Medical Neuroscience | Tutorial Notes

Visual System: Pupillary Light Reflex

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. Describe the distribution of the axons of retinal ganglion cells to major processing centers in the forebrain and brainstem.
2. Discuss the neuroanatomical basis for the pupillary light reflex.

TUTORIAL OUTLINE

I. Overview of Central Visual Pathways

- A. central projections of the retina arise from retinal ganglion cells
- B. among the targets of these central projections are a set of nuclei just anterior to the tectum of the midbrain, in a transitional region between the diencephalon and the mesencephalon called the pretectum (see **Figure 12.1**[2] for gross overview and)
  1. **pretectum**: coordinates the pupillary light reflex (see **Figure 12.2**)
     - a. afferent (sensory) limb
       - i. inputs reach the **pretectal nuclei** from the ipsilateral optic tract
       - ii. thus, each side of the pretectum receives input from both eyes
     - b. efferent (motor limb)
       - i. the pretectal nuclei send projections *bilaterally* to the **Edinger-Westphal nuclei**
       - ii. parasympathetic, preganglionic outputs leave the brainstem through the oculomotor nerve and govern the activity of *constrictor* muscles in the iris (pupillary constriction) via ganglionic input from the ciliary ganglion

[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]

iii. *pupillary dilation* is under the control of the sympathetic division of the visceral motor system, with preganglionic neurons in the upper thoracic spinal cord (intermediolateral cell column)

2. pretectum is also involved in coordinating the activities of the preganglionic neurons that innervate the ciliary muscles and allow for accommodation (changing the shape of the lens)

STUDY QUESTIONS

Q1. Patient 1. During a physical exam, you shine a light into a patient's left eye and you note that both pupils react only sluggishly to light. You stimulate the right eye and you find a brisk constriction of both pupils. From this information alone, what sort of neurological problem might you suspect?

A. lesion in the left eye or left optic nerve
B. lesion in the right eye or right optic nerve
C. lesion in the left optic tract
D. lesion in the right optic tract
E. lesion in the left Edinger-Westphal nucleus or left oculomotor nerve
F. lesion in the right Edinger-Westphal nucleus or right oculomotor nerve
G. insufficient sympathetic tone to the left iris.
H. insufficient sympathetic tone to the right iris.

Q2. Patient 2. A patient has come to you complaining of double vision. His left eye fails to adduct when he makes eye movements to the right. His left eyelid droops (ptosis) and the pupil in his left eye is larger than the pupil in the right. The pupil in the left eye does not react to light nor does it respond when light is shown in the right eye. How would you explain this deficit in the pupillary light reflex?

A. lesion in the left eye or left optic nerve
B. lesion in the right eye or right optic nerve
C. lesion in the left optic tract
D. lesion in the right optic tract
E. lesion in the left Edinger-Westphal nucleus or left oculomotor nerve
F. lesion in the right Edinger-Westphal nucleus or right oculomotor nerve
G. insufficient sympathetic tone to the left iris.
H. insufficient sympathetic tone to the right iris.

Q3. Patient 3. A third patient comes to see you with ptosis of his left eye. You examine his eye movements and these seem normal. Then you notice that the pupil in his left eye is measurably smaller than that of his right eye. How do you account for the symptoms in this case?

A. lesion in the left eye or left optic nerve
B. lesion in the right eye or right optic nerve
C. lesion in the left optic tract
D. lesion in the right optic tract
E. lesion in the left Edinger-Westphal nucleus or left oculomotor nerve
F. lesion in the right Edinger-Westphal nucleus or right oculomotor nerve
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