POSTURAL CONTROL

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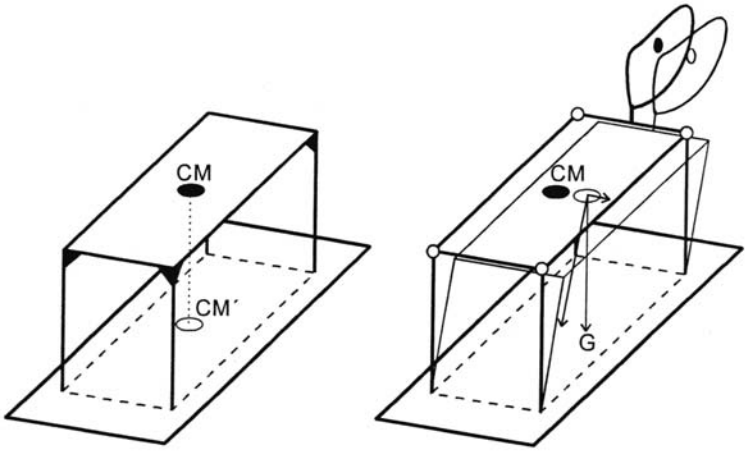
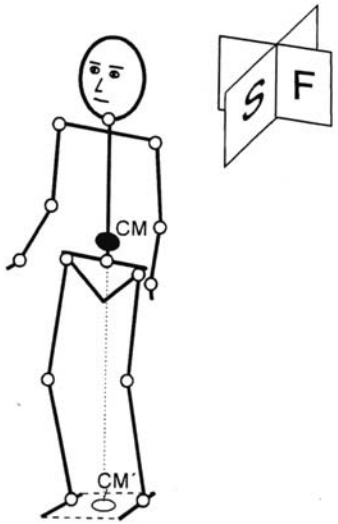
1. Stabilization of upright posture
2. Postural support of voluntary movements
3. Stabilization of head and limb orientation in relation to the body and to the gravity vector
4. Role of different parts of CNS in the postural control
5. Development of postural control

Stabilization of the upright posture

Postural control system is keeping the projection of the centre of mass within the limits of the supporting area

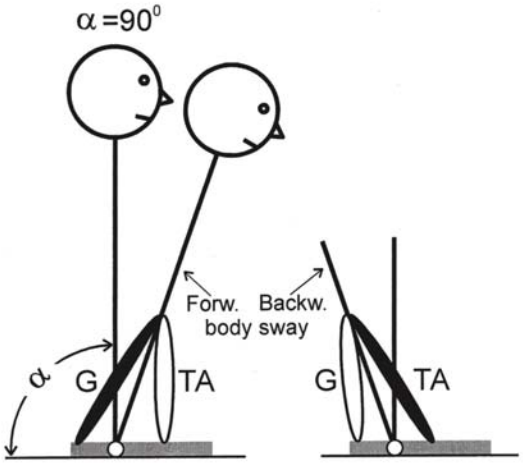


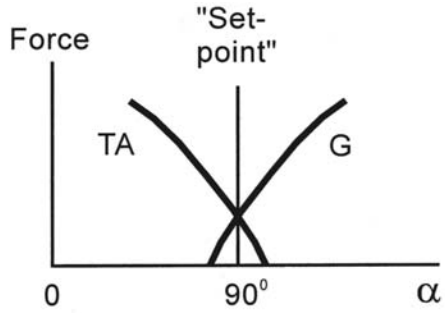
Postural stability in the frontal plane and in the sagittal plane is maintained by two different systems



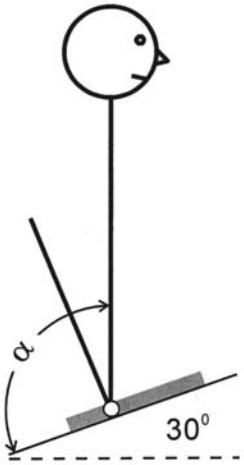
Operation of the sagittal plane system

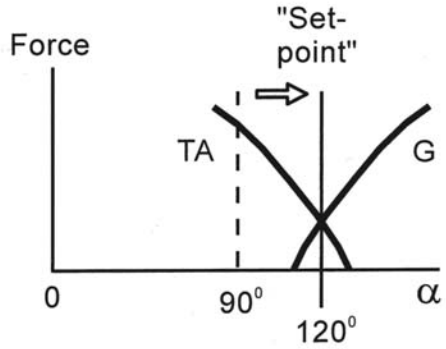
Correcting motor responses



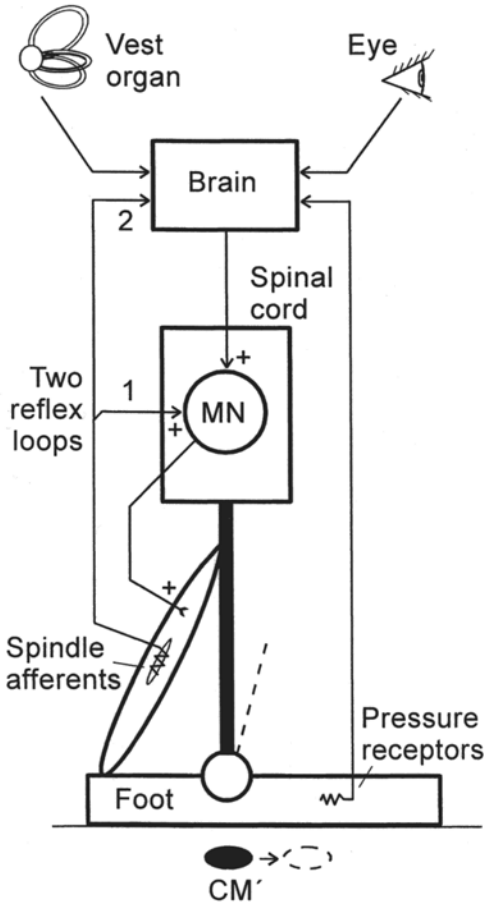


Postural control system can stabilize different positions

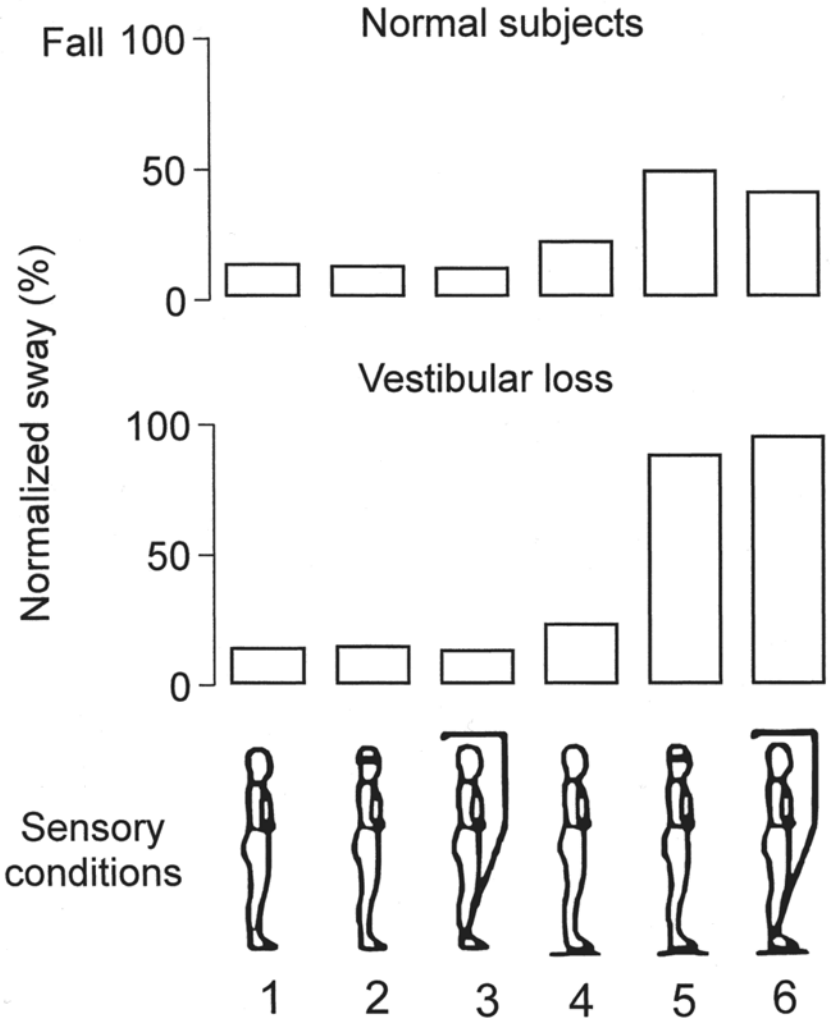




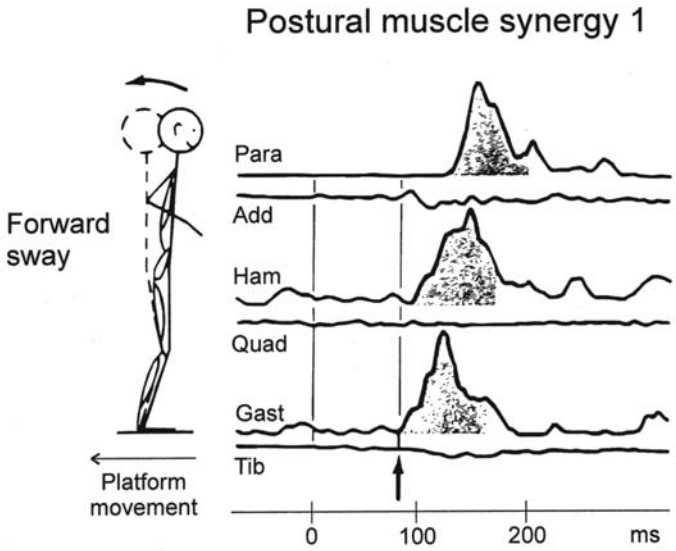
Sensory inputs for postural control system

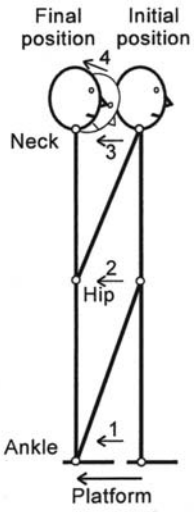


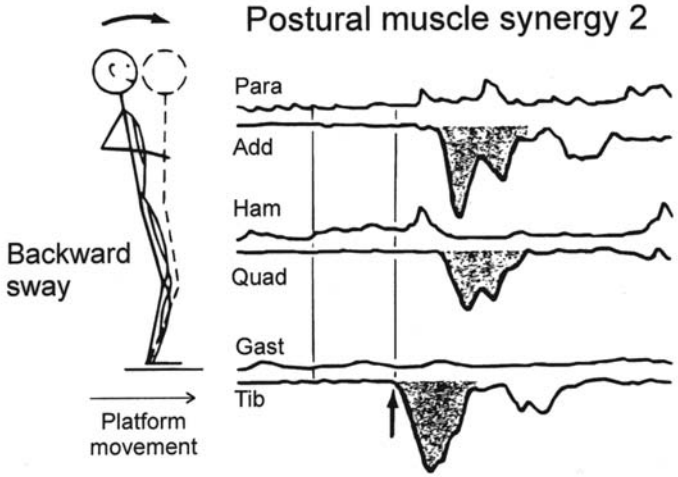
Role of different sensory inputs for stabilization of the upright posture



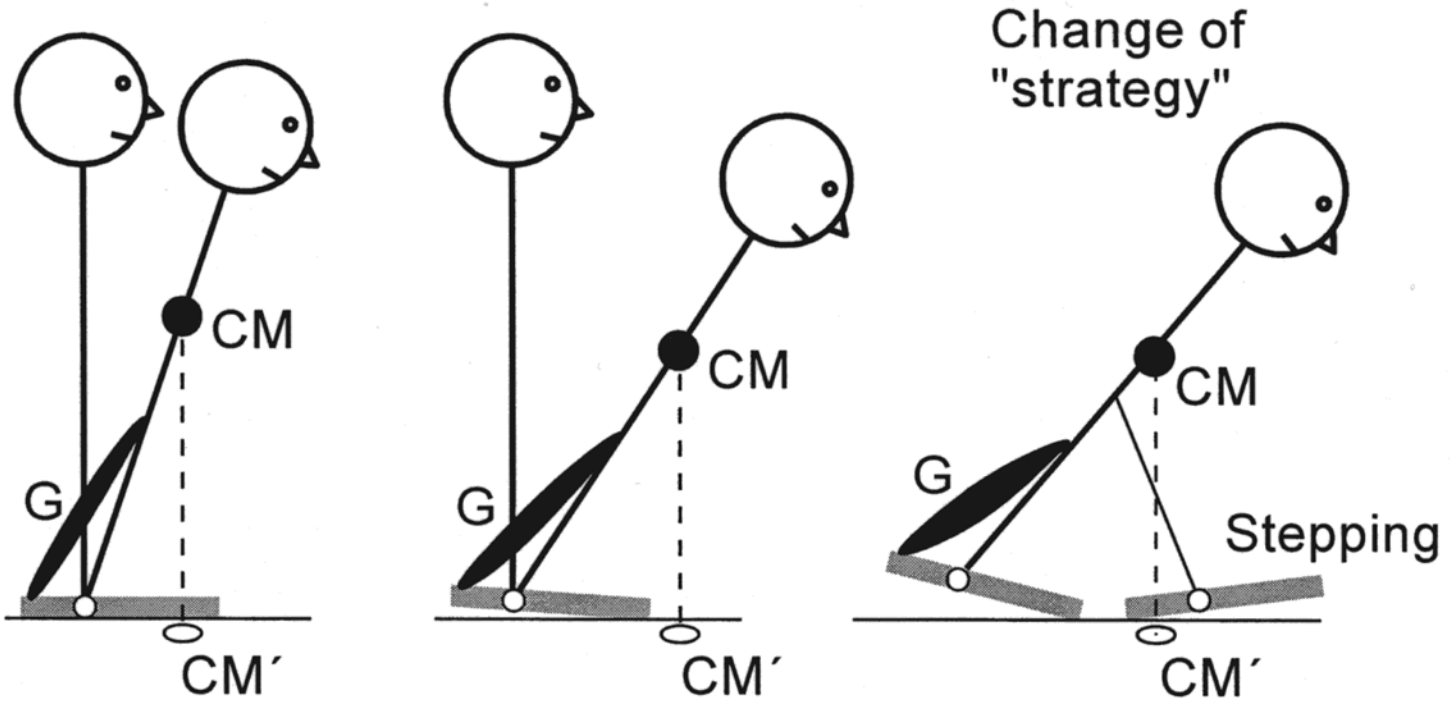
A corrective motor response organized in the distal to proximal sequence







If the projection of the CM occurs outside the supporting area, the only way to prevent falling down is to perform a step

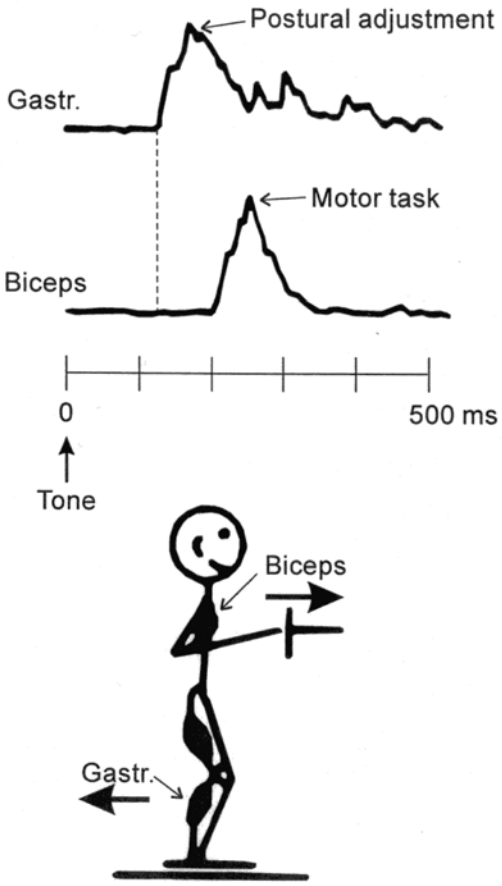


2. Postural support of voluntary movements

Postural support of voluntary movements

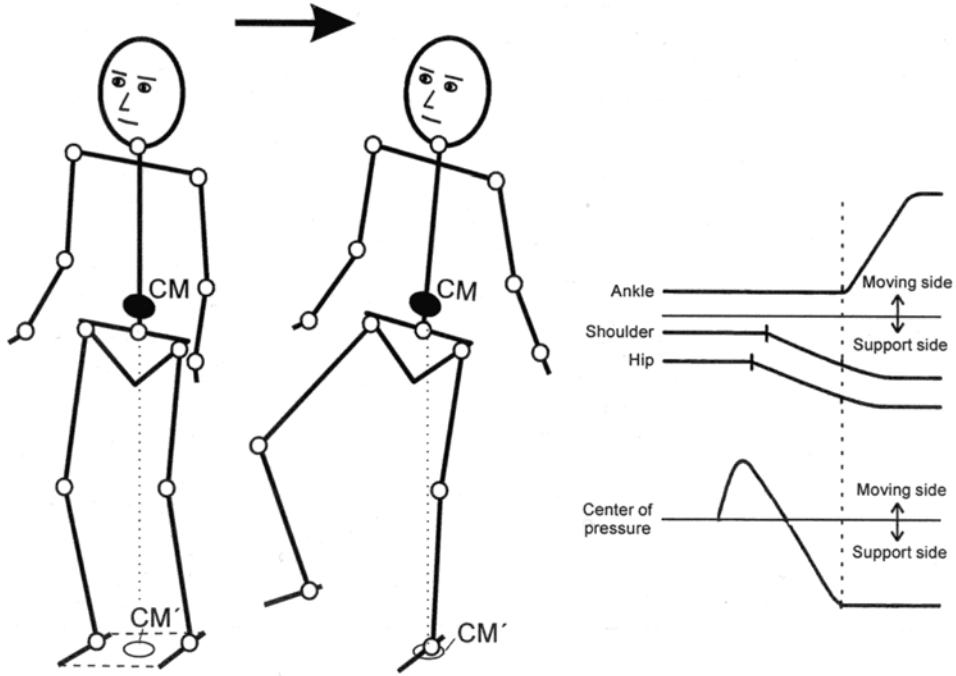
Aim of anticipatory adjustment - to counteract the destabilizing consequences of a voluntary movement

Subject pulls on handle

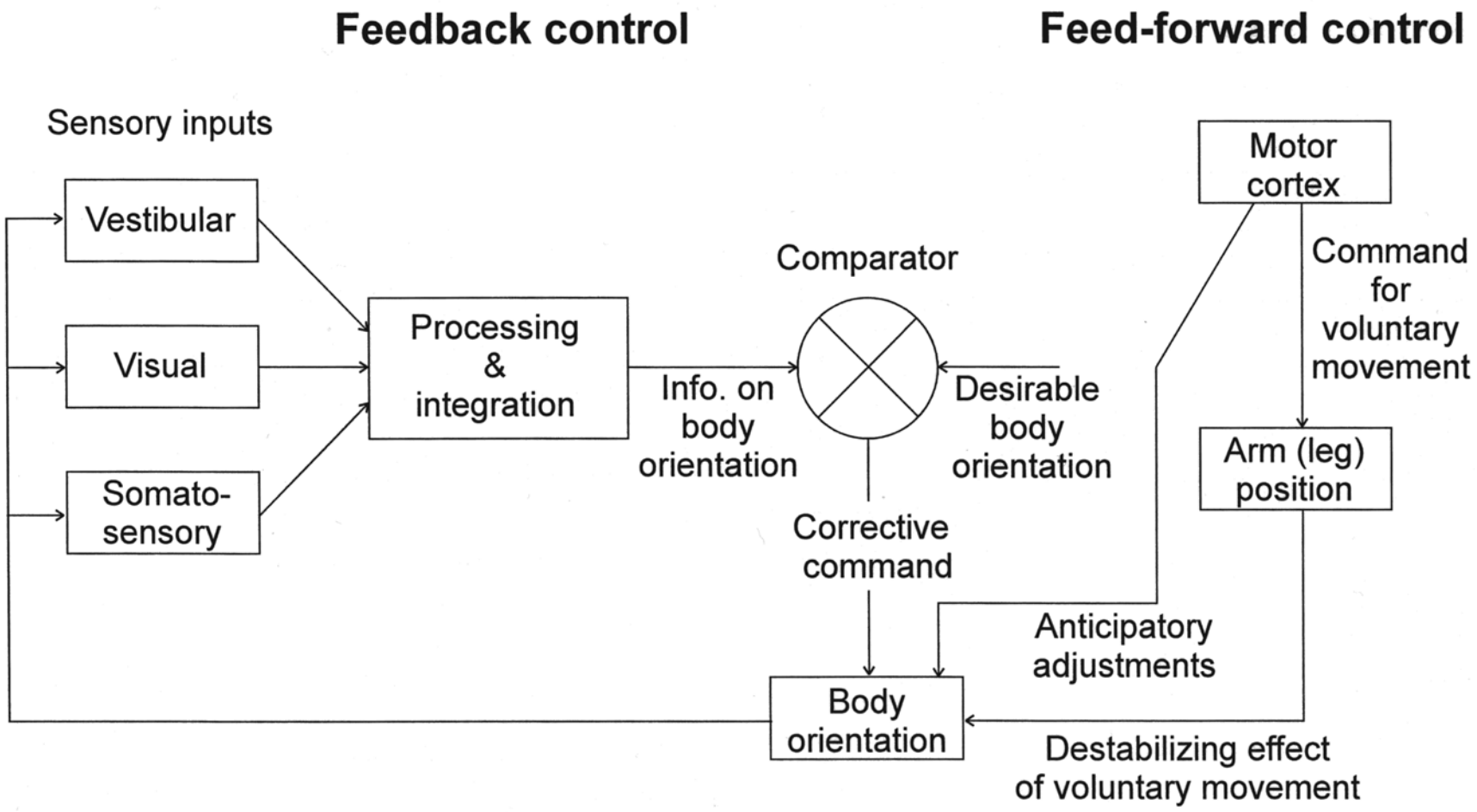


Subject lifts the leg

Postral adjustment - shift of CM

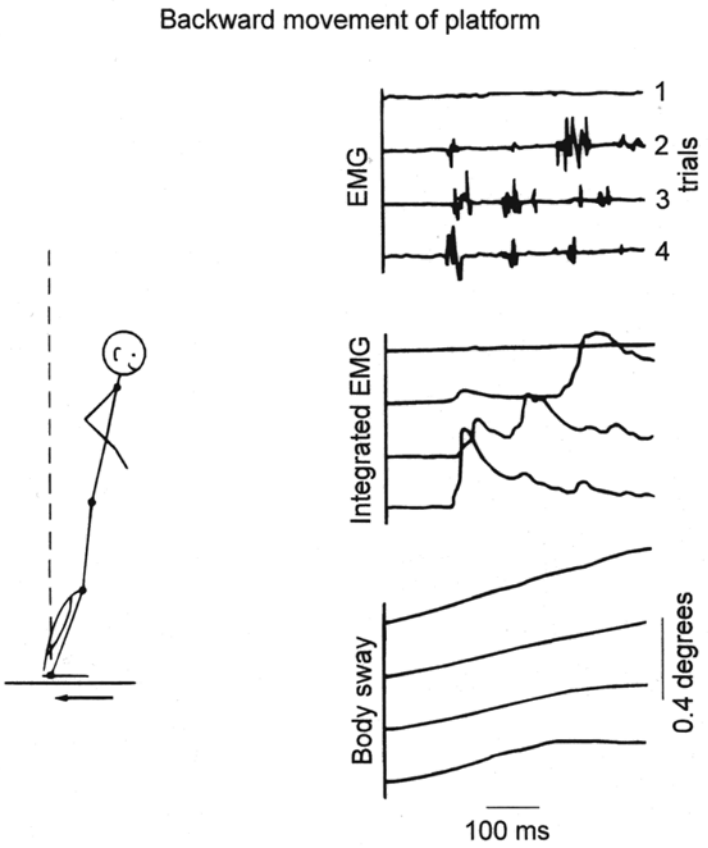


Basic principles of postural control

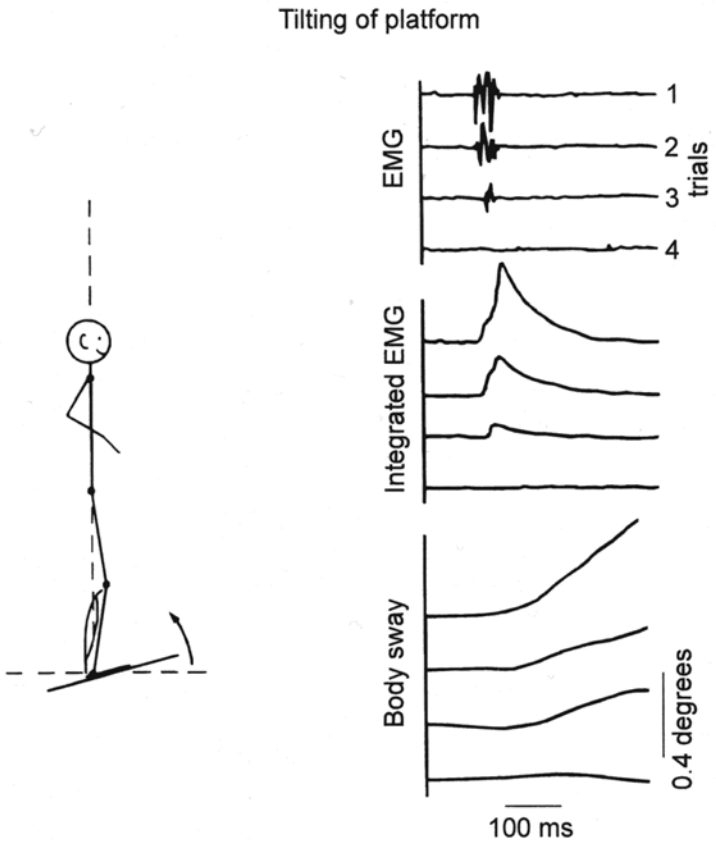


Role of experience and expectation

A rapid postural response in the gastrocnemius muscle occurs progressively earlier with repeated trials

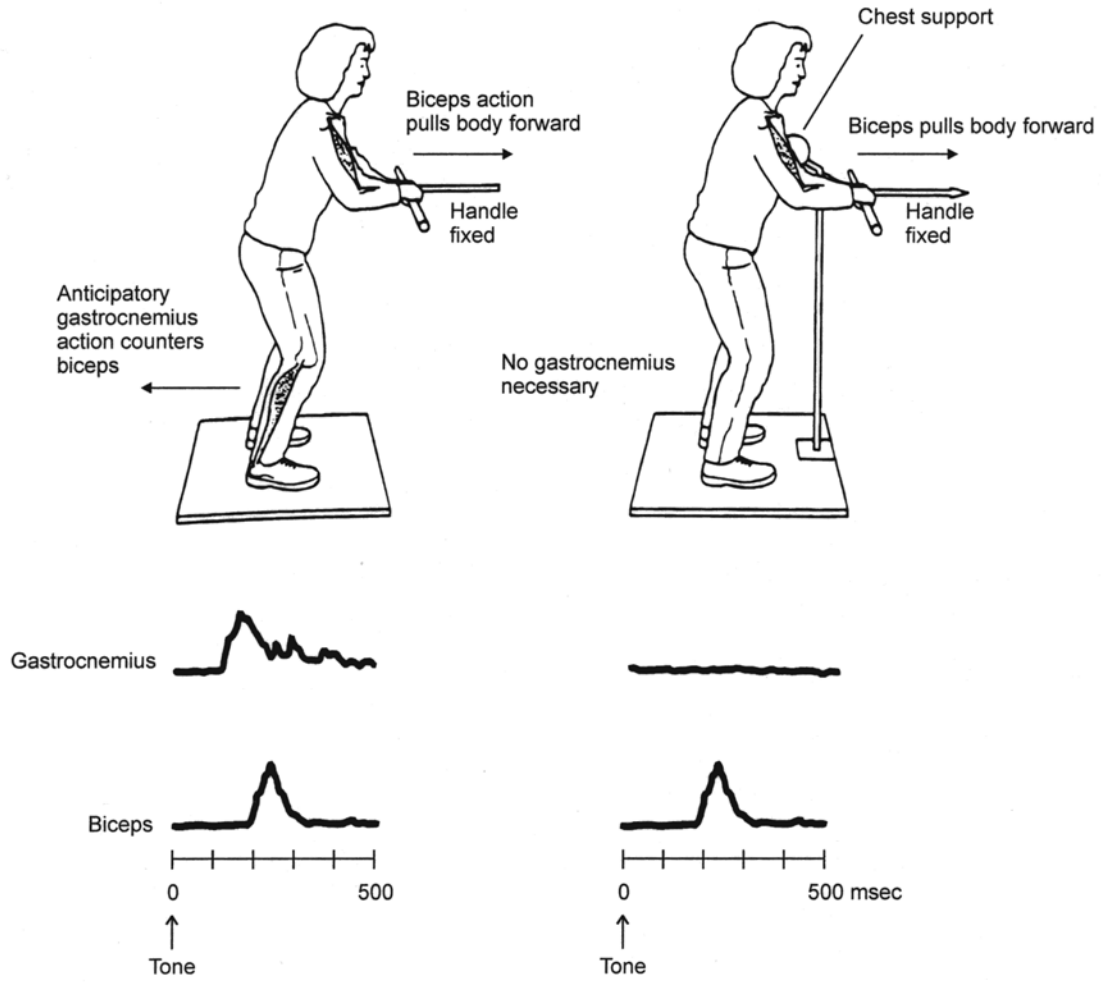


The large contraction of gastrocnemius evoked by unexpectidly tilted platform is attenuated after a few trails



Postural control can be adapted to suit specific behaviors

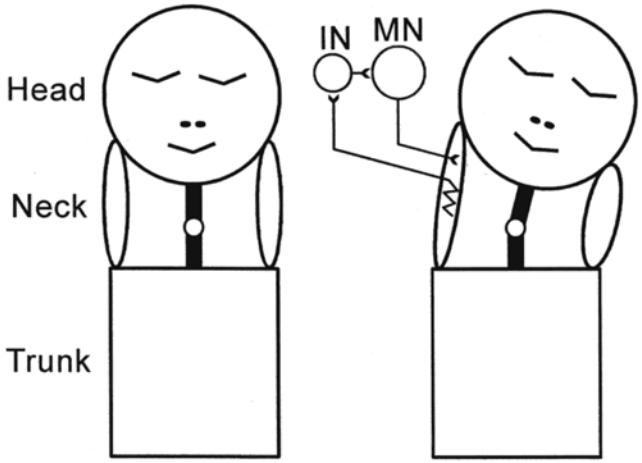
Anticipatory adjustment adapts to the behavioral context

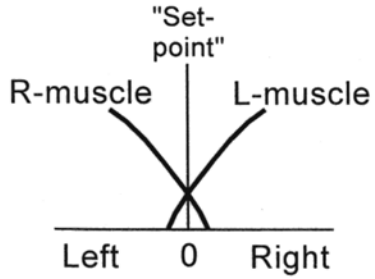


3. **Stabilization of head and limb orientation in relation to the body and to the gravity vector**

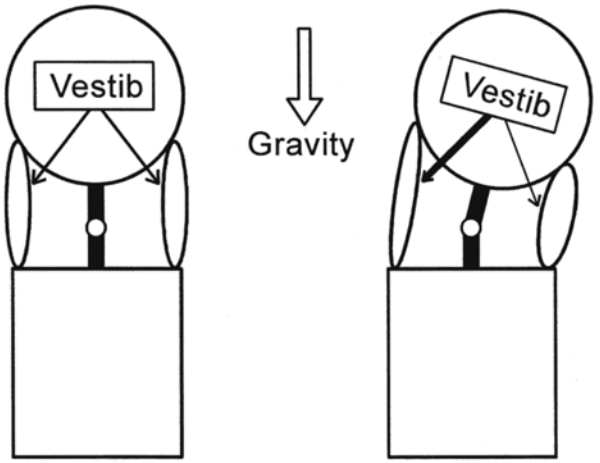
Vestibular and neck reflexes stabilize the head position

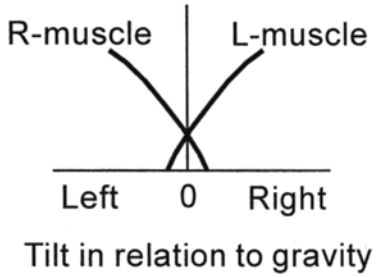
Neck-neck (cervicocollic) reflexes stabilize the head position in relation to trunk





Vestibular-neck (vestibulocollic) reflexes stabilize the head position in relation to the gravity vector





Tilt in relation to gravity

Goals of the two systems:

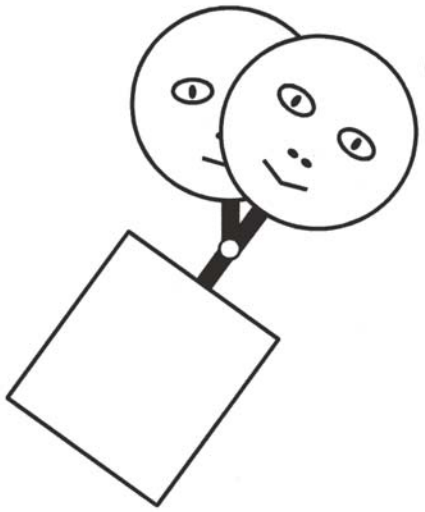
The same

Vestibulocollic reflexes
Cervicocollic reflexes

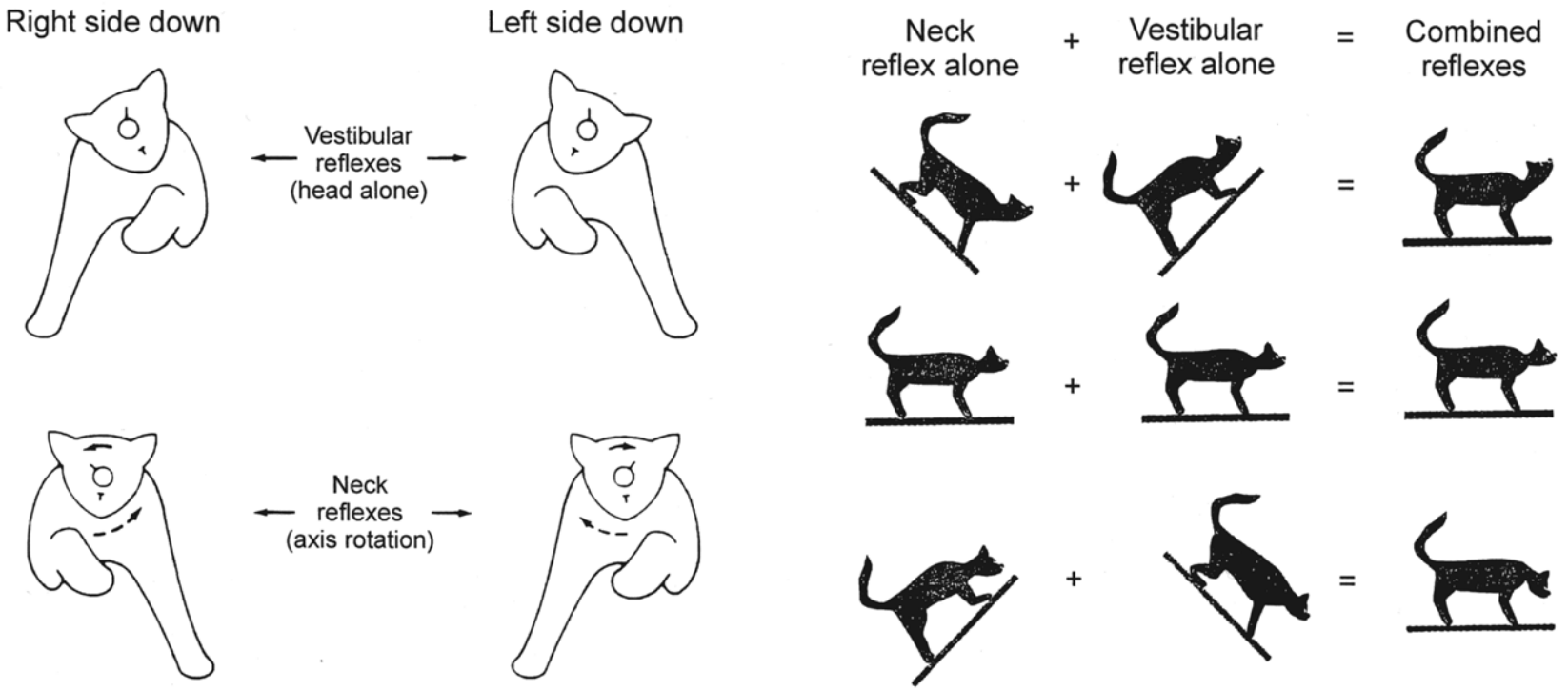
Different

Vestibulocollic reflexes

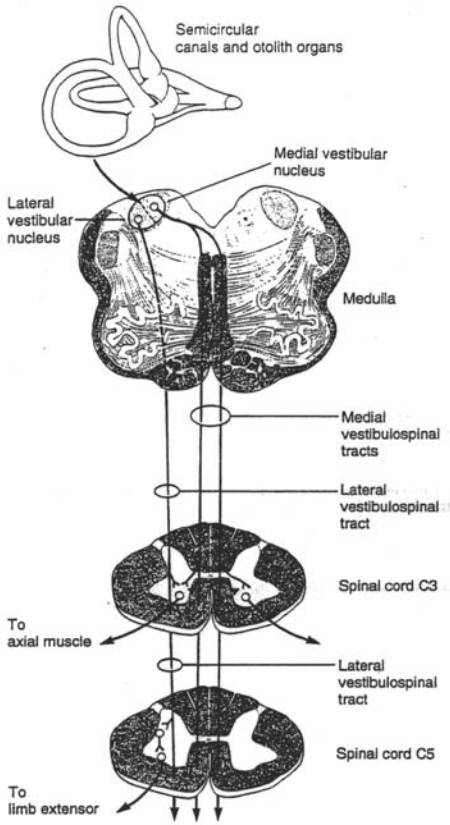
Cervicocollic reflexes



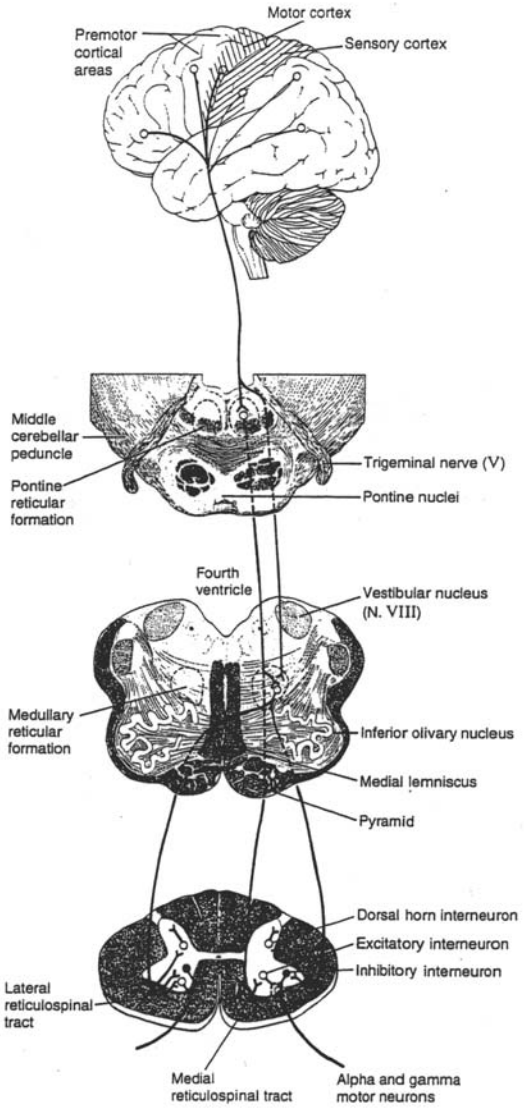
Vestibulospinal and cervicospinal reflexes have opposing actions on limbs



Vestibulospinal projections

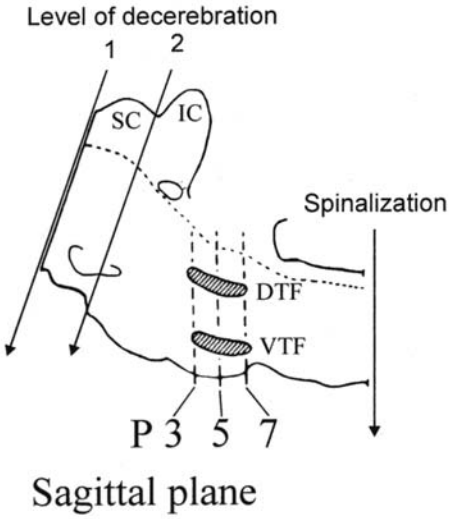


Reticulospinal and corticoreticular pathways

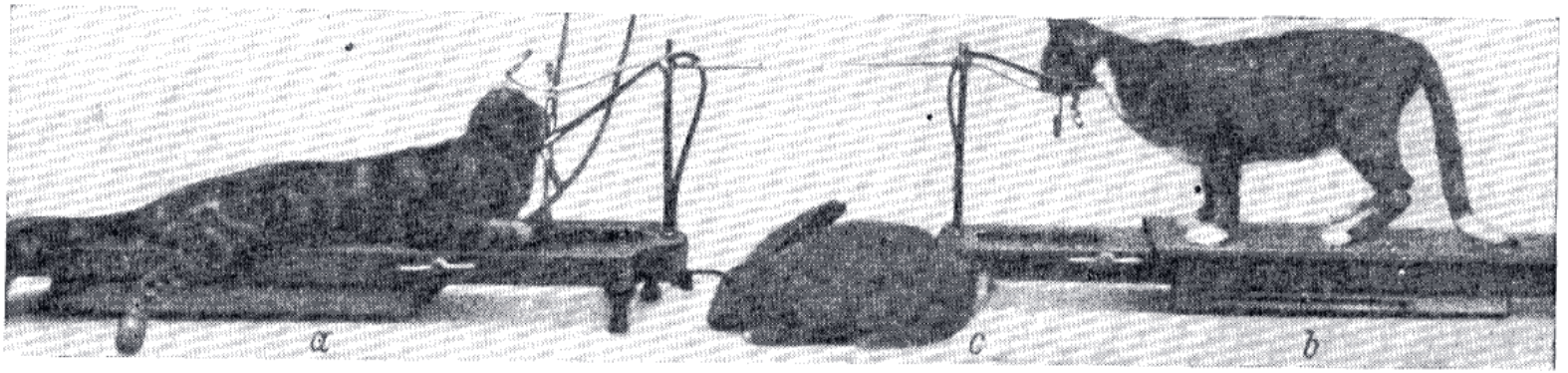


4. Role of different parts of CNS in the postural control

Integrity of brainstem centres is necessary for postural control



1. Spinal animal is not able to maintain the body weight.
2. Animal decerebrated between the superior and inferior colliculi (level 2) maintains the the body weight but is not able to generate postural adjustments.
3. Animal decerebrated rostrally to superior colliculi (level 1) exhibits righting reflexes.



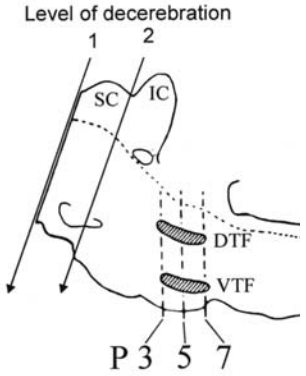
Spinal cat

Decerebrated rabbit (level 1)

Decerebrated cat (level 2)

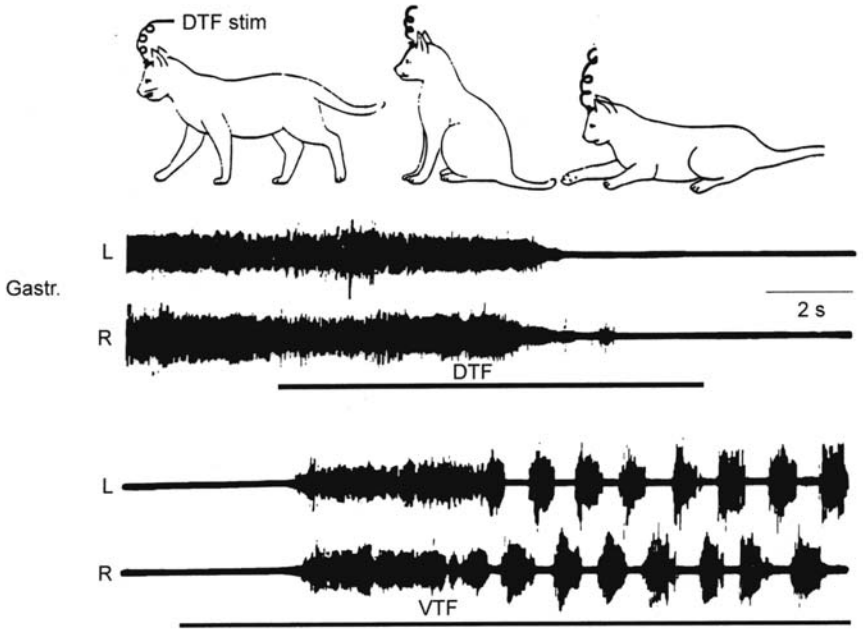
Postural centres of the brainstem

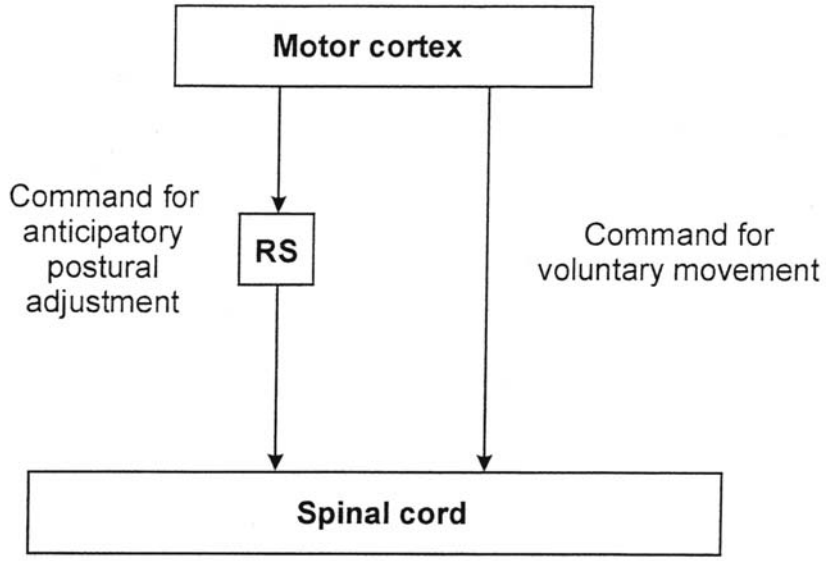
Integrity of brainstem centres is necessary for postural control

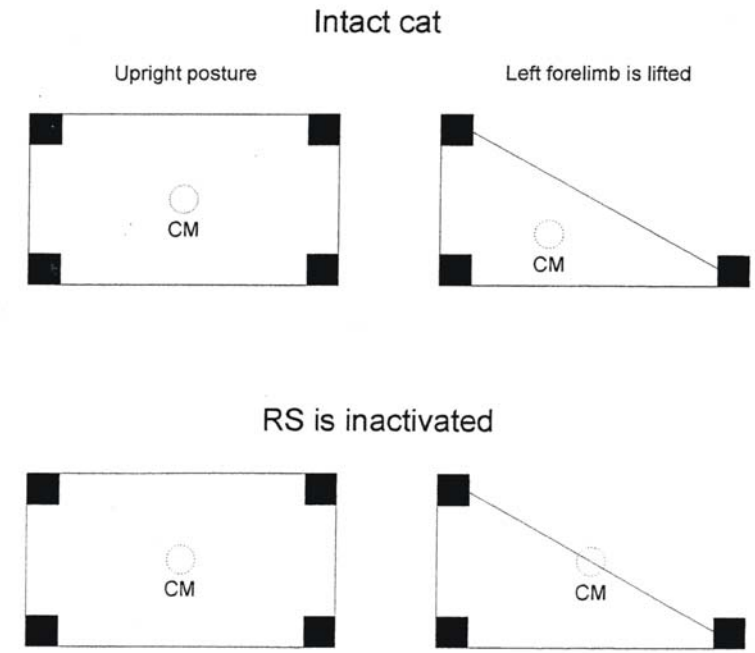


Sagittal plane

Stimulation of DTF and VTF affects posture

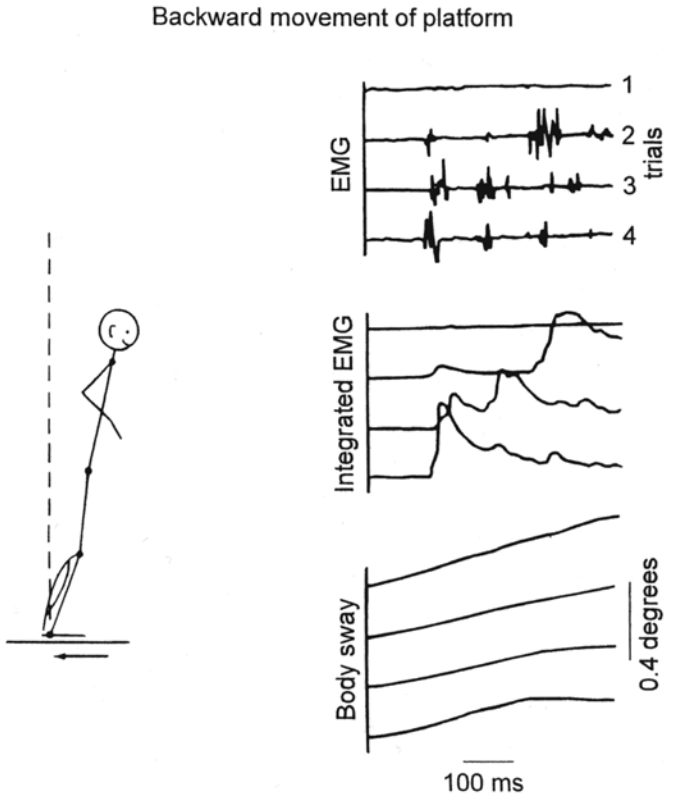



Motor cortex
Command for anticipatory postural adjustment
RS
Command for voluntary movement
Spinal cord

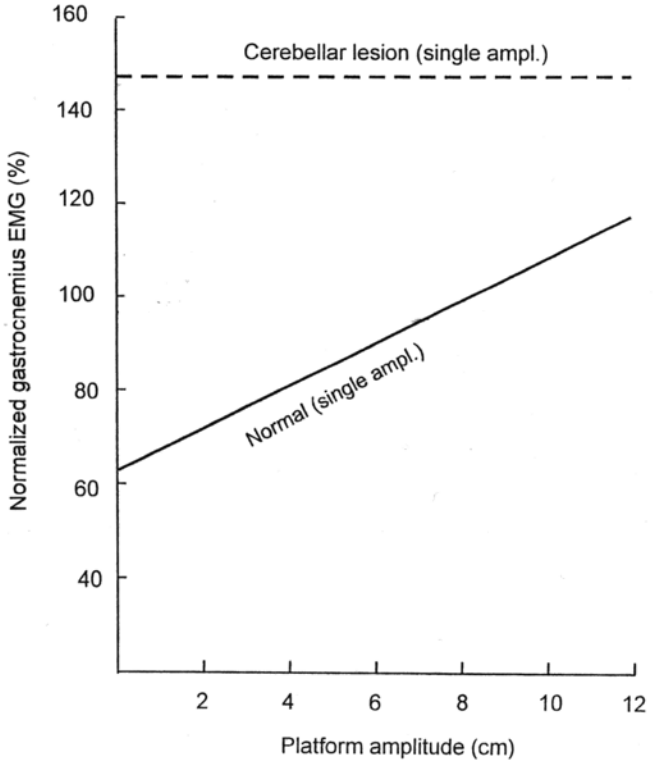

Intact cat
Upright posture
Left forelimb is lifted
CM
CM
RS is inactivated
CM
CM

Adaptive postural control requires an intact cerebellum

A rapid postural response in the gastrocnemius muscle occurs progressively earlier with repeated trials in intact subject

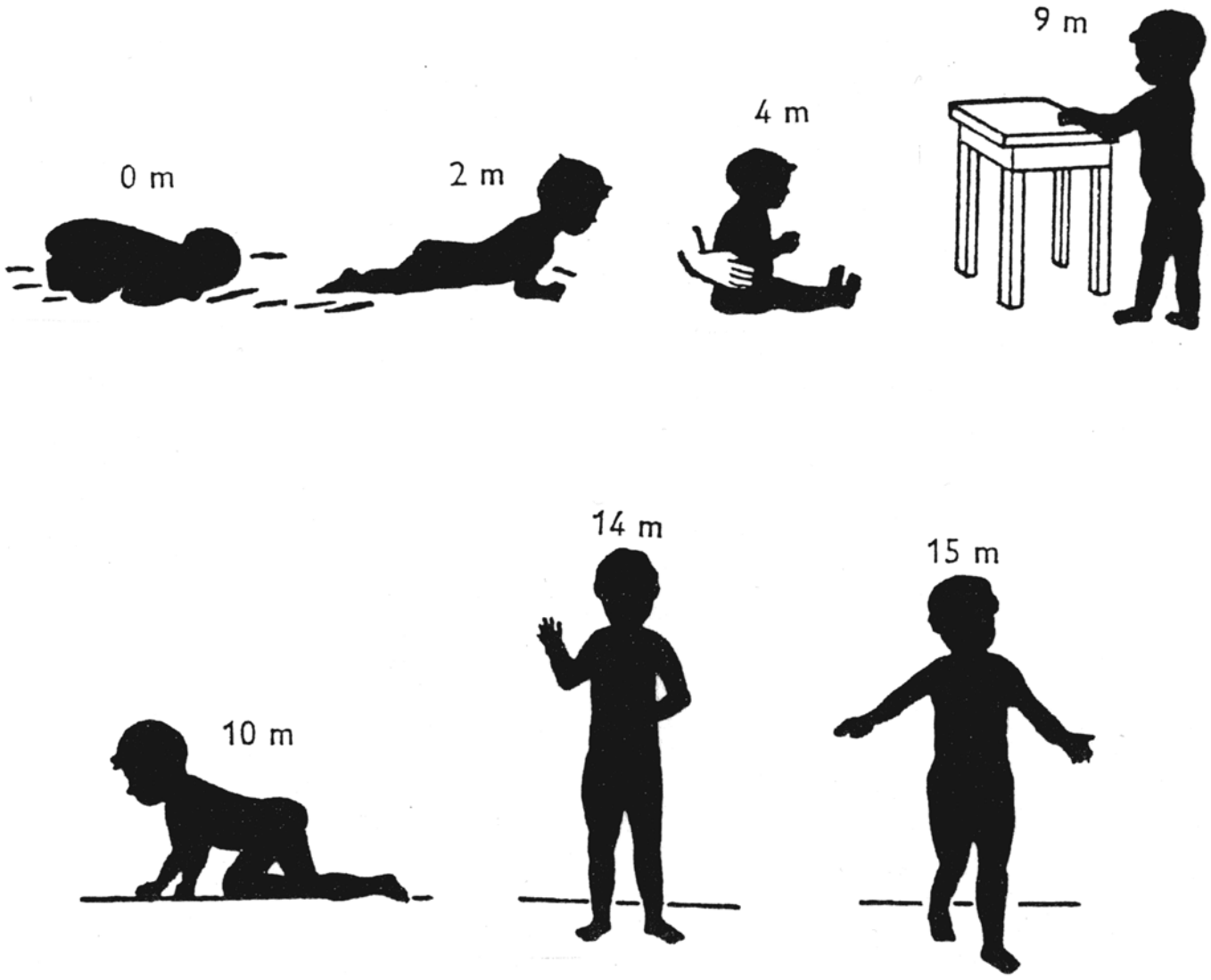


Atrophy of the anterior cerebellar lobe prevents appropriate scaling of correcting postural response



5. Development of postural control

Motor development of the infant and young child



Conclusions

1. Posture is an actively stabilized definite orientation of the body and its segments in space and in relation to each other.

2. Postural control systems minimize deflections of the body from desirable orientation. Postural control systems are able to stabilize different postures.

3. Multimodal sensory inputs – somatosensory, visual, vestibular are used for postural control.

4. To maintain a desirable posture, a family of adjustments is needed. Postural adjustments are necessary also for all motor tasks and need to be integrated with voluntary movements.

5. Postural adjustments are achieved by means of two major mechanisms:

(i) The compensatory or *feedback* mechanisms are activated by sensory events following loss of desirable posture. (Compensatory postural adjustments).

(ii) The anticipatory or feed-forward mechanisms predict disturbances and produce preprogrammed responses that maintain stability. (Anticipatory postural adjustments).

6. Some of the compensatory postural adjustments are innate, while others have to be acquired by motor learning. Anticipatory postural adjustments must be learned, and then they operate automatically.

7. Postural control is adaptive. The shape of postural adjustment depends on behavioral context.

8. All levels of CNS are involved in postural control. Integrity of brainstem centers is necessary for generation of compensatory postural adjustments. Integrity of highest levels of the CNS including the motor areas of the cerebral cortex is necessary for anticipatory postural adjustments. Adaptive postural control requires an intact cerebellum.