The Myth of Critical Periods

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Conventional wisdom in the fields of neurology and development has led to general acceptance of the fact that "critical periods" exist in the development of certain aspects of the human visual process. However, as more understanding of the supporting physiology of the neural networks that comprise the brain emerges, the length of time that makes up critical period must be extended to coincide with the only true critical period there is -- death.

Originally, the concept of a critical period emerged from observations of young chickens and ducks. Specific insights into critical periods of vision development came from studies involving single cell recording from the visual cortexes of cats and monkeys. Many of these studies involved altering the distribution of the cells that reacted to monocular versus binocular stimulation after varying periods of single lid suturing and various types of stimulation programs after unsuturing the lid. The early studies, which were prior to 1976, all supported the view that, in order for the underlying neurology to develop the ability to handle binocular information, the eye->optic nerve->optic radiation complex required binocular stimulation during a certain critical period. In the late 1970s, a series of studies done by Hubel & Wiesel, Blakemore & Pettigrew, and Hirsch & Spinelli began to find evidence of a repression/de-repression model. This means that there are processes that regulate periods of increased and decreased plasticity. Separate studies by Cynader and Pettigrew state that attention systems, originating in the reticular activating system (RAS), appear to be the regulator of the critical period phenomena.

Separate reversal studies by vonNoorden, vanSluyters and Pettigrew all showed that complete reversals of experience deprivation could be overcome well after established critical periods had come and gone . Several of these studies centered on the locus coeruleus, a center in the RAS which has as many synapses in the visual cortex (V1, formerly called Broadmans area 17) as come from the primary optic radiations.

Singer, Tretter, & Yinon and a separate study done by Kasamatsu showed that stimulation of the locus coeruleus after the critical period opened up a new period of increased or even hyper plasticity. According to Dr. Steven Cool, the midbrain reticular activating system mechanism associated with selective attention/arousal levels sets a "gate" on the primary sensory information input system and helps to determine what and how much information will get through. The primary visual information, the retino->geniculo->cortical system, is modulated by the selective attention system.

The majority of this research was done specifically in the area of binocularity. In my opinion, this was because these cells were more easily accessible to the researchers than the cells directly associated with high spatial frequency information in single channel (amblyopia). It goes without saying that if the work was done with lid suturing techniques, that the cats and monkeys were made amblyopic. It also goes without saying that, if totally normal binocularity was restored, a pre-requisite to this level of binocularity is normal information throughout the full spectrum of spatial frequencies, which would mean that no amblyopia would be present

For references, please see the article "The Scientific Basis for the Functional Approach to Vision Care", by Steven Cool.

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