CHAPTER 6

Proprioception and Vision
PROPRIOCEPTION AND MOTOR CONTROL

- Call Kinesthesia (space and body awareness)
- A source of feedback for closed loop control
- Used to make corrections as we move
INVESTIGATING PROPRIOCEPTION

- Surgical deafferentation
- Sensory polyneuropathy patients
- Nerve block technique (Temporary deafferentation)
- Tendon Vibration technique
ROLE OF PROPRIOCEPTIVE FEEDBACK

- Affects movement accuracy
- Affects the timing of the onset of motor commands
- Affects coordination of body and limb segments used in the movement
  - Spatial-temporal coupling between limbs
  - Postural control
  - Ability to adapt to movement situations
Proprioceptors

- Muscle spindles
  - Skeletal muscles
  - Length, velocity, acceleration & spatial position
- Golgi tendon organs
  - Junction of tendons and skeletal muscles
  - Length and spatial position
- Joint Receptors
  - Joint capsules and ligaments
  - Full range of joint positions, flexion & extension
VISION PREDOMINATES OUR SENSORY-PERCEPTUAL SYSTEM

- We trust vision more than the other senses.

- Two components
  - Central vision (width of your thumb)
    - Movement information
  - Peripheral vision
    - Detects environment and context and moving limb
VISION & AIMING TASKS

- Tasks that require a person to move one or both arms over a prescribed distance to a target.
- Vision plays different roles across the phases in an aiming task.
How to the eyes work together to carry out actions?

- Used eye tracking devices
- Point of gaze was the used to measure eye fixation and calculate the timing/location of the hand movement.
  - Gazing was well ahead of hand arrival at the target.
  - Gazing dominates during the first phase of aiming task where as actual limb movement is part of phases 2 and 3.
IS THEIR A MINIMUM AMOUNT OF TIME NEEDED TO MAKE A CORRECTION?

- Research found little precision
  - Best estimate is 100 to 160 msec of visual information for simple manual tasks
- In terms of the three phases
  - If limb movement is faster than the minimum time, only first two phases describe movement
  - The movement is under open loop control where the movement is dependent on preparation phase
If the skill to be performed is faster than minimal time to use visual feedback to regulate the accuracy of movement then:

Success depends on the initial position of the limb!!! (Phase 1)

e.g., catching a ball
hitting a ball
foot position in kicking a soccer ball
VISION AND PREHENSION

- Act of 1) reaching and 2) grasping an object then 3) object manipulation. (last stage differs from manual aiming task)
  - Stage 1  Prior to reaching information about the object characteristics and distance of object is provided visually. **During reaching (transport stage) we use this information.**
  - Stage 2  Just before grasping the objects, we make corrections to our grasp. **This information is given visually.**

Again if there is little time, only visual information in stage 1 is used to perform the intended movement (open loop control).
Should I use one eye or both eyes?

- Monocular versus binocular vision
- Motor control system operates more effectively and efficiently when it receives information from both eyes.
- Accuracy and efficiency of movements decrease as the distance to the object increases.
  - Monocular vision problems appear to be due to the preparation phase from underestimating distance to the object.
Role of central & peripheral vision related to prehension tasks.

- Peripheral vision seems to affect the transport phase or the reaching for the object but not the grasp.

- Central vision provides information specific to the object.
  - If you block central vision both the phases are affected.
Central & Peripheral Vision are two separate anatomical systems

- Based on neurophysiological evidence
- Both operate in parallel

Central vision detects:
  - Static objects which are slow moving, responsible for recognizing object presences

Peripheral vision detects:
  - Objects and high-speed movement around us, provides limb movement direction, and perceptually guides movements
Optical Variable Tau

- *Time to contact* or distance based information
- Tau is amount of time remaining until the object contacts the person (or vice versa) from a specific distance.
- Tau is predictive function which allows action initiation and object contact to occur *automatically* at a specific time to contact regardless of the speed of the object and person.
  - *E.g. breaking to avoid hitting a car*…….process time needed by visual information to brake rather than knowledge of how much distance there is between you and oncoming car.
  - *Go thing it happens automatically because a lot of training is gain knowledge of distance based information.*
VISION AND HANDWRITING

- Vision helps to control the overall spatial arrangement of words on a horizontal line
- Vision helps one produce accurate handwriting patterns
VISION AND LOCOMOTION

- Vision promotes dynamic postural balance
  - Peripheral vision is key player.
  - Peripheral vision detects visual cues in environment by assessing optical flow patterns (light-object reflection)
- Vision provides time to contact rather than distance based information called TAU.
  - Studies completed with long jumping
- Vision provides body-scaled information and predictive information that relates to skills that require one to avoid them or set over them.
VISION AND JUMPING FROM HEIGHTS

- Tau triggers specific preparatory actions so that the jumper can land correctly
- Vision controls the onset of the muscle activity required for jumping from different heights
Vision & Catching

- Catching involves a moving object; prehension typically involves a stationary object

- Grasp of the ball in catching is the end of the action; prehension typically involves manipulation of the object
Three Phases of Catching an Object

- Body and limb transport toward oncoming object
  - No arm movement in first 160 to 240 ms of ball flight.
  - Elbow flexion begins at 80% of ball flight
- Shape the hand to catch the object
  - Hand begins to flex at 80% of the ball flight
- Fingers must grasp the object
  - (Vision provides advanced information spatially and temporally for arms, hands, and fingers before the ball arrives)
  - Grasping actually occurs before ball contact
VISION AND CATCHING

- Visual contact is needed during the initial part of flight and period of time just prior to contact with the hand(s)
  - Only the first 300 ms of flight is needed to determine direction & distance.
  - Only the last 200-300 ms before hand contact is critical.
- Viewing the object between these two time periods is not critical to catching
- Optical variable tau is involved in solving the time to contact problem in catching
DOES ONE NEED TO SEE THEIR HANDS TO CATCH AN OBJECT?

- Smyth & Marriott study of seeing or not seeing their hands..
  - Seeing their hands were more accurate
- What influence does experience have???
  - Experienced catchers do not need to see their hand.
  - Lowly skill catcher do need to see their hands throughout the flight
VISION AND HITTING

- One Can see the ball only to the point at which the swing is made (Hubbard & Seng) not to the point of contact.
- Batters synchronize the start of their step to release of the ball.
- Experience hitters track the ball longer
- Duration of the swing adjusted according to the speed of the oncoming pitch.
- All adjustments and decision to swing is made in the first 500 msec.
- Last 2/3 of flight is most important for accuracy
Visual Training

- Experimental evidence is lacking about the effectiveness of general vision training to improve sport performances
  - Sport Vision
  - Eyerobics
- Many common visual functions (e.g., do improve in training) do improve and training is similar to the same apparatus used to test these visual functions.
- Visual ability is sport specific.
  - Visual training exercises should be sport specific.