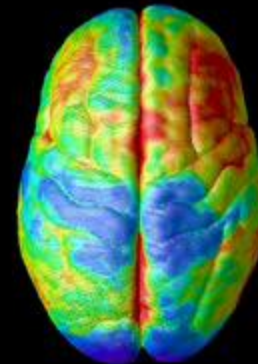
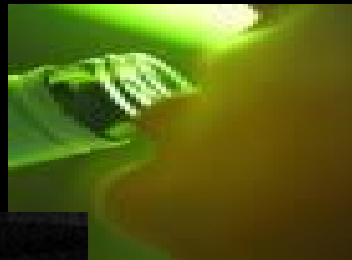


Adolescent Risk Behavior: Environmental Influences on Biobehavioral Processes

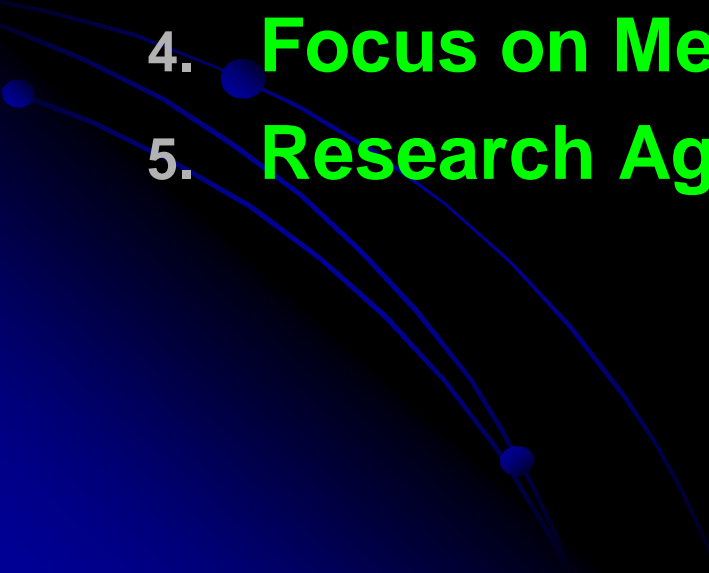
Ron Dahl University of Pittsburgh



Gray Matter Amount
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0



Introduction

1. **Overview: Why Focus On Puberty x Environment Interactions?**
 2. **A Tipping-point Model: Risk-taking, Sensation-seeking, Socio-emotional Influences**
 3. **Sleep as Example to Illustrate the Model**
 4. **Focus on Mechanisms of Risk?**
 5. **Research Agenda For Reducing Risk?**
- 

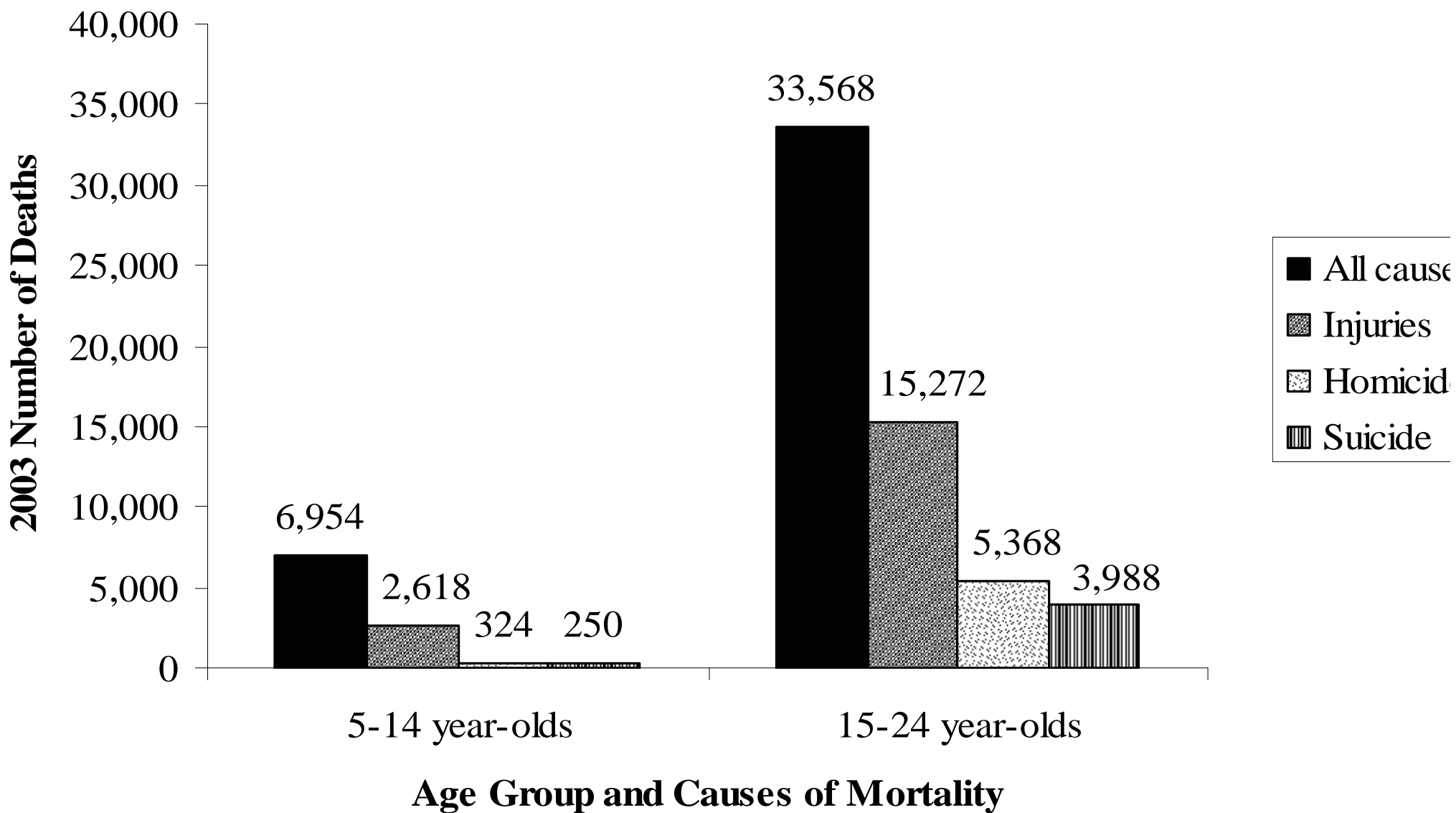
Overview:

High-Stakes Issues:

The Health Paradox of Adolescence

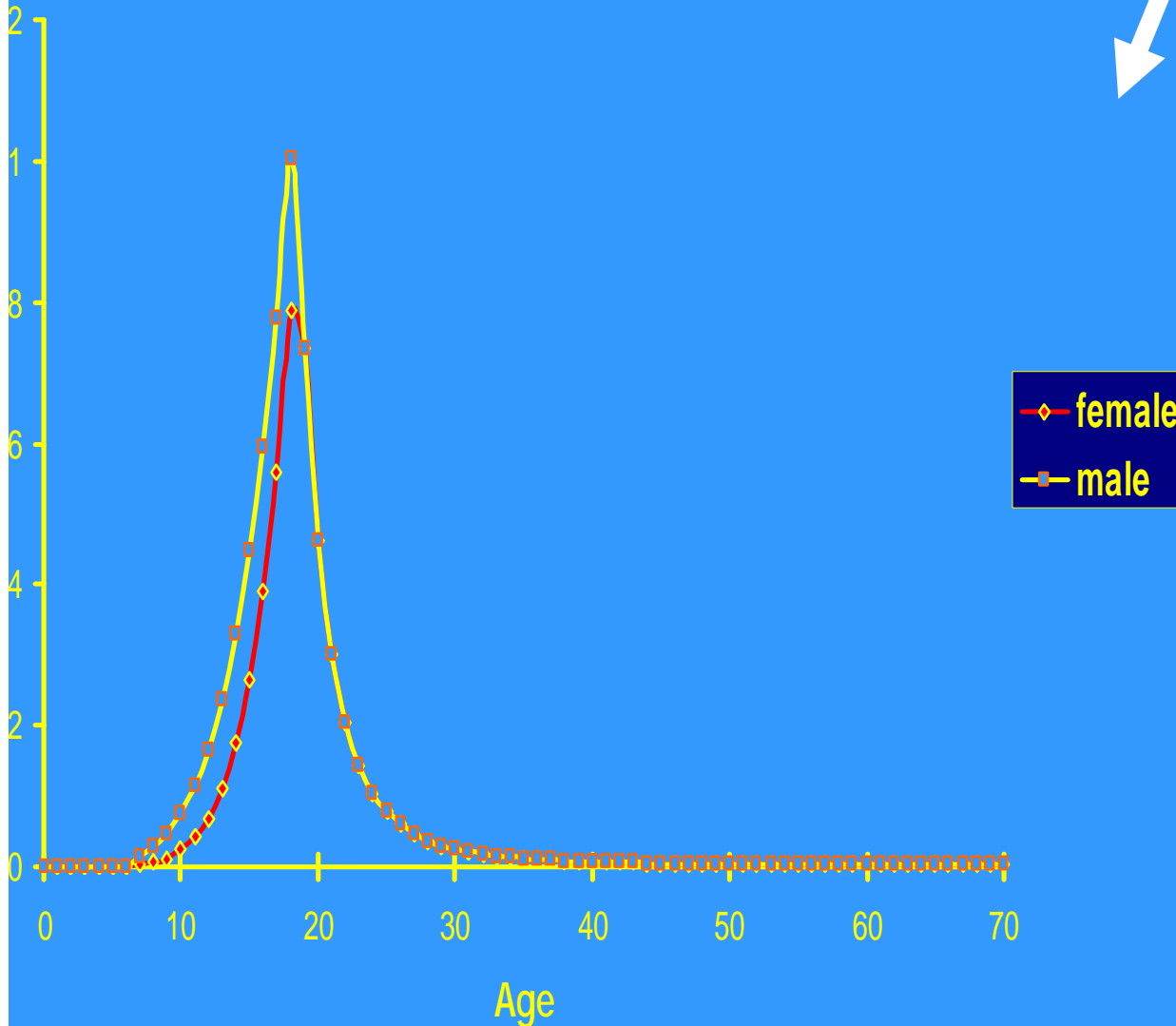
- Adolescence is (physically) the healthiest period of the lifespan: prior to adult declines; beyond the frailties of infancy and childhood:
 - Improvements in strength, speed, reaction time, reasoning abilities, immune function ...
 - Increased resistance to cold, heat, hunger, dehydration, and most types of injury ...
- Yet: overall morbidity and mortality rates *increase* 200% from childhood to late adolescence

Figure 1: Mortality During Childhood and Adolescence



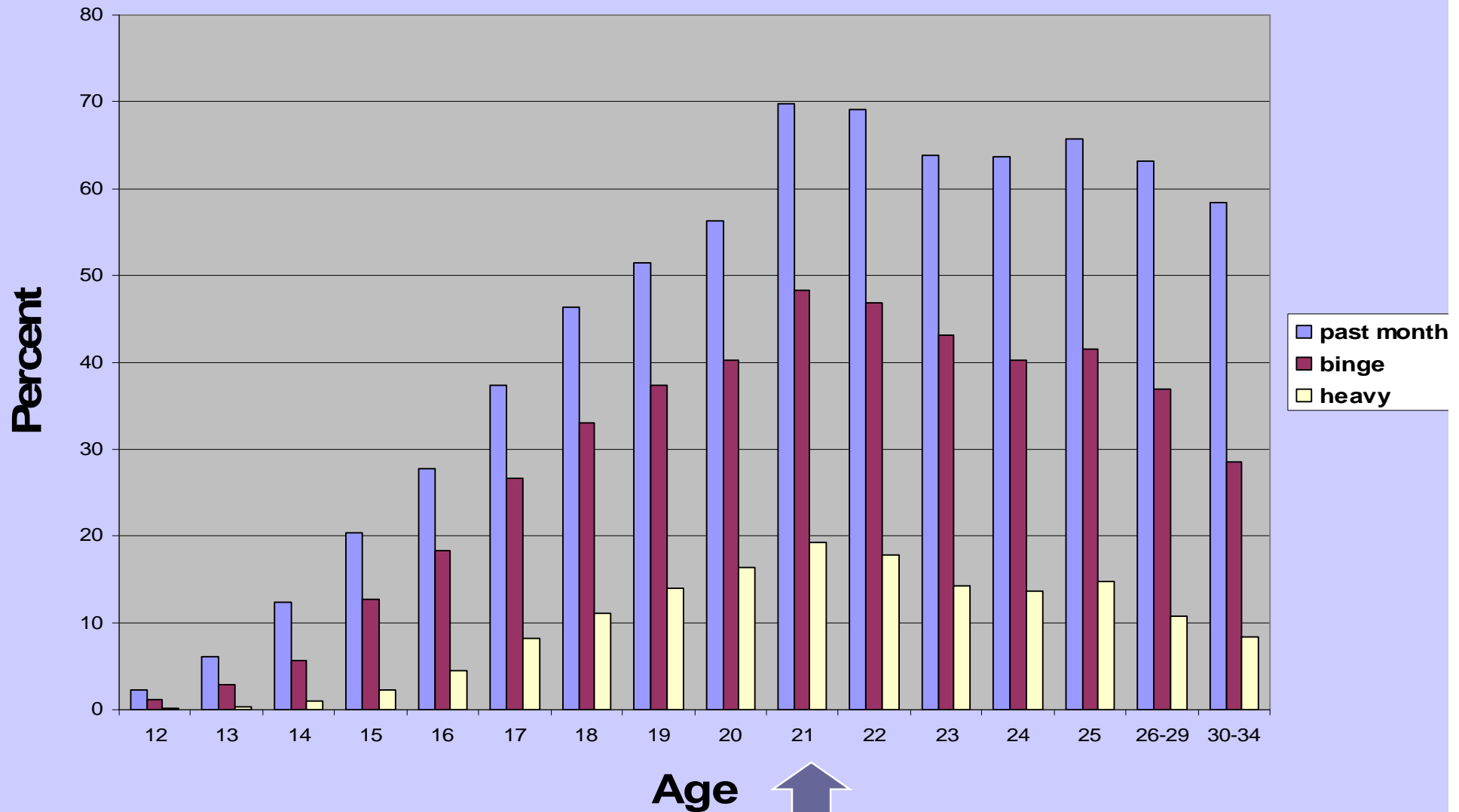
Adolescence: an inflection-point in life course trajectory

Probability of Smoking *Initiation*



- | Alcohol use/abuse
- | 95% of MJ use begins before 25
- | Onset of initial depression episode
- | Greatest risk of HIV exposure
- | Rates of accidents related to violence and reckless behavior

Alcohol Use by Age



Source: SAMHSA National Survey on Drug Use and Health 2003

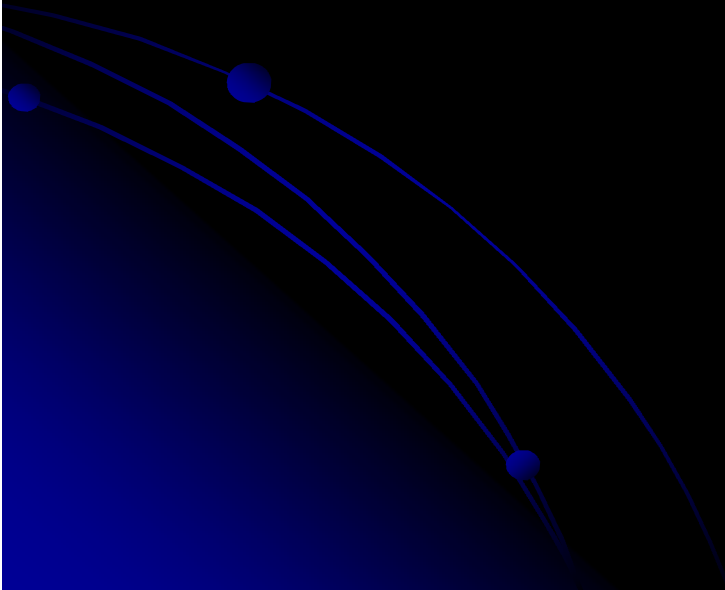
Morbidity & Mortality in Adolescence:

- | Primary sources of death/disability are related to **problem with control of behavior and emotion**
- | Increasing rates of accidents, suicide, homicide, depression, alcohol & substance use, violence, reckless behaviors, eating disorders, health problems related to risky sexual behaviors...
- | **Development of self-regulatory processes (broadly, including emotion-regulation)**
- | **Balancing with “other”-regulatory processes (adult monitoring, scaffolding, social policies....)**

Morbidity & Mortality in Adolescence:

I **Puberty x Environment Interactions?**

- I risk-taking
- I sensation-seeking
- I socio-emotional influences on behavior



2. A Tipping-Point Model

Adolescence as a time
(biobehaviorally and socially)
of self-exploration?

- n A natural inclination toward novelty and exploration
- n Cross species data (evolutionary perspective)
- n Individual differences
- n Social Context effects
- n Risk taking, sensation-seeking, status-seeking?

The past 150 years have witnessed a quiet revolution in human development that still sweeps across the globe today: children nearly everywhere are growing faster, reaching reproductive and physical maturity at earlier ages, and achieving larger adult sizes than perhaps ever in human history.

--Carol M Worthman, Ph.D.

ADOLESCENCE HAS EXPANDED from a 2-4 year interval in traditional societies to an 8-15 year interval in contemporary society

Puberty: Changes in Motivation/Emotion

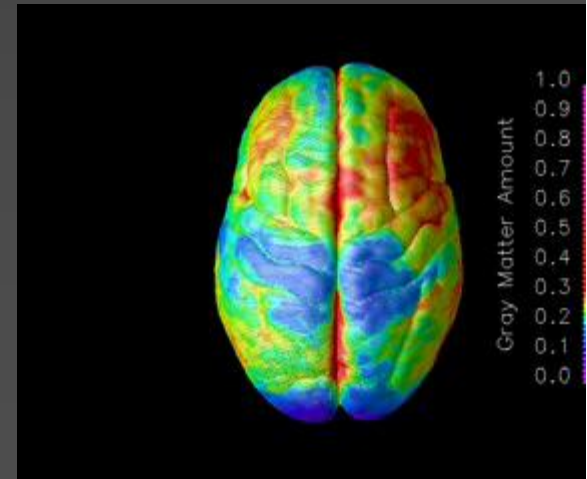
- n Strongest *direct* links to puberty:
 - n changes in romantic motivation, sexual interest,
 - n emotional reactivity/intensity
 - n sleep/arousal regulation,
 - n appetite,
 - n risk for affective disorders
 - n increase in sensation seeking (status seeking?)
- n Animal studies: increase in exploratory behaviors, novelty-seeking, dopamine changes...

Human Puberty: *Igniting Passions* in the Developing Brain

Profound changes in romantic interest,
motivation, emotional intensity

Intensification of many types of goal-
directed behavior, including intense
motivation for long-term and abstract
goals (particularly those related to social-
status)

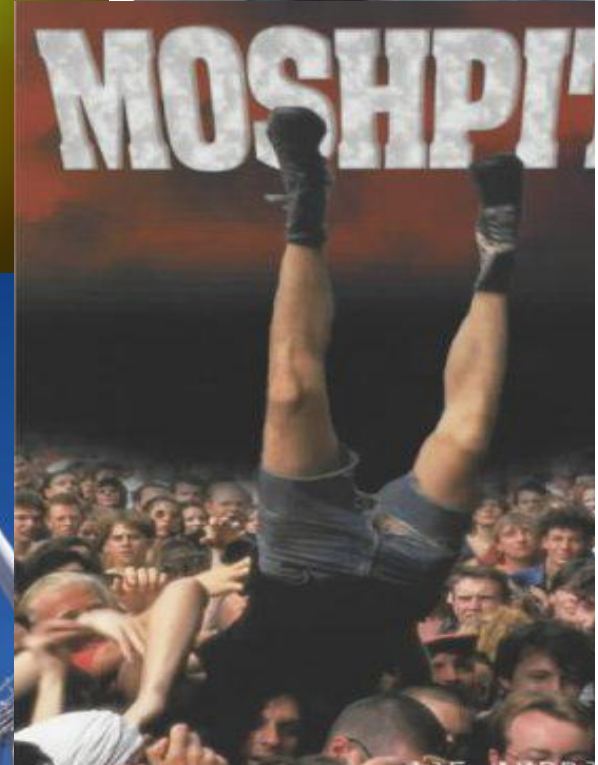
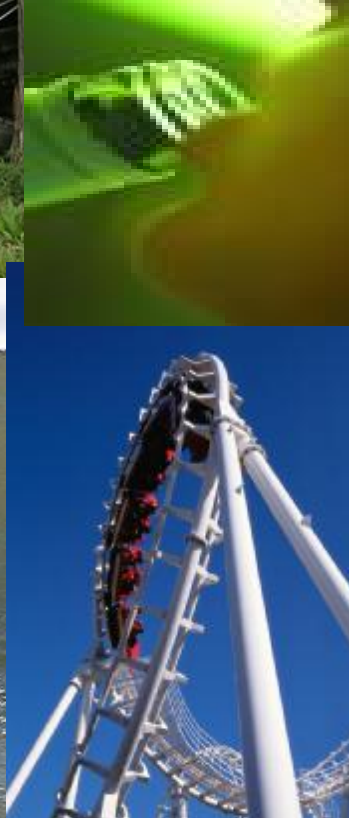
Empirical evidence for neurobehavioral
changes in emotion and motivation?



Evidence for Puberty-Specific Changes in Affect (Emotion and/or *Motivation*)?

- n Behavioral studies (emotional reaction)
- n Behavioral studies (motivational changes)
- n Behavioral studies (risk-taking & sensation-seeking)
- n Clinical studies of depression risk
- n Psychophysiological studies (pupil; blink startle; PAR; ERP)
- n Neuroendocrine (social stress)
- n Structural and fMRI studies (focus on puberty)

Adolescent Risk Taking?



Risk-taking in Adolescence

MYTHS: Adolescents as “bad” decision makers
Adolescents believe they are invulnerable
Adolescents are less fearful

EVIDENCE:

Puberty-specific changes in *emotional* systems

Affective influences on decision making

Risks *despite* fear (“thrills” and passions)

Sensation-seeking:

Reward? Excitement? Arousal? Novelty?

Status seeking?

Wild Things Run Fast

*Strange to say, if you do not stamp yourself
with the words
exhilarated or terrified,
those two things feel
exactly the same in a body.*

—Barbara Kingsolver

Conceptually and methodologically: *Sensation seeking vs. Impulsivity*

- n Impulsivity: quick actions without engaging thoughtful processes (leads to hasty, unplanned behavior)
- n **Sensation-seeking: appetitive drive for exciting feelings (leads to pursuit of novel, varied, and highly stimulating experiences and the willingness to take risks in order to attain them).**
- n *Not all impulsivity* leads to stimulating activities (e.g., impulsively deciding to turn off alarm clock return to sleep)
- n *Not all sensation seeking* is done impulsively (e.g., saving money to learn to hang-glide or sky dive).

Steinberg et al 2008

- n Large, ethnically diverse sample (n= 935) ages 10 to 30, self-report and behavioral measures of *each* construct.
 - n Impulsive subscale and latency to first move TOL
 - n Excitement-seeking and pattern of behavior in “chicken game”
- n Results:
 - n Impulsivity follows a linear decline from age 10 – 30
 - n In contrast, sensation-seeking follows a curvilinear pattern, *increasing between 10 and 15 and declining or remaining stable thereafter.*
 - n In males SS correlates with puberty (controlling for age).
- n Martin et al 2002 found SS correlates with puberty (controlling for age in both males and females).

A natural affinity for high-intensity feelings in adolescence?

- n Interesting to consider why, at the developmental period when adolescents are facing such emotional challenges, they usually tend to show an increasing *appetite* for high-intensity feelings and exhilaration.
- n It is as if they are naturally drawn to situations that help them to learn how to tolerate and manage turbo-charged feelings.

Playing with Emotional Fire

- n Adaptive value of experimenting with high-intensity feelings?
- n Perhaps telling that courage is a valued and admired quality across all human cultures and societies
- n Few things in life are as emotionally salient to adolescents as their desire for admiration

*Courage is resistance to fear,
mastery of fear –
not absence of fear*
--Mark Twain

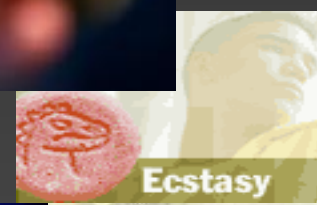
Adult perspective: novelty-driven adolescent 'play' behavior may seem of poor judgment and impulsive

- n Not sufficiently 'goal-directed'...work, future, safety, responsibility to others, long-term consequences of actions...
- n *Goals* of adolescents (and children) more in the affective domain?...the 'goal' may be to achieve a desirable feeling...fun, excitement, thrills...
- n Learning to navigate high-intensity feelings?

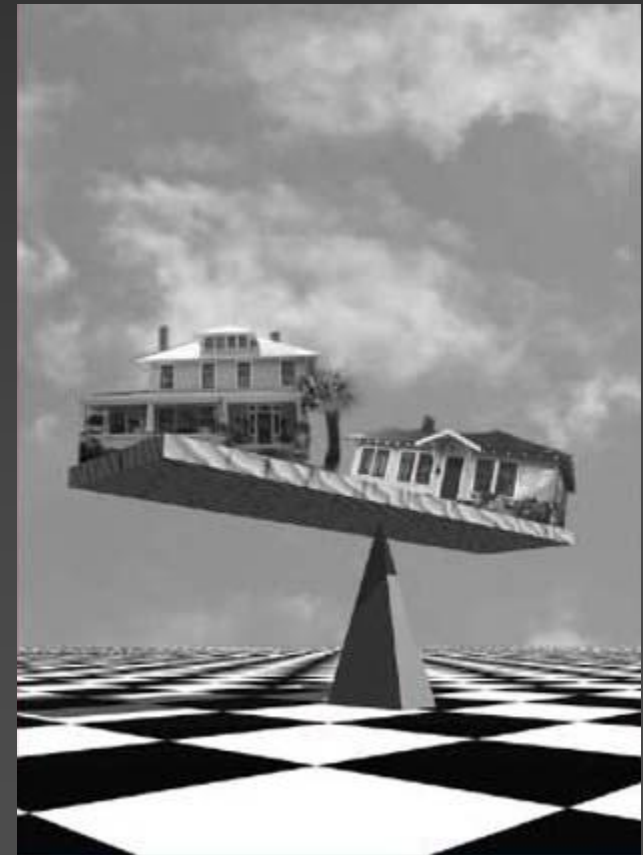
Adolescence



Vulnerability for Negative spirals



4. A Tipping Point Model?



Overview of General Model

A maturational gap?

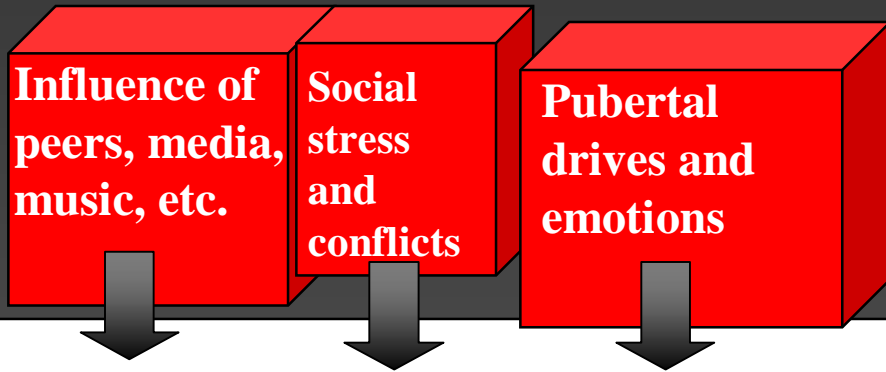
Onset of puberty: Activational effects on neural systems of motivation and emotions

Versus gradual emergence of cognitive control

Relevance: Earlier timing of puberty
Scaffolding/social support
Social policy and intervention

AFFECTIVE LOAD

These effects increase sharply at puberty (*relatively early effects*)

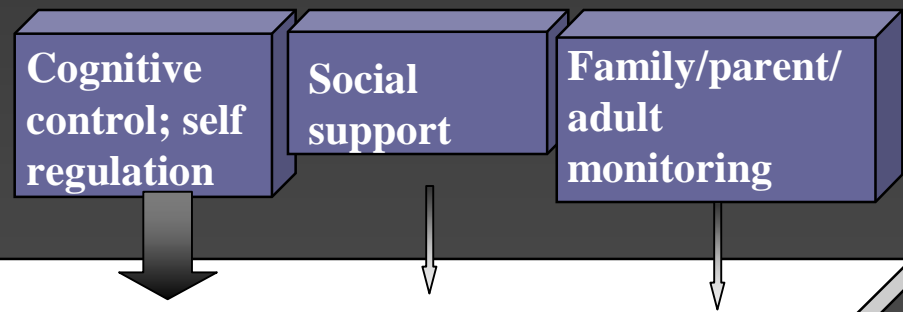


REGULATORY CONTROL

Improvements occur slowly across adolescence (*relatively late*)

External controls on behavior *diminish* across adolescence

Variable



Higher stakes status seeking?
Social anxieties?

Rumination?

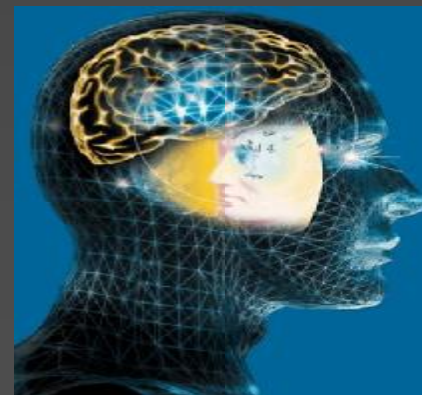
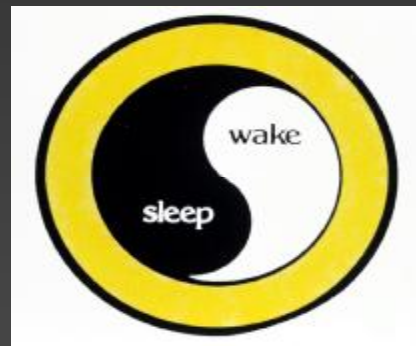
Early Romantic Relationships?

Genetic influences: cognitive control/self regulation? (COMT; VAL/MET)

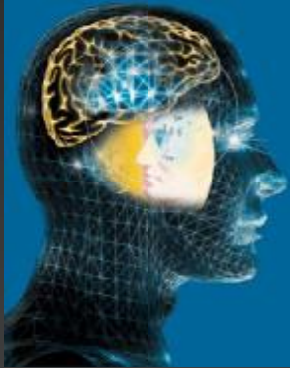
Skills for dealing with strong emotion?

5. Sleep to Illustrate the Model

The Development of Sleep/Arousal Regulation:
Window of opportunity in adolescent brain maturation?

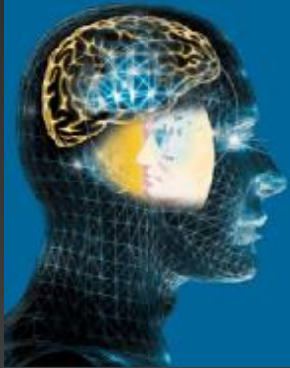


Adolescent Sleep: Pubertal Change 1



- n Phase-Delay Shift in biologic timing systems—physiologic change in *tendency* to prefer to stay up late/sleep-in late
 - n Related to changes in circadian system
 - n Lee et al animal model in *O. degus*...

Adolescent Sleep: Change 2



- n Sharp drop in deepest delta (slow-wave sleep)
- n Decreased threshold of arousal
- n Pubertal increase in daytime sleepiness
 - n Probably an *increase* need for sleep during puberty and adolescence

Interactions with social and cultural influences on sleep

- n Tendency to want to stay up later + increased sleepiness (greater need for sleep)
 - n In earlier centuries?
 - n In contemporary society?

Factors contributing to LATE bedtimes/sleep onset times:

- n Biologic tendency for sleep delay +
- n Social influences toward sleep delay +
- n Greater freedom to self-select bedtimes +
- n Access to light and stimulating activities +
- n Stress/anxiety or excitement \Rightarrow DFA +
- n Major circadian shift on weekends/vacation
- n Work, Sports, Homework, Projects, meds...

Items in an Adolescent's Bedroom

- n 90% of adolescents have electronic music devices, such as a radio or MP3 player, in their bedroom
- n 57% have a television in their bedroom
- n 43% have electronic or video games and 42% with a cell phone (42%) in their bedroom

Contributing Factors/Vicious Cycle

- n "Catch-up" sleep on week-ends pushes circadian system to further delay
- n Use of stimulants (caffeine and nicotine) can contribute to DFA
- n Full time students working greater than 20 hours/week with significant sleep sx
- n Stress and conflict contribute to emotional arousal and further DFA

Circadian (Biological Clock) Factors

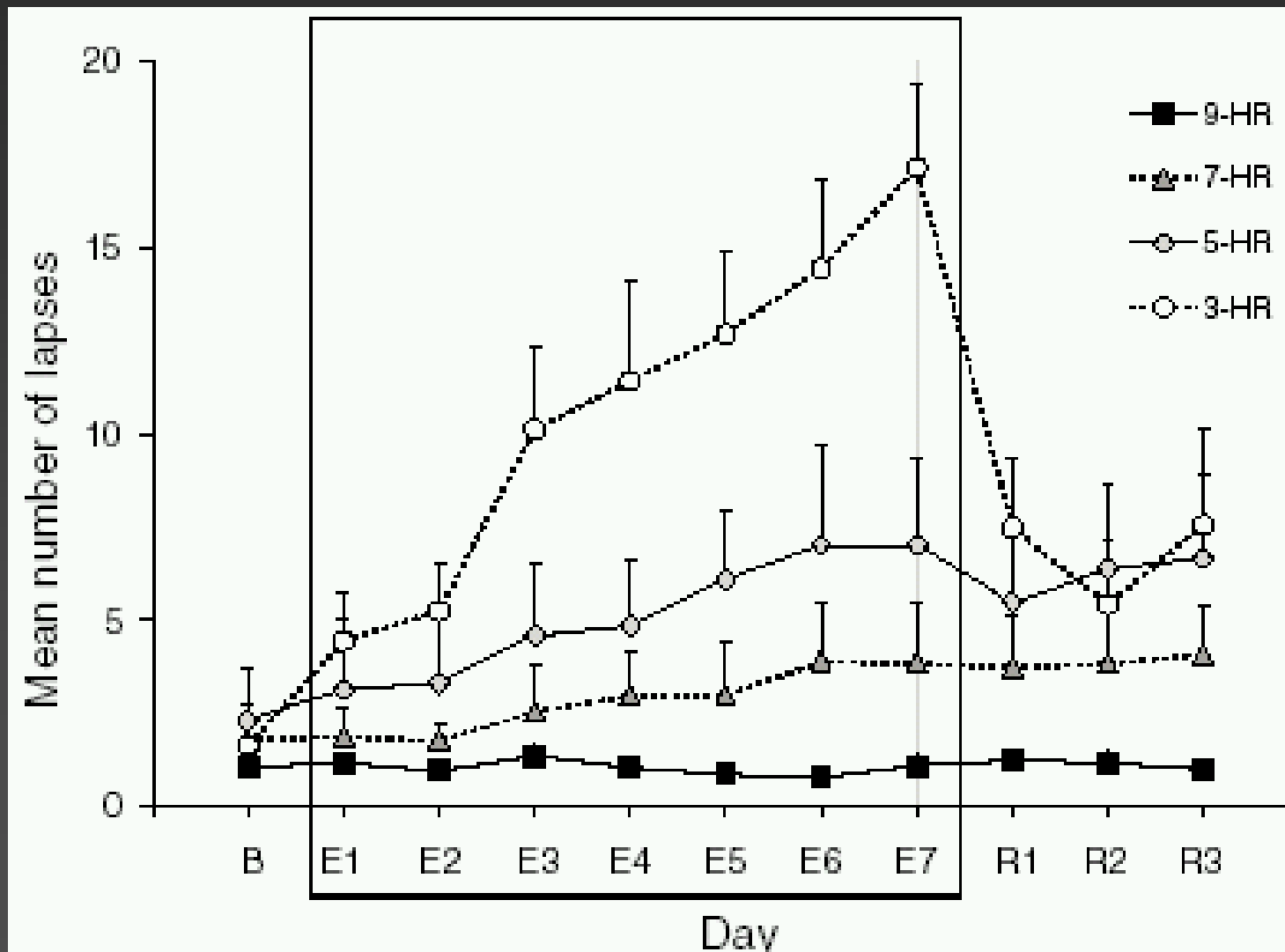
- n During summers, vacations, and weekends, adolescent sleep/wake schedules are phase delayed (e.g. 3 am - noon)
- n Circadian advance requires slow, steady changes (students often partially-adapted to school schedules)
- n Delayed circadian phase contributes to difficulty falling asleep, difficulty waking

What are the consequences?

- n If 30-50% of U.S. adolescents are typically getting less than optimal sleep what are the costs?

Adults: sleep deprivation

Belenky, J. *Sleep Research*, 2003



What are the Consequences of Insufficient Sleep in Adolescents?

- n Missed school
- n Sleepiness (including micro-sleeps)
- n Tiredness (decreased motivation)
- n Irritability and low-frustration tolerance
- n Difficulties with self-control of attention, emotion, and behavior
- n Negative synergy with alcohol

Adolescent sleep deprivation ?



Danner & Phillips 2008

- n Sleep habits and driving accidents in conjunction with changing school start times by 1 hour
- n Increase in sleep between 15-30 minutes on average
- n Proportion of students getting at least 8 hours of sleep increased from 35% to 50%
- n Driving accidents in this age group decreased 16% over the next 2 years (whereas accident rates in this age group state wide increased 7% over the same period)

Consequences of Insufficient Sleep in Adolescents

- n Direct effects on learning, memory consolidation
- n Increase use of caffeine, stimulants
- n Tipping the balance between cognitive control and affective influences?
- n Metabolic effects increasing obesity?

Sleep and Irritability/Aggression in Youth

The relationship between sleeping problems and aggression, anger, and impulsivity in a population of juvenile

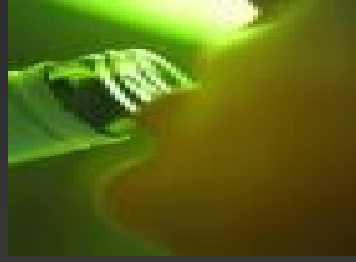
and young offenders. Ireland JL, Culpin V. J Adolescent Health (2007)

Sleep and aggression in substance abusing adolescents: results from an integrative, behavioral sleep treatment pilot program.

Haynes PL, Bootzin RR,
et al. Sleep (2007)



Tipping Points?

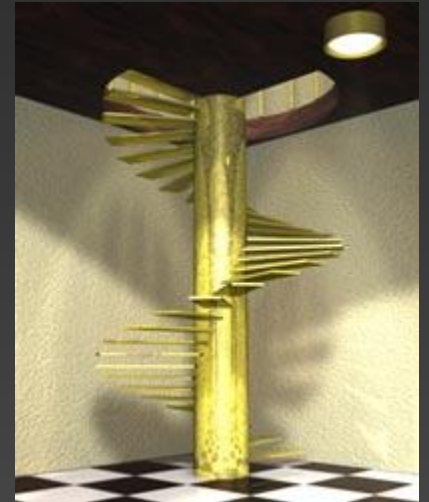


A Small Biological Change in Adolescence Can Lead to a Spiral of Negative Effects

Late night/erratic schedules ⇒
Sleep Deprivation

- ⇒ erodes mood and motivation
- ⇒ greater stress and affective problems
- ⇒ interferes further w sleep/arousal regulation
- ⇒ greater difficulty falling asleep

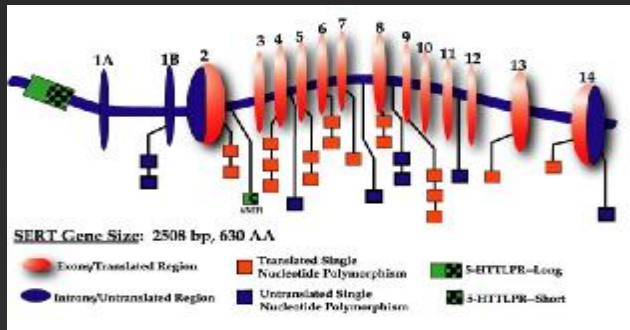
Social context that **amplifies** the biologic change ⇒ a descending spiral



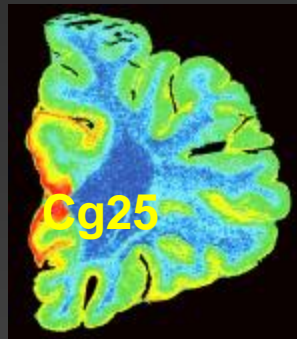
Environment

Harsh parenting; poor
Maternal depression.

Genetic variation



Environment

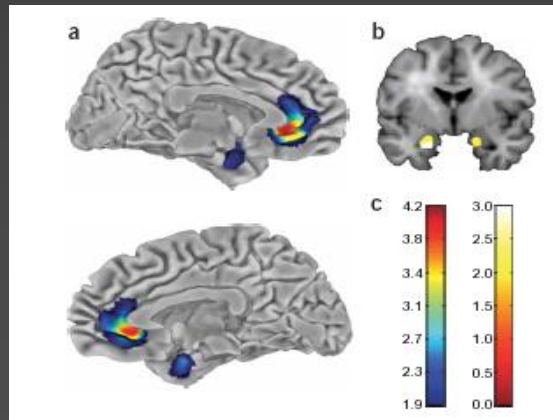


Altered Development

Attributional bias;
Negative self-image



Biased Processing of affective information



Neg cog distortions
Sleep; Social withdrawal

Stress



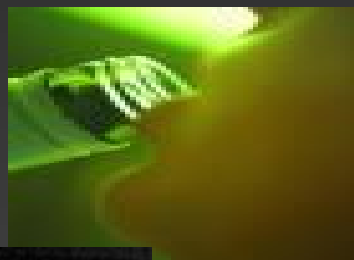
Mood Disorder

4. Focus on neural mechanisms?

Reproductive hormones (activational effects) on affective function?

- n Sensation seeking
- n Emotional reactivity
- n Preference for high-intensity feelings (independent of valence)
- n **Face processing**
- n Sensitivity and salience of status
- n Self
- n Rumination and worry
- n Sleep regulation
- n **Social Context**

Research Agenda For Reducing Risk?



Gray Matter Amount

Compelling questions...

- n Puberty specific changes in affective systems?
- n Sensation-seeking?
- n Development of *self*-regulatory processes (broadly)
- n Implicit versus explicit cognitive processes (Wiers et al)
- n Self-identity....a deep area to investigate...crucial to emotion, motivation, and self-control...
- n **Critical role of social context**
- n Adolescents increasingly create their own contexts (friends, music, magazines, sports/hobbies/etc groups; role of self-identity and appetitive motivations (spirals))

Compelling questions....

- n Mastering high-intensity emotions key to navigating the social-emotional domain for courtship/mating?
- n Relationship to status-seeking?
- n Is adolescence a key time for some types of motivational learning?
 - n Igniting passions aimed at specific types of goals
 - n Development of high-intensity appetitive (natural) motivations toward learned goals and/or activities?
 - n Role of identity and self-formation (linked to goals and emotions)?

THE DEVELOPMENT OF SELF

Erikson called adolescence the "stage of identity,"

It is clear that adolescence is a testing period for both sexes. Adolescents are newly arrived players, standing in the wings of the adult stage... they are on trial for the roles they will assume...

Memories are long in small communities, and one rarely had the opportunity to start over somewhere else

--Alice Schlegel

The Myth of Narcissus



Adolescence: Intense Emotions and Motivations at Puberty ALSO A Period of Opportunity

- n Igniting Passions:
 - n Sports
 - n Literature/Arts/Music
 - n Science
 - n Politics
 - n Caring for others
 - n Inspired Goals
 - n Idealism & Larger Purpose
 - n Changing the world in positive ways



Thank you

