

## The Touch, the sense of body and the sense of action

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### Abstract

*The tactile sensitivity has been used as a model to analyze the cortical organization's principles in order to realize a conscious perception. Somatosensory cortex is a perceptive macrosystem localized in the parietal cortex organized to represent the whole tactile system. Touch is a double complex sensory system because is localized in the hand, but also generalized as the whole body presence and may be described in three tactile perceptions forms: the passive touch, the active touch and the dynamic one. In last years, tactile perception received particular attention from scientists linked to the possible application in robotics, using the haptic perception, and for the therapeutic application in rehabilitation.*

**Keywords:** *proprioception, sense, stimulus, touch, vibration*

Psychophysics is the psychology branch concerning the physical characteristics of the tactile stimulus and of the sensitive experience. Different pressure stimuli that make vibration with different frequencies are translated into words, sound and music by our brain. So, perception is not a photographic reproduction or a copy of the world around us, but is an internal rebuilding make using the functional anatomy and the dynamic properties of neurons [1].

By Aristotele on, five different sensory modalities has been identified : vision, touch, hearing, taste and smell. But other somatic sense has not been considerate as the proprioception, the vestibular sense of balance that together maybe considered as "the sense of movement", and so on the pain and the sense of temperature [2]. Has been shown that the human sensory systems use the same based principles to elaborate the information like in animals. Despite the different sensory forms there is a common mechanism in the sensory creation; when receptors are stimulated they send four informative stimulus elements : intensity, localization, duration and time trend; these properties are able to make the complex sensation. The tactile sensitivity has been used as a model to analyze the cortical organization's principles in order to

realize a conscious perception. Tactile information are fragmentary acquired by the different peripheral mechanoreceptor, for example Merkel receptors give information about object's bending and Meissner corpuscle report angularity; all these informations together with those of the mechanical receptors allow the apprehend of the object form: the stereognosis.

Somatosensory cortex is a perceptive macrosystem localized in the parietal cortex organized to represent the whole tactile system. Homunculus theory refers to the somatotopic cortex organization of the somatosensitive afferents; this is a distorted map defined by the cutaneous density innervations and by the functional role (for example fingers). Homunculus theory is nowadays outdate because in the parietal cortex are present different nervous maps that make a redundancy due to the possibility of acquiring different sensitivity information with different modalities [1]. Therefore touch is a double complex sensory system because is localized like what happen in the hand, but also generalized as the whole body presence. J Gibson in the book "The sense considered as a perceptual system", a milestone in the perception philosophy, described three tactile perceptions forms: the passive touch, the active touch and the

dynamic one [3]. The passive touch is the less efficacy tactile modality in order to recognize the object from Gibson say: “the active touch is an explorative sense more than only receptive; movement made with the fingers are the same of the eyes movement. Intact the active touch may be determinate as a tactile scanning like the ocular scanning”. Touch with the hand means directly recognize; hand is the instrument to definitively verify. In the Giovanni’s Gospel is written: “Unless I see the nail marks in his hands and put my finger where the nails were, and put my hand into his side, I will not believe it” (20;25). JG Herder oppose the vision illusionary character to one more true and authentic of the touch. Vision is considered as a shorthand of touch. Vision is a dream, touch is truth [4]. In the XIX Odyssey song, Euriclea, Ulysses blind nurse, recognize him only when feel under her fingers the sign of a hunting wound on the thigh occurred when he was a child “ the lovely old woman recognized this scar, groping”.

The third type of tactile perception has been defined by Gibson as a dynamic touch and involves not only the cutaneous stimulations and joint movement but also the muscle effort and represent the tactile and haptic perception form useful to explore all around in order to give a less fragmented vision of the human knowledge, ecological cognitivism. In last years, tactile perception received particular attention from scientists with several published articles. This attention is linked to the possible application in robotics, using the haptic perception in the virtual reality in order to give a new tactile perception using a cybernetic hand, and the touch screen application for recognize the wood roughness.

The interaction between our fingers and a surface is determinate by the activation of different receptors

localized under the skin; someone are sensitive to a static touch (Ruffini e Merkel, slow adapting receptors) and some other to a vibrations produced by movement (fast adapting receptors for dynamic touch).

Neurophysiologic studies about haptic touch and cutaneous sensibility have demonstrated the role of the sensitivity mechanoreceptors, nervous cells and fibers and the cortical centers implicated in the identification of temperature, nociceptive stimuli and physical properties. Other psychophysics aspects of the touch has been less investigated; for example the interaction between finger and a surface is complex and correlated with the pressure produced, the lateral movement and the friction forces between finger and surface. A multidimensional approach has recently been used in a paper to investigate the (perceptual) dimensionality of touch. The main two dimensions reported are the “rough/smooth” and “hard/soft” dimensions, with a third dimension suggested by some to be a “ sticky-slippery” dimension . They have demonstrated that in the same way that the human auditory system is sensitive to multiple frequencies simultaneously, the tactile sensing system has similar capacity for complex frequency analysis [5].

All these studies laid the groundwork for the creation of a cybernetic hand able to give back the sense of touch to amputated limbs and to quadriplegic people. Last but not least a more simple application in musculoskeletal or neurological disorders has been introduced in recently years; neuromuscular taping, based on eccentric stimulation of the skin to rise the skin in a wave, is able to activate cutaneous receptors and is used in rehabilitation programs [6].

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