The Science Behind the Issue:

Adolescent Brain Development

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Agenda

• What we know about adolescent development, capacities, decision making, behavior, and treatment needs and amenability

• The Neuroscience of Adolescence

• The Application of Neuroscience to Rehabilitation, Intervention and the Justice System
What do we know about Brain Development?
Brain Development

Time-Lapse Brain

Gray matter wanes as the brain matures. Here 15 years of brain development are compressed into five images, showing a shift from red (least mature) to blue.

- Age 5
- Age 12
- Age 20
- Age 8
- Age 16

PERCENTAGE OF GRAY MATTER

50% — 40% — 30% — 20% — 10% — 0%

NEXT: Launch Flash Movie
Brain Development

Child Brain Development

GOOD NUTRITION LEADS TO MORE STABLE Moods. INCREASES IN ABILITY TO PAY ATTENTION, AND IMPROVED MEMORY.

LOVING AND CONSISTENT CARE-GIVING LEADS TO A BRAIN THAT HAS AN ABILITY TO LEARN TO DELAY GRATIFICATION, PROBLEM SOLVE, AND HAVE EMPATHY FOR OTHERS.

Brain
- At birth, the brain has 300 billion brain cells (called neurons).
- The brain grows 1.7 grams a day during baby’s first year.

Nutrition
- 60% of an infant’s energy intake from food is used for brain growth.
- Babies need loving interaction, touch, and parents that are tuned into their needs, as much as they need nutrition.
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Social/Emotional
- By age one, infants typically understand about 70 words, but speak only a handful of them.
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0-1 years
- Babies need loving interaction, touch, and parents that are tuned into their needs, as much as they need nutrition.

1-2 years
- Communication across different regions of the developing brain occurs most rapidly during the first two years of life.
- By age two, the brain reaches about 75% of adult weight.
- DHA, an omega-3 fatty acid and cholesterol, are critical building blocks for the developing brain.

2+ years
- Calcium and vitamin D, which promotes calcium absorption, help strengthen bones and teeth.
- By two years most toddlers have a 300-word vocabulary and are putting together simple two-word sentences.
- Toddlers imitate behavior of others, especially adults and older children.

At this age, toddlers become increasingly independent and interested in new things.

At 18 months, a toddler’s spoken vocabulary starts to expand; they add one new word every two waking hours.
BRAIN DEVELOPMENT

ADOLESCENCE (12 – 19 YEARS)

Brain undergoes structural changes

Age 12 - Parietal Lobe mature

- **Corpus callosum**
  - nerve fibers connect the brain’s left and right hemispheres
  - thickens, improves adolescents’ ability to process information

- **Amygdala** - matures earlier than the prefrontal cortex

- **Synapses** – at adult density

18 – 25 years: Frontal Lobe/ Prefrontal cortex matures
Because of structural and chemical changes in the brain, we know that adolescence extends to young adulthood.

Adolescents do not process information as efficiently as adults.

Older adolescents may be as capable as adults of making decisions in some contexts.
Adolescents are more sensitive to emotion and social evaluation.

Adolescents’ capacities to weigh risks and long-term consequences are relatively impaired.
Adolescents have different needs than children or adults

- Sleep
- Physical activity
- Exposure to range of activities & risks
- Active teaching of thinking
Because of physical and chemical changes in the brain, we know that....

Adolescents are particularly susceptible to the environment

Adolescence is a time of increased vulnerability and opportunity
The Science of Adolescent Brain Development
Brain Structures
Frontal Lobe

- Frontal Lobe: Thinking, Planning
- Parietal Lobe: Perception
- Temporal Lobe: Memory, Language
- Occipital Lobe: Vision
The Neuron: Transmitter of Information

Structure of a Typical Neuron
WHAT IS WHITE MATTER?

White matter fills nearly half the brain. It consists of millions of cables (white) that connect individual neurons (gray matter) in different brain regions, like trunk lines connecting telephones across a country.

Corpus callosum, a mass of white matter cables, connects the brain's left and right hemispheres. On either side, the cables extend up and outward toward the cortex, creating a structure called the cingulum. A new form of imaging, DTI tractography, can chart the actual cable pathways.

Each cable leads from a neuron in one region to a neuron elsewhere. A cable is an axon insulated with milky-white myelin.
Changes in the Brain

- White matter increases (linear) during myelination.
- Gray matter increases and then begins to decrease as pruning occurs.
Synaptic Pruning

The first change after this synaptic growth spurt is a selective pruning which takes place. In adolescence, most of this pruning is taking place in the frontal lobes. The adolescent loses approximately 3 percent of the gray matter in the frontal lobes.

at a child's birth  at 7 years of age  at 15 years of age
Adolescent Brain Development

- Changes in gray and white matter

- Location and direction of change

Ken Winters, Ph.D. University of Minnesota
http://pruegill.wordpress.com/
Cognitive Skill Development Improvements in

- Information processing speed, memory
- Planning, reasoning about hypothetical situations, reflection, introspection
- “Executive functioning” – regulation of lower processes, inhibition, planning, goal-setting

[Diagram showing the process of cognitive skill development with categories such as higher thinking, automatic processing, attention, processing speed, decision, and knowledge bank.]
The Amygdala
and connections to other regions

Processing Emotions
and signals of emotion

Planning Defensive responses
Neurotransmitters
Dopamine

During adolescence there is an increase in the activity of the neural circuits using dopamine, a neurotransmitter central in creating our drive for reward.
Dopamine

Enhanced dopamine release/reactivity causes....

- Thrill seeking behavior
- Selective focus on rewards rather than risks
- Increased susceptibility to alcohol/substance abuse

Research even suggests that the baseline level of dopamine is lower—but its release in response to experience is higher—which can explain why teens may report a feeling of being “bored” unless they are engaging in some stimulating and novel activities.
Effect of Adolescent Brain Development on Behavior

Ineffective levels of neurotransmitters

Moody, less attentive, ineffective problem solving, & more risky behaviors

Less reliance on frontal lobes in decision making

Impulsivity, “gut” reactions; problems ignoring distractions

Less efficient connections, such as those to and from memory centers of the brain

Less reliance on experience and memory in decision making
Implications for Intervention
Implications

Intervention

Increasing family, social, and community support can minimize psychosocial stress during adolescents.

Adolescents learn better when responding to rewards rather than through punishment (or removal of rewards).

Adolescents benefit from treatment and skills-development, both behaviorally and through structural changes in the brain.
Summary

Cognitive Functioning

- Decision Making, Problem Solving
- Reasoning Ability
- Planning
- Weighing Consequences

Emotional Functioning

Behavioral Impulsivity and Risk Taking

Increased Vulnerability and Unique Needs

Treatment Amenability
Summary of Findings and Implications

In some situations, adolescents make decisions as well as adults.

Adolescents are less efficient in processing information pertaining to social cognition.

Adolescents are more sensitive to the effects of emotion and social evaluation.

Adolescents’ emphasis on short-term rewards increases their involvement in risk-taking behaviors.

Adolescence is a critical time, both for protection and for intervening and developing life skills.
Resources & References

National Institute of Mental Health: The Teen Brain: Still Under Construction


