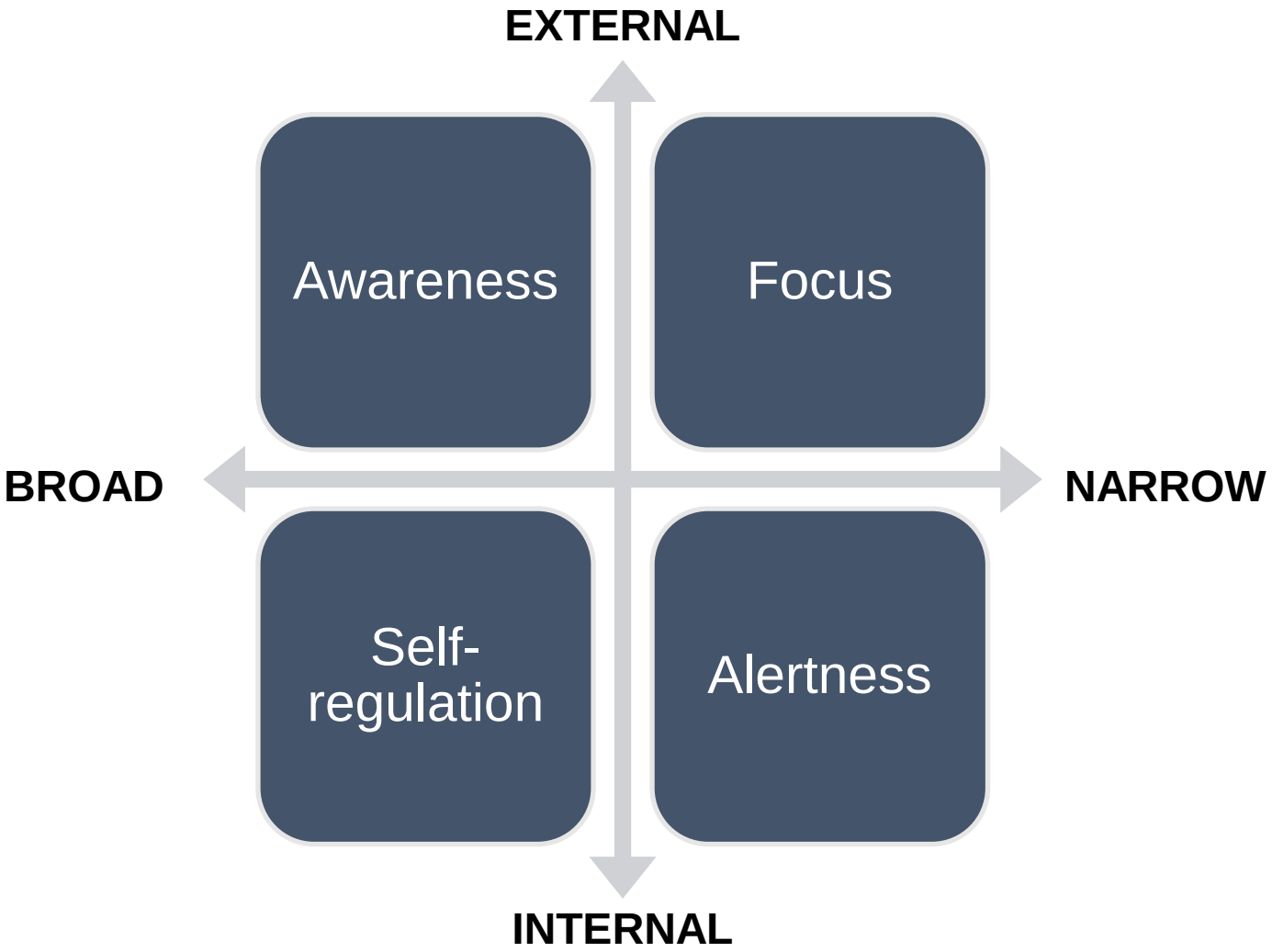


Filter theories

- If we are able to process information even from the unattended message:
  - Filter might not be so early in processing (precategorial)
  - Filter might not be dichotomous
  - Filter might not be so hermetic

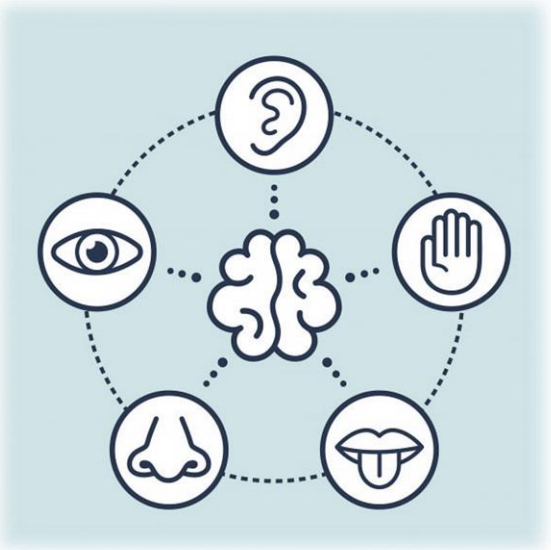
E.g., If you listen your name somewhere else while attending a lesson / conversation

Nideffer's attentional styles



Exercise

- Think about examples of sporting situations in which using one or the other attentional style might be more adequate.



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Cognitive Processes
Perception and Attention

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