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Speaker (Honoraria):

- Yachad, Union of Orthodox Jewish Associations, Brooklyn, NY
- Archimede – ADHD Association, Padua, Italy
- Chesapeake Academy, Virginia Beach, VA
- Kansas City Children's Mercy Hospital & Midwest ADHD Conference, Kansas City, MO
- Lines & Thoughts, ADHD Association of Israel, Tel Aviv
- US Navy Hospital, Portsmouth, VA
- Medical College of Wisconsin – Dept. of Psychiatry
- Forman School, Litchfield, CT
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ADHD and Aggression: The Role of Executive Functioning and Its Implications for Management

Russell A. Barkley, Ph.D.

Clinical Professor of Psychiatry
Virginia Treatment Center for Children
Virginia Commonwealth University Medical Center
Richmond, VA

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Sources:

- Barkley, R. A. (2015). *Attention deficit hyperactivity disorder: A handbook for diagnosis and management* (4th ed.). New York: Guilford Press
- Barkley, R. A. (2012). *Executive Functions: What They Are, How They Work, and Why They Evolved*. New York: Guilford Press.
- Barkley, R. A. (2011). *The Barkley Deficits in Executive Functioning Scale*. New York: Guilford.

Email: drbarkley@russellbarkley.org
Websites: russellbarkley.org, adhdlectures.com

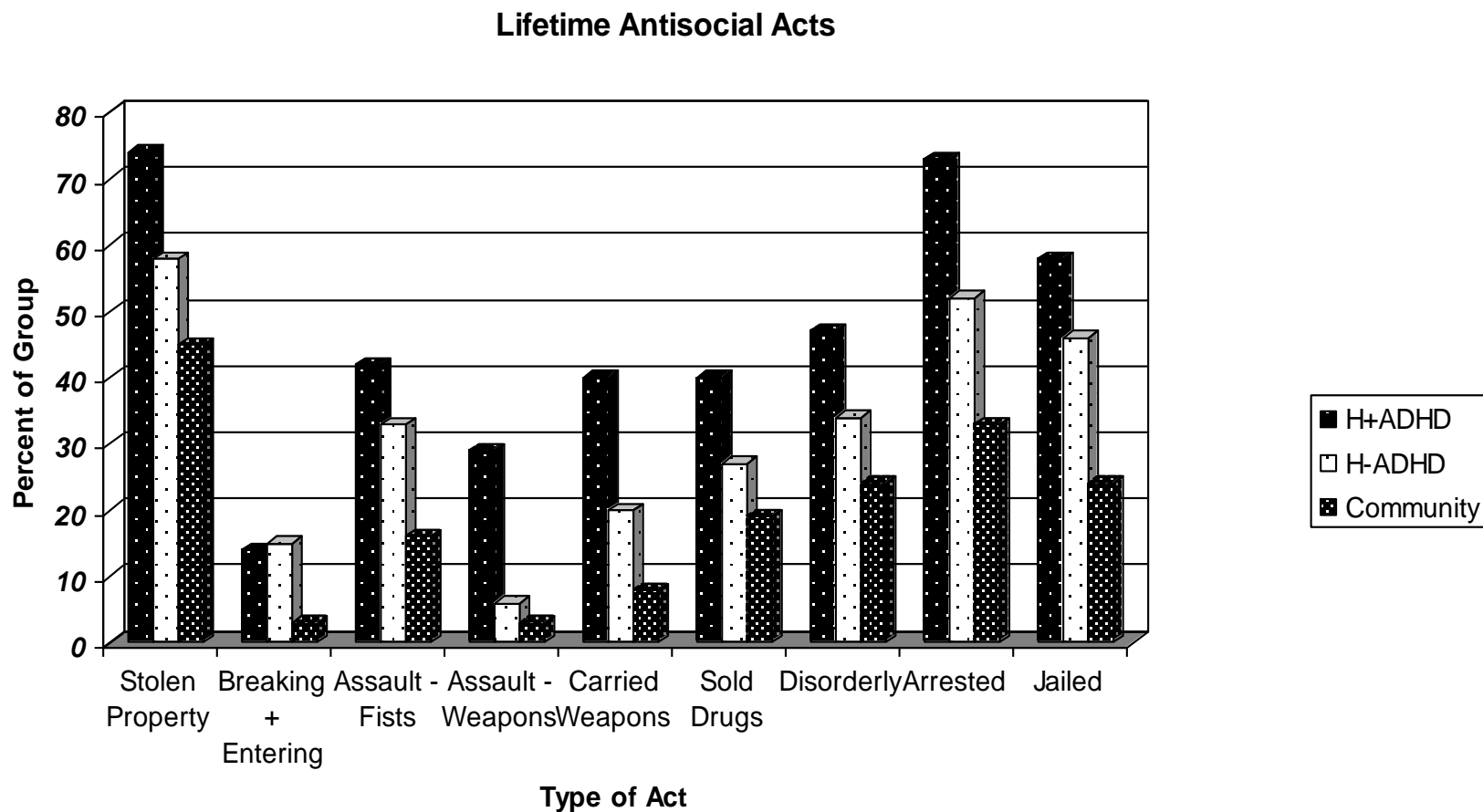


What is ADHD? DSM-5 Criteria

- Developmentally Inappropriate Symptoms
 - Two lists of inter-related symptoms (Inattention, Hyperactive-impulsive)
 - To be a symptom it must occur “Often” or more frequently
 - Need to have 6 (or 5 for adults) symptoms from either symptom list
 - Parenthetical clarifications added for teens and adults (untested)
- Childhood Onset (Symptoms - Impairment)
 - Age 12 (treat as being flexible – 16 is better)
 - Unless acquired secondary to neurological injury
- Cross-setting Occurrence of Symptoms
- Significant Impairment
- Corroboration of self-reports through others
- Exclusion of Other Disorders
- No Subtypes – Just “presentations” emphasizing current symptoms: Inattentive, Hyperactive, or Combined Types

ADHD & Antisocial Activities

Milwaukee Longitudinal Study (age 27)



H+ADHD = Hyperactive as a child and still ADHD at adult outcome (4+ symptoms and 1+ impairments):

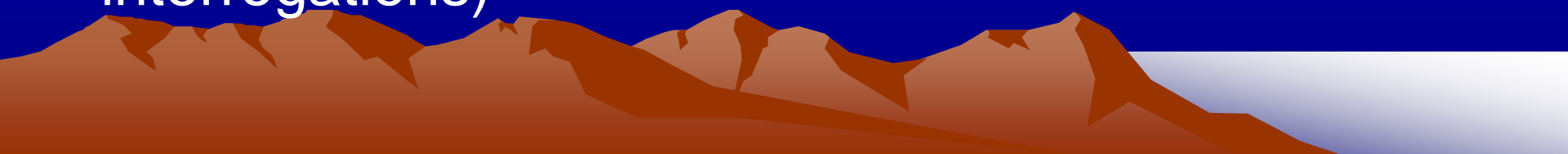
H-ADHD = Hyperactive as a child but is not diagnosable as ADHD at adult outcome;

Controls = Community control group

Dimensions of Antisocial Acts

- Predatory:
 - Mugs, fights, carries & uses weapons
 - Related chiefly to CD
- Self-sufficiency:
 - Runs away, steals money, prostitution
 - Associated with CD
- Drug-related:
 - Possesses, uses, & sells drugs; steals
 - Related to both CD and ADHD

Other Findings of Antisocial Activity

- More frequent episodes of impatience, frustration, anger, and violent actions and of greater intensity
 - Higher rates of reactive aggression on provocation
 - More likely to engage in intimate partner violence as teens and young adults
 - Greater risk of engaging in “road rage” while operating a motor vehicle
 - Greater propensity for untruthfulness in and highly variable self-reporting of prior antisocial activities (also higher likelihood of false confessions during interrogations)
- 

Other Contributing Factors to Antisocial Activities

All are more likely in ADHD cases:

- Comorbid mood disorders (besides ODD and CD)
- Low parental monitoring of teen activities
 - Parent may also have ADHD that impairs parenting & monitoring
 - Single parent household – father abandonment
- Greater conflict among family members
 - Arguments, greater expressed emotion, aggression,
- Deviant peer affiliations
 - Related to father absence, low monitoring, poor school achievement, criminogenic neighborhoods
- Substance use and abuse
 - Linked to impulsivity, deviant peers, low monitoring, and parental substance use
- Parental Disorders – ADHD, ASP, SUDS

Comorbid DSM-IV Disorders

- Oppositional Defiant Disorder (40-84%; M = 55%)
- Conduct Disorder (15-56%; Mean = 45%)
- Anxiety Disorders (20-35%; odds = 3.0)
- Major Depression (25-35%; odds = 5.5)
- No elevated rates of PTSD except in comorbid CD/ODD and especially Bipolar cases (22-24%)
 - Early abuse/neglect does not predispose to ADHD
- Autistic Spectrum Disorders (22%)
 - 28-52% of ASD cases have ADHD or Sluggish Cognitive Tempo
- Bipolar Disorder (0-27%; likely 6-10% max.)
 - Not elevated in follow-up studies (2-3%); Could be a one-way comorbidity? (80-97% BPDs have ADHD but only 2-3% of ADHD cases have BPD)
- All require separate management, but some ODD and CD symptoms may decrease with medication management of ADHD with earlier management likely being most optimal

Understanding the Symptoms of ADHD

The two dimensions of neuropsychological deficits are in:

1. **Hyperactivity-Impulsivity (Executive Inhibition)**

- Deficient motor inhibition (restless, hyperactive)
- Impaired verbal inhibition (excessing talking, interrupting)
- Impulsive cognition (difficulty suppressing task irrelevant thoughts, rapid decision making;
- Impulsive motivation (prefer immediate gratification, greater discounting of delayed consequences)
- **Poor emotional inhibition and self-regulation** (impulsive affect; poor “top down” emotional self-regulation)
- Restlessness decreases with age, becoming more internal, subjective by adulthood

More on ADHD

Inattention: But 6 types of attention exist – not all are impaired in ADHD. What is?

Executive Attention (& Functioning)

- Poor persistence and **self-motivation** toward goals, tasks, and the future (can't sustain attention/action over time)
- Distractible (impaired resistance to responding to goal-irrelevant external and internal events)
- Deficient task re-engagement following disruptions (skips across uncompleted tasks)
- Impaired **working memory** (forgetful in daily activities, cannot remember what is to be done)
- Diminished **self-monitoring and awareness**
- Thus, at least 6 of 7 executive functions are implicated in this understanding of ADHD

Executive Functioning:

Nature and Problems

From R. A. Barkley (2012). *The Executive Functions: What They Are, How They Work, and Why They Evolved*. New York: Guilford Press



Current Status of EF

- A term used extensively in education, psychology (especially neuropsychology), psychiatry, neuroscience, and other disciplines
- Typically regarded as “*those cognitive abilities needed for goal-directed action*” but little agreement exists beyond this
- Considered to be an umbrella term (meta-construct) that comprises a set of interacting mental abilities but no consensus exists on why they qualify as EF or on how many
Some consensus that EF serves as the basis for self-regulation but little effort has been made to explain the link
- Argued as being humanity’s highest faculty, but why?
- Largely mediated by the brain’s prefrontal cortex but not exclusively so

Serious Problems with the EF Construct

- Lacks a consensus theory— just vague descriptions, component lists, and thematic diagrams
- Lacks any consensus definition
 - More than 20 definitions exist
 - Most emphasize self-regulation, goal directed behavior, and planning and problem-solving
- Recent reviews consider EF to be a “meta”-construct or “umbrella” term for a set of numerous specific components
 - Up to 33 components have been attributed by experts to meta-construct of EF
 - Yet there is no definitional or operational basis for making such a determination – how does an EF and non-EF mental ability differ?
 - And factor analytic studies of EF batteries often reveal a single, large construct with smaller (weaker) dimensions often reflecting method variance (the tests given)
- As a result, assessment batteries and their component tests vary widely
- And there is great controversy over whether ADHD is a disorder of EF given the marked variability in results of studies using such tests
- So why not just abandon the term altogether? (Koziol, 2015)

Does ADHD = EFDD?????

(Executive Function Deficit Disorder)

The Neuro-Anatomy and
Neuropsychology of ADHD Virtually
Guarantee It!



Neuro-Imaging Findings

All 7 major functional brain networks involve the cortical, basal ganglia, thalamic, and cerebellar regions. [There are likely 17 minor networks]

In ADHD we find smaller (3-10%), less activity (10-25%+), and delayed development (2-3 yrs.) in these brain regions:

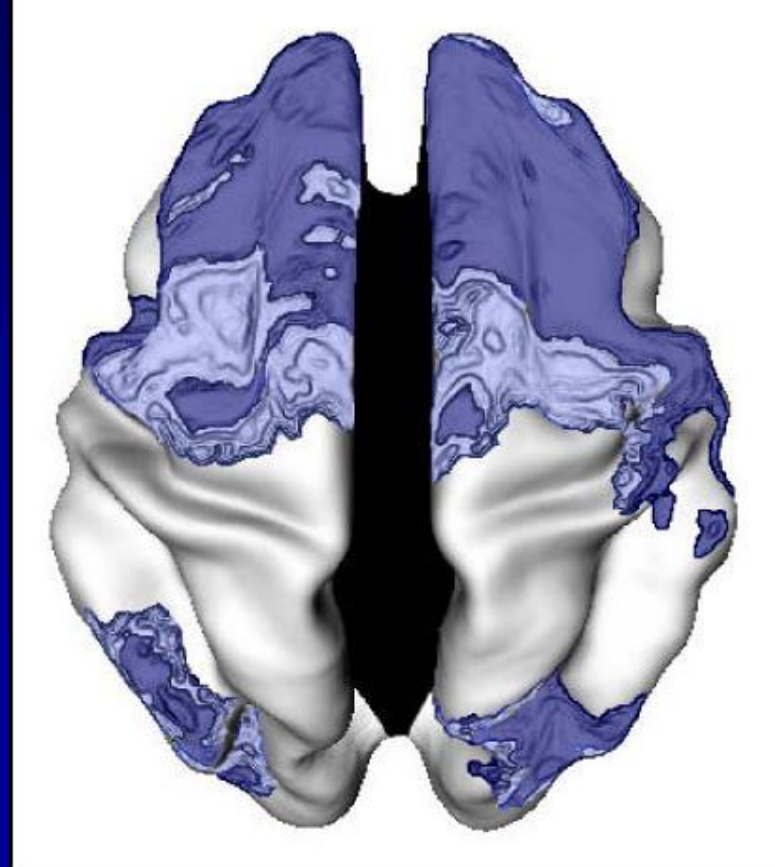
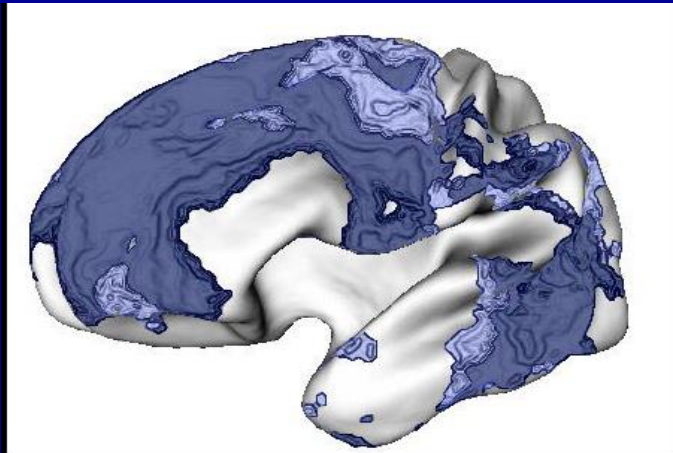
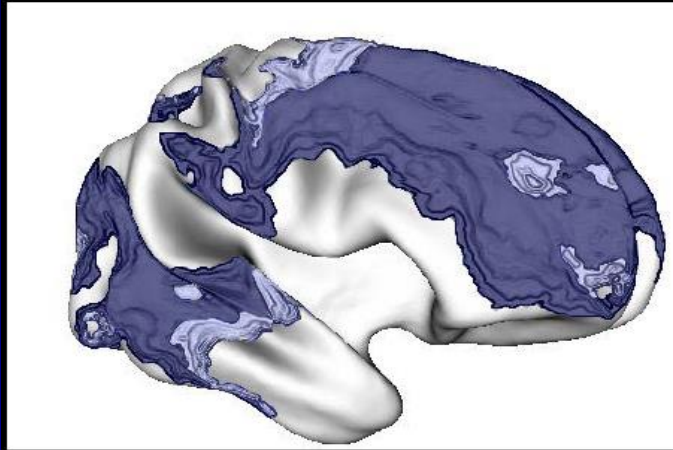
- Orbital-Prefrontal Cortex (primarily right side)
- Basal Ganglia (mainly striatum & globus pallidus)
- Cerebellum (central vermis area, more on right side)
- Anterior cingulate cortex
- Amygala
- Hippocampus and Thalamus (??)

More Neuro-Imaging Results

- Size of these regions is correlated with degree of ADHD symptoms, particularly inhibition
- No substantial gender differences
- Structural differences in volume persist to late adolescence then some normalization
- Functional differences may persist into adulthood in most cases, especially in frontal-parietal regions
- Results are not due to taking stimulant medication
- Indeed, longer term use of stimulants has been associated with improved growth in these regions (neuroprotection)

Delayed brain growth in ADHD (3 yrs.)

From Shaw, P. et al. (2007). ADHD is characterized by a delay in cortical maturation.
Proceedings of the National Academy of Sciences, 104, 19649-19654.



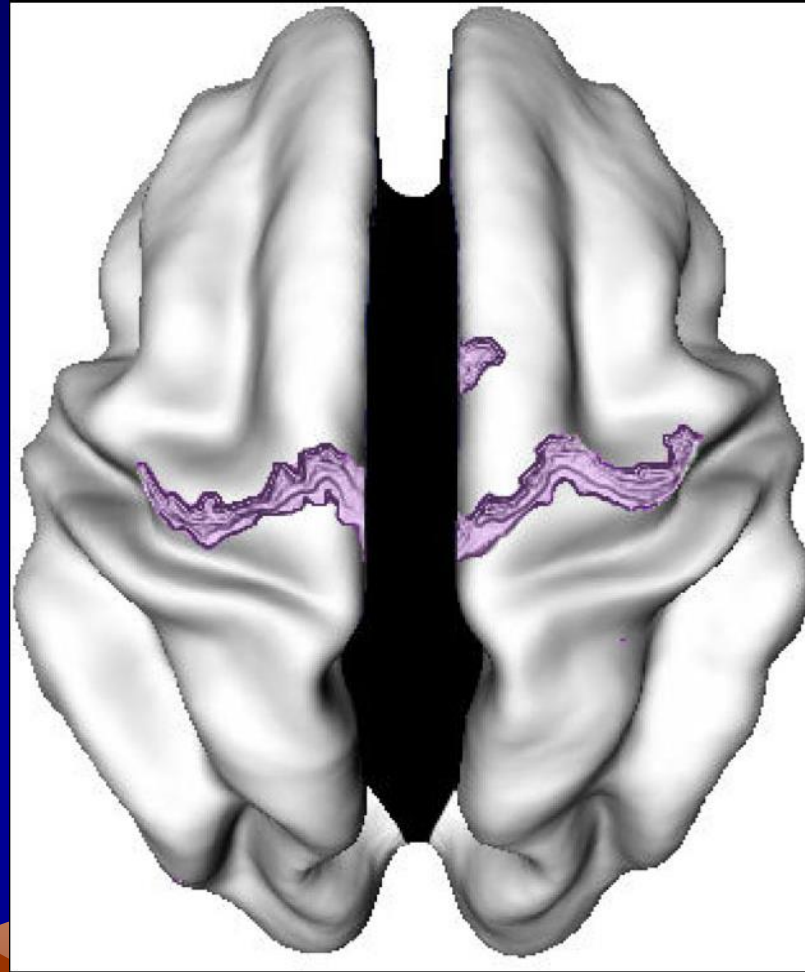
Greater than 2 years' delay
0 to 2 years delay

Ns: ADHD=223; Controls = 223

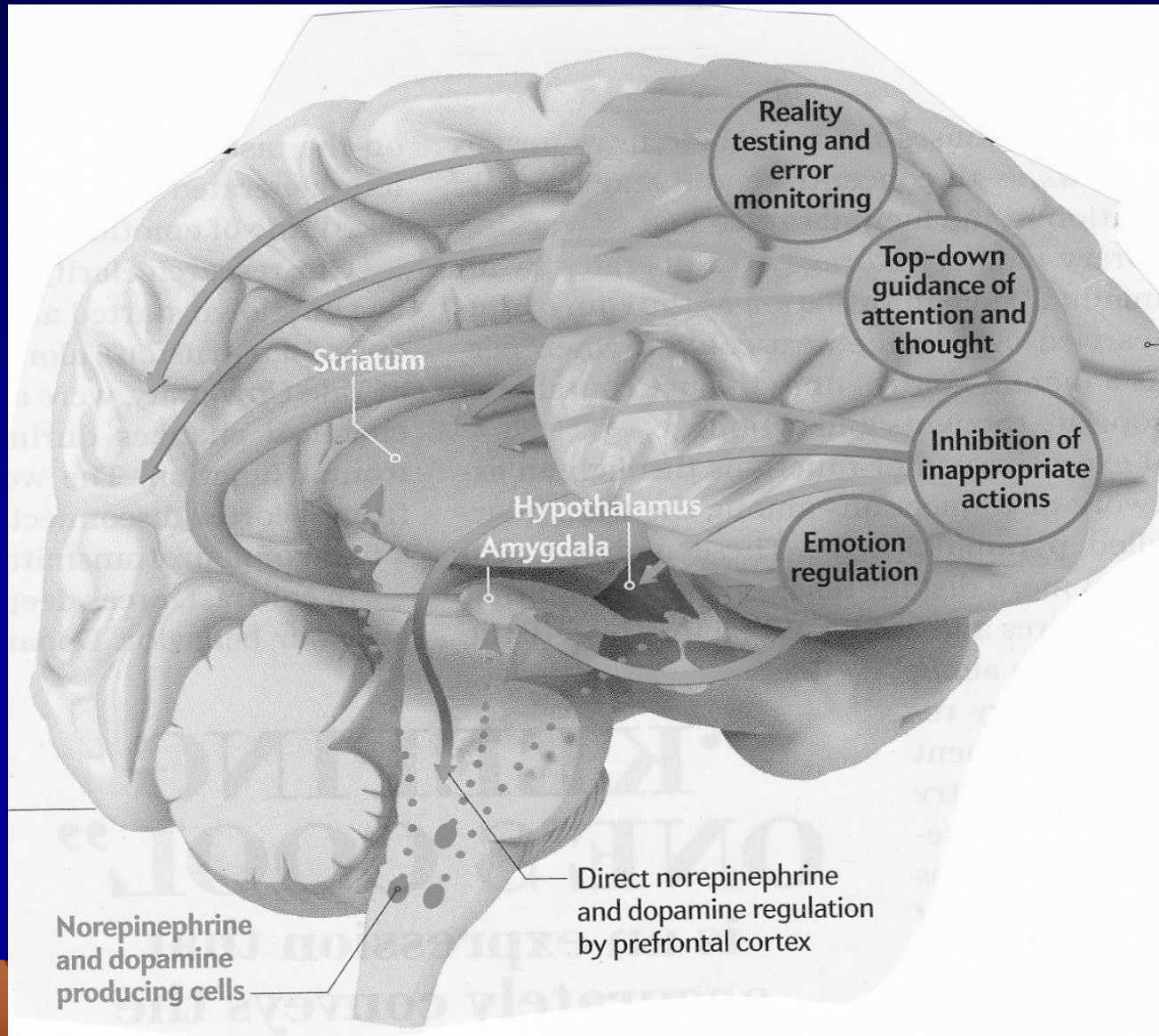
Early cortical maturation in ADHD children

From Shaw, P. et al. (2007). ADHD is characterized by a delay in cortical maturation.
Proceedings of the National Academy of Sciences, 104, 19649-19654.

Fig. 4. Regions where the ADHD group had early cortical maturation, as indicated by a younger age of attaining peak cortical thickness.



Executive Brain Networks



The Frontal Parietal Cortical Network Can Be Usefully Fractionated into Four EF Reciprocal Sub-networks: All are Implicated in Self-Regulation and in ADHD

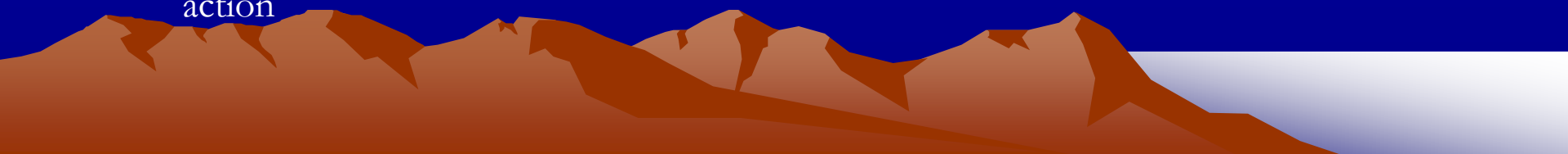
- The frontal-striatal-thalamic circuit: Associated with deficits in response suppression, freedom from distraction, mental representations that guide behavior (working memory), manipulation of mentally held information (organization, planning, and problem-solving), and responding to novelty. Typically known as the “cool” or “**what**” EF network
- The frontal-cerebellar circuit: Associated with motor coordination deficits, but also with problems with the automaticity of actions, the anticipation of rewards, and the rate, rhythm, force, and especially timing and timeliness of behavior and thought. I call it the “**when**” EF network.
- The frontal-limbic circuit: Associated with symptoms of emotional self-regulation, motivation deficits, hyperactivity-impulsivity, and proneness to reactive aggression, known as the appraisal, “**hot**” or “**why**” EF network
- The frontal-cingulate-parietal network: Associated with deficits in self-awareness, performance monitoring, and error detection.

If Emotional Self-Regulation is Deficient in ADHD, What Would We Expect?

Emotional impulsiveness (EI) – Part of Poor Inhibition

- ✓ Poor inhibition of inappropriate behavior related to strong emotions (weak expressive suppression)
- ✓ Low frustration tolerance, impatient
- ✓ Quick to anger and become hostile
- ✓ Greater emotional excitability, reactivity, & raw expression
- ✓ More frequent reactive aggression to provocation

Difficulties self-regulating (moderating) emotional reactions to evocative events (DESR)

- ✓ Deficient in effortful, cognitive “top-down” regulation of induced emotions (self-soothing, refocusing attention, distraction, etc.)
 - ✓ Difficulties inducing positive, more acceptable mood states (i.e. cognitive re-appraisal, proactive situation selection/modification)
 - ✓ Hence slower to recover emotional control and stability
 - ✓ Impaired self-motivation and activation (arousal) when needed to support goal-directed action
- 

Building a Theory of EF:
Linking Inhibition, Self-Control, and
the Executive Functions



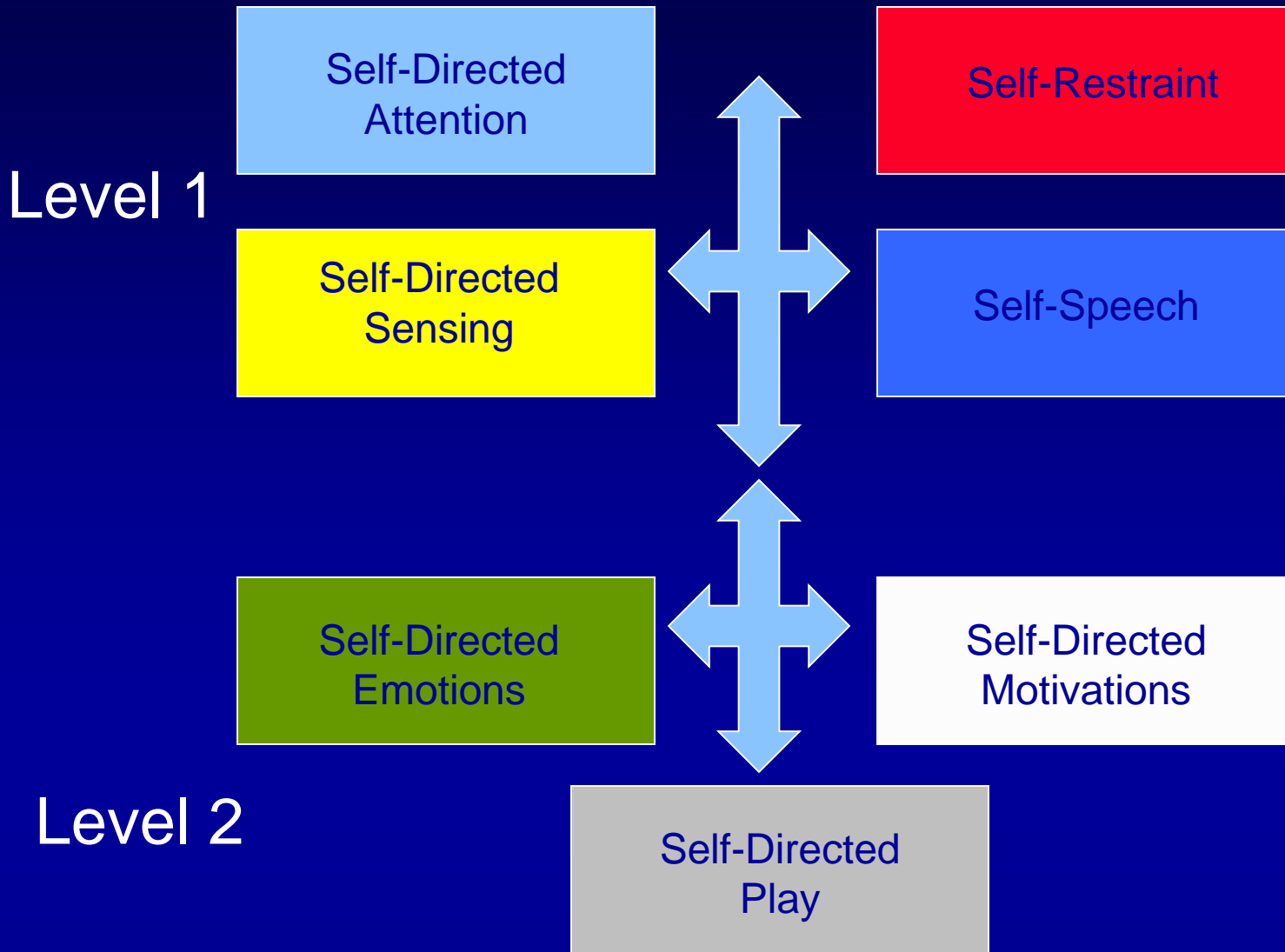
What is EF?

- My Hybrid Theory states that EF is self-regulation.
- Self-regulation (SR) is
 - A self-directed action
 - Intended to change subsequent behavior
 - So as to alter the probability of a delayed consequence
- Thus, SR is self-control in support of one's longer term welfare (delayed gratification)
- An executive function can be defined as step 1 above – **an action-to-the-self**
- There appear to be 7 types of self-directed actions and so 7 forms of self-regulation
- Each likely develops the same way – outer directed behavior becomes turned on the self and then internalized (privatized, inhibited)

3 Important Processes in the Development of EF

- The **Self-Direction** of Actions
 - Behavior toward the world and others gets redirected to the self, occurring in the absence of external events and others that initially would prompt such behavior.
 - The stimulus for such behavior is initially a mental visual image but later can be self-speech
- The **Privatization** of Those Self-Directed Actions
 - With development, self-directed actions become less visible
 - This is likely the result of the inhibition of the brain-related activity associated with these actions from entering the spinal cord (switch is the basal ganglia and right frontal lobe?)
- The **Regulation** of the Behavior by These Self-Actions
 - The self directed actions come to govern the self and ongoing behavior, resting control of behavior from the environment

7 Major Self-Directed Actions (EFs)



Sequential Development of the 7 EFs

The EFs likely develop in a step-wise sequence and in a hierarchy - Each needs the earlier ones to function well

Planning & Problem-Solving (Self-Directed Play)

Motivation Regulation (Self-Directed Motivation)

Emotion Regulation (Self-Directed Emotions)

Verbal Working Memory (Self-Speech)

Nonverbal Working Memory (Self-Directed Sensing)

Inhibition (Self-Restraint)

Self-Awareness (Self-Directed Attention)

Age – Neurological Maturation



Human Variation in the Executive Functions and Self-Regulation: The Sound Mixer Metaphor

Personality traits and experience can fine tune the input



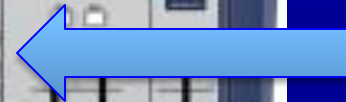
Think of each of the first 7 channels here as one of your executive functions



Their combined output is your degree of self-regulation



And the others as your different types of intelligence



The 5 EFs Used in Daily Life

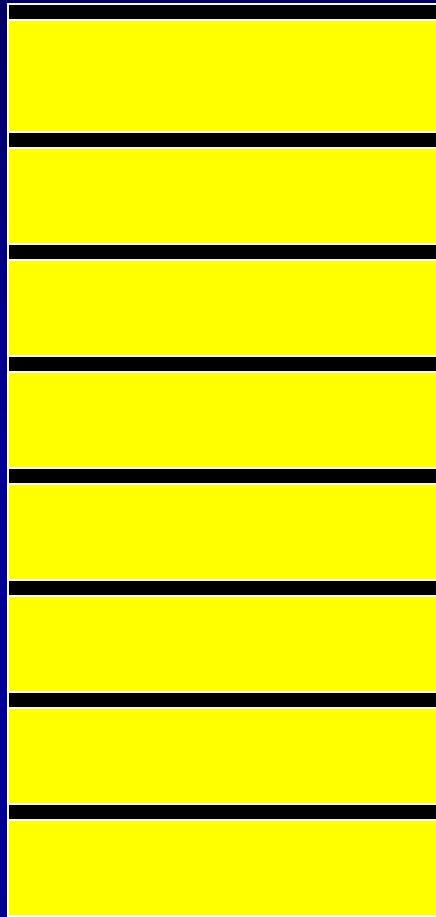
- The 7 EFs are largely cognitive/mental in nature
- They are used interactively to allow self-regulation over time to attain goals and improve one's longer term welfare during daily life activities
- The 7 cognitive EFs result in at least 5 EFs in daily life activities:
 - Self-Restraint (subordinating immediate desires for longer term goals and welfare)
 - Time Management (self-management to time)
 - Self-Organization and Problem Solving
 - Self-Motivation (and activation)
 - Emotional Self-Regulation

The EFs Create Four Developmental Transitions in What is Controlling Behavior

- External → Mental (private or internal)
- Others → Self
- Temporal now → Anticipated future
- Immediate → Delayed gratification
(A Decrease in the Temporal Discounting of Delayed Consequences)

Self-Regulatory Strength May Be a Limited Resource Pool or Capacity

S-R Fuel Tank
(Willpower)



Inhibition & Self-
Restraint

Self-Management
to Time

Self-Organization
& Problem-
Solving

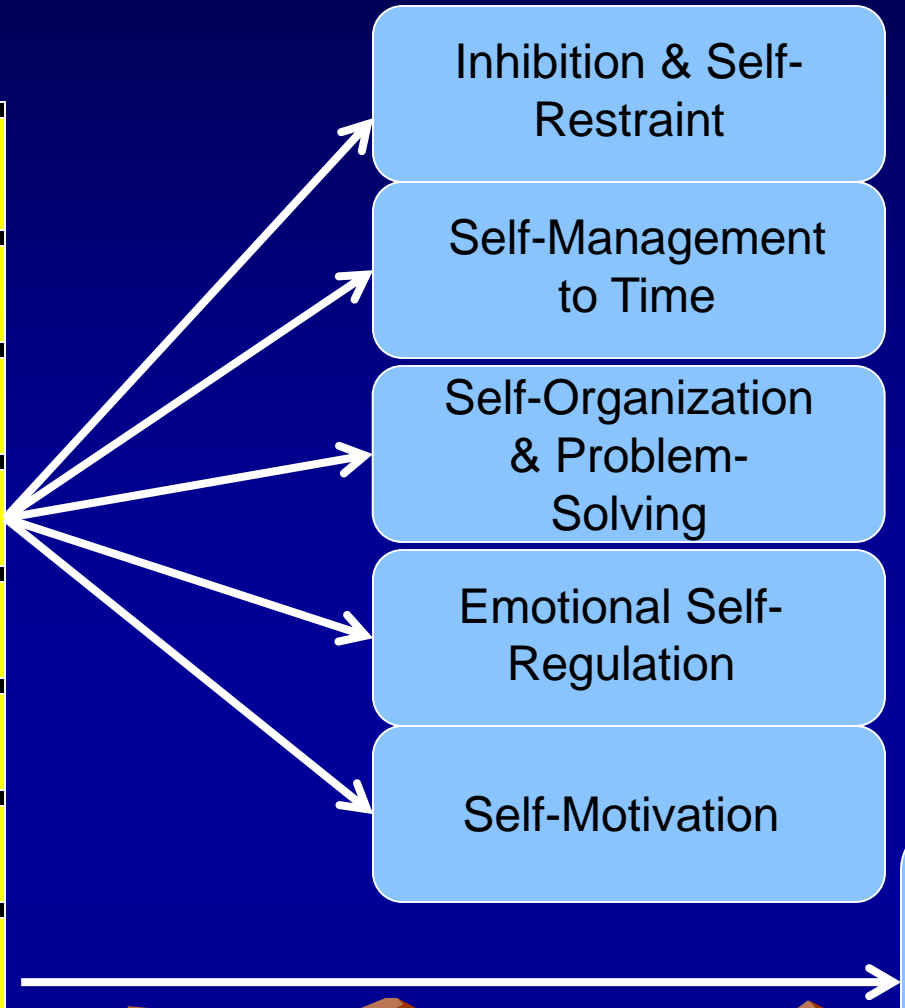
Emotional Self-
Regulation

Self-Motivation

The pool increases
in capacity with
maturation.

Using EF/SR
reduces the pool.
temporarily

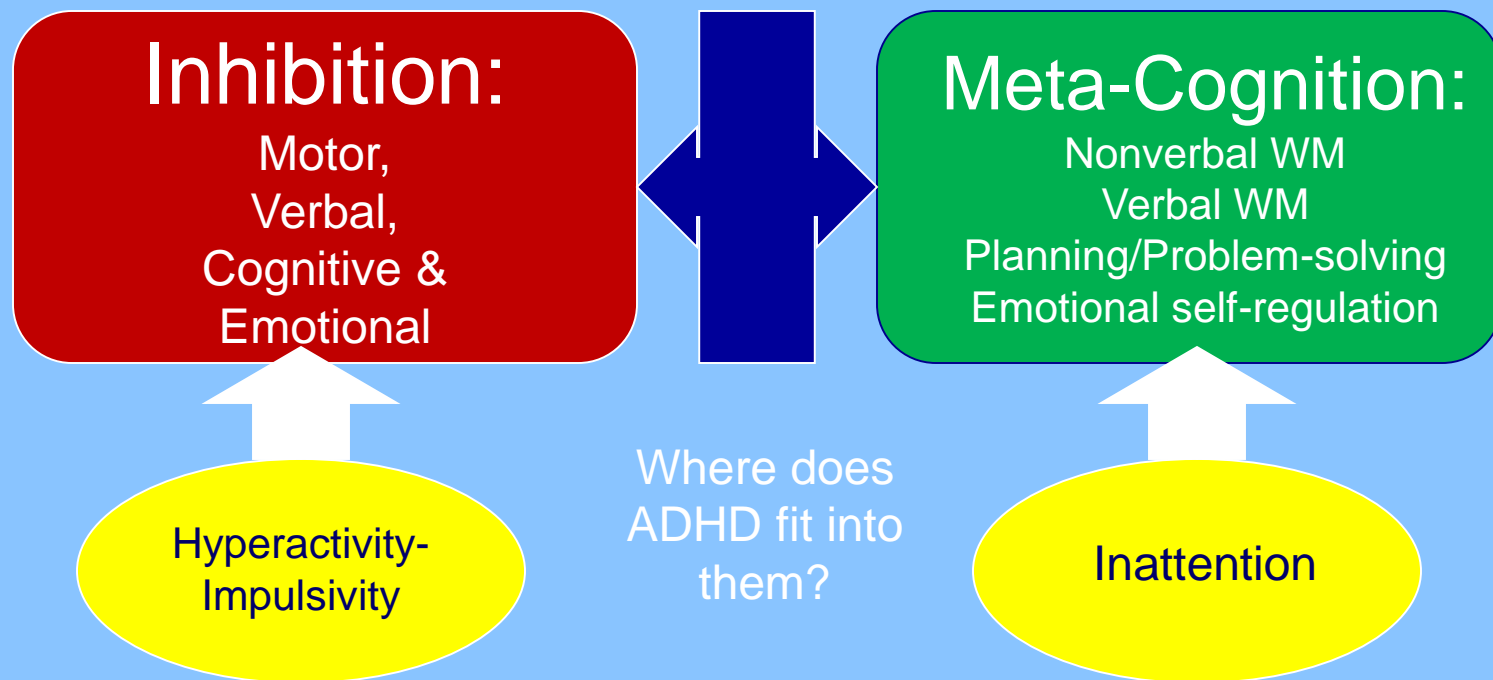
So Does:
Stress, Alcohol,
Drug Use, &
Illness



How Does ADHD Fit Into EF?

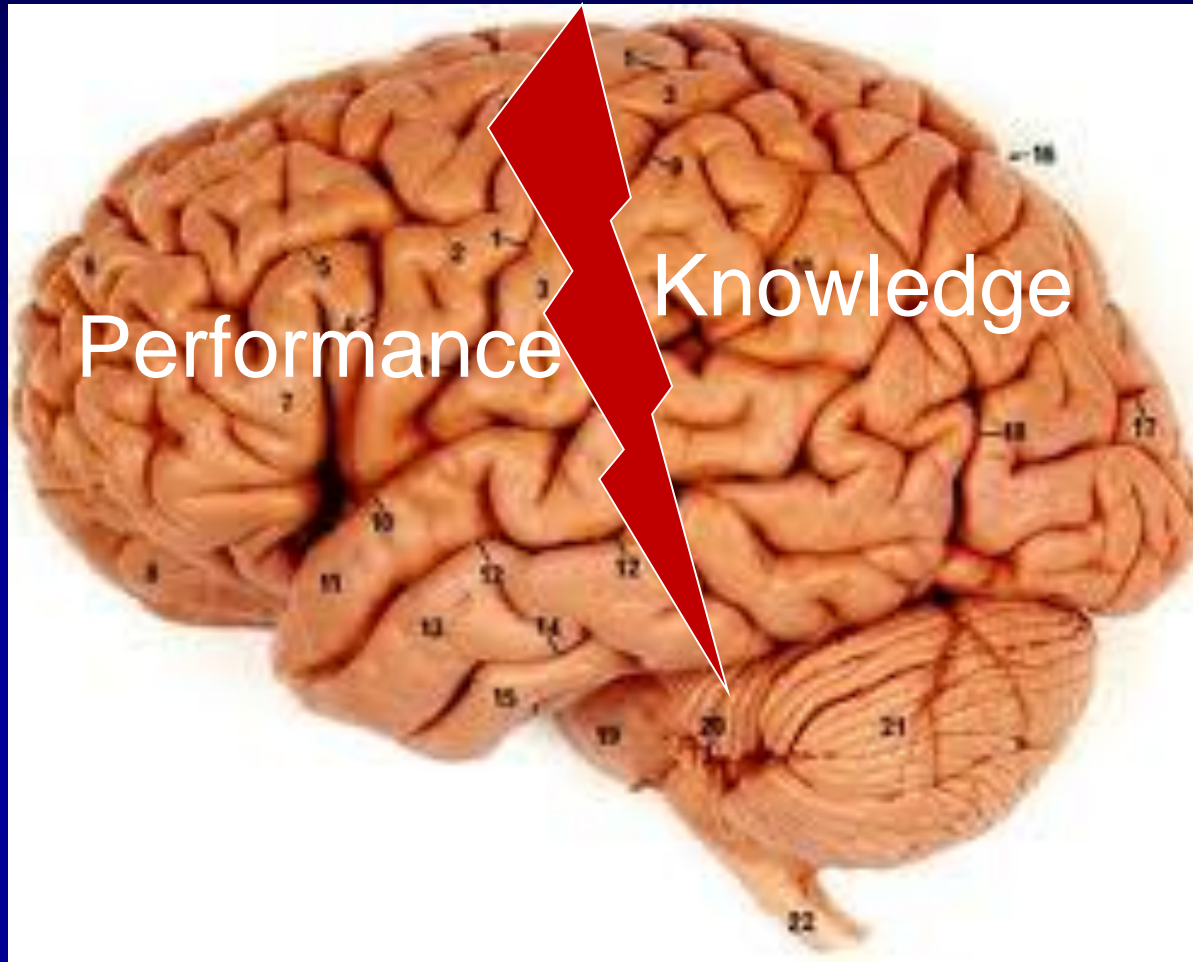
EF Comprises a Single Domain – Probably Self-Regulation.
It Can Be Usefully Subdivided into two Broad Dimensions

How Do Stimulants Improve Behavior and Work?



The Brain as a Knowledge vs. Performance Device

ADHD



Understanding ADHD

- ADHD disrupts the 7 forms of EF/SR thereby creating a disorder of self-regulation across time
- It therefore diminishes the 5 EFs in daily life
- ADHD can be considered as “Time Blindness” or a “Temporal Neglect Syndrome” (myopia or near-sightedness to the future)
- It adversely affects the capacity to hierarchically organize behavior across time to anticipate the future and to pursue one’s long-term goals and self-interests (welfare and happiness)
- Thus, it’s not an Attention Deficit but an Intention Deficit (Inattention to the probable future)

Understanding ADHD

It's a Disorder of:

- The guidance of actions by mental representations
- Performance, not skills or knowledge
- Doing what you know, not knowing what to do
- The when and where, not the how or what
- Using your past at the “point of performance”
 - The point of performance is the place and time in your natural settings where you should use what you know, but are not. Hence, the problems posed by ADHD and other EF disorders

The Value of the Concept of Delayed Executive Age in ADHD

- ADHD appears to delay EF development by 25-40%, or an average of 30%
- Use this estimate to understand a child's executive age (EA) not his or her chronological age (CA)
- Adjust expectations to match this EA, not the CA
- Determine new responsibilities and freedoms based on their EA, not their CA
- Provide accommodations or scaffolding to support the child at this level of EA

Implications for Treatment

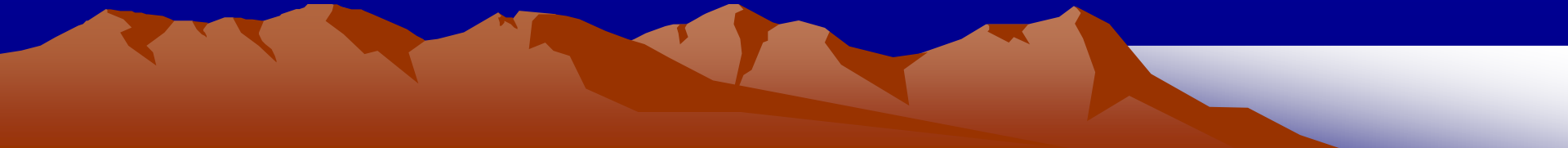
- Teaching skills is inadequate
- The key is to design prosthetic environments around the individual to compensate for their EF deficits
- Treatments must be at the “point-of-performance”
- The EF deficits are neuro-genetic in origin
- Therefore, medications may be essential for most (but not all) cases – meds are neuro-genetic therapies
 - They are also associated with neuro-protective effects (normalizing effects) on brain structure and functioning as well as on EF tasks
- Is EF responsive to direct training?
 - Preschool play-based EF training (maybe – 2 promising pilot studies focusing on “at risk” children)
 - EEG Neurofeedback (questionable effectiveness; placebo controlled, blinded studies find no effects)
 - Cognitive training technology (e.g., CogMed, ACTIVATE, etc.) (no far transfer to functioning in natural settings for CogMed and no effects found for ACTIVATE)
 - fMRI Neurofeedback training (1 promising pilot study by Katya Rubia)

More Treatment Implications

- Behavioral treatment (BT) is essential for restructuring natural settings to assist the EFs – think of it as the external scaffolding needed to support the EF/SR system (externalizing what the prefrontal lobes ordinarily do)
 - BT provides artificial prosthetic informational cues to substitute for the working memory deficits (signs, lists, cards, charts, posters)
 - BT provides artificial prosthetic consequences placed in the large time gaps between natural or social consequences thus increasing accountability and motivation (i.e., tokens, points, etc.)
- But BT serves two different purposes depending upon the nature of the problem or disorder being treated
 - Informational - knowledge and skill building
 - Motivational - knowledge and skill performance
- The effects of BT do not generalize or endure after removal because they primarily address the motivational deficits in ADHD and so must be sustained if gains are to be maintained

More Treatment Implications

- Treatments that might be promising but remain largely untested in EF/SR disorders like ADHD
 - Over-learning and repeated behavioral rehearsal (moving from novelty and the EF “slow” system to automaticity/routinization in the non-EF “fast” brain)
 - Repeated mental simulation of “if-then” situations to facilitate acquisition and practice of EF even in the absence of that situation
 - Observational learning – like mental simulation, video modeling or video self-modeling may be useful in promoting acquisition and practice of self-regulation and EF even in the absence of such direct learning events (being used in ASD treatment now)
- The compassion and willingness of others to make accommodations at points of performance are vital to success
- A chronic disability perspective is most useful
- ADHD creates a diminished capacity: But this does not excuse accountability (The problem is with time, not with consequences)



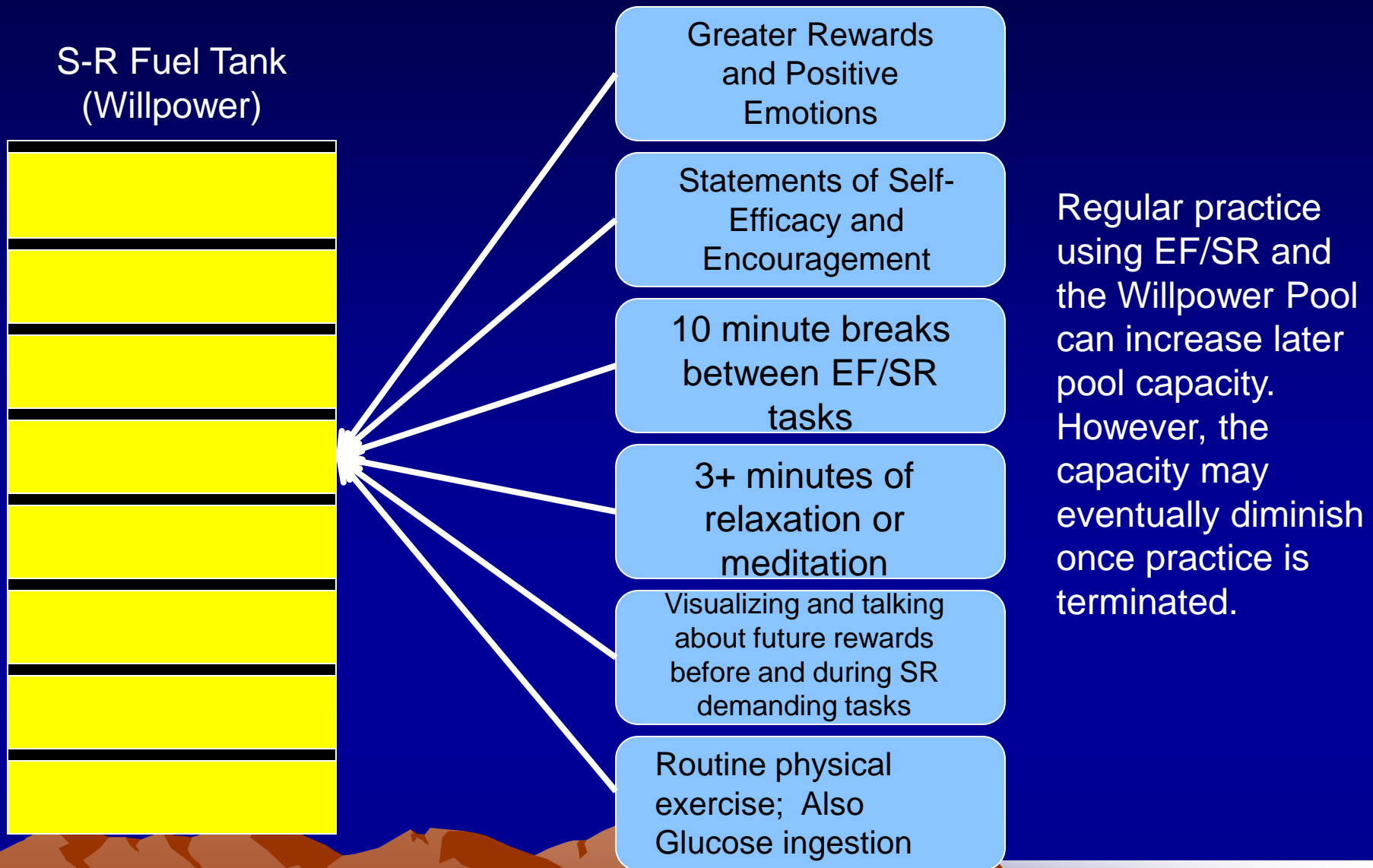
How can we compensate for EF deficits?

- Mental representations do not guide behavior very effectively – so off-load [externalize] them outside of the mind and into the environment
- Externalize important information at key points of performance (off-load it to external storage devices)
- Externalize time and time periods related to tasks and important deadlines (make time physical)
- Break up lengthy long-term tasks into many smaller steps to be done more frequently

More Compensatory Rules

- Externalize task organization, both spatially and temporally [as in task analysis and time-motion studies]
 - think about not just location, but frequency and sequencing of use of materials
 - Whatever is needed must be at “the point of performance”
- Externalize motivation – make consequences more external, frequent, & compelling
- Externalize and manualize mental problem-solving – put the pieces in their hands
- But what to do about emotional self-regulation???? (training alone doesn't work)
- And what can be done about that resource pool?

Replenishing the EF/SR Resource Pool



Conclusions

- ADHD delays and disrupts behavioral inhibition and the internalization of self-directed EFs producing deficits in all 7 EFs – mental events can't guide actions toward goals and the future
- In essence, ADHD produces a time or future blindness causing the individual to live more in “the now” and so be a less future-directed individual
- By disrupting EF/SR, ADHD affects the 5 major EFs seen in daily life activities: self-restraint, time management, self-organization, self-motivation, and self-regulated emotions



Conclusions

- This results in
 - a serious and pervasive disorder of self-regulation across time and settings
 - impaired social functioning (social self-defense, reciprocity, cooperation, and mutualism)
- The impulsivity, impulsive emotion, and poor emotional self-regulation components of ADHD create:
 - a heightened risk for reactive aggression upon provocation and
 - an impaired capacity for regaining emotional control as quickly as others
- The deficient sense of time and impaired future contemplation create:
 - the higher risk for aggression and other antisocial behavior due to impaired consideration of behavioral consequences
- Management requires creating scaffolding or prosthetic environments that compensate for EF deficits combined with neuro-genetic medicines to improve the self-directed EFs