New Understandings of ADHD: Executive Function Impairments

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TEBrown, Yale Medical School, 2013
Overview

1. What is the essential problem in ADHD?
2. Brain differences that underlie ADHD
3. Mystery of ADHD: Role of Emotions
4. Working memory “googles” emotions
5. ADHD WM problems bias emotions

TEBrown, Yale Medical School, 2013
What is essential problem in ADHD?

- **Old**: behavior problems & not listening
- **New**: developmental impairment of the brain’s management system: EF
  - Aspects of brain’s EF don’t come online in usual time frame.
  - And don’t work consistently

TE Brown, Yale Medical School, 2013
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

TE Brown, Yale Medical School, 2013
“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

TE Brown, Yale Medical School, 2013
Characteristics of ADHD Symptoms

- **Dimensional, not “all-or-nothing”**
  - Everyone sometimes has some impairments in these functions; in ADHD: 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 willpower problem, but it isn’t!

Brown’s Model of Executive Functions Impaired in ADHD

Executive Functions

1. Activation
2. Focus
3. Effort
4. Emotion
5. Memory
6. Action

1. Organize, Prioritize, and Activate

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

T. Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
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

T. Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
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”

T.Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
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”

T.Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
5. Utilize Working Memory, Access Recall

- Difficulty holding one or several things “online” 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

T. Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
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

T. Brown, Attention Deficit Disorder: The Unfocused Mind in Children & Adults (2005)
Executive Functions are complex and 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

TEBrown, Yale Medical School, 2013
Executive Functions: Development and Demands

- EF capacity develops through childhood, into adolescence, and beyond; it is not fully present in early childhood

- Environmental demands for EF increase with age, from preschool through adulthood

- EF impairments often are not noticeable by age 12 yrs!

TE Brown, Yale Medical School, 2013
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.

TE Brown, Yale Medical School, 2013
Sean
18 years old-college freshman

- On meds for ADHD 8th grade thru 12th
- Honor student in competitive high school
- Varsity athlete, shy in social activities
- No meds in college; fell behind early
- Excessive alcohol, marijuana, computer
- Missed many classes and assignments

“Just their being around…”
2. Brain differences underlying ADHD (temporary and/or longer term)

1. Delay in unfolding of brain development that supports executive functions
2. Impaired white matter connections between brain regions
3. Impaired control of oscillations that coordinate brain region communications
4. Inadequate release/reloading of transmitter chemicals at synapses

TE Brown, Yale Medical School, 2013
Cortex Maturation in ADHD vs NC

- MRI studies of 40K cortex sites in 223 youths with ADHD vs matched controls
- Brain maturation was delayed ~3yrs in specific regions in ADHD youths vs NC
- Frontal areas of cortex slower in ADHD
- Medial PFC developed lagged 5 yrs

(Shaw, et al, PNAS, Nov, 2007)
Is ADHD Brain Wired Differently?

- New model shifts focus from regional brain abnormalities to dysfunction in distributed network organization.
- DTI shows converging evidence for white matter pathology & disrupted anatomical connectivity in ADHD

(Konrad & Eichoff, Human Brain Mapping, 2010)

TE Brown, Yale Medical School, 2013
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)

TE Brown, Yale Medical School, 2013
Chemical Dynamics of Brain also contribute to impairments of ADHD

- Not due to overall “imbalance of chemicals” (not too much/too little salt in soup)
- But to inadequate release and/or reloading of transmitter chemicals in countless infinitesimal network junctions
- Except for “messages” re priority interests or fear of imminent unpleasantness

TE Brown, Yale Medical School, 2013
A Chemical Problem

- ADHD is fundamentally a chemical problem
- Most effective treatment is to change the chemistry with medication
- Unless the problematic chemistry is changed, other interventions are not likely to be very effective
In the Human Brain

- 100 billion neurons
- each one linked to >1000 others
- in complex sub-systems
- that have to “talk to each other”
- using low voltage electrical impulses
- that have to jump across gaps
- so fast that 12 can cross in 1/1000 sec.
The Jungle
Neuron

Synapse

Intertwined neurons
Inside brain >50 different chemicals are continuously made.

Every neuron system uses 1 of them.

Stored in little vesicles near tip of neuron.

When electrical impulse comes, mini-dots of that chemical are released,

cross the gap, fire next neuron, then reload in fractions of a second.
Zips in
Releasing transmitter
Reloading transmitter
How do ADHD Impairments of EF Usually Respond to Medication?

- This wide range of cognitive impairments responds to medication treatment in 70-90% of cases in children, adolescents and adults.

- Symptom improvement varies from modest to very dramatic.

- Adverse effects are usually transient, not significant.
Set Realistic Expectations for Tx Medications do not cure ADHD!

- Cannot realistically promise “there will be no problematic effects” for any medication for any disorder.
- Cannot realistically promise that medication will effectively treat ADHD. ~80% success rate w/stims
- Close collaboration with prescriber is essential for “fine-tuning”
Time Frames and Rebound

If sustained feeling/acting excessively:

- “wired” or racy
- irritable
- serious, loss of “sparkle”

during the time dose is active, dose is probably too high

If these effects occur as med is wearing off, problem is more likely to be “rebound”, ie dropping too fast.
Misuse of ADHD Medications

- Many students take meds without scrip
- May be helpful, but can cause trouble
- If you have prescribed meds, protect them from theft
- Protect yourself from “borrowers”
1. Essential problem in ADHD is developmental impairment of EF
2. Those with ADHD usually can focus well for some tasks
3. Inherited brain differences underlie ADHD.
4. Tailored medication treatment helps 80%
Books by Thomas E. Brown, Ph.D.
(www.DrThomasEBrown.com)

- “Smart but Stuck: Emotions in Teens and Adults with ADHD” – 2014
- “A New Understanding of ADHD in Children and Adults: Executive Function Impairments” – 2013
- “Attention Deficit Disorder: The Unfocused Mind in Children and Adults” - 2005