ADHD
Two Attentions
One Deficit

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January 7, 2015
ADHD Classic Presentation

 Symptoms
  - Inattention
  - Hyperactivity
  - Impulsivity

 Prevalence 5%

 Cause - unknown

 Treatment – Ritalin, extra time for tests
ADHD Genetics

ADHD adults fail to utilize the most efficient pathway to process information in an attention-based task.

Attention Network

The Cingulo-Frontal-Parietal Cognitive/Attention Network

Default Mode Network
Cortical Thickness

In the brains of individuals with ADHD, the cortex is thinner in areas related to EF.
Functional Connectivity
Brain Volume: Age 6-20
ADHD: Delayed Growth

AGE: 6

ADHD

HEALTHY CONTROLS
Neurologic Function Discoveries

Deficits in ADHD neurological function

– Pathways with decreased “traffic”

Blue: paths unique to “Normal” brains
Red: paths unique to ADHD brains
Executive Functions

- Time sense
- Modulation of activity and arousal
- Focus or attention
  - selection
  - maintenance
  - modulation
  - termination
- Organization, planning and prioritization
- Task skills:
  - initiation
  - perseverance
  - withdrawal/resumption
  - shifting
  - completion
- Self-assessment, self-awareness
- Emotional self-modulation
Executive Function

- The brain’s capacity to allow us to separate action and reward.
- Allows us to execute goal-directed behavior across time.
- Normal development allows increasingly complex, prolonged separation of action and reward.
Executive Function Developmental Perspective

- EF develop in children as a function of brain growth/development.
- Teaching methods presume prior brain development.
- Kids are “moving targets” of progress in brain development.
- At least 20% of children lag peers in brain development—thus, in EF
Normal executive function presumes an interplay of cognitive and emotional motivators.

- **Just do it.**
  - Cognitive Attention

- **I’m lovin’ it.**
  - Emotional Attention
## Motivation

<table>
<thead>
<tr>
<th>Cognitive motivation</th>
<th>Emotional motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Just do it”</td>
<td>“I’m lovin’ it”</td>
</tr>
<tr>
<td>Importance-based performance</td>
<td>Interest-based performance</td>
</tr>
<tr>
<td>Modulated, adjustable</td>
<td>Powerful, not adjustable</td>
</tr>
<tr>
<td>Durable, enduring, high availability</td>
<td>110% or absent</td>
</tr>
<tr>
<td>Willfully engaged</td>
<td>Passively experienced</td>
</tr>
<tr>
<td>Time sensitive</td>
<td>Time blind</td>
</tr>
<tr>
<td>Socially aware</td>
<td>Socially blind</td>
</tr>
</tbody>
</table>
Motivation Drives Exec Fx

Cognition

Task Initiation
Task Completion
Attention
Self-Awareness

Emotions

Cognitive Task Initiation
Emotional Task Initiation
Cognitive Task Completion
Emotional Task Completion
Cognitive Attention
Emotional Attention
Cognitive Self-Awareness
Emotional Self-Awareness
Observer’s View of Attention

Emotional intensity

Blah-ness

Time’s passage
Interplay of 2 Attentions

Time's passage

Emotional intensity
Blah-ness

Emotional attention
Cognitive attention
ADHD adults fail to utilize the most efficient pathway to process information in an attention-based task.

ADHD Affects All Executive Functions

<table>
<thead>
<tr>
<th>Impaired EF</th>
<th>Observed Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>inattention, distractibility</td>
</tr>
<tr>
<td>Sustained effort</td>
<td>“not trying”, poor follow-through</td>
</tr>
<tr>
<td>Modulation of impulse</td>
<td>poor self-control, risk-taking</td>
</tr>
<tr>
<td>Organization</td>
<td>disorganized locker/backpack, schedule</td>
</tr>
<tr>
<td>Social skills</td>
<td>may not play well with others, loses friends</td>
</tr>
<tr>
<td>Self-observation</td>
<td>unaware of behavior, emotions, effectiveness, others</td>
</tr>
<tr>
<td>Emotional self-control</td>
<td>poor frustration tolerance, lack of empathy</td>
</tr>
</tbody>
</table>
Pattern of Function—ADHD

Emotional intensity

Blah-ness

Normal

ADHD

Time’s passage

Importance-based performance

Interest-based performance
ADHD is a Disability of Executive Function

- Impairs the ability to separate action and reward
- ADD/ADHD is a disability of the “To-Do” mechanism of the brain.
  - Not a disability of interest-based function
  - Disability of importance-based function
- Affects every action, every second
- Disrupts every life path
ADHD concept

Children with ADHD:

Lack the basic, learned self-control mechanism which school is designed to rehearse.
Learn to attend and function by artificially inducing emotional engagement
Interest-based production when possible
Anxiety and shame otherwise
ADHD is a Disability
Not a Disease

Marlon Shirley

• Amputee age 5
• Paralympics Gold Medal winner for USA in 100m and 200m sprints
• World record holder in men’s 100m sprint for single amputees – 10.97 sec
Prevalence of ADHD

Range of estimates

- Avg estimate
- High estimate
Risks of ADHD

ANNUAL DEATHS due to ADHD (USA):

- 4,000 MVA deaths
- 1,200 suicides
Risks of ADHD

Calculated effect of ADHD on life expectancy:

7 year decrease in adults with AD/HD*

3 year decrease in adults with heart disease.

*Calculation R. Barkley due to increased smoking, obesity, decreased medical compliance, exercise in adults with AD/HD.
Risks increase for ADHD adults

Success decreases for ADHD adults

### Annual Cost of ADHD (US)

Billions of dollars in the USA

<table>
<thead>
<tr>
<th></th>
<th>Annual Societal Cost</th>
<th>Annual Medical Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Disease</td>
<td>$50 B</td>
<td>$500 B</td>
</tr>
<tr>
<td>Diabetes</td>
<td>$162 B</td>
<td>$124 B</td>
</tr>
<tr>
<td>ADHD Children</td>
<td>$45 B</td>
<td>$10 B</td>
</tr>
<tr>
<td>ADHD all ages</td>
<td>$143-266 B</td>
<td>$12 B</td>
</tr>
</tbody>
</table>
Accommodations for ADHD students

**Medication-optimized**
- Review and reinforce academic routines

**Not optimized**
- Replace deficient self-controls with external controls
  - Monitor task completion
  - Coordinate with parents who must do the same in evening
  - Provide intermittent rewards
  - Provide frequent reminders to sustain attention, effort
  - Individualize motivational structure
  - Token behavioral reward systems
  - Workload reduction
Teaching ADHD Students

General strategies:
- Increase emotional engagement
- Support executive function

Adopt “Disability Model”

30% rule—ADHD students can maintain the executive function of a child 30% junior.
- 6th grader—3rd grade function
- 9th grader—5th grade function

Do not teach organizational/functional methods
- You may require use of a method
- Must follow up and reward use of the method

Do not expect to withdraw support
Teaching ADHD Students

Increase emotional engagement.

- Maintain rewarding environment
  - Reward every positive thing you can
  - 10:1 ratio of positive encouragement to correction.
- Touch can be very effective
  - Polite, respectful, positive, low-key, appropriate
  - Hand on shoulder/back to signal “pay attention”
Teaching ADHD Students

- Increase emotional engagement.
  - Allow students to work in areas of interest whenever possible.
  - To create a rewarding environment, take a lesson from video games:
    - State objective clearly
    - Provide feedback on progress
    - Reward frequently
    - Reward immediately
    - Reward visibly
    - Small tokens are adequate
Teaching ADHD Students

Increase emotional engagement.

– Time outs should deprive a student of a rewarding environment.
  - Physically separate from rest of class
  - Involve assignment (worksheet) that must be complete to return to class
  - Time out can be proportionate: 2-sheet, 3-sheet
  - Return to class setting without comment

– Threats of harm can be effective, are not desirable.
Teaching ADHD Students

Increase emotional engagement.
  – Participatory events effective
  – Peer tutoring effective
  – Students teaching younger students highly effective
  – Work done should be rewarded
  – Cash awards are very effective. (Get over it.)
Teaching ADHD Students

Support executive function

- Reward/consequence at “point of performance”.
  - Teachers cannot augment homework performance
  - Parents cannot augment school performance
  - Daily report cards effective through high school

- Feedback immediate
  - Example:
    - Assign class 20 math problems
    - Raise hand when two completed
    - Score and encourage (or repeat)
  - Grades impact performance only when prompt
# Daily Report Card

<table>
<thead>
<tr>
<th></th>
<th>Homework turned in</th>
<th>Listened</th>
<th>Participated</th>
<th>Assignment in planner</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>History</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Band</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Teaching ADHD Students

Support executive function

- Extended time may not be effective
  - ADHD students work best against a deadline
  - Multiple short deadlines often more effective
Teaching ADHD Students

Parent sends note to Josh’s first hour teacher:

“Josh had a rough morning.
• “He didn’t eat breakfast or finish his morning chores. Please have him eat his fruit and some protein. A banana and a yogurt are what I offered, but whatever you have there is fine.
• “He still needs to brush his teeth and make his bed. Check under the quilt; he doesn’t always straighten the sheets well.
• “Have him return his brother’s tape player and put it away!
• “I’ll post his chore scores on our family website Friday or next Monday at the latest. Let’s keep in touch. Feel free to contact me anytime. Thanks.”
Teaching ADHD Students

Support executive function

- Schoolwork best done in school
  - Hard deadline (end of class period) improves function
  - Teachers available for guidance
  - Allowing *any* work at home guarantees that *most* work will be left for home
  - Parents generally ill-equipped to help
  - Work at home is generally very inefficient

- Until 6th grade, homework does not improve performance or indicate progress
  - It does give direct feedback on the parent’s level of executive function
  - Memory drills—math and spelling—may be an exception.
Teaching ADHD Students

Support executive function

- When homework is assigned, parents need tools to assume executive function support at home:
  - Prior missing work
  - Actual assignment
  - Deadline for completion, waypoints

- When dealing with late/missing assignments
  - Parents need same day feedback to help correct
  - Students need same day feedback to adjust
  - “Automatic failure” for late assignments may be counter-productive for most ADHD students.
Accommodation Summary

- Teachers and parents cooperate to extend support from home to school and back

- ADHD children (and their parents) need:
  - Timely grade reports
  - Accurate assignment details
  - Immediate behavioral feedback
ADHD Treatment
Medication increases dopamine

Serial PET Brain Images Showing Striatal Dopamine Transporter Receptor Occupancy After Receipt of a Single Dose of Immediate-Release or Osmotic-Release Methylphenidate in 2 Healthy Subjects

Concerta

Ritalin
Medication Effects

Behavioral improvements often profound:
- Control of attention
- Control of activity
- Self-esteem

Academic improvements
- Standardized test scores improve
- Self-esteem improves
- Reduced absenteeism
- Reduced grade retention
- Efficient use of time improves
- Strattera may improve dyslexia
Medication Effects

Improvements in home and family life
- Mothers reduce controlling behaviors
- Family time and participation improves
- Parent stress decreases
- Overall quality of life improves

Driving Improvements
- Stimulants and Strattera improve attention while driving
- Daytrana decreases collisions
- Driving improvements in simulator studies:
  - Concerta-15 hours
  - Adderall XR-9 hours
  - 3 doses methylphenidate-9 hours
Problems when we *don’t* treat ADHD medically

Per cent of children whose score declined from 4\textsuperscript{th} to 7\textsuperscript{th} grade.

Who Should Take ADHD Medication?

Everyone with AD/HD should undergo trials of medication.

Everyone who responds well should take the medications.
Medication classifications

Stimulants
Long-acting Stimulants
Non-stimulants
## Stimulant duration of effect

<table>
<thead>
<tr>
<th>Medication</th>
<th>Brand Name</th>
<th>Duration of action (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylphenidate Transdermal(^1)</td>
<td>Daytrana</td>
<td>Up to 16</td>
</tr>
<tr>
<td>Lisdexamfetamine(^2)</td>
<td>Vyvanse</td>
<td>10-14</td>
</tr>
<tr>
<td>OROS Methylphenidate(^3)</td>
<td>Concerta</td>
<td>10-12</td>
</tr>
<tr>
<td>Mixed amphetamine salts XR(^4)</td>
<td>Adderall XR</td>
<td>9-12</td>
</tr>
<tr>
<td>Dexmethylphenidate XR(^5)</td>
<td>Focalin XR</td>
<td>8-10</td>
</tr>
<tr>
<td>Methylphenidate ER (SODAS)(^3)</td>
<td>Ritalin LA</td>
<td>6-10</td>
</tr>
<tr>
<td>Methylphenidate SR</td>
<td>Ritalin SR</td>
<td>6-8</td>
</tr>
<tr>
<td>Methylphenidate</td>
<td>Ritalin, others</td>
<td>3-4</td>
</tr>
</tbody>
</table>

## Nonstimulants

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Trade Name</th>
<th>Duration of action (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomoxetine&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Strattera</td>
<td>&gt;24</td>
</tr>
<tr>
<td>Bupropion SR&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Wellbutrin SR</td>
<td>12</td>
</tr>
<tr>
<td>Bupropion XL&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Wellbutrin XL</td>
<td>24</td>
</tr>
<tr>
<td>Guanfacine&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Tenex</td>
<td>12-24</td>
</tr>
<tr>
<td>Guanfacine XR&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Intuniv</td>
<td>24</td>
</tr>
<tr>
<td>Clonidine&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Catapres</td>
<td>6-12</td>
</tr>
<tr>
<td>Clonidine XR&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Kapvay</td>
<td>12-24</td>
</tr>
</tbody>
</table>

SR, sustained release; XL, extended release

How safe are ADHD medications?
Risk with stimulants

Effects on growth:

Short-term

Children with ADHD are slightly shorter and weigh less than peers.

Stimulants cause growth in height and weight to slow for at least two years.

Long-term

By year 4, growth is almost normal.

Final adult height is not significantly changed.
Stimulant risks

Risk of sudden death ages 5-21

<table>
<thead>
<tr>
<th>Population</th>
<th>Risk Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>General population</td>
<td>0.8 per 100,000/year</td>
</tr>
<tr>
<td>Stimulant users</td>
<td>0.5 per 100,000/year</td>
</tr>
</tbody>
</table>
Risk of atomoxetine—Strattera

Risk of *non-fatal* liver damage:
1 in 1,000,000

Risk of *fatal* auto accident, with monthly 5-mile trip to pharmacy for 1 year:
1 in 1,000,000
Side effects diminish with *constant* use.
Treatment Strategies

Improving efficacy and duration
Evaluate symptoms frequently

VANDERBILT ADHD DIAGNOSTIC PARENT RATING SCALE

<table>
<thead>
<tr>
<th>Patient Name:</th>
<th>Date of Birth:</th>
<th>Grades:</th>
</tr>
</thead>
</table>

| Each rating should be considered in the context of what is appropriate for the age of your child. |

<table>
<thead>
<tr>
<th>Frequency Code</th>
<th>0 = Never; 1 = Occasionally; 2 = Often; 3 = Very Often</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Does not pay attention to details or makes careless mistakes, such as in homework</td>
<td>3</td>
</tr>
<tr>
<td>2. Has difficulty sustaining attention to tasks or activities</td>
<td>2</td>
</tr>
<tr>
<td>3. Does not seem to listen when spoken to directly</td>
<td>2</td>
</tr>
<tr>
<td>4. Does not follow through on instruction and fails to finish schoolwork (not due to oppositional behavior or failure to understand)</td>
<td>2</td>
</tr>
<tr>
<td>5. Has difficulty organizing tasks and activities</td>
<td>3</td>
</tr>
<tr>
<td>6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort</td>
<td>2</td>
</tr>
<tr>
<td>7. Loses things necessary for tasks or activities (school assignments, pencils, or books)</td>
<td>3</td>
</tr>
<tr>
<td>8. Is easily distracted by extraneous stimuli</td>
<td>3</td>
</tr>
<tr>
<td>9. Is forgetful in daily activities</td>
<td>3</td>
</tr>
<tr>
<td>10. Fidgets with hands or feet, or squirms in seat</td>
<td>3</td>
</tr>
<tr>
<td>11. Leaves seat when remaining seated is expected</td>
<td>3</td>
</tr>
<tr>
<td>12. Runs about or climbs excessively in situations when remaining seated is expected</td>
<td>3</td>
</tr>
<tr>
<td>13. Has difficulty playing or engaging in leisure activities quietly</td>
<td>3</td>
</tr>
<tr>
<td>14. Is “on the go” or often acts as if “driven by a motor”</td>
<td>3</td>
</tr>
<tr>
<td>15. Talks too much</td>
<td>3</td>
</tr>
<tr>
<td>16. Blurs out answers before questions have been completed</td>
<td>3</td>
</tr>
<tr>
<td>17. Has difficulty waiting his or her turn</td>
<td>3</td>
</tr>
<tr>
<td>18. Interrupts or intrudes on others (butts into conversations or games)</td>
<td>3</td>
</tr>
</tbody>
</table>
Optimize Efficacy

- Increase dose until intolerable, then reduce
- Repeat scales at every visit.
- If one medication gives an inadequate response, try another
- Consider combination therapy.
Benefits of combination therapy

Stimulants Improve Dopamine Pathways

Non-stimulants Improve Norepinephrine Pathways
Efficacy: combination therapy

Symptom reduction with combination therapy

Meds, psychosocial support or both

MultiModal Treatment Study in children with ADHD for 14 months in 579 children ages 7-10

[Graph showing normalization rates for different treatment groups]

Arch Gen Psychiatry. 1999 Dec;56(12):1073-86
Effect of medication

Medications for ADHD
- normalize brain function
- improve self-control
- improve control of attention
- improve decision-making

Medications allow the practice of self-control
Thank you!

Questions?

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January 7, 2015