

Chapter 4

Sensory Systems

- Sensory nervous system is responsible for movement monitoring and relaying information back to the CNS
- Sensory detection enables us to be aware of the external world and internal body functioning.
 - Plays a role in maintaining tissue homeostasis
- Sensory system is also responsible for initiating reflex movements that do not require participation from the brain
 - Reflexes are stereotyped and repeatable motor actions in caused by stimulation of sensory receptors.

Sensory Receptors

- Receptors are special organelles designed to detect stimuli from the environment and translate that stimuli into electrical signals
- Classification schemes for sensory receptors include type of stimulus detected and location of receptor
 - Type of stimulus
 - Mechanoreceptors, thermoreceptors, and so forth.
 - Location
 - Interoceptors/visceroreceptors
 - Exteroreceptors
 - Proprioceptors

Receptor Function

- A stimulus causes the receptor to form action potentials that are sent along its sensory neuron to the spinal cord.
 - The pattern and firing rate of these action potentials are directly related to the strength and nature of the stimuli.
 - Receptor sensitivity is the ability of a receptor to detect or discriminate a stimulus
 - Receptor acuity is similar to sensitivity, but generally refers to groups of receptors working together

Receptors and Body Awareness

- Visceroreceptors are in the viscera and provide information on physiological processes contributing to viscer-awareness
- Exteroreceptors are in the skin and membranes exposed to the outside world, provide info on the external environment
- Proprioceptors are in the musculoskeletal system and provide information on movement
- Somatoreceptors (exteroreceptors + proprioceptors) contribute to somatosensory awareness (kinesthesia)
- Viscero-awareness plus kinesthesia make up body awareness, which is conscious and subconscious

Proprioception and Reflexes

- Each somatic reflex has

- A sensory ending to detect a stimulus
- A sensory neuron to transmit the signal
- An integrating center (spinal cord) to encode and relay the signal
- A motor neuron to transmit the signal to the effector organ
- An effector organ
- Not all reflexes cause a muscle contraction
 - Some reflexes inhibit the target muscles
 - Some modify other reflex actions

Muscle Spindle

- Located in the muscle, the spindle provides info on muscle length, velocity of shortening/lengthening, static length, perhaps force.
 - Different kinds of information due to different kinds of sensory endings contained within it.
- The most important somatoreceptor regarding movement.
- Spindle function is controllable by CNS
 - Control is enabled by the spindle having its own intrafusal muscle fibers and motor innervation
- Muscle Spindle function
 - Alpha-gamma co-activation enables the spindle to shorten along with the contracting extrafusal fibers.

The Stretch Reflex

- Spindle firing causes facilitation or a stretch reflex contraction in homonymous muscle, and
 - Reciprocal inhibition in antagonist
 - Opposite effects in contralateral limbs
 - Distal effects that may vary
- Activation history, CNS control, multisensory inputs, experience, age/health all influence spindle effects.

Golgi Tendon Organ and Reflex

- Free sensory endings intertwined within tendon fascicles
- Acts like a force detector
- Primary "reflex" action is to
 - Inhibit the homonymous muscle and its synergists, may override spindle facilitation
 - Facilitate antagonist muscle and its synergists
- Training and experience may modify GTO reflex actions considerably

Other Somatoreceptor Actions

- Somatoreceptors often work together to produce strong or far reaching effects
- The type of effect can be specific to locale, for example, activation of cutaneous receptors has different effects in hands and feet than in other areas
- Effects can be specific to the type of stimulus, such as high pressure or stretch versus low pressure.
- Among the more well-known reflex actions arising from somatosensation include the extensor thrust, withdrawal, crossed extensor thrust, and arthrogenic muscle inhibition

Arthrogenic Muscle Inhibition

- AMI is a strong effect, particularly in cases of injury
- Somatosensation from joint area inhibits agonist muscle

Vestibular and Neck Reflex Systems

- Vestibular (labyrinthine) receptors detect fluid movement in the labyrinth of the inner ear
 - Act as mini gyroscopes in the head and serve contributor balance and equilibrium
- Neck receptors located in the joints, muscles, and ligaments of the neck and provide info on the head and neck's position
- Produce righting reflexes (orientation during falling)

Vestibular Systems

- Cerebellar pathways combine postural control with motor planning
- Neck and limb pathways prevent and adjust to falling, maintain the head in an upright position
- Extraocular muscles control the orientation of the eyes

Visual Systems

- Provide feedback and feedforward info
 - Feedforward exteroceptive info is unmatched by other sensory modalities
- Visual detection is highly controllable
 - Amount of light and focus of light are controlled consciously and reflexively
- Visual processing is vast through dorsal and ventral streams

Focal and Ambient Vision

- Visual detection is both sharp (foveal) and less sharp (peripheral)
- Processing of foveal info gives focal vision
- Processing of combined foveal and peripheral vision gives ambient vision

Focal Vision

- Uses sharp, foveal detection, often requires head movements to center gaze and maintain sharpness
- Uses conscious processing
- Identifies objects and details

Ambient Vision

- Uses both foveal and peripheral detection
- Uses widespread subconscious processing, both dorsal and ventral streams
- Detection of motion, relationships among objects

Visual Search

- Focal and ambient systems are always working
- Focal vision rapidly changes from one moment to the next as attention from one object to another changes
 - Switching visual attention is called visual search
 - Skilled visual search enables anticipation of actions, faster info processing
- Visual search also provides a field of view from which to gather ambient visual info