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The Limits of Human Motor Control

UNIV 197K-01

The Limits of Human Performance

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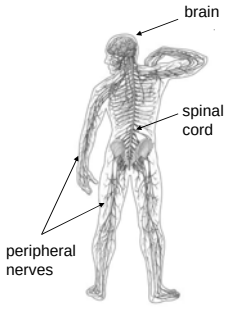
Kinesiology

Neural Aspects of Performance

- So far, we have focused mostly on muscles and metabolism
- Neural factors also play a major role in limiting maximum performance
- Examples:
  - gradation of muscle force
  - responding to sensory information
  - reaction time
  - coordination of complex movements

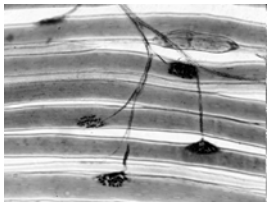
Neuromuscular System

- The signals that control and coordinate the actions of the muscles originate in the central nervous system (brain and spinal cord)
- These signals travel through peripheral nerves along motor neurons to the muscles



Neuromuscular System

- When a motor neuron arrives at a muscle, it branches and "innervates" a certain number of muscle fibers (cells)
  - A motor neuron may innervate only a few muscle fibers, to well over 2000, depending on the muscle
- Every muscle fiber receives input from only one motor neuron
- Every fiber innervated by a single motor neuron is of the same type (ST or FT)



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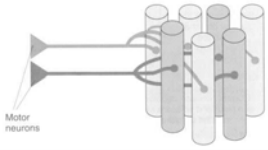
Motor Unit

- A single motor neuron, and all of the muscle fibers that it innervates is called a "motor unit"
  - A single muscle can have only a few motor units, to well over 1000
- Represents the functional control unit of the neuromuscular system



two motor units within the same muscle

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Motor Unit

- Control of muscle force is brought about through two primary mechanisms
  - Recruitment: activate more motor units
  - Rate Coding: stimulate active motor units more strongly
- Motor units within a muscle are usually recruited in an orderly fashion (from small to large) following an all-or-none principle
- This represents two constraint on performance
  - Muscle fibers can not be recruited individually, only as part of a motor unit
  - With extreme training, it may be possible to recruit all motor units simultaneously

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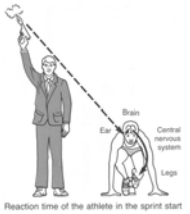
Reaction Time

- The delay in the response to a simple knee-jerk reflex is only about 30-40 ms (0.03-0.04 sec)
- Responding to auditory or visual stimuli, however, takes much longer
  - Reactions to visual stimuli take ~190 ms
  - Reactions to auditory stimuli take ~160 ms



Reaction time of the athlete in the sprint start

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Reaction Time

- Having "slow" reactions is a major disadvantage in many sports
- Having a reaction time of 170 ms versus 150 ms in the 100 m sprint, which lasts ~10 s (10,000 ms) may not sound like much
- However, this can easily be the difference between 1st and 2nd place! (or between 3rd and 4th)

Note that in the 100 m, a reaction time of <100 ms results in a false start charged to the runner

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Coordination

- Can you pat your head and rub your stomach? (at the same time)
- Now what if you speed up? What if you only speed up one hand?
- Your right and left limbs do not function completely independently
- There is actually a strong, anatomical basis for this

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Coordination

- When a task requires the two limbs to do different things, they are naturally drawn to do the same thing
- The ability to "uncouple" the two limbs (arms or legs) is one factors that distinguishes great performers from good performers
- What are some examples of skills that require very different movements on the two sides of the body?

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Up next ...

- next article: exceeding the limits of human performance with advanced technology
- a short assignment