

# Sensory systems

- **Sensation** - is how the senses deliver signals to the CNS about the current state of the world
- **Perception** - is how an individual interprets these signals in terms of previous experience, knowledge of the world and expectation
- sensory systems: sensory receptor, afferent pathway, central projection

# Components of sensory pathways

# Stimulus

- any change in the external environment or internal milieu
- a stimulus is only registered to the extent that we possess the machinery to transduce that stimulus into a neural signal
- sensory organs steer stimuli to sensory receptors

# Stimulus

- transduction – conversion of stimulus energy into a receptor potentials (mostly depolarization)
- transformation – conversion of receptor potential into action potential

# All sensory systems convey

types of information:

1. **modality** (what it is)

2. **location** (where)

1 and 2 - labelled line coding

3. **intensity** (how much)

4. **timing** (when)

3 and 4 - frequency coding

# Modality

- is a property of sensory nerve fiber that is activated primarily by a certain type of stimulus
- the axon of the receptor functions as a modality-specific line of communication; activity in the axon necessarily conveys information about a particular type of stimulus
- each sensory nerve fiber makes specific connections to structures in the CNS whose activity give rise to specific sensation

# Sensory receptors - types of energy

**mechanical** - touch, pressure, sound ...

**chemical** - taste, olfaction, osmoreceptors...

**thermal** - warm and cold receptors (skin, hypothalamus)

**electromagnetic** - photoreceptors

# Sensory receptors - structure

- encapsulated receptors - touch, pressure..
- free nerve endings – myelinated and unmyelinated – nociceptors, thermoreceptors



# Receptors

- **slowly adapting** - tonic (carotid bodies, nociceptors ..)
- **rapidly adapting** - phasic (cones, muscle spindle, olfactory receptors.....)

# Receptive field

- the range of locations where stimulation will excite a sensory receptor  
e.g. skin sensation, vision

# Stimulus intensity coding

Frequency of AP and a number of receptors activated.

# Perception and stimulus intensity

**psychophysical law:**

$$R = K \times S^A$$

R... sensation felt

S... stimulus intensity

K, A... constants

Stimulus duration coding - pattern of generated APs

# Sensory systems have a common plan

- populations of sensory neurons convey sensory information + somatotopic organization
- hierarchy: cortex - thalamus
- parallel and serial processing

# Somatosensory system

- different types of receptors
  - 1) touch, vibratory sense, proprioception
  - 2) crude sensation, temperature, pain
- primary somatosensory cortex - postcentral gyrus

# Pain

- an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”
- subjective
- stimuli:
  - thermic above 45°C or below 5°C (thermoreceptors)
  - intensive mechanical - sharp, localized pain (mechanoreceptors)
  - mechanic, thermic and chemical - diffuse pain (polymodal receptors)



# Pain

- acute (physiologic) x chronic (pathologic)
- surface, deep, visceral

- referred pain
- modulation of pain:
  - endogenous opioids
  - spinal cord mechanisms (rubbing close to the wound decrease pain)
  - brainstem mechanisms: periaqueductal grey, serotonergic and noradrenergic descending pathway

# The ear has three functional parts

- capturing mechanical energy
- transmission to the receptor organ
- transduction into electrical signals

# Optical apparatus

- refractive power (app. 60 D): cornea and lens
- accommodation: changes of refractive power of the lens to focus on near point or far point

Myopia (nearsightedness)

Hypermetropia (farsightedness)

Presbyopia

# Pupils

- 2-8 mm
- regulation of light intensity
- miosis = constriction, parasympathetic NS, m. sphincter
- mydriasis = dilatation, sympathetic NS, m. dilatator
- pupillary light reflex: direct and consensual