

# Changing Understandings of ADHD and Motivation

Implications for Educators

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## Outline

1. ADHD as Executive Function Impairment
2. Central mystery of ADHD
3. Cognitive chemistry of motivation & stress
4. Impact of ADHD on motivation
5. Impact of medication on ADHD and stress

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## 1. Change in Understanding ADHD

- ♦ OLD: ADHD = “disruptive behavior disorder of childhood”
- ♦ NEW: ADHD = developmental impairments of brain’s self-management system, its “executive functions”

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## Executive Functions

- ♦ Wide range of central control processes of the brain
- ♦ Connect, prioritize, and integrate cognitive functions—moment by moment
- ♦ Like conductor of a symphony orchestra

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## “Will you do it and, if so, how and when?”

(Lezak, 2004)

Will you do it?	Motivation/Activation
How will you do it?	Planning/Organizing
When?	Timing/Remembering

(Brown, 2013)

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## Executive Functions operate in dynamic, integrated ways

For example, EF of “focus”

- Does not mean
  - as in holding the camera still to take a photo of an unmoving object
- Does mean
  - as in focusing on the task of driving a car

Brown TE. 2005.

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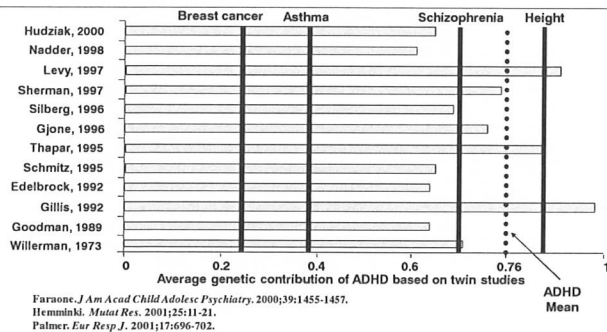
## Prevalence and Genetics of ADHD

- ♦ 9% children; 8.7 adolescents 4.4% adults
- ♦ Male-female: 6:1, 3:1, 1:1
- ♦ All levels of IQ
- ♦ All levels of socioeconomic status
- ♦ Family genetic transmission: 7.6
- ♦ Inheritance not specific to subtype

CDC 2008; Kessler, 2006; Merikangas, 2010; Gaub M, Carlson CL. *J Am Acad Child Adolesc Psychiatry*. 1997;36(8):1036-1045. Levy F, et al. *J Am Acad Child Adolesc Psychiatry*. 1997;36(6):737-744. Smalley SL, et al. *J Am Acad Child Adolesc Psychiatry*. 2000;39(9):1135-1143.

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## ADHD Genetics: Heritability Coefficient



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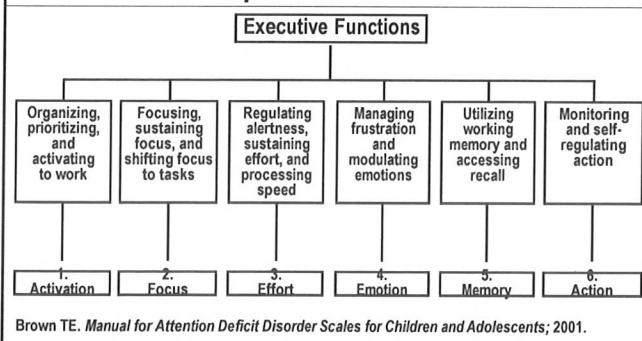
## Brown's Model of Executive Functions Impaired in ADHD Symptom Characteristics

- ♦ Dimensional, not “all-or-nothing”
  - Everyone sometimes has some impairments in these functions; in ADHD, it is a chronic, severe impairment
- ♦ Situational variability: “If I’m interested”
  - Most persons with ADHD have a few activities where ADHD impairments are absent

ADHD looks like a willpower problem, but it isn't!

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## Brown's Model of Executive Functions Impaired in ADHD



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## 1. Organize, Prioritize, and Activate

- ♦ Difficulty organizing tasks, materials
- ♦ Difficulty estimating time, prioritizing tasks
- ♦ Trouble getting started on work

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## 2. Focus, Shift, and Sustain Attention

- ◆ Loses focus when trying to listen or plan
- ◆ Easily distracted—internal/external
- ◆ Forgets what was read, needs to re-read

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## 3. Regulating Alertness, Effort, and Processing Speed

- ◆ Difficulty regulating sleep and alertness
- ◆ Quickly loses interest in task, especially longer projects; doesn't sustain effort
- ◆ Difficult to complete task on time, especially in writing—"slow modem"

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## 4. Manage Frustration, Modulate Emotion

(Not included in DSM-IV criteria)

- ◆ Emotions impact thoughts, actions too much
- ◆ Frustration, irritations, hurts, desires, worries, etc., experienced "like computer virus"
- ◆ "Can't put it to the back of my mind"

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## 5. Utilize Working Memory, Access Recall

- ◆ Difficulty holding one or several things "on line" while attending to other tasks
- ◆ Difficulty "remembering to remember"
- ◆ Inadequate "search engine" for activating stored memories, integrating these with current info to guide current thoughts and actions

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## 6. Monitor and Self-Regulate Action

(Not just hyperactive/impulsive behavior)

- ◆ Difficulty controlling actions, slowing self and/or speeding up as needed for tasks
- ◆ Doesn't size up ongoing situations carefully
- ◆ Hard to monitor and modify own actions to fit situation/aims

Brown TE. *Attention-Deficit Disorders and Comorbidities in Children, Adolescents, and Adults*; 2000. Brown TE. *Manual for Attention Deficit Disorder Scales for Children and Adolescents*; 2001.

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## When Are ADHD Impairments Noticeable?

- ◆ Some are obvious very early and are noticeable in preschool years
- ◆ Some are not noticeable until middle elementary or junior high
- ◆ Some are not apparent until child leaves home to go to college or later

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## 2. The Central Mystery of ADHD: Situational Variability of Symptoms

- ♦ Why focus for this, but not that?  
“If it really interests me” (attraction)
- ♦ Why focus then, but not now?  
“If I feel the gun to my head” (fear)
- ♦ Why is motivation in ADHD so variable in one situation to another?

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## The central mystery of ADHD 2 hypotheses

“Willpower”  
vs  
Erectile Dysfunction of the Mind

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## 3. Cognitive Chemistry of Motivation (for everyone, not just those with ADHD)

- ♦ Emotional value is automatically, uncsly assigned to stimuli (amygdala, medial PFC)  
[how threatening, important, interesting is this?]  
(Damasio, 1994, 1999; Ledoux, 1996, 2002.)
- ♦ The amygdala integrates many types of info, incentive magnitude and valence, response cost, prior learning history, and motivational state to gauge potential rewards. (L. Pessoa, 2013)

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## Stress and Motivation

- ♦ Stress is a reaction to a situation perceived (consciously/unconsciously) as a challenge, threat or burden
- ♦ can motivate action or inaction, which may be productive and/or unproductive
- ♦ Chronic stress can cause hormonal reactions which can impair health

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## How does brain determine motivation to ignore or attend, to do or not do now?

- ♦ **Motivation** is not a unified variable; it is not just “gas in the tank” It is **idiosyncratic and specific** to particular tasks and settings.
- ♦ Each perception, thought or task is instantly screened by the brain’s “google search” that pulls up relevant, unconscious memories throughout cortex; these compete to activate approach, avoidance and/or disinterest

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## How does the brain “google” to choose responses to thoughts or tasks?

- ♦ “amygdala contributes as much to positive reinforcement as to negative” (E. Murray, 2009)
- ♦ “Amygdalar neurons help track gradations of **both positive and negative value** moment to moment” \*
- ♦ Basolateral amygdala integrates info re: response cost, incentive valence & prior learning history to guide decisions re action\*

(L. Pessoa, *The Cognitive-Emotional Brain*.2013)

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**Amygdala**  
Schematic Graph of Amygdala Output by Young et al. (1994)

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### Bottom-Up

Emotions arise from biological processes based on appraisal of perceptions

\*\*\*\*\*

"...each child is born with a profile of temperamental biases...that creates initial tendencies to be vocal or quiet, vigilant or relaxed, irritable or smiling, energetic or lethargic with regard to particular events or situations"<sup>1</sup>

TE Brown, Ph.D. Yale Medical School (1J. Kagan, 2010)

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### Top-Down EF

#### Process Networks of Elicited "Memories"

In ways which can bias attention:

♦ to intensify

AND/OR

♦ to modulate

the way any given stimuli are appraised and responded to

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### 4. Impact of ADHD on Motivation

- ♦ Inherited problem in development of EF infrastructure, (3 yr delay in parts of cortex)
- ♦ Impacts development of networks
- ♦ Impacts communication between networks, (esp. default, working memory)
- ♦ Impacts electro-chemical communication between neurons

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### Chemistry of Motivation in ADHD

- ♦ Dysfunction of dopamine reward pathway has been associated with motivation deficit in ADHD (Volkow, 2009,2010)
- ♦ Yet dysfunction of dopamine reward system is not unitary or constant in ADHD, it is dynamic and situationally specific
- ♦ Motivation deficit in ADHD may be linked to ADHD impairments of working memory & constriction/diffusion of focus

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### Meta-Analysis of 55 fMRI studies of ADHD Children & Adults vs Controls (Cortese, Castellanos, et al, 2012)

- ♦ ADHD involves dysfunctions in multiple large scale brain networks
- ♦ Mostly hypoactivation in control networks
- ♦ Also hyperactivation in default & visual circuits
- ♦ Inconsistency in ADHD results from faulty interregulation between networks

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### Structural & Functional Connectivity in ADHD

- ♦ fMRI and DTI (diffusion tensor imaging) show connectivity between brain regions is impaired in ADHD
- ♦ Shown in default mode network at rest and in failure to attenuate DMN during active task performance
- ♦ Overall white matter volume is reduced in children & adolescents with ADHD

Konrad & Eickhoff (2010); Nagel, Bathula, Herting, et al, (2011)

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### Motivation & Reward Impairments in ADHD

(Volkow, Wang, et al, 2004, 2009)

- ♦ PET scans indicated decreased DA release in reward circuits of adults with ADHD vs controls
- ♦ Also decreased receptors for DA in the accumbens which correlated with attention measures
- ♦ MPH increased motivation for task, PBO did not.

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### How and why do those with ADHD have more problems with motivation?

Children & adults with ADHD experience similar emotions to others of similar age

Yet they have more difficulty in:

- ♦ recognizing,
  - ♦ responding to,
  - ♦ and managing their emotions
- This causes impairments in motivation.

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### How ADHD can affect emotions:

Reactions to small frustrations or transient wishes can gobble up all the space in their mind—like a computer virus

- frustration/anger
- hurt feelings
- “got to have it now”
- “what if?”

→ Emotional flooding/stress

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### Flooding with one emotion

- ♦ While flooded with one emotion, persons with ADHD tend to forget about other relevant facts or emotions

-may forget their love & wish to protect the person—friend, parent, child, co-worker who frustrated or angered them and say or do things that are too hurtful

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### ADHD Working Memory Impairments can bias and impair motivation

- ♦ Is important for holding in mind multiple thoughts and emotions, relevant to any specific situation or task
- ♦ Impairment in working memory is a key aspect of ADHD
- ♦ Often people with ADHD are unable to keep multiple emotions in mind at same time so they can prioritize

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### ADHD “Hyperfocus” can bias and impair motivation

Focused too intensely on one goal or task, they may forget other goals they have or how actions of the moment may affect their bigger picture

like one who is watching a basketball game through a telescope, they may miss other relevant aspects of the situation

living too much in the moment, eg. want to sleep longer in am, may forget boss' warning about excessive lateness

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## Executive Function Networks Depend primarily on 2 chemicals

### dopamine and norepinephrine

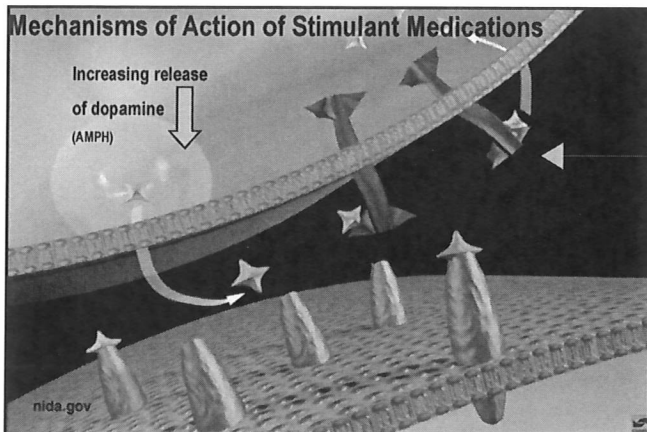
- ♦ control most functions impaired in ADHD
- ♦ brain of person with ADHD makes these chemicals
- ♦ but does not release & reload effectively
- ♦ → control messages often not connecting
- ♦ For 80% medications improve this problem.

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## 5. How Do Medications Alleviate ADHD Sx?

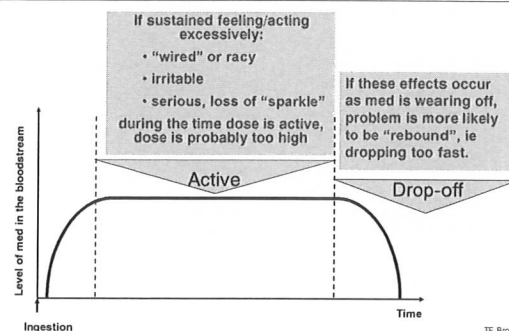
- ♦ Meds slow reuptake +/- increase release of DA or NE
- ♦ Not a cure (eyeglasses, not antibiotic)
- ♦ Alleviate sx only for duration of action
- ♦ Effective amount of stim not related to age, weight or sx severity
- ♦ "Fine-tuning" of meds essential

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## Time Frames and Rebound



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## Clinical Assessments

- ♦ Clinicians should know how to recognize and routinely screen for ADHD in every diagnostic eval
- ♦ Partial response, refractory sx, or patient non-compliance with usual tx for other disorders may be related to unrecognized ADHD

(Barkley & Brown, 2008)

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## Reported Benefits of ADHD meds for treating anxiety & mood problems

- ♦ improved emotional lability as well as core ADHD sx in children
- ♦ improved depressive sx in MDD adults who failed SSRI trial
- ♦ improved stable bipolar pts as add-on to their usual meds
- ♦ Adding stim reduced anxiety sx in pts unresponsive to SSRI alone.<sup>1</sup>

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(<sup>1</sup>Sinita & Coghill, 2014)

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## Key Points

1. Those with ADHD often have chronic difficulties with motivation in many, but not all situations
2. Chemistry of motivation is modulated by complex processes resulting from amygdalar integration of idiosyncratic emotion-laden memories embedded in perceptions and various cognitive networks
3. Working memory & focusing impairments characteristic of ADHD may impair motivation by causing emotional flooding or constricted focus
4. Effective treatment of ADHD with appropriate medication and support may reduce stress and increase productive behaviors

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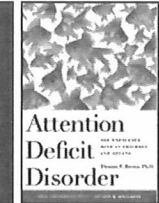
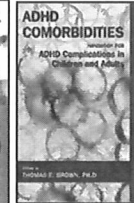
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