

Chapter 14:
Center of Gravity
and Stability

KINESIOLOGY

Scientific Basis of Human Motion, 11th edition
Hamilton, Weimar & Luttgens

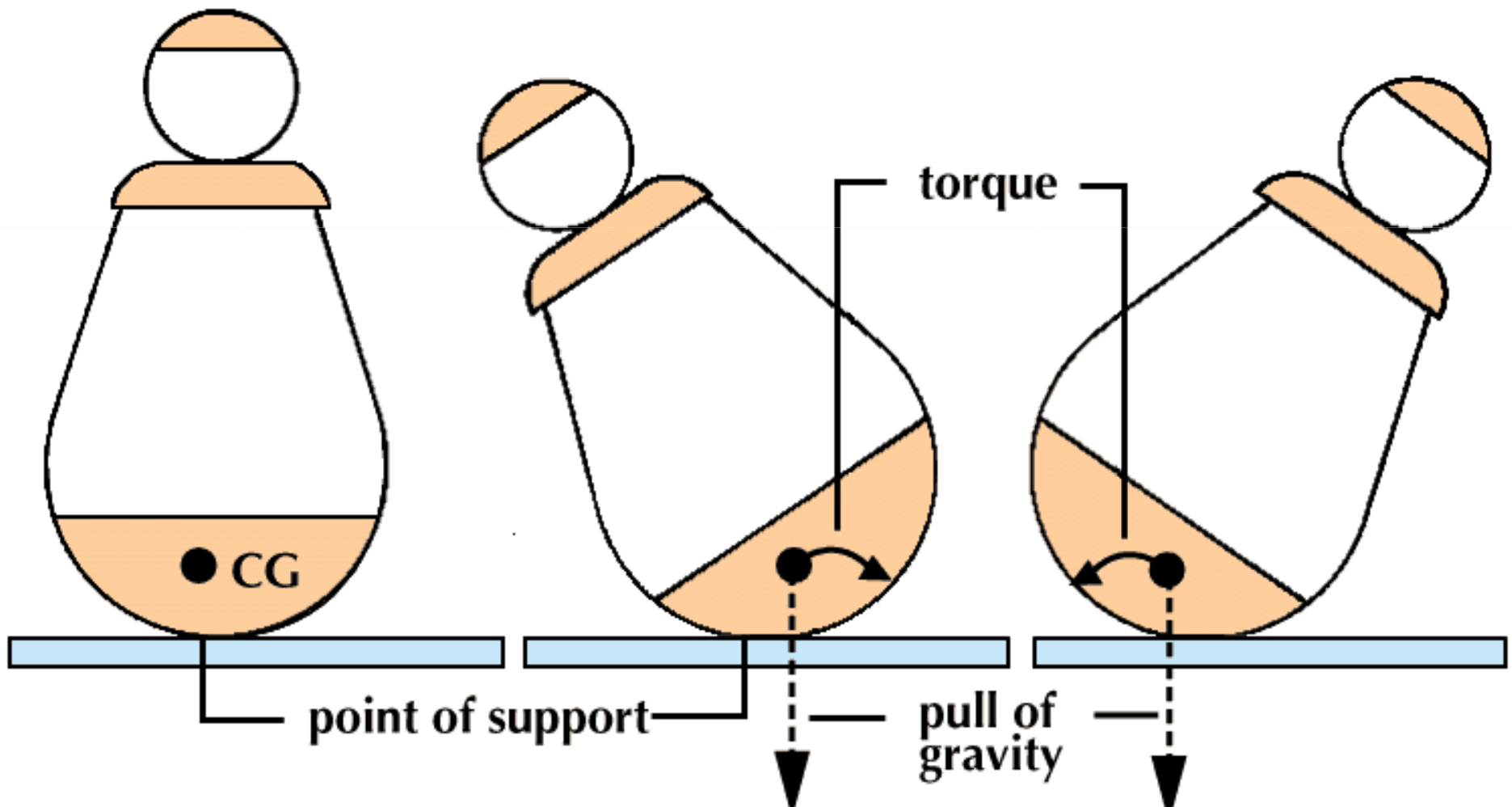
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Agenda

1. Center of Gravity (**CG**)
2. Equilibrium, Stability, and Mobility



CENTER OF GRAVITY (CG)

- “Balance point” of body
- Point where weight of body acts
- Point where all forces acting on the body equal summed
 - Linear forces.
 - Torques
- If object’s shape or position changes, the location of CG changes

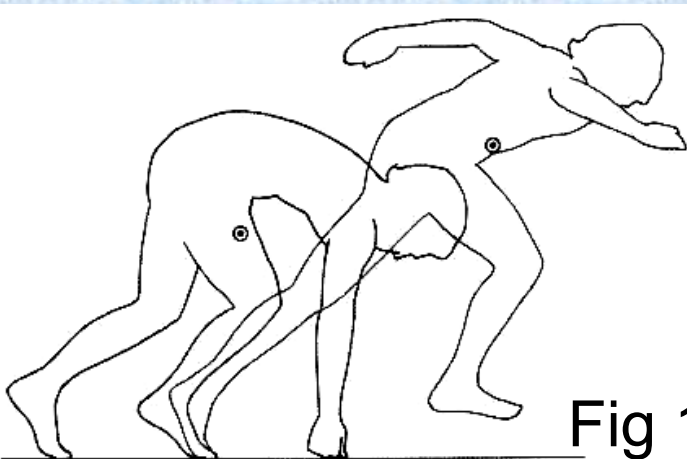


Fig 14.3

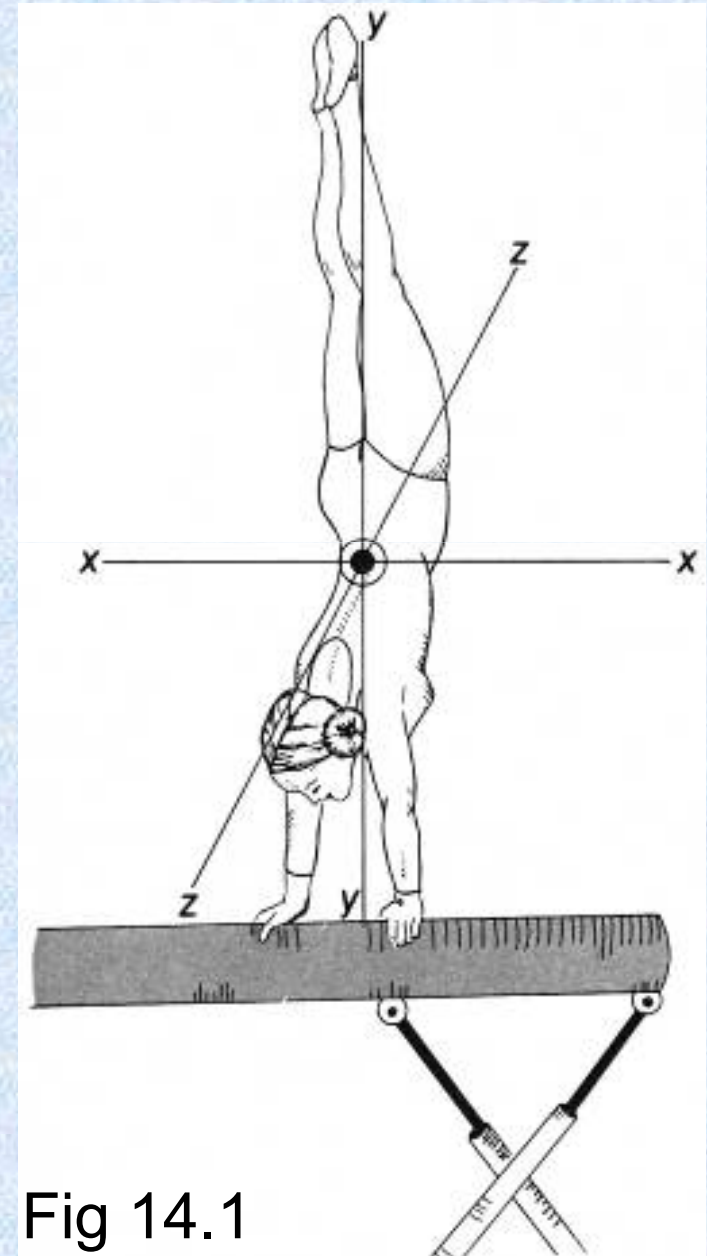
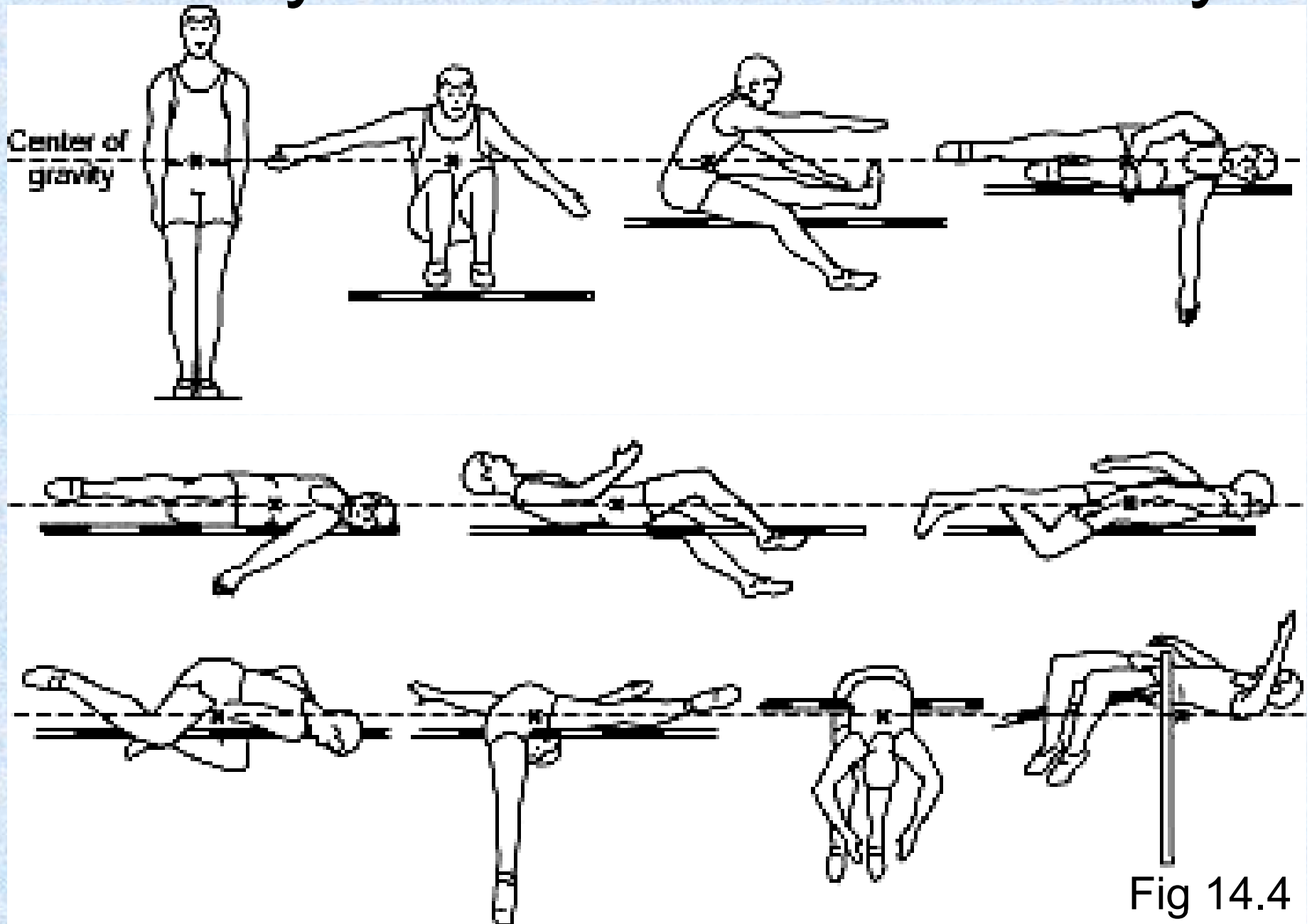


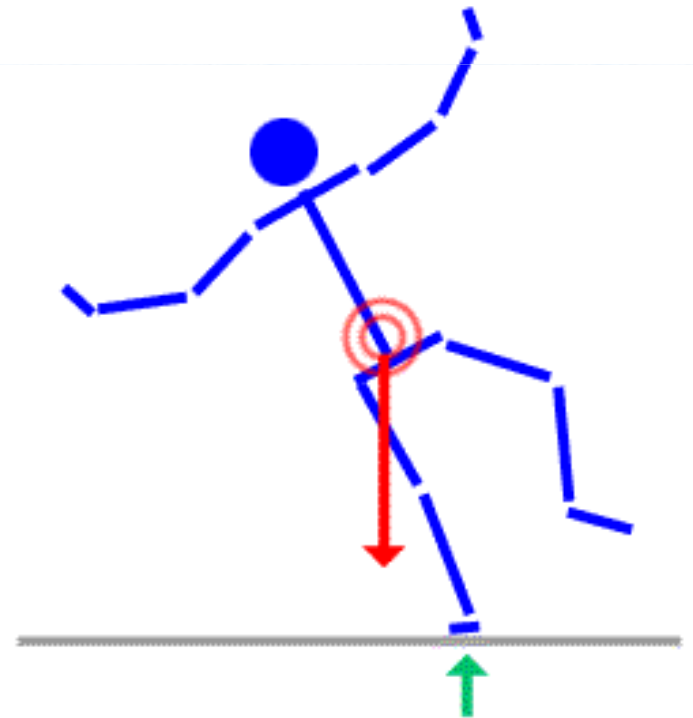
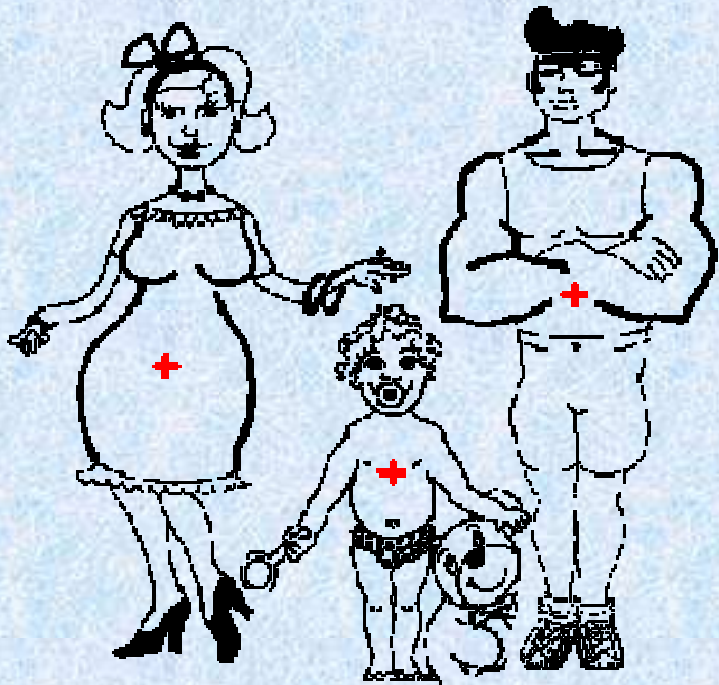
Fig 14.1

CG may be located outside body



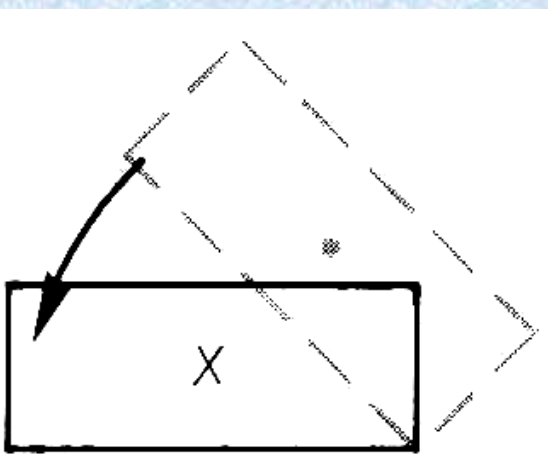
Placement of CG in Humans

- Location of CG in the normal standing position varies with body build, age, and sex
- Female's CG is ~ 55% of standing height
- Male's CG is ~ 57% of standing height



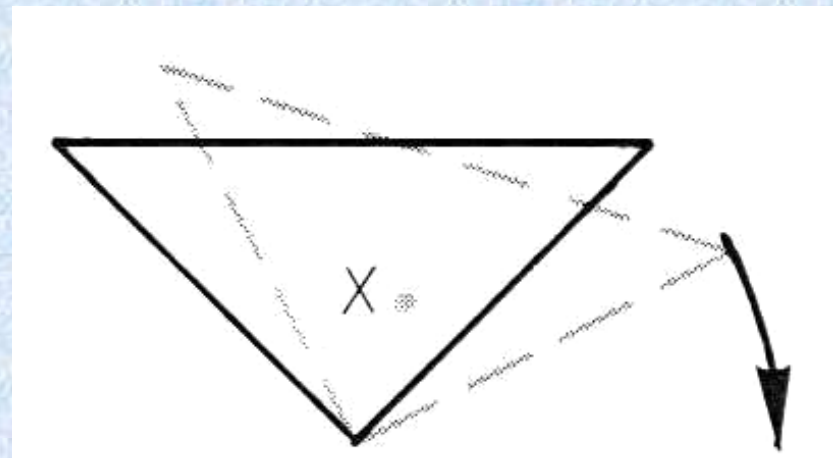
STABILITY AND EQUILIBRIUM

- All objects at rest are in equilibrium
- All forces acting on them are balanced
- Sum of all linear forces equals zero
- Sum of all torques equals zero
- However, all objects at rest are not equally stable



Stable

Fig 14.5a

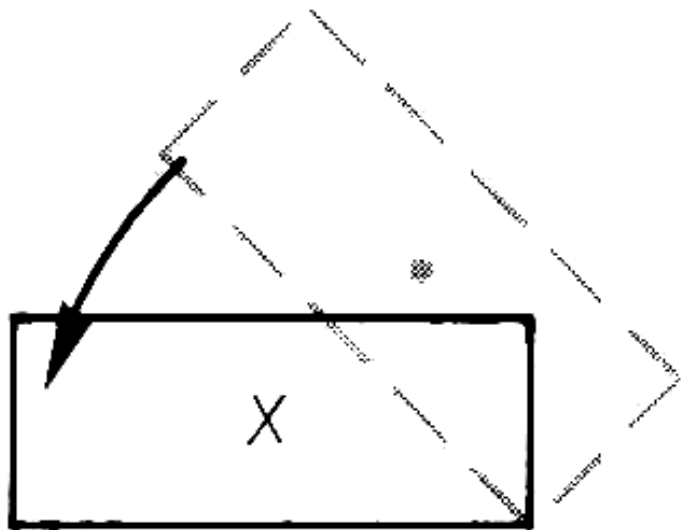


Unstable

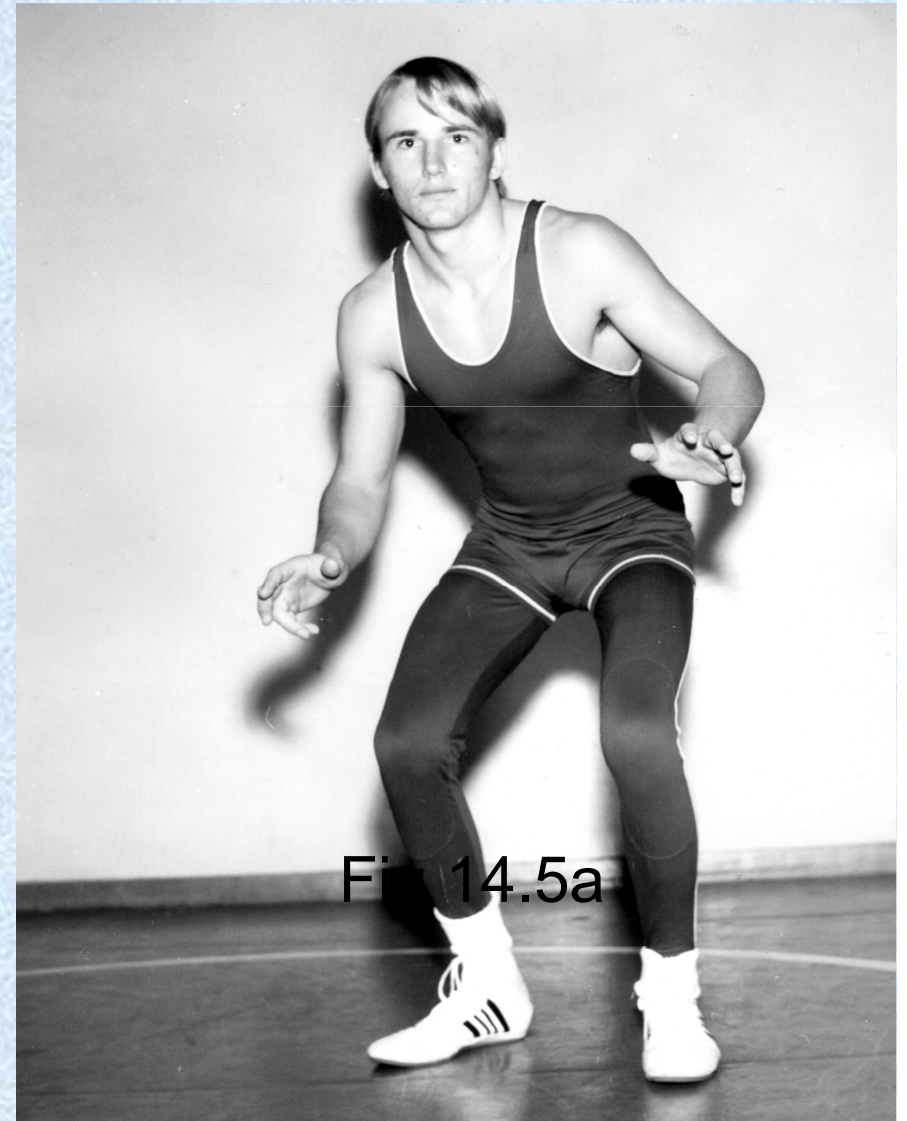
Fig 14.5b

Stable Equilibrium

- Occurs when an object is placed such that an effort to disturb it would require its CG to be raised



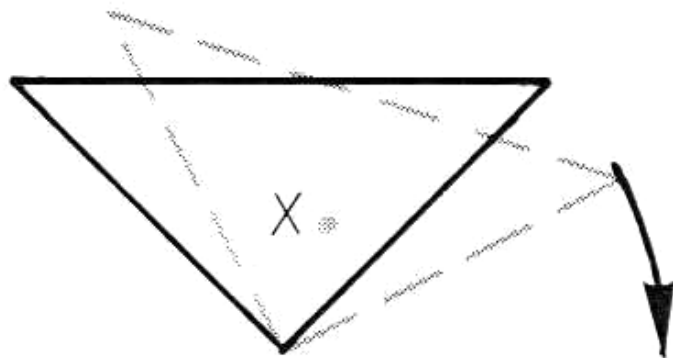
Stable



Unstable Equilibrium

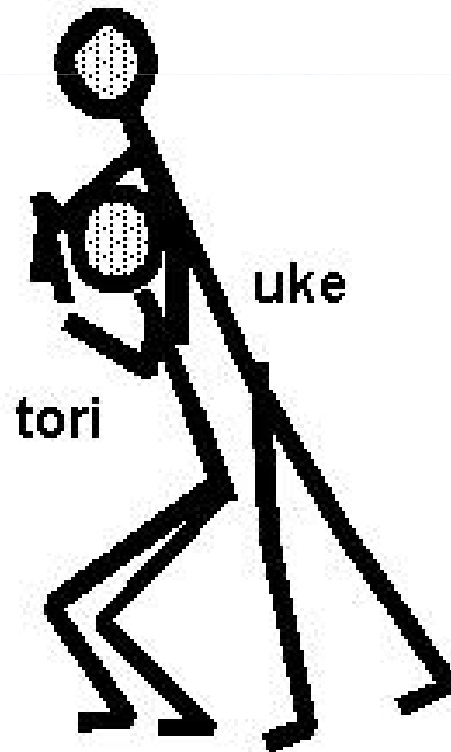
- When a slight disturbance will drop the objects CG to a lower point

Fig 14.5b



Unstable

unbalancing

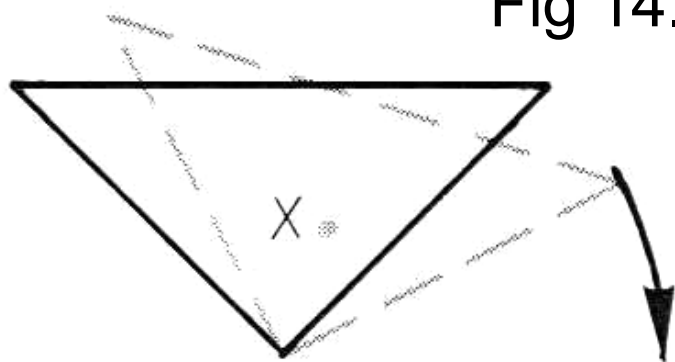


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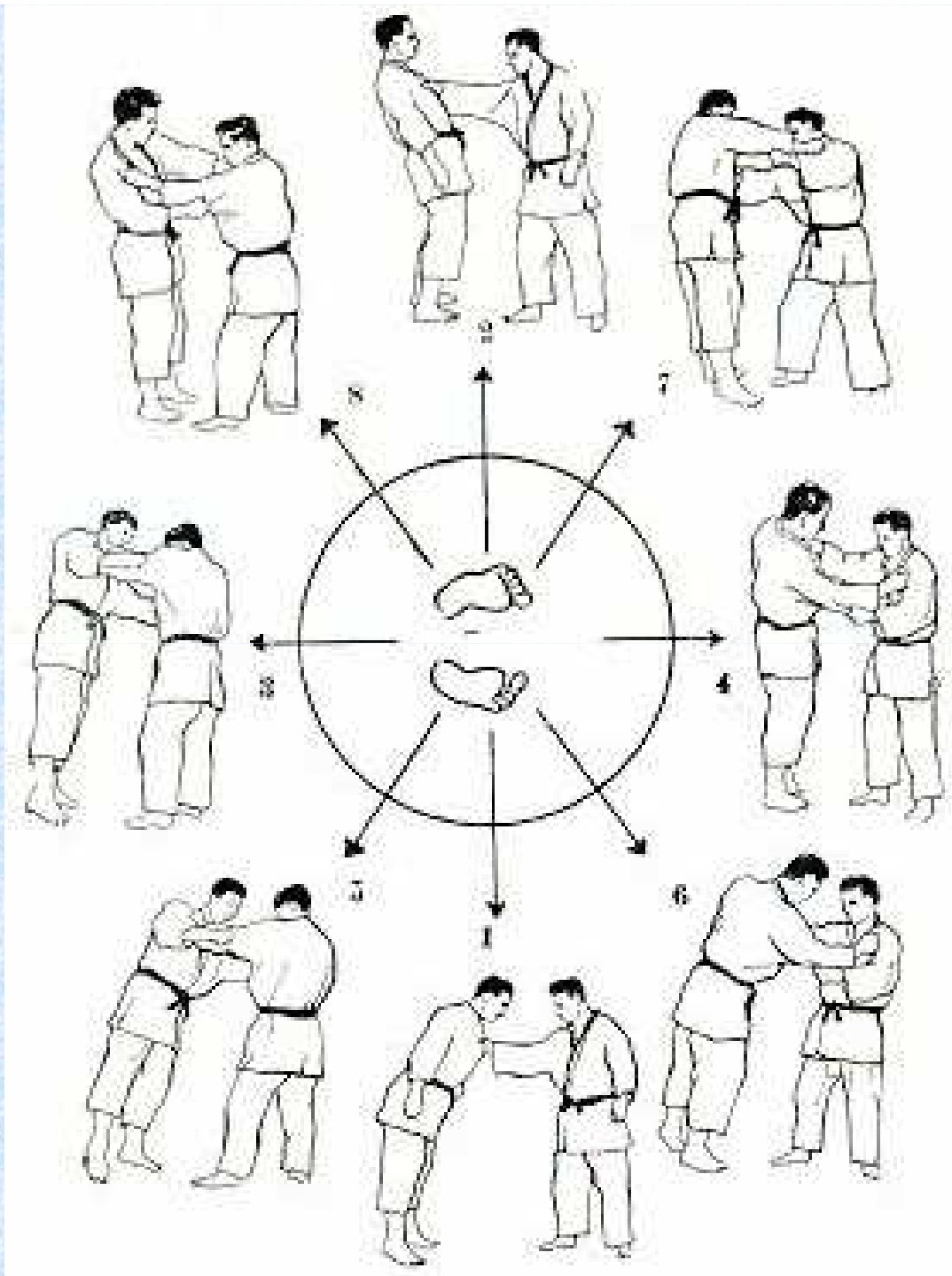
tori

KUZUSHI is to unbalance opponent (i.e., create unstable equilibrium !!)

Fig 14.5b

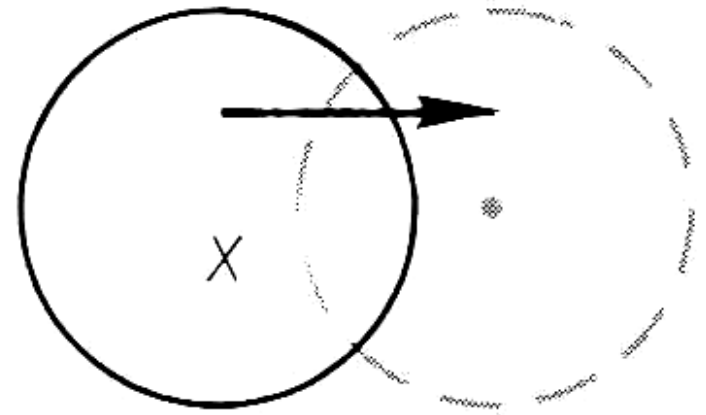


Unstable



Neutral Equilibrium

- CG neither raised nor lowered when moving



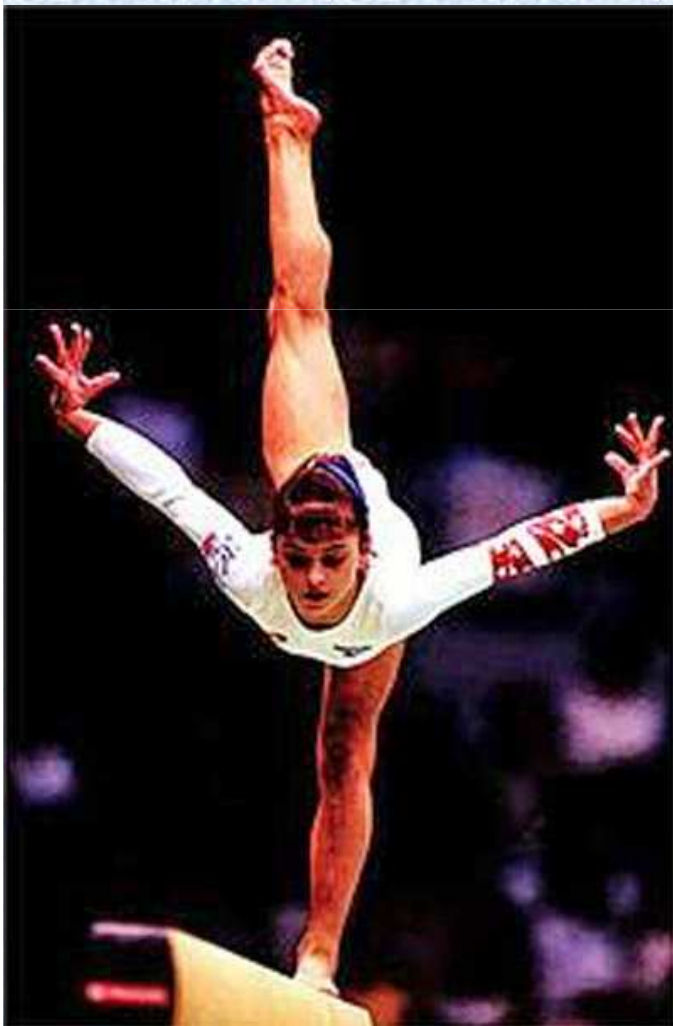
Neutral

Fig 14.5c

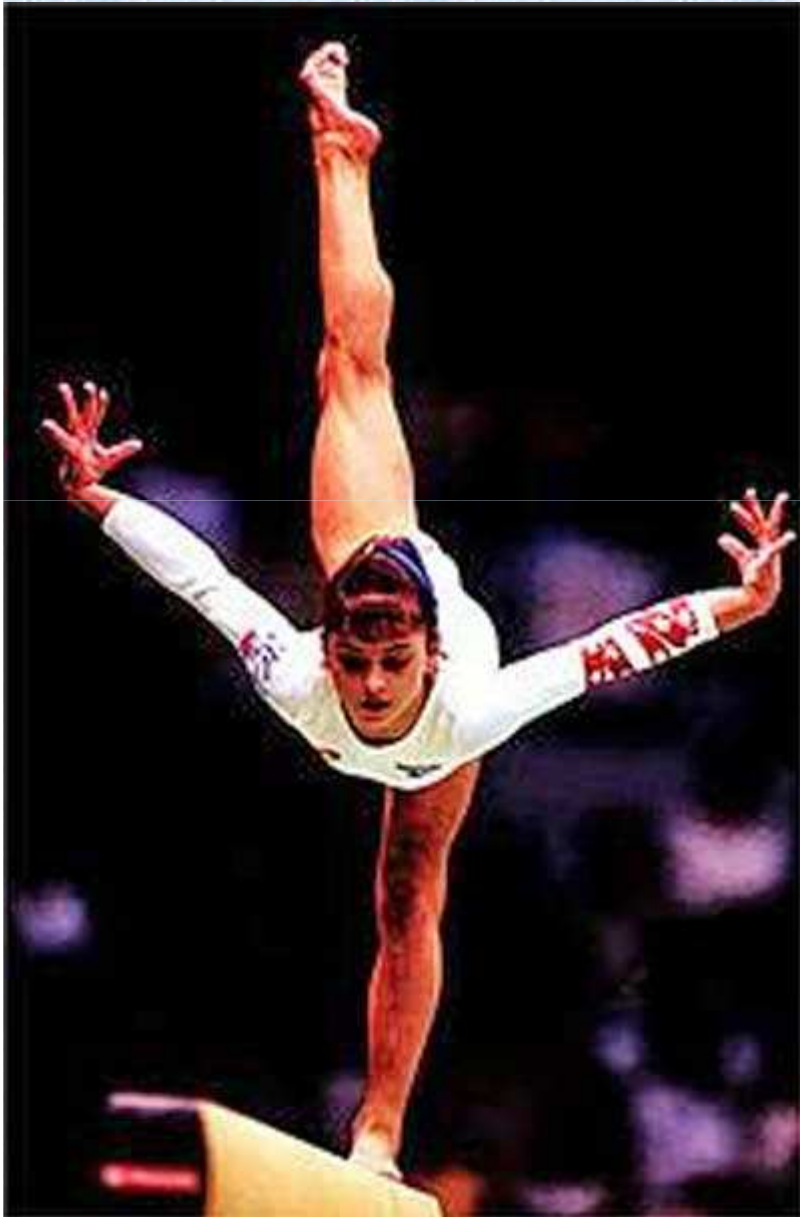


Factors Affecting Stability

- Ability to maintain one's balance under unfavorable circumstance is one of the basic motor skills



Stability



Base of Support

- CG must remain within base of support in order to maintain equilibrium
- Easier with larger base of support.

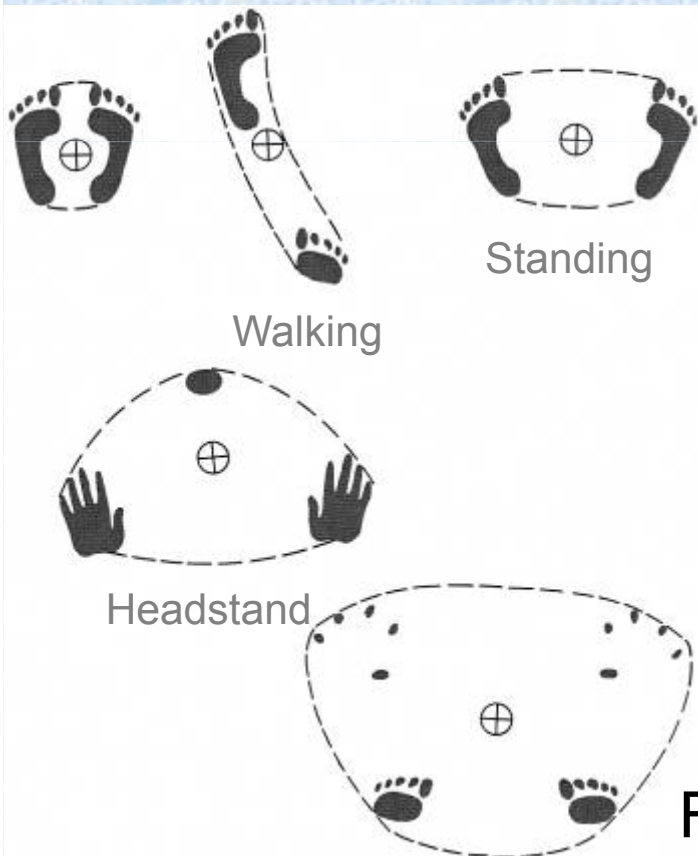


Fig 14.6



Shape of the Base of Support

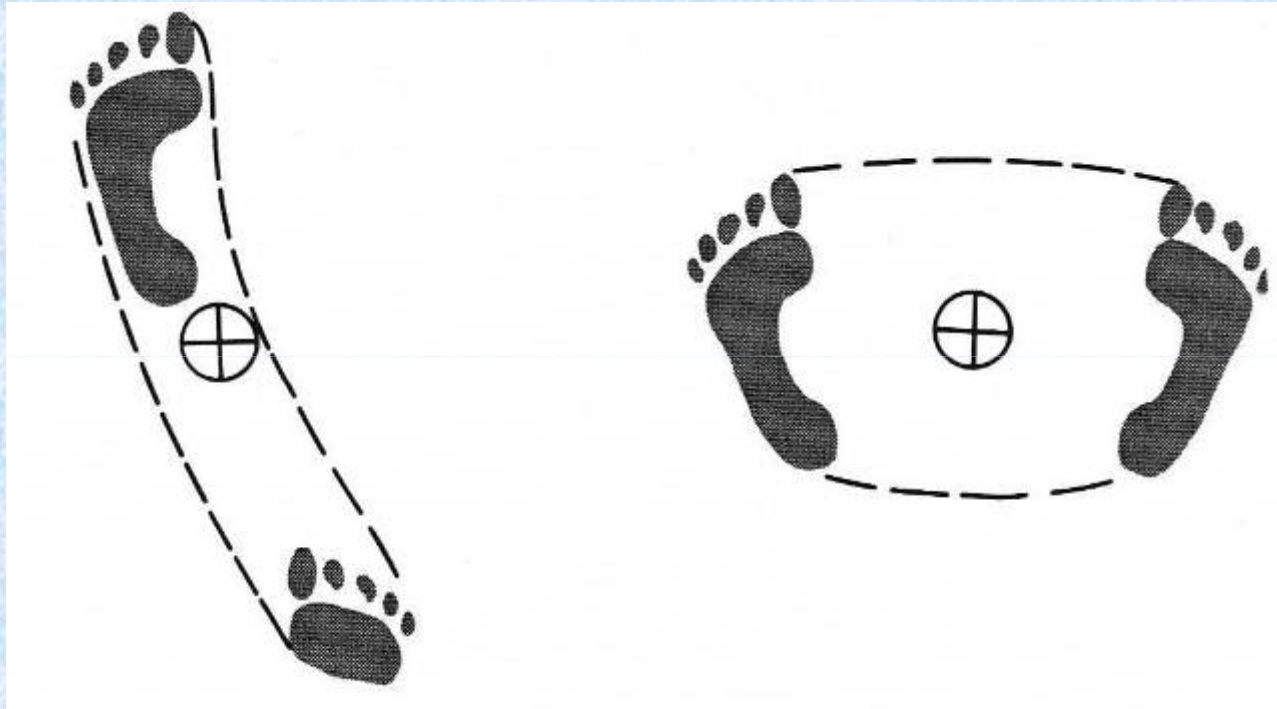


Fig 14.6c

Fig 14.6b

Resistance to
forward forces

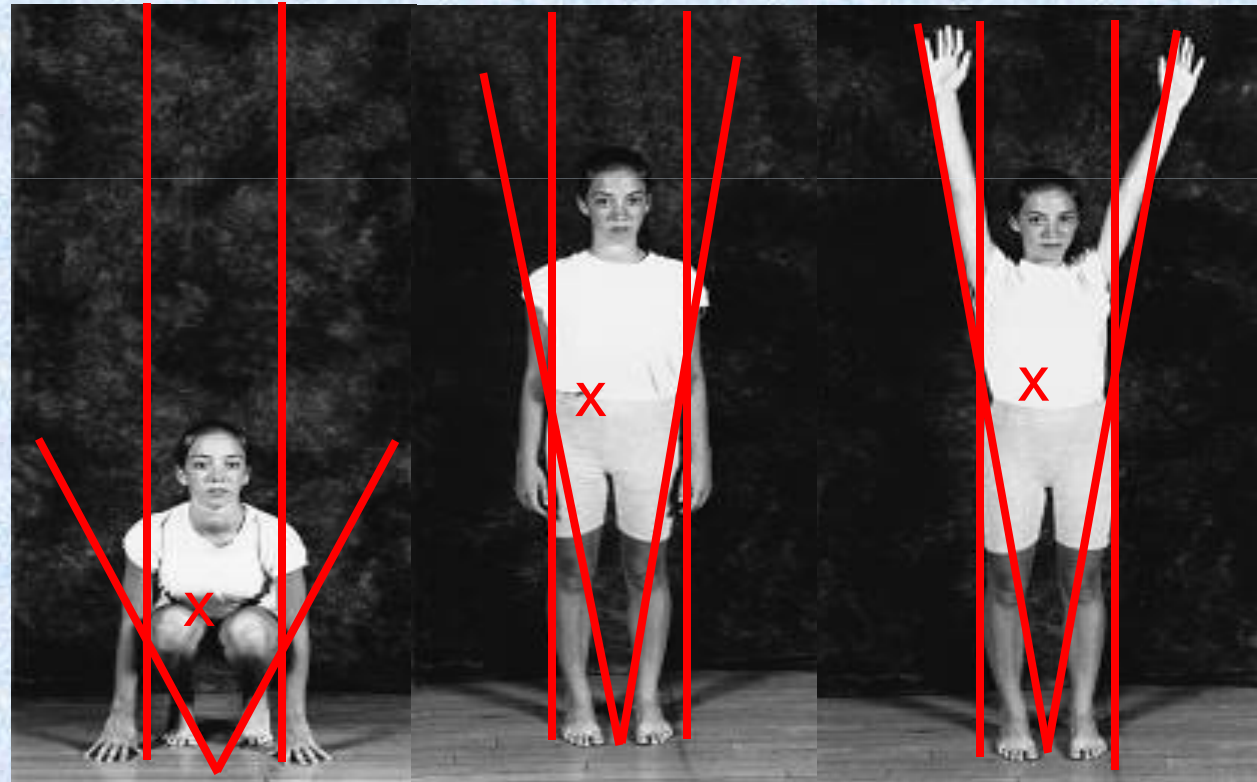
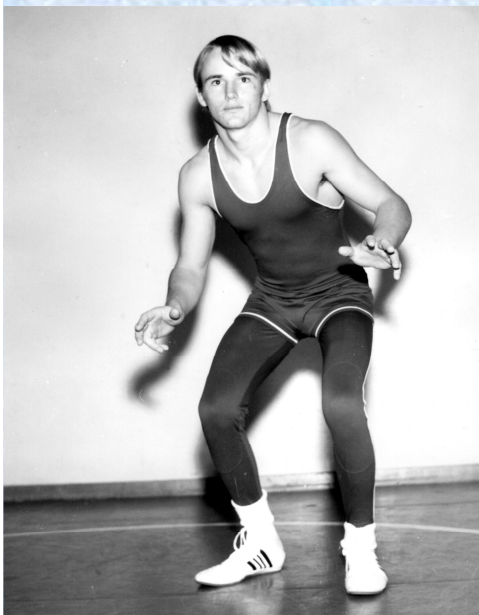
Resistance to
lateral forces

Height of the Center of Gravity

- Height of CG changes with body position.
- As CG moves closer to base of support more angular displacement can occur before it goes beyond the base of support

Fig 14.8

$a > b > c$ with respect to lateral stability



a

b

c

Relationship of the Line of Gravity to the Base of Support

- To maintain equilibrium, line of gravity must remain within the base of support

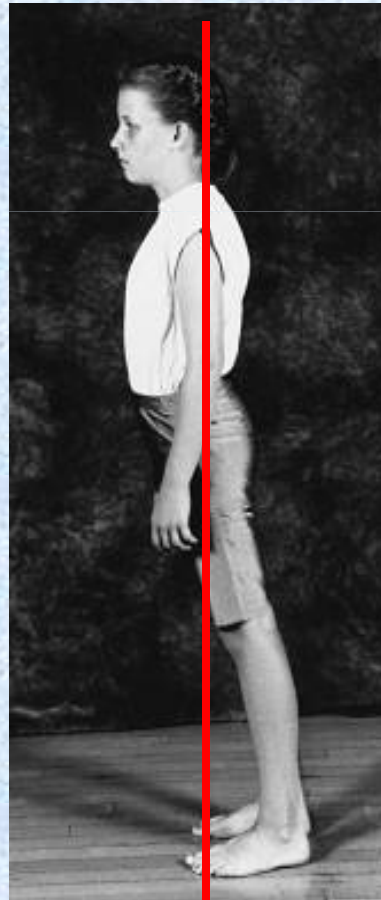
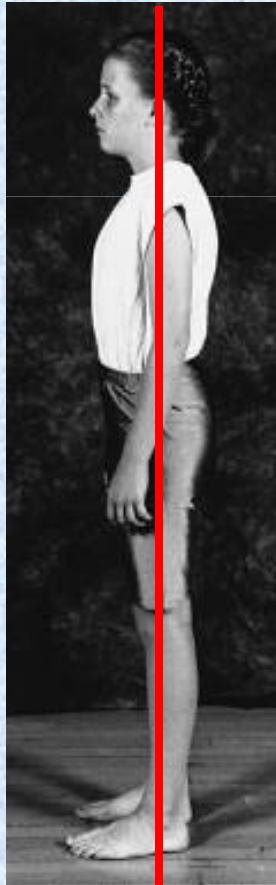


Fig 14.9 &
14.10

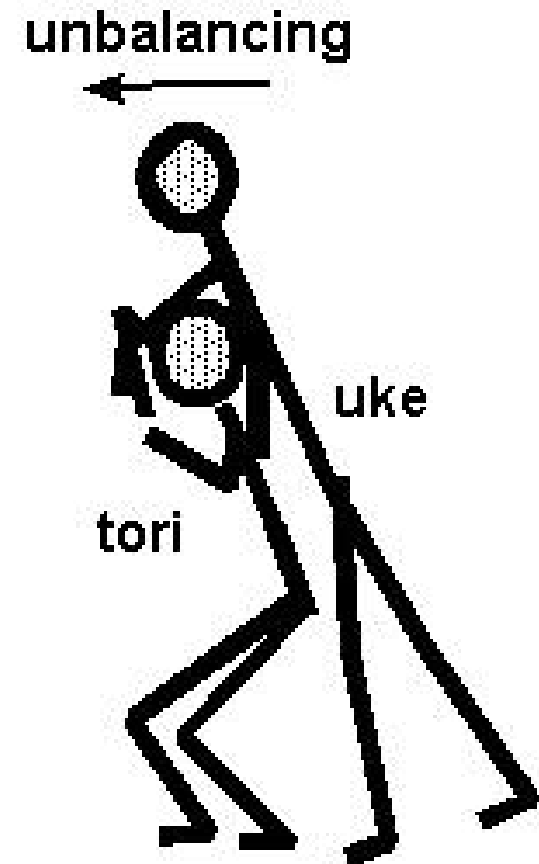
Mass of the Body

- The greater the mass, the greater the stability



Segmental Alignment

- Body consists of a series of segments. The problem of retaining equilibrium is a multiple one.
- When segments are aligned in a single vertical line, there is less strain to joints and muscles.
- When one segment gets out of line, another segment must compensate for it.



Mobility

- Mobility & stability have an inverse relationship
- A critical point is the change from a position of stability to a state of mobility & vice versa

