Medical Neuroscience | Tutorial Notes

Visceral Motor System—Micturition

MAP TO NEUROSCIENCE CORE CONCEPTS[1]

NCC1. The brain is the body's most complex organ.

NCC3. Genetically determined circuits are the foundation of the nervous system.

LEARNING OBJECTIVES

After study of the assigned learning materials, the student will:

1. Discuss the interplay among the sympathetic and parasympathetic divisions of the visceral motor system and the volitional somatic motor system in the control of micturition (urination; voiding urine).

TUTORIAL OUTLINE

I. Control of micturition (urination; voiding urine): an example of visceral motor activity and the coordination of volitional and non-volitional motor systems (see **Figure 21.9**[2])

- A. innervation
  - 1. sensory afferents (sense bladder filling)
    - a. stretch receptors in bladder wall (and spindle afferents in striated urethral sphincter) sense distension of the bladder and relay signals to the intermediate gray of the sacral spinal cord
    - b. afferents synapse on cells in the ventral horn that control the external (striated) sphincter (not illustrated in **Figure 21.9**)
    - c. afferents also synapse on second order (anterolateral system) neurons that project to the periaqueductal gray, "micturition centers" in the reticular formation and the nucleus of the solitary tract
  - 2. sympathetic innervation (promotes filling of bladder)
    - a. postganglionic fibers innervate the smooth muscle of the bladder and the internal urethral sphincter
    - b. sympathetic outflow relaxes the smooth muscle of the bladder and closes the internal urethral sphincter, which allows the bladder to fill
  - 3. parasympathetic innervation (promotes emptying of bladder)

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[1] Visit **BrainFacts.org** for *Neuroscience Core Concepts* (©2012 Society for Neuroscience) that offer fundamental principles about the brain and nervous system, the most complex living structure known in the universe.

[2] Figure references to Purves et al., *Neuroscience, 5th Ed.*, Sinauer Assoc., Inc., 2012. [click here]

a. preganglionic fibers from the sacral cord innervate peripheral ganglia that innervate the bladder wall and cause contraction

4. somatic motor innervation (prevents emptying of bladder)

a. alpha motor neurons in the ventral horn of the sacral cord innervate striated muscle of the external sphincter, causing it to contract

B. micturition

1. when the bladder is full, afferent activity causes an **increase** in parasympathetic tone and a **decrease** in sympathetic tone (internal sphincter muscle relax, smooth muscle in the bladder wall contracts), but ongoing contraction of the external sphincter prevents micturition

2. under the appropriate circumstances (usually, hopefully!), descending inputs coordinate an increase in parasympathetic tone, while simultaneously decreasing the activity of relevant alpha motor neurons in the sacral cord

a. involves the periaqueductal gray and inputs from pontine micturition "centers" in the reticular formation

b. these brainstem centers are supervised by the anterior hypothalamus, which receives input from amygdala and medial prefrontal cortex

3. in the absence of descending control, autonomic reflex control may be preserved in the spinal cord; but reflex activity is insufficient to provide fully adequate control over voiding (urinary tract infections are common)

STUDY QUESTION

Which of the following changes in neural activity promotes voiding urine?

A. an increase in sympathetic activity and a decrease in parasympathetic activity
B. a concurrent increase in both sympathetic and parasympathetic activity
C. a concurrent decrease in both sympathetic and parasympathetic activity
D. a decrease in sympathetic activity and an increase in parasympathetic activity
E. an increase in somatic motor outflow to the external striated sphincter muscle