
Neuromyth 1

The brain is only plastic for certain kinds of information during specific 'critical periods'-thereby the first three years of a child are decisive for later development and success in life.

The concept of critical periods states that there are certain periods during early life when the brain's capacity for adjustment in response to experience is substantially greater than it is in adulthood. This concept originated from observations by some of the pioneers in the study of animal behaviour. For example, Konrad Lorenz examined a dramatic example of a critical period: imprinting in birds. Newly hatched birds will become indelibly attached, or imprinted, to almost any prominent moving object in their environment, normally their mother. Such imprinting can only occur during a critical period soon after hatching. In some species this period lasts only a few hours. Once the attachment is formed, the birds will follow the "imprinted" object to the exclusion of all others; subsequent experience won't alter the behaviour. Neuroscientists explain this phenomenon with neuronal correlates that underlie imprinting. In one model system, the guinea fowl, changes in neurons in the forebrain correlate with imprinting to an auditory stimulus. Another dramatic example shows that visual experience during a critical period determines how much of the visual cortex is devoted to processing input from each eye and the degree to which binocular inputs are combined (Hubel et al. 1977). If one eye of a kitten is closed during a certain critical period, the structures for this eye in the visual cortex won't develop normally. Thus, visually guided behaviours mediated by the deprived eye are severely and permanently impaired.

Nowadays, however, scientists recognize that the critical periods are not sharply delineated and are influenced by many factors e.g. kind of input, modality. In recognition of this, most use the softer term "sensitive period", with which they refer to a developmental stage during which neurons select their repertoire of inputs from a wider array of possible inputs. If we look at a large body of research within vision, audition and language we can see that different brain systems display very different amounts and types of changes with experience ("i.e. "plasticity"). Some systems (like semantics) retain the ability to change with experience throughout life and thus do not display evidence of a "sensitive period". On the other hand the ability to learn the sounds of a language (phonology, including accent) and the grammar of a language (the rules) appears to be optimal in the early and middle childhood years. There is plenty of evidence for this. This doesn't mean that with exposure/training beyond what people usually obtain there couldn't be changes, but given the sorts of natural situations that people find themselves in these three different aspects of language display different degrees of "plasticity". This is also true of the visual system, the auditory system and the somatosensory system. While there might be sensitive periods for some stimuli, the capacity to form synapses, i.e. plasticity, is not limited to the first three years of life. Thus it can not be generalized that there is a sole sensitive period (up to 3 years) for every possible stimuli. Any kind of specific environmental stimulation causes the brain to form new connections. This ability is conserved throughout life. Musicians have e.g. fine-tuned cortical representations of their fingers. Another study showed London taxi drivers to have enlarged hippocampi (an area of the brain that is important for spatial memory). People are now investigating the possibility of plasticity and sensitive periods for learning math, music, social and emotional skills etc. This is an important agenda for future research because it will provide input to the design of educational programs.

More references:

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Neville, H.J., & Bruer, J.T. (2001) "Language Processing: How Experience Affects Brain Organisation". In D.B. Bailey, J.T. Bruer, F.J. Symonds, & J.W. Lichtman, [Critical Thinking About Critical Periods \(pp.151-172\)](#). Baltimore: Paul H. Brookes Publishing CO.; [posted by permission \(without figures\)](#). See also Round Tables section on this website answers to the question:

[How important are the early years to successful life-long learning?](#)

Newport, E.L. (2002). [Critical periods in language development](#). In L. Nadel (Ed.), Encyclopedia of Cognitive Science. London: Macmillan Publishers Ltd./posted by permission of Nature Publishing Group.

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