PRESENTATION USAGE

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Understanding the Adolescent Brain

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BOSTON COLLEGE
WORLDWIDE WEBINARS
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WEBINAR OUTLINE

PART I: Framing Adolescence

PART II: The Adolescent Brain Needs…
   a. Building
   b. Connecting
   c. Laughing
   d. Sleeping

PART III: Resources
What is the first word that comes to mind when I say....

Teenager
STRENGTHS PERSPECTIVE

Asset Based

Look at what we've got!!

Look at what we're missing!!

Deficit Focused

https://aipractitioner.com/?attachment_id=3766
Framing Adolescence

Brains are Built

Opportunity
THREE MAIN CONCEPTS
The Adolescent Brain ...

1. IS UNDER CONSTRUCTION
   - Maturity: Adult Brain > Adolescent Brain
   - Balance: Childhood Brain > Adolescent Brain

2. NEEDS MODELS
   - Plasticity: Adolescent Brain > Adult Brain
   - This is not a time to back off
   - Opportunities for trial and error are important
   - The adult brain is on loan to the adolescent brain

3. CRAVES REWARD, PURPOSE AND BELONGING
   - Highly responsive to reward
   - Signifies an incredible time of opportunity
are trying to understand the world and
their place in it. They are sometimes compared to toddlers in
terms of behavior. However, they have different responsibilities,
relationships, perceptions and life
experiences than toddlers. Adolescents have substantively different brains than
any other stage of development, including toddlerhood.
The Adolescent Brain Needs

1. Building
2. Connecting
3. Laughing
4. Sleeping
1. Our brain’s job is that of a learning machine.
   ■ The brain adapts
   ■ The brain is structured and restructured by interactions with our environments

2. The “use it or lose it” principle applies to brain development.
   ■ Neural connections that remain are the ones used
   ■ Sensitive Periods – experiences have greater impact

3. The sensitivity of the brain to respond to experience is referred to as neuroplasticity.
   ■ Education seeking positive/sustained behavioral changes relies on neuroplasticity.
   ■ Change is possible at the neurobiological level - any behavioral change is in fact a brain-based one
1. **LEARNING**: modification of neural networks

2. **NEUROPLASTICITY**: capacity to grow new neurons and form new neuronal connections throughout life
NEURAL SYSTEMS

• Neural systems are constructed through synaptogenesis.
• There is a synapse between the axon of one neuron and the dendrite of another.
• Neurotransmitters pass from one neuron to the other (firing).
• The way our neurons connect depends on what happens to us.
• New configurations of neurons can become activated leading to increased activation of synapses and new synaptic connections (synaptogenesis).

HOW THE BRAIN CHANGES

NEUROGENESIS
Continuous generation of new neurons in certain brain regions

NEW SYNAPSES
New skills and experiences create new neural connections

STRENGTHENED SYNAPSES
Repetition and practice strengthens neural connections

WEAKENED SYNAPSES
Connections in the brain that aren't used become weak
In adolescence key structural and functional changes take place in the limbic system and the neocortex, such as the frontal lobe (prefrontal cortex).

The brain of a six-year-old child is already 90-95% the size of an adult brain.
GROWTH ON PLATFORM 9 ¾

EXPECTATIONS

EXPERIENCE
Changes in the Adolescent Brain

1. Parts of the brain that control planning, decision making, impulse control, language, memory and reasoning have developed prior to puberty.

2. Adolescent brain undergoes another period of overproduction of gray matter just prior to puberty and then a second version of pruning.

3. “Higher order” brain centers, like the prefrontal cortex, that inhibit risky behavior do not fully develop until young adulthood.
1. Pruning **gray matter volume is decreasing** and weak synaptic connections are being eliminated (especially frontal lobe 15% pruned) (Giedd 2004, Lebel et al. 2012).

1. **White matter fiber tracts continue to develop** and myelination allows for more efficient/timely communication between brain regions (Giedd 2004, Lebel et al. 2012).

1. **Temporal specificity pattern** and brain regions important for higher-order cognitive functioning (e.g., frontal-subcortical brain regions) reach peak maturity last compared to lower-order sensorimotor regions (Stiles & Jernigan 2010).
BRAIN DEVELOPMENT IS NONLINEAR

Development of Earlier Subcortical Limbic Regions versus Protracted Prefrontal Control Regions

WOULD YOU...

BITE ON A LIGHTBULB?
SIGNIFICANCE OF NONLINEAR DEVELOPMENT

1. There is differential development of bottom-up limbic systems, implicated in incentive and emotional processing, to top-down control systems (compared to childhood and adulthood).

2. Decision-making relies on limbic regions more so than frontal executive regions.

2. During adolescence there is a heightened responsiveness to incentives and socio-emotional contexts during this time, when impulse control is still relatively immature.
FUELING RESILIENCE IN ADOLESCENCE

1. Building
2. Connecting
3. Laughing
4. Sleeping
<table>
<thead>
<tr>
<th><strong>ADULT BRAIN</strong></th>
<th><strong>ADOLESCENT BRAIN</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reward center – the nucleus accumbens active (dopamine – exciting/pleasurable)</td>
<td>1. Do not get pleasure out of things they find mildly/moderately rewarding</td>
</tr>
<tr>
<td>1. Brain scans revealed quick visualization of scenarios, distress and aversion (automatic)</td>
<td>1. Did not have different responses but response took longer (they were thinking about it, not feeling it)</td>
</tr>
<tr>
<td>1. Less influenced by the group when making decisions</td>
<td>1. Are afraid of the possibility of having their preferences displayed – enough that the brain is signaling distress and danger</td>
</tr>
<tr>
<td>1. Amygdala registers facial expressions + frontal lobe finds the meaning</td>
<td>1. Amygdala registers facial expressions but frontal lobe cannot accurately identify them</td>
</tr>
</tbody>
</table>
1. Build brain architecture

2. Does not rely on fancy games, activities or complex toys

3. Can be built and maintained in the everyday experiences

SERVE AND RETURN RELATIONSHIPS

Center on the Developing Child, Harvard University
How do secure attachments seem to build the brain? (Cozolino, 2014)

- Optimize network integration, autonomic arousal and positive coping strategies – regulation of the systems early in life becomes established
- Organizes patterns of arousal, stress reactivity, and interpersonal behavior

How do insecure attachments build the brain? (Cozolino, 2014)

- The role of the physiological stress reaction – insecurely attached individuals more a measure of arousal than a form of coping
1. Need adults to help model/regulate emotions (not parents just backing off)
2. Remember then that the immature (adolescent brain) uses the mature (adult) brain for mood regulation, impulse control, judgment, and moral reasoning.
1. People who lack social support are more prone to a variety of ailments.
   - An analysis of 148 of these studies suggests that social isolation increases the risk of death about as much as smoking cigarettes and more than either physical inactivity or obesity (Miler, 2011).

2. Lonely people also have elevated molecular markers of stress.
   - Cortisol and epinephrine are elevated in saliva and urine, respectively, lonely people report feeling more stressed in situations most people experience as only moderately stressful.
     - Boosts the body’s fight-or-flight responses.
     - Prepares the body for some looming threat. Quality of sleep is also not as good.

3. In the fMRI study those who reported loneliness exhibited less activation in the ventral striatum, a component of the brain’s reward circuitry, when they viewed pictures of smiling faces.
Summary and conclusions

- The brain is plastic, built to change in response to experience
- The prefrontal cortex is key and is a convergence zone for affect and cognition; negative emotion will interfere with cognitive prefrontal function
- Social-emotional learning is an empirically verified strategy to improve skills of emotion regulation and social adaptation
- As such, social-emotional learning likely produces beneficial brain changes
- Education literally shapes the child’s brain and likely produces alterations that lay the foundation for all future learning, emotion regulation and social functioning
1. Mirror neuron systems (so far discovered in frontal and parietal lobes) – social and skill-based behaviors to be automatically transferred from one animal to another across the social synapse
   - The brain automatically connects these behaviors with a goal, motivate and reinforce the behavioral sequence leading to it
   - Mirror neurons are important in the establishment of language (to grasp = to understand)

2. Being connected to others is good, but also lets us become “infected” by others’ feelings – adult phobias and facial expressions, teachers’ fatigue or stress

3. Teacher expectations can greatly influence student achievement (Pygmalion in the Classroom) and academic self-concept
   - “Students will not remember what you said, but they will remember how you made them feel” (Cozolino, 2013, p.154)
   - Why? Prefrontal cortex: pairs positive social experiences with feeling good/optimism (and reward circuitry).
UCLA study (2016)
- More “likes” = heightened reward responses
- “Likes” of risky behaviors/images = less executive function involvement (e.g., the brakes)

More texting = less time to process faces and practice regulatory mechanisms (e.g., serve and return, conversation, balance of limbic and frontal activity)

1. TV no longer at pace of life
2. Learning Works for Kids online games by skill area
MHS Unplugged is a 15-minute recess period every day for all Montpelier High School students. Recess includes activities that are student- or teacher-led, like yoga, meditation, Frisbee, basketball, jam band, and art projects. Students unplug from the curriculum, from stress, and from electronics during these 15 minutes. The short break provides them an opportunity to connect with one another and teachers in a new way, and as a result, students feel more productive and more connected to the school community.
FUELING RESILIENCE IN ADOLESCENCE

1. Building
2. Connecting
3. Laughing
4. Sleeping
POSITIVE EMOTION
SELECTED BECAUSE MAXIMALLY DISTINCT & CROSS-CULTURAL

(Fredrickson, 1998)

JOY
CONTENTMENT
INTEREST
LOVE
Barbara L. Fredrickson: "As a product of recurrent play, joy can have the incidental effect of building on individual's physical, intellectual, and social skills. Importantly, these new resources are durable and can be drawn on later, long after the instigating experience of joy has subsided."


**BROADEN-AND-BUILD THEORY OF POSITIVE EMOTIONS**

**Broadens our Scope of…**
1. Attention
2. Cognition
3. Action

**Resource Building…**
1. Physical
2. Intellectual
3. Social

"Upward Spiral"

Theory points to positive emotions perhaps protecting health and effects of negative emotions.
Adolescence is a time of increased dopamine release.
- Dopamine is involved in all behaviors and substances that are addictive.
- The teen years are a time of increased susceptibility to addiction.
- Teens are more likely to experiment with new experiences and more likely to respond with a very strong dopamine release. This can become part of an addictive cycle.
- If alcohol wears off then dopamine plummets (need more of it for the same response in the future).
- Foods with a high glycemic index (processed foods, bread) lead to a rapid rise in blood sugar, rise in dopamine levels, activation of reward circuitry.
• Less (neuroscience) research attention is paid to elucidating the development and function of positive affective states such as humor relative to work examining negative affective states like fear and sadness.

• The paucity of attention paid to positive emotion and humor in neuroscience is surprising given findings from other fields suggesting that, for example, humor
  • is critical to adaptive social functioning
  • plays an essential role in positive mental health
  • aids in coping, acts as a natural stress antagonist,
  • and enhances adaptive cardiovascular, immune, and endocrine responses.

(For review see Vritcka, Black, & Reiss, 2013)
The results of aggregated postscan ratings demonstrate that with few exceptions, clips were assessed in general agreement with the Pilot 1 and Pilot 2 participants’ evaluations. Gray symbols represent funny ratings; black symbols represent enjoyable ratings. Funny, Neutral, and Positive clips are represented by squares, circles, and triangles, respectively. (Neely et al. J Neuro, 2012)
HUMOR PROCESSING: TWO STAGES

In this image we see the functional (activation) data (funny > positive) from our child group sample (N=22) overlaid on a single-subject anatomical brain template.

The first stage (cognitive humor component) involves the detection and resolution of incongruity, and is associated with activity in temporo-occipito-parietal brain areas (TOPA).

The second stage (emotional humor component) includes the positive feelings related to mirth/reward. This is linked with reward-related activity in mesocorticolimbic dopaminergic circuits.
Those who are resilient tend to be flexible

1. These individuals do not rely on just one pattern of coping (*cross-training*)

1. They use cognitive reappraisal – positive reappraisal (find meaning), gratitude, humor

- fMRI: reappraisal of negative situations relies on PFC (cognitive control) and reduced amygdala activation

- fMRI: humor shows nucleus accumbens, amygdala and ventromedial PFC (cognitive appraisal, reward, motivation)

Southwick & Charney, 2018
FUELING RESILIENCE IN ADOLESCENCE

1. Building

2. Connecting

3. Laughing

4. Sleeping
1. **Sleep is required for healthy and adaptive neurobehavioral and psychosocial functioning throughout the life course.**

1. **Sleep is restorative,** facilitates memory consolidation, improves immune function, and regulates emotional responses.

1. **Sleep deprivation,** whether due to sleep disorders or other life conditions and transitions, is a significant risk factor for negative developmental outcomes at all stages in the life course.

(for review see Black, ESW, 2016)
1. Brain is 3% of body weight and needs 25% of the energy.

2. The brain does not seem to conserve energy well and slow wave sleep is needed to “restock” the depleted energy reserve that you experience through the day.
The majority of US parents (90%) think that their child is getting enough sleep (National Sleep Foundation).

The majority of US high school students (60%) report daytime sleepiness.

Somewhere between 20-33% of US high school students report falling asleep in class at least once a week.

One study suggests half of US high schoolers are getting about 6.5 hours per night and only 5% are getting the recommended 8 hours.

One study found 94% of high schoolers set their own bedtimes.
SLEEP DISORDERS AND STATISTICS

~1/2 of teenagers fall asleep in class at least once a week

Poor Sleep Increases Risk of

- Heart disease
- Diabetes
- Stroke

Poor Sleep in Adolescence

- High cholesterol
- Blood pressure
1. Neurons lose their plasticity without enough sleep, and the brain can forget what it just learned.

2. Young people may be inattentive because the sleep loss negatively impacts the body’s ability to extract glucose from the bloodstream – this basic energy is needed for the prefrontal cortex (impulse control, executive function, abstract reasoning, difficulty coming up with new solutions).

3. Sleep deprivation affects the hippocampus (positive emotions, memories) more than the amygdala (negative emotions, memories).

4. Sleep loss increases ghrelin (appetite up) and decreases leptin (suppressed appetite). It increases cortisol (lipogenic increases fat).

5. Human growth hormone is affected, and HGH breaks down fat.
Emotion processing is a key aspect of social competence
Sleep and facial information processing was assessed among 94 healthy children (age 10 at Time 1)
Facial information was processed under neutral (gender) and emotional (expression) conditions.

1. Findings suggest that elevated night wakening and decreased sleep efficiency significantly predicted poor performance on the emotional processing task but not the neutral task.
2. Poor sleep is associated with compromised emotional information processing during adolescence.
3. Adolescence is a sensitive period for socio-emotional development.
Shifts in circadian rhythms cause teens to be more alert late at night and to wake later in the morning.

Risks of sleep deprivation include:
- Police-reported traffic collisions
- Substance use, including caffeine, nicotine, and alcohol
- Misdiagnosis for ADHD
SLEEP DEPRIVATION IS STRESSFUL
SCHEDULE: Keep a consistent sleep schedule. (Get up at the same time every day, even on weekends or during vacations.)

BEDTIME: Set a bedtime that is early enough for you to get the minimum amount of sleep recommended for your age group.

TIMING: Don’t go to bed unless you are sleepy.

LIMIT: If you don’t fall asleep after 20 minutes, get out of bed.

ROUTINE: Establish a relaxing bedtime routine.

HABITS: Bed is for sleep.

http://sleepeducation.org/essentials-in-sleep/healthy-sleep-habits
SLEEP HYGIENE

- **CLIMATE**: Make your bedroom quiet and relaxing. Keep the room at a comfortable, cool temperature.
- **LIGHT**: Limit exposure to bright light in the evenings.
- **ELECTRONICS**: Turn off electronic devices at least 30 minutes before bedtime.
- **EXERCISE**: Exercise regularly and maintain a healthy diet.
- **CAFFEINE**: Avoid consuming caffeine in the late afternoon or evening.
- **FLUID**: Reduce your fluid intake before bedtime.
- **FOOD**: Don’t eat a large meal before bedtime. If you are hungry at night, eat a light, healthful snack.

http://sleepeducation.org/essentials-in-sleep/healthy-sleep-habits
SUMMARY

OUR SOCIAL BRAINS ARE BUILT, NOT BORN

wired to connect

need stimulating interactions

brains on loan

healthy adult brains
IMPORTANCE OF BALANCE FOR BRAIN DEVELOPMENT

- Boundaries, Limits and Consequences
- Healthy Risk-taking and Creativity
- Positive Activities and Social Influences
- Learn and Practice Real-Life Skills
1. Brain Facts
2. Neuroscience for Kids
3. Edutopia: Learning and the Brain
4. Learning and the Brain Conference
5. Mind, Brain and Education (Journal)
6. Trends in Neuroscience and Education (Journal)
TALKS ON RESEARCH ON THE ADOLESCENT BRAIN

- Dr. Adriana Galvan (10 min)
- Dr. Sarah-Jayne Blakemore (15 min)
- Dr. Dan Siegel (1 hr. 30 min)
- Dr. Richard Davidson (30 min)
- Dr. Jill Bolte (15 min)
- Dr. Abigail Baird (1 hr.)
- Dr. B.J. Casey (30 min)
- PBS Inside the Teenage Brain (1 hr.)
- NPR: The Teen Brain: It’s Just Not Grown Up Yet (5 min)
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Question & Answer

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