University of Idaho

Spinal Reflexes

Psychology 372

Physiological Psychology

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Overview

- Importance first recognized Sherrington
  - Believed that simple reflexes activated by receptors in the skin and muscles were the basic units of movement.
  - Also, complex sequences of movement were the combinations of simple reflexes.
- Has been the dominant view for 100 years.
- New data shows that you can complete coordinated movement without sensory information.
- Is still important

2

Overview Continued

- Stimuli for reflexes comes from receptors in:
  - Skin
  - Joints
  - Muscles

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Past

- Reflexes were automatic and stereotyped
- Occurred in response to some stimulus being applied to peripheral receptors.

4

Today

- Know reflexes can be modified and adapt to tasks.
- Can be smoothly incorporated with movements initiated by the cortex.

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Three Principles of Reflexes

- Transmission in reflex pathways is set according to the motor task.
  - Called a functional set.
- Sensory input from a localized stimulus source produces reflex responses in many muscles
  - Some responses can be far away from the stimulus
- Supraspinal centers modulate and help spinal reflexes adapt.

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Reflexes

- Two types
  - Monosynaptic
  - Polysynaptic

Monosynaptic Reflex

- Involves one synapse between a sensory fiber from a muscle and an alpha-motor neuron
  - Monosynaptic stretch reflex (posture)
  - Patellar reflex

Stretch Reflex

- Is a contraction of a muscle that occurs when a muscle is lengthened.
  - As you begin to stretch out the muscle, it begins to contract.
  - Also, the opposing muscles relax
- Thus, stretch stimuli cause excitation in some motor neurons and inhibition in others.

How

- Sensory receptors in the muscle sense that the muscle is beginning to stretch. Their signals to neurons in the spinal cord tell other neurons to
  - Relax opposing muscles
  - Contract the muscle that begins to stretch
- Allows a feedback loop

Polysynaptic Reflexes

- Involves multiple synapses between sensory axons, interneurons, and motor neurons
  - Axons from the afferent muscle spindles can synapse onto
    - Alpha motor neuron connected to the agonist muscle
    - An inhibitory interneuron connected to the antagonist muscle
    - Signals from the muscle spindle activate the agonist and inhibit the antagonist muscle

Example, Noxious Stimulus Withdrawal - Reflex Arcs

- Occurs from interaction with
  - Afferent neurons (sensory)
  - Internuncial neurons
  - Efferent neurons (Motor)
- Also sends information to cortical structures.

Why are they important?

- Stimulus (stepping on a nail)
  - Afferent to dorsal horn in spinal cord
  - Spinal cord pathways (gracile and cuneate fasciculus) to the thalamus
  - Thalamus to areas 312
  - 312 to supplementary, premotor, motor, extrapyramidal pathway structures.
  - Motor areas fire
  - Signal goes down lateral and ventral corticospinal tracts plus other pathways
  - Synapse at ventral horn
  - Final common pathway
  - Contract muscle
  - Lift foot
- What is the problem with this system?

Answer

- It takes a long time before you pick up your foot. By the time you do, the nail is through your foot.

Alternative

- Stimulus
  - Afferent neuron sends information to dorsal horn of spinal cord.
  - Synapses on an internuncial neuron
  - Synapses with an efferent neuron
  - Efferent neuron sends information via final common pathway to muscle.
  - Contraction takes pressure off the nail

Differences

- Significantly less damage to the tissue
- Is a gross system. Do not get a fully defined movement – Do not pick up the foot all the way.
  - Need other pathways
- Is an all or nothing system.

So, What Ultimately Happens

- Stimulus (step on a nail)
  - Afferent to dorsal horn in spinal cord
  - Synapses on an internuncial neuron
  - Internuncial is a Unipolar neuron shaped like a T (T-Cell)
  - Sends to two pathways

1. To Motor Neurons

- Connects to an efferent neuron in ventral horn
- Efferent to final common pathway
- To muscle – contraction
- Takes pressure off nail.
- Simultaneously

2. Contralateral Muscles

- Are also stimulated to provide support during limb withdrawal

3. Inhibitory Interneurons

- Shut down antagonistic muscles

4. Cortical Loop

- Internuncial neuron uses spinal cord pathways (gracile and cuneate fasciculus) to the thalamus
- Thalamus to areas 312, association areas, etc.
- 312 to supplementary, premotor, motor, extrapyramidal pathway structures.
- Motor areas fire
- Signal goes down lateral and ventral corticospinal tracts Also, rubrospinal, tectospinal, and other spinal pathways
- Synapse at ventral horn
- Final common pathway
- Contract muscle
- Lift foot

Other Structures from Thalamus

- Goes to association areas, memory areas to speech integration areas (Wernickes)
- Wernicke's area to Broca's area
- You say "ouch" or other things.

Finally

- As you lift foot, opposing muscles relax
- Systems related to balance fire so you do not fall down.
- You develop memory traces of what happened.
- Others

Conclusion

- Reflexes are biphasic
  - Have a initial removal of pressure
  - Remove limb from the damaging object
- Many systems are involved depending on the stimulus event.
- Sometimes can be overridden by cognitive systems. Train yourself not to pull away.