

ANSI/IES **LS-7-20**



LIGHTING SCIENCE:
VISION – EYE AND BRAIN
AN AMERICAN NATIONAL STANDARD



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has been approved by the IES.
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should be directed to IES.

**Prepared by the
IES Vision Science Committee**



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CONTENTS

1.0	Introduction and Scope	1
1.1	Introduction	1
1.2	Scope	1
2.0	Ocular Anatomy and Function	1
2.1	Structure	1
2.1.1	Tunics	1
2.1.2	Cornea	2
2.1.3	Iris and Pupil	2
2.1.4	Lens and Ciliary Muscles	2
2.1.5	Humors	2
2.1.6	Retina	2
2.2	Muscles and Eye Movement	3
2.2.1	Saccades	3
2.2.2	Pursuit or Tracking	3
2.2.3	Vergence Movements	3
2.2.4	Version Movements	3
2.3	Photoreceptors, Neural Layers, and Signal Processing	3
2.3.1	Classical Photoreceptors	4
2.3.2	Photoreceptor Distribution	5
2.3.3	Horizontal, Amacrine, and Bipolar Cells	5
2.3.4	Ganglion Cells and the Optic Nerve	6
2.3.5	Nerve Signals	6
3.0	Optics of the Eye	7
3.1	Retinal Image Formation	7
3.2	Accommodation	7
3.3	Scatter	7
3.4	Retinal Irradiation	7
4.0	The Visual System behind the Eye	9
4.1	Optic Nerve	9
4.2	Lateral Geniculate Nucleus (LGN)	9
4.3	Visual Cortex	9
4.4	Receptive Fields	10
4.5	Perceptions and Performance	11

5.0	Vision and the State of Adaptation	11
5.1	Adaptation	11
5.1.1	Mechanical Change: Pupil Size	12
5.1.2	Photochemical Change: Pigment Bleaching	12
5.1.3	Neural Change: Synaptic Interaction	12
5.1.4	Temporal Effects	12
5.2	Photopic Vision	13
5.3	Mesopic Vision	13
5.4	Scotopic Vision	13
6.0	Color Vision	15
6.1	Chromatic Receptive Field Opponency	15
7.0	Individual Differences	16
7.1	Color Vision Deficiencies	16
7.1.1	Congenital Color Vision Deficiencies	16
7.1.2	Acquired Color Vision Deficiencies	16
7.2	Refractive Errors	17
7.3	Effects of Age	18
7.3.1	Presbyopia	18
7.3.2	Lens Yellowing, Clouding, and Fluorescence	19
7.3.3	Pupil Size Limits	19
7.3.4	Decreased Retinal Illumination and Increased Scattering	20
7.3.5	Cell Loss	20
7.3.6	Increased Prevalence of Retinal Disease	20
7.4	Partial Sight	20
7.4.1	Cataracts	20
7.4.2	Macular Degeneration	21
7.4.3	Glaucoma	21
7.4.4	Retinopathy	21
7.4.5	Lighting for the Partially Sighted	21
References	22

The eye is the window to the world.
 – Lael Wertenbaker, 20th century author

1.0 Introduction and Scope

1.1 Introduction

The most complex of the senses, vision is perhaps the most important mechanism we have for perceiving the world. Vision results from the interaction of eye and brain. From vision come perceptions, and from perceptions we build our individual worlds, always largely affected by the luminous environment. An understanding of this process will guide the design of that environment, and to consider the eye and brain as a single unit is the best way to understand the biological machinery that provides vision.¹

The eye contains components that work together to produce an image of the external world on a layer of photoreceptive cells in the retina at the back of the eye. This layer encodes information about this image as neural signals that are conducted to the center of the brain, combined with similar signals from the other eye, and processed further, with the result conducted to the area at the back of the brain that is primarily responsible for visual processing. Along the way, signals are generated to move the eyes in order to track visual targets, and to change the shape of the eye's lens to bring the visual target into sharp focus. A combination of mechanical, chemical, and neural mechanisms change the system's sensitivity so that it can operate in light levels ranging from starlight only to noon sunlight. Complex neural circuitry is responsible, in part, for motion detection, color vision, and pattern recognition.

1.2 Scope

The purpose of this document is to describe and explain the human visual system, including its components in the eye and the brain. The structure and function of these various components are explained, as well as the ways in which individual people differ in their visual abilities. It is important to note that this document is not intended to provide comprehensive coverage on the subjects contained herein.

2.0 Ocular Anatomy and Function

This section describes the components of the eye, giving their structure and their various mechanical, optical, and neural operation functions. **Figure 2-1** shows the anatomical structure of the eye-brain system. The general structure of the visual system is a series of layers that receive, process, and transmit visual information. These layers are connected by neural pathways that convey visual information from one layer to the next. The principal layers are the retina, located in the eye; the lateral geniculate body, located in the brain center; and the primary visual occipital cortex, located at the back of the brain. Though visual information is transmitted by the visual cortex to “higher” parts of the brain, the cortex is usually considered the last stage of the visual system proper.

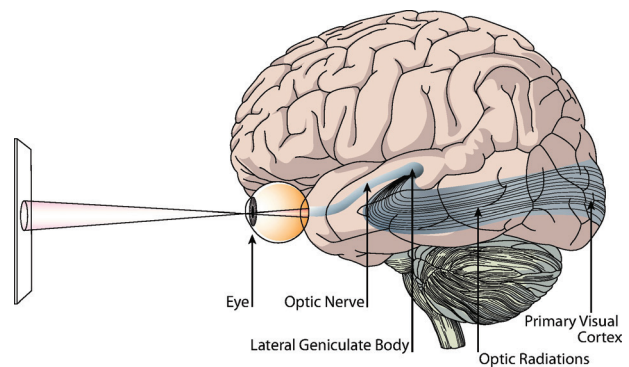


Figure 2-1. The eye and the principal components of the brain that comprise the human visual system. (Image redrawn from original, © David H. Hubel)

2.1 Structure

The anatomy of the eye consists of components that do the following: provide and hold its shape; comprise the optical elements that form an image; control the amount of optical radiation that enters the eye; encode the image; and provide for movements required to track the image. **Figure 2-2** shows the general structure of the eye. As described below, much of the eye functions purely with the purpose of maintaining a focused image of the world on the retina at the back of the eye.

2.1.1 Tunics. The *sclera* is the relatively thick, tough, opaque, white, outer layer of the eye. Filled with blood vessels, the sclera is visible from the front and is what is often called the “white of the eye.” The choroid is a dark, thin layer just inside the sclera. It covers most of the back portion of the eye and brings blood vessels to the