Animal Physiology
Zoology 485
12 February 2001

Today’s plan

• Review Size principle
  o Motor units
  o Motor neuron sizes
  o Recruitment order

• Motor control – hierarchical and parallel
  o Reflexes – simple and complex
  o Central pattern generators
  o Descending control

• Surprise!!!

Motor unit
A motor unit and all muscle fibers it innervates

Motor units within a given muscle vary in many parameters
• Motor neuron size
• Number of muscle fibers innervated
• Size of individual muscle fibers
• Force generated by fibers

• These parameters are all positively correlated!!!
Size principle
Within a given muscle:
• Large motor neurons connect to more, larger, more forceful muscle fibers
• Recruitment of motor units in a contraction is in order of smaller motor units first, and larger motor units later.

Size principle makes sense
• Smaller force increments for finer movements
• Simple mechanism: Input resistance difference in motor neurons. A given synaptic current will produce a greater voltage effect on smaller neurons (higher input resistance)

Hierarchical view of motor control

```
Higher control
  “volition”

Central pattern generator

Reflex
```

Stretch reflex
Stretch reflex

Central pattern generators

- Key feature: don’t require sensory feedback to generate the pattern
- Often, but not always rhythmic
- Some innate, some learned

Example vertebrate central patterns

- Locomotion (swimming, walking, flying)
- Chewing
- Breathing
- Suckling (in mammals)

- Others? (not necessarily rhythmic)