The Science Behind the Issue:

Adolescent Brain Development

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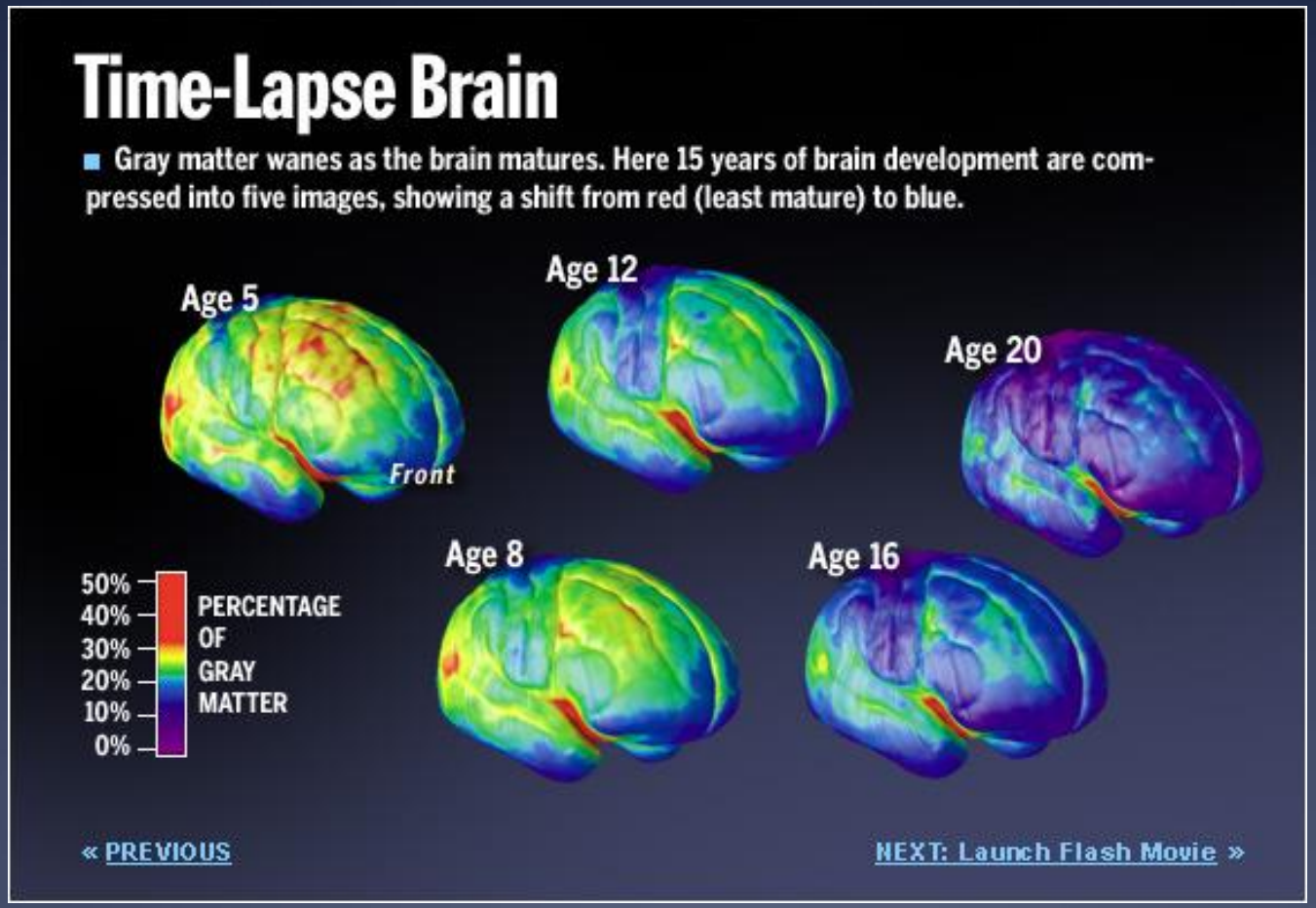
Agenda

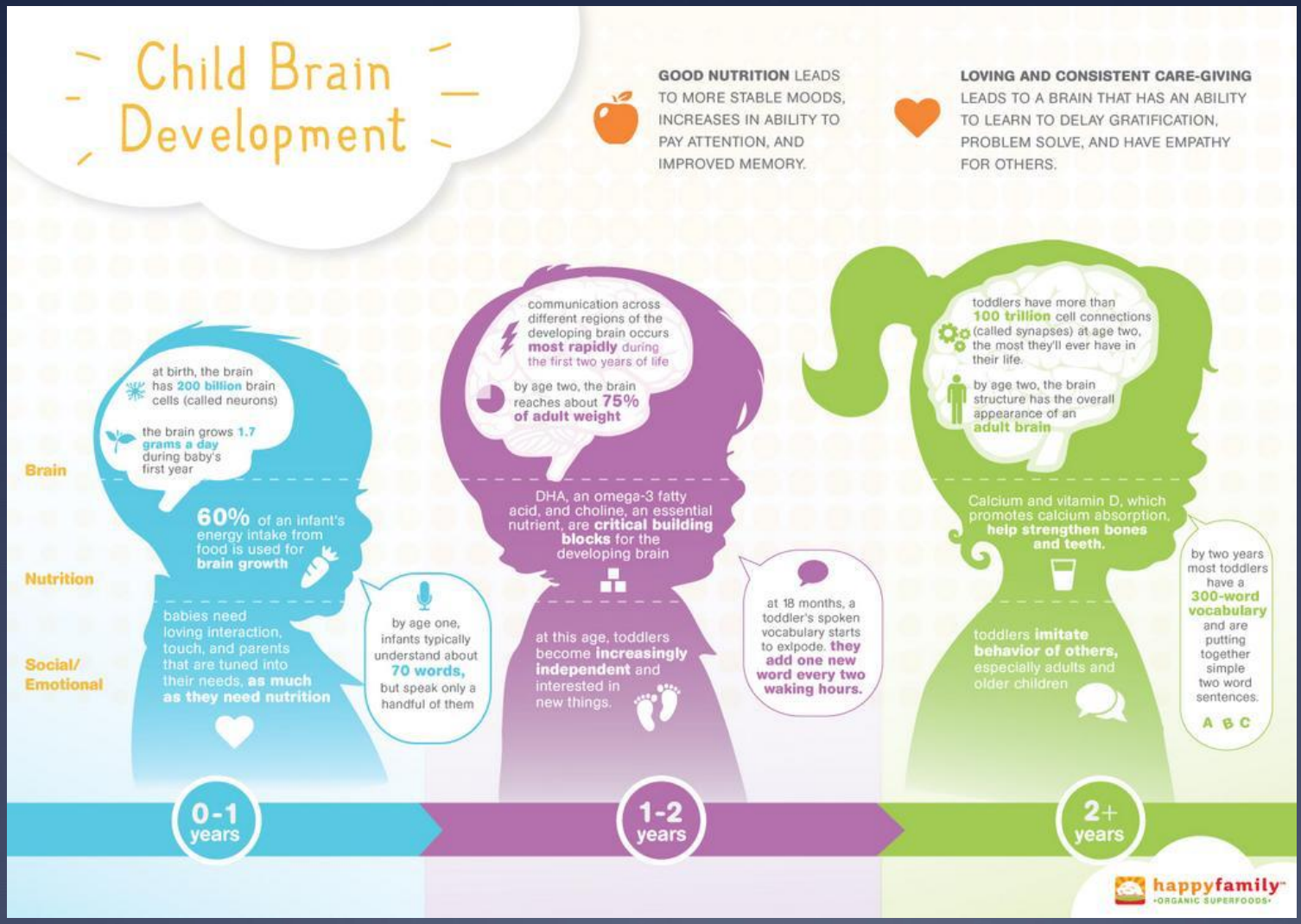
- What we know about adolescent development, capacities, decision making, behavior, and treatment needs and amenability
- The Neuroscience of Adolescence
- The Application of Neuroscience to Rehabilitation, Intervention and the Justice System

What do we know about Brain Development?

Brain Development

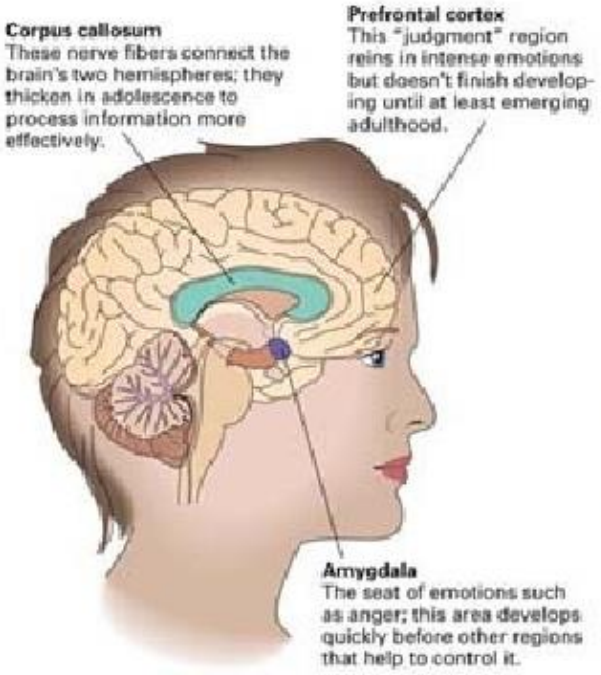


Brain Development



Brain Development

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

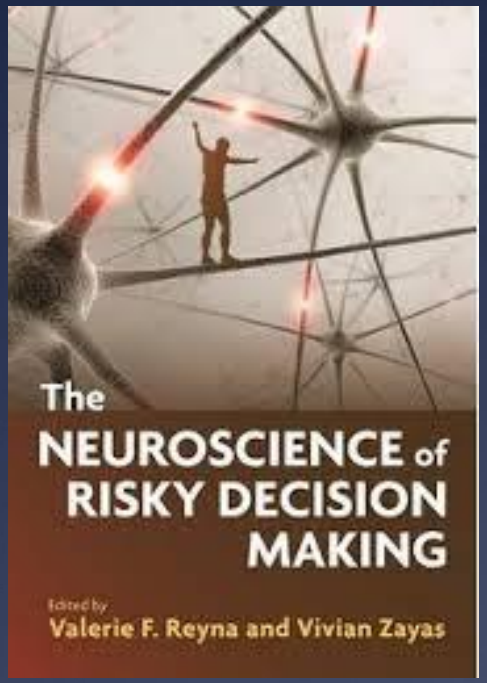
18 – 25 years: Frontal Lobe/ Prefrontal cortex matures

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

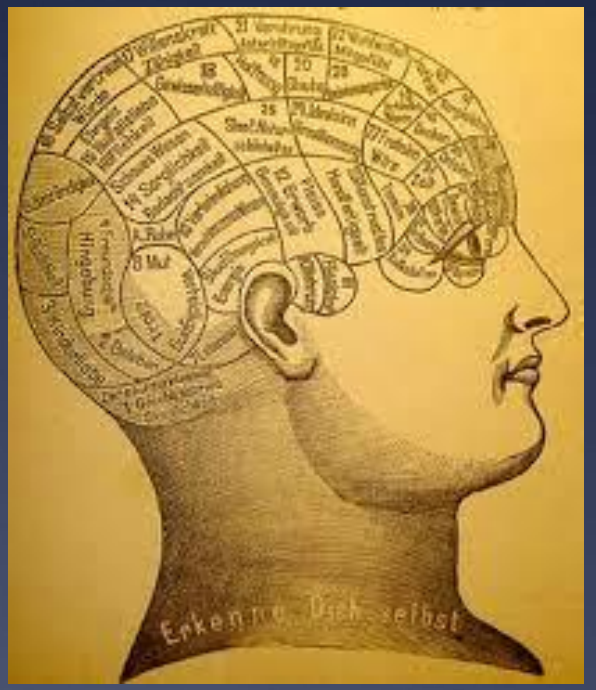
Because of physical and chemical changes in the brain, we know that….

Adolescents are particularly susceptible to the environment

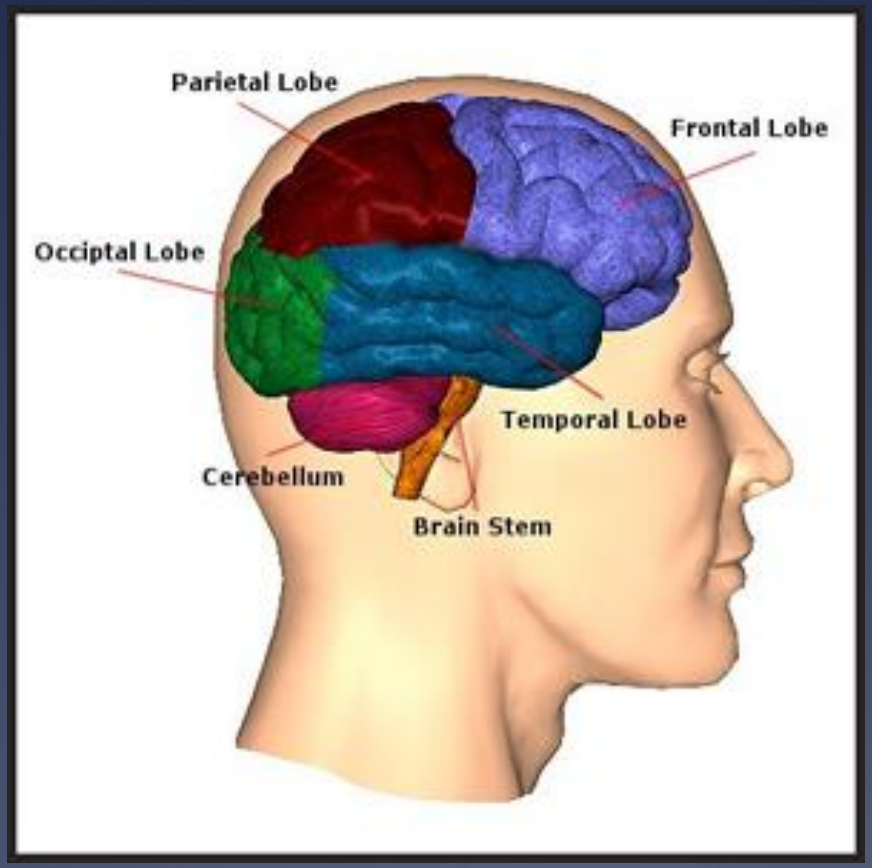
Adolescence is a time of increased vulnerability and opportunity

The Science of

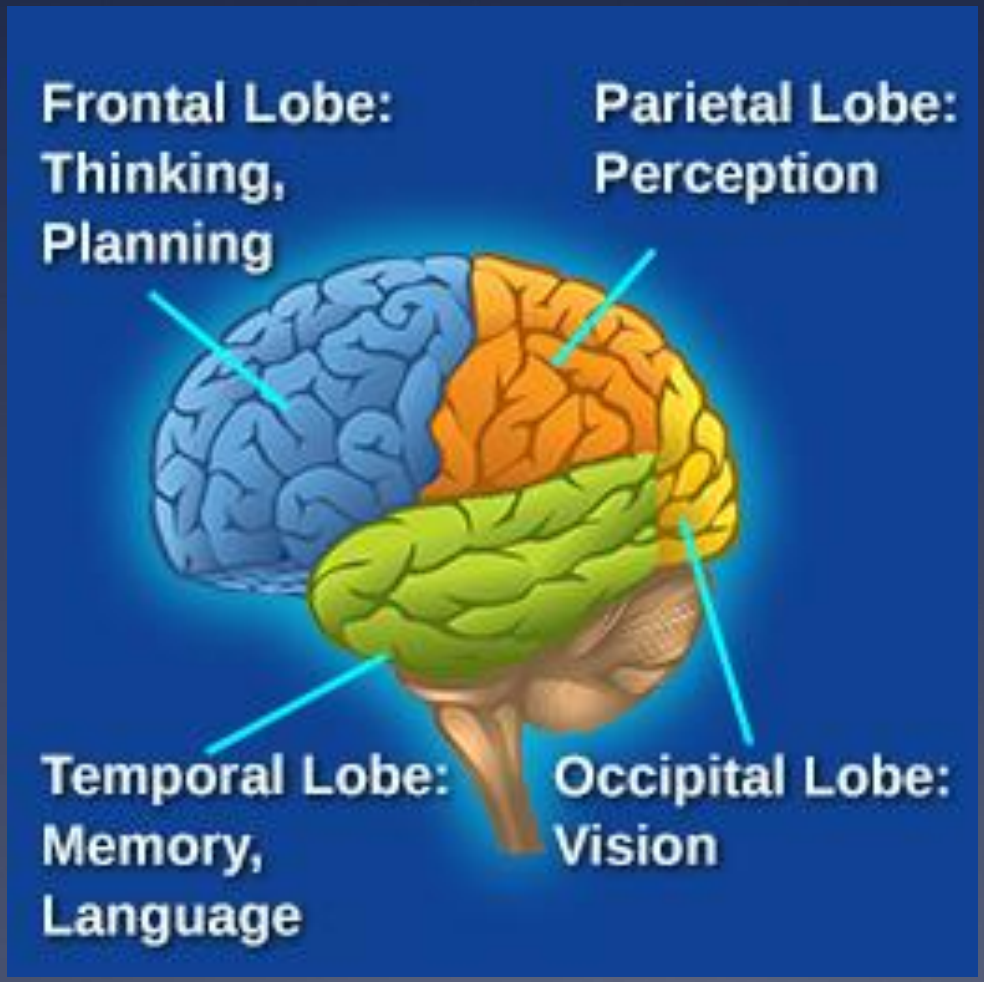
Adolescent Brain Development



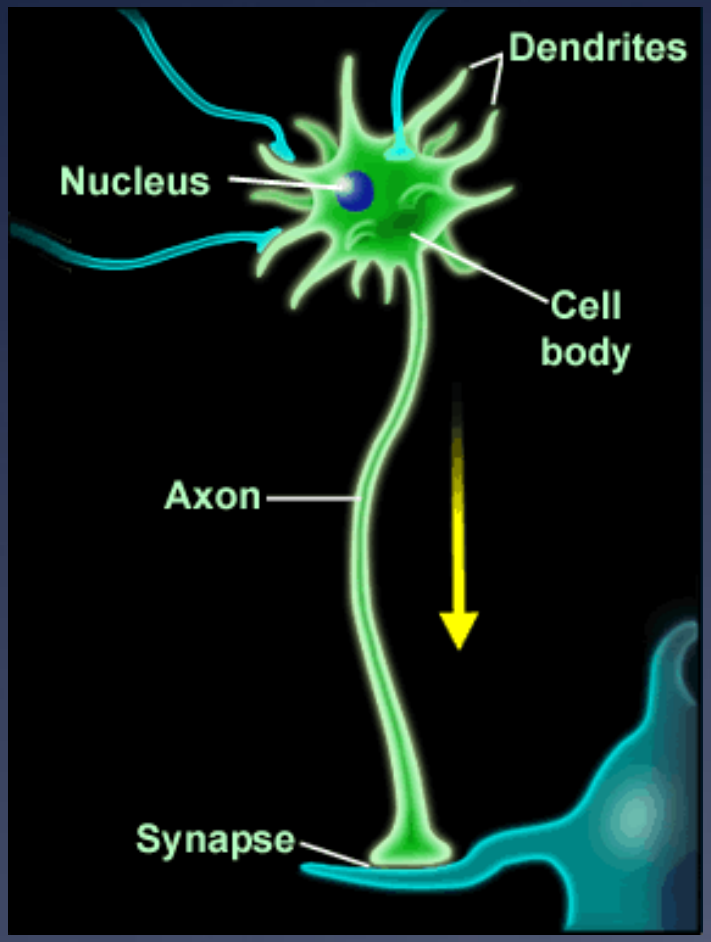
Brain Structures

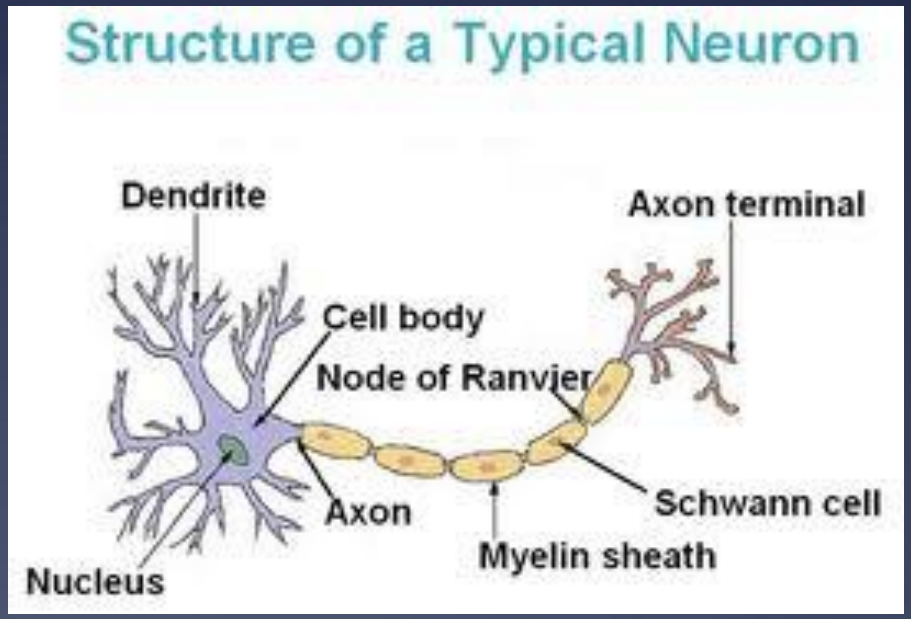


Frontal Lobe



The Neuron: Transmitter of Information

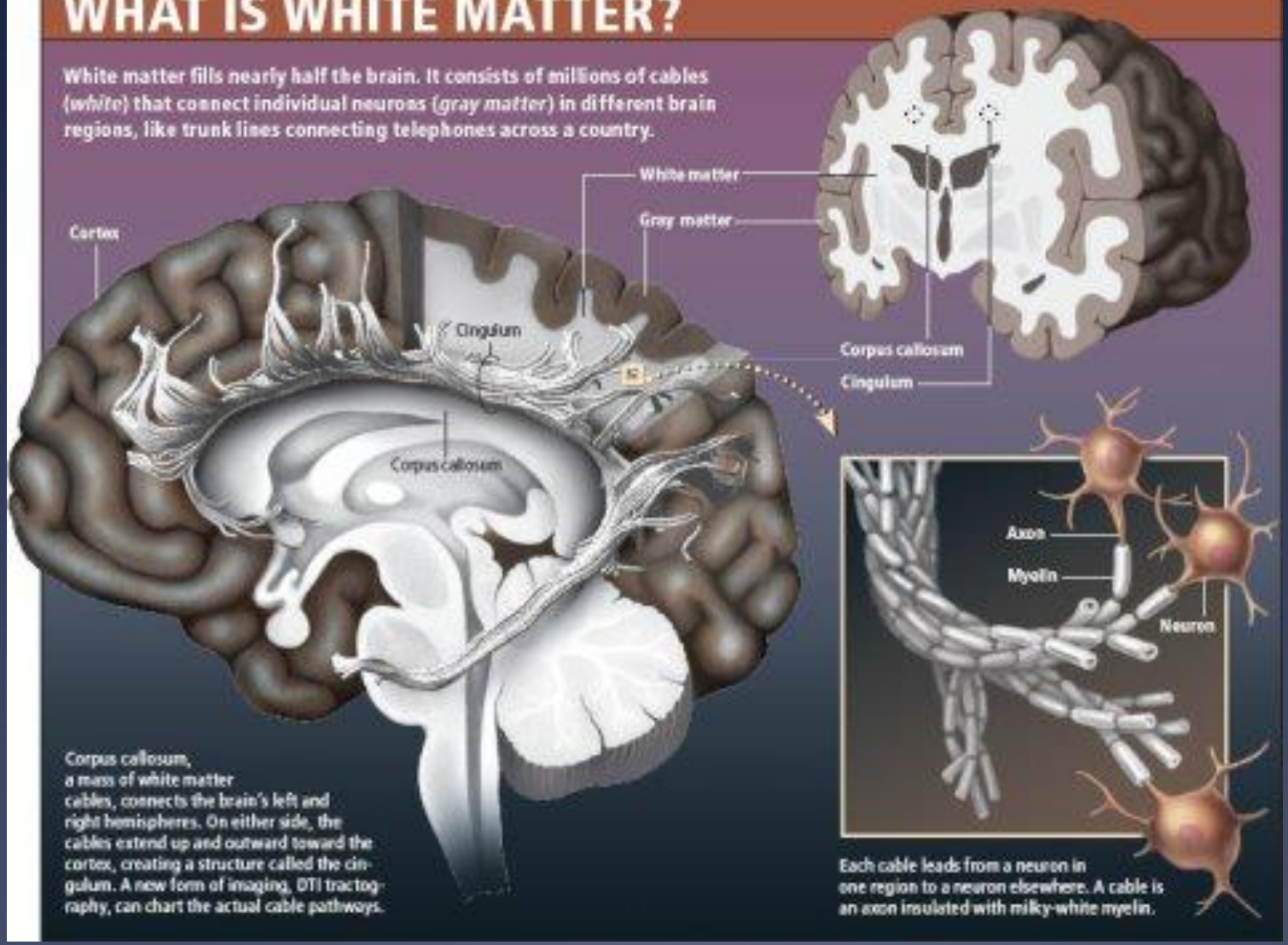




[BASICS]

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.

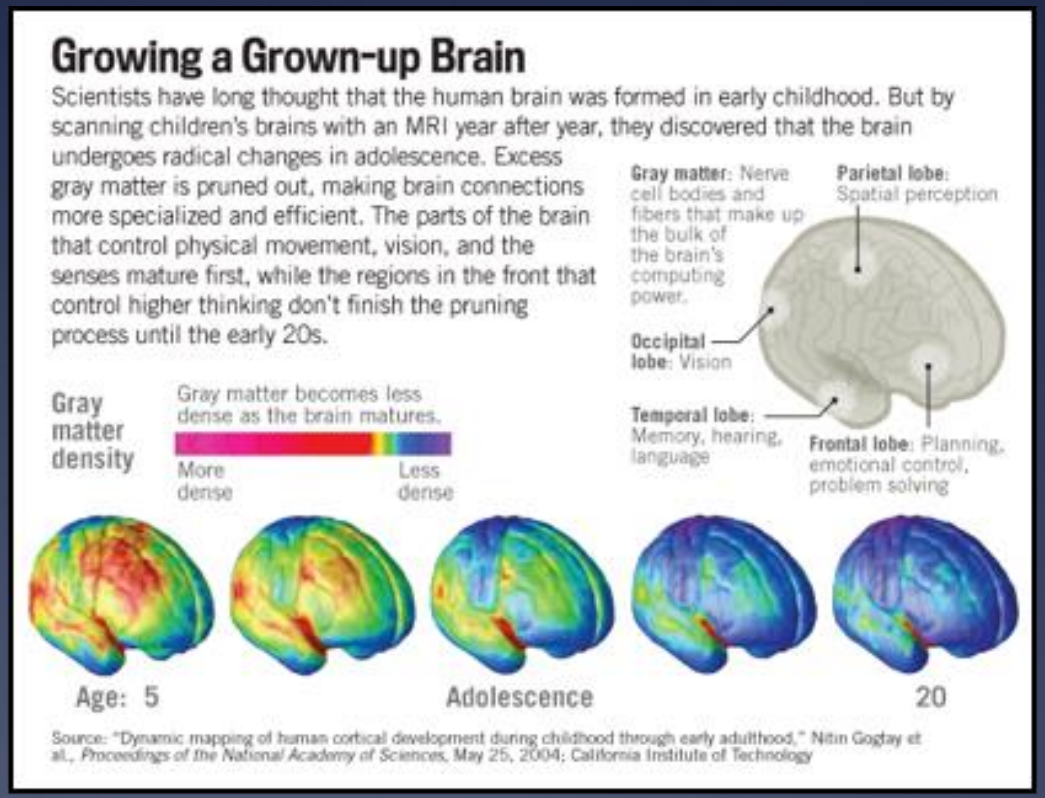


Corpus callosum, a mass of white matter cables, connects the brain's left and right hemispheres. On either side, the cables extend up and outward toward the cortex, creating a structure called the cingulum. A new form of imaging, DTI tractography, can chart the actual cable pathways.

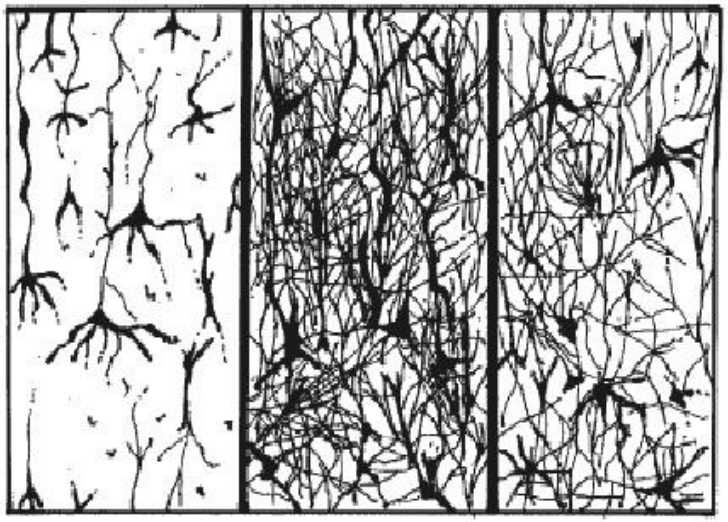
Each cable leads from a neuron in one region to a neuron elsewhere. A cable is an axon insulated with milky-white myelin.

Changes in the Brain

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



Synaptic Pruning



at a child's birth | at 7 years of age | at 15 years of age

The first change after this synaptic growth spurt is a selective pruning which takes place.

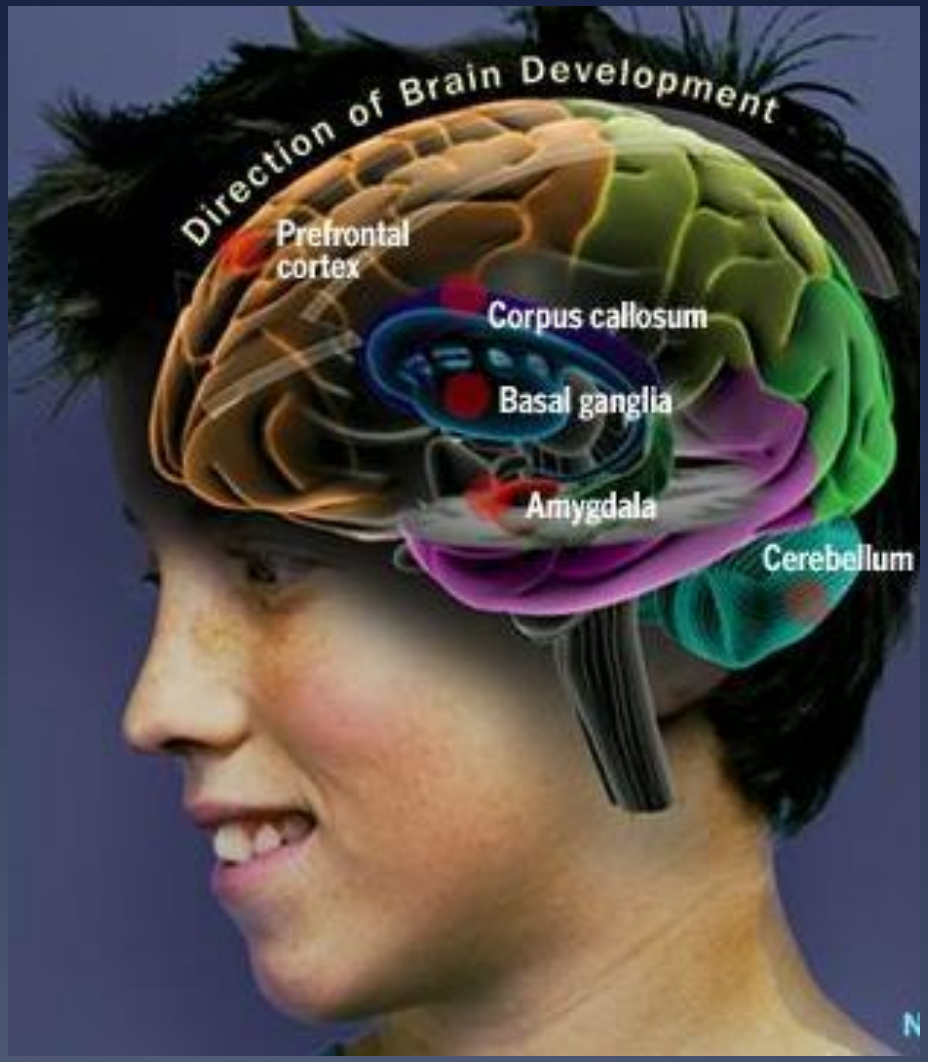
In adolescence, most of this pruning is taking place in the frontal lobes.

The adolescent loses approximately 3 percent of the gray matter in the frontal lobes.

Adolescent Brain Development

- Changes in gray and white matter

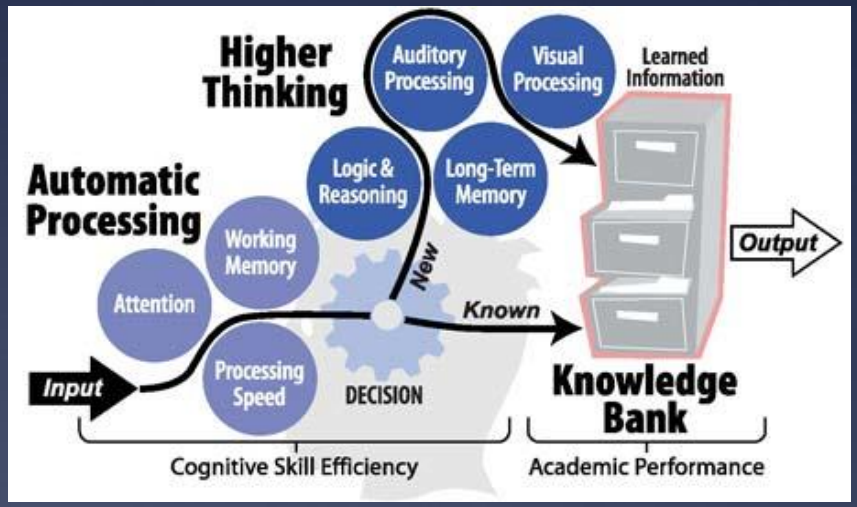
- Location and direction of change



Ken Winters, Ph.D. University of Minnesota
http://pruegill.wordpress.com/

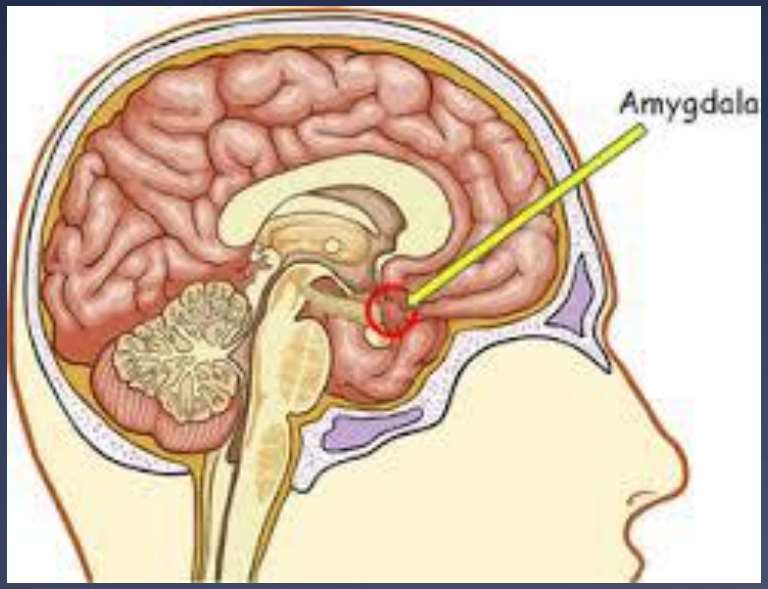
Cognitive Skill Development Improvements in

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



The Amygdala

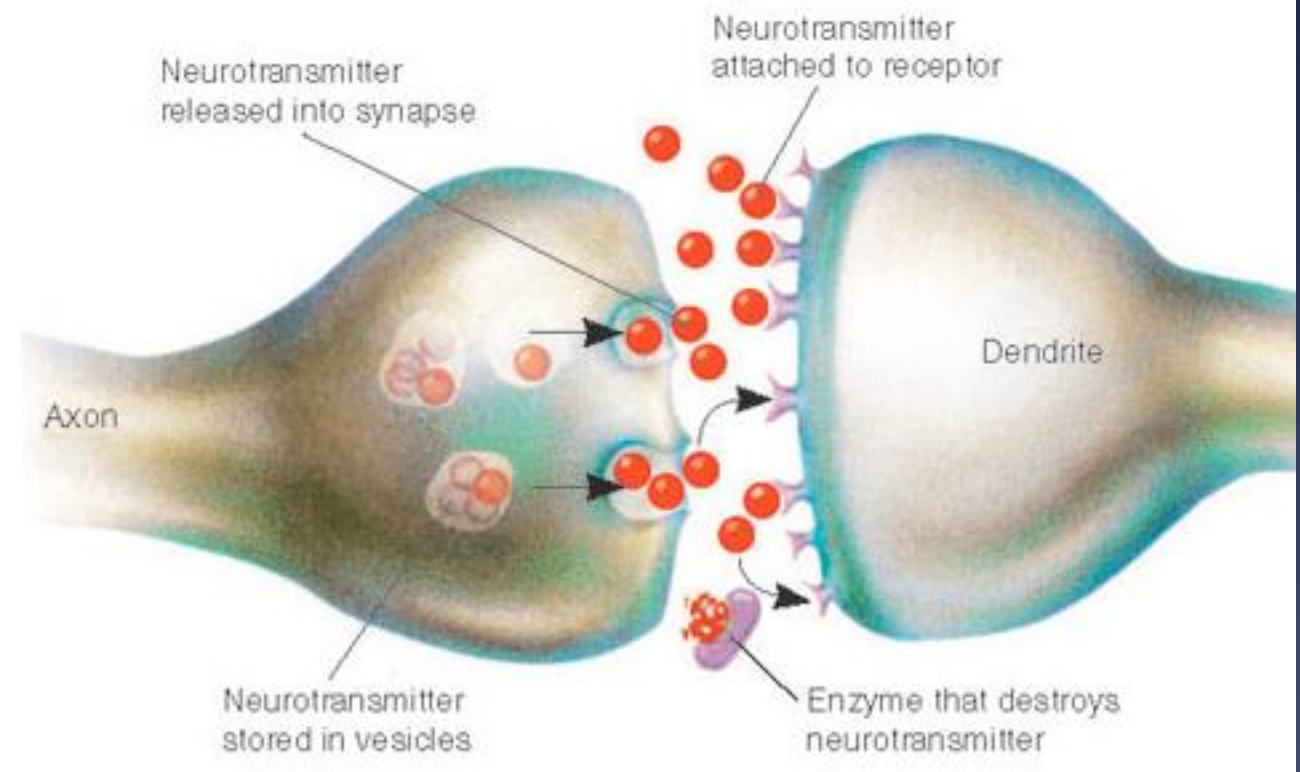
and connections to other regions



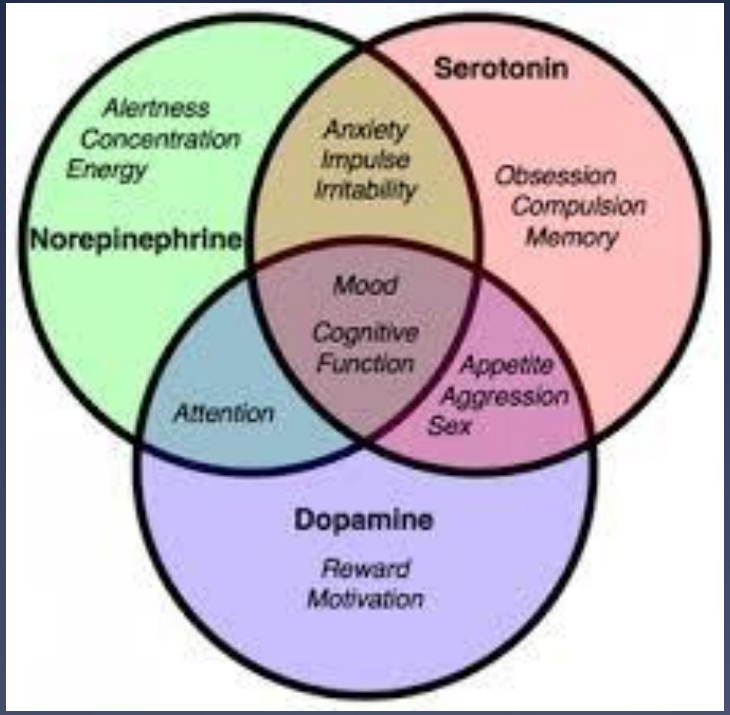
Processing Emotions and signals of emotion

Planning Defensive responses

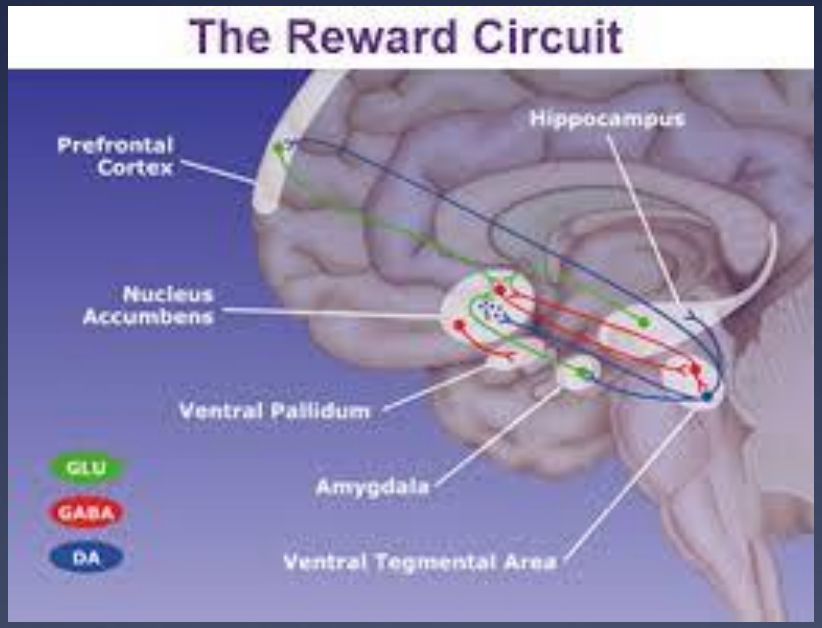
Neurotransmitters



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….

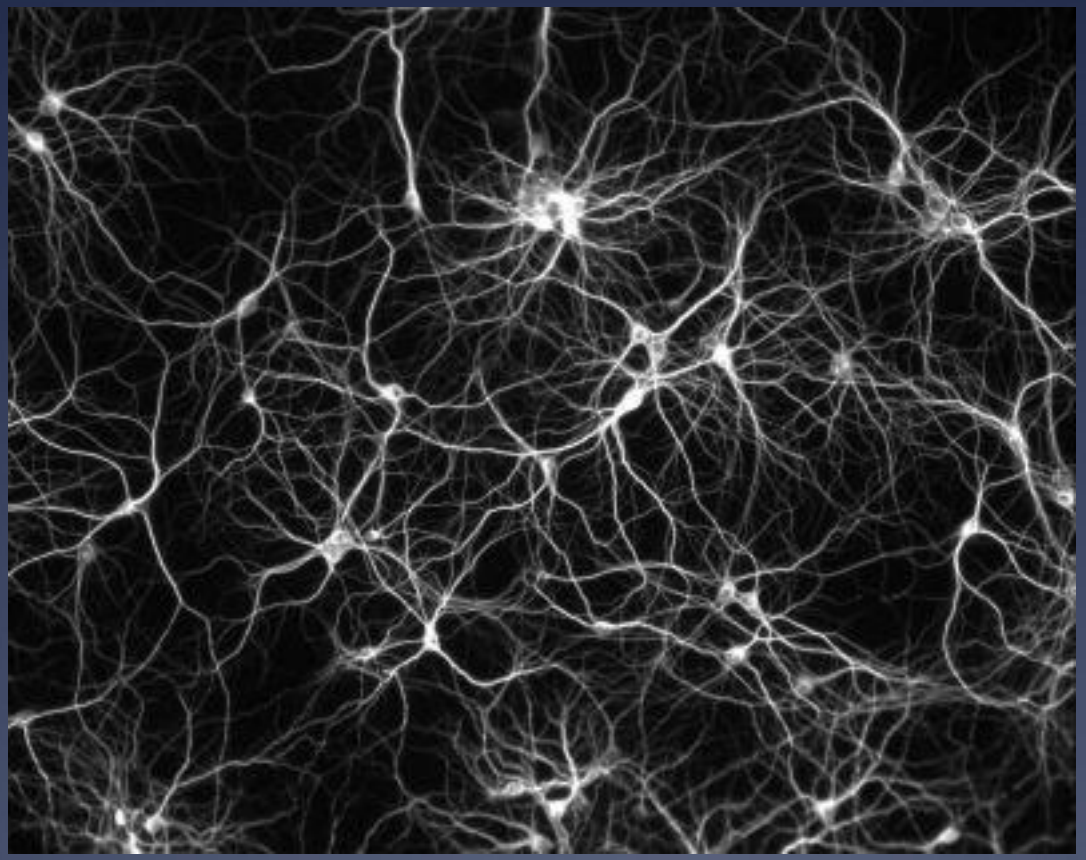
- Thrill seeking behavior
- Selective focus on rewards rather than risks
- Increased susceptibility to alcohol/substance abuse

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

* L. P. Spear. The Behavioral Neuroscience of Adolescence. W.W. Norton: London (2010).
* L. Steinberg, Ph.D. Age of Opportunity: Lessons from the new science of adolescence. 2014
* M. K. Jetha, S. J. Segaloqitz. 2012. Adolescent Brain Development: Implications for behavior.

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