The Roles of The Nervous System In Fatigue

Historical Perspective


- Hill may have been one of the first exercise physiologists to theorize a central processing “governor”.

- The irony of Noakes’ model is that it is named from the work of Hill, who most exercise physiologists argue provided evidence of muscle and cardio-pulmonary derived causes of fatigue during exercise!

“… it would clearly be useless for the heart to make an excessive effort if by so doing it merely produced a far lower degree of saturation of arterial blood; and we suggest that, in the body (either in the heart muscle itself or in the nervous system), there I some mechanisms which causes a slowing of the circulation as soon as a serious degree of unsaturation occurs, and vice versa. This mechanism would tend to act as a ‘governor’ maintaining a high degree of saturation of the blood.”


Hill’s Model

Classic Exercise Physiology View of Exercise-Induced Fatigue

Experimenter controlled increase in work rate produces linear physiological changes in metabolism/energy supply, cardiovascular system and body temperature

Fatigue results from a failure to maintain homeostasis either in the active muscles (peripheral fatigue) or in the central nervous system (central fatigue)

Noakes’ Central Governor Model

Physiological and Psychological inputs before exercise:
- Physiological state
- Expected distance/duration
- Previous experience/motivation/external competition

Feedback during exercise:
- Fuel reserves
- Rate of heat accumulation
- Hydration state
- Self-belief

Continuous feedback from various body systems is integrated to regulate the exercise intensity by continuously modifying the number of motor units recruited in the exercising limbs
Organization of the Nervous System

The human nervous system consists of two divisions. The central nervous system includes the brain and spinal cord, and the peripheral nervous system includes the spinal nerves and the nerves of the autonomic nervous system.

Major structural divisions of the nervous system:

- Central nervous system (CNS)
  - Brain
    - Gray matter
    - White matter
  - Spinal cord
    - Gray matter
    - White matter

- Peripheral nervous system (PNS)
  - Nerves
    - Cranial nerves (12 pairs)
    - Spinal nerves (31 pairs)
  - Ganglia

Functional classes of peripheral nerve fibers:

- Somatic
  - Sensory
  - Motor

- Autonomic
  - Sensory
  - Motor
Nerve Classification
Motor and Sensory Regions of the Brain

- Primary sensory cortex
- Premotor cortex
- Primary motor area
- Somatosensory cortex
- Cerebellum

Motor Pathways

- Left hemisphere
- Frontal lobe
- Central sulcus
- Parietal lobe
- Occipital lobe
- Right hemisphere
- Primary motor area
- Primary sensory area
- Anterior
- Posterior
Autonomic Nervous System

- **Sympathetic Axis**
- **Parasympathetic Axis**

**Sympathetic**
- Preganglionic neuron
- Nicotinic receptors
- Postganglionic neuron
- ACh
- Usually
- Alpha or beta-adrenergic receptors

**Parasympathetic**
- Preganglionic neuron
- Nicotinic receptors
- Postganglionic neuron
- ACh
- Occasionally
- Muscarinic receptors
Sensory Functions

- Primary motor area
- Primary somatosensory area
- Primary gustatory (taste) area
- Somatosensory association area
- Visual association area
- Primary visual area
- Frontal association area
- Primary olfactory (smell) area
- Primary auditory area
- Auditory association area

Free nerve endings
- Expanded tip receptor
- Tactile hair
- Pacinian corpuscle
- Meissner's corpuscle
- Krause's corpuscle
- Ruffini's end-organ
- Golgi tendon apparatus
- Muscle spindle

Action potential
- Receptor potential
- Deformed area
- Node of Ranvier
Heat Sensitivity

- Muscle energy store depletion?
- Muscle metabolite accumulation?
- Acidosis?
- Membrane potential dysfunction?
- Intracellular Ca^{++} issues?
- Motor unit recruitment?
- CNS over-ride (heat, brain fatigue)?