Understanding Planes and Axes of Movement

Terminology

When describing the relative positions of the body parts or relationship between those parts it is advisable to all use the same standard terminology.

Anterior: Toward or on the front of the body: in front of
The pectorals are on the anterior aspect of the body

Posterior: Towards or on the back of the body: behind
The rhomboids are on the posterior aspect of the body

Superior: Toward the head or upper part of a structure: above
The humerus is superior to the radius

Inferior: Toward the lower part of a structure: below
The tibia is inferior to the femur

Medial: Toward or at the midline of the body: inner side
The adductors are on medial to the abductors

Lateral: Away form the midline of the body: outer side
The abductors are on the lateral aspect of the leg

Proximal: Closer to the origin of a point of reference
The elbow is proximal to the wrist

Distal: Further from the origin or point of reference
The foot is distal to the knee

Planes and Axis

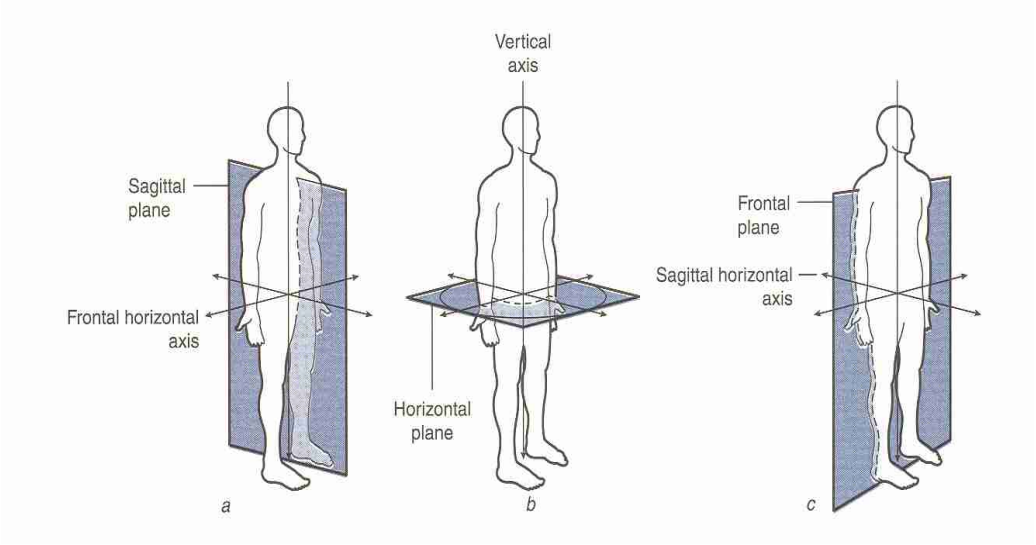
Human movements are described in three dimensions based on a series of planes and axis. There are three planes of motion that pass through the human body.

- The sagital plane
- The frontal plane
- The transverse (horizontal) plane

The sagital plane lies vertically and divides the body into right and left parts.

The frontal plane also lies vertically however divides the body into anterior and posterior parts.

The transverse plane lies horizontally and divides the body into superior and inferior parts.



Behnke 2000

Axis

An axis is a straight line around which an object rotates. Movement at the joint take place in a plane about an axis. There are three axis of rotation.

- Sagital axis
- Frontal axis
- Vertical axis

The sagital axis passes horizontally from posterior to anterior and is formed by the intersection of the sagital and transverse planes.

The frontal axis passes horizontally from left to right and is formed by the intersection of the frontal and transverse planes.

The vertical axis passes vertically from inferior to superior and is formed by the intersection of the sagital and frontal planes.

Planes of motion and function

- There is a tendency when describing a movement for it to be referred to in the particular plane that it is dominated by. An example of this would be a description of walking as a sagital plane movement.

- In reality this is really only a description of the gross direction of movement. At individual joint level, movement will be occurring in several planes not solely in the sagital plane. For example during walking, the hip will be flexing/extending in the sagital plane, adducting/abducting in the frontal plane and internally/externally rotating in the transverse plane.

- The same concept applies to all the individual joints in the lower limb

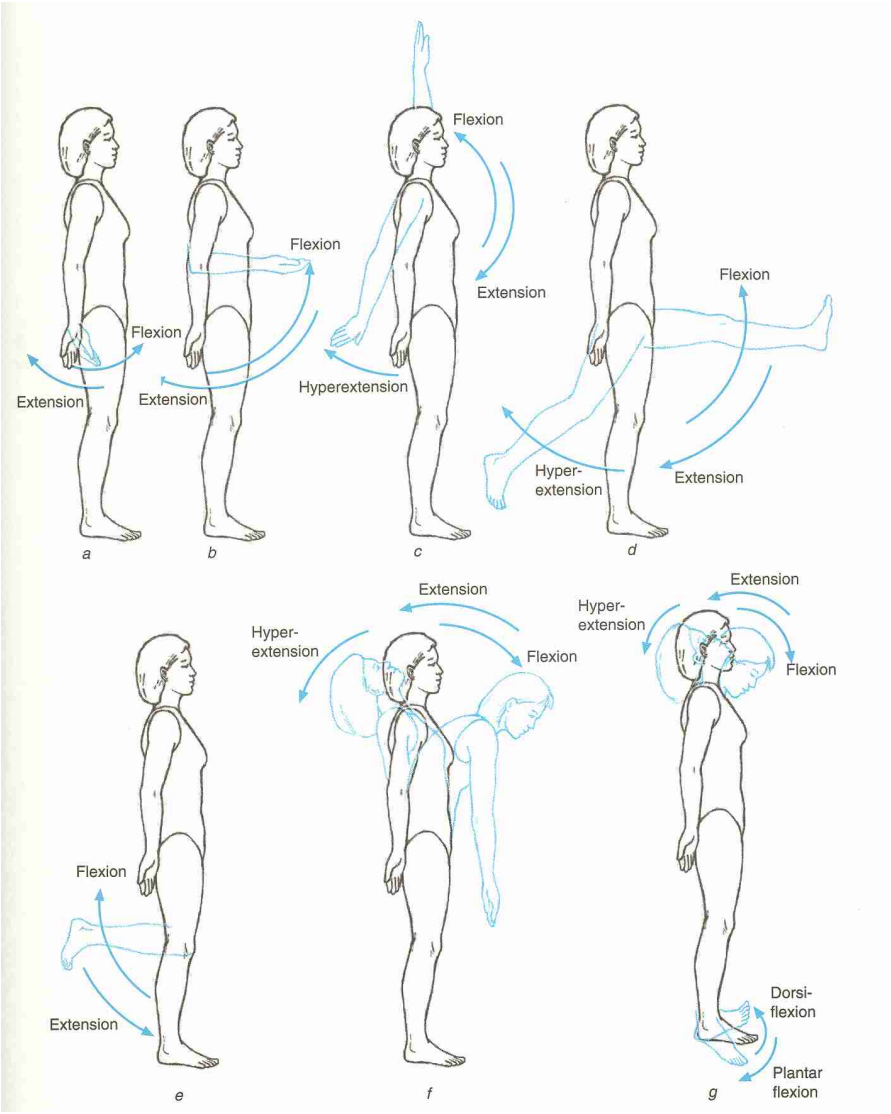
- This simultaneous movement can be seen as one motion with three components……**tri-planar motion**

- It is essential that the exercise professional is comfortable with the concepts of tri-planar motion and the fact that all functional movements are three dimensional, however it is biomechanically understood that description in single plane terms is most useful when generalising about gross movement patterns.

Examples of dominant planes, motions and axis in gross movements

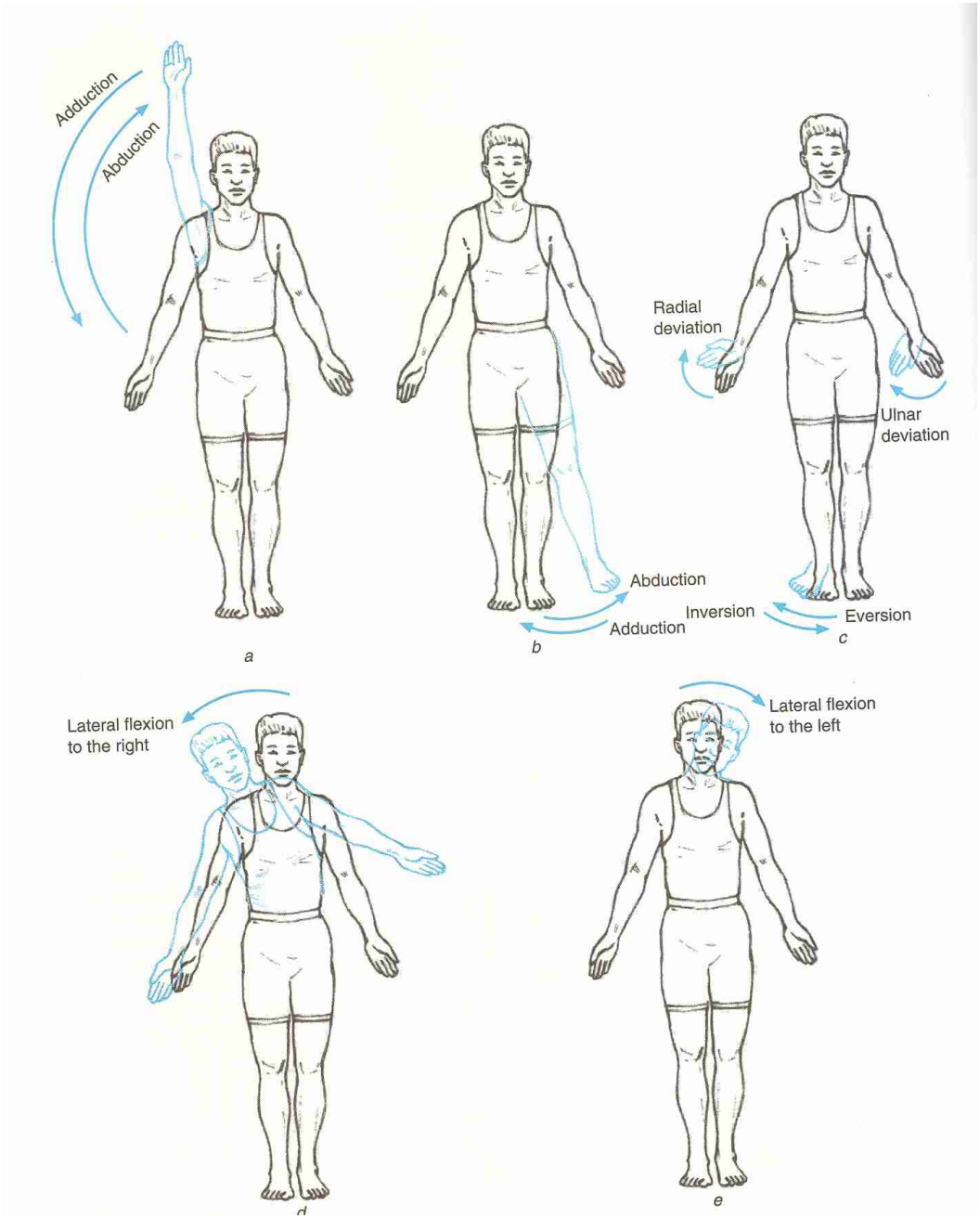
Plane	Motion	Axis	Example
Sagital	Flexion/extension	Frontal	Walking Squatting Overhead press
Frontal	Abduction/abduction Side flexion Inversion/eversion	Sagital	Star jump Lateral arm raise Side bending
Transverse	Int rotationn/ext rotation Horizontal flexion/extension Supination/pronation	Vertical	Throwing Baseball swing Golf swing

Movement in the sagital plane about the frontal axis



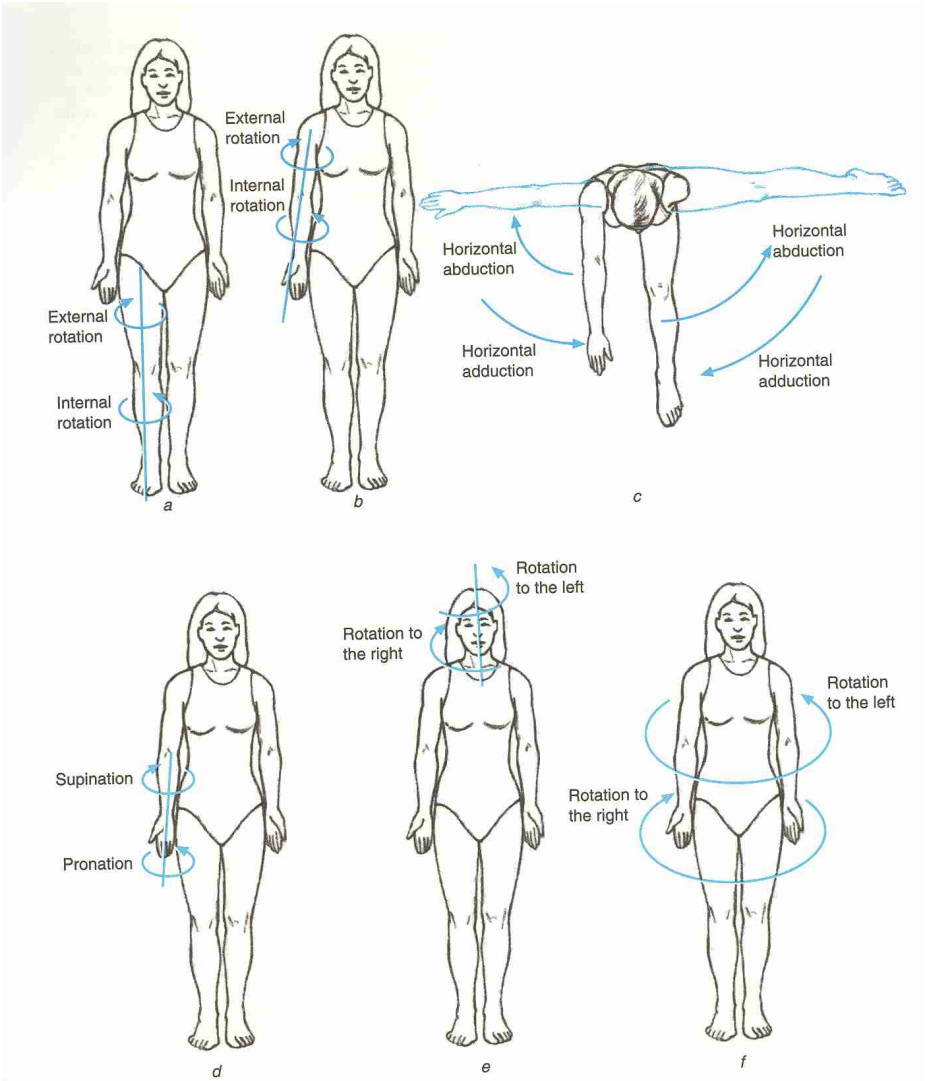
McGinnis, (1999)

Movement in the frontal plane about the sagital axis



McGinnis, (1999)

Movement in the transverse (horizontal) plane about the vertical axis



McGinnis, (1999)

As well as missing many other components of functional training, our current popular methods involve machine-based exercises that do everything possible to ensure movement is strictly limited to one plane. E.g

Quads bench, bicep curl, hip abduction, hamstring curl, calf raise, tricep press!

These examples show how movement is dominated in the sagital plane closely followed by the frontal plane. Even when machines are temporarily neglected and, for example, a dumbbell is selected, the planes that the dumbbell exercises are often biased toward still remain sagital and frontal. E.g.

Bicep curl, lateral arm raise, overhead press, tricep extension.

This training approach has brainwashed the average gym member into believing all exercises must be performed in strict planes of movement, which usually tend to be the sagital and frontal planes.

Now look at the functional activities of life and sport. eg.

Rolling, walking, skipping, twisting, running, jumping, hopping,

Catching, throwing, kicking, climbing, squatting, pushing, pulling

All of these component movements will combine to achieve a backhand at tennis, or a golf swing, a header in football, a spike in volleyball, paddling in kayaking.

They are all activities that require motion in all three planes simultaneously.

Multi-plane movement dominates activities of life and sport. Current popular training methods take no account of this with exercises that dominate in the sagital plane and often neglect the transverse plane entirely.

How many machines can you think of in the average gym that utilise the **transverse** plane.

Multi-plane movement is an essential component of functional training and furthermore the transverse plane as a 'functional cornerstone'. This plane has been neglected but must be recognised in order for an exercise to be deemed truly functional.

How can one expect **carryover** from training to sport if training methods continue to be dominated by single plane exercises in a proprioceptively sparse environment.

Key Points

- We function in a 3 dimensional environment
- Traditional training methods tend to emphasise movement in one plane
- The transverse plane is often neglected in training programmes