Somatic Pain &

Thermal Sensation

By

Dr. NourelhudA a. Mohammed

Associate professor of physiology

Faculty of medicine , Mutah University

2025-2026

Sensations

•They are divided according to the site of origin into:

1. Somatic sensations (comes from soma or body)

2. Visceral sensations (from viscera). As visceral pain and fullness of the bladder.

3. Special sensations (vision, hearing, smell, taste)

4. Hypothalamic or organic sensations (thirst-hunger-fear).

Somatic sensations

•further subdivided according to site of receptors into :

1. Cutaneous sensations or(superficial)(e.g. pain-touch-temperature)

2. Deep sensations or (proprioceptive) : as sense of position, movements, muscle tension, deep pressure, relation of the body parts to each other and relation of the body to the space.

3. Mixed or combined sensations (receptors in skin and deep structures):

a) Stereo-gnosis

b) Vibration sense

Pain sensation

characters:

• unpleasant sensation resulting from tissue damage and resulting in protective mechanisms as withdrawal reflex.

• Pain is a specific type of sensation and is not due to over stimulation of other sensations.

• The threshold of excitation of pain receptors is much higher than other sensations.

• Pain is a "pre-potent stimulus" inhibited as hunger sensation . during pain; any other sensations are weaker.

Types of pain :

•According to the site, pain is classified to:

➢ Cutaneous pain

➢Deep pain

➢Visceral pain

pain receptors :

They are specific naked free nerve endings (slowly or even not adapt at all) called nociceptors & subdivided into 3 types according to the mode of stimulation.

1. Mechanosensitive pain receptors stimulated by excessive mechanical stress as crushing or sever trauma.

2. Thermosensitive pain receptors stimulated by extremes of either cold or hot i.e., above 45c° or below 10 c°.

3. Chemosensitive pain receptors which respond to chemical injurious stimuli.

The first two types are connected to (A delta) myelinated fibers. (5-15 meters/sec) while the third type is attached to C-fibers-non myelinated a slowly conducting fibers (0.2 - 2 meters/sec.).

Mechanism of stimulation of pain receptors

• Painful stimuli → tissue damage → liberation of pain mediators → stimulation of nociceptors.

• Pain mediators like substance P & Prostaglandins & Potassium & Bradykinin.

1- Cutaneous pain

•It arises from the skin.

•Usually described as pricking , stitching or burning pain.

•There are 2 types of cutaneous pain: fast & slow pain

•Cutaneous pain is accompanied by sympathetic reactions as increase in heart rate and blood pressure, sweating and dilatation of the pupil. Also, protective withdrawal reflexes occur in this type of pain.

fast pain

• Bricking.

• Immediate and persist for short time.

• well localized.

• Conducted by fast myelinated group "A delta " fibers(neo- lat. spinothalamic tract)

• Moderate compression on nerve, blocks "A" fibers

• Relay in thalamus then to somatic sensory cortex

slow pain

• Burning .

• Delayed and persists for long time.

• Poorly localized.

• Conducted by "C" un-myelinated fibers(paleo- lat. spinothalamic tract)

• local anesthesia block "C" fibers

•Relay mainly in reticular-formation then to all areas of cerebral cortex.

2- Deep pain

•It arises from deep structures (muscle, ligaments, joints, capsules).

•It is described as dull aching pain and is not well localized.

•Transmitted by "C" fibers.

•Deep pain is accompanied by parasympathetic reactions as bradycardia ,drop of the blood pressure, miosis ,nausea and even vomiting.

•Important type of deep pain is (intermittent claudication) occurs in skeletal muscles due to ischemia or atherosclerosis.

Reactions to pain

➢Somatic reflexes :

• protective withdrawal reflex

• Reflex spasm of skeletal muscle over diseased viscera.

• The mechanism is that the nerve fibers which carry pain sensations on entering the spinal cord will give collaterals to the anterior horn cells which innervate the surrounding muscles.

➢ Emotional reactions :

• As impulses carrying pain sensations to sensory cortex send collaterals to the hypothalamus which is one of the higher centers of emotions.

• This causes emotional reactions like crying, anger or depression. Very severe pain on the other hand may cause even complete loss of consciousness or fainting attacks.

➢Autonomic reactions :

• By impulses that reaches the reticular formation from ascending pain fibers.

• Autonomic reactions include changes in heart rate, respiratory rate, dilation of pupil, sweating and even inhibition of gastrointestinal activity. Mild pain as a rule causes sympathetic stimulation ; while very severe or visceral pain stimulates parasympathetic activity

➢Hyperalgesia: (Hyper = increase & Algesia = pain)

• It is state of pathological skin condition.

✓Primary hyperalgesia:

• It becomes edematous, red, hot and very painful (At site of the lesion itself)

• The mechanism is by local axon reflex

• Destroyed tissues release mediators that lower threshold of pain receptor (Non painful stimulus →painful)and cause local vasodilatation Also, anti-dromic impulses that cause arteriolar dilation→ edema which causes continuous pressure on the hypersensitive nerve endings causing maintained pain.

• Mechanism is Facilitation of receptors

✓ Secondary hyperalgesia

• In the surrounding area of the lesion.

• It appears normal but painful stimulus to it induces severe pain. (Increase Reactions to pain)

• It is explained by convergence- facilitation theory

As pain from primary area is carried by sensory nerve that converge on a certain neuron in the spinal cord. This neuron becomes "facilitated" have a lot of chemical transmitter, now if painful sensation reach this neuron from the surrounding secondary area, it will transmit it to sensory cortex as if it is very painful sensation.

Mechanism is Facilitation of neuron.

Temperature Sensation

•"Cold" sensation between 10° and 30c°.

•"warm" sensation between 30° and 45c°.

•Below 10° and above 45° tissue damage begins to occur, and this is described as pain sensation.

•At 0 °C No action potential is recorded from nerves.

•Thermo receptors adapt between 20c° and 40c°.

Types of thermo-receptors:

A. Superficial receptors in skin ,they are divided into:

1) Warm spots: transmitted by "C " fibers.(Free nerve ending receptor)

2) Cold spots: transmitted by " A delta " fibers. (Krause's end bulb receptors !)

B. Deep receptors in hypothalamus: detect body temperature from blood.

•Mode of stimulation of thermo-receptors.

Chemically by change in their metabolic activity.

• Stimulation of receptors depends on rate of heat conduction from stimulant. So, a piece of metal at 12 °C appears colder than apiece of wool at 12 °C.

• Four groups of fibers carry temperature: Cold fibers, warm fibers, pain cold fibers and pain hot fibers.

• Paradoxical cold sensation: On taking hot shower at 45 °C, we 1st feel cold (shivering) followed by warm sensation. Because cold receptors are:

a) 10 Times More numerous & More superficial than warm receptors.

b) Momentary Brisk discharge at 45°C.

•Temperature pathway: Through Lateral spinothalamic tract

Pathway of Sensations

The ascending tracts can be classified into three major systems:

1) The anterolateral spinothalamic system. (Ventral & Lateral).

a) Lateral spinothalamic tract: carries pain & temperature.

b) Ventral spinothalamic tract: carries crude touch .

2) The posterior (dorsal) column system.

3) Tracts which carry unconscious proprioceptive sensations.

Characters of somatic sensory pathways:

1) All of them are formed of 3 order neurons .

2) The 1st order neuron: the dorsal root ganglion cells (DRG).

3) The 2nd order neuron: the crossing neuron either:

a) At spinal cord: spinothalamic tracts.

b) At brain stem: Gracile & Cuneate tracts.

4) The 3rd order neuron: PLVNT. (Except smell & unconscious proprioception)

5) The pathway of sensory the tracts in brain stem are called "lemnisci".

Neo lateral Spinothalamic

• Carry Fast pain& Cold temperature.

• 1st Order Neuron: DRG → Lissauer's tract → dorsal horn (A delta)

• 2nd Order Neuron: Lamina I & V → cross → ascend → spinal lemniscus.

• 3rd Order Neuron: PVLNT → internal capsule → sensory cortex (3,1,2).

Paleo lateral Spinothalamic

• Carry Slow pain& Warm temperature.

• 1st Order Neuron: DRG → Lissauer's tract → dorsal horn (C fibers)

• 2nd Order Neuron: Lamina II & III (SGR) → cross → ascend.

• 3rd Order Neuron: 10% to thalamus; 90% to RF, Tectum, PAG.