Sackler Institute for Developmental Psychobiology
Weill Medical College of Cornell University
Insights into the Adolescent Brain from Functional Neuroimaging Studies

BJ Casey, Ph.D.,
Sackler Professor and Director

Sackler Institute for Developmental Psychobiology

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Key Points

1) Examine developmental progressions in terms of transitions into and out of adolesence rather than single snap shot in time;

2) Examine individual differences within a developmental stage in terms of potential risk and/or resilience factors.
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**Sackler Fellows**
* Adriana Galvan (now at UCLA)
  * Todd Hare
  Rebecca Jones
  * Conor Liston
  Fatima Soloman
  Liat Levita

**Faculty**
Dima Amso
Nim Tottenham
Henning Voss
* Sarah Durston (Utrecht)
* Inge-Marie Eigsti (U Conn)
Gary Glover (Stanford)
Walter Mischel (Columbia)

**Staff**
Sarah Getz and Alex Millner
* Julie Spicer (now at Columbia)

Funded in part by R01 MH63255, P50 MH62196, R21 DA15882, R01 DA018879, NSF 06-509, the Mortimer D. Sackler family and Dewitt-Wallace Reader’s Digest.
Overarching Question
How is the brain changing during adolescence that may explain behavioral changes during this period?
Dramatic developmental changes in prefrontal and subcortical regions during adolescence

Subcortical limbic regions involved in motivational behavior

Focus has typically been on prefrontal cortex (PFC)

Sowell et al 1999
*Nature Neuroscience*
Protracted Development of Prefrontal Control Regions
Earlier Development of Subcortical Limbic Regions
Protracted Development of Prefrontal Control Regions
Earlier Development of Subcortical Limbic Regions
Assessment of Developmental Differences in Response to Rewarding Events

- Thirty-seven participants
  - 12 adults (mean age: 25 years; 6 female)
  - 12 adolescents (mean age: 16 years; 6 female)
  - 13 children (mean age: 9 years; 7 female)
Participants are faster on trials that give the largest reward.
**Imaging Results**

Adolescents are similar to adults in volume of accumbens activity. BUT similar to children in prefrontal activity.
Protracted development of the OFC relative to the accumbens

Galvan et al 2006 J Neuroscience
Neural recruitment differs by region for age groups and corresponds to enhanced activity in the accumbens in adolescents.
Differential development of subcortical relative to prefrontal control regions may explain increased engagement in high risk, incentive driven behaviors.
Individual variability in accumbens activity across development
Accumbens activity is correlated with risky behavior

Galvan et al 2006 *Developmental Science*
Increased risk-taking behavior in adolescence may be related to differential development of limbic subcortical vs. cortical control regions.

Developmental changes may be exacerbated by individual differences in tendency to engage in risky behavior.
Is there a similar pattern in the amygdala to negative events?

Monk et al 2003 *Neuroimage*
Emotional Go/Nogo Task

Hare et al 2005 Bio Psychiatry
Enhanced activity in amygdala in adolescents relative to children & adults when approaching negative information.
Emotional Reactivity to Empty Threat: initial reactivity versus sustained reactivity
Habituation of Amygdala Response to empty threat related to Trait Anxiety (i.e., decrease in activity from early to late trials)

Sustained amygdala activity (late - early trials)
Functional Connectivity Between Prefrontal Regions and Amygdala is associated with Habituation of Amygdala Response
Changes in behavior during adolescence paralleled by differential development of subcortical limbic regions relative to prefrontal control regions. Individual differences in responses to positive or negative events, together with these developmental changes may put certain teens at risk for poor outcomes.
Imaging the Adolescent Brain... Groovy
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