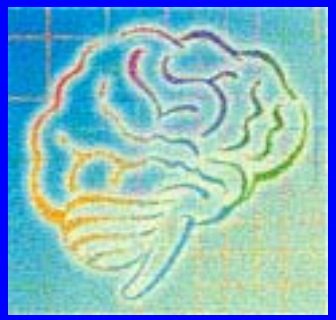


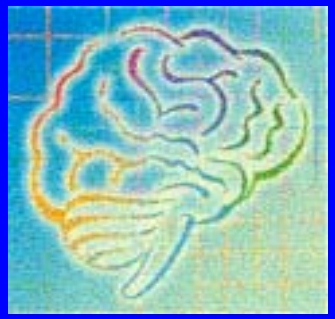
Sackler Institute for Developmental Psychobiology
Weill Medical College of Cornell University

Insights into the Adolescent Brain from Functional Neuroimaging Studies

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

Sackler Institute for Developmental Psychobiology

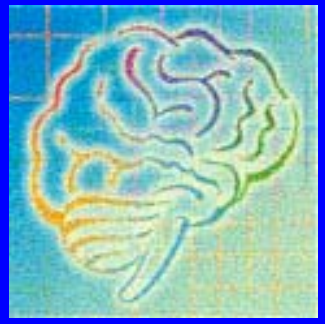
Weill Medical College of Cornell University



Key Points

1) Examine developmental progressions in terms of transitions into and out of adolescence 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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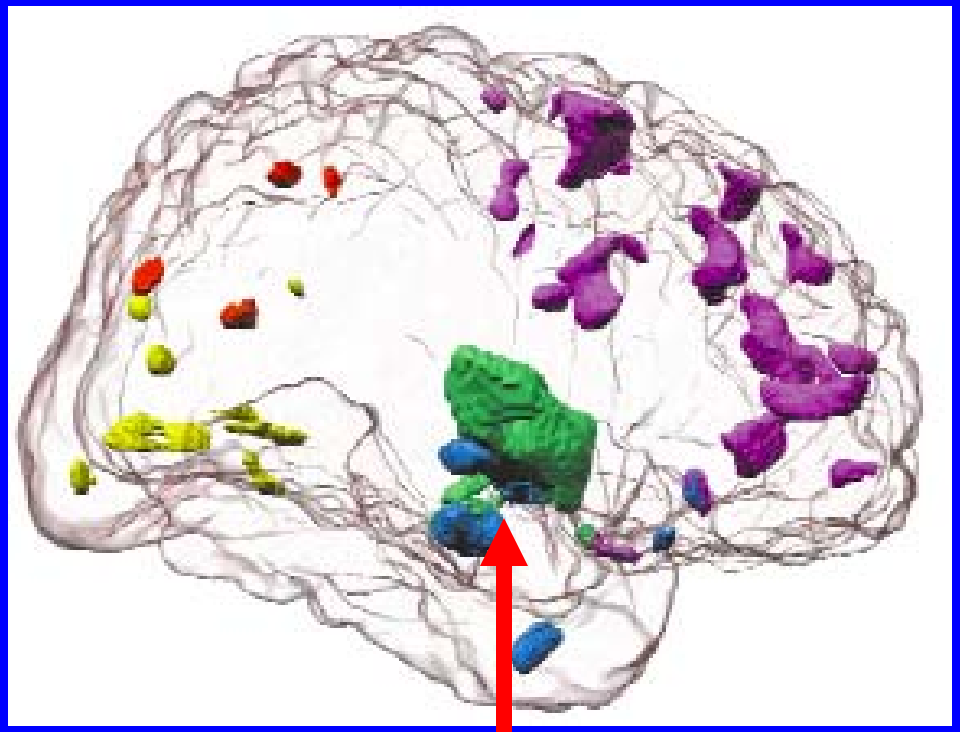
Overarching Question

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

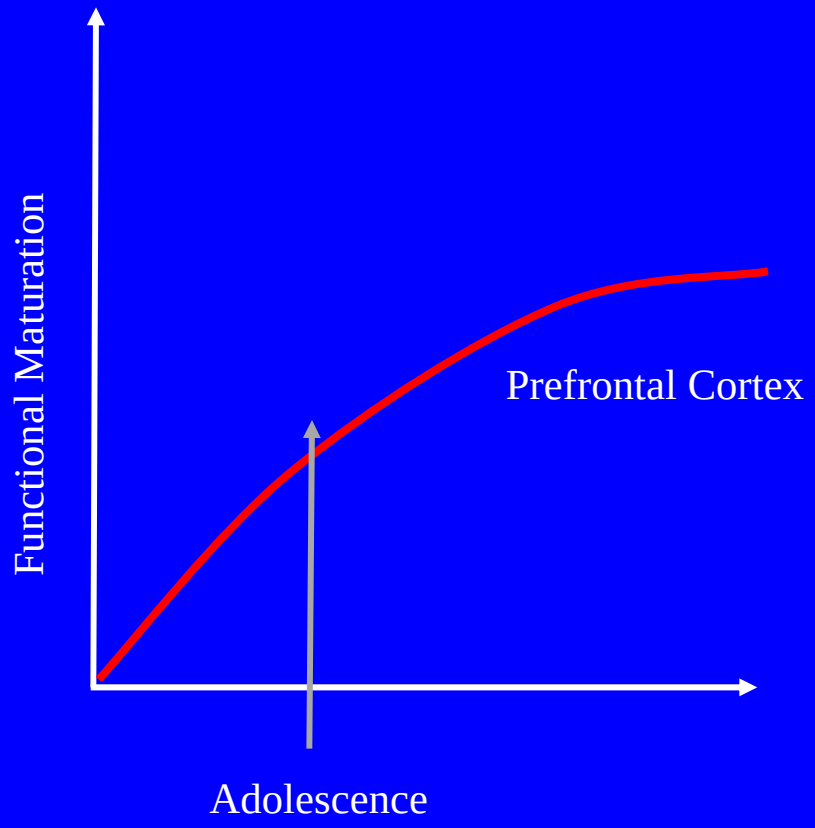


Focus has typically been on prefrontal cortex (PFC)

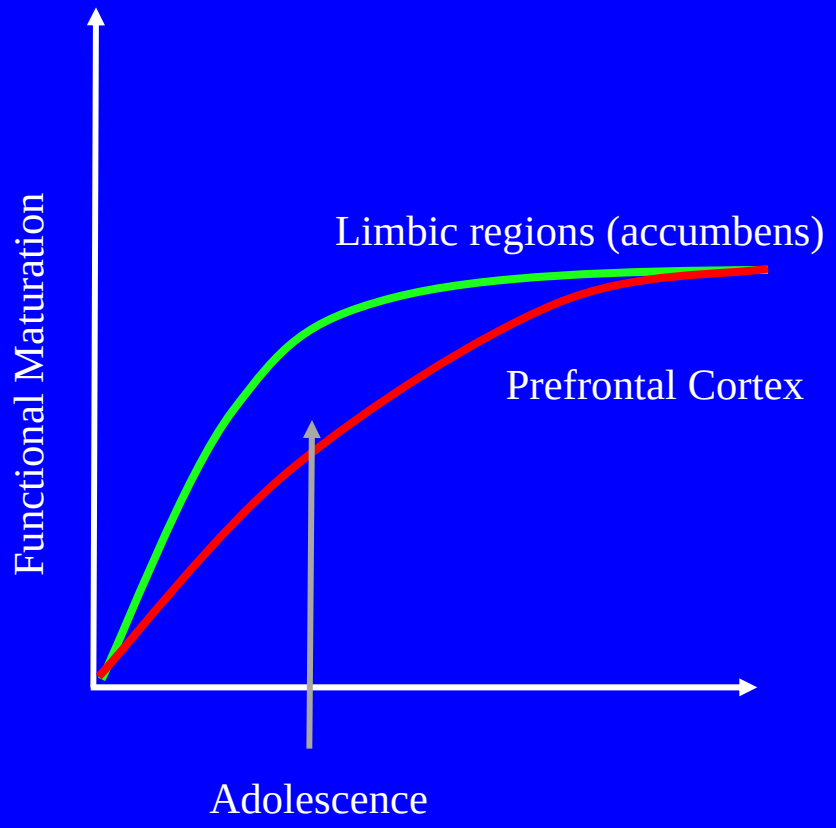
Subcortical limbic regions involved in motivational behavior

Sowell et al 1999
Nature Neuroscience

Protracted Development of Prefrontal Control Regions
Earlier Development of Subcortical Limbic Regions

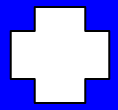


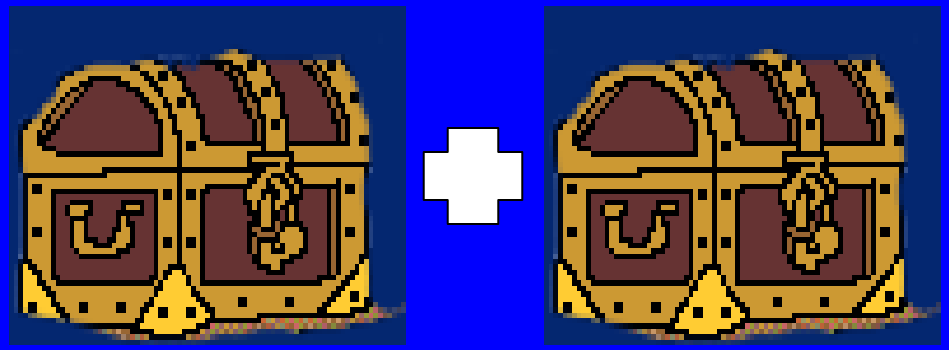
Protracted Development of Prefrontal Control Regions
Earlier Development of Subcortical Limbic Regions

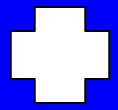


Assessment of Developmental Differences in Response to Rewarding Events

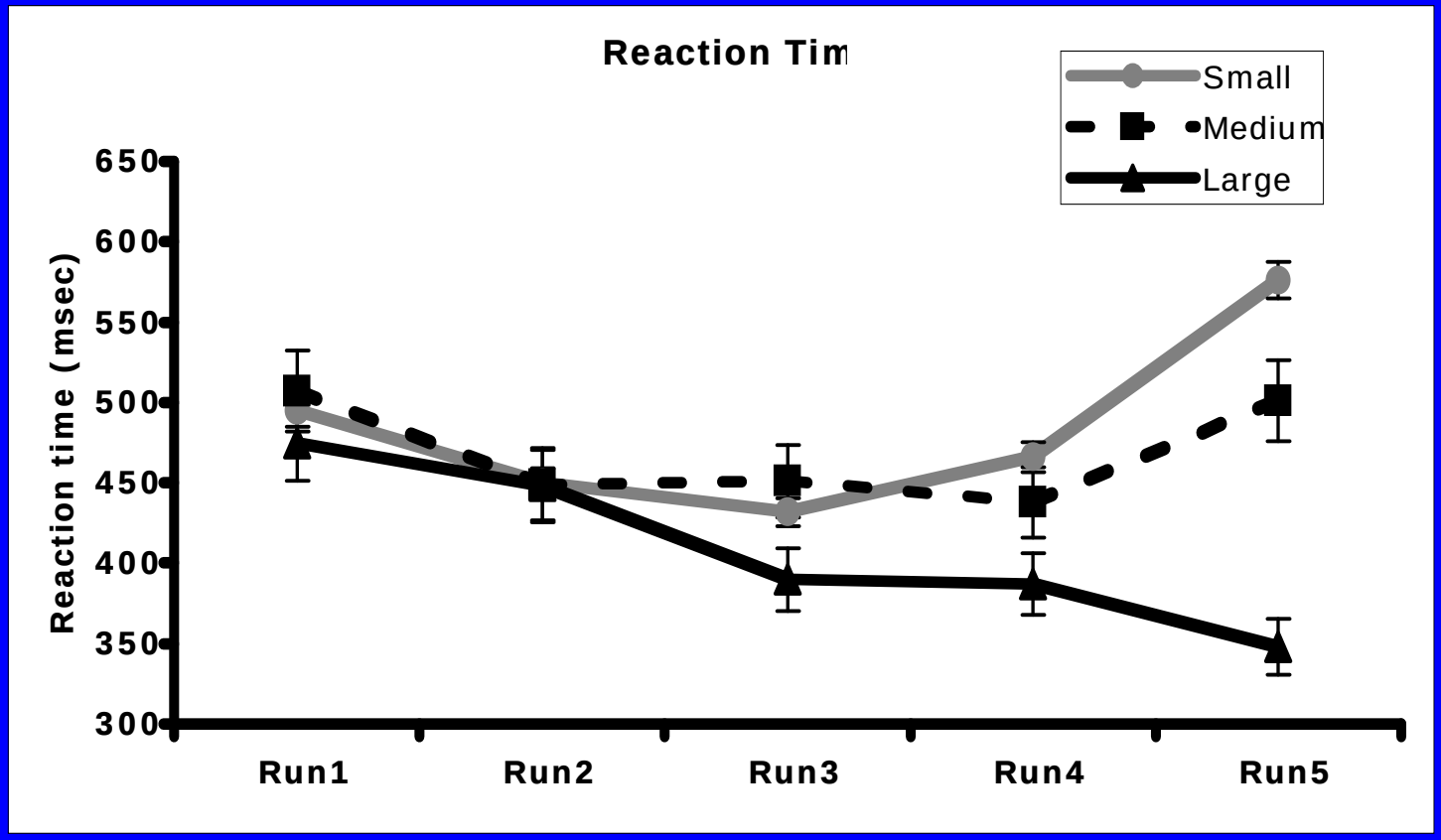
- Thirty-seven participants
  - •12 adults (mean age:25 years; 6 female)
  - •12 adolescents (mean age:16 years; 6 female)
  - •13 children (mean age: 9 years; 7 female)





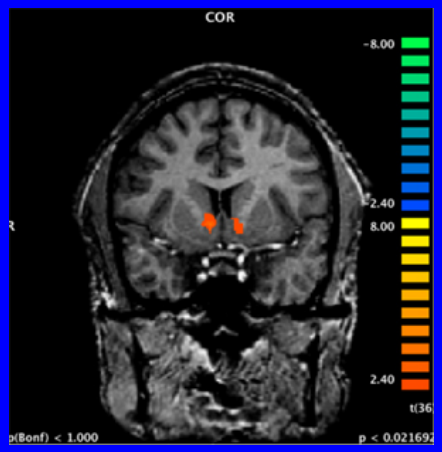


Participants are faster on trials that give the largest reward.

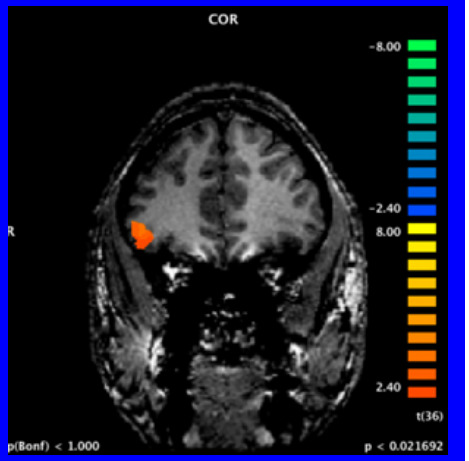


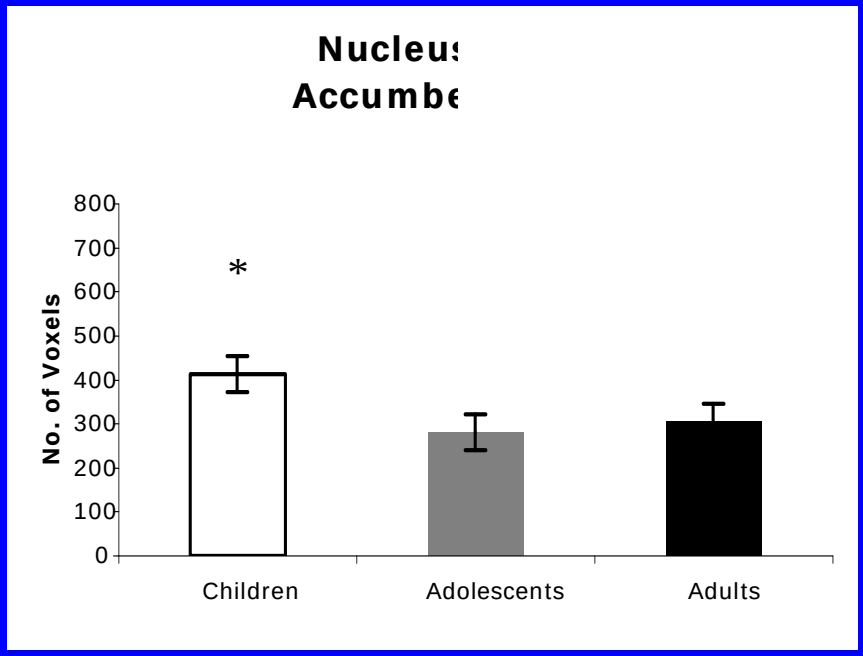
Imaging Results

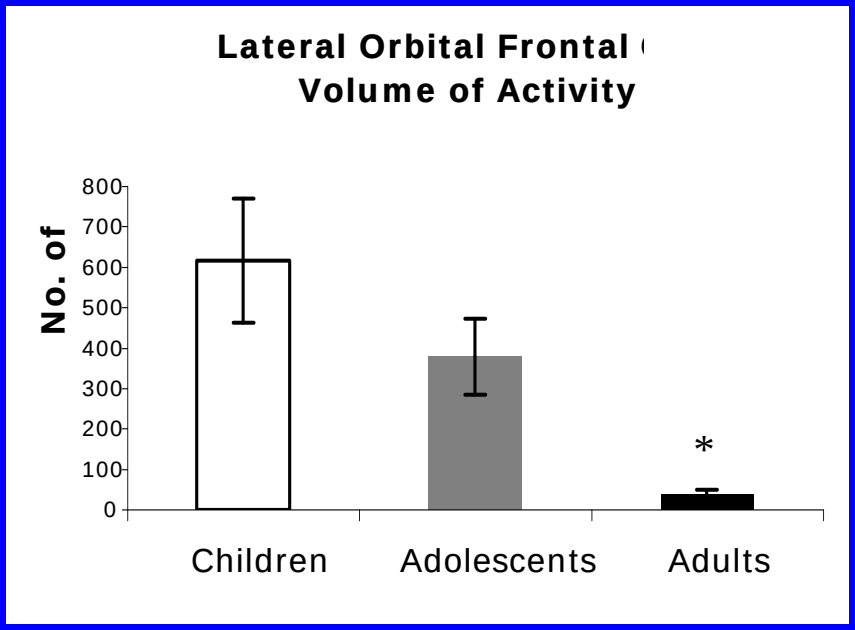
Adolescents are similar to adults in volume of accumbens activity



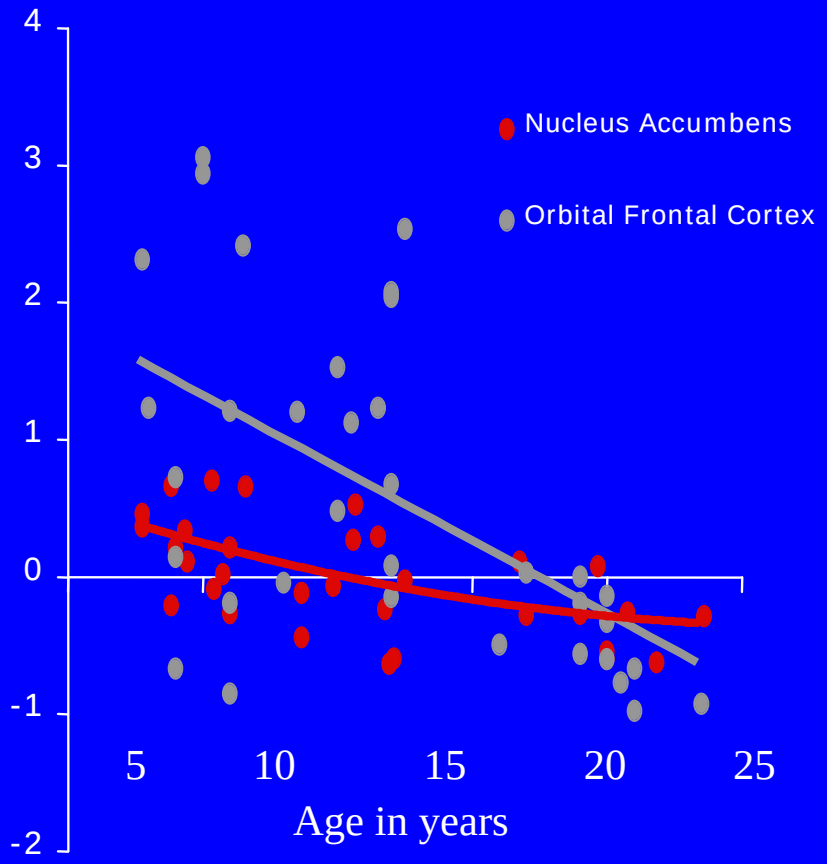
BUT similar to children in prefrontal activity.





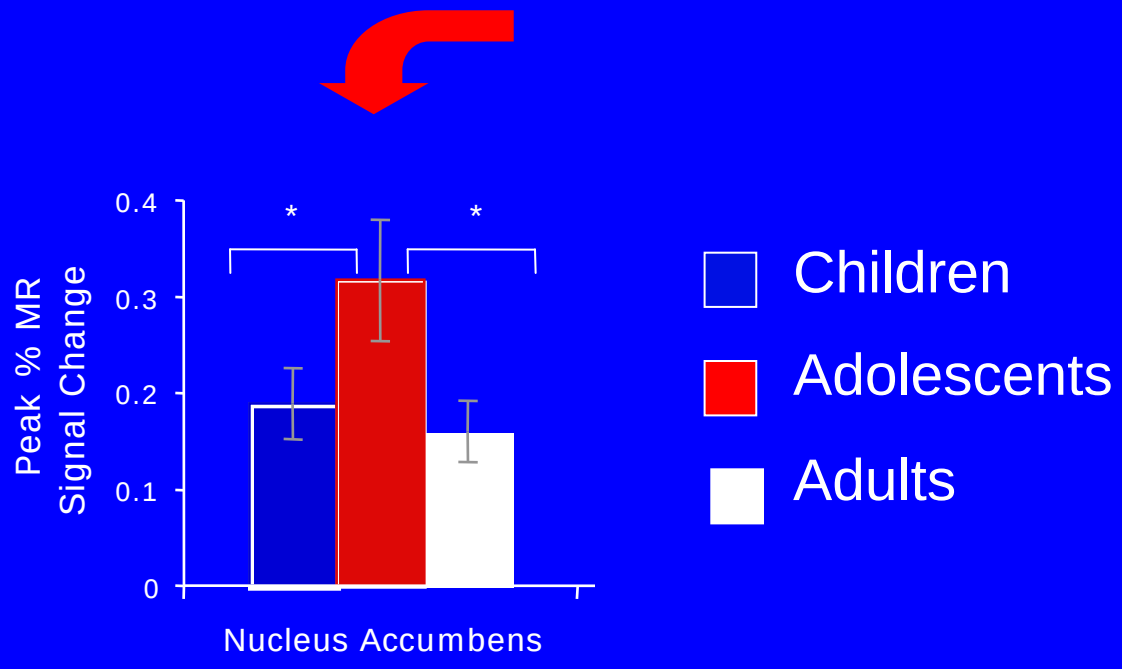


Protracted development of the OFC relative to the accumbens

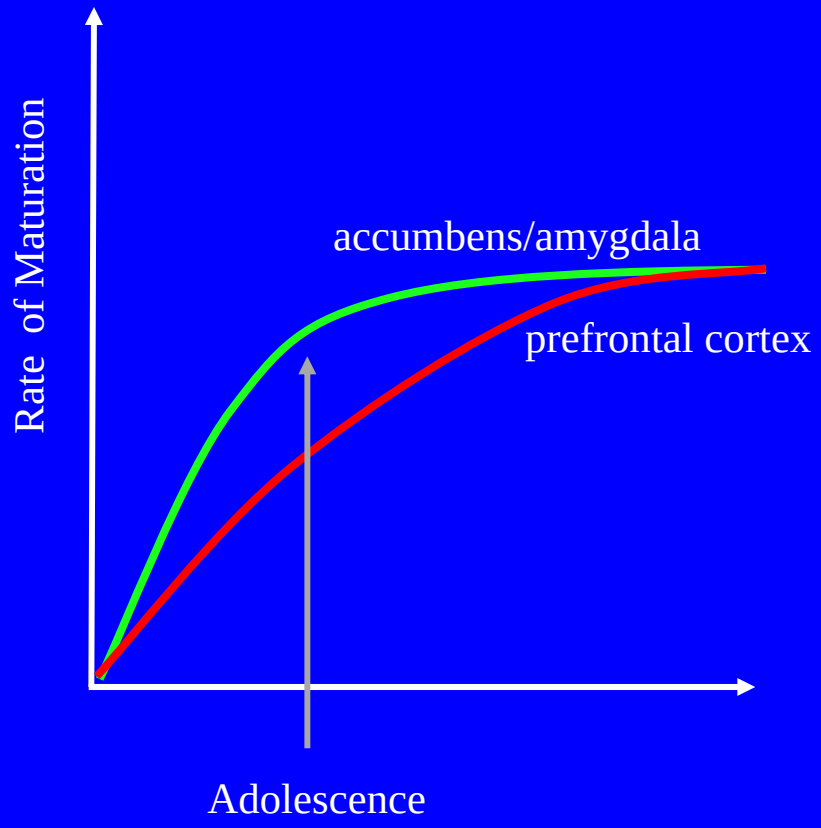


Galvan et al 2006 J Neuroscience

Neural recruitment differs by region for age groups and corresponds to enhanced activity in the accumbens in adolescents.

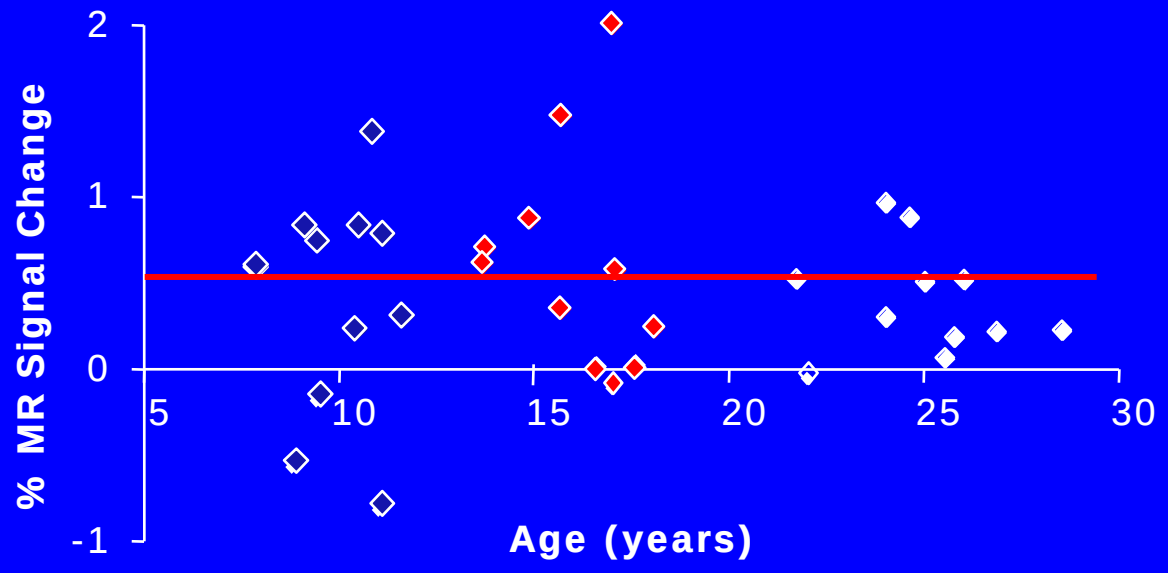


Different Developmental Trajectories

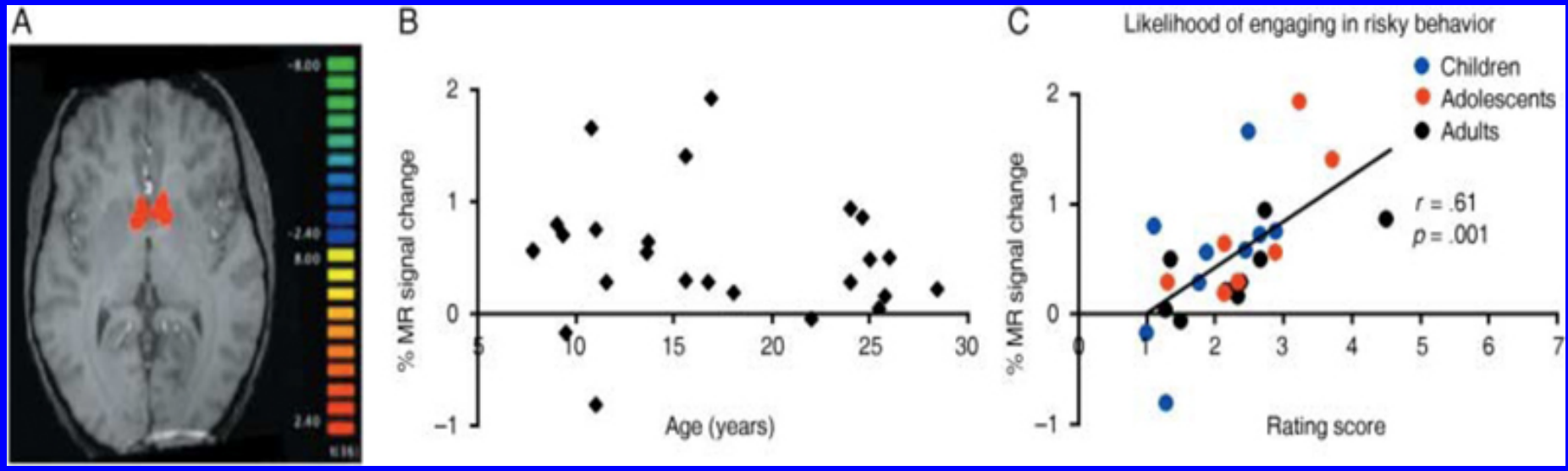


-Differential development of subcortical relative to prefrontal control regions may explain increased engagement in high risk, incentive driven behaviors.

Individual variability in accumbens activity across development

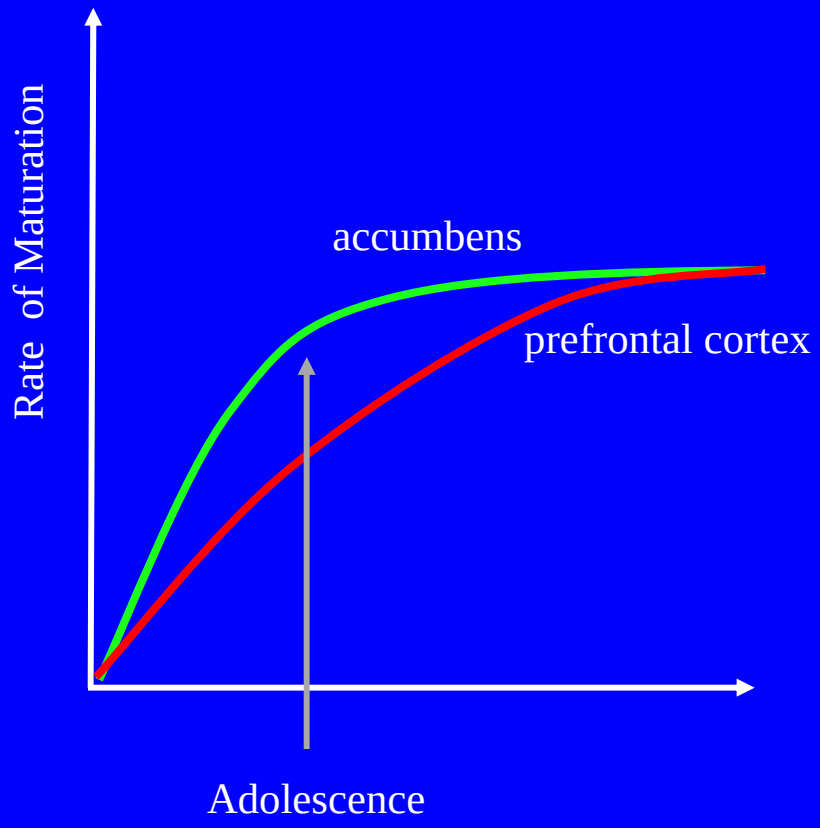


Accumbens activity is correlated with risky behavior



Galvan et al 2006 *Developmental Science*

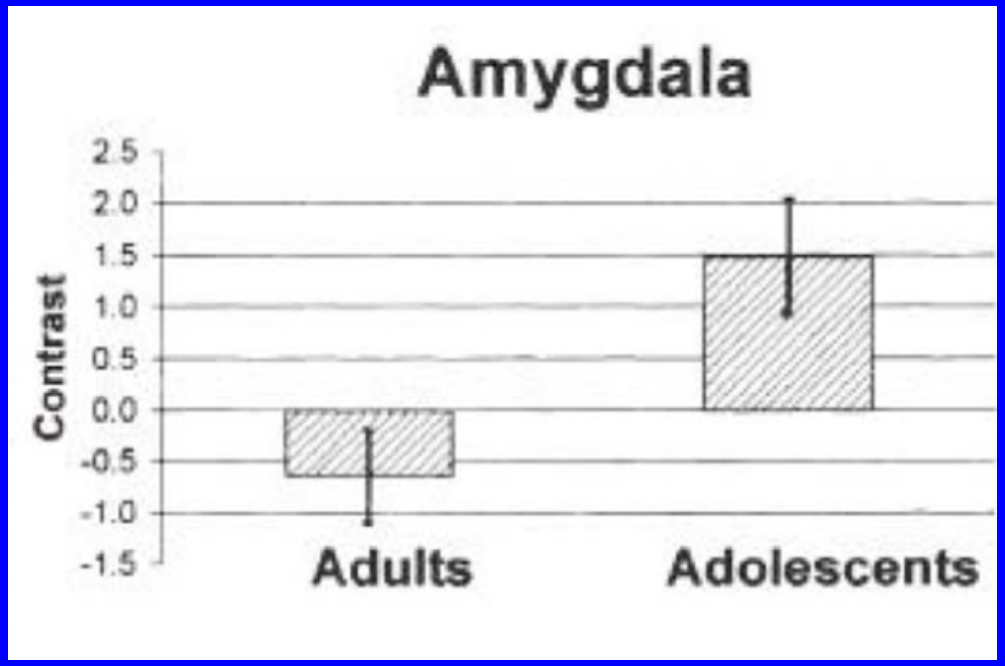
Impulsive and risky behavior



Increased risking taking behavior in adolescence may be related to differential development of limbic subcortical vs. cortical control regions.

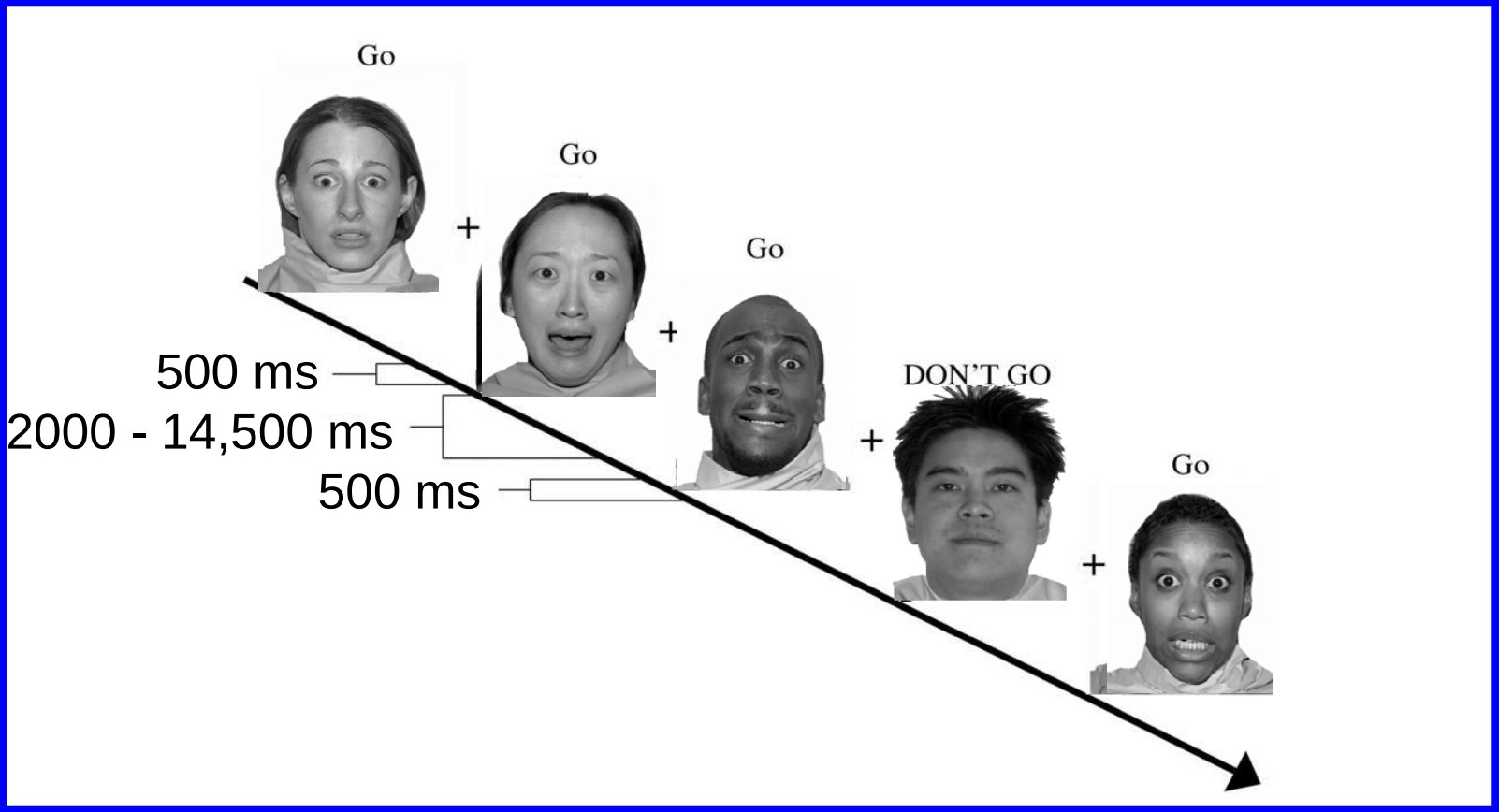
Developmental changes may be exacerbated by individual differences in tendency to engage in risky behavior.

Is there a similar pattern in the amgydala to negative events?



Monk et al 2003 *Neuroimage*

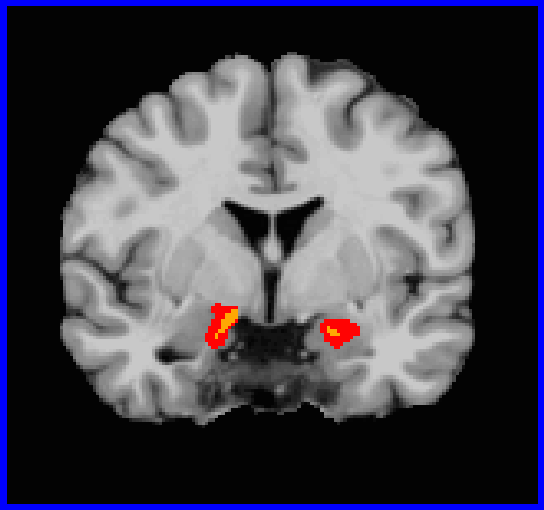
Emotional Go/Nogo Task

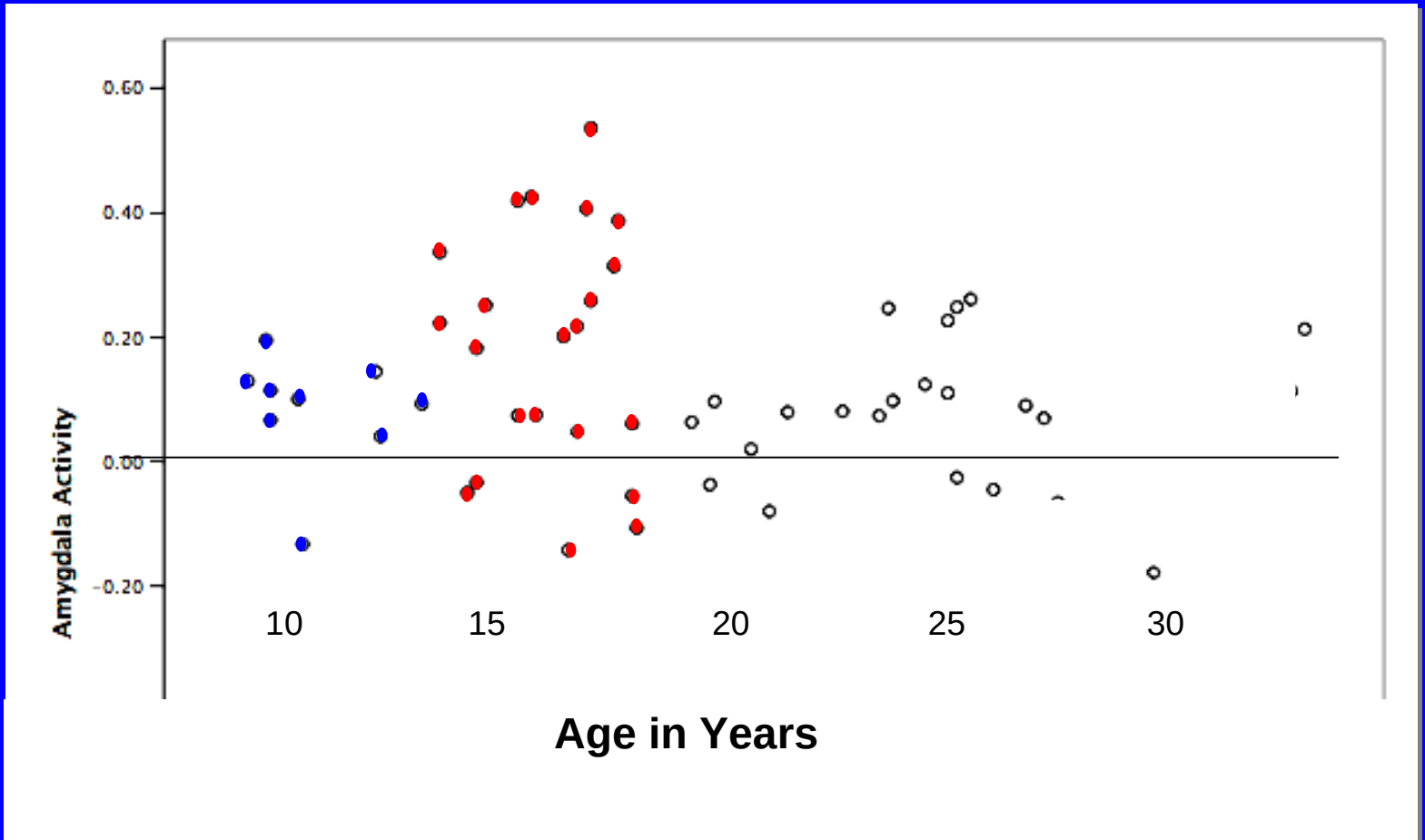


Hare et al 2005 Bio Psychiatry

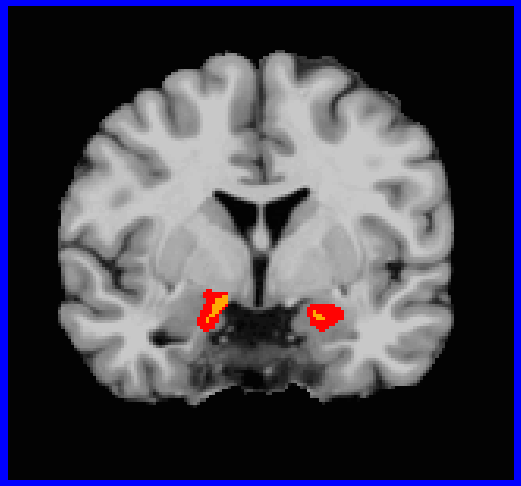
Enhanced activity in amygdala in adolescents relative to children & adults

when approaching negative information

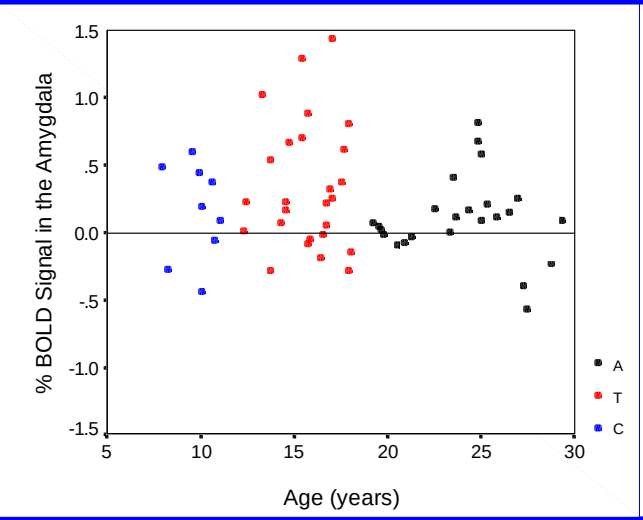




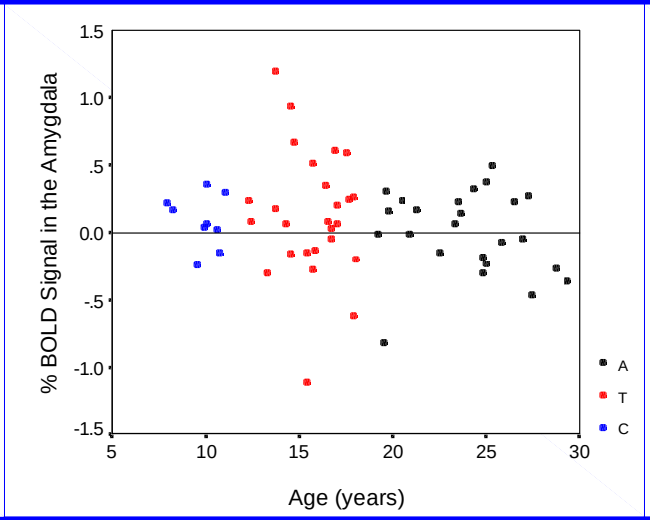
Emotional Reactivity to Empty Threat: initial reactivity versus sustained reactivity



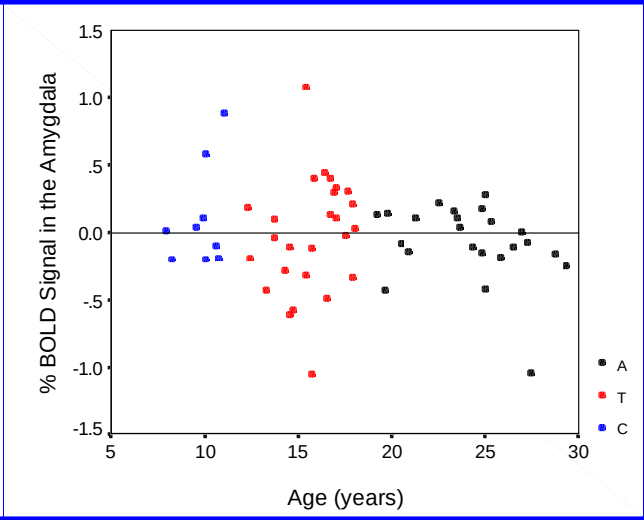
Early Trials



Middle Trials

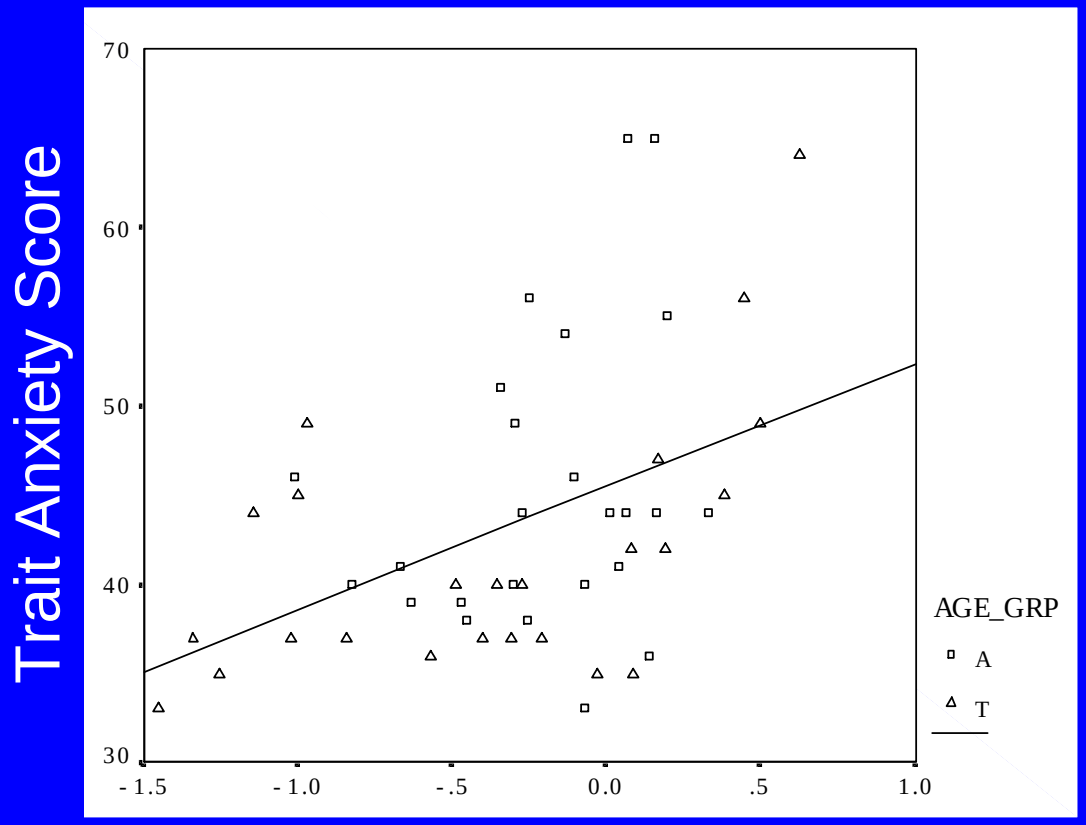


Late Trials

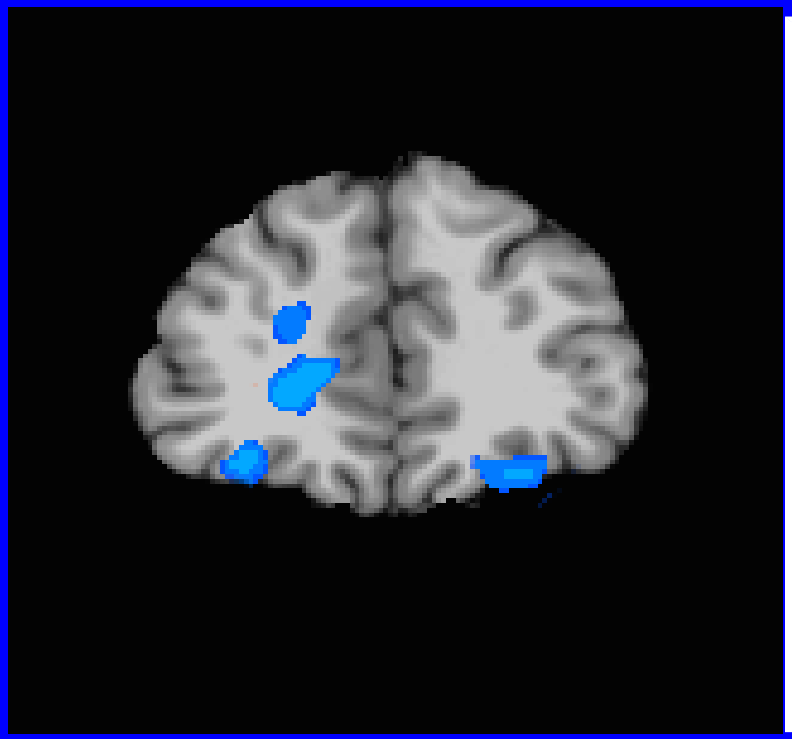


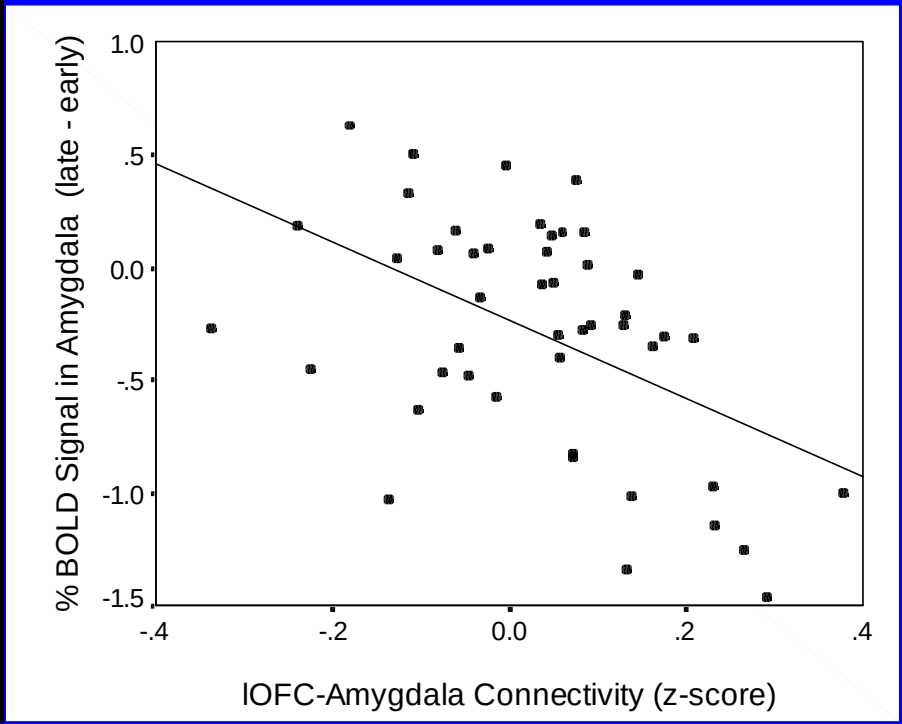
Habituation of Amygdala Response to empty threat related to Trait Anxiety

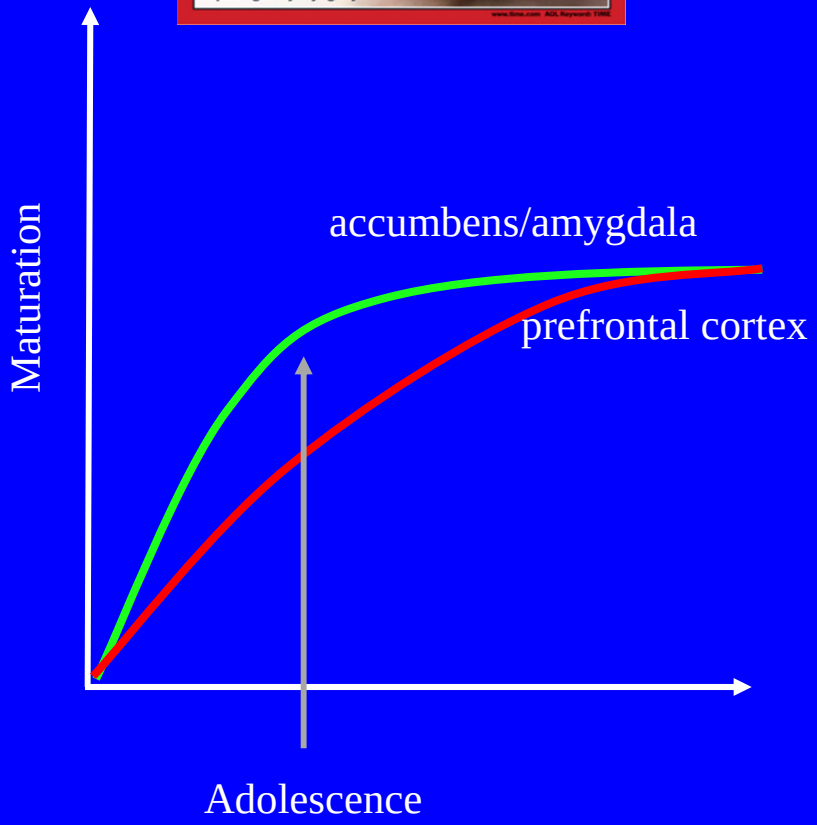
(i.e., decrease in activity from early to late trials)



Functional Connectivity Between Prefrontal Regions and Amygdala is associated with Habituation of Amygdala Response







Conclusions

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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