

# Developmental trajectories in ADHD

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## Learning Objectives



- Know definition of developmental trajectory
- Learn about different types of trajectories
  - Behavioral (ADHD symptoms & co-morbidities)
  - Cognitive
  - Brain development
- Understand how developmental trajectories inform current and future treatment practices

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## Brief Overview of ADHD

- ADHD affects 5-10% of children and ~4% of adults.
- DSM-IV diagnosis: requires 6/9 inattentive sxs and/or 6/9 hyperactive/impulsive sxs
- Affects mostly boys: 9:1 in clinic samples, 3:1 in community
- Impaired social relationships, emotional lability, learning disorders are common

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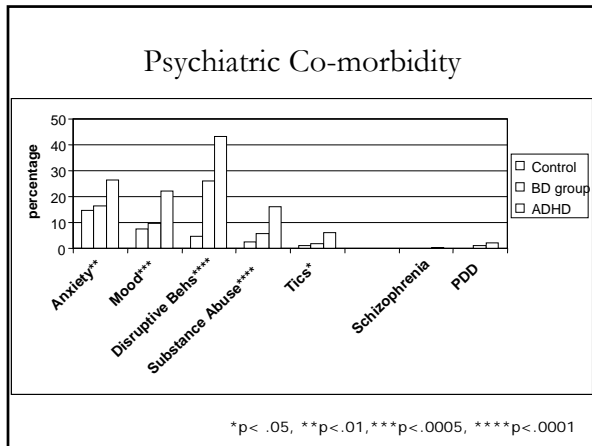
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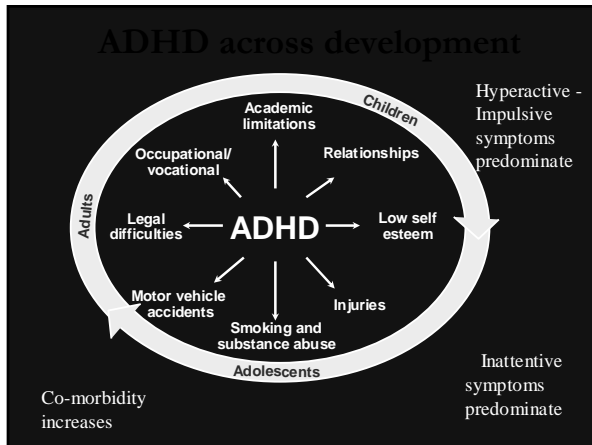
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- ### ADHD in adulthood
- Diagnostic remission is highly variable (ranges from 30-70%)
  - Impairment continues for 60-80%
  - Significant morbidity associated with adult ADHD:
  - Estimates of the annual societal costs of ADHD (health care costs, costs of lost productivity, criminality, and life years lost) range between \$31.6 and \$52.4 billion

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### Million dollar question:

What predicts ADHD remission?



- 'So Yesterday': try to predict from childhood characteristics at single point in time (diagnosis, sx's, treatment, etc....)
  - ADHD severity
  - Greater behavioral impairment
  - Treatment
  - Increased psychiatric comorbidity
  - Poor family functioning (parental psychiatric disorder, family conflict)

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### What predicts ADHD remission?

- 'New & improved': examine developmental trajectory across multiple domains of functioning
- Related Qs:
  - What are the pathways out of ADHD?
  - Are there things we can do to help someone get on the right pathway?

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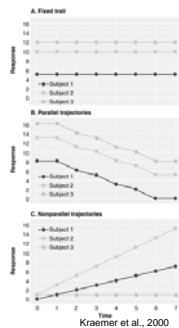
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### What is a developmental trajectory?

- **Trajectory** (Merriam-webster): a path, progression, or line of development resembling a physical trajectory
- **Developmental trajectory:** group of individuals that follow approximately the same developmental course



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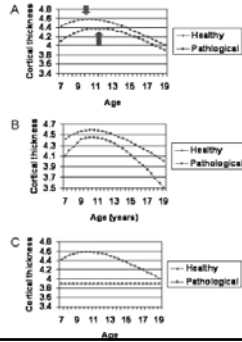
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## Trajectories in child psychiatric disorders

- Developmental deviation (a)-ADHD
- Higher velocity (b)-autism
- Profound deviance (c)-child onset schizophrenia




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## Trajectories of behavioral functioning




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## Trajectories of behavioral functioning

- Most commonly studied predictor
- Lots of heterogeneity: how to identify groups with distinct trajectories?

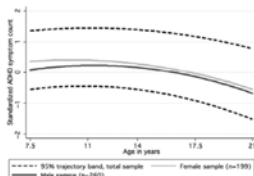


Figure 1 Predicted change in ADHD symptoms across development in male and female youth

Monuteaux et al 2010

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## ADHD subtypes-remission rates

- Into early teens: ADHD-CT: 36%, ADHD-PI: 56%, ADHD-HI: 75% (Lacey & Willcutt, 2010)
- At age 18: ADHD-CT: 30%, ADHD-PI: 35%, ADHD-HI: 69% (Hurtig et al., 2008)
- ADHD-HI appears to be a developmental precursor to ADHD-CT or a mild syndrome from which children often recover.

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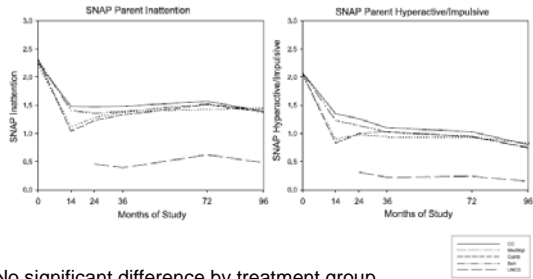
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## MTA 8-yr follow up



- No significant difference by treatment group
- 62% of children taking meds at 14 mo had stopped by 8 yr f/u (Molina et al., 2009)

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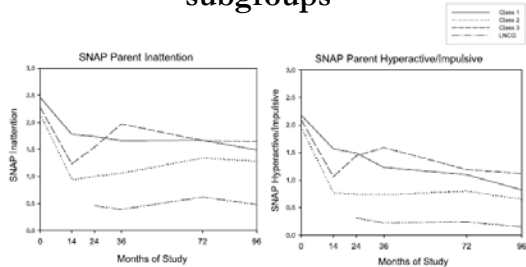
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## Identifying more homogeneous subgroups




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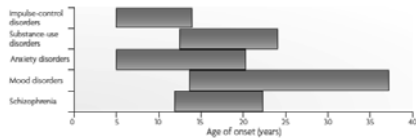
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## Psychiatric co-morbidity

- Number of co-morbidities strongly related to impairment and later functioning.
- Appears to be strongly related to family environment and genetics




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## Psychiatric co-morbidity

- Existing research is extremely limited and primarily correlational (rather than longitudinal)
- Transactional nature of child problems and family functioning hard to capture
  - Positive parenting protects against conduct problems
  - Child disruptive behavior exerted a greater influence on parenting practices than parenting behavior did on child sxs.




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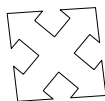
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## Theoretical model of family factors

**ADHD Child**  
 Difficult temperament  
 Emotion dysregulation  
 Locus of control  
 Co-morbid disorders



**Parenting practices**  
 Harsh & coercive (→ODD/CD)  
 More negative/cold (→ODD/CD)  
 Inconsistent (→depression)  
 More controlling (→ anxiety)

**Parent**  
 More likely to be depressed (moms)  
 or abuse substances (dad)

**Family milieu**  
 Increased conflict (→ODD)  
 Decreased cohesion (→CD)




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## Treatment implications

- Child treatments: long-term benefits may be same overall, but well proven to improve functioning of children and in some cases, their families.
- Assess/Treat parent psychiatric conditions
- Parent training (consistency, positive parenting)
- Reduce family conflict/break cycle of coercion

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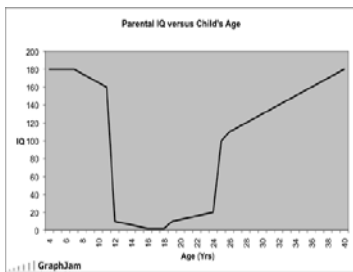
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## Trajectories of cognitive functioning



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## Trajectories of cognitive functioning

- ADHD conceptualized as a disorder of Executive Functioning (EF) (Barkley, 1997)
- Non-EFs such as processing speed, motor coordination, language, visual-motor integration, learning and memory that are also affected.
- Deficits in cognitive functioning well-documented, however, they are 'neither necessary nor sufficient to cause all cases of ADHD' (Willcutt et al., 2005)

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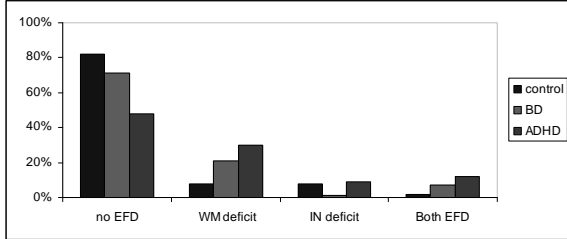
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Executive function deficits occur with greater frequency (~50%) in ADHD




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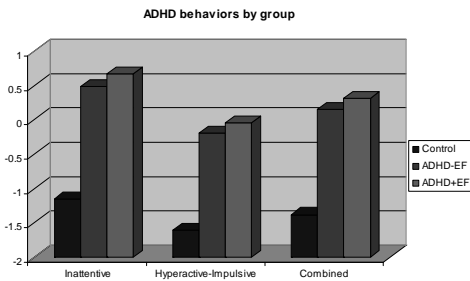
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ADHD behavior ratings are not sensitive to EF deficits




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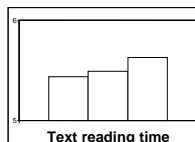
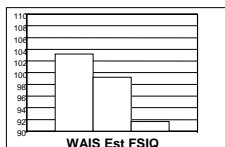
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Effects of EF deficits in ADHD

- While not the cause of ADHD, EF deficits likely contribute to functional impairments.



Control  
ADHD-EF  
ADHD+EF

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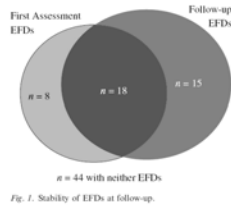
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## Executive function deficits are highly stable & associated with impairment

- ~70% continued to show EF deficits 7 yrs later
- WM performance was highly stable
- Grade retentions
- Tutoring & resource services
- Decreased educational and occupational attainment



Biederman et al 2007

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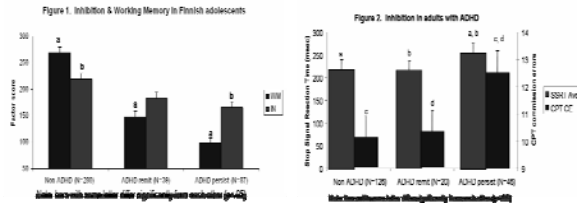
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## EFs in ADHD persistence/remission




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## Are EFs a pathway to recovery?

- EFs may be a compensatory mechanism that diminishes ADHD sxs and reduces impairment
- Implicates neural circuits involved in cognitive control: PFC & caudate, Fronto-parietal but not well studied across development

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## Cognitive training

- Computerized progressive attentional training (CPAT) program (Shalev et al., 2007)-led to improvement on academic tests and inattentive symptoms
- Cogmed Working Memory Training Program (Klingberg et al., 2002; 2005)-resulted in improvement on visual & verbal WM, nonverbal reasoning, & inhibition. Gains maintained at 3 mo follow up.

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## Treatment implications

- Enhancing EFs may be an important step in reducing impairment in ADHD.
- Educational therapy for explicit training of EFs
- Cognitive exercises show promise as effective interventions for slowing cognitive decline in the elderly, needs more exploration for ADHD.
- Combination of meds and cognitive training?

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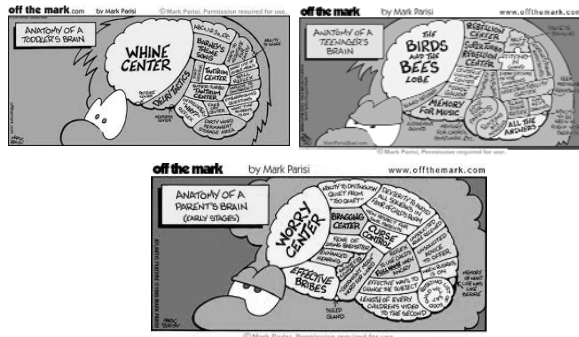
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## Trajectories of neurobiological development




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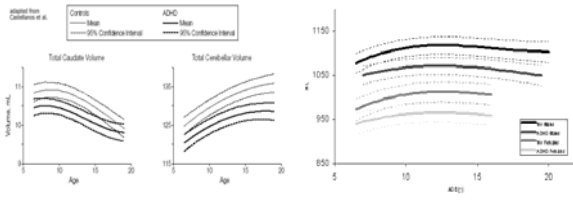
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## Trajectories of neurobiological development

- Neurobiological differences widely reported: smaller brain volumes and lobular volumes, reduced activation in frontal, parietal, striatum




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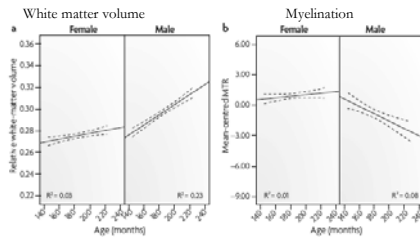
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## New technology and data analyses change the way we measure the brain...




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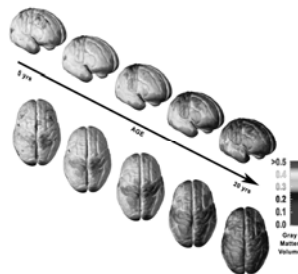
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## Normal brain development

- Brain develops in utero & is ~80% of adult size by 2 yrs. Age 5: brain organization & refinement
- Peak Cortical thickness 10-12yrs depending on region
- Pruning and thinning to facilitate efficient neural transmission for functional brain maturation




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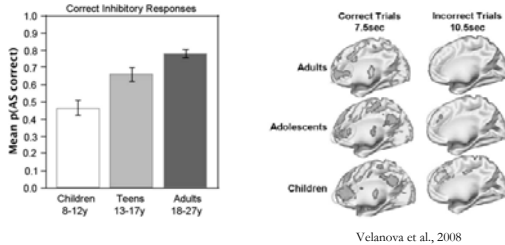
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## Brain maturation

- Improved inhibitory functioning
- Increased specialization and efficiency with age




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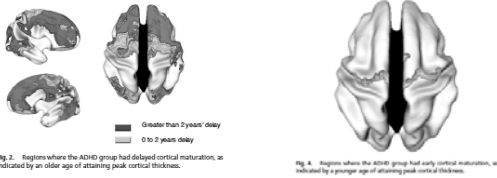
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## Neural development in ADHD

- Delayed cortical maturation supported but the lack of normalization in cognitive and behavioral domains remains an issue.




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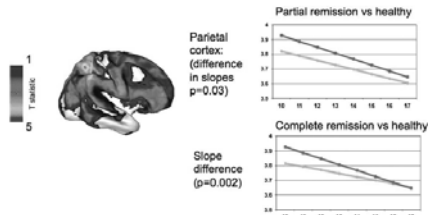
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## Does cortical maturation=outcome?

- Worse outcome – thinning of left medial PFC
- Better outcome – Rt parietal normalization suggests compensatory cortical change
- ADHD remission = normalization of initial delays or deficits in brain networks
- ADHD persistence = more deviant trajectory of brain growth




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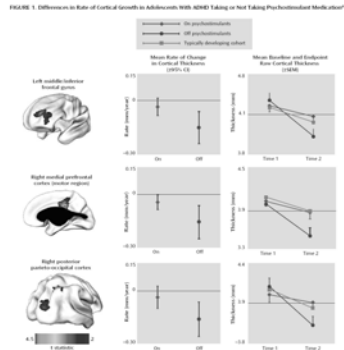
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## Do medications affect cortical development?

- Consistent with more normalized white matter density with meds (Castellanos et al., 2002)
- Meds are related to highly focal (rather than global) changes
- Suggests med effects facilitate use of neural circuits




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## Summary & conclusions

- Examining developmental trajectories may give us more power to understand childhood psychiatric disorders.
- May also allow us to identify pathways out of disorder
- Most studies examine one type of trajectory (behavior, cognitive, neurobiological); we need more integration determine functional significance of findings.

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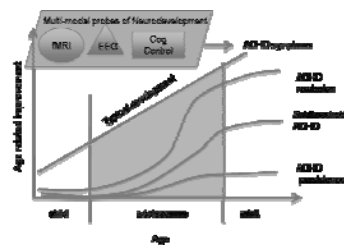
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## Research directions for the future

- Longitudinal studies that integrate brain imaging, cognitive functioning, and behavioral status
- Need more treatment studies that incorporate novel txs and combinations of txs




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## Overall treatment implications

- Need more holistic treatment approaches that treat the child in the context of their family.
- 'Exercising' the neural circuits involved may be key to driving developmental changes in behavior, cognition, and neurobiology.
- Interventions that promote neural growth and lasting improvements in cognitive functioning could be a fruitful avenue of treatment.

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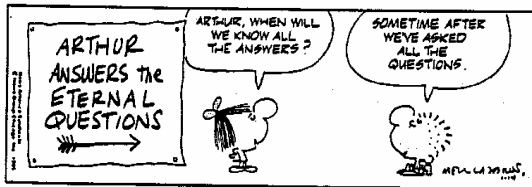
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## Questions & Discussion



<http://faculty.spokanefalls.edu/InetShare/AutoWebs/imp/Cartoons/questions.gif>

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## UCLA Research Studies

(310) 295-7667

- ADHD Genetics Study (6-18 yrs, 2 children available, at least 1 affected)
- ADHD Medication Study (7-14 years)
- Tic/Tourette Syndrome Study (9-14yrs)



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