OPEN ACESS
Advances in Health and Exercise

REVIEW ARTICLE

Proprioception and Kinesthesia: The sixth sense organ

Kishore Mukhopadhyay

Department of Physical Education, Union Christian Training College, West Bengal, India.

Received:
August 14, 2021
Accepted:
September 09, 2021
Published:
September 25, 2021

Abstract

The words kinesthesia and proprioception are often used interchangeably. Kinesthesia is awareness of how the body is moving in space while proprioception is associated with any postural, positional, or kinetic information provided to the CNS by sensory receptors in muscles, tendons, joints, or skin. It is an important bodily neuromuscular sense. It falls under our "sixth sense", more commonly known as somatosensation. It is associated with Sense of Force, Sense of change of Velocity, joint position, and kinesthesia. The role of the proprioceptor is immensely significant to maintain balance, agility, and learning motor skills. The present article critically discussed the various aspects of the proprioception and kinesthesis sense and depending upon its roller it can be considered as the sixth sense organ.

Keywords: Proprioception, kinesthesia, neuromuscular junction, sense of awareness.

Introduction

Success in sports performance depends on how athletes receive, acquire and use appropriate sensory information. In many cases, the winner of the contest is the one who can quickly detect the movements of the opponent based on both deceptive and special stimuli, the first to see and hear the sensory organs (Jerosch & Heisel, 2010).

The view provides details of movement and personal movement (Singh, 1991) around it. The second external source of information is based on the sensory part of the hearing. Although less important, many types of activities depend on a well-developed sense of hearing.

Another source of information is the sensory information based on body language. This interprets details from within the body such as joint positions, muscle strength and position as the upper extremities. The same type of information is also known as kinesthesis where "cows" means movement and "thesis" sensory. So everything can refer to joint movements, muscle pressures and preferences. This means that these are usually a set of sensory neurons built into the body to detect joint positions, movements, and muscle mass within space (Dickinson, 1976).

The sense of the movement of the position was first described in 1557 by Julius Caesar Scaliger as a "sense of locomotion". (Sherrington, 1906) More recently, in 1826, Charles Bell defined the concept of "muscle sense" (Musculoskeletal Key, 2021) called one of the first definitions of physiologic feedback mechanisms (The Sensory Toolbox, 2021). In 1906, Charles Scott Sherrington published a landmark work introducing the words "proprioception", "interoception", and "exteroception". (https://www.physiopedia.com/Proprioception). Interoceptors provide information about internal organs and " exteroception " are organs that provide information from outside the body, such as eyes, ears, mouth and skin, while “proprioceptors” provide information on movement from muscle, tendon, and articular sources.

Humans differ in their ability to move about in their natural state. This ability is achieved by a complex combination of the muscles of the extremities directed by the central nervous system (CNS). To maintain balance and back control we rely on sensory information from the edges from our visual, vestibular, and somatosensory systems. The nervous system

K. Mukhopadhyay, e-mail: kishore.km2007@gmail.com
To Cite: Mukhopadhyay, K. (2021). Proprioception and kinesthesia: The sixth sense organ. *Adv Health Exerc*, 1(1), 12-17.

integrates this peripheral afferent information to maintain postural control during stance.

Locomotion control, including walking or running, occurs in complex neural pathways in the spinal cord called central pattern generators or limb controllers. The feedforward mechanism operates on the premise of initiating a motor response in anticipation of a load or activity that will disrupt the integrity of a joint and gauges the response from previous experiences. In contrast, the feedback system works directly in response to a potentially destabilizing event by using a common point of reference to monitor the muscle activity needed to restore homeostasis.

Both the feedback and feedforward systems rely on the use of synchronized data from the edges at different levels of the CNS (spinal, brainstem and cerebellum, and cerebral cortex), with the final effect performed on muscle integration during movement to maintain joint stability. The motor response varies depending on the combined position, type of power, the direction of power, and which higher institution operates the data processing (Riemann & Lephart, 2002).

Proprioception & Kinesthesia

The words kinesthesia and proprioception are often used interchangeably. Kinesthesia is awareness of how the body is moving in space., proprioception is defined as any postural, positional, or kinetic information provided to the CNS by sensory receptors in muscles, tendons, joints, or skin. Other texts define proprioception as “awareness of the position and movements of our limbs, fingers, and toes derived from receptors in the muscles, tendons and joints.” Sherrington’s classic definition of proprioception is “afferent information arising from the proprioceptive field,” and mechanoreceptors or proprioceptors were identified as being the source of the origination of this afferent information. In short, kinesthesia cares about movement, while the proprioceptive system does not. Proprioception cares about where the body is in space, regardless of how it got into that position (https://www.physio-pedia.com/Proprioception; Sherrington, 1907).

Proprioception (sense of proprioception) is an important bodily neuromuscular sense. It falls under our "sixth sense", more commonly known as somatosensation. The term somatosensation (or somatosensory senses) is an all-encompassing term that includes the sub-categories of mechanoreception (vibration, pressure, discriminatory touch), thermoreceptor (temperature), nociception (pain), equilibrioception (balance), and proprioception (sense of positioning and movement). (Hung, 2015) The feedback from all these different sensory components arise from our peripheral nervous system (PNS), and feed information to our central nervous system (CNS), both at the level of the spinal cord (reflexive) and sent to the cerebral cortex for higher processing. (Gilman, 2002). The brain integrates information from proprioception and from the vestibular system into its overall sense of body position, movement, and acceleration. This has sometimes been referred to as kinesthetic sense.

Important Considerations:

- **Kinanesthesia:** Kinanesthesia (kinaesthesis) is the awareness of motion of the human body (motion sense). (Hung, 2015) Sense of movement refers to the ability to appreciate joint movement, including the duration, direction, amplitude, speed, acceleration, and timing of movements (Shakoor, Agrawal, & Block, 2008).
- **Sof F:** Sense of Force (SoF) is also known as a sense of effort/heaviness/tension or the force of making sense. SoF is the ability to reproduce a desired level of force one or more times. Sense of force is thought to stem from the afferent feedback of the Golgi Tendon Organs (GTOs) embedded within our tendons, the muscle spindles within our muscles, and proprioceptions within our skin (Ager et al., 2020).
- **SoV:** Sense of change of Velocity is the ability to detect vibration, derived from oscillating objects placed against the skin. (Blanche, Bodison, Chang, & Reinoso, 2012) It is believed to travel through the same type of large afferent nerve fibers (Aαβ) as proprioception. (Suetterlin & Sayer, 2013).

All considerations of proprioception arise from the sum of neural inputs from the joint capsules, ligaments, muscles, tendons, and skin, in a multifaceted system, which influences behavior regulation and motor control of the body (Risberg et al., 2001).

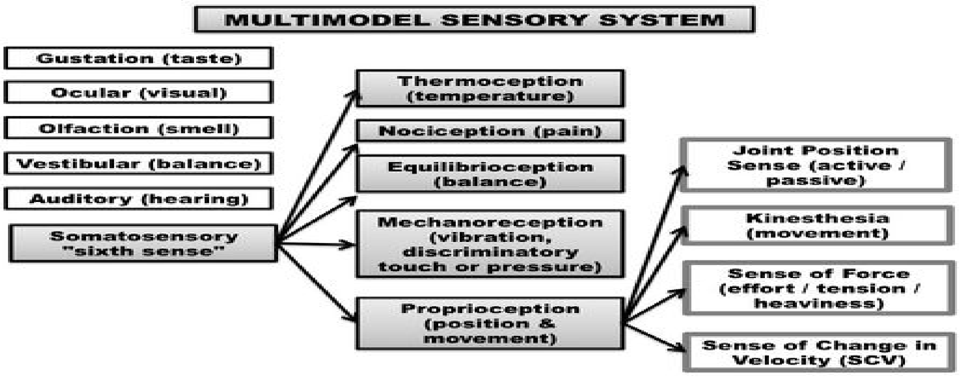

Figure 1. Represents the Somatosensation of a human body (Ageberg et al., 2010).

Various Receptors:

The different types of receptors are able to sense various kinds of stimuli such as pressure against the skin, limb position, distention of the bladder, and body temperature. If a stimulus becomes so strong that it may be harmful, the somatosensory system is also responsible for feeling pain (nociception (Ageberg & Roos, 2015) Sensory receptors are classified into five categories:

1. Mechanoreceptors: Detects mechanical changes or deformations in tissues.

2. Thermoreceptors: Detects temperature changes.

3. Proprioceptors: Detects changes to limb position (joint position sense), movement detection (kinesthesia).

4. Pain receptors (nociceptors): Neural processing of injurious stimuli in response to tissue damage.

5. Chemoreceptors: Detects changes and is responsive to chemical stimuli. Proprioception is basically a continuous loop of feedforward and feedback inputs between sensory receptors throughout the body and nervous system. (Mechanoreceptors and proprioceptors) located in your skin, joints, and muscles (muscle spindles with a smaller component from tendon organ afferents, cutaneous receptors, and minimal input from joint receptors), which is considered to be a stretch receptor as well (Ageberg & Roos, 2015).

Different types of mechanoreceptors include:

- Pacinian Corpuscles
- Meissner's Corpuscles
- Merkel's Discs
- Ruffini Corpuscles
- Golgi Tendon Organs (GTO)
- Free nerve endings

There are also mechanoreceptors within the hair and skin.

Neuromuscular Exercises

Neuromuscular exercise unlike conventional exercises stressed the quality of movement and emphasizes joint control in all three Biomechanical/movement planes. (https://www.athletescare.com/chiroblog/view.php?cid=7) Neuromuscular exercise has effects on functional performance, biomechanics, and muscle activation patterns of the surrounding joint musculature. Therefore, both mechanical stability and neuromuscular control are probably important for a long-term functional outcome, and both aspects must be considered in the design of a neuromuscular rehabilitation program (https://www.healthline.com/health/body/proprioception).

To improve sensorimotor control, exercises are performed mainly in closed kinetic chains in different positions (e.g., lying, sitting, standing) with the intention to obtain low, evenly distributed articular surface pressure by muscular coactivation. The level of training and progression is guided by the patient's sensorimotor function, taking into account various factors related to the individual and the injury/disease (Hendrayana, 2017).

Balance and Proprioception:

Balance and proprioception are controlled by our central nervous system and are controlled by 3 main sub-systems: the somatosensory (the nerves in our joints, tendons, and muscles) the vestibular system (the inner ear canals), and the visual system. If any one of these subsystems is injured or working improperly, dysfunction in balance and function ensues. Balance and proprioception can be easily trained and added to any workout for individuals of all ages and skill levels. Figure-2 shows the functions of Mechanoreceptors for human bodily awareness (Hamilton, 2006).

Proprioception is basically a continuous loop of feedback between sensory receptors throughout the body and nervous system. Sensory receptors are located on your skin, joints, and muscles. When we move, our brain senses the effort, force, and heaviness of our actions and positions and responds accordingly (Tanaka et al., 1986). In humans, it is provided by proprioceptors in skeletal striated muscles (muscle spindles) and tendons (Golgi tendon organ), and the fibrous membrane in joint capsules. It is distinguished from exteroception, by which one perceives the outside world, and interoception, by which one perceives pain, hunger, etc., and the movement of internal organs.

The brain integrates information from proprioception and from the vestibular system into its overall sense of body position, movement, and acceleration. This has sometimes been referred to as ***kinesthetic sense*** (https://gretchengoerlitz.com/proprioception).

Types of Pathways of Sensory information

a) Afferent pathways: Sensory information coming from the sensory receptors through peripheral nerves to the spinal cord and brain.

b) Efferent pathways: Motor commands coming from the brain and spinal cord, through peripheral nerves to effecter organs.

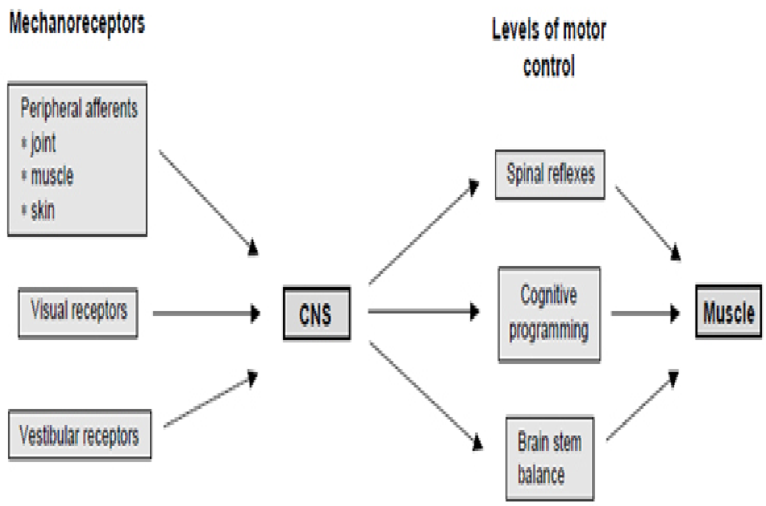

Figure 2. The function of mechanoreceptors and motor control (https://www.healthline.com/health/body/proprioception).

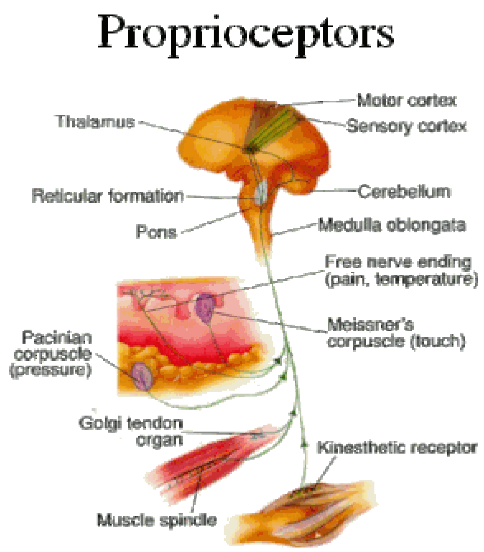

Figure 3. Proprioceptors (https://gretchengoerlitz.com/proprioception).

Learning New Skills

A complete sense of appreciation is essential in learning a new skill. During the learning of any new skill, (sports performance or artwork, for example) it is often necessary to become familiar with other specific reception activities related to that profession. Without the right combination of proper proprioception, the player would not be able to play properly. Importantly, our sense of identity is important for training and development, as it allows us to interact with our environment without relying on visual feedback (for example, accessing a cup on the top shelf, without looking at the cup).

Kinesthetic vision and vestibular sensors are both involved in many reflex movements that contribute to response management. Sudden rupture in the muscles triggers a signal of air pressure that connects directly to the cells causing muscle contraction.

These organs of spinning muscles, Golgi muscles, and joint receptors are involved in various manifestations. However, disputes have been going on for a long time between psychology and physiology regarding sensory receptors stimulating unconscious body parts. In other words, a person's ability to sense the posture and movement of body parts in space is acquired based on visual, auditory, and verbal information. Each of the receptors has its own function in relation to state and movement. The success of the walking behavior depends on the person's ability to photograph from around and distribute it to various parts of the body to get the answer.

The accuracy of the adjustment also depends on the response of internal kinesthesis. This means that this response occurs automatically after departure. It is therefore clear that kinesthetic perception plays a very important role in regulating mobility (https://gretchengoerlitz.com/proprioception).

Role of Proprioception in Sports

- Increases in injury prevention
- More awareness of where an athlete is physically; internally and externally
- Improvements in performance
- Reduction in fear of failing (improvement in confidence,
- Agility, balance, and coordination controlled by proprioceptors,
- It is the ability of the body to transmit position sense, interpret the information and respond accordingly,
- Play an important role in posture control and movement,
- It allows knowing the position of a body with outlook other parts of the body
- It is the perception that provides the ability to change the direction, to maintain balance and the coordination to produce the activity,
- Proprioceptors are afferent nerves that receive and transmit impulses from stimuli from skin, muscle, tendons, and joints to the Central Nervous System (CNS).

Conclusion

Athletes differ in their ability to move about in their natural state. This ability is achieved by a complex combination of the muscles of the extremities directed by the central nervous system (CNS). To maintain balance and back control we rely on sensory information from the edges from their visual, vestibular, and somatosensory systems. The nervous system integrates this peripheral afferent information to maintain postural control during stance. The present article critically discussed the various aspects of proprioceptor and kinesthetic sense, and it can be considered as our sixth sense organ.

References

Ageberg, E., Link, A., & Roos, E.M. (2010). Feasibility of neuromuscular training in patients with severe hip or knee OA: The individualized goal-based NEMEX-TJR training program. *BMC Musculoskeletal Disorders*, 11(1), 126.

Ageberg, E, Roos, E.M. (2015). Neuromuscular exercise as treatment of degenerative knee disease. *Exercise and Sport Sciences Reviews*, 43(1), 14-22.

Ager, A.L., Borms, D., Deschepper, L., Dhooghe, R., Dijkhuis, J., Roy, J.S., & Cools, A. (2020). Proprioception and shoulder pain: A Systematic Review. *J Hand Ther,* 33(4), 507-516.

Blanche, E.I., Bodison, S., Chang, M.C., & Reinoso, G. (2012). Development of the comprehensive observations of proprioception *(COP): Validity, reliability, and factor analysis. Am J Occup Ther,* 66 (6), 691–698.

Dickinson, J. (1976). *Proprioceptive control of human movement.* NJ, USA: Princeton Books Company.

Gilman, S., (2002). Joint position sense and vibration sense: Anatomical organization and assessment. *Journal of Neurology, Neurosurgery, and Psychiatry,* 73(5), 473-477.

Hamilton, S. (2006). Screening for developmental delay: Reliable, easy-to-use tools: win-win solutions for children at risk and busy practitioners. *Journal of Family Practice*, 55(5), 415-423.

Hendrayana, Y., (2017). The role of kinesthetic perception in supporting the acquisition of skills in sports games.

IOP Conference Series Materials Science and Engineering, 180(1), 012228.

https://gretchengoerlitz.com/proprioception

Musculoskeletal Key (2021). https://musculoskeletal-key.com/proprioception-and-neuromuscular-control/

The Sensory Toolbox, (2021). https://thesensorytool-box.com/kinesthesia-proprioception/

https://www.athletescare.com/chroblog/view.php?cid=7

https://www.healthline.com/health/body/propriocep-tion

https://www.physio-pedia.com/Proprioception

Hung, Y.J. (2015). Neuromuscular control and rehabilitation of the unstable ankle. *World Journal of Orthopedics*, 6(5), p. 434.

Jerosch, J., & Heisel, J. (2010). *Management der Arthrose: Innovative Therapiekonzepte*. Deutscher Ärzteverlag. p. 107.

Riemann, B. L., & Lephart, S.M. (2002). The sensorimotor system, part 1: The physiological basis of functional joint stability. *Journal of Athletic Training*, 37(1), 71-79.

Risberg, M.A., Mørk, M., Jenssen, H.K., & Holm, I. (2001). Design and implementation of a neuromuscular training program following anterior cruciate ligament reconstruction. *Journal of Orthopaedic & Sports Physical Therapy*, 31(11), 620-631.

Shakoor, N., Agrawal, A., & Block, J.A. (2008). Reduced lower extremity vibratory perception in osteoarthritis of the knee. *Arthritis and Rheumatism*, 59(1), 117-121.

Sherrington, C.S. (1907). On the proprioceptive system, especially in its reflex aspect. *Brain,* 29, 467–482.

Sherrington, C.S. (1906). *The integrative action of the nervous system.* NewHaven, CT: Yale University Press.

Singh, A.K. (1991). *The Comprehensive History of Psychology*. Motilal Banarsidass. p. 66.

Suetterlin, K.J., & Sayer, AA. (2013) Proprioception: Where are we now? A commentary on clinical assessment, changes across the life course, functional implications, and future interventions. *Age and Ageing,* 43(3), 313-318.

Tanaka, K., Hikosaka, K., Saito, H. A., Yukie, M., Fukada, Y., & Iwai, E. (1986). Analysis of local and wide-field movements in the superior temporal visual areas of the macaque monkey. *Journal of Neuroscience,* 6(1), 134-144.