# Adolescent Brain Development: Window of Opportunity for Social, Emotional, & Motivational Learning

#### Ron Dahl



### CENTER ON THE DEVELOPING ADOLESCENT

Connecting Emergent Brain Research to Programs and Policy

Mission is to advance understanding of adolescence through innovative trans-disciplinary developmental science...

Team-science approach, incorporating expertise spanning basic areas of developmental science, social, affective and cognitive neuroscience, as well as clinical, educational, public health, cultural, social, and global perspectives on adolescence.

### Developmental Science of Adolescence: A perfect storm of *interacting* levels of change...

Rapid physical growth; the activation of new drives and motivations; Sex-specific changes in facial structure, voice, and body characteristics; Changes in sleep and circadian regulation; metabolic changes; Wide array of cognitive and emotional changes; **Profound changes in social motivations, social context and social roles** 

Biological/ Behavioral/ Neurodevelopment/ Peer/ Family/ School/ Culture/ Media....

...and figuring out how to relate to the world, and yourself, as a suddenly and mystifyingly sexual being...



### Adolescence:

A perfect storm of *interacting* levels of change...

Molecular/Cellular/ Neurodevelopmental/ Peer/ Family/ School/ Culture/ Technology....



Multiple levels of bi-directional interactions; dynamic brain/behavior processes that are actively sculpting these developing neural systems ...

rapid spirals...



### The Dark Side: The Health Paradox of Adolescence

- Adolescence (physically) the healthiest period of the lifespan (prior to adult declines)
- Beyond the frailties of infancy and childhood
  - Improvements in strength, speed, reaction time, reasoning abilities, cognitive skills, immune function ...
  - Increased resistance to cold, heat, hunger, dehydration, and most types of injury ...

Yet: overall morbidity and mortality rates *increase* > 200% from childhood to late adolescence

### Morbidity & Mortality in Adolescence

- Primary sources of death/disability are related to problems with control of behavior and emotion
- Increasing rates of accidents, suicide, homicide, depression, alcohol & substance use, violence, reckless behaviors, eating disorders, STDs, health problems related to risky sexual behaviors... obesity
- Behaviors with long-term health consequences across the lifespan





# The Light Side: Adolescence as a Perfect Storm of Opportunities

Learning/Exploration/Acquiring Skills/Habits/Intrinsic Motivations Identity formation/Attitudes/ Setting Goals & Priorities Unique opportunities for social, emotional, and motivational learning Positive Developmental Spirals





### Adolescent Brain Development: Myth of the 'broken' brain or 'missing' brain and 'immature PFC'



## Adolescent Brains

- Very well adapted for the tasks and challenges of adolescence
- Unique *opportunities* for social, emotional, & motivational learning
- Learning about the complex social world they must navigate including the hierarchies, social rules for gaining acceptance and status, and the mystifying discovery of a sexual self....

Developing neural systems: learning to calibrate complex social and emotional 'valuing' systems –

fast automatic systems that use 'feelings' as signals;

...learning that underpins *heartfelt goals, priorities...* 



#### Adolescent Brain Development Crone & Dahl 2012





Adolescence ("awkward period from the onset of puberty to attaining adult status/roles") precarious (tipping) points....

Helpful to consider three (general) developmental windows within adolescence:

- 1) The transition into adolescence (ages 10-14) onset of puberty... (biological inflection point)
- 2) The spiraling patterns across mid-late adolescence (ages 15 19)
- 3) Transition into adulthood -- social role challenges and 'falling off the cliff' (ages 20 25)

Puberty (the onset of adolescence) as a bio-behavioral activation of socio-affective changes

- A natural inclination toward novelty and exploration
  - Cross species data & evolutionary perspective
  - Individual differences & social context effects
- Increased sensation-seeking
- Increased motivational salience of social status
- Effects of specific hormones? (*Testosterone* Estradiol Oxytocin)?
- A period of plasticity for learning?



Neural Plasticity



- Encompasses a wide range of synaptic and non-synaptic processes that underpin the brain's capacity to instantiate learning.
- A great deal of scientific interest has focused on understanding 'sensitive' or 'critical' periods of development.
- Windows of opportunity for specialized learning

### Werker and Hensch 2015 Windows of opportunity for specialized learning



#### Figure 3

Illustration of the cascading nature (*arrows*) of the steps in perceptual development (*colored boxes*) that guide acquisition of the native language. Each step has a different critical (or sensitive) period (*solid lined curves*). The opening, closing, and duration of each of these periods can be altered by sensory deprivation, pharmacological exposure, and linguistic experience (*dashed lined curves*), ultimately influencing language outcomes (e.g., vocabulary size, reading).

Early brain plasticity for learning to (expertly): talk, walk, control one's eyes, read emotions in faces... Practice !!!

- By 2 months, infants have executed more than
  2.5 million eye movements (Johnson et al 2003).
- By 2 years of age: have looked at faces...emotional faces...hundreds of thousands of times
- Toddler learning to walk takes 14,000 steps/day (46 football fields) and incurs 100 falls per day. (Adolf et al 2012)



Plasticity: Patterns of neural connection are shaped by: patterns of behavior

- Practice, practice, practice...
- **Mastery-curve learning...**
- Social contexts interacting with 'attractors' ...





## Neural Plasticity

- Capacity for learning and experience to shape key developing neural systems does **not** end at age 3...
- As some windows of plasticity close, others open.
- Brain development requires *balance of stability and plasticity*.
  Onset of puberty (ages 9 -14) represents another important set of shifts in this balance.
- Not a question of plastic (yes or no); but rather what kinds of plasticity, what specific windows of opportunity

What are the natural attractors for the adolescent brain?

- How does pubertal maturation impact the sensitivity of neural systems for sensitive and engaged learning?
- What kinds of information processing does the adolescent brain become naturally more attuned to and motivated to engage for rapid learning?
- What are the adolescent corollaries to an infant's natural attraction to repeatedly *practice*—and eventually master—control of eye movements, speaking words, reading faces, and walking?



![](_page_18_Picture_5.jpeg)

Social Emotional Learning (about self and others)

We search on our journeys, for a self to be, for other selves to love and work to do.

— Frederick Buechner

![](_page_19_Picture_3.jpeg)

I've learned that people will forget what you said, people will forget what you did, but people will never forget how you made them feel. —Maya Angelou

![](_page_20_Picture_0.jpeg)

# **Developmental Science of Adolescence**

![](_page_20_Picture_2.jpeg)

Developmental Pathways to Individual Differences?

(height as simple exemplar of developmental science principles)

World's tallest man: **Sultan Kosen 8'9"** meets world's shortest man: **Chandra Danoi 1'9"** 

"Even though he is short and I am tall, we have had similar struggles throughout our lives," Kosen said...

![](_page_21_Picture_4.jpeg)

## Pubertal Spurt in Growth Velocity

![](_page_22_Figure_1.jpeg)

Does the onset of puberty initiate a 'learning spurt' in human development?

- Changes in neural systems (especially dopamine systems involved in reward processing and learning) during pubertal maturation
- Evidence that puberty is associated with re-orientation to social and emotional information processing streams:
  - Learning about social relationships, social roles, peers, potential romantic partners, social hierarchies, and interest in sexual behavior
  - Learning about the self and exploring one's place in these social hierarchies, strong desire for acceptance, belonging, admiration and respect
- Creates a window of opportunity (and vulnerability) to learning/social contexts that will impact individual differences across the lifespan....

**Testosterone increases attention to social status and drives motivation to acquire/defend it;** Testosterone rises dramatically for both males and females across adolescence, but begins and peaks earlier for females. Braams et al 2015

![](_page_24_Figure_1.jpeg)

![](_page_25_Picture_0.jpeg)

![](_page_25_Figure_1.jpeg)

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## Human Puberty: *Igniting Passions* in the Developing Brain

- Profound changes in romantic interest, motivation, emotional intensity
- Increase in sensation-seeking
- Developing passions for specific types of goal-directed behavior (particularly goals related to social-status)
- A period of natural motivational learning?
- The affective (feeling-based) aspect of wanting, liking, desiring particular kinds of goals and priorities....
- Heartfelt goals, values, and priorities..

![](_page_26_Figure_7.jpeg)

Early adolescence as a maturational period for adjusting motivations and early identity (self-relevant emotions)

- The intensity of romantic and sexual feelings
- Finding a path to acceptance, belonging, respect, autonomy...
- Feelings of being valued, respected, admired
- Contribution values... finding a valued niche
- Seeking meaning and purpose...
- Interactions with other adolescent domains (risk taking, novelty seeking, increased fear and emotional reactivity)
- High-intensity motivational learning...

New capacity for *sudden transformational changes in motivation* in adolescence...

Falling in love... Igniting passions...

Prepubertal children develop 'crushes'

Romeo and Juliet exchange 100 words and two kisses and feel like the universe always intended for them to be together...would rather die (and destroy their families) ...than live apart...

(though they just met four days ago and barely know each other) there is a reason that Shakespeare made Juliet 13...

# Capacity for sudden transformational changes in motivation in adolescence...

Falling in love: can be literal...exchange 100 words and two kisses... also as a metaphor:

Falling in love with literature, dance, music, a particular religion or philosophy, the idealistic ambition to make the world a better place, with math, science, social justice...

Capacity to hijack motives for addiction (alcohol, drugs, smoking, thrillseeking...)

Withdrawal and disconnection from any passion (apathy, boredom, depression)

Developmental Science of Motivation?

# Summary

- Adolescence appears to be a key developmental window of motivational learning—a time of development when the brain expects to adjust the targets and intensity of motivational feelings.
- The *particular social and mastery experiences practiced during this maturational window shape (and strengthen*) the patterns of connections related to heartfelt goals.
- Compelling developmental social neuroscience questions about mechanisms and processes (precision in developmental timing and targets...)
- Compelling developmental science questions relevant to health, education in the broadest sense – about positive impact during this interval.

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![](_page_31_Picture_1.jpeg)

![](_page_31_Picture_2.jpeg)

# Thank you

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