

Critical & Sensitive Periods

Concept

History

Methods

Critical Period: The Concept

A critical period is a time during an organism's life span when it is more sensitive to environmental influences or stimulation than at other times during its life.

Critical Period: The Semantics

- Critical period:
 - begins and ends abruptly
 - period beyond which a phenomenon will not appear
- Sensitive period:
 - begins and ends gradually
 - period of maximal sensitivity
- Window of opportunity:
 - popular metaphor
 - introduced by P. Bateson, 1978 in his critique

Critical Period: Embryology

As is well known, a certain organ arises much earlier or later in the embryo than certain others. When the primary developmental changes are on the verge of taking place or when an important organ is entering its initial stage of rapid proliferation or budding, a serious interruption of the developmental progress often causes decided injuries to this particular organ, while only slight or no ill effects may be suffered by the embryo in general. Such particular **sensitive periods** during development I have termed '**critical moments.**'

-- Charles R. Stockard
Am. J. of Anat. 1921
28:115-275, p. 139

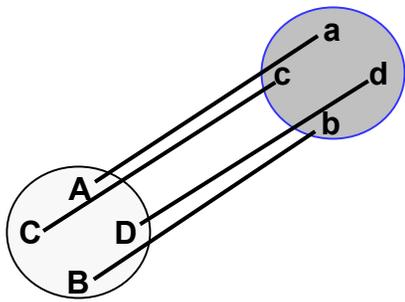
Critical Period: Induction

Embryonic cells transplanted before (but not after) a certain stage of development are *induced*, by influences in their new cellular environment to develop like cells typical of the new site, not as they would have developed at their original site.

-- Hans Spemann, 1938

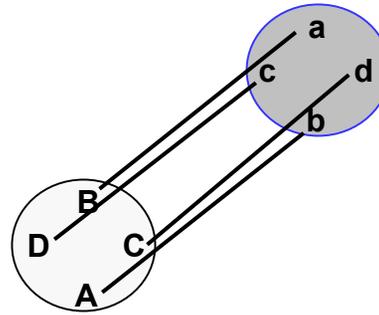
Critical Period: The Frogs

No Eye Rotation



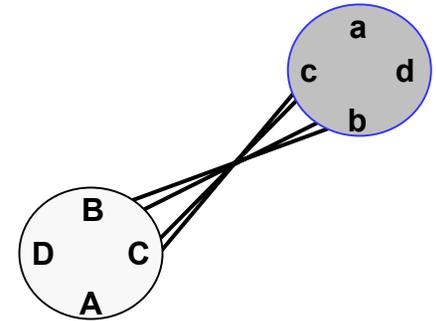
Kermit

180° Eye Rotation



Kelvin

180° Eye Rotation
24 Hours Later



Klyde

Imprinting: Konrad Lorenz



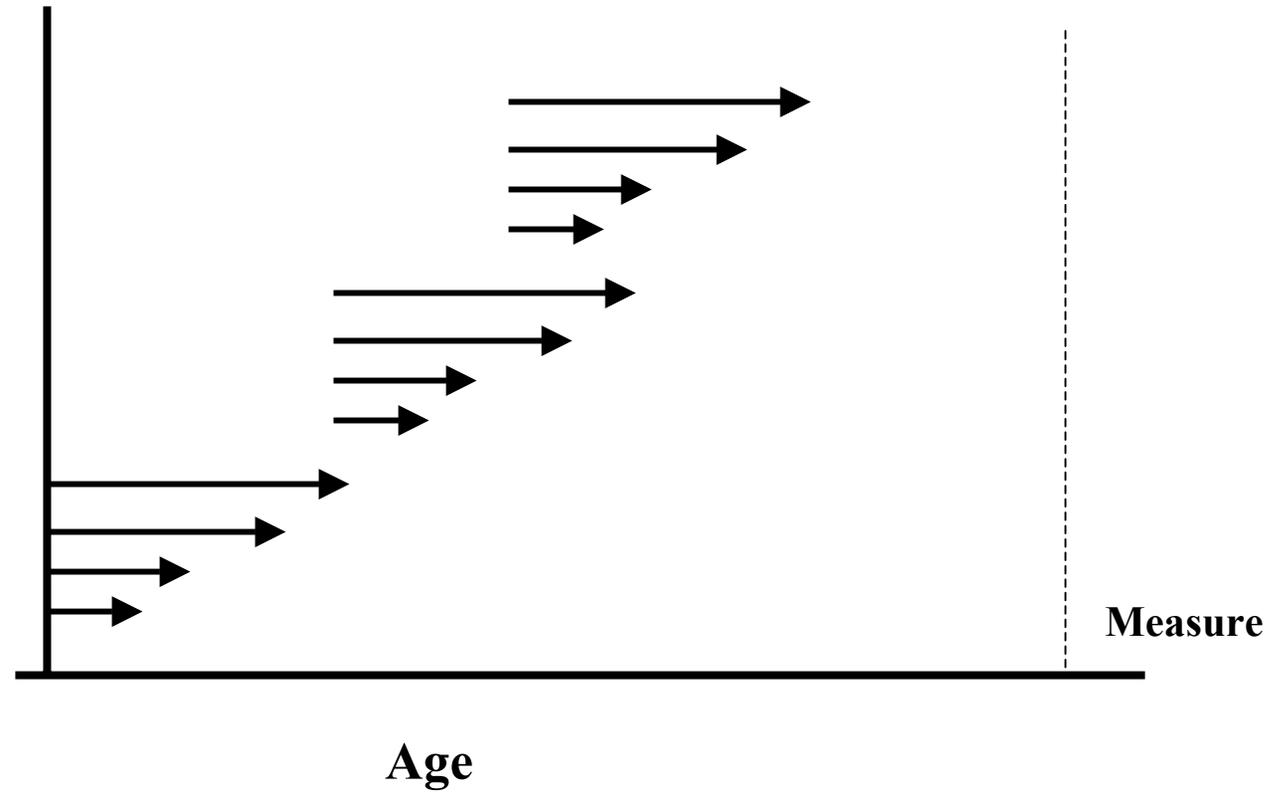
Characteristics of Imprinting

- Confined to a definite time period
- Irreversible
- Long-term developmental consequences independent of the original “imprinted object”

Critical Period: The Criteria

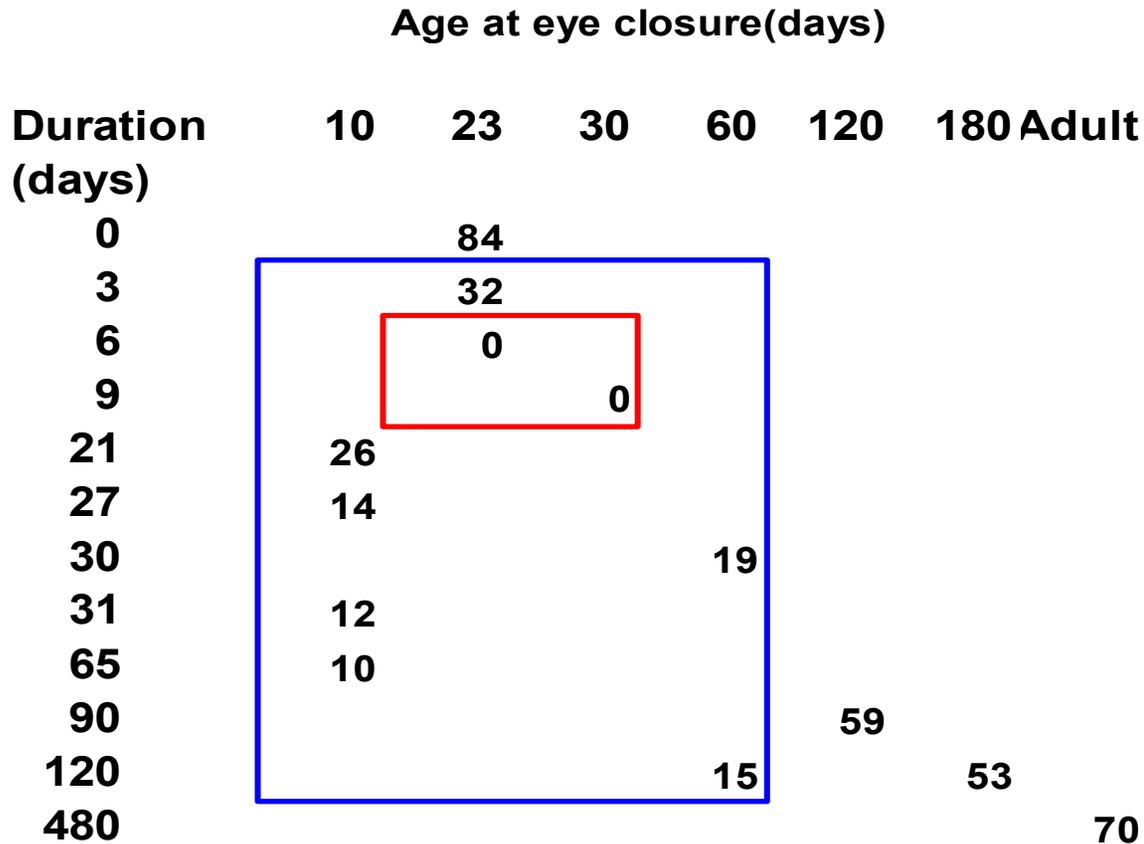
- Identifiable beginning point
- Identifiable end point
- Intrinsic component
- Extrinsic component
- A specified critical system

Experimental Study: Hubel & Wiesel's Blind Kittens

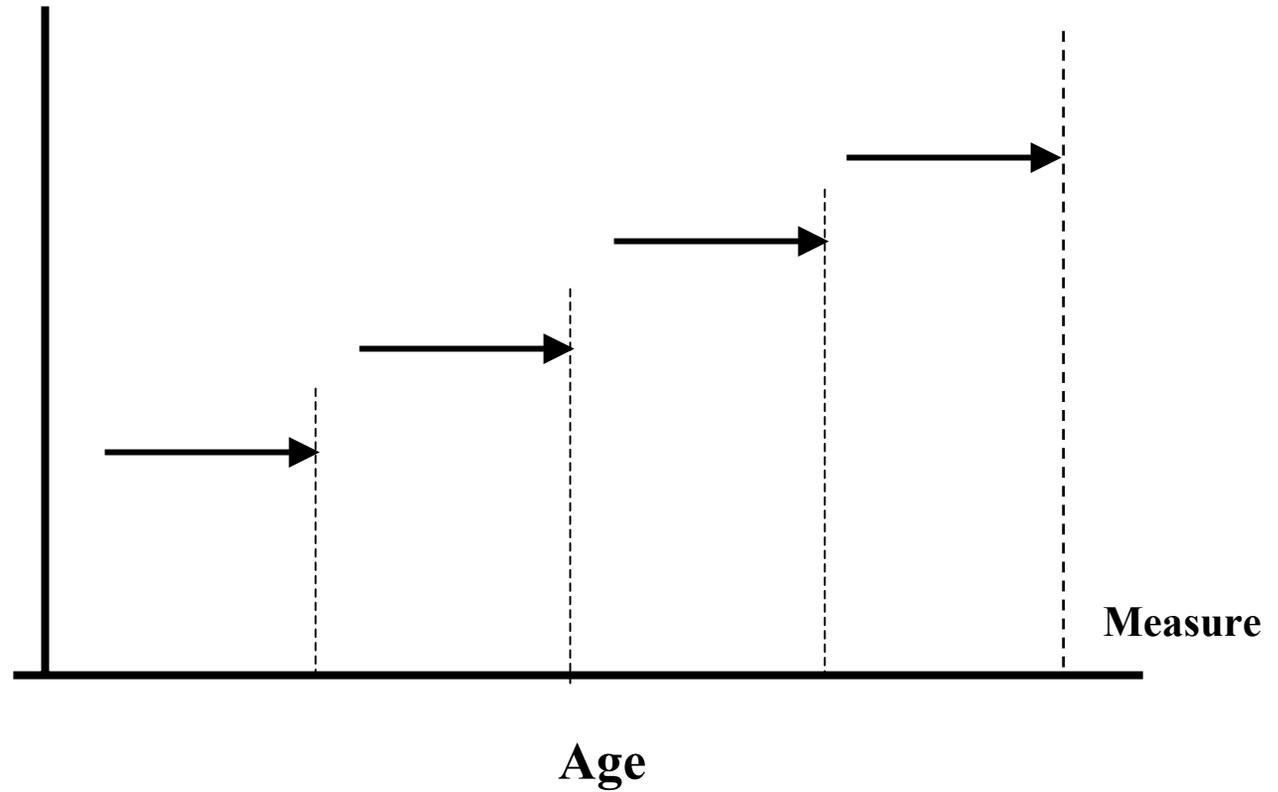


Experimental Study: Hubel & Wiesel's Kittens

PERCENT LEFT VISUAL CORTEX CELLS
RESPONDING TO CLOSED RIGHT EYE
(Normal > 50%)

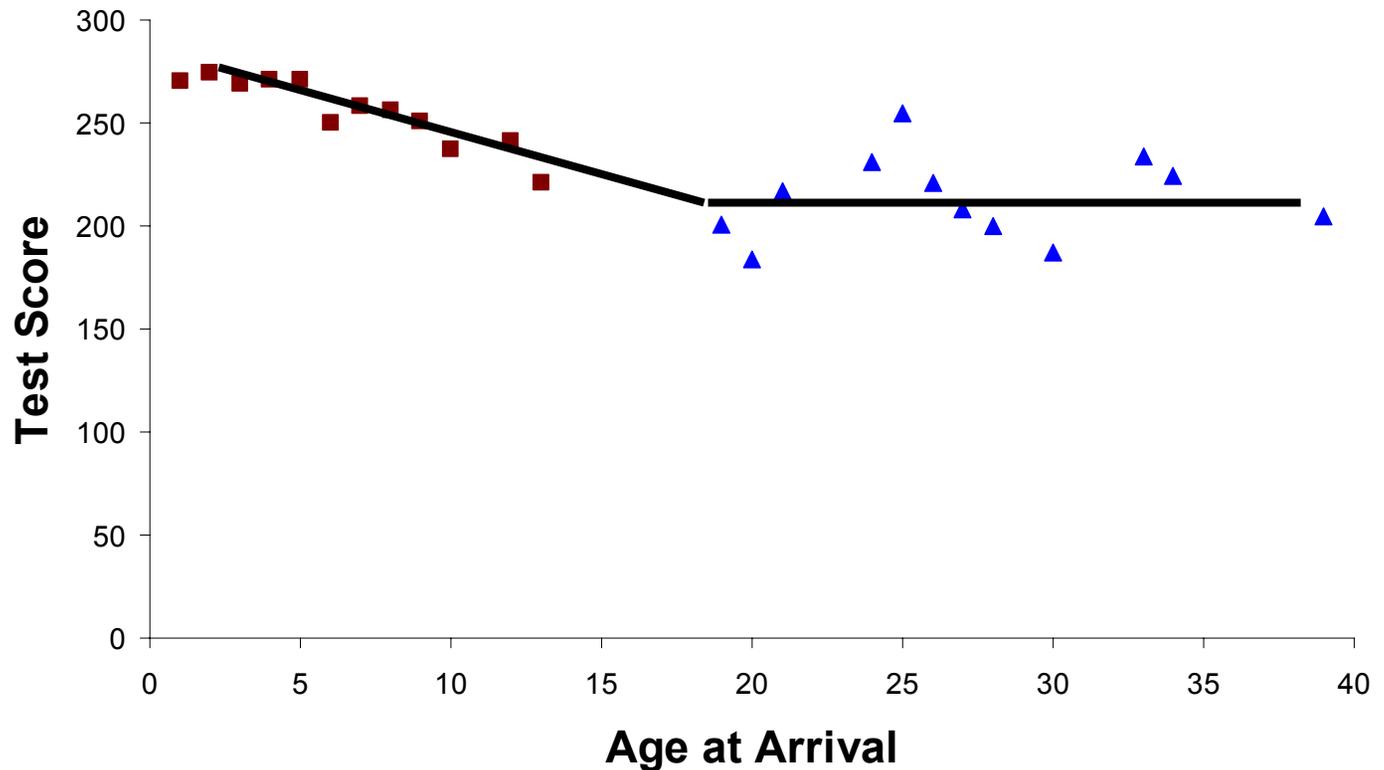


A Natural Experiment: Second Language Learning



A Natural Experiment: Second Language Learning

Grammar Score as Function of Age of Arrival (10 Yrs. Duration)

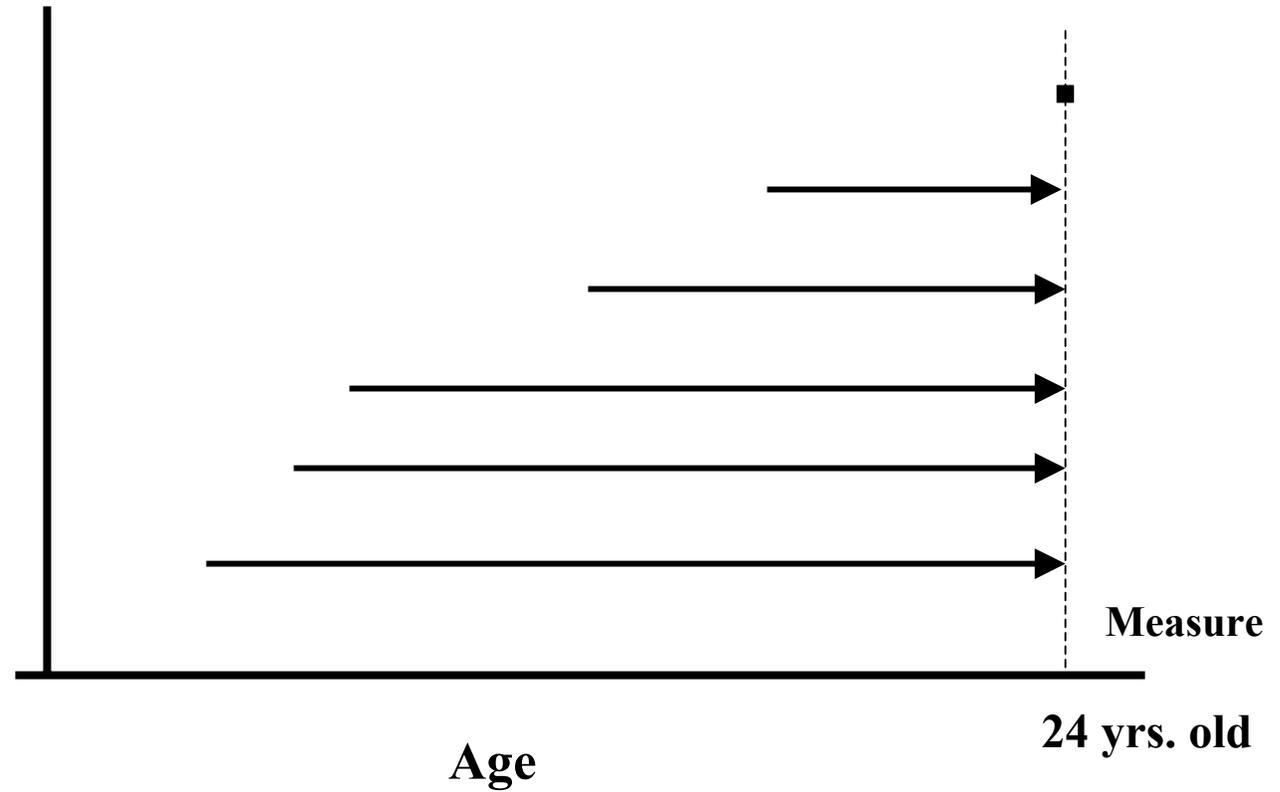


A Critical Period for Music?

In the brains of nine string players examined with magnetic resonance imaging, the amount of somatosensory cortex dedicated to the thumb and fifth finger of the left hand -- the fingering digits -- was significantly larger than in nonplayers. How long the players practiced each day did not affect the cortical map. But ... the younger the child when she took up an instrument, the more cortex she devoted to playing it.

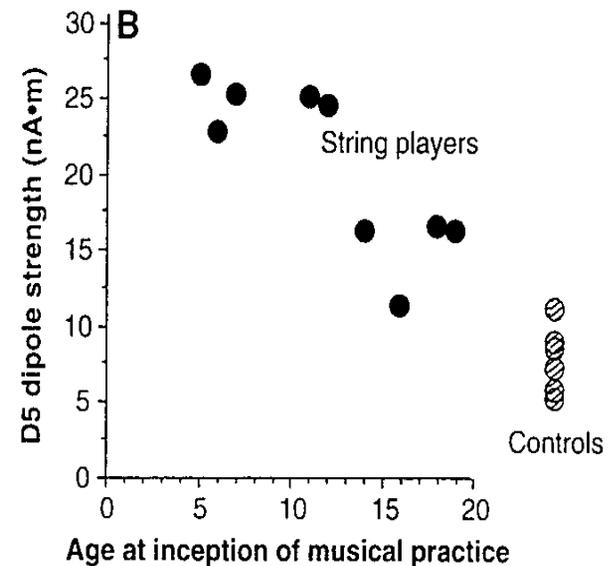
-- Newsweek, February 19, 1966

A Critical Period for Music?



Not on the Basis of That Study!

- Found correlation between age and size of response
- But, did not control for duration or practice effect
- Not a critical period study
- Rather adult brain plasticity



Ebert, et als. 1995

Early Childhood Intervention: Abecedarian Project

But they imply, too, that if you miss the window you're playing with a handicap. They offer an explanation of why the gains a toddler makes in Head Start are often so evanescent this intensive instruction begins too late to fundamentally rewire the brain.

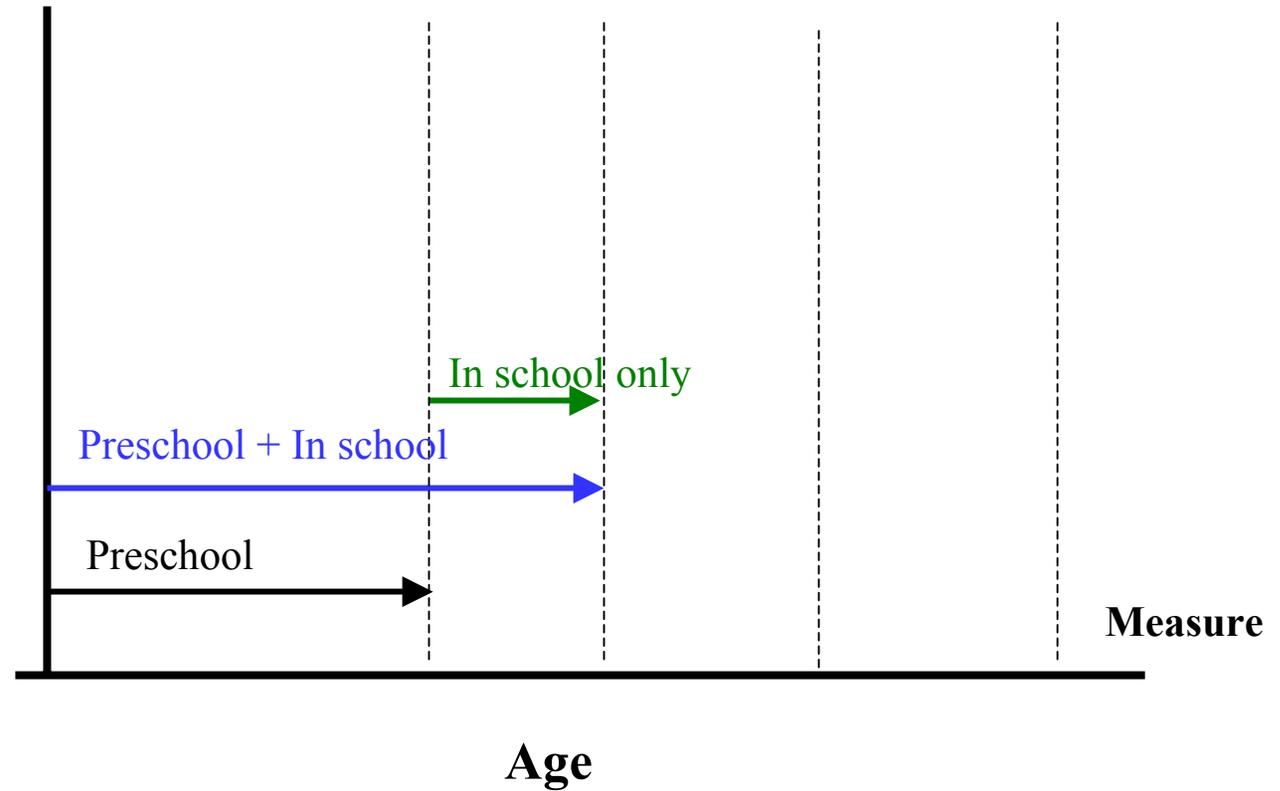
-- Newsweek, February 19, 1996

Early Childhood Interventions: Abecedarian Project

To date, there are no compelling data to support the notion of an absolute critical period such that educational intervention provided after a certain age can be beneficial; rather, this is a principle of relative timing effects.

Ramey & Ramey, 1998

Early Childhood Interventions: Abecedarian and IDHP Studies



Critical Periods: Science and the Young

It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast. It keeps him young.

-- Konrad Lorenz

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