

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 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 medial to the abductors

Lateral: Away from 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

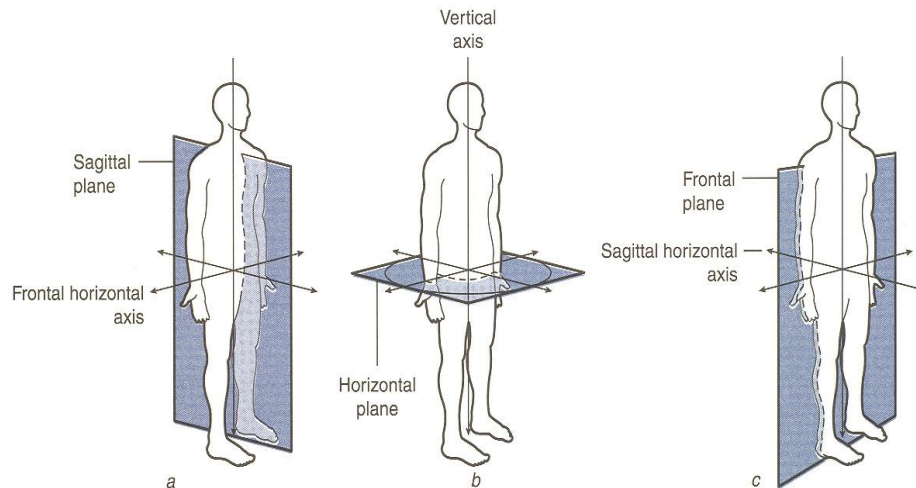
Human movements are described in three dimensions based on a series of planes and axis. There are three planes of motion that pass through the human body.

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

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

The frontal plane also lies vertically and 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 a joint takes place in a plane about an axis. There are three axes of rotation.

- Sagittal axis
- Frontal axis
- Vertical axis

The sagittal axis passes horizontally from posterior to anterior and is formed by the intersection of the sagittal 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 sagittal 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 sagittal 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 all three planes not solely in the sagittal plane. For example during walking, the hip will be flexing/extending in the sagittal 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

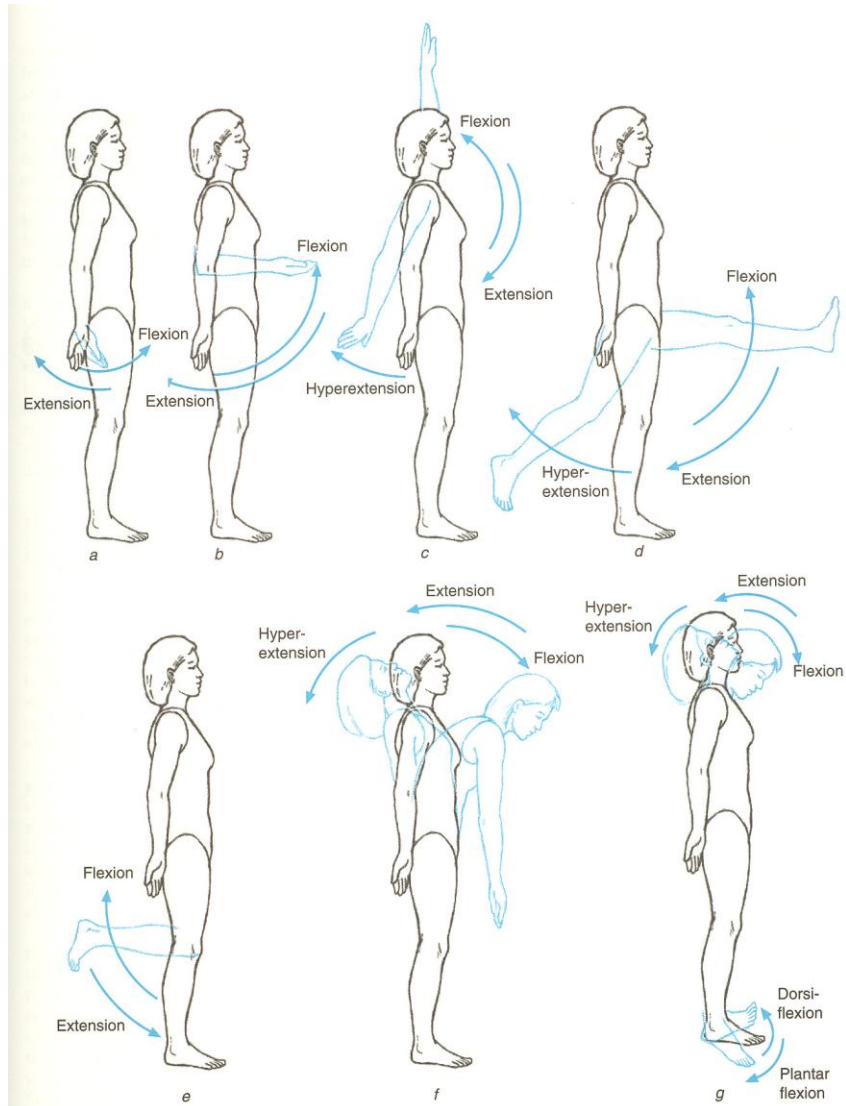
- The movement that you effectively “see” does not represent what is occurring in terms of motor control and force absorption within all three planes.
- For example during gait the most obvious hip movement is expressed in the sagittal plane, but at the joint there is an interplay between eccentric force absorption and concentric force production in all three planes. The hip is subtly decelerating internal rotation and adduction and then accelerating external rotation and abduction.
- This simultaneous movement can be seen as one motion with three components..... it can be termed **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
Sagittal	Flexion/extension	Frontal	Walking Squatting Overhead press
Frontal	Abduction/adduction Side flexion Inversion/eversion	Sagittal	Star jump Lateral arm raise Side bending
Transverse	Int rotationn/ext rotation Horizontal flexion/extension Supination/pronation	Vertical	Throwing Baseball swing Golf swing

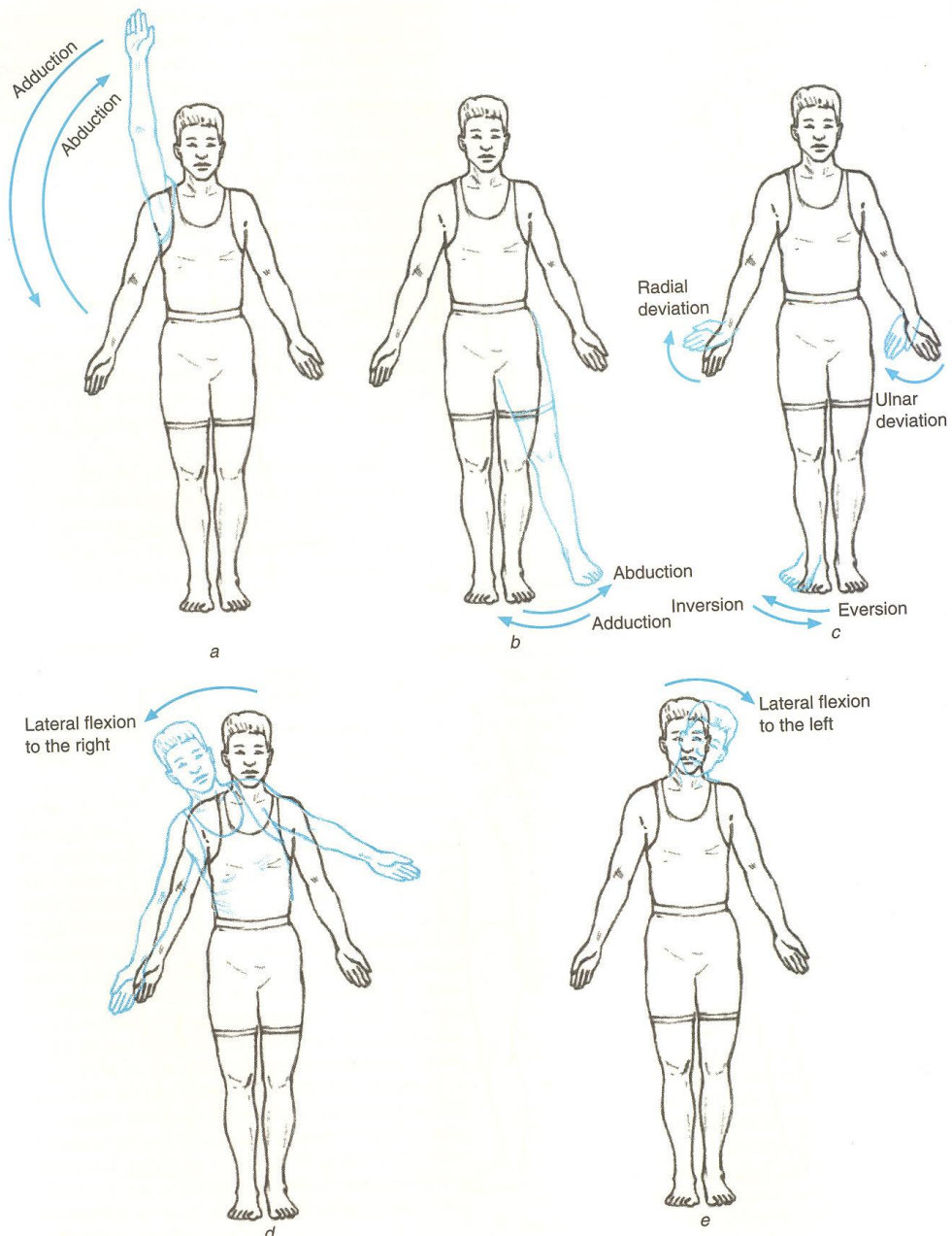
*The above are acceptable only as terms of **gross movement**.*

Movement in the sagittal plane about the frontal axis



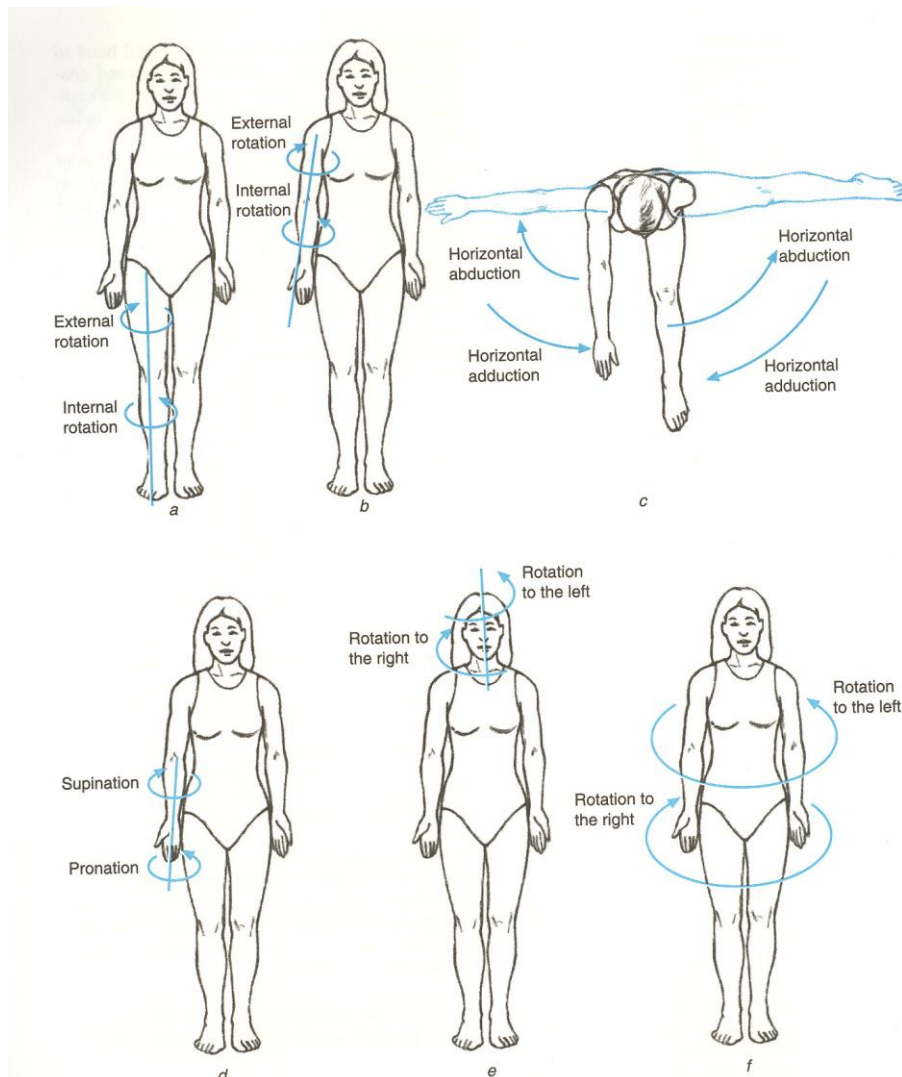
McGinnis, (1999)

Movement in the frontal plane about the sagittal axis



McGinnis, (1999)

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



McGinnis, (1999)

Practical Reasoning

Familiar machine based , weight training, lifting and even bodyweight exercises may appear to be performed entirely within one plane, and their “descriptions” can re-enforce this i.e.

Quads bench, bicep curl, hip abduction, hamstring curl, calf raise, tricep press, lateral arm raise, overhead press, tricep extension.

However, just as in walking, there will also be elements of motor control, stability and internal joint moments (directional control) in all 3 planes of motion occurring that may not be entirely obvious just by simple observation. This tri-plane control tends to be exaggerated in free weight and “open chain” lifts as opposed to the more enforced fixation of machine based resistance exercise.

If we look at the functional activities of life and sport i.e.

Rolling, walking, skipping, twisting, running, jumping, hopping, Catching, throwing, kicking, climbing, squatting, pushing, pulling etc

We can identify small patterns and “segments” that again may appear to be dominant in one plane of movement. However these component movements will combine to achieve more complex motor sequences, such as a backhand at tennis, or a golf swing, a header in football, a spike in volleyball, paddling in kayaking.

These are all activities that require motion in all three planes simultaneously. But once again even at this higher level of complex movement, simple observation may lead to a conclusion that the movement is dominated by one plane i.e. the transverse plane in golf. However the body is stabilising, redirecting, controlling and subtly shifting in all three planes of motion, at all the involved joints in order to successfully complete the golf swing.

Multi-plane movement dominates activities of life and sport. An understanding of the interplay between the three planes of movement can help with your “reasoning” when considering exercises and training activities.

For example, the machine based “culture” can dominate the commercial and home based gym installations.

How many machines can you think of in the average gym that fully utilise and challenge the **transverse** plane?

What functional carry-over to dynamic movement would you expect from casual use of a seated pec deck?

How does a bilateral seated adductor press relate to the list of component patterns of movement?

A simple lift, such as a bent knee dead-lift variation, may appear to be very sagittal plane dominant but to perform it successfully the other two planes will be contributing significantly. The same basic pattern of a floor lift could be expressed as an overhead medicine ball lift and then a squat jump. There has been a progression in tri-plane “control” of what appears to be a simple sagittal plane movement... and this “control” has been adapted in terms of range, speed and load.

Traditional bodyweight exercises such as lunges, presses and pull ups, balances and floor work can all be plane biased or plane adapted.

Key Points

- The “three planes of motion” are as much a training variable, or “tool” as the application and progression of resistance, load, speed, range, frequency, reps and time.
- What appears to be movement in one plane may hide its “control” and contribution from the other two planes.
- The transverse plane is often neglected in training programmes.

Please visit www.physical-solutions.co.uk for more training and educational resources.