Section 3 - Part 4: Coordination and balance

- **Introduction**: The ability to maintain good posture during movement dictates an ability to balance and to control these movements. Consequently, posture is determined and maintained by *coordination* of the various muscles that move the limbs and by the *sense of balance*.

- **Coordination** is the ability to perform smooth, accurate and controlled movements. (O'Sullivan and Schmitz, 1994).
  - Coordination is necessary to perform fine motor skills requiring the manipulation of small objects (i.e. writing, typing) but also when performing gross motor skills such as walking, running, jumping, kicking, throwing and so on. Coordinated movements involve the proper sequencing and timing of synergistic and antagonistic muscle activity, and require proximal stability and the maintenance of posture.
  - The concept of coordination includes balance.

- **Balance** is the ability to maintain equilibrium or the ability to maintain the centre of gravity (COG) over the base of support (BOS). (Crutchfield et al, 1989).
  - In most activities of daily life the COG must be maintained over the BOS. Chek (2000) states that this function is so vitally important that, under normal circumstance, it is mastered within the first 24 months of life.
  - A certain amount of anteroposterior (front to back) and lateral (side to side) sway occur naturally in maintaining balance in a standing position. Hall and Brody (1999) describe this naturally occurring movement as a "sway envelope" which defines the limits of stability and creates a "cone of stability". When the COG is aligned in the middle of the cone of stability and over the BOS the degree of sway can be easily controlled and remains within the cone.
  - If, during static and dynamic postures, an individual's COG is aligned more anterior, posterior, or lateral than centre (i.e. no longer over the BOS), a smaller sway envelope is tolerated before losing balance. In this case, the degree of sway exceeds the limits of the cone of stability and some strategy must be employed to regain balance or to "right" oneself.
Control of balance: three systems contribute to the maintenance of the COG over the BOS (i.e. balance) and have been referred to as forming the triad of balance control (Hall and Brody, 1999):

- **Proprioceptive system**
- **Visual system**
- **Vestibular system**

The proprioceptive and visual systems gather information from the environment (i.e. position relative to other objects, stability of surface) and the vestibular system provides an internal reference, providing information about the head’s orientation in space (Nashner, 1982).

- **Proprioceptive system**: Information from proprioceptors arises from peripheral sources such as the muscle, joint capsule and other soft tissue structures. It is transmitted centrally for processing. This information assists in stabilising the visual system during eye, head and neck movements and in maintaining postures and coordinated movement patterns (Rowinski, 1985).

- **Visual and vestibular systems**: Both these systems contribute information about the body’s position and movement in space. The visual system provides information about the position of the head relative to the environment and orients the head to maintain level gaze. It will, therefore, have a direct impact on head and neck postures.
The visual system also provides information about the movement of surrounding objects, thereby providing information about the speed of movement.

The challenge of an exercise can be increased by removing the visual system (closing the eyes). This will reduce the body’s ability to process external information about the surrounding environment and will increase the dependence on the other two systems.

The equilibrium receptors in the semicircular canals and vestibule of the ear, collectively called the vestibular apparatus, send sensory signals to the brain that initiate the reflexes needed to make the simplest changes in position, as well to serve a tennis ball precisely to the right spot (Marieb, 1995).

Any movement of the head stimulates the vestibular or equilibrium receptors. The vestibular system, therefore, provides information on the orientation of the head in space and on acceleration.

The relative contributions from each system and the integration of each system’s information are critical to the maintenance of balanced and coordinated movements.
• **Training implications**

  - The goal of training is to get the client to the autonomous stage of motor learning, so that effective movement can occur with little thought. The ability to balance, while coordinating the physical and cognitive requirements of an exercise requiring a complex movement strategy, is an example of functioning at an autonomous level.

  - In order to improve balance and coordination it must be challenged through appropriately progressive and demanding exercise prescription.

  - Once a client is able to perform an exercise competently with little effort a new challenge must be provided if balance capabilities are to be further refined and improved. For example, as balancing on a single leg or on a balance board becomes easy, less attention is necessary, and the exercise becomes automatic. The nervous system must be challenged at a new level. This can be done by changing the surface or the BOS, adding external perturbation (i.e. a small push from a training partner) or eliminating the visual input (eyes closed).

**Increasing the balance demand of an exercise**

- **Key point**: If balance and coordination skills can be refined in a gym environment, using functionally related exercise, this will improve the overall function of the kinetic chain. Such benefits will carryover to all movement activities in any environment.