9.20 M.I.T. 2013

Lecture #6

Fixed Action Patterns and the Central Nervous System

Scott ch 2,
"Controlling behavior: the role of the nervous system"

3. Give an example of a "**supernormal stimulus**" that acts as a **releaser** of a fixed action pattern in herring gull chicks. (See p 21)

- See the conspicuous red-orange spot on the beak of an adult Herring gull on the next slide. Gull chicks respond to this visual stimulus with a gaping response—which elicits a feeding response from the parent.
- A stronger gaping response can be elicited by a human who moves a yellow pencil painted with an orange spot. The spot plus the movement forms a "supernormal" stimulus.
- Another example: Triggering the egg-rolling response from an adult gull: A larger-than-normal egg can elicit a stronger response.

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Can you give examples of supernormal stimuli for humans?

Supernormal stimuli for humans:

- Foods: Sweet in taste, high in fats (Beware of restaurants!)
- Stimuli of sexual attraction: The “poster effect” in advertizing
- Enhancements of male appearance
  - Shoulder width, exagerated
  - Penis prominence enhanced: Sheath in tribal dress, cowl in medieval constumes
- Enhancements of female appearance:
  - Waist-to-hip ratio enhancements: Girdle, bustle
  - Breast prominence increased
  - Lip color, size enhanced (How? For what purpose?)
  - Shoulder size: But what is the purpose of shoulder pads in women’s dress?

Scott ch 2,
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4. Define: Primary sensory neuron, secondary sensory neuron, motor neuron, interneuron (neuron of the great intermediate net).

   [This textbook is not as clear as I would like in discussing the nervous system. Do not depend on this book for neuroscience information.]

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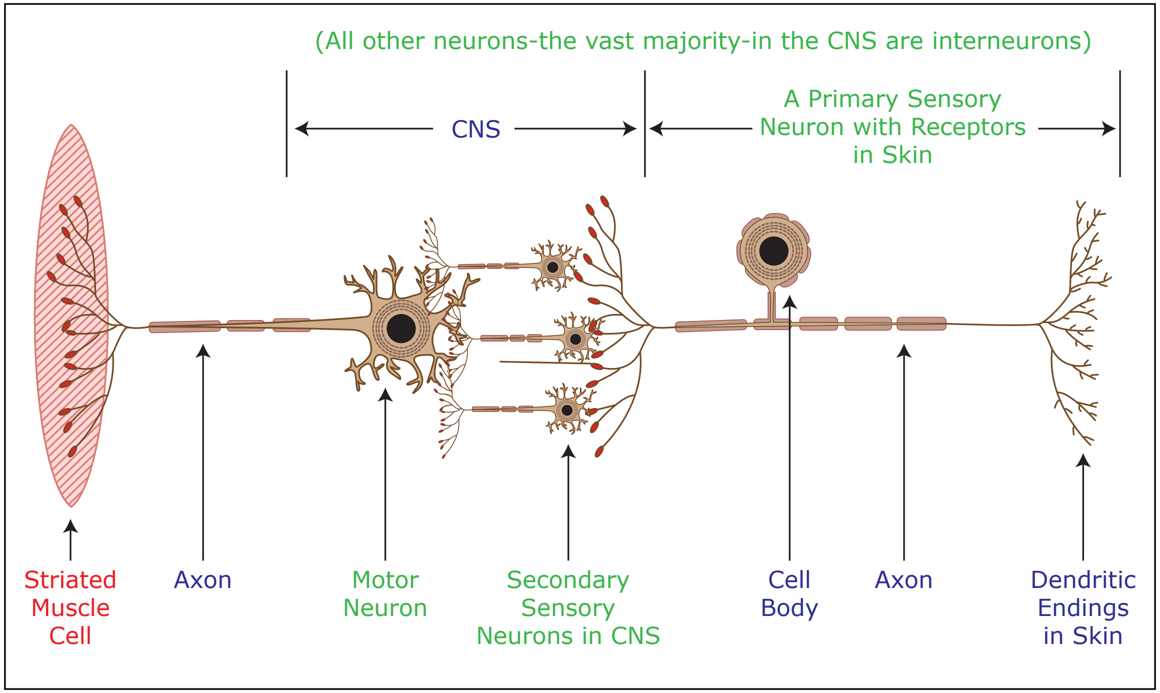

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5. What are the major specializations of nerve cells, compared with other cells of the body? (Use 9.01 information, or the equivalent.)

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- Irritability of membrane

- Conduction:

  At "axon hillock"
  an action potential can be initiated

- Transmission:

  At synapses

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Questions on innate releasing stimuli, or key stimuli:

6. How can a "wandering spider" catch its prey without using a web, by a kind of touch sensitivity that does not involve direct contact?

   Box, p 27-28

7. What features of a visual stimulus are detected by the visual system of a toad in the triggering of prey-catching behavior?

   Pp 29-30; fig 2.6

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8. Where in the central nervous system of a toad could an electrical stimulus elicit a prey-catching FAP? What would change if the electrode were moved a short distance parallel to the brain surface?

The orienting movement component of prey-catching can be elicited by stimulation of the optic tectum of the midbrain. Each position in the tectum corresponds to a position in the visual field of the opposite eye.

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9. Contrast "**command neuron**" and "**motor neuron**". You may want to check the definition of motor neuron in your 9.01 text or the equivalent – see above, Q4.

   Activate one motor neuron → muscle twitch. Activate a command neuron → a coordinated sequence of movements.

10. What is the main advantage of a "giant axon" in the triggering of an escape response, as in a squid or crayfish? (I.e., why did giant axons evolve?)

    Greater speed of conduction

Axonal conduction speed

- The larger the diameter, the faster the conduction of action potentials.
- The addition of the myelin sheath, formed by Schwann cells (PNS) and oligodendroglia (CNS) also speeds conduction.
  - Myelin is found in all vertebrates except hagfishes and lampreys, i.e., in all the jawed vertebrates (reviewed by Striedter, *Principles of Brain Evolution,* 2005)
  - Because of myelin, mammals do not have truly "giant" axons
- Quantitative expressions from 9.01 (2003):

Supplementary information:

The rate of passive spread of current down the axis cylinder is proportional to $\mathbf{1/(r_a\ c_m)}$.

Therefore, rate of passive spread down the axon increases when $\mathbf{c_m}$ decreases: the effect of myelin.

In addition:

Rate increases when axon diameter increases, because

$\mathbf{r_a}$ decreases in proportion to $\mathbf{d^2}$

$\mathbf{c_m}$ increases in proportion to **d.**

So how does an action potential move down a myelinated axon?

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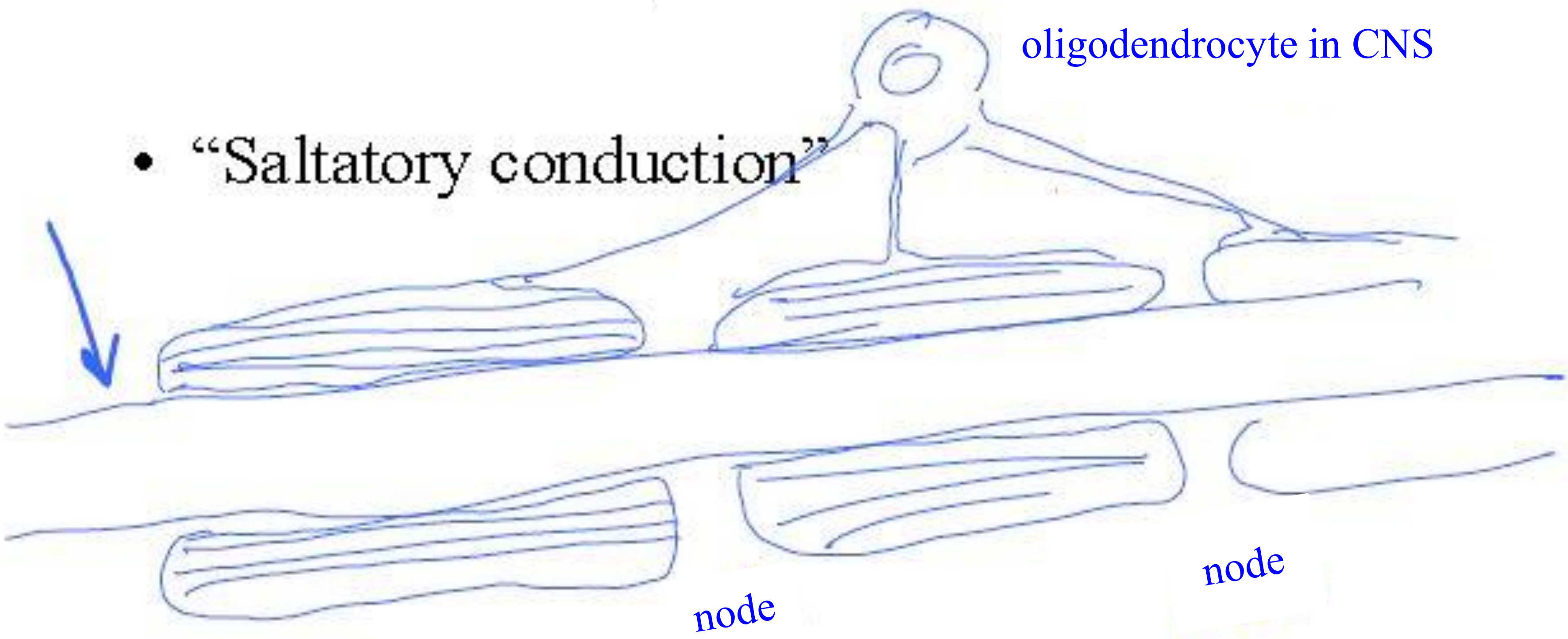
- "Saltatory conduction"



"Nodes of Ranvier:" An action potential initiated at the position of the arrow jumps from node to node. Where the myelin sheath is present, the current spreads down the axon very rapidly, by decremental conduction--not as an action potential. The larger the diameter, the more rapidly the potential spreads between nodes. The nodes are spaced just close enough so that the depolarization at one node is great enough to be above the threshold for firing an action potential at the next node.

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9.20 Animal Behavior
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