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SOMATOSENSORY PATHWAY

The somatosensory system is a part of the sensory nervous system. The somatosensory system is a complex system of sensory neurons and neural pathways that responds to changes at the surface or inside the body. The axons (as afferent nerve fibers) of sensory neurons connect with, or respond to, various receptor cells. These sensory receptor cells are activated by different stimuli such as heat and nociception, giving a functional name to the responding sensory neuron, such as thermoreceptor which carries information about temperature changes. Other types include mechanoreceptors, chemoreceptors, and nociceptors which send signals along a sensory nerve to the spinal cord where they may be processed by other sensory neurons and then relayed to the brain for further processing. Sensory receptors are found all over the body including the skin, epithelial tissues, muscles, bones and joints, internal organs and the cardiovascular system. Somatic senses are sometimes referred to as somesthetic senses, with the understanding that somesthesis includes the sense of touch, proprioception (sense of position and movement), and (depending on usage) haptic perception. The mapping of the body surfaces in the brain is called somatotopy. In the cortex, it is also referred to as cortical homunculus. This brain surface map is not immutable, however, dramatic shifts can occur in response to stroke or injury.

All afferent touch/vibration information ascends the spinal cord via the posterior (dorsal) column-medial lemniscus pathway via gracilis (T7 and below) or cuneatus (T6 and above). Cuneatus sends signals to the cochlear nucleus indirectly via spinal grey matter, this information is used in determining if a perceived sound is just villi noise/irritation. All fibers cross (left becomes right) in the medulla. A somatosensory pathway will typically have three neurons: First order (primary), Second order (secondary), and Third order (tertiary) neurons. The cell bodies of the three neurons in a typical somatosensory pathway are located in the dorsal root ganglion, the spinal cord, and the thalamus.

* The First-order neuron: This is a type of pseudounipolar neuron and always has its cell body in the dorsal root ganglion of the spinal nerve with a peripheral axon innervating touch mechanoreceptors and a central axon synapsing on the second-order neuron. If the somatosensory pathway is in parts of the head or neck not covered by the cervical nerves, the first-order neuron will be the trigeminal nerve ganglia or the ganglia of other sensory cranial nerves.
* The Second-order neuron: The second order neuron has its cell body either in the spinal cord or in the brainstem. This neuron’s ascending axons will cross (decussate) to the opposite side either in the spinal cord or in the brain stem.
* The Third-order neuron: In the case of touch and certain types of pain, the third-order neuron has its cell body in the ventral posterior nucleus of the thalamus and ends in the post central gyrus of the parietal lobe in the primary somatosensory cortex.

Photoreceptors, similar to those found in the retina of the eye, detect potentially damaging ultraviolet radiation (ultraviolet A specifically), inducing increased production of melanin by melanocytes. Thus, tanning potentially offers the skin rapid protection from DNA damage and sunburn caused by ultraviolet radiation (DNA caused by ultraviolet B). However, whether this offers protection is debatable, because the amount of melanin released by this process is modest in comparison to the amounts released in response to DNA damage caused by ultraviolet B radiation.

The primary somatosensory area in the human cortex is located in the post central gyrus of the parietal lobe. This is the main sensory receptive area for the sense of touch. Like other sensory areas, there is a map of sensory space called the homunculus at this location. Areas of this part of the human brain map to certain areas of the body, dependent on the amount or importance of somatosensory input from that area. For example, there is a large area of cortex devoted to sensation in the hands, while the back has a much smaller area. Somatosensory information involved with proprioception and posture also target an entirely different part of the brain, cerebellum. The thalamus is a midline symmetrical structure within the brain of vertebrates including humans. It is situated between the cerebral cortex and the midbrain, and surrounds the third ventricle. Its function includes relaying sensory and motor signals to the cerebral cortex, along with the regulation of consciousness, sleep and alertness.

The receptor for the sense of balance resides in the vestibular system in the ear (for the three dimensional orientation of the head, and by inference, the rest of the body). Balance is also mediated by the kinaesthetic reflex fed by proprioception (which senses the relative location of the rest of the body to the head). In addition, proprioception estimates the location of objects which are sensed by the visual system (which provides confirmation of the place of those objects relative to the body), as input to the mechanical reflexes of the body. The tactile feedback from proprioception is derived from the proprioceptors in the skin, muscles and joints.

Fine touch (or discriminative touch) is a sensory modality that allows a subject to sense and localize touch, that is, it allows a subject to sense that something has touched them, without being able to localize where they were touched (contrasting ‘’fine touch’’).The form of touch where localization is not possible is known as crude touch. The posterior column-medial leminscus pathway is the pathway responsible for the sending of fine touch information to the cerebral cortex of the brain. Its fibres are carried in the spinothalamic tract, unlike fine touch, which is carried in the dorsal column. As fine touch normally works in parallel to crude touch, a person will be able to localize touch until fibres carrying fine touch (posterior column-medial leminscus pathway) have been disrupted. Then the subject will feel the touch, but will be unable to identify where they were touched.

The somatosensory cortex encodes incoming sensory information from receptors all over the body. Affective touch is a type of sensory information that elicits an emotional reaction and is usually social in nature, such as a physical human touch. This type of information is actually coded differently than other sensory information. Intensity of affective touch is still encoded in primary somatosensory cortex and is processed in a similar way to emotions invoked by sight and sound, as exemplified by the increase of adrenaline caused by the social touch of a loved one, as opposed to the physical inability to touch someone you don’t love.