Vestibular System

Balance is the ability to maintain the body's centre of mass over its base of support. A properly functioning balance system allows humans to see clearly while moving, identify orientation with respect to gravity, determine direction and speed of movement, and make automatic postural adjustments to maintain posture and stability in various conditions and activities.

Balance is achieved and maintained by a complex set of sensorimotor control systems that include sensory input from vision (sight), proprioception (touch), and the vestibular system (motion, equilibrium, spatial orientation); integration of that sensory input; and motor output to the eye and body muscles. Injury, disease, certain drugs, or the aging process can affect one or more of these components. In addition to the contribution of sensory information, there may also be psychological factors that impair our sense of balance.

Sensory Input

Maintaining balance depends on information received by the brain from three peripheral sources: eyes, muscles and joints, and vestibular organs. All three of these information sources send signals to the brain in the form of nerve impulses from special nerve endings called sensory receptors.

Sensory receptors in the retina are called rods and cones. Rods are believed to be tuned better for vision in low light situations. Cones help with colour vision, and the finer details of our world. When light strikes the rods and cones, they send impulses to the brain that provide visual cues identifying how a person is oriented relative to other objects. For example, as a pedestrian takes a walk along a city street, the surrounding buildings appear vertically aligned, and each storefront passed first moves into and then beyond the range of peripheral vision.

Input from the Muscles and Joints

Proprioceptive information from the skin, muscles, and joints involves sensory receptors that are sensitive to stretch or pressure in the surrounding tissues. For example, increased pressure is felt in the front part of the soles of the feet when a

standing person leans forward. With any movement of the legs, arms, and other body parts, sensory receptors respond by sending impulses to the brain. Along with other information, these stretch and pressure cues help our brain determine where our body is in space.

The sensory impulses originating in the neck and ankles are especially important. Proprioceptive cues from the neck indicate the direction in which the head is turned. Cues from the ankles indicate the body's movement or sway relative to both the standing surface (floor or ground) and the quality of that surface (for example, hard, soft, slippery, or uneven).

Input from the vestibular system

Sensory information about motion, equilibrium, and spatial orientation is provided by the vestibular apparatus, which in each ear includes the utricle, saccule, and three semi-circular canals. The utricle and saccule detect gravity (information in a vertical orientation) and linear movement. The semi-circular canals, which detect rotational movement, are located at right angles to each other and are filled with a fluid called endolymph. When the head rotates in the direction sensed by a particular canal, the endolymphatic fluid within it lags behind because of inertia, and exerts pressure against the canal's sensory receptor. The receptor then sends impulses to the brain about movement from the specific canal that is stimulated. When the vestibular organs on both sides of the head are functioning properly, they send symmetrical impulses to the brain. (Impulses originating from the right side are consistent with impulses originating from the left side.)

Integration of sensory input

Balance information provided by the peripheral sensory organs—eyes, muscles and joints, and the two sides of the vestibular system—is sent to the brain stem. There, it is sorted out and integrated with learned information contributed by the cerebellum (the coordination centre of the brain) and the cerebral cortex (the thinking and memory centre). The cerebellum provides information about automatic movements that have been learned through repeated exposure to certain motions. For example, by

repeatedly practicing serving a ball, a tennis player learns to optimize balance control during that movement. Contributions from the cerebral cortex include previously learned information; for example, because icy sidewalks are slippery, one is required to use a different pattern of movement in order to safely navigate them.

https://vestibular.org/understanding-vestibular-disorder/human-balance-system