Early Experiences and Brain Development

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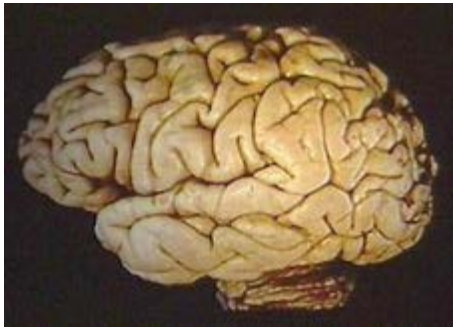
Brain Development
Post-Conception to the Third Decade of Life

27 weeks

Newborn

Adult



Stages of Brain Development

	Begins	Ends
Cell migration	4th prenatal week	6th prenatal month
Cell differentiation	4th prenatal week	1-2 years postnatally
Synaptogenesis	22 weeks gestation	Late adolescence
Myelination	3rd trimester	Middle adulthood

Prenatal and Early Postnatal

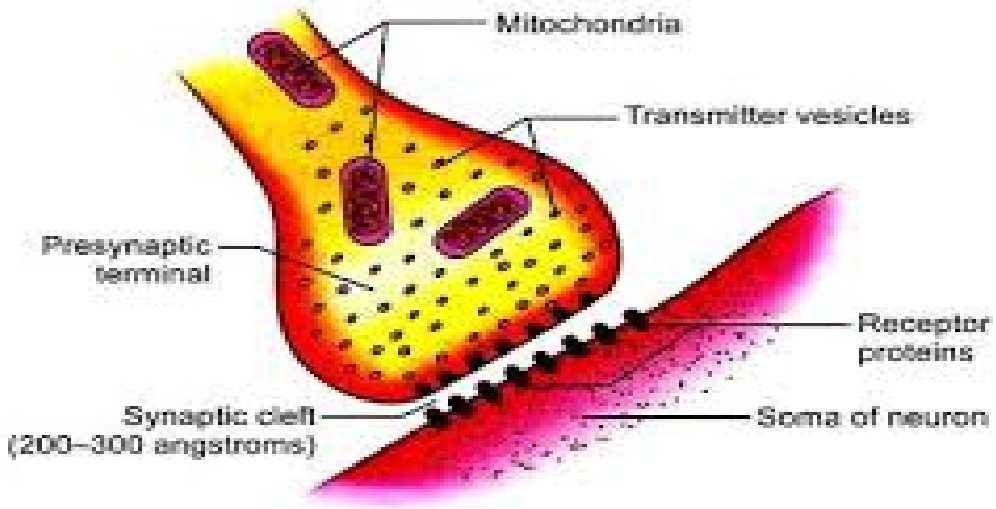


Fig. 9.5: Diagram of a typical chemical synapse

- Exuberant overproduction of
  - neurons
  - synapses
    - newborn has many more synapses than adult brain.
    - prune synapses to adult numbers over early years.
- Allows for maximum adaptability

How we become who we are: biological inheritance & individual experiences

- Genes specify properties of neurons and neural connections to different degrees in different pathways and at different levels of processing.

- Brain circuitry relies on experience to customize connections to serve the needs of the individual.
  - Experience shapes these neural connections and interactions but always within the constraints imposed by genetics.

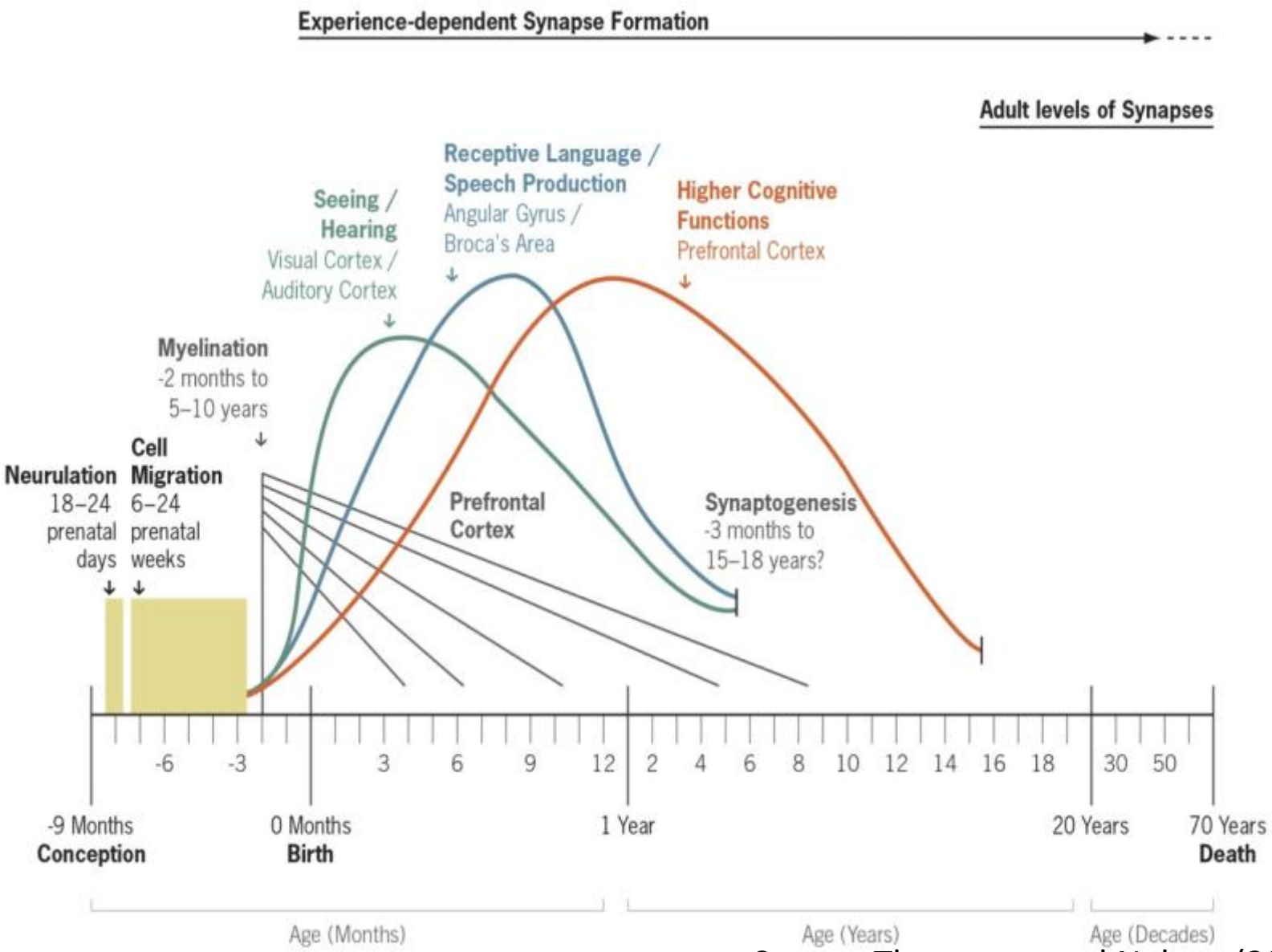
Basic Principles of Brain Architecture

- Basic information circuits wire first
- Higher circuits build on lower circuits, skills beget skills
- Foundation matters

What shapes brain development?

- Synapse creation and elimination shaped powerfully by experiences
- After repeated stimulation, synapse stabilizes; otherwise it tends to be eliminated (“use it or lose it” principle)
- Pruning/recruitment of synapses occurs in response to experience.

Synapse formation in different areas at different ages



Source: Thompson and Nelson (2001).

Contributions to Brain Development

- Genetic unfolding of blueprint
- Experience incorporated into the structure of the brain in two ways.
  - Experience expectant development
  - Experience dependent development

Experience expectant development

- Expected experiences
  - Patterned light information facilitates the development of
    - low-level visual abilities (e.g., depth perception)
    - high-level visual abilities (e.g., face perception).
  - Complex auditory information facilitates the development of speech and language processing.
  - Availability of a caregiver facilitates the development of attachments.

Experience dependent development

- Unique is to each person
- Active formation of new synaptic connections throughout the life span, based on individual's interaction with the environment.
  - Remembering events
  - Acquiring vocabulary
  - Quality of attachment

Survival of the Species…

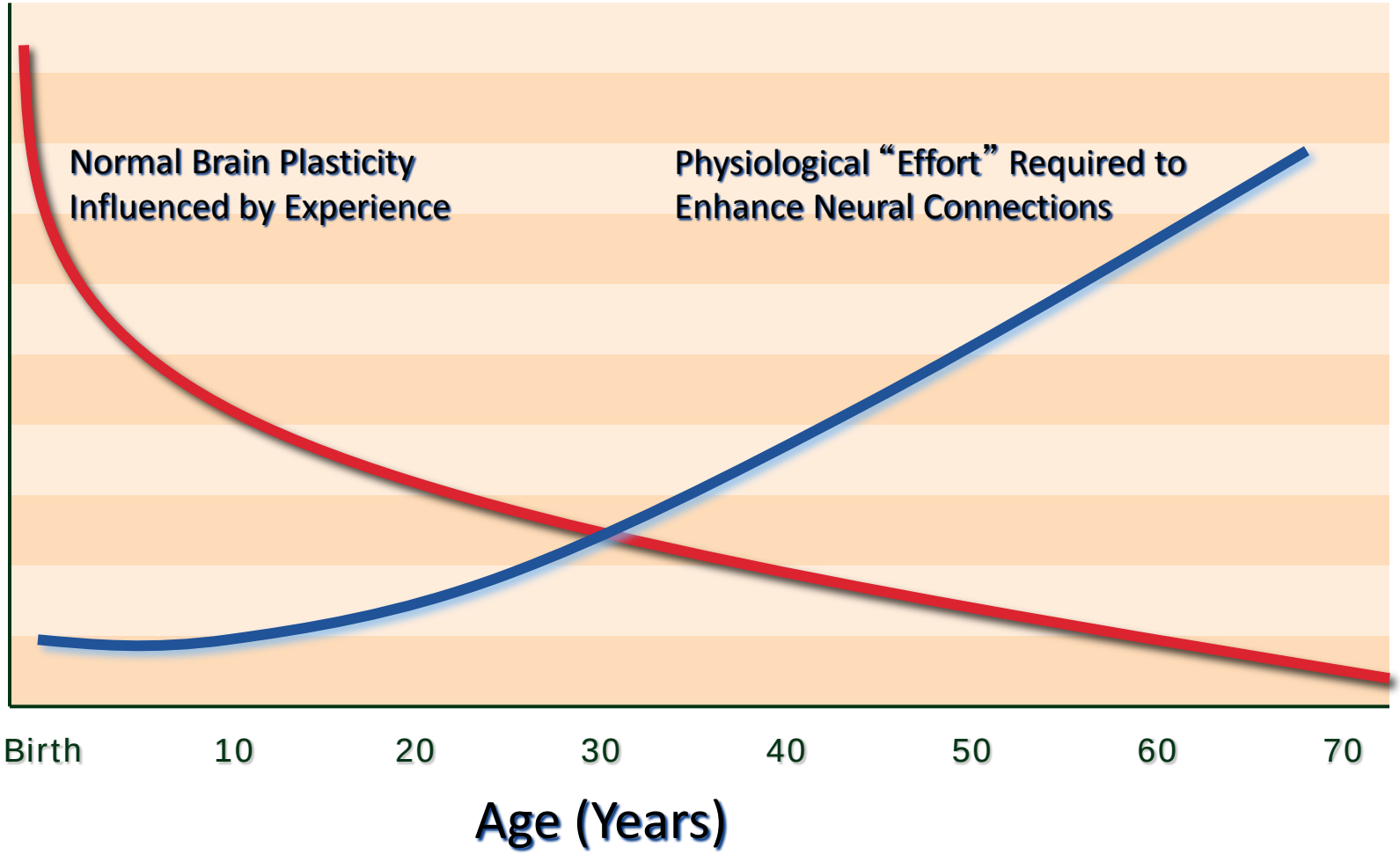
Genetics

Experience Expectant

Experience Dependent

plasticity

Plasticity and Restorative Processes



Source: Levitt (2009)

Summary of Experience and Brain Development

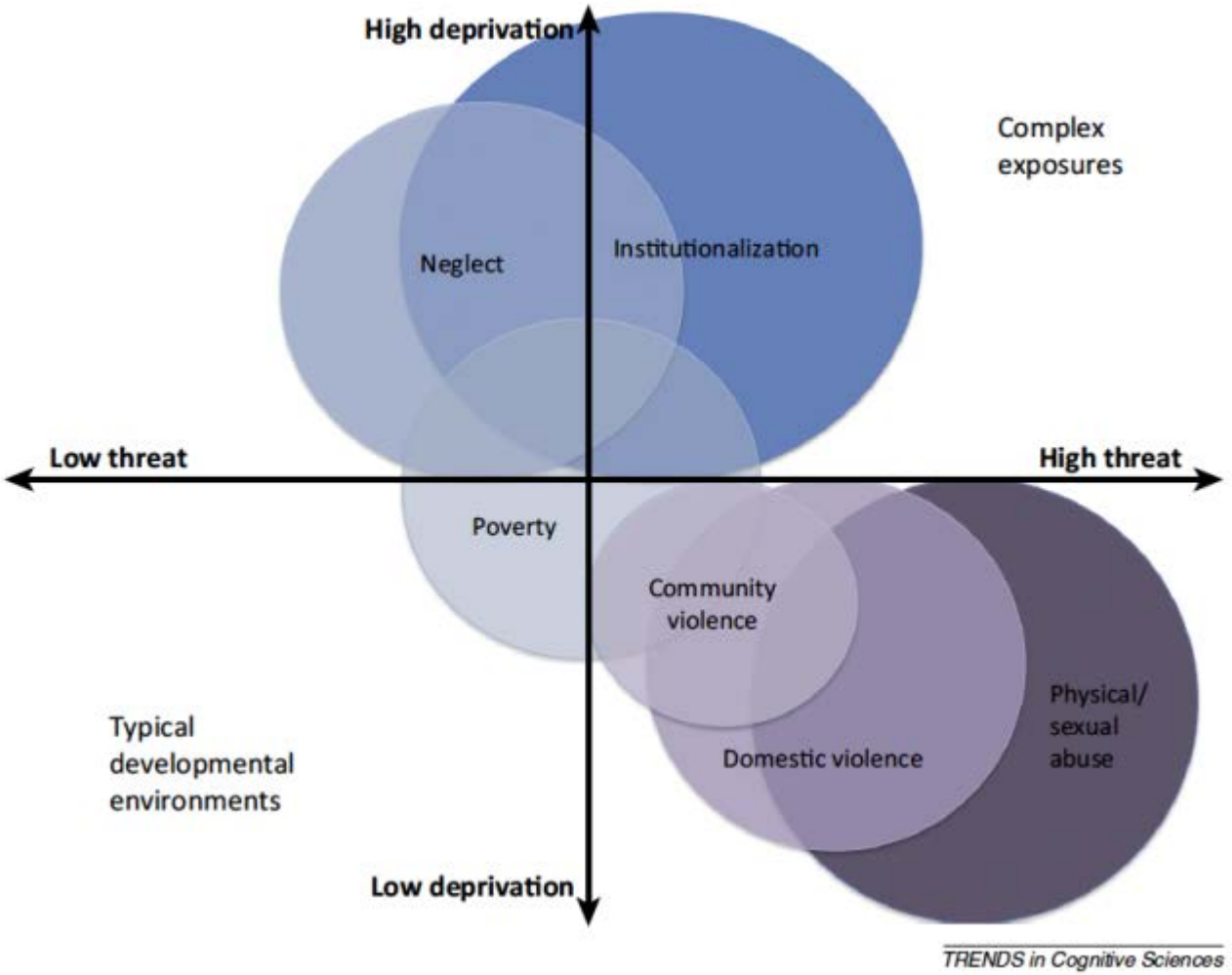
- Some circuits develop largely impervious to experience.
- For other circuits, the impact of experience on the brain is not constant throughout life—instead experience exerts an especially strong influence at certain times—sensitive periods.
- Finally, other circuits remain open to the effects of experience throughout the life cycle.
- Early experience often exerts a particularly strong influence in shaping the immature brain.

Absence of the Expectable Environment

Inadequate input (neglect, deprivation)

Excessive/unwanted input (threat/abuse/exposure to violence)

Humphreys & Zeanah, 2015



Sheridan & McLaughlin, 2015

Effects of adverse experience

Deviations from the expectable environment

Inadequate input

age-specific reductions in thickness and volume of association cortex
(overpruning of synaptic connections, lower numbers of synaptic connections reduced dendritic branching)

reduced performance on tasks that depend on these areas (e.g., complex cognitive tasks)

Harmful input

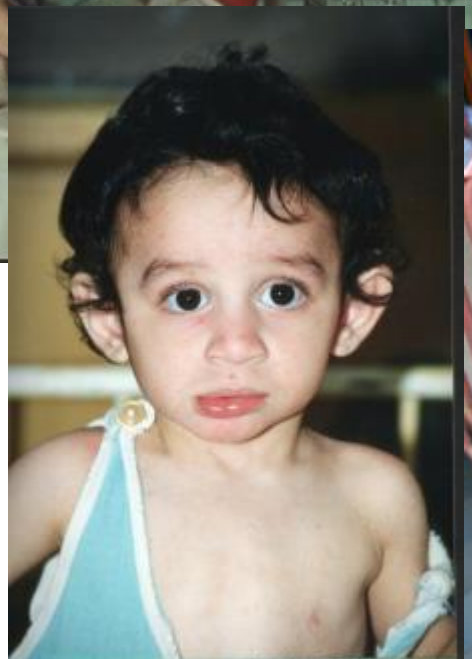
hippocampus
reduced dendritic spines and arborization
reduced functioning

amygdala
elevated activation to emotional stimuli
increased vigilance and attention to threat related cues

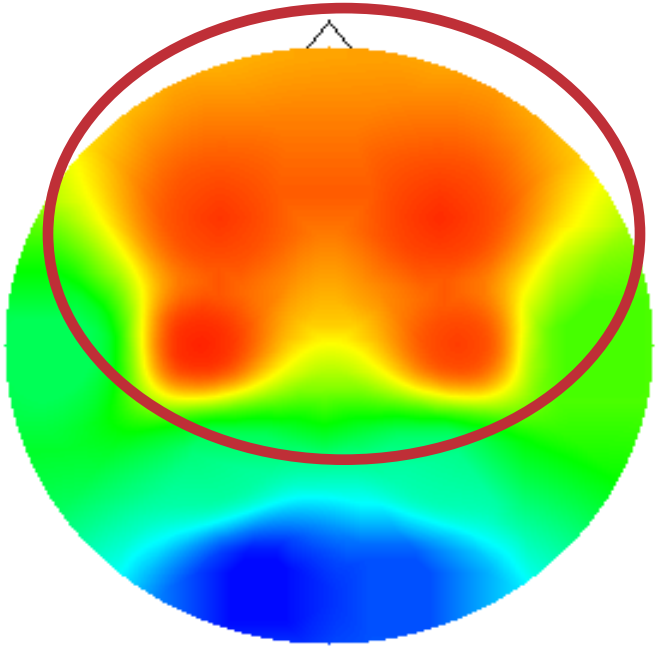
vmPFC
reduced vmPFC thickness
low vmPFC during emotion processing
reduced structural/functional connectivity with amygdala & hippocampus

Teicher & Sampson, 2016; McLaughlin & Sheridan, 2014

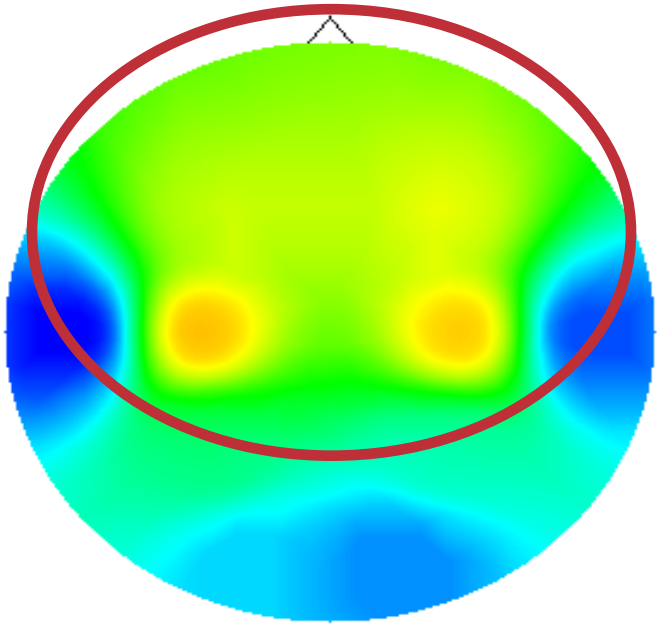
Deprivation/neglect leads to reduced needed input for normal brain development



Extreme Neglect Reduces Brain Power



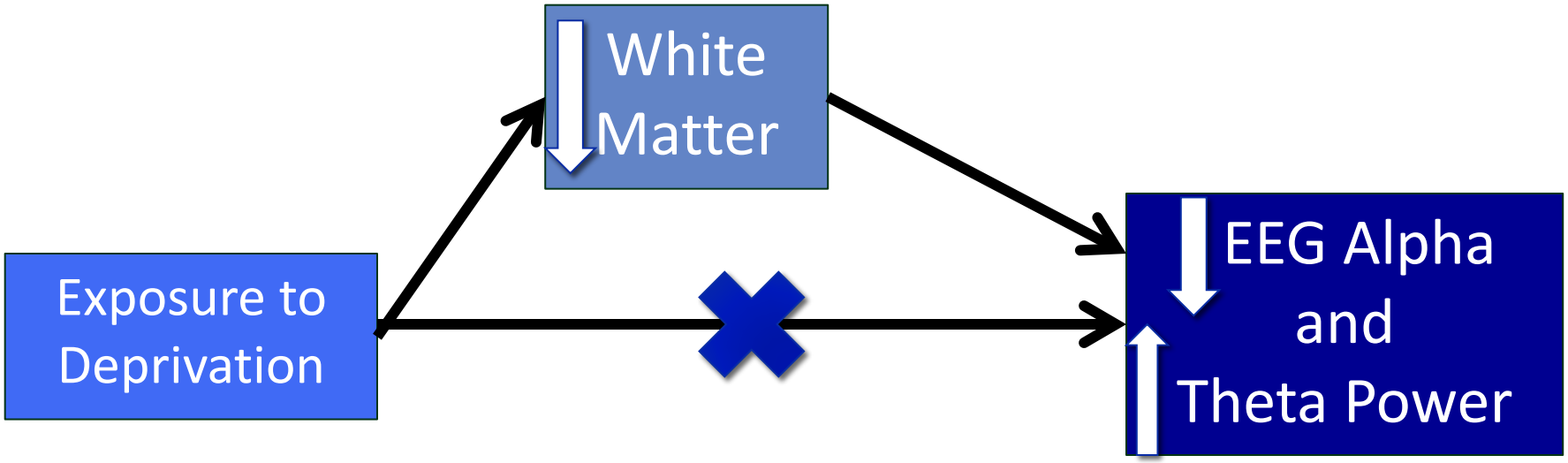
Raised in Families



Raised in Institutions

Marshall & Fox, 2004

Institutional rearing and EEG power are mediated by changes in white matter development



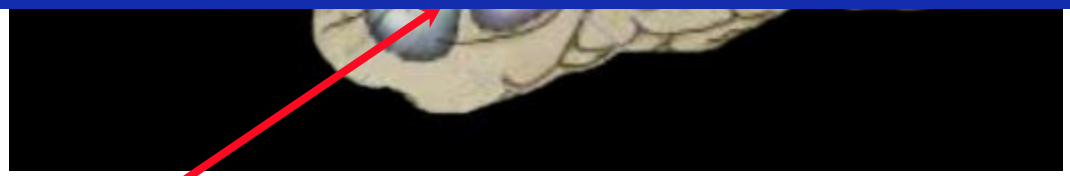
Sheridan et al., 2012

Threat/abuse/violence leads to excessive activation of fear circuitry and stress response systems compromising normal brain development

Prefrontal Cortex & Anterior Cingulate Gyrus

Attenuated ACC
Attenuated dorsolateral prefrontal cortex
Attenuated orbitofrontal cortex

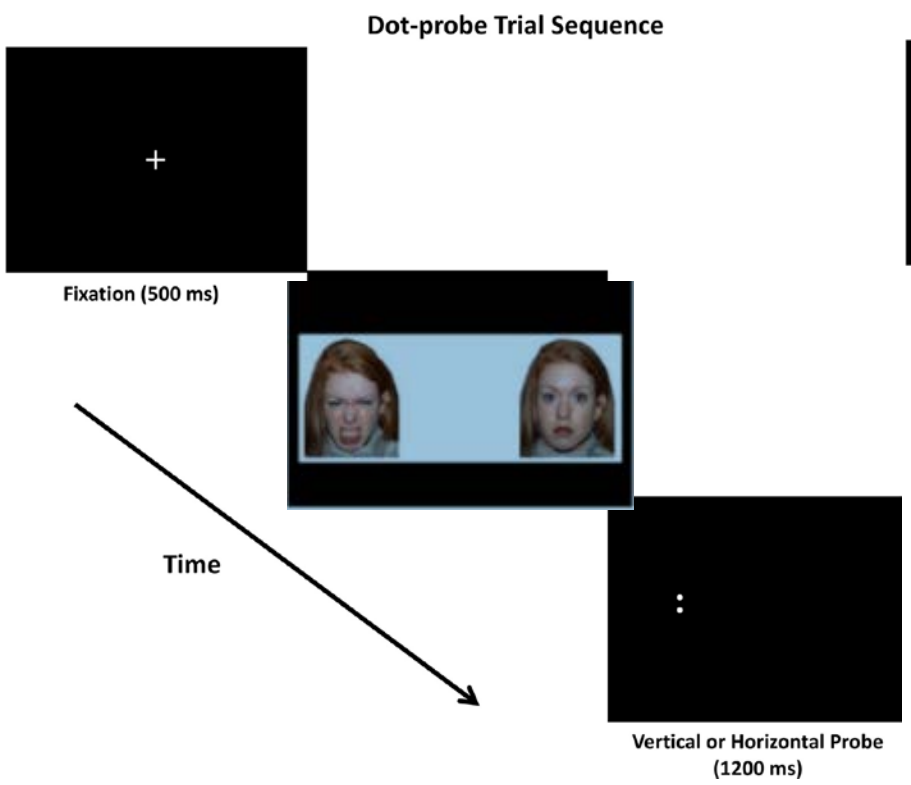
Brain regions and pathways involved in regulating response to threatening stimuli *overlap extensively* with regions found to differ structurally in maltreated Individuals: thalamus, visual cortex, anterior cingulate, cortex, ventromedial prefrontal cortex, amygdala and hippocampus.

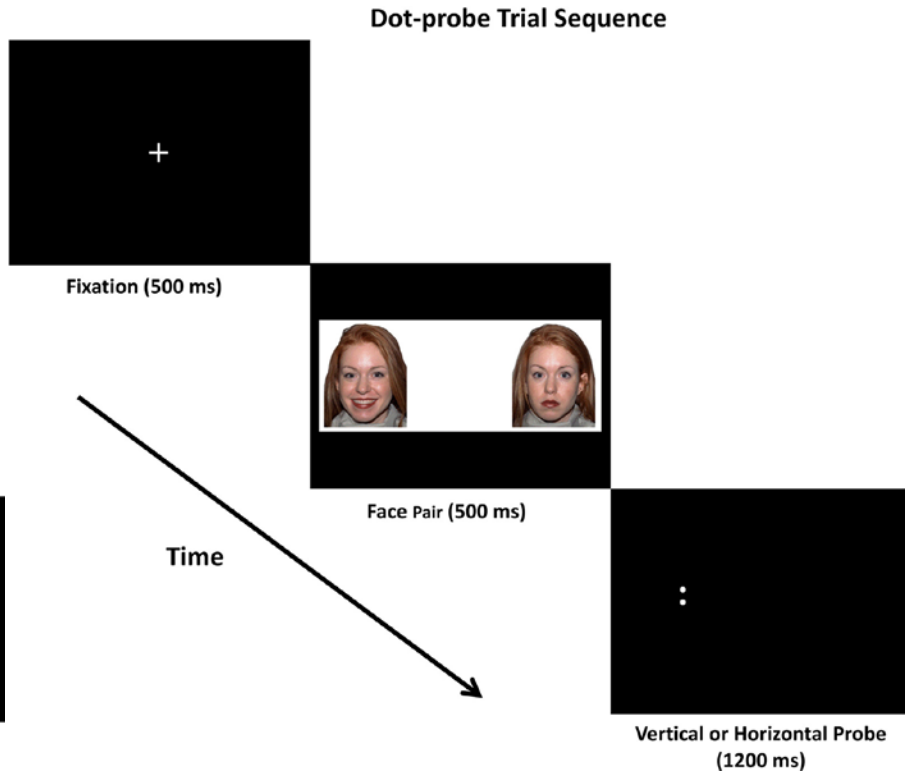


Amygdala

Increased volume in childhood
Decreased volume in adulthood

Attention bias following threat/abuse or neglect/deprivation





Attention bias *away* from threat (face) in severely abused children with PTSD

Pine et al., 2005

Reduced attention bias to happy in severely deprived young children.

Troller Renfree et al., 2017

Sensitive periods in brain and behavioral development

Brain is primed for input from the *expectable environment* at certain times.

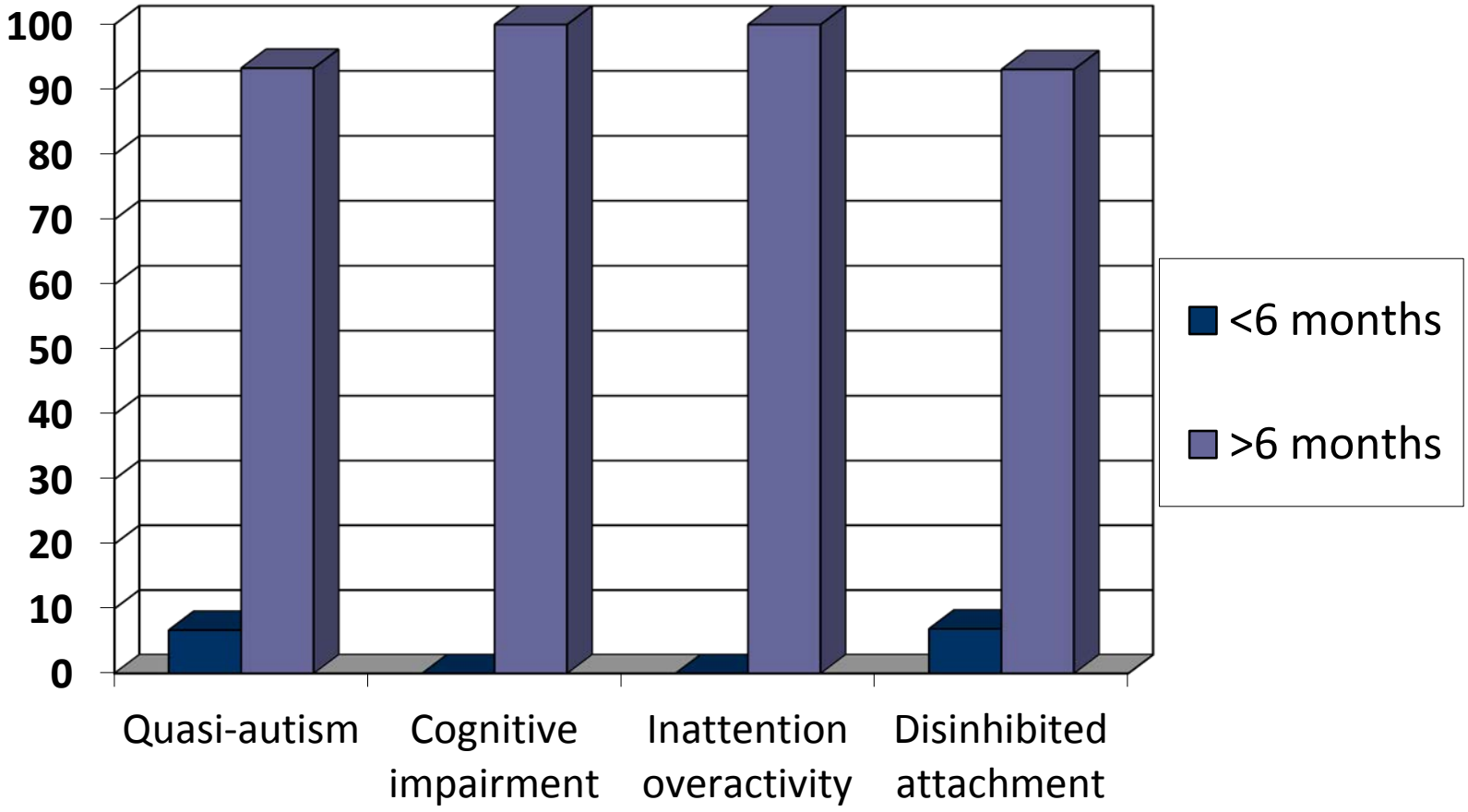
Sensitive period:

- When the effect of experience on the brain is particularly strong during a limited period in development.

Critical period:

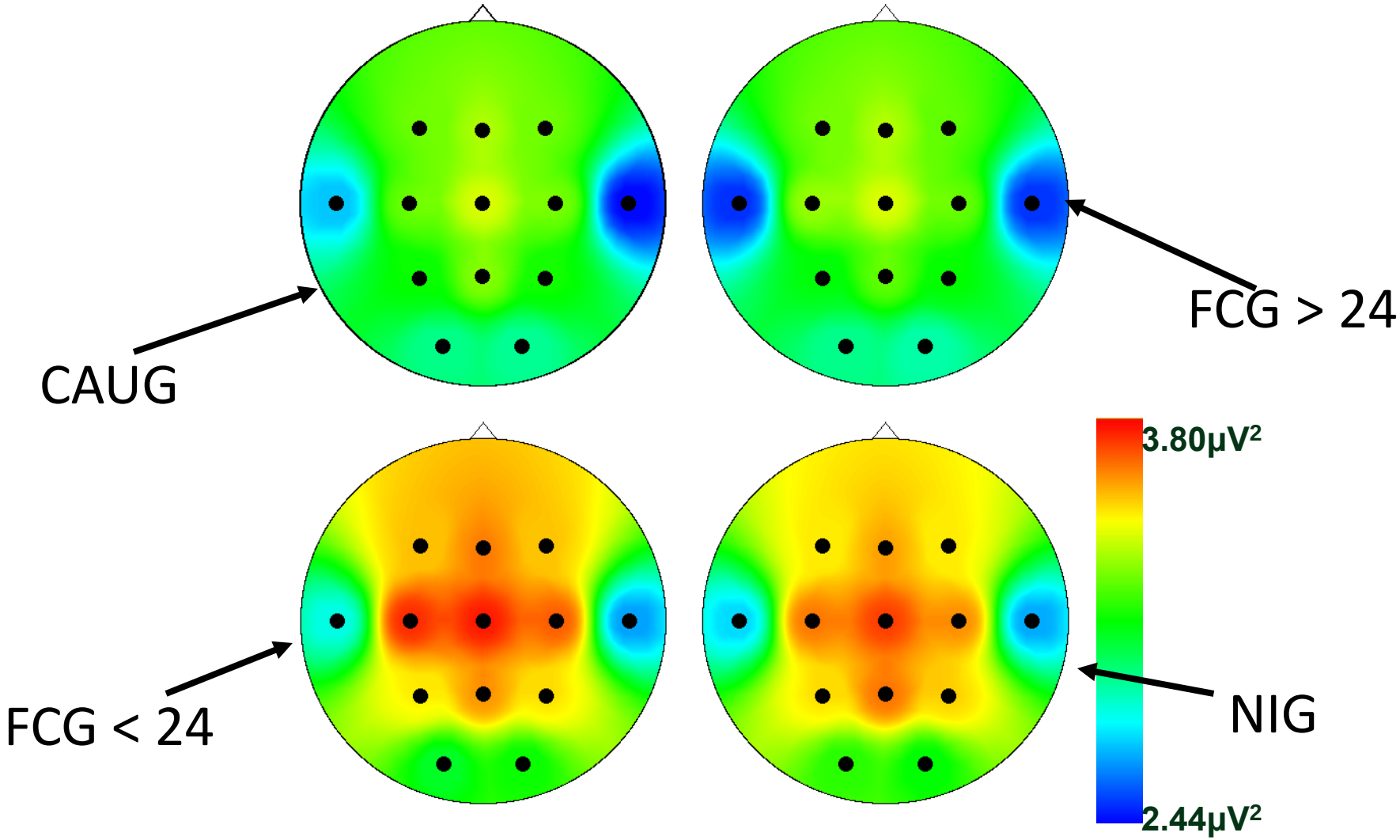
- A special class of sensitive periods that result in "irreversible" changes in brain function.

Persistence to age 15 years of deprivation specific patterns of impairment



Rutter et al., 2010

Distribution of alpha EEG power across the scalp by timing and group



Importance of child caregiver relationships

- Human infants *require* caregivers' *protection and support* to ensure survival for years after birth.
- Relationships with caregivers essential in helping children *regulate responses to stressors and adversity*.
- THE most important context for child development is child's *relationship(s) with primary caregiver(s)*.

What builds healthy brains?


Thankyou!
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