Medical Neuroscience | Tutorial Notes

Visual System: Visual Field Deficits

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.

NCC8. Fundamental discoveries promote healthy living and treatment of disease.

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 topographic representation of visual space in the primary visual cortex (V1) and its anatomical basis in the organization of visual projections.
3. Characterize, using appropriate clinical terms, the visual field deficits associated to damage or disease along the central visual pathways.

TUTORIAL NARRATIVE

Visual field deficits

A deficit in the visual fields (a region in the visual field of one or both eyes in which there is a loss of sight) is referred to as a **scotoma**. You might think that a scotoma would be very obvious to an individual who has one, and many times they are. But sometimes, especially when it occurs in the periphery, a scotoma may go unrecognized until the individual has an accident that all too vividly reveals her/his sensory loss. (Traffic accidents are a common way to uncover such visual field deficits.)

Review the central projections of retinal ganglion cells to targets in the diencephalon and midbrain (see **Figure 12.1**[2] for gross overview and tutorial: "Visual System—Central Visual Pathways").

On the right side of **Figure 12.6**, you will see examples of different types of visual field deficits. In each case, the regions of the visual field of each eye that are affected are shown in black. That is, the part of the visual field that is not visible in that eye is blacked out. Visual field diagrams are always done for each eye individually. Some deficits would not be easy to demonstrate if both eyes were open during the testing. On the left of the figure, lines are drawn through parts of the visual pathways to indicate locations that could be damaged to give each of the illustrated patterns of deficits.

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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]

Some rather cumbersome names are used to refer to particular patterns of visual field deficits. **Anopsia** (also spelled anopia) simply means loss of sight in one or both eyes. **Hemianopsia** indicates loss of sight in one half of the visual field. **Quadrantanopsia** is a loss of sight in one quadrant of the visual field. **Bitemporal hemianopsia** is a loss of sight in the right visual field of the right eye and the left visual field of the left eye. It is also called **heteronymous hemianopsia** because the affected regions of the visual fields in the two eyes are not congruent. When the affected regions of the visual fields of both eyes overlap (i.e., loss of vision in the left or right visual field of both eyes), the deficit is called **homonymous**. A patient could be described as having a homonymous hemianopsia or a homonymous quadrantanopsia, etc.

Widespread loss of vision without damage to the most central part of the visual field representation is called **macular sparing**. Macular sparing is a phenomenon often associated with lesions in the visual cortex but it can be found with lesions along the length of the visual pathways.

Consider the visual field deficits shown in **Figure 12.6** and identify each by the proper clinical term (or combination of terms) highlighted on this page in bold font. You should be able to relate this figure back to previous figures on visuotopy and explain why each visual field deficit is associated with damage to the particular structure along the visual pathway from retina to visual cortex.

STUDY QUESTIONS

Q1. Patient 1. A patient complains of bumping into objects on the right, especially objects such as chairs and tables that are at waist height or below. You suspect a visual field deficit involving which structure(s)?

A. lesion in the left eye or left optic nerve
B. lesion in the right eye or right optic nerve
C. lesion in the optic chiasm
D. lesion in the left Meyer's loop
E. lesion in the right Meyer's loop
F. lesion in the left parietal white matter
G. lesion in the right parietal white matter
H. lesion in the left cuneus gyrus
I. lesion in the right cuneus gyrus
J. lesion in the left lingual gyrus
K. lesion in the right lingual gyrus

Q1. Patient 2. A patient undergoes neurosurgery to remove an operable tumor (an early stage glioblastoma, which arises in white matter) from the right temporal lobe. Upon recovery in the acute care setting, the patient's caregivers discover that when resting in bed she doesn't readily notice visitors approaching from her left. What visual structure may have been injured in this surgical procedure?

A. lesion in the left eye or left optic nerve
B. lesion in the right eye or right optic nerve
C. lesion in the optic chiasm
D. lesion in the left Meyer's loop

E. lesion in the right Meyer's loop
F. lesion in the left parietal white matter
G. lesion in the right parietal white matter
H. lesion in the left cuneus gyrus
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