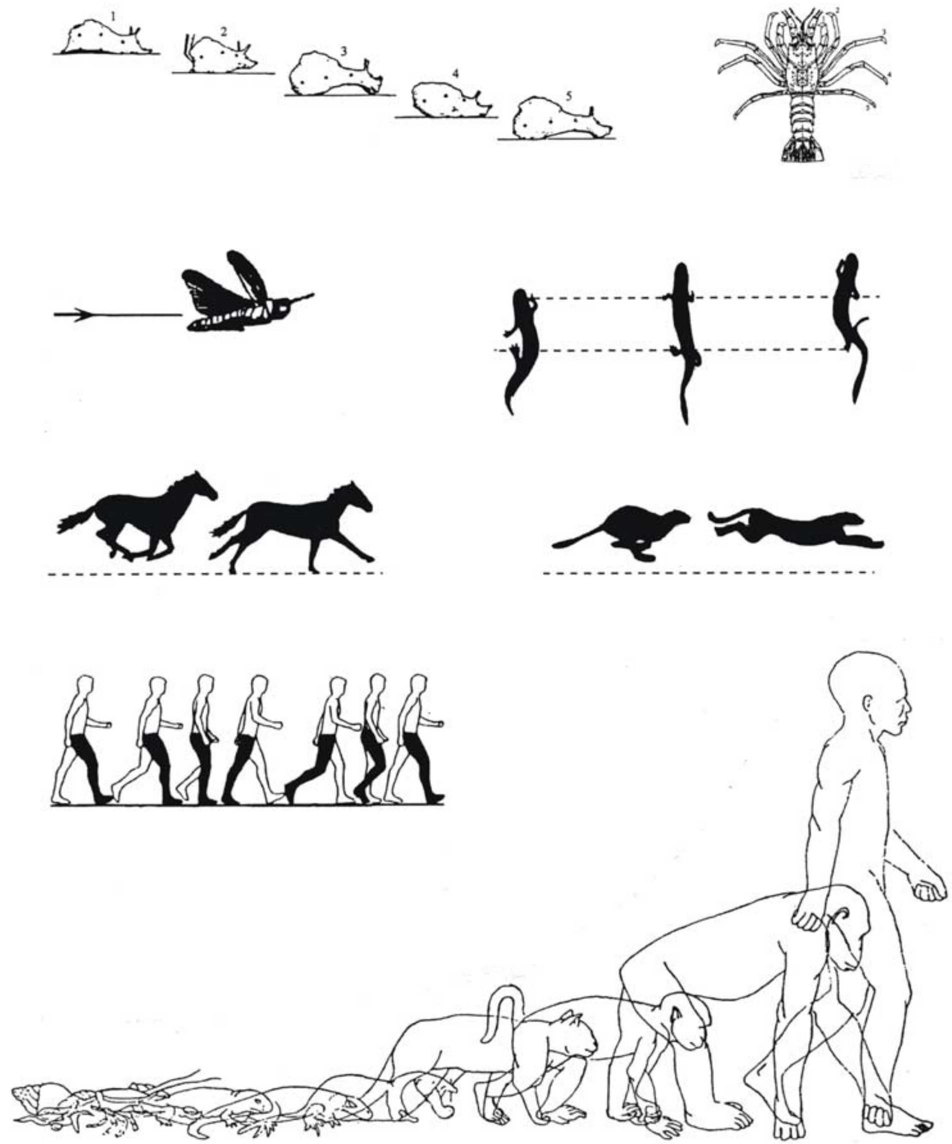
LOCOMOTION

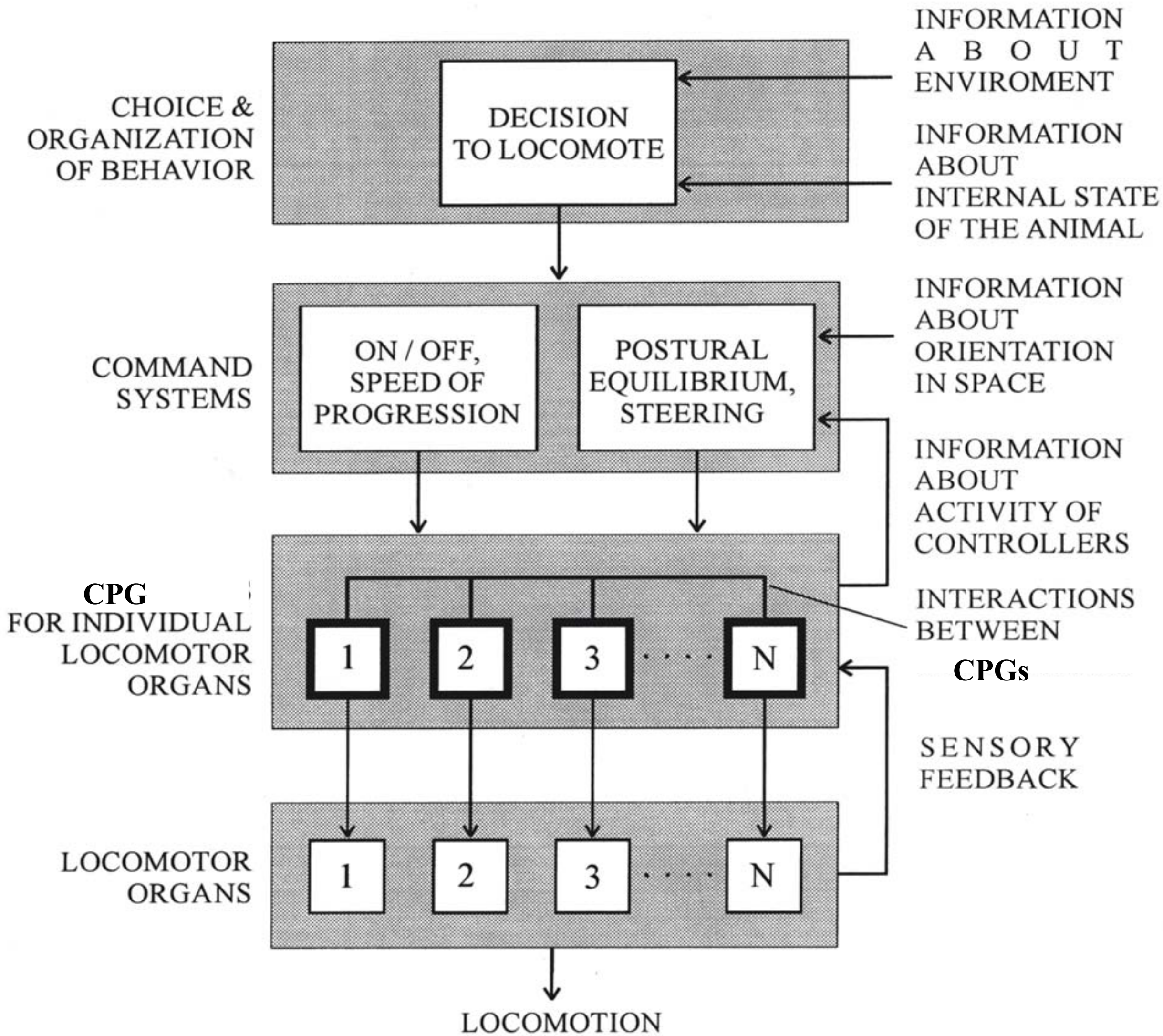
Locomotion



During locomotion following tasks must be achieved:

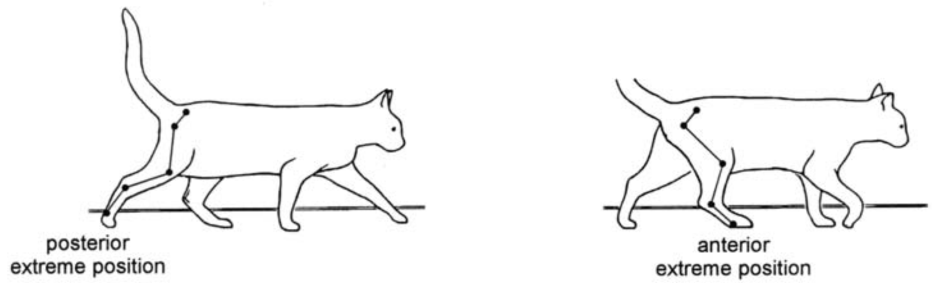
1. Propulsion.
2. Equilibrium control.
3. Steering.
4. Compensation of predicted and unpredicted perturbations of locomotion
5. Combination with other movements.

Basic components and functional organization of the system for the control of locomotion

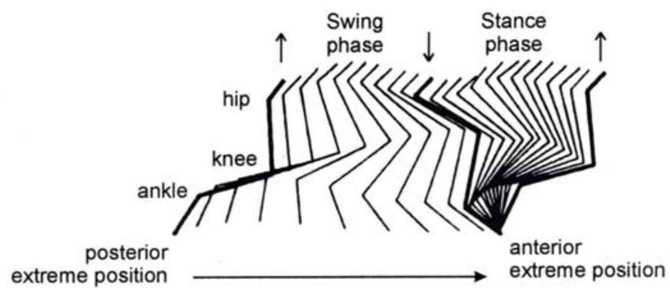


Locotor limb movements & Locomotor pattern

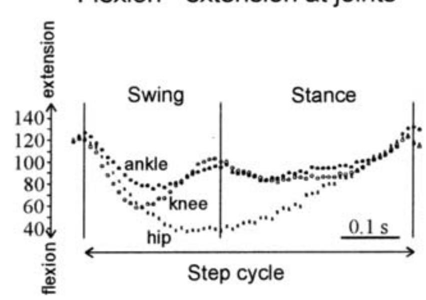
Locomotion: stepping movements



Two phases of the step cycle

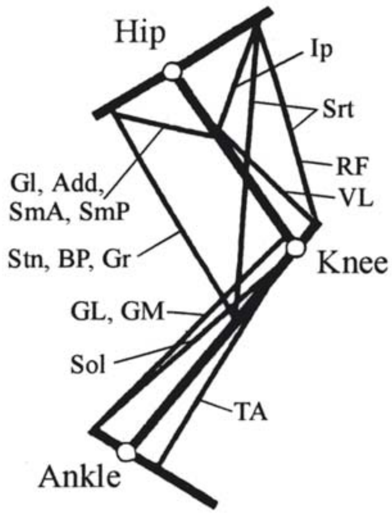


Flexion - extension at joints

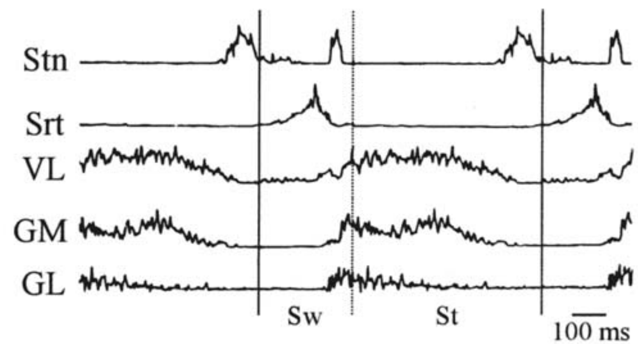


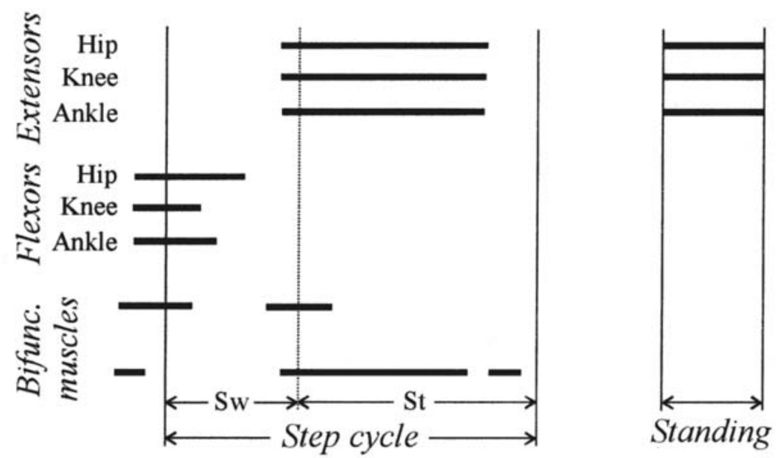
The basic pattern of leg muscles activity

Scheme of the limb with muscles

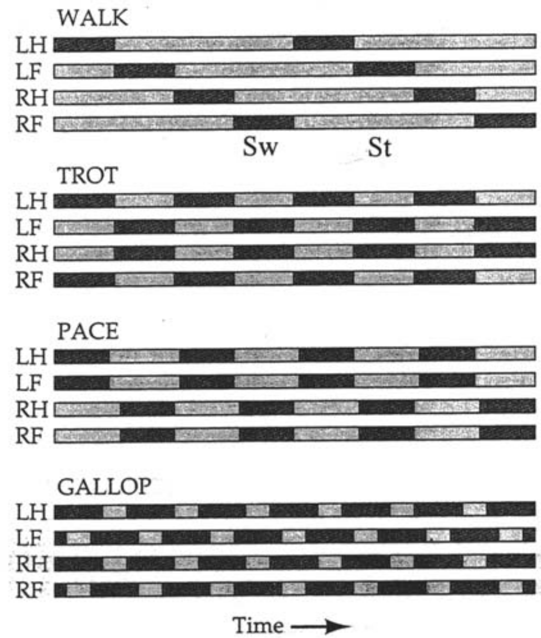


EMG pattern during locomotion

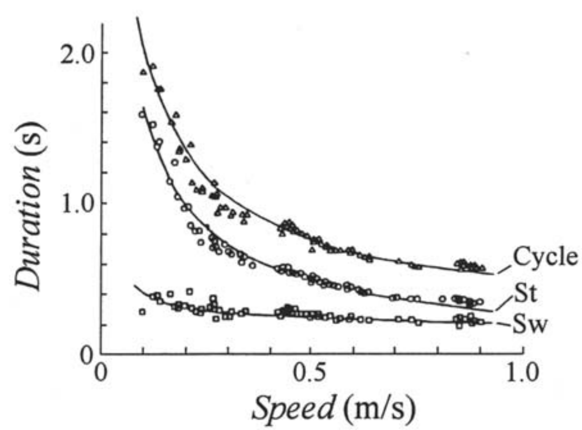




Changes in locomotor speed are accompanied by changes in interlimb coordination

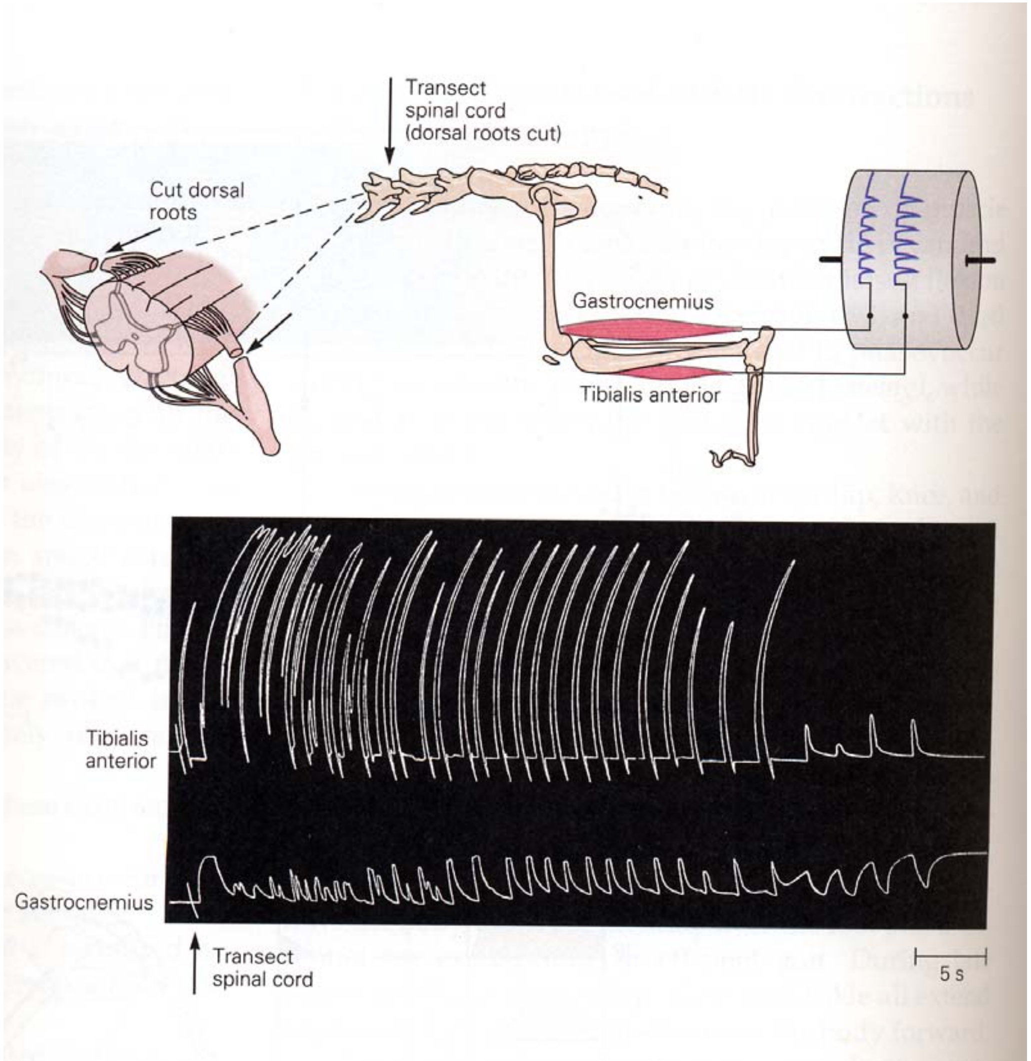


The shortening of the cycle duration with increasing of locomotor speed is mainly due to the shortening of the stance phase

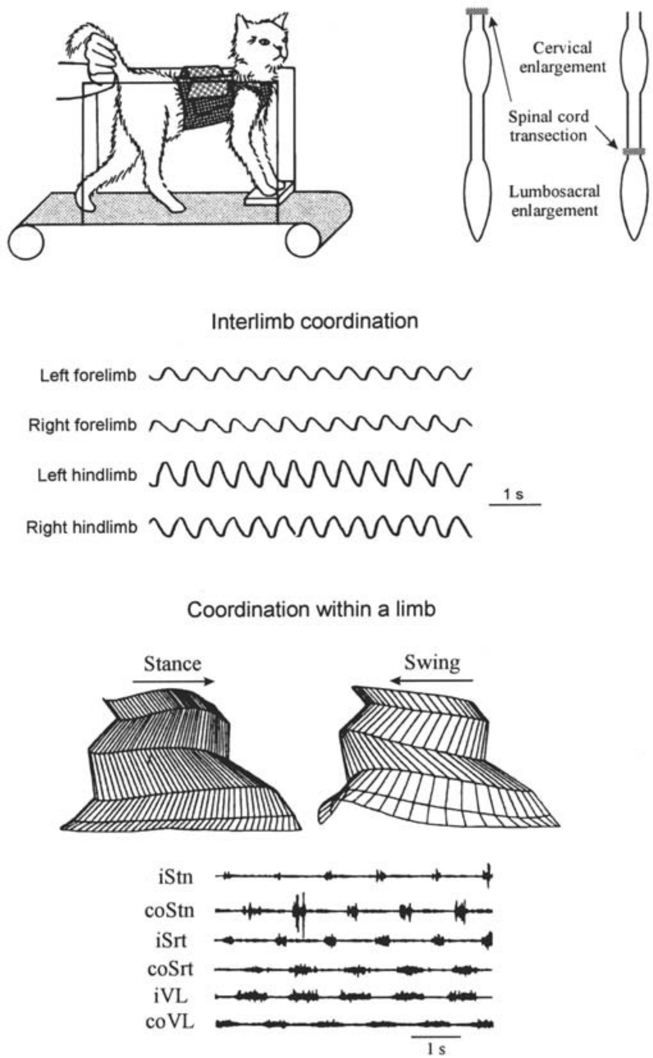


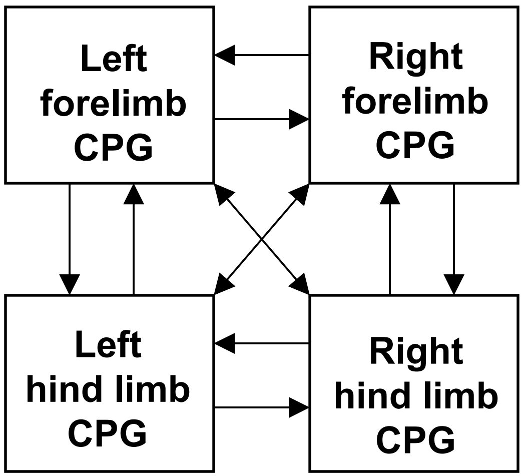
Locomotor CPG

Locomotor CPG is capable to generate the basic locomotor pattern without sensory feedback from the limb



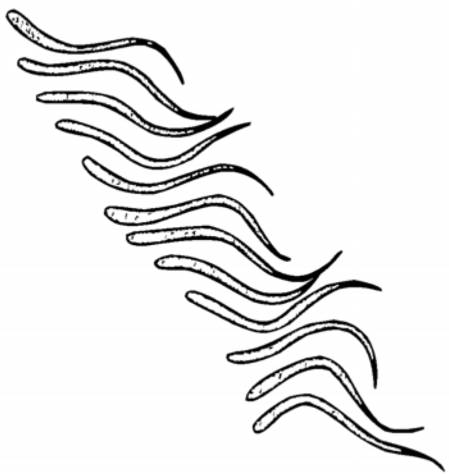
Locomotor CPG is located in the spinal cord

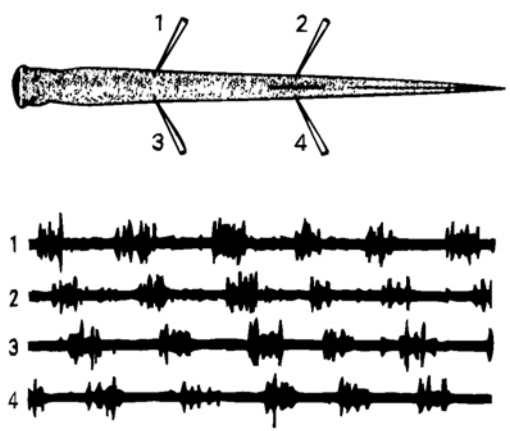




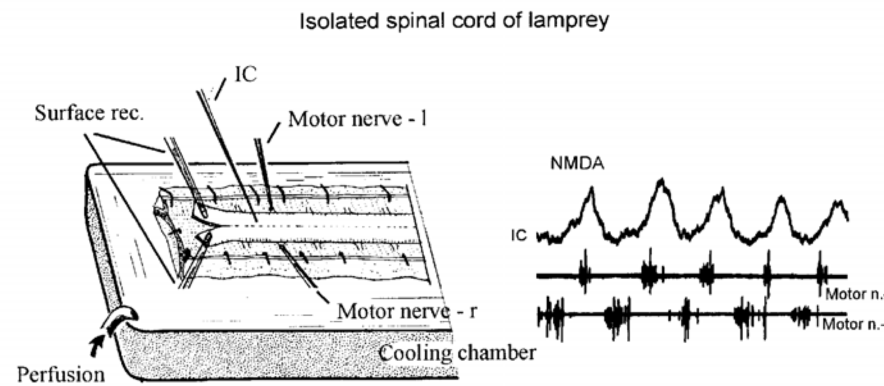
Network generating locomotion in lamprey does not require rhythmic sensory input from periphery

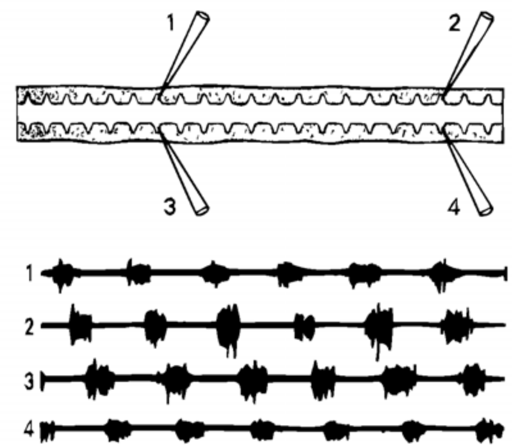
Intact lamprey





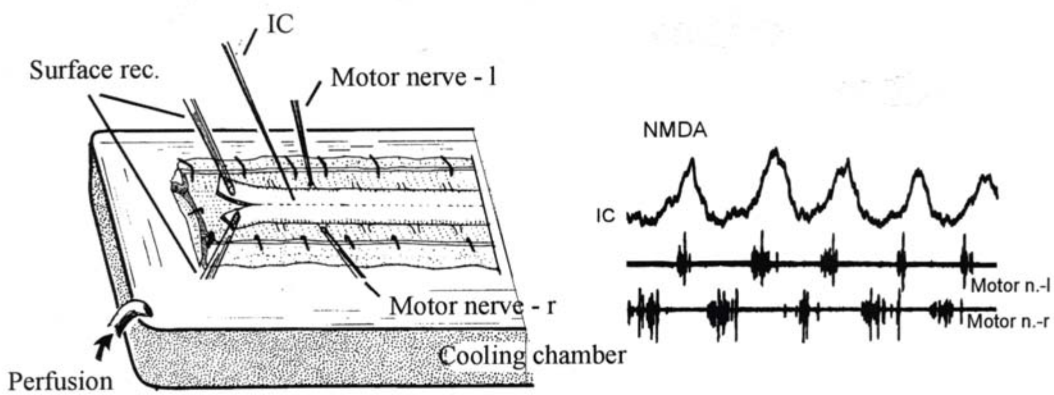
In vitro preparation



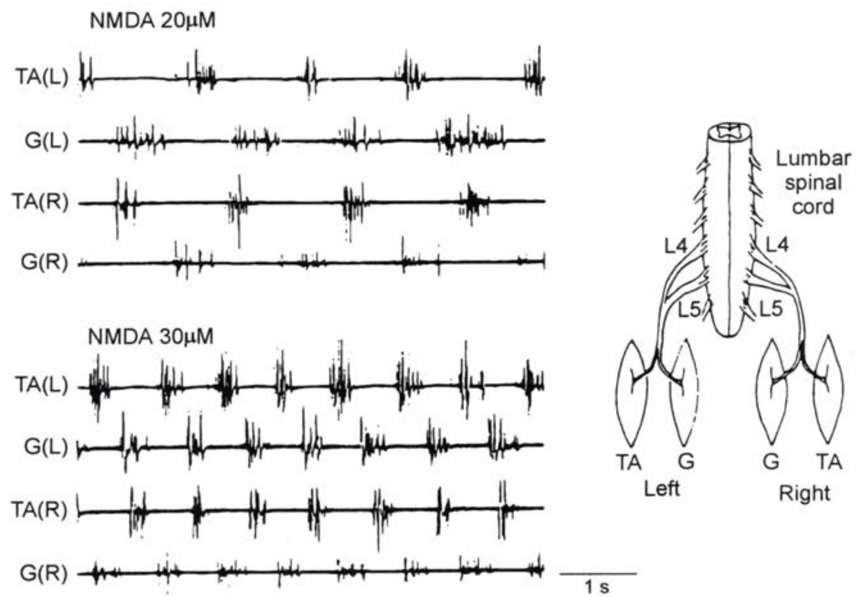


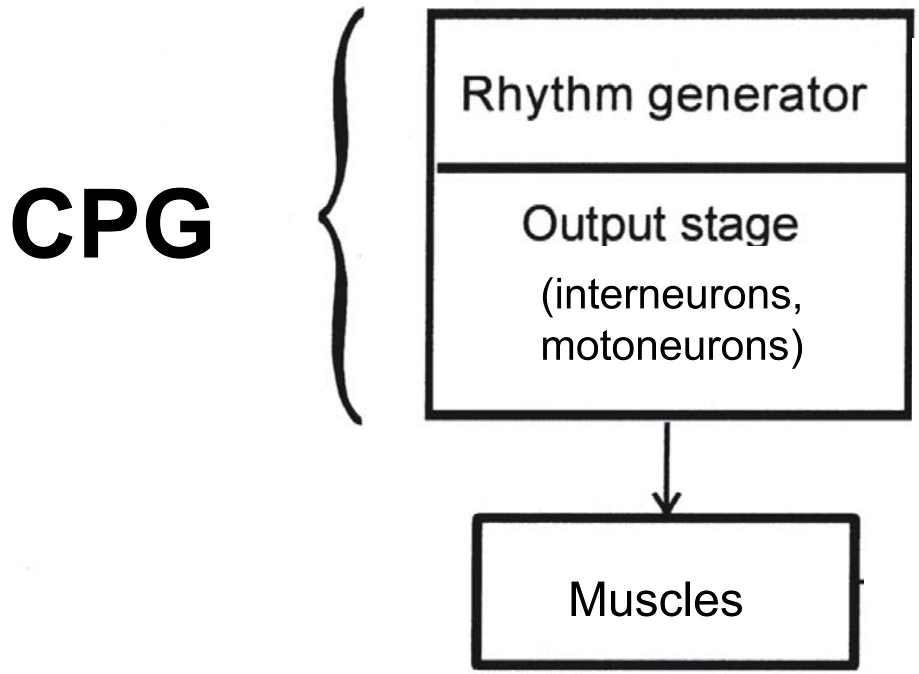
Central pattern generator (CPG) for locomotion can be activated by N-methyl-D-aspartate (NMDA)

Isolated spinal cord of lamprey



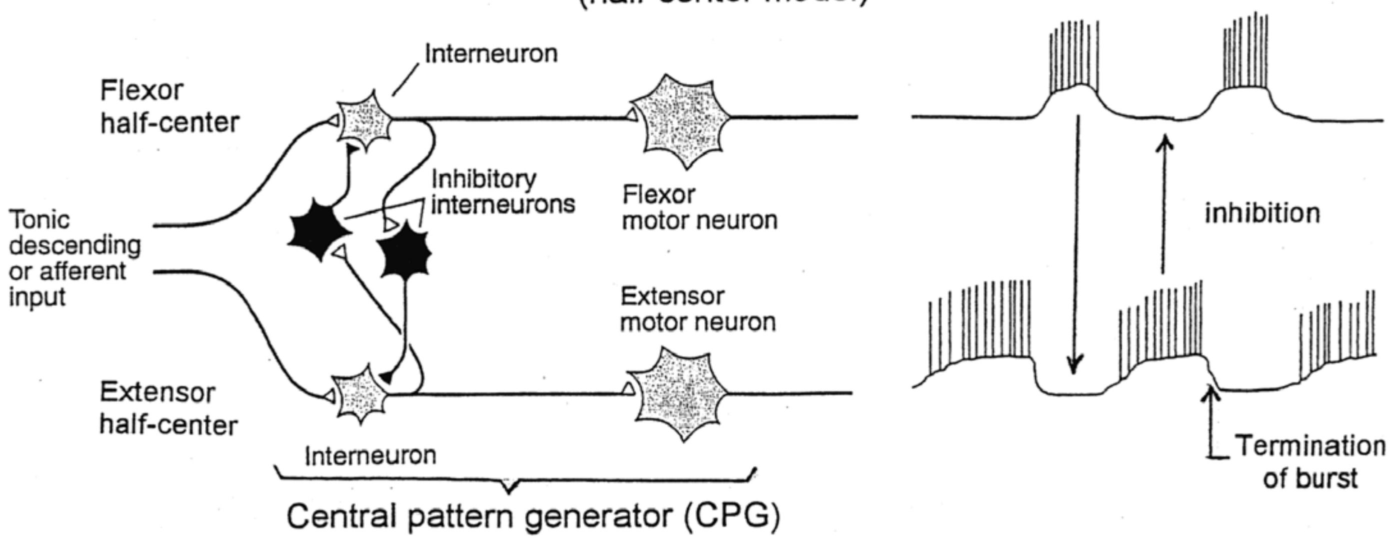
Isolated spinal cord of the newborn rat




CPG
Rhythm generator
Output stage
(interneurons,
motoneurons)
Muscles

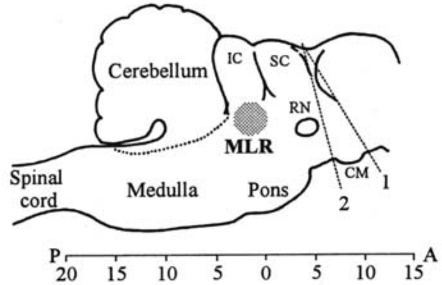
Generation of rhythmical motor patterns

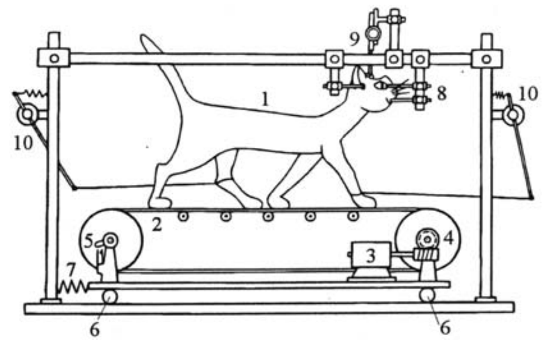
(half-center model)

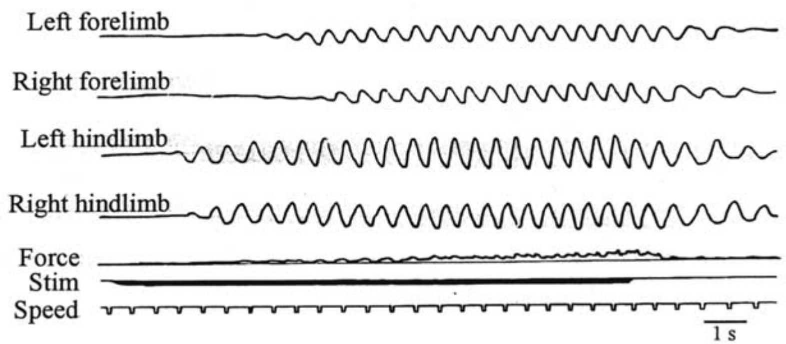


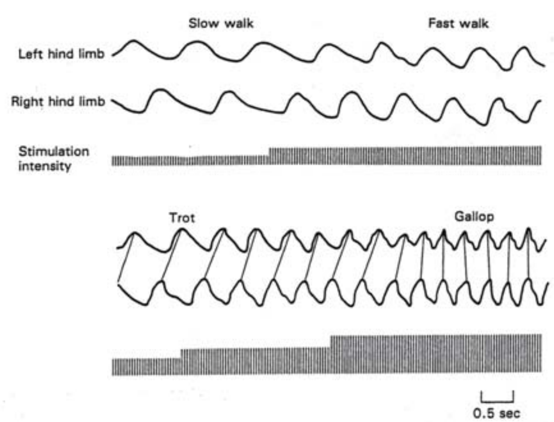
Initiation of Locomotion

Spinal locomotor mechanism is activated from the brainstem



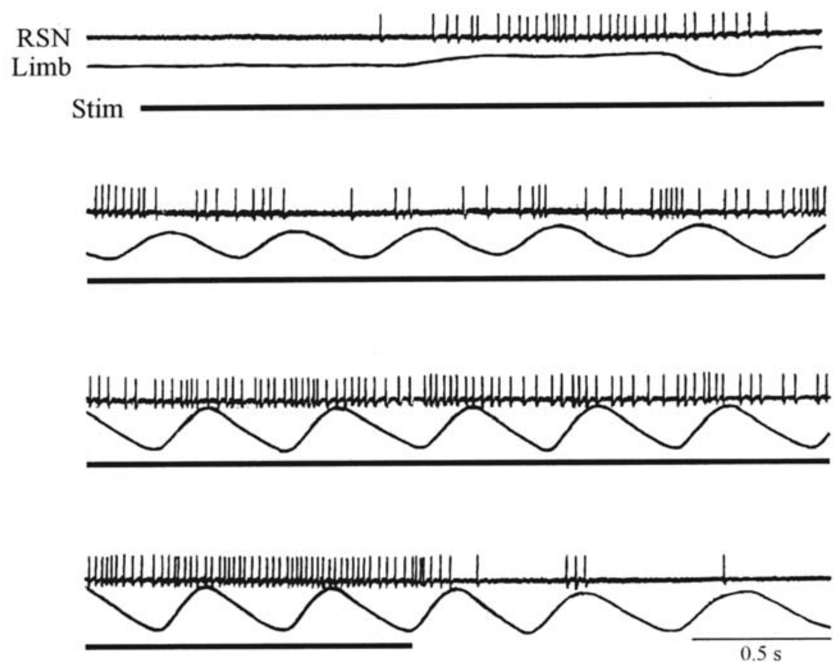






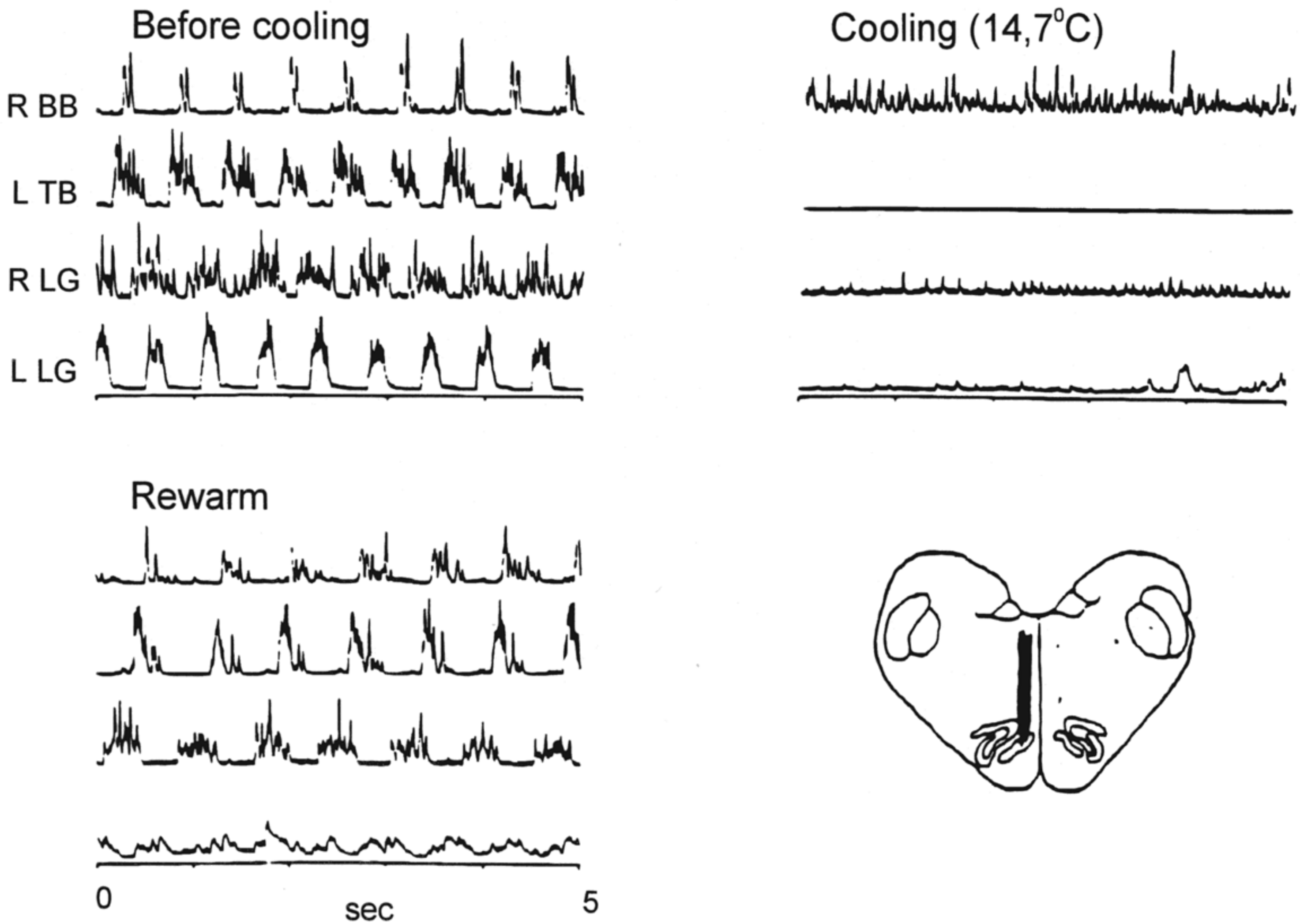
Reticulospinal neurons constitute a command system for activation of the spinal locomotor mechanisms

Stimulation of MLR causes activation of a reticulospinal neurons

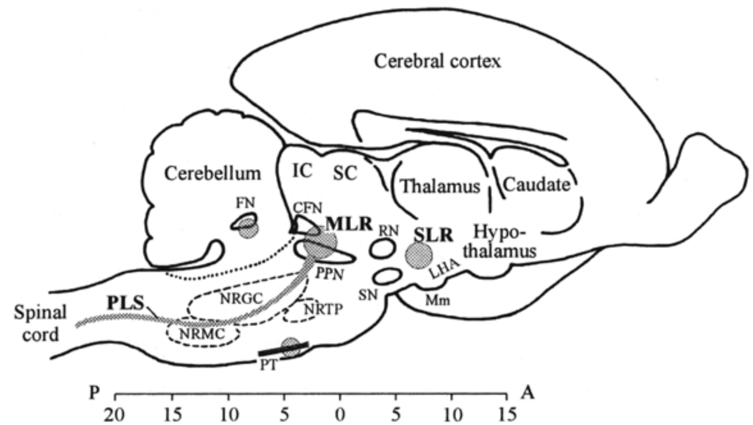


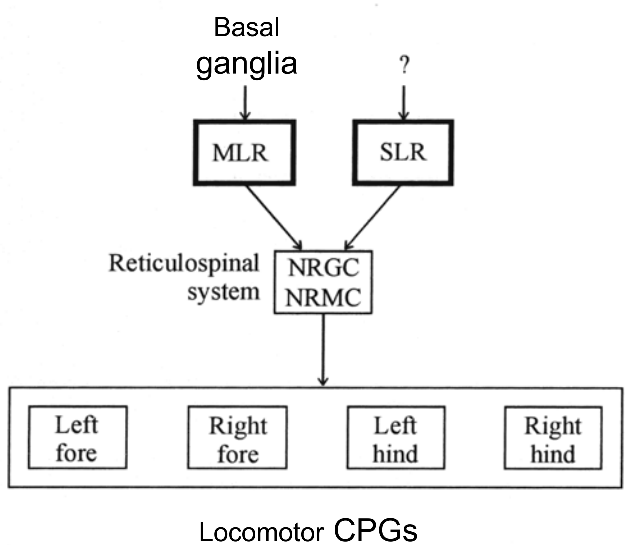
Stimulation of MLR evokes short latency EPSPs in reticulospinal neurons

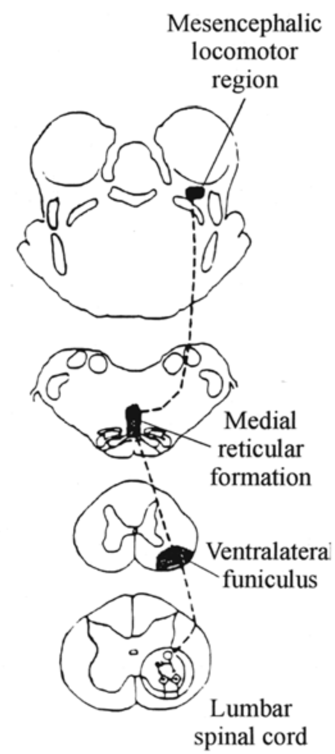
Integrity of the reticulospinal pathways is essential for the initiation of locomotion



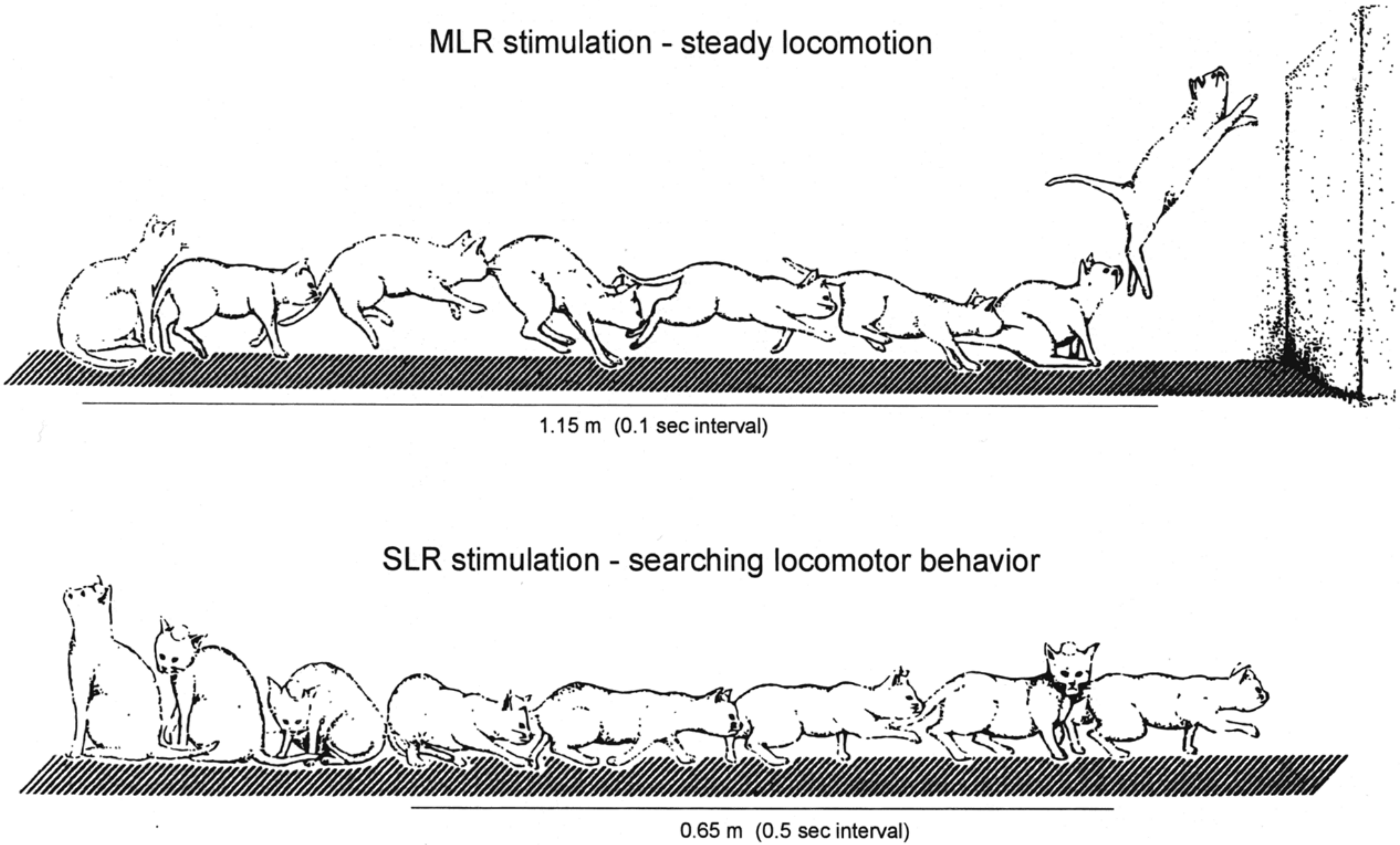
Locomotor regions of the brainstem



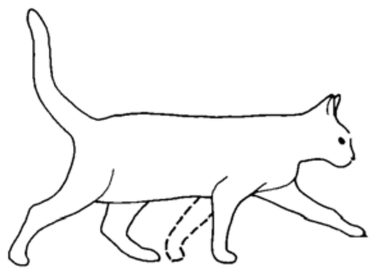


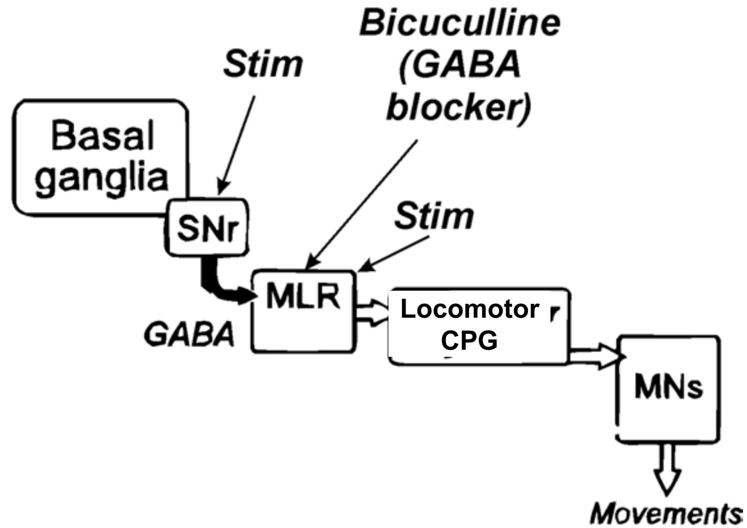


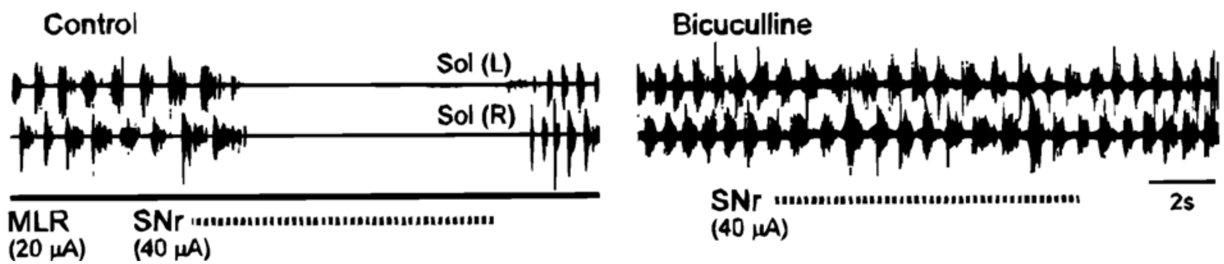
MLR and SLR are used for eliciting locomotion in different behavioral contexts



Contribution of basal ganglia in control of locomotion

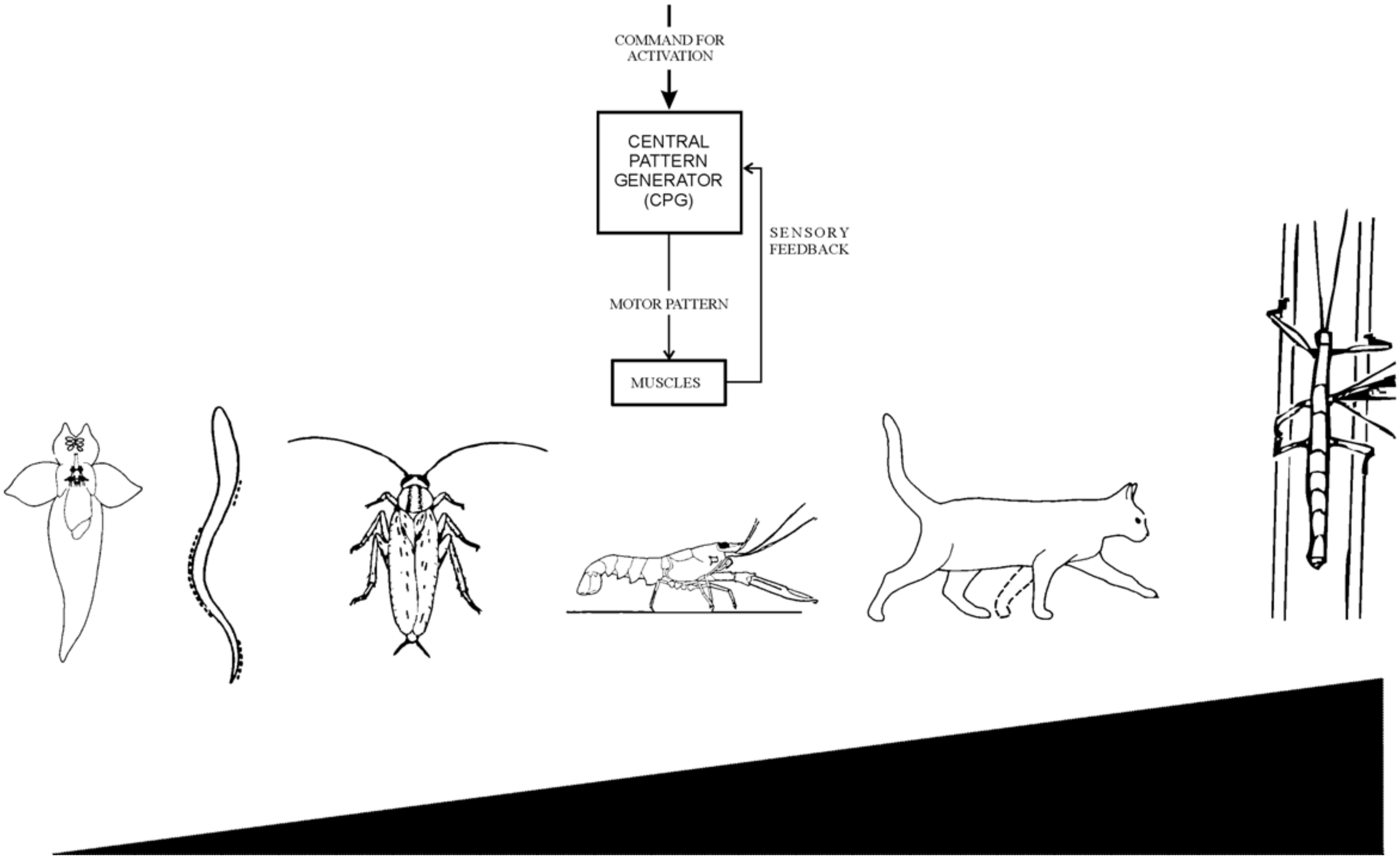






Role of sensory feedback

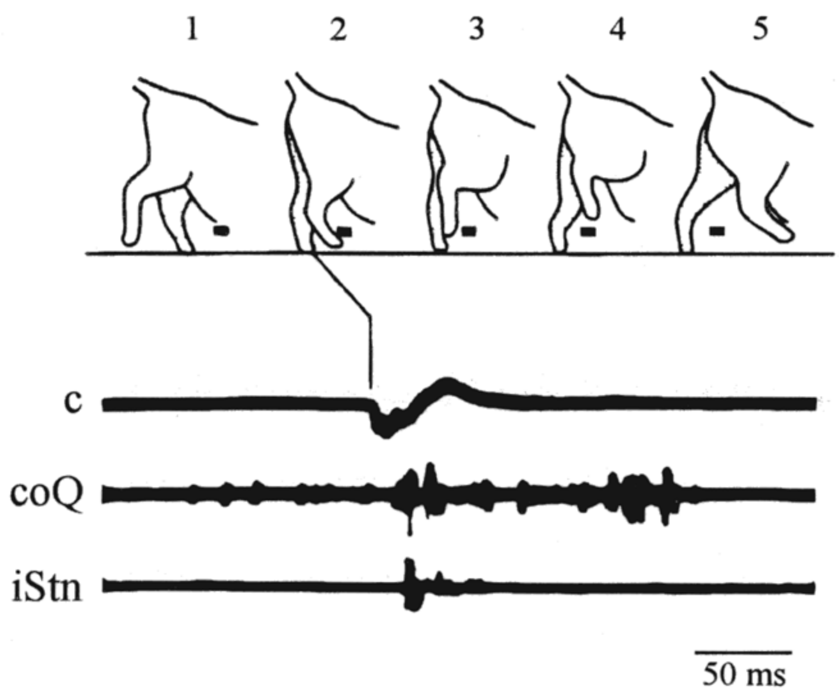
Role of peripheral sensory feedback in control of locomotion

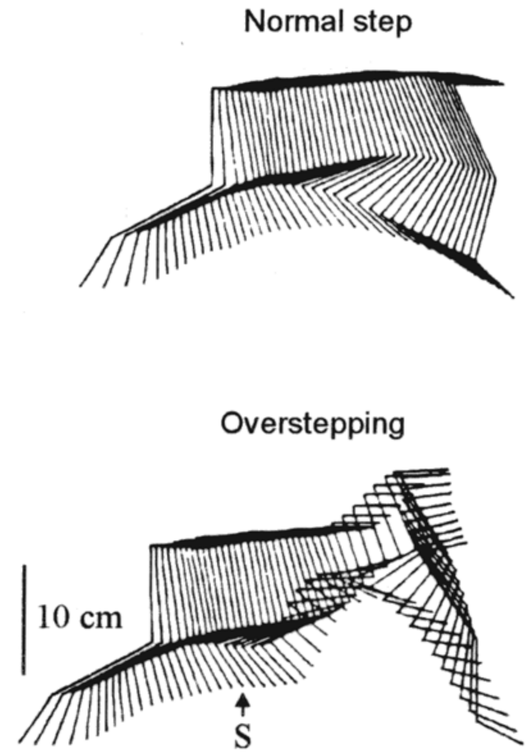


Sensory corrections of the basic locomotor pattern

Adaptation to external conditions (overstepping an obstracle)

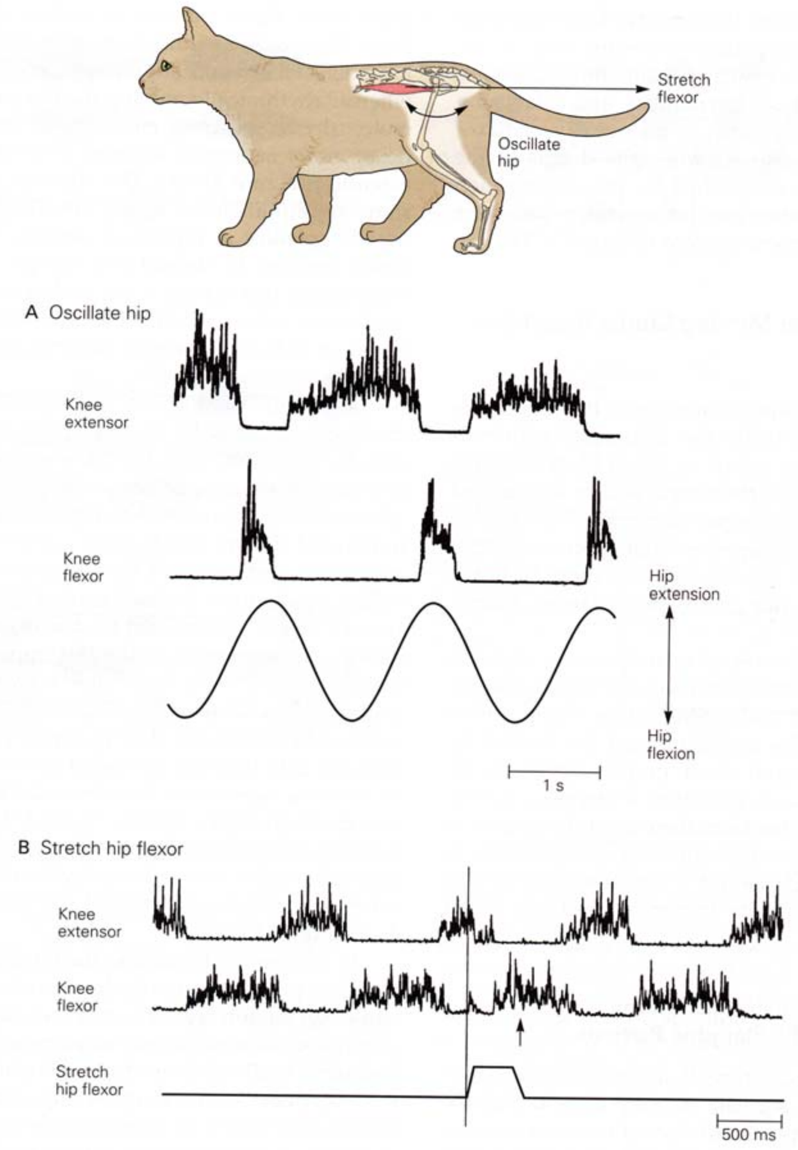
Spinal cat



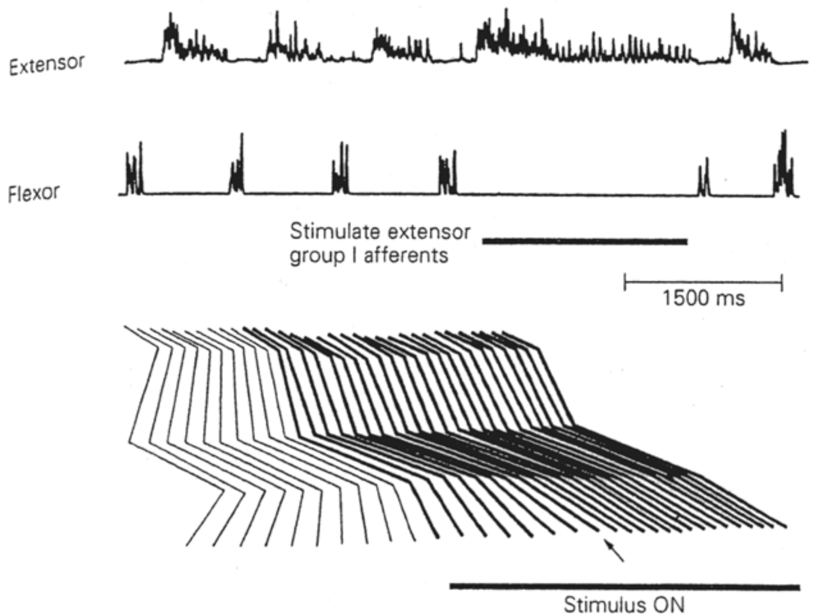


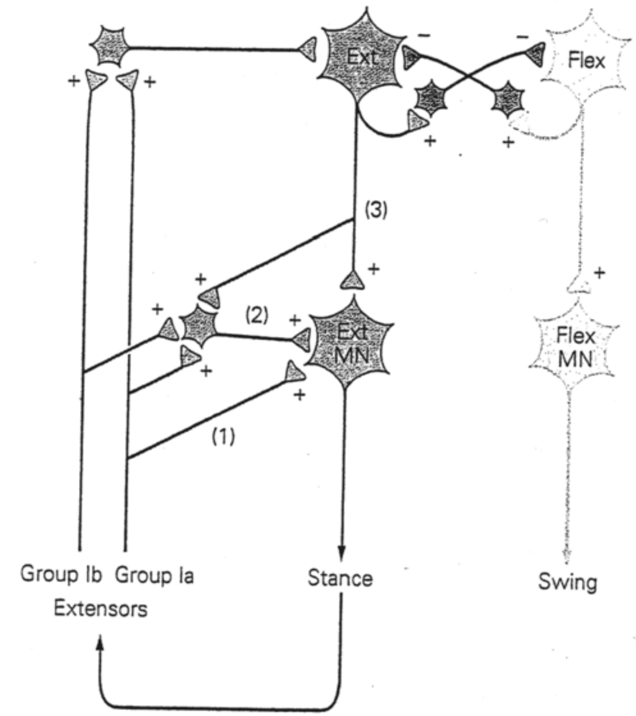
Spinal locomotor CPG is subjected to sensory influences

Afferent input from the limb assists in switching from one phase of the locomotor cycle to another



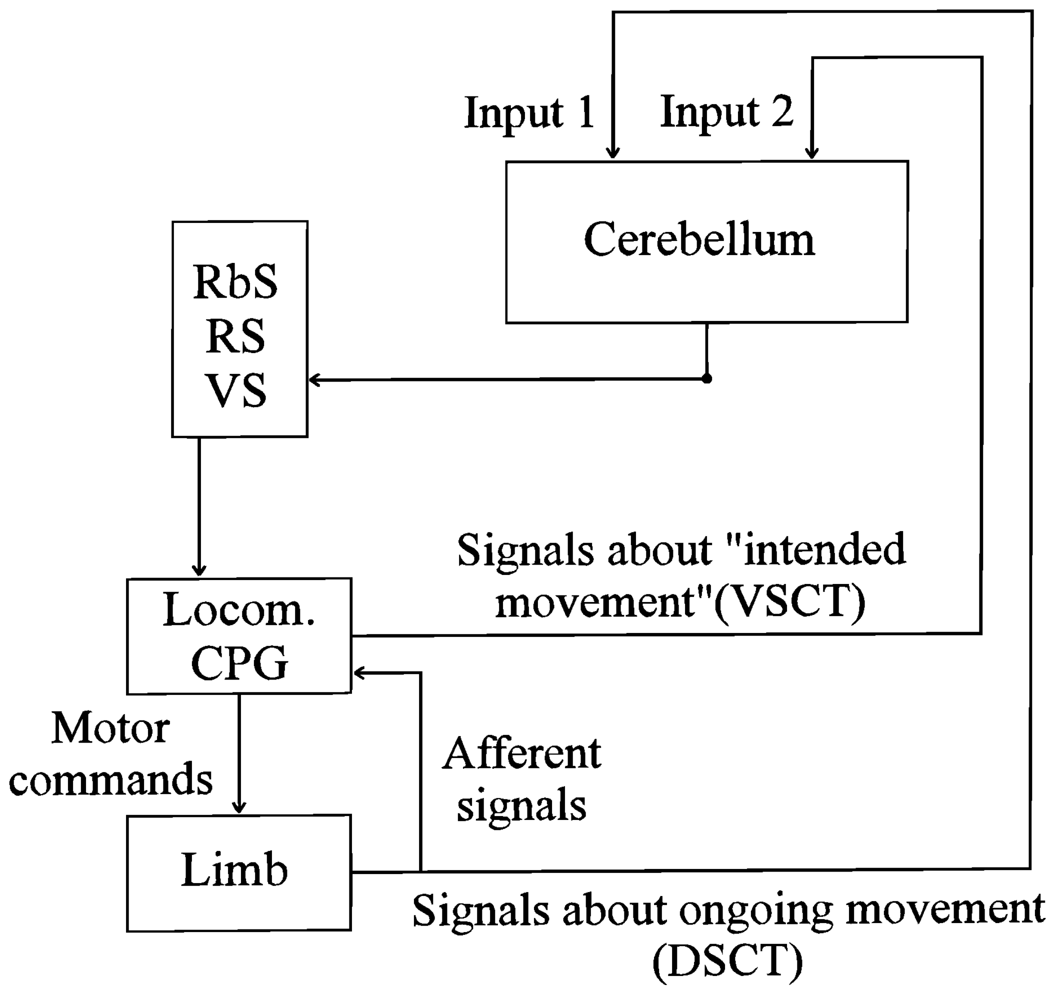
Initiation of the swing phase of walking is controlled by feedback from Golgi tendon organs and muscle spindles in extensor muscles



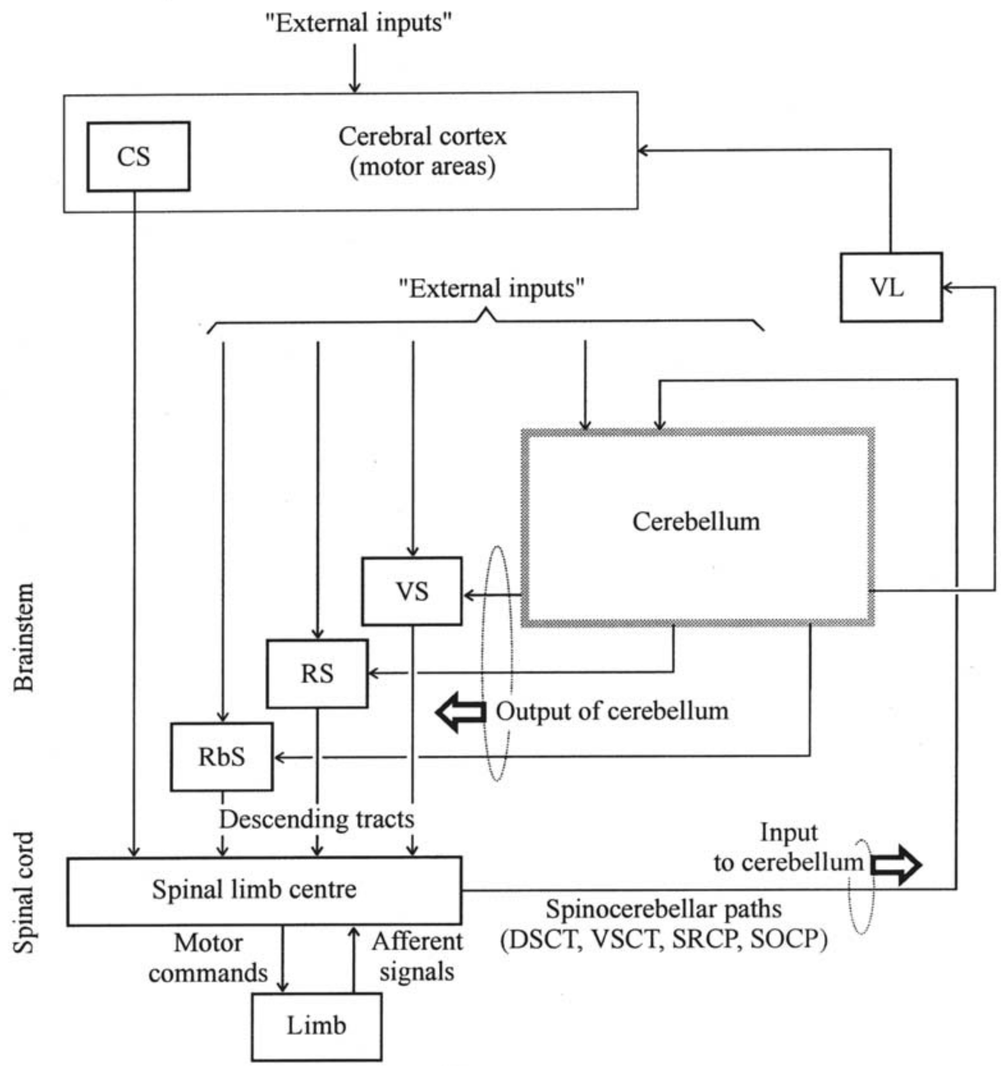


Role of cerebellum and motor cortex in control of locomotion

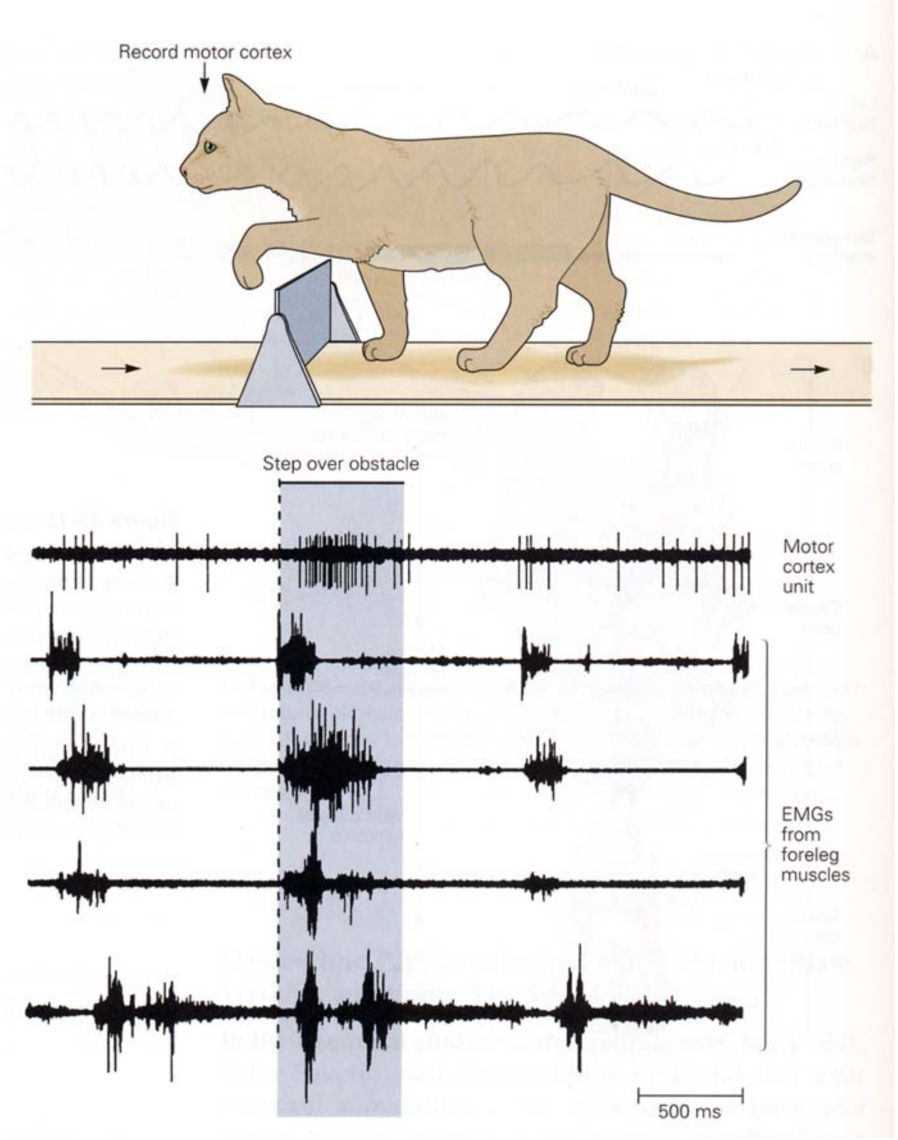
Function of cerebellum in locomotor coordination is optimization of the motor pattern



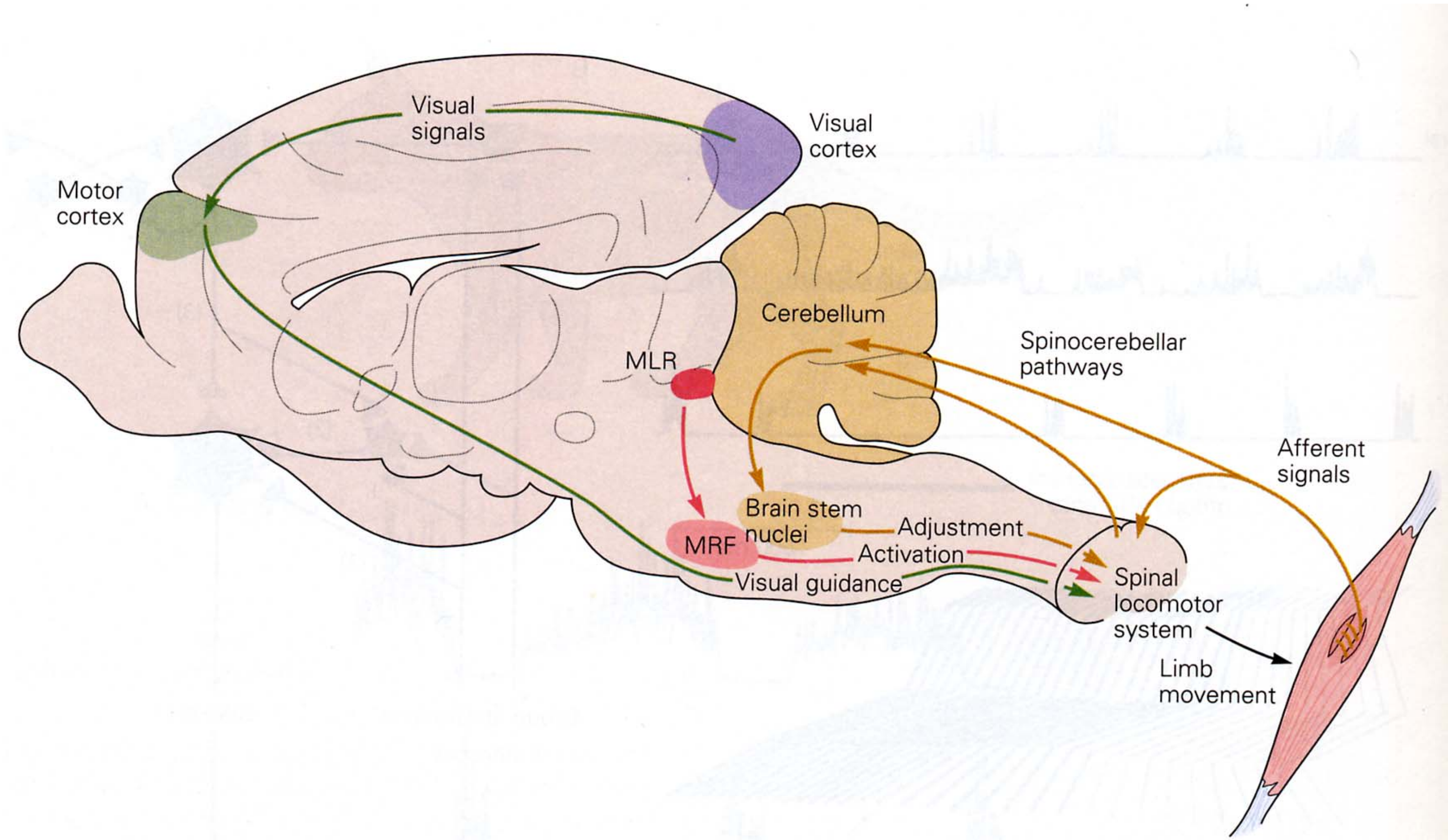
Interactions between the cerebellum, cerebral cortex and related structures of the brainstem and spinal cord which participate in the control of locomotor movements



Commands for visually induced modifications of the locomotor pattern come to the spinal locomotor CPG from the motor cortex



Role of different parts of CNS in control of locomotion



Conclusions

1. Locomotion is an active propulsive movement of the animal in space. Movements of locomotor organs (limbs, wings, etc.) are cyclic. In terrestrial animals, each cycle of the limb movement consists of the stance and swing phases.

2. The basic locomotor pattern of each limb can be generated without sensory feedback from the limb, by a spinal network termed the central pattern generator, CPG. It provides the basic features of the movement – the rhythm, the duration of the stance and swing phases, and the level of muscle activity. In intact animals, however, afferent influences from the moving limb can be strongly modify this centrally generated pattern thus adapting it to the environmental conditions. Coordination of movements of the limbs is achieved due to interactions of individual CPGs.

3. Activation of spinal locomotor CPGs is produced by a population of reticulospinal neurons. They can be activated via two inputs – from the mesencephalic locomotor region (MLR) and from the subthalamic locomotor region (SLR). MLR receives input from the basal ganglia – substantia nigra, ventral pallidum. Via the MLR, these structures may initiate and terminate locomotion.

4. During locomotion, the cerebellum receives information about intended locomotor movements (from CPGs) and about ongoing locomotor movements (sensory information from limbs). It processes this information and through the descending pathways of the brainstem optimizes the locomotor pattern.

5. The motor cortex does not play any significant role in the control of steady locomotion in a regular environment. Its role becomes decisive, however, when visually induced modifications of the locomotor pattern are necessary.