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 Discuss The somatosensory pathways

The somatosensory system is distributed throughout all major parts of our body. It is responsible for sensing touch, temperature, posture, limb position, and more. It includes both sensory receptor neurons in the periphery (eg., skin, muscle, and organs) and deeper neurons within the central nervous system.

### Structure

A somatosensory pathway will typically consist of three neurons: primary, secondary, and tertiary.

1. In the periphery, the primary neuron is the sensory receptor that detects sensory stimuli like touch or temperature. The cell body of the primary neuron is housed in the dorsal root ganglion of a spinal nerve or, if sensation is in the head or neck, the ganglia of the trigeminal or cranial nerves.
2. The secondary neuron acts as a relay and is located in either the spinal cord or the brainstem. This neuron’s ascending axons will cross, or decussate, to the opposite side of the spinal cord or brainstem and travel up the spinal cord to the brain, where most will terminate in either the thalamus or the cerebellum.
3. Tertiary neurons have cell bodies in the thalamus and project to the postcentral gyrus of the parietal lobe, forming a sensory homunculus in the case of touch. Regarding posture, the tertiary neuron is located in the cerebellum.

### Processing

The primary somatosensory area of the human cortex is located in the postcentral gyrus of the parietal lobe. The postcentral gyrus is the location of the primary somatosensory area, the area of the cortex dedicated to the processing of touch information. At this location there is a map of sensory space referred to as a sensory homunculus.

A cortical homunculus is the brain’s physical representation of the human body; it is a neurological map of the anatomical divisions of the body. The surface area of cortex dedicated to a body part correlates with the amount of somatosensory input from that area.

For example, there is a large area of cortex devoted to sensation in the hands, while the back requires a much smaller area. Somatosensory information involved with proprioception and posture is processed in the ccerebellum.

### Functions

The somatosensory system functions in the body’s periphery, spinal cord, and the brain.

* Periphery: Sensory receptors (i.e., thermoreceptors, mechanoreceptors, etc.) detect the various stimuli.
* Spinal cord: Afferent pathways in the spinal cord serve to pass information from the periphery and the rest of the body to the brain.
* Brain: The postcentral gyrus contains Brodmann areas (BA) 3a, 3b, 1, and 2 that make up the somatosensory cortex. BA3a is involved with the sense of relative position of neighboring body parts and the amount of effort being used during movement. BA3b is responsible for distributing somatosensory information to BA1 and shape and size information to BA2.

## Tactile Sensation

Touch is sensed by mechanoreceptive neurons that respond to pressure in various ways. A mechanoreceptor is a sensory receptor that responds to mechanical pressure or distortion. For instance, in the periodontal ligament, there are mechanoreceptors that allow the jaw to relax when biting down on hard objects; the mesencephalic nucleus is responsible for this reflex.

In the skin, there are four main types in glabrous (hairless) skin:

1. Ruffini endings.
2. Meissner’s corpuscles.
3. Pacinian corpuscles.
4. Merkel’s discs.

There are also mechanoreceptors in hairy skin. The hair cells in the cochlea are the most sensitive mechanoreceptors, transducing air pressure waves into nerve signals sent to the brain.

## Proprioceptive Sensations

Proprioception refers to the sense of knowing how one’s body is positioned in three-dimensional space. Proprioception is the sense of the relative position of neighboring parts of the body and the strength of effort being employed in movement. It is distinguished from exteroception, perception of the outside world, and interoception, perception of pain, hunger, and the movement of internal organs, etc.

The initiation of proprioception is the activation of a proprioreceptor in the periphery. The proprioceptive sense is believed to be composed of information from sensory neurons located in the inner ear (motion and orientation) and in the stretch receptors located in the muscles and the joint-supporting ligaments (stance).

Conscious proprioception is communicated by the posterior ( dorsal ) column–medial lemniscus pathway to the cerebrum. Unconscious proprioception is communicated primarily via the dorsal and ventral spinocerebellar tracts to the cerebellum.

An unconscious reaction is seen in the human proprioceptive reflex, or Law of Righting. In the event that the body tilts in any direction, the person will cock their head back to level the eyes against the horizon. This is seen even in infants as soon as they gain control of their neck muscles. This control comes from the cerebellum, the part of the brain that affects balance.

Muscle spindles are sensory receptors within the belly of a muscle that primarily detect changes in the length of a muscle. They convey length information to the central nervous system via sensory neurons. This information can be processed by the brain to determine the position of body parts. The responses of muscle spindles to changes in length also play an important role in regulating the contraction of muscles.

## Somatic Sensory Pathways

The somatosensory pathway is composed of three neurons located in the dorsal root ganglion, the spinal cord, and the thalamus. A somatosensory pathway will typically have three long neurons: primary, secondary, and tertiary. The first always has its cell body in the dorsal root ganglion of the spinal nerve.



**Dorsal root ganglion**: Sensory nerves of a dorsal root ganglion are depicted entering the spinal cord.

The second has its cell body either in the spinal cord or in the brainstem; this neuron’s ascending axons will cross to the opposite side either in the spinal cord or in the brainstem. The axons of many of these neurons terminate in the thalamus, and others terminate in the reticular activating system or the cerebellum.

In the case of touch and certain types of pain, the third neuron has its cell body in the ventral posterior nucleus of the thalamus and ends in the postcentral gyrus of the parietal lobe.

In the periphery, the somatosensory system detects various stimuli by sensory receptors, such as by mechanoreceptors for tactile sensation and nociceptors for pain sensation. The sensory information (touch, pain, temperature, etc.,) is then conveyed to the central nervous system by afferent neurons, of which there are a number of different types with varying size, structure, and properties.

Generally, there is a correlation between the type of sensory modality detected and the type of afferent neuron involved. For example, slow, thin, unmyelinated neurons conduct pain whereas faster, thicker, myelinated neurons conduct casual touch.

## Somatic Sensory Pathways to the Cerebellum

The ventral and dorsal spinocerebellar tracts convey proprioceptive information from the body to the cerebellum. A sensory system is a part of the nervous system responsible for processing sensory information. A sensory system consists of sensory receptors, neural pathways, and the parts of the brain involved in sensory perception. Commonly recognized sensory systems are those for vision, hearing, somatic sensation (touch), taste, and olfaction (smell).

In short, senses are transducers from the physical world to the realm of the mind where we interpret the information, creating our perception of the world around us.

The ventral spinocerebellar tract conveys proprioceptive information from the body to the cerebellum. It is part of the somatosensory system and runs in parallel with the dorsal spinocerebellar tract.

Both tracts involve two neurons. The ventral spinocerebellar tract will cross to the opposite side of the body then cross again to end in the cerebellum (referred to as a double cross). The dorsal spinocerebellar tract does not decussate, or cross sides, at all through its path.