Early Visual Development: Implications for the Neonatal Intensive Care Unit and Care

Stanley N. Graven, MD

KEYWORDS

• Premature infant • Endogenous stimuli • Visual development
• NICU • Melanopsin • Epigenetics • Human

Much of the early development of the human visual system occurs while the preterm infant is in the neonatal intensive care unit (NICU). Critical events and processes occur between 20 and 40 weeks' gestational age, before the onset of vision at term birth. Knowledge of the development of the visual system and the timing of the processes involved is essential to adapting NICU care to support all neurosensory development including visual development.

The human visual system is the most thoroughly studied of the sensory systems. Studies from the 1950s and 1960s created the framework for much of the subsequent research. It was the work of Hubel and Wiesel[1,2] in the 1960s on the need for and role of visual experience that became the basis for much of the research through the 1970s and 1980s. Shatz and coworkers[3,4] continued with the studies of retinal function and the development of the retinogeniculate pathway. LeVay and colleagues[5] continued the work on the development of ocular dominance columns in the visual cortex and the effects of visual deprivation. New technology for studying the brain has greatly advanced the studies of the human visual system.

The sensory systems of humans and other mammals develop sequentially in clearly defined periods or stages. The main sensory systems with critical developmental periods in late fetal and neonatal life are listed in **Table 1**. The visual system is the last to develop functionally. Protecting the development of the visual system remains important because visual problems continue to be common among NICU graduates who were preterm births.

Department of Community and Family Health, College of Public Health, University of South Florida, 13201 Bruce B. Downs Boulevard, MDC 56, Tampa, FL 33612-3805, USA
E-mail address: sgraven@health.usf.edu

Clin Perinatol 38 (2011) 671–683
doi:10.1016/j.clp.2011.08.006 **perinatology.theclinics.com**
0095-5108/11/$ – see front matter

Table 1
Neurosensory systems with early critical periods

1. Limbic system	Emotion and feeling
2. Hippocampus	Memory, early sensory development, brain plasticity
3. Chemosensory	
a. Olfactory	Smell
b. Gustatory	Taste
4. Somatosensory	Touch, pressure, vibration, temperature, pain
5. Kinesthetic proprioception: vestibular	Position and movement Balance and motion
6. Auditory	Hearing
7. Visual	Vision

THE COMPONENTS OF THE VISUAL SYSTEM

The Eye, Eyelids, and Optics

The cornea, iris, lens, and eyelids are all parts of the optic function (**Fig. 1**). The eyelids and iris control the amount of light entering the eye, whereas the lens provides focus and image detail. Infants at or before 32 weeks' gestation have thin eyelids and little or no pupillary constriction. This allows little ability to limit light reaching the retina.[5] By 34 to 36 weeks' gestation, the pupillary constriction is more consistent and the eyelids are thicker, allowing some ability to limit light exposure to the retina. There is no developed pathway for an image to reach the visual cortex in utero and the fetus in utero has no exposure to light or visual image. The pathways from the retina to the visual cortex that transmit visual images become functional at 39 to 40 weeks' gestation. Preterm birth does not accelerate the maturation of the human visual system, although it

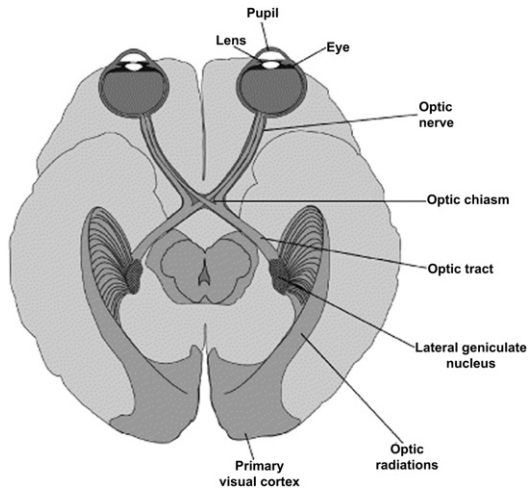

Fig. 1. The human brain. The components of the visual system are highlighted and labeled. (*Data from* Hubel DH. Eye, brain, and vision. New York: Scientific American Library; 1988.)