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**PHYSIOLOGY OF BALANCE**

 Balance is the ability to maintain the body’s center 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. Everyday tasks such as bending, reaching and maneuvering around objects require the skill of balance. Any minor upset which affects our body system can have a negative effect on balance and create difficulties with movement. Several body systems are involved in the balance process, including the musculoskeletal system, inner ear, eyes and skin. The brain receives signals from each of these systems and, when processed correctly, the brain is then able to pinpoint exactly what our body is doing – i.e., in which direction we are moving, turning, standing still, where our arms and legs are positioned etc. Good balance relies on all of these systems and processes functioning perfectly. A defect in any one of these systems (whether due to injury or disease) may affect an individual’s ability to balance.

Inner Ear: The inner ear is involved in detecting movements of the head and is designed with such accuracy that it can detect even very small changes in head position. The anatomy of the inner ear consists of semicircular canals (which detect rotation) and the vestibule (which detects linear movements). Both of these structures are lined with tiny minute hairs and filled with fluid. The hair cells detect movement of the fluid, which allows the brain to work out the direction and speed of the head movement. For example, fluid will move in different directions and at varying speeds when nodding your head slowly compared with quickly looking left to right. If a person spins around several times then stands still, the ongoing feeling of dizziness is due to the fluid in the inner ear still moving; the brain detects this as the body still spinning, hence the confusion and dizziness. The inner ear on the right side of the body is paired with the inner ear on the left side of the body via the brainstem and each side works in unison with the other to send an accurate message to the brain regarding head position and movement.

Skin: The body is covered in tiny “position detectors” known as proprioceptors. These tiny receptors send messages back to the brain to decipher where each part of the body is located in space. Most receptors are located in the peripheral extremities furthest from the body; i.e. arms, fingers, legs and toes. This allows the brain to map out body position exactly. For example, if you close your eyes and allow your fingers to bend and straighten you will easily know when your fingers are bent and when your fingers are straight, even though you cannot see them. This is the role of the proprioceptors. Skin also has the ability to detect sensation. Your brain knows when you are wearing socks or when your feet are flat on the floor because this sensation can be felt. However, we have all experienced a “sleeping foot” after we have sat for too long and the fun at attempting to walk immediately afterwards. Many people experience this sensation of paralysis daily (due to injury or disease) and therefore regularly lose their balance.

Vision: The visual system plays a major role in the control of balance. Not only can an individual see where their body is positioned but they can also visualize their body position in relation to the world around them; e.g., ground surface, uphill/downhill, obstacles, etc. Even the simple task of standing upright becomes much more difficult when the eyes are closed due to losing the visual image of our environment. Eye movements also play a role in compensating for body movements. If, for example, an individual attempts to balance while looking forward they will potentially find this easy. If they then turn their head to look left, their spatial awareness is affected and causes them to lose balance. However, the eyes can move independently of head position and continue to look forward despite the head being turned to the left, enhancing spatial awareness once again and improving balance.

MUSCLOSKELETAL SYSTEM: Whenever the brain receives signals regarding body position, it then has to immediately analyze what appropriate action to take in order to maintain balance. An instantaneous reflex should take place where the brain sends a signal to appropriate muscles, the muscles contract and realign the body. If this reflex arc takes place in minimal time then usually the individual maintains balance without any conscious effort. If the reflex arc is delayed slightly, the individual usually experiences a short sensation of loss of balance, which is then corrected. However, if the reflex arc is interrupted or the process is impaired then usually there is insufficient time to correct the misalignment and the individual will lose balance, stagger, or, in extreme circumstances, fall over. For example, if an individual steps off a curb with their right foot on to an uneven surface, causing them to tilt to one side, the following processes should take place: The inner ear detects the head tilting to the right side, proprioceptors detect that the feet are not on level ground and that the right hand and shoulder may now be lower than the left and the visual image will detect the uneven ground surface in relation to body position. All of these messages are instantly relayed back to the brain and analyzed. Signals are then immediately sent to relevant muscles (core abdominal muscles will help pull the spine back into alignment, deltoid muscles will lift the arms away from the body for stability, hip flexors on the trailing left leg will bring the left foot off the curb and on to the ground, allowing bodyweight to be transferred between two feet) producing immediate restoration of balance. The balance process is far more complex than implied here but this is a brief introduction for those fitness professionals who find this topic particularly interesting.

**BALANCE PROBLEMS**

There are many reasons why balance can be affected, including:

* Inner ear: infection, Meniere’s disease
* Vision: blindness, cataracts, double vision
* Skin: numbness due to diabetes, injury
* Musculoskeletal: age-related muscle weakness, joint deformity, poor posture
* Brain/Central Nervous System: Parkinson’s disease,multiple sclerosis

Balance is a skill that can be improved by training your body to compensate for any of the problems noted above. For example:

1. Muscular strength and endurance exercises can improve core strength and posture leading to better alignment of the full body.
2. Parkinson’s disease usually causes an individual to fall backwards; this can be compensated by teaching your Parkinson’s client to focus their weight forward when balancing.
3. An injury leading to left leg weakness can be compensated by teaching the client to concentrate on using additional muscles to transfer their weight between their good and bad leg as needed; e.g., abdominals, gluteal muscles etc.

Fitness professionals will work with clients of varying ability who wish to improve their balance. Most basic balance exercises can be modified to suit varying fitness levels, but several balances are noted below as a starting point (examples of these balances can easily be found online for readers who are unsure of the exercise).