

The Nature of ADHD: The Executive Functions and Self-Regulation

Russell A. Barkley, Ph.D.

Clinical Professor of Psychiatry
Medical University of South Carolina
Charleston, SC

©Copyright by Russell A. Barkley, Ph.D., 2011

Sources:

Barkley, R. A. (in press). *Executive Functioning in Everyday Life: Extended Phenotype, Synthesis, and Clinical Implications*. New York: Guilford Press.

Barkley, R. A. (2011). *The Barkley Deficits in Executive Functioning Scale*. New York: Guilford.

Barkley, R. A. (2006) *Attention deficit hyperactivity disorder: A handbook for diagnosis and treatment* (3rd ed.). New York: Guilford Press.

Barkley, R. A. (1997/2001) *ADHD and the Nature of Self-Control*. New York: Guilford Press

Email: drbarkley@russellbarkley.org

Website: russellbarkley.org



Disclosure

Retirement Pension: State of Massachusetts (UMASS Medical School)

Speaking Fees Received From (for 2010):

- Puerto Rico Association of Pediatricians (San Juan)
- Canadian Attention Deficit Disorders Resource Alliance (Toronto)
- ADHD Resource Alliance (The Netherlands)
- Region IV School District of Houston, TX
- PACER Center (Minneapolis, MN)
- Berkshire Area Health Education Cooperative (Pittsfield, MA)
- Association of Educational Therapists (Los Angeles, CA)
- Premier Education Solutions (PESI, Eau Claire, WI)
- Texas A & M University
- American Professional Society for ADHD and Related Disorders (APSARD)
- Southern Connecticut State University
- Fitchburg State College
- University of South Carolina Medical School – Pediatrics Dept.
- Springer School – Cincinnati, OH
- Macon County Mental Health Center
- The Lovett School – Atlanta, GA
- Premier Educational Seminars, Inc. (PESI)

Royalties:

- Guilford Publications (books, videos, newsletter)
- Jones & Bartlett Publishers (books & products)
- J & K Seminars (videotapes), New England Educational Institute (audiotapes), PESI (CDs)
- ContinuingEdCourses.net (internet CE courses)

Speaker/Consultant/Expert Witness for these Pharmaceutical Companies:

Eli Lilly, Shire, McNeil, Janssen-Ortho, Janssen-Cilag, Novartis

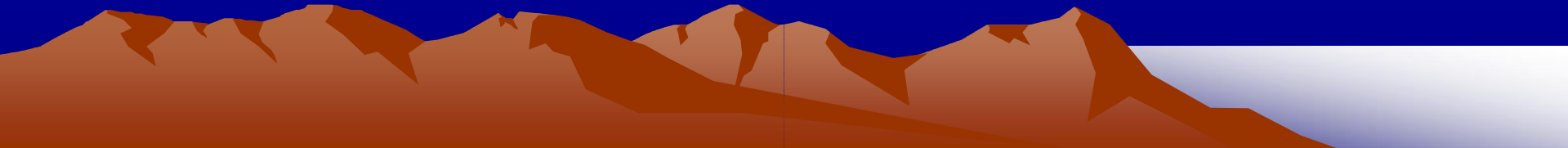
What is ADHD?

The Current Clinical View

A disorder of age-inappropriate behavior in two domains of neuropsychological development:

I. Hyperactivity-Impulsivity (Poor Inhibition)

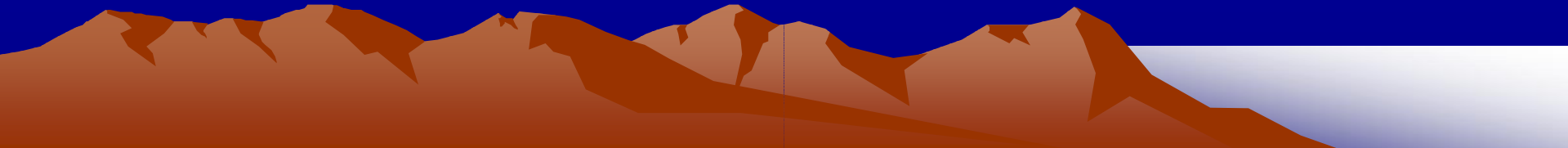
- Impaired verbal and motor inhibition
- Impulsive decision making; cannot wait or defer gratification
- Greater disregard of future (delayed) consequences
- Excessive task-irrelevant movement and verbal behavior
 - Fidgeting, squirming, running, climbing, touching
- Emotionally impulsive; poor emotional self-regulation
- NOTE: Restlessness decreases with age, becoming more internal or subjective by adulthood



More on ADHD

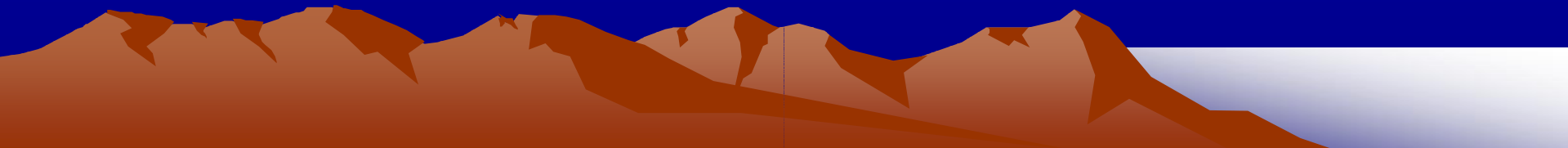
II. Inattention

- But there are at least 6 types of attention:
 - Arousal, alertness, selective, divided, span of apprehension, & persistence.
- Not all are impaired. What is?
 - Poor persistence toward goals or tasks
 - Impaired resistance to responding to distractions
 - Deficient task re-engagement following disruptions
 - Impaired working memory (remembering so as to do)



Does ADHD = EFDD????

(Executive Function Deficit
Disorder)



The Prefrontal Cortical Networks Involved in EF Are Also the Networks Implicated in Self-Regulation and in ADHD

- The frontal-striatal circuit: Associated with deficits in response suppression, freedom from distraction, working memory, organization, and planning, known as the “cool” or “**what**” EF network
- The frontal-cerebellar circuit: Associated with motor coordination deficits, and problems with the timing and timeliness of behavior, known as the “**when**” EF network
- The frontal-limbic circuit: Associated with symptoms of emotional dyscontrol, motivation deficits, hyperactivity-impulsivity, and proneness to aggression, known as the “**hot**” or “**why**” EF network

Nigg, J. T., & Casey, B. (2005). An integrative theory of attention-deficit/hyperactivity disorder based on the cognitive and affective neurosciences. *Development and Psychology*, 17, 785-806.

Castellanos, X., Sonuga-Barke, E., Milham, M., & Tannock, R. (2006). Characterizing cognition in ADHD: Beyond executive dysfunction. *Trends in Cognitive Science*, 10, 117-123.

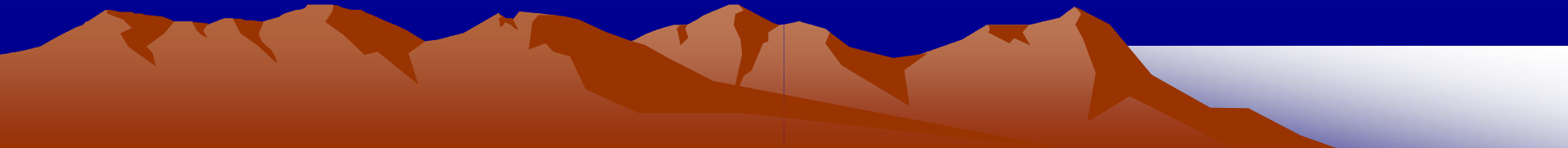
Sagvolden, T., Johansen, E. B., Aase, H., & Russell, V. A. (2005). A dynamic developmental theory of attention-deficit/hyperactivity disorder (ADHD) predominantly hyperactive-impulsive and combined subtypes. *Behavioral and Brain Sciences*, 28, 397-408.

Defining Executive Functioning

- More than 30 definitions exist and more than 33 constructs have been included in the construct of EF
- For example:
 - Those mental processes we use for sustaining problem-solving toward a goal (Behkterev, 1902; Luria, 1966; Welsh & Pennington, 1988)
 - Those capacities that enable a person to engage successfully in independent, purposive, self-serving behavior: (1) volition; (2) planning; (3) purposive action; and (4) effective performance. All are necessary for appropriate, socially responsible, and effectively self-serving adult conduct. (Lezak, 1995)
 - Self-regulation so as to choose, enact, and sustain actions over time toward goals, often in the context of others, usually using social and cultural means so as to maximize one's longer-term welfare as the individual determines it to be. (Barkley, 2011)

Most Common EF Components

- Inhibition and interference control
- Self-Awareness and self-monitoring
- Nonverbal working memory
- Verbal working memory
- Planning and problem-solving
- Anticipation and preparation to act
- Self-Regulation across time
- Emotional Self-Control



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
(Decreased Temporal Discounting of Delayed Consequences)

How Does ADHD Fit Into EF?

EF Comprises 2 Broadband Domains

Inhibition:

Motor,
Verbal,
Cognitive &
Emotional

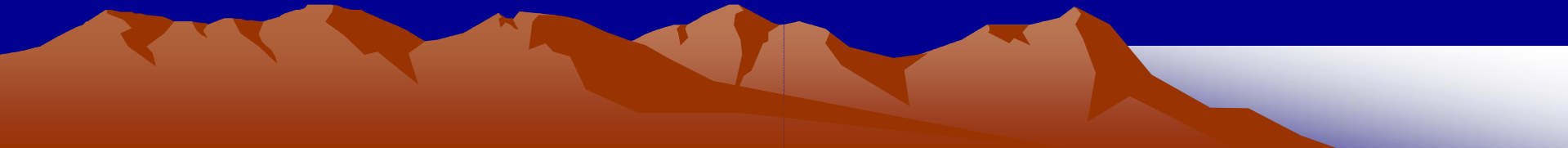
Hyperactivity-
Impulsivity

Meta-Cognition:

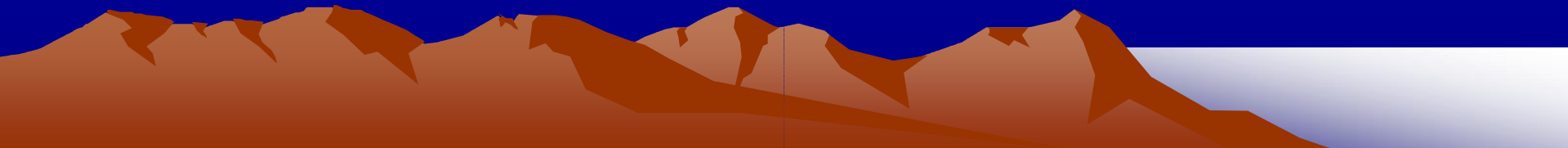
Nonverbal WM
Verbal WM
Planning/Problem-solving
Emotional self-regulation

Inattention

Where does
ADHD fit into
them?

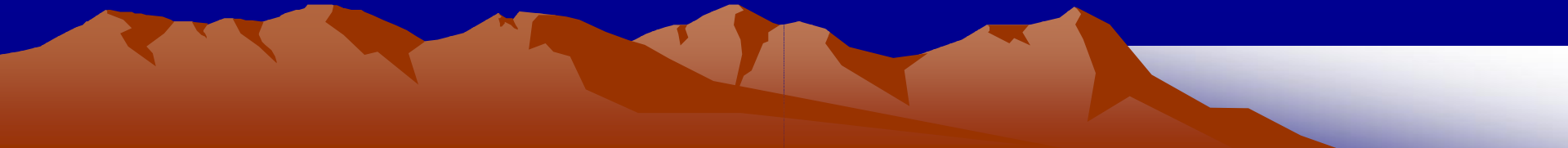


Building a Theory of EF and ADHD: Linking Inhibition, Self-Control, and the Executive Functions



Building Blocks of A Theory

- Start with a theory of normal
- Inhibition creates the foundation for self-regulation and EF
- Inhibition comprises three related processes:
 1. Inhibiting the prepotent or dominant response (motor, verbal, cognitive, & emotion)
 2. Interrupting ongoing behavior
 3. Interference control: Protecting the EFs from distraction

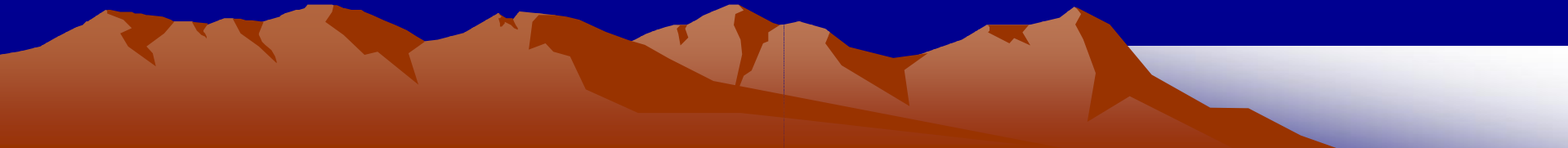


What is Self-Regulation?

Self-regulation can be defined as:

1. Any action a person directs toward one's self (a behavior-to-the-self)
2. So as to change their own subsequent behavior from what they otherwise would have done
3. In order to change the likelihood of a future consequence

You cannot direct an action at yourself without inhibiting your responses to the ongoing environment – they are mutually exclusive

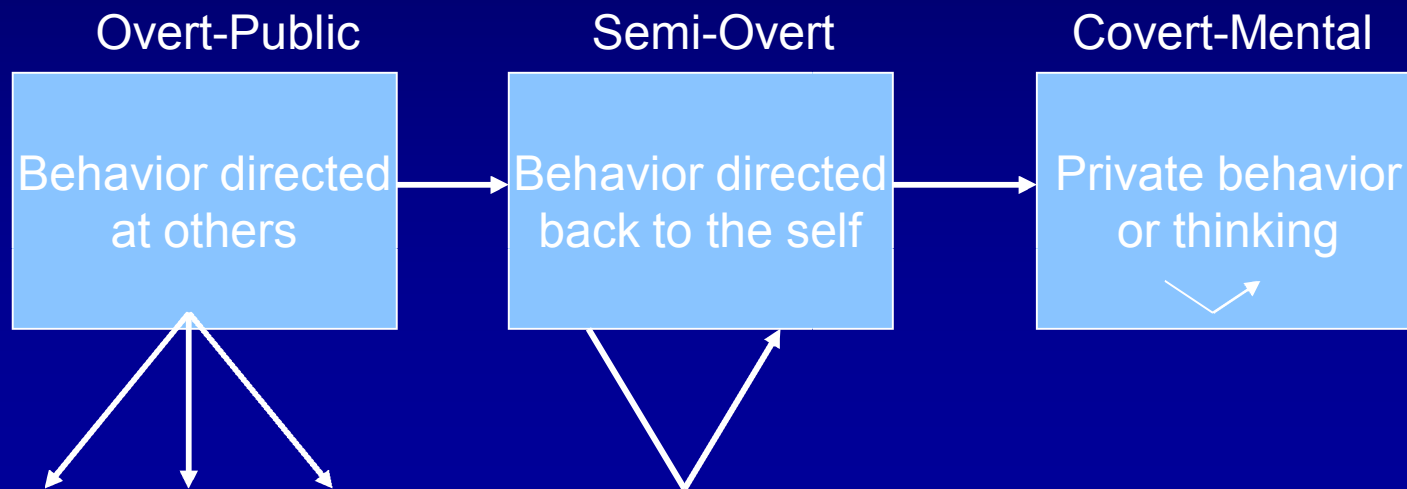


What is EF?

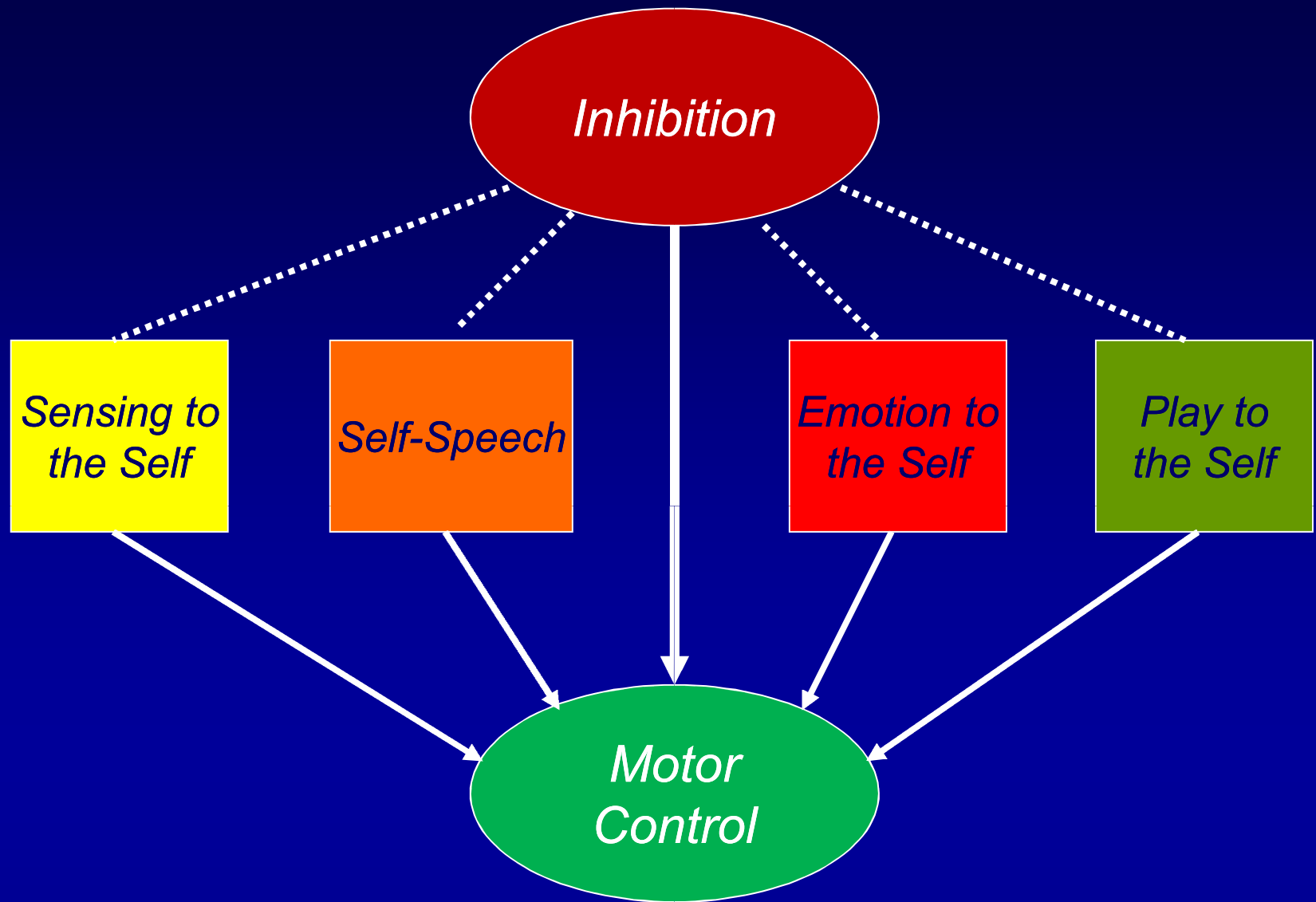
- An executive function can be defined as a major type of action-to-the-self (a type of self-regulation)
- There are 6-7 major types of EFs:
 - Self-Awareness (meta-cognition)
 - Inhibition and interference Control
 - Nonverbal and verbal working memory
 - Emotional - motivational self-regulation
 - Planning and problem-solving
- All can be redefined as actions-to-the-self
- Each likely develops by behavior being turned on the self and then internalized (privatized, inhibited)
- They likely develop in a step-wise hierarchy - Each needs the earlier ones to function well

Developmental Progression

The Internalization (or Privatization) of Outward Behavior



What are the 5 majors types of EF or action-to-the-self?



What Arises From Each EF?

Sensing to the Self

(nonverbal working memory)

- Self-awareness (self-directed attention)
- Hindsight, foresight, and anticipation
- Sensing and using time for self-management
- Imitation and vicarious learning
 - Using the experiences of another for self-change
- Reciprocal exchange (sharing & trading)
 - Both immediate exchange and delayed reciprocity
- Social cooperation and coalition formation
 - Achieving together what one cannot do alone

Self-Speech

(Verbal Working Memory)

- Descriptions to the self
- Self-instructions
- Rule and meta-rule development
- Self-organization
- Listening, viewing, and reading comprehension
- Moral regulation of behavior
 - (rules concerning the long-term consequences of one's actions for self and others)

Emotion to the Self

- Inhibition of initial strong emotions
- Modifying emotional states
 - Distraction, re-appraisal, situation modification & selection
- Creating new emotions
 - Using visual imagery and self-speech about past experiences associated with the desired emotion
- Creating intrinsic motivation (drive states)
 - fueling future-directed behavior in the absence of immediate consequences by imagining and self-verbalizing those consequences

Koole, S. L. et al. (2011). *Handbook of Self-Regulation* (2nd Ed.) (pp. 22-40). New York: Guilford.

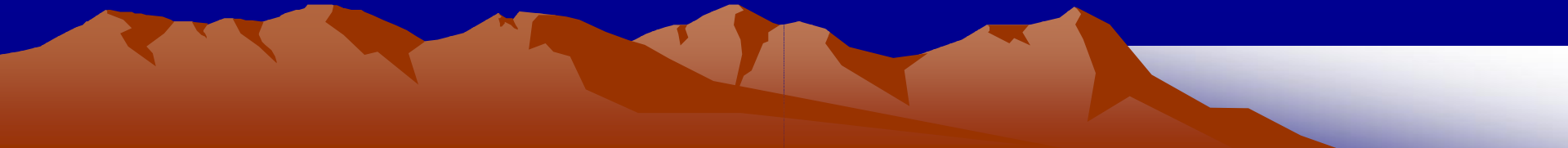
Gross, J. J. (1998). *Review of General Psychology*, 2, 271-299.

Gross, J. J. & John, O. P. (2003). *Journal of Personality and Social Psychology*, 85, 348-362.

Play to the Self

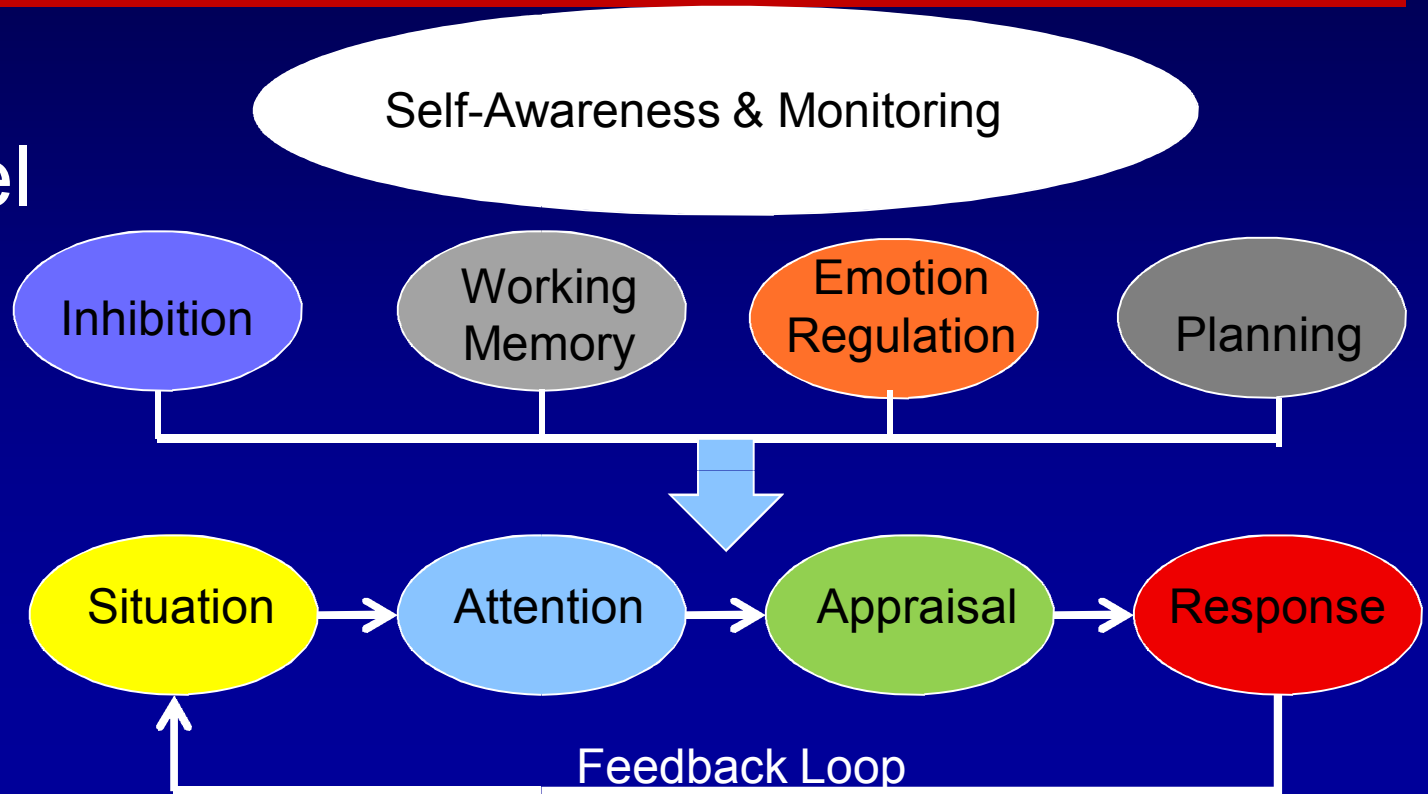
(Planning, Problem-Solving)

- Reconstitution:
 - Analysis (taking apart) and synthesis (recombining) information being held in mind
- Planning:
 - Generating multiple options toward a goal
- Goal-directed innovation (problem-solving)
 - Recombining mental information to get new ideas
- Rapidly assembling complex, hierarchical goal directed ideas into statements and behavior into sustained actions



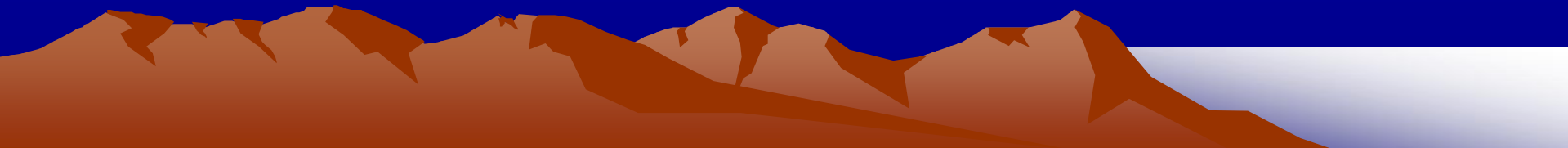
The Two-Level View of Self-Regulation

EF Level

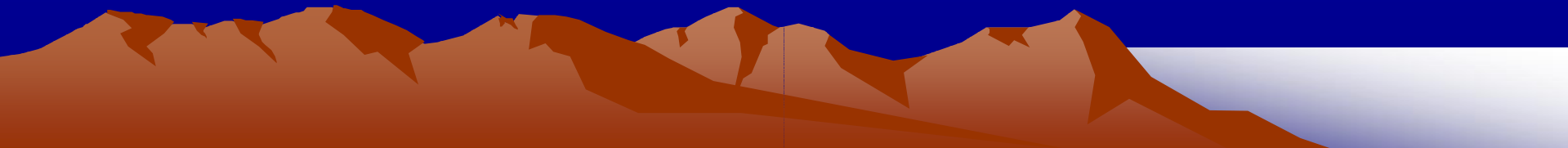


4 Stages at the Automatic Level of Human Action

ADHD disrupts the development of inhibition and the other self-directed executive functions producing a disorder of self-regulation across time and so interfering with the capacity to choose, enact, and sustain actions toward goals.



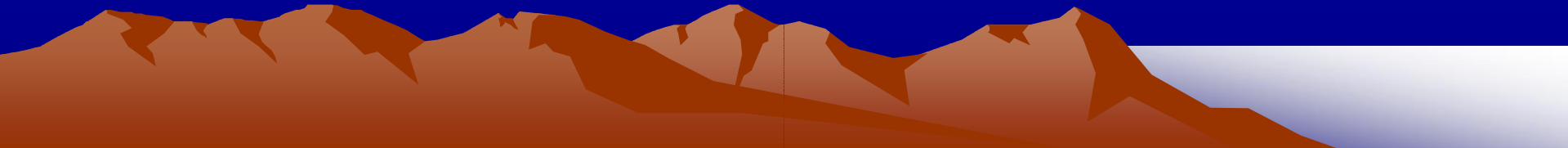
The Current Paradox in Research on EF and ADHD



The Psychometric Approach to Assessing EF Relies on Testing

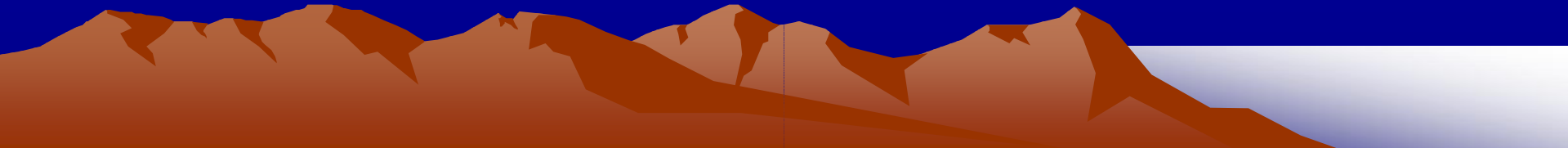
For Instance:

- Inhibition and Interference Tasks
 - CPTS, Go/No-Go, Stop Signal, Stroop
- Working Memory Tasks
 - Digit span, Mental Arithmetic, N-Back, Spatial Memory, Sequence Memory, Simon Game
- Fluency Tasks
 - F-A-S Test, 5-Points Task, Ideational Fluency
- Planning and Problem-Solving Tasks
 - Tower of London, Tower of Hanoi, Wisconsin Card Sorting Task



But What is Being Tested Does Not Capture What is Being Lost in Clinical Descriptions of Patients with PFC (EF) Injuries

- Impaired social relationships, socially inappropriate behavior
- Selfish disregard for the future consequences of one's actions for one's self and others
- Impulsive – behaviorally, verbally, cognitively, and emotionally
- Impatient, easily frustrated, emotionally dysregulated, hostility
- Disinhibited sexual conduct
- Antisocial behavior and, sometimes, even psychopathic features
- Unable to manage social, familial, and community responsibilities
- Difficulties with occupational functioning
- Problems managing money (careless spending, credit binges, disregard for their financial obligations and future)
- Disregard for social norms and laws



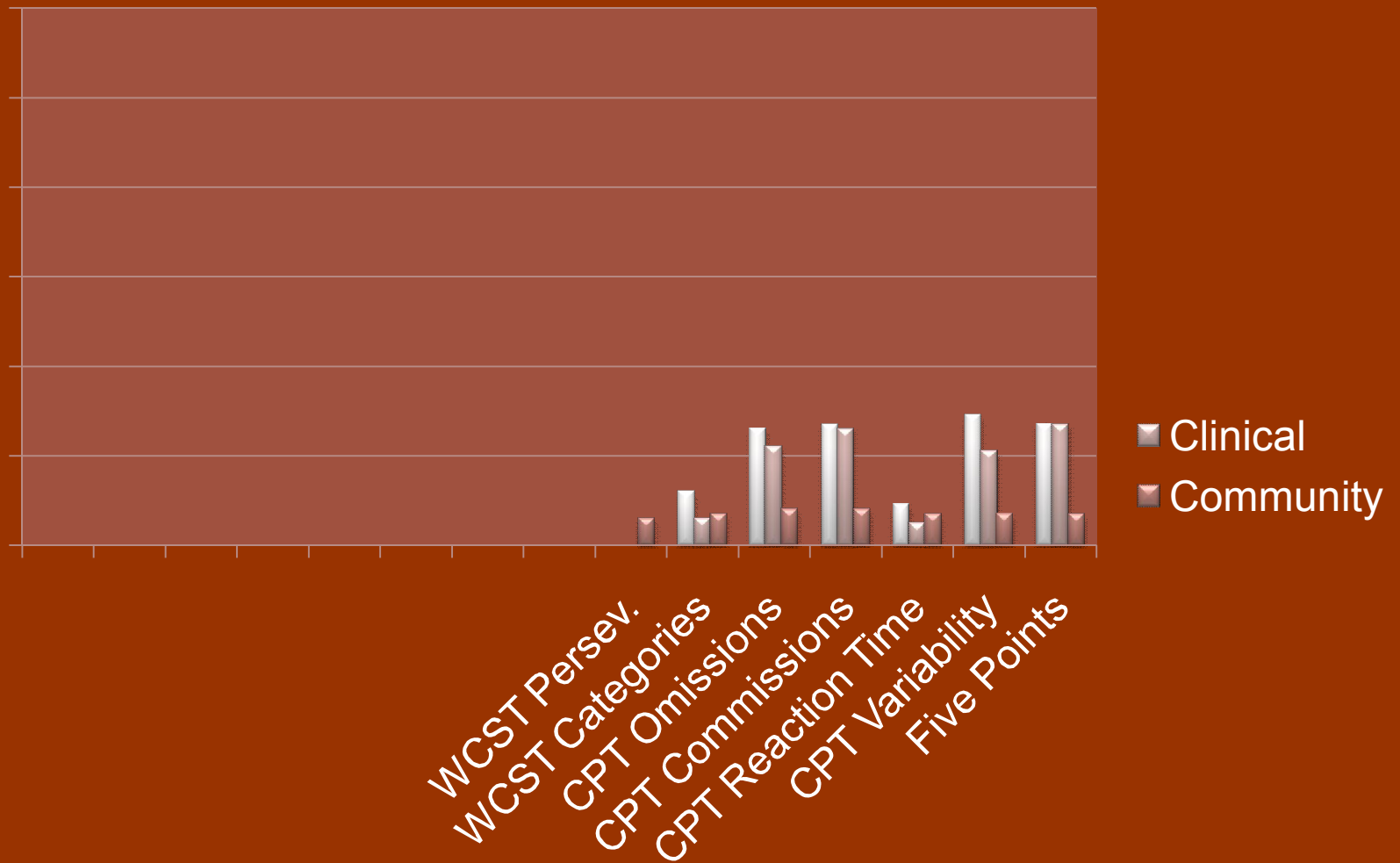
Current Paradox

- ADHD is a disorder of brain networks that contribute to EF – so it has to be an EF disorder
- But only 35-50% or fewer ADHD cases are impaired on EF psychometric tests ($\geq 93^{\text{rd}}$ %)
- Yet 86-98% of clinical-referred adults with ADHD are impaired on rating scales of EF in daily life as are 65-75% of ADHD children by adulthood with persistent ADHD.
- EF tests have low or no significant relationships with EF ratings in daily life
 - 0-10% of shared variance between tests & ratings
 - less than 20% for best combination of EF tests
- EF tests and EF ratings are NOT measuring the same construct

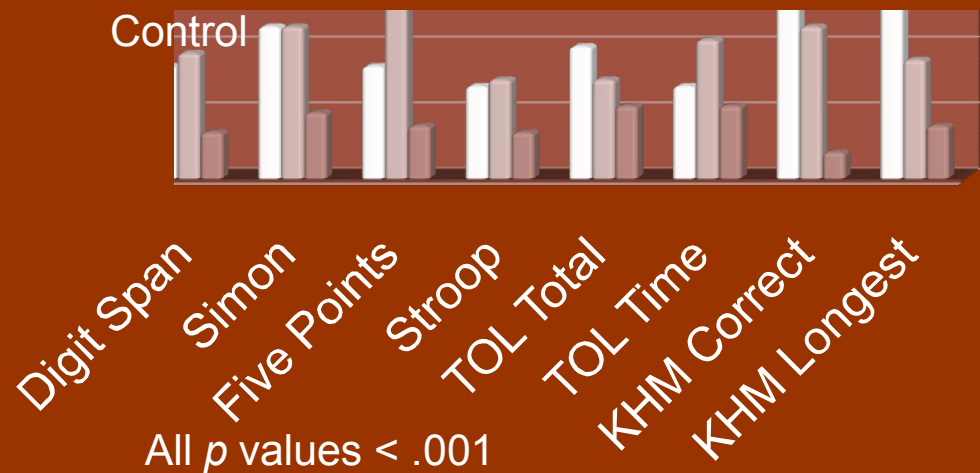
Rating Scales of EF in Daily Life Reveal 5 Major Inter-Related Factors

- Self-Restraint (Inhibition)
 - Cognitive, behavioral, verbal, emotional
- Self-Management to Time
 - Consideration of past and future consequences before acting; managing self relative to time and deadlines
- Self-Organization & Problem-Solving
 - Innovating, planning possible response options, problem-solving to overcome obstacles to goals, rapid assembly and performance of novel goal-directed behavior
- Self-Motivation
 - Substituting positive goal-supporting emotions for negative goal-destructive ones
- Self-Regulation of Emotion

From Barkley, R. A. (2011). *The Barkley Deficits in Executive Functioning Scale*. New York: Guilford Press.



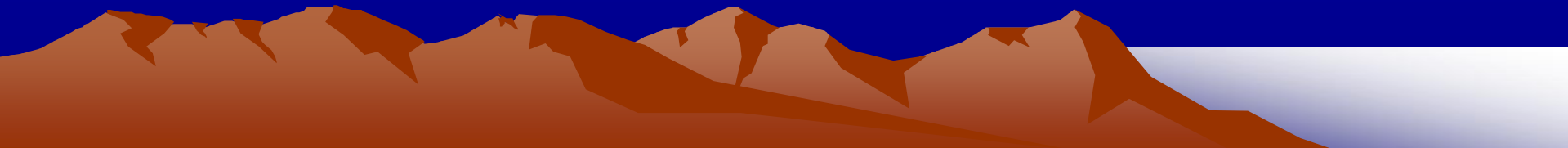
From Barkley, R. A., & Murphy, K. R. (2010). Impairment in occupational functioning and adult ADHD: The predictive utility of executive function (EF) ratings vs. EF tests. *Archives of Clinical Neuropsychology*, 25, 157-173.



ADHD-P = Persistent ADHD,
ADHD-NP = Nonpersistent ADHD
Control = Community Control Group

Barkley, R. A., & Fischer, M. (2010). Predicting impairment in occupational functioning in hyperactive children as adults: Self-reported executive function (EF) deficits vs. EF tests. *Developmental Neuropsychology*, in press.

How do we bridge this
huge chasm between
what tests measure and
what patients have lost?

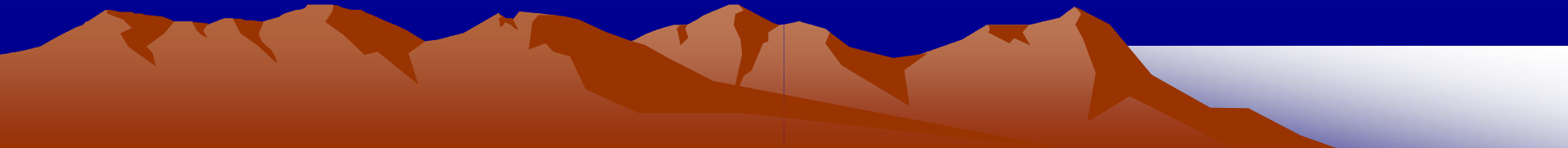


How to Understand the Paradox

- ✓ View EF not as a unitary construct but as a multi-level meta-construct
- ✓ Yet these levels are only partially coupled
- ✓ New abilities arise at higher levels not represented at the lower ones (similar to models of driving behavior).
- ✓ Social and cultural means to achieving goals become increasingly important at higher than lower levels.
- ✓ EF tests assess the most basic instrumental level; EF ratings assess the self-reliant , tactical, and strategic levels.
- ✓ Measures of impairment detect the outcomes of the higher levels of EF and so relate better to ratings of EF that evaluate behavior closer to those levels

More on the Paradox

- ✓ Higher levels are only partially based on lower levels but will direct those lower levels in the service of higher order goals and desires
- ✓ Deficits at lower levels may radiate upward (outward) to adversely impact higher levels of performance
- ✓ Yet new deficits can arise at the higher level that are not evident at lower levels - deficits at higher levels do not typically adversely affect lower level performance
- ✓ Some deficits at the tactical and strategic levels can arise purely from lack of opportunity for learning the skills required at that level (i.e. poverty, limited or no exposure to training)



Anterior-posterior (rostral-caudal) hierarchy of cognitive control of behavior

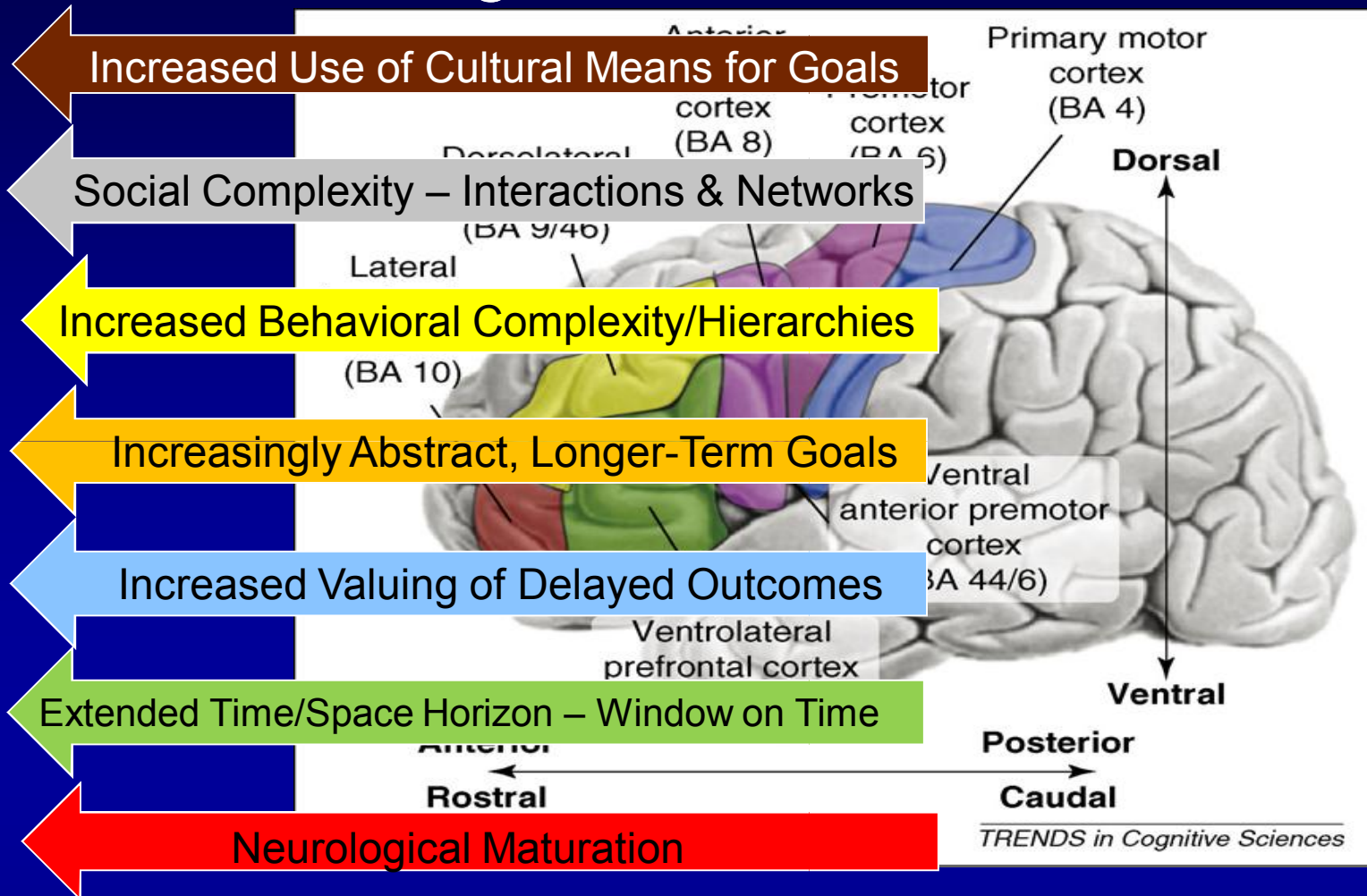


Figure 1. Badre, D. (2008). *Trends in Cognitive Sciences*, 12(5), 193-200.

6 Level Hierarchy of EF

Pre-Executive (non-EF)

A stylized, low-poly mountain range in shades of brown and orange, positioned at the bottom of the slide.

Level 1 – Pre-Executive

Nature: These are the cognitive abilities from which the specific EFs will be developed. They are not self-directed, self-regulatory activities and so are not EF in nature.

Specific Features: arousal, attention, memory, senses, sensory-motor actions, visual-spatial ability, speech, emotion-motivation, play etc.

Time Horizon and Motivation Preference: seconds to minutes

Behavioral Complexity: minimal

Use of Rules: none

Social and Cultural Complexity: none

6 Level Hierarchy of EF

Instrumental – Self-Directed

Pre-Executive (non-EF)



Level 2: Instrumental – Self-Directed

Nature: Self-directed moment-to-moment actions used for initial self-control (i.e. inhibition, nonverbal working memory, verbal working memory, emotional self-regulation, timing, planning-problem-solving). These are what EF tests likely assess – the most momentary neuro-proximal EF activities.

Specific features: self-awareness, self-direction of actions, privatization of actions, and interaction of EFs to achieve human reasoning

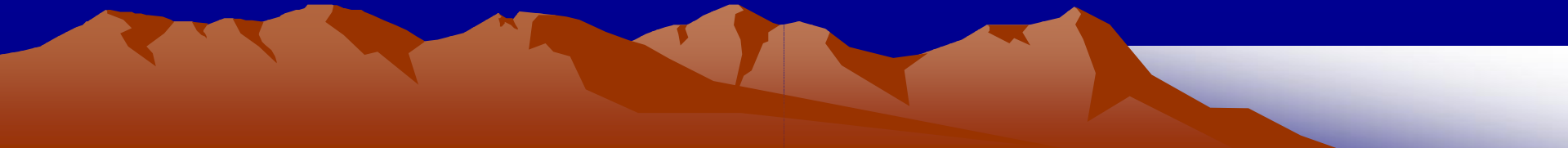
Time Horizon & Motivation Preference: minutes - few hours

Behavioral Complexity: low

Use of Rules: low

Social Complexity: very low

Cultural Scaffolding: simple methods for thinking and reasoning toward goals.

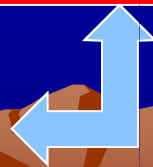


6 Level Hierarchy of EF

Methodical – Self-Reliant

Instrumental – Self-Directed

Pre-Executive (non-EF)



Level 3: Methodical – Self-Reliant

Nature: Uses the instrumental EF level for meeting daily needs of survival and self-care by creating a sequence of actions (a method) needed to attain a near-term goal. Focuses on fulfilling biological needs in the material world and how well the person uses judgment to conform to physical reality to achieve self-determination and self-sufficiency.

Specific Features: Includes self-care, hygiene, personal safety and self-defense, acquiring nourishment, finding/creating shelter and general protection from the physical elements (clothing, housing, etc.). The “Robinson Crusoe” level of EF.

Distinctive Feature: Unique to this level is the use (re-arrangement) of the physical environment to assist with self-regulation. The individual self-organizes their environment so as to better facilitate attaining their goals.

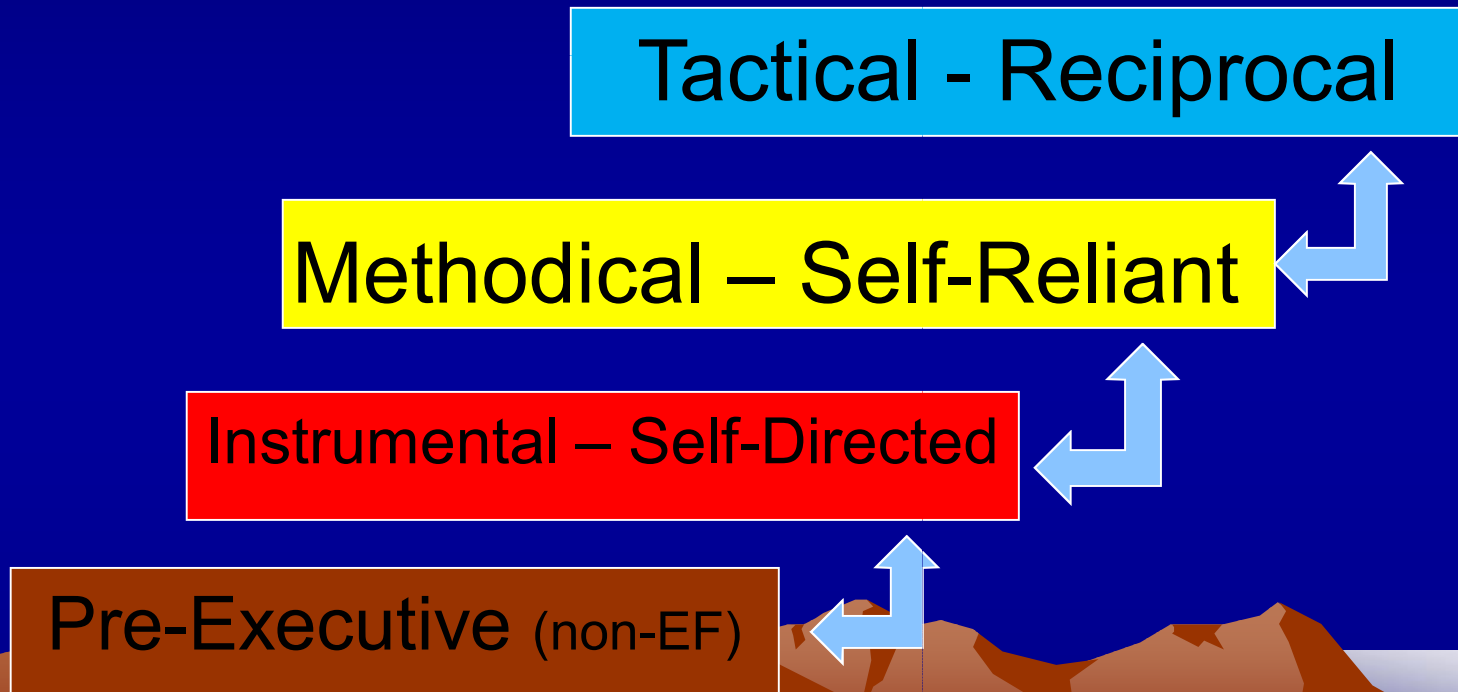
Time Horizon & Motivation Preference: Hours to a few days

Behavioral and Rule Complexity: Low-to-moderate

Social Complexity: Low

Cultural Scaffolding: The use of cultural devices, methods, and products as means to ends. The concept of property ownership

6 Level Hierarchy of EF



Level 4: Tactical - Reciprocal

Nature: Uses the lower EF levels for self-regulation across daily social interactions. Includes the 5 EFs in daily life: self-management to time, self-organization and problem-solving, self-restraint, self-motivation, and self-regulation of emotions

Specific features: reciprocity and trading, sharing, turn-taking, vicarious learning, etiquette, rule-following, etc.

Distinctive Features: Unique to this level is that the individual is now using others to assist with their self-regulation and goal-directed actions increasing the likelihood of success. Other abilities that come into play at this level are social skills, theory of mind, and imitation/vicarious learning.

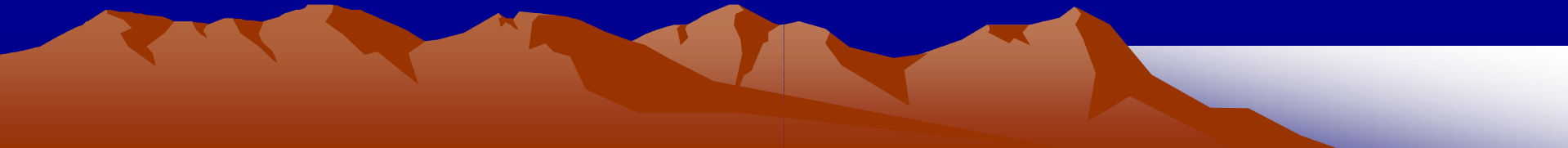
Time Horizon & Motivation Preference: Days to a few weeks

Behavioral Complexity: Moderate

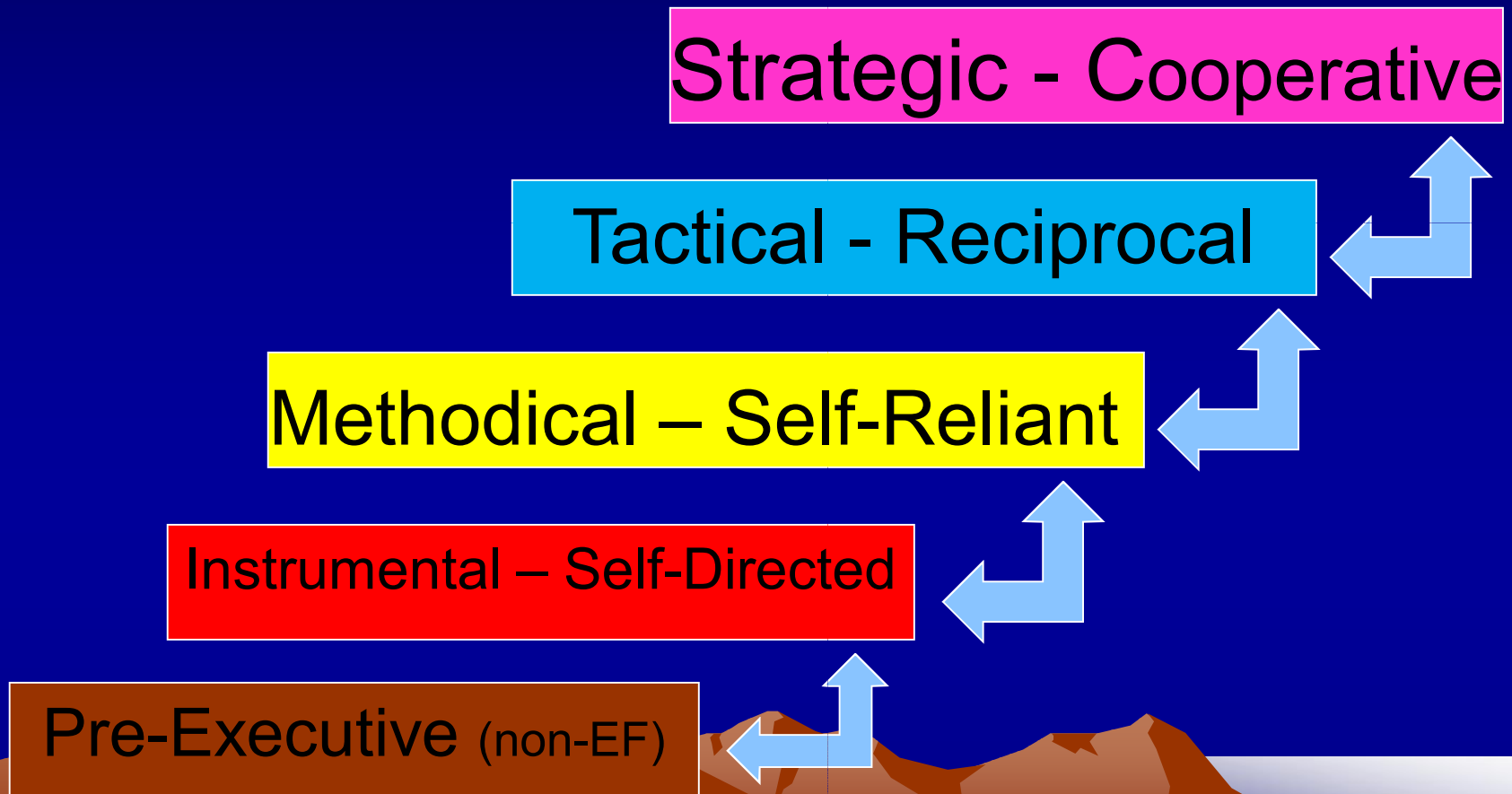
Use of Rules: Low to moderate; Increasing in complexity

Social Complexity: Low to moderate

Cultural Scaffolding: *The concept of trading among self-reliant people; private ownership of property, contract enforcement, policing against fraud and use of force to obtain property of others*



6 Level Hierarchy of EF



Level 5: Strategic - Cooperative

Nature: – Uses the tactical and lower EF levels to achieve mid-term to longer-term goals, see to our mid-term to longer-term welfare and happiness, fulfill responsibilities, act morally, achieve economic self-sufficiency, and behave effectively across time in society. These are reflected in ongoing educational activities, occupational functioning, peer relations, cohabiting, child rearing, managing finances, participating in community organizations, etc.

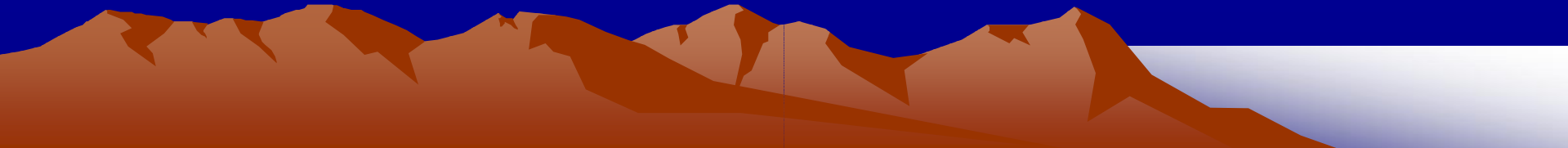
New Abilities: The individual now uses a group of others (Cooperation) for self-regulation to achieve common goals

Time Horizon & Motivation Preference: Weeks to Months

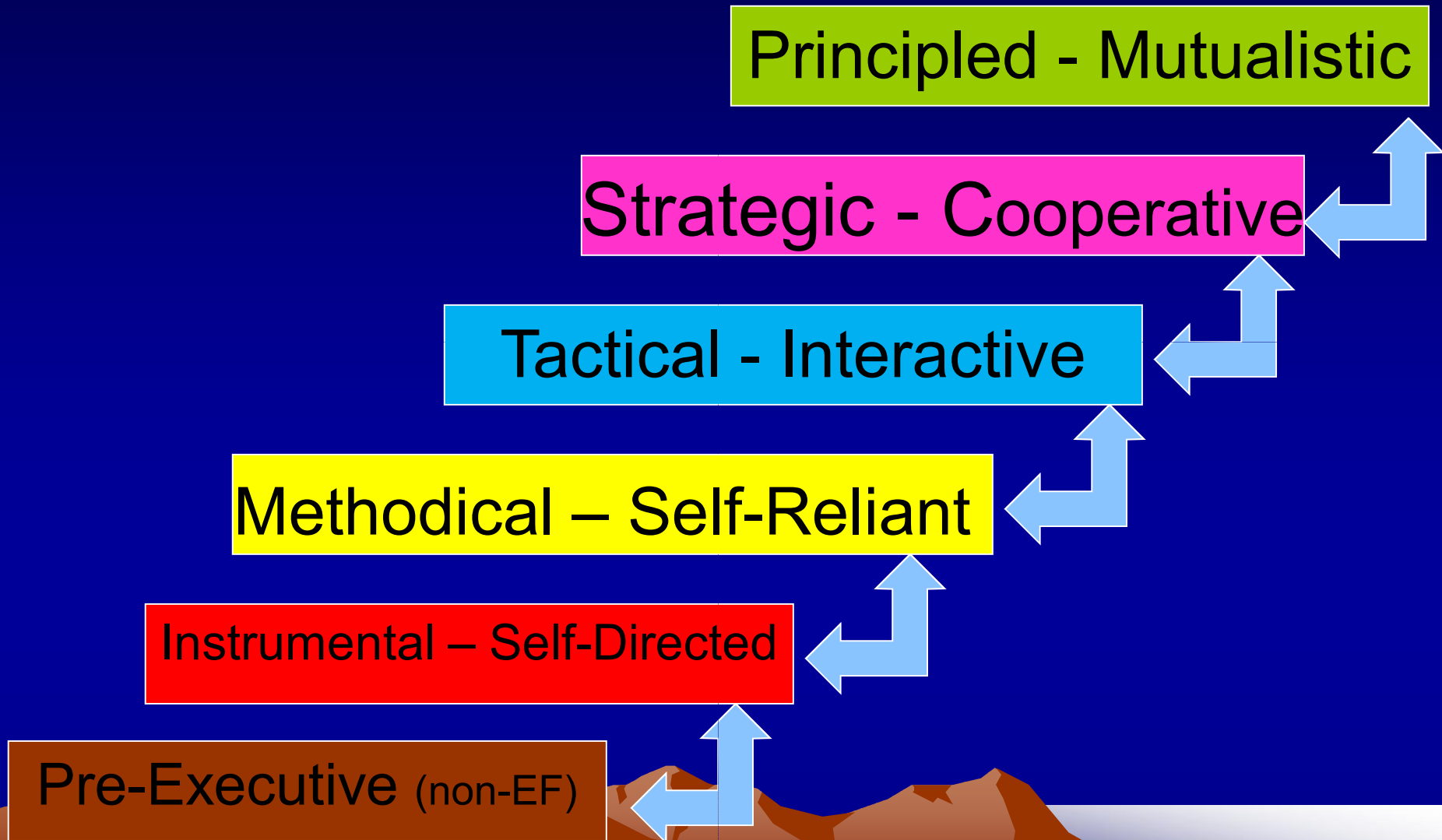
Behavioral and Rule Complexity: High

Social Complexity: High

Cultural Scaffolding: *Mutual concerted action; Division of labor with trade (reciprocity)*



6 Level Hierarchy of EF



Level 6: Principled - Mutualistic

Nature: – Uses the earlier EF levels to achieve long-term highly abstract goals, see to our long-term welfare and happiness, fulfill extended responsibilities, act ethically/morally, achieve economic self-sufficiency, develop communities (and even societies) involving community political and legal systems, codify rules of human interaction, and behave civilly across time in society. These are reflected in ongoing higher level educational activities, occupational functioning, legal activities, participation in government, extensive social networks, long-term financial planning, participating in community organizations, etc.

Distinctive Features: The individual now uses entire communities of people to achieve their long-term goals and enhance their self-regulation to do so. This is Mutualism (Communalism) -- seeing to each other's welfare over time and across situations

Time Horizon & Motivation Preference: Years

Behavioral and Rule Complexity: Very High

Social Complexity: Very High

Cultural Scaffolding: Constitutions, Bills of Civil Rights, Provisional delegation of the use of force to government with restrictions on government use of force.

Religious doctrine concerning in-group cooperation and civility

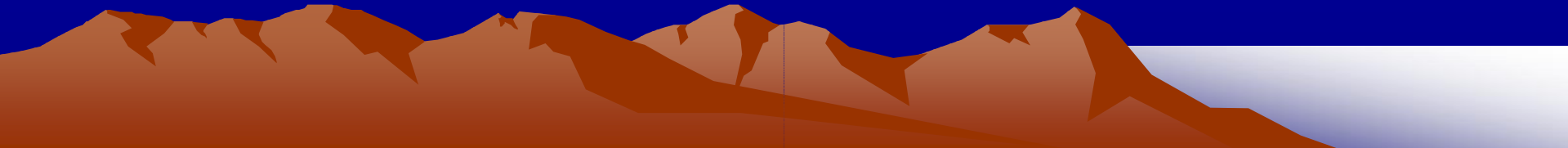


Extended Utilitarian Outcomes

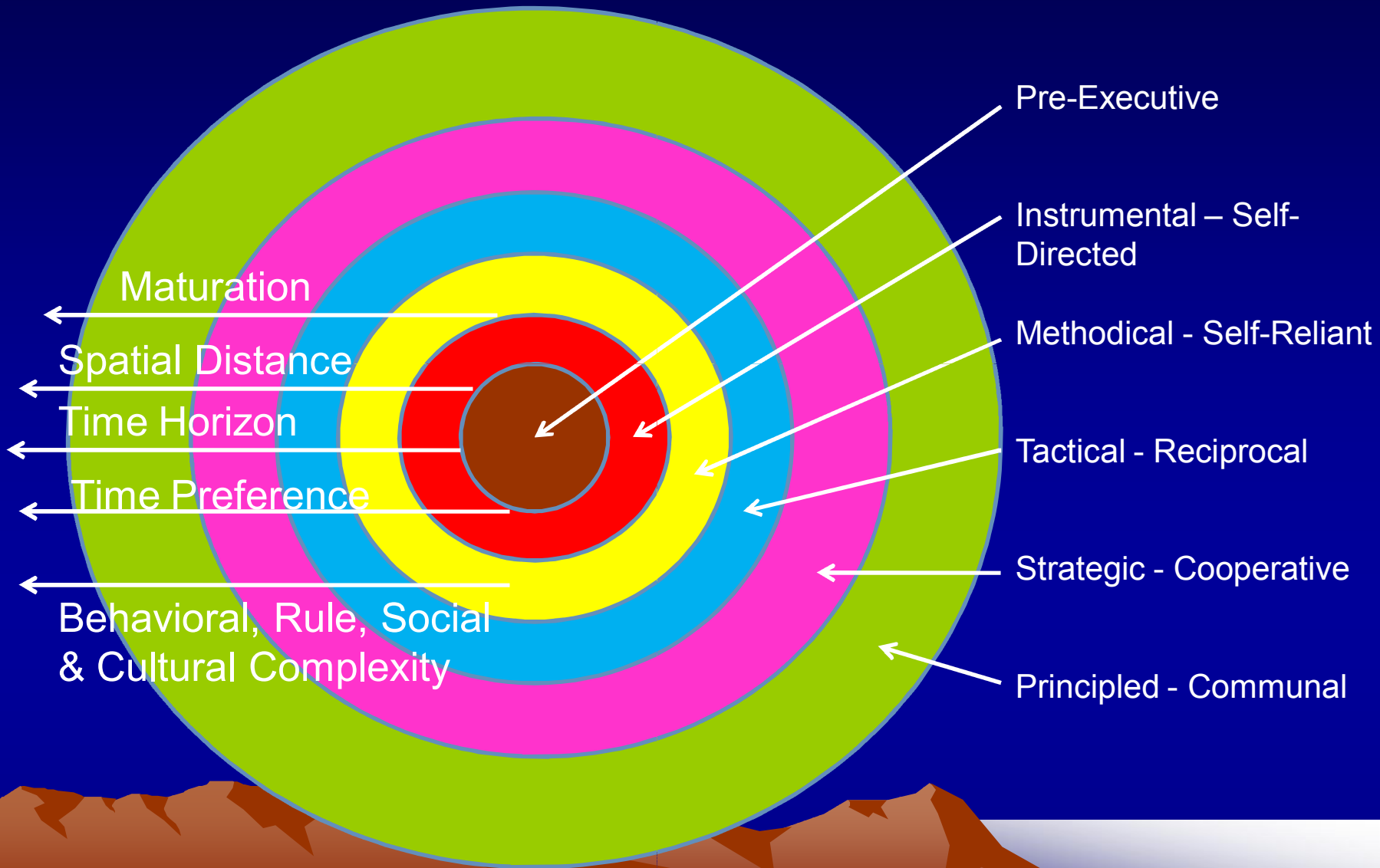
Time line: years to decades

Nature: Not an EF level. This level reflects the long-term outcomes of EF for one's longer-term welfare, such as achieving educational milestones/degrees, getting occupational promotions, resource (property) maintenance/replacement, saving/investing for major purchases and retirement, sustaining marriages, sponsoring children into adulthood, long-term health, estate planning, investment in grand-children, etc.

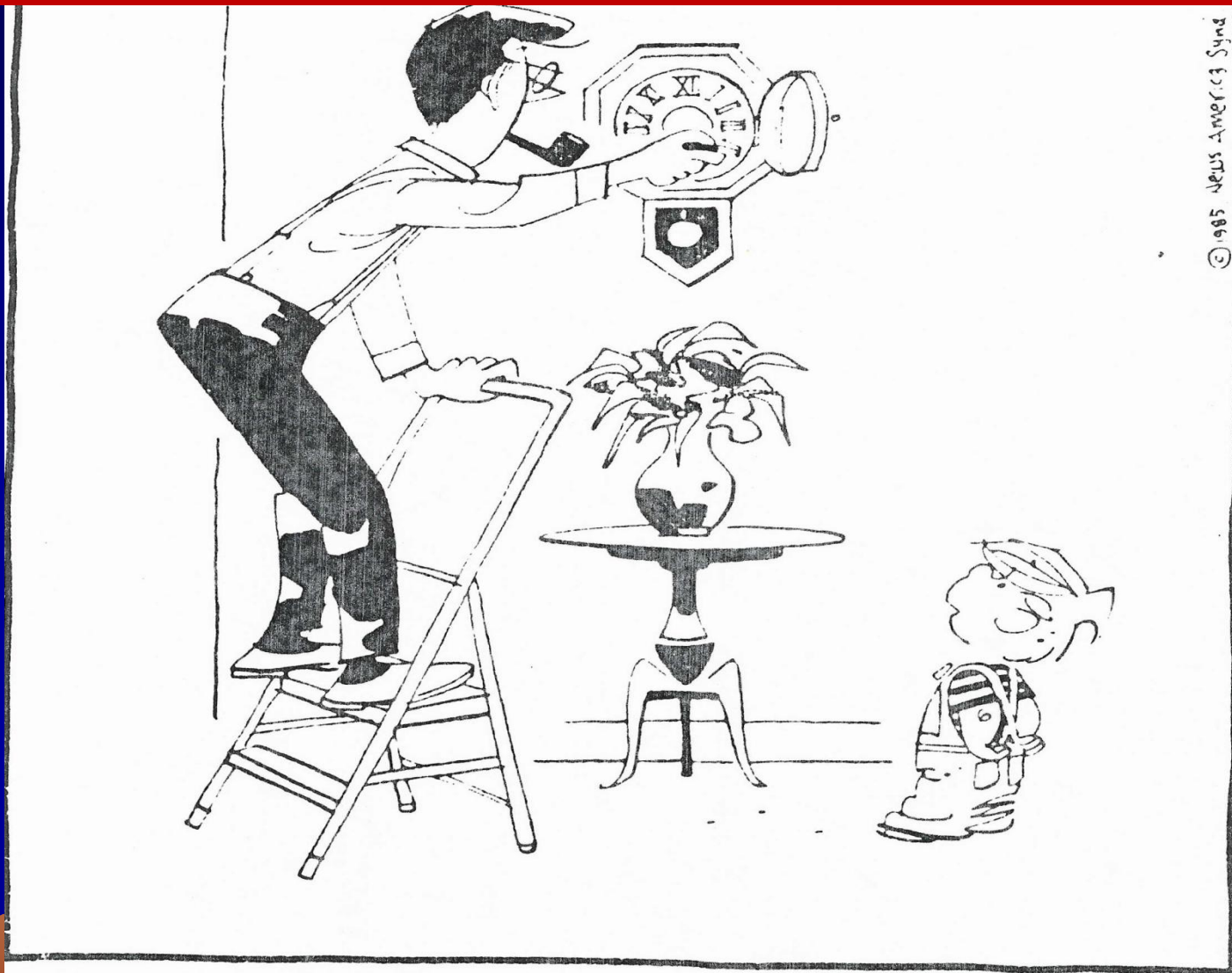
Assessment: *The accrued consequences over time and the archival records of one's life*



6 Level Extended Phenotype of EF



ADHD Impairs Executive Functioning and Self-Regulation Across Time



© 1985 News America Synd.

"ISN'T IT ALWAYS NOW?"

Anterior-posterior (rostral-caudal) hierarchy of cognitive control of behavior

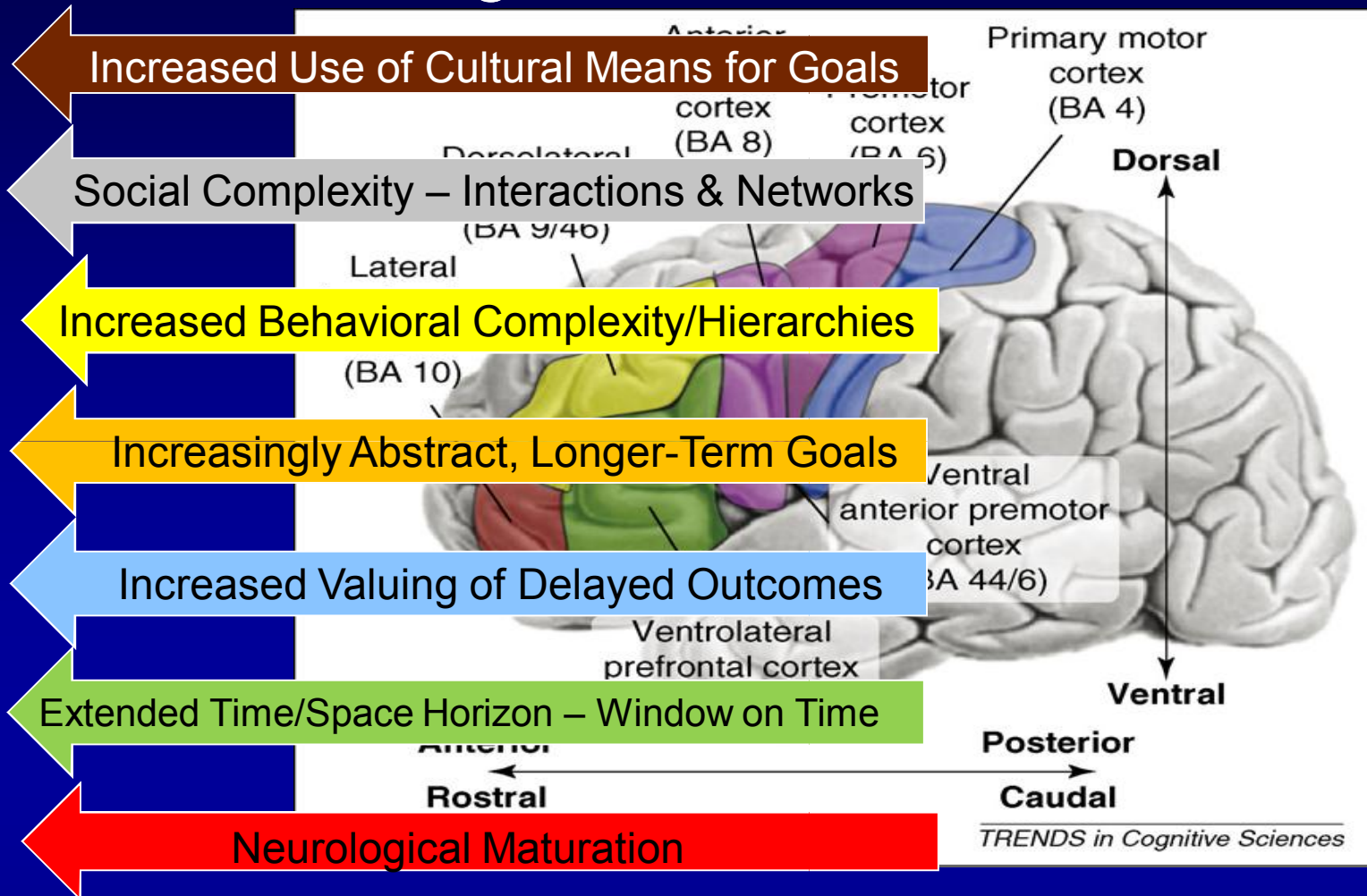


Figure 1. Badre, D. (2008). *Trends in Cognitive Sciences*, 12(5), 193-200.

Anterior-posterior (rostral-caudal) hierarchy of cognitive control of behavior

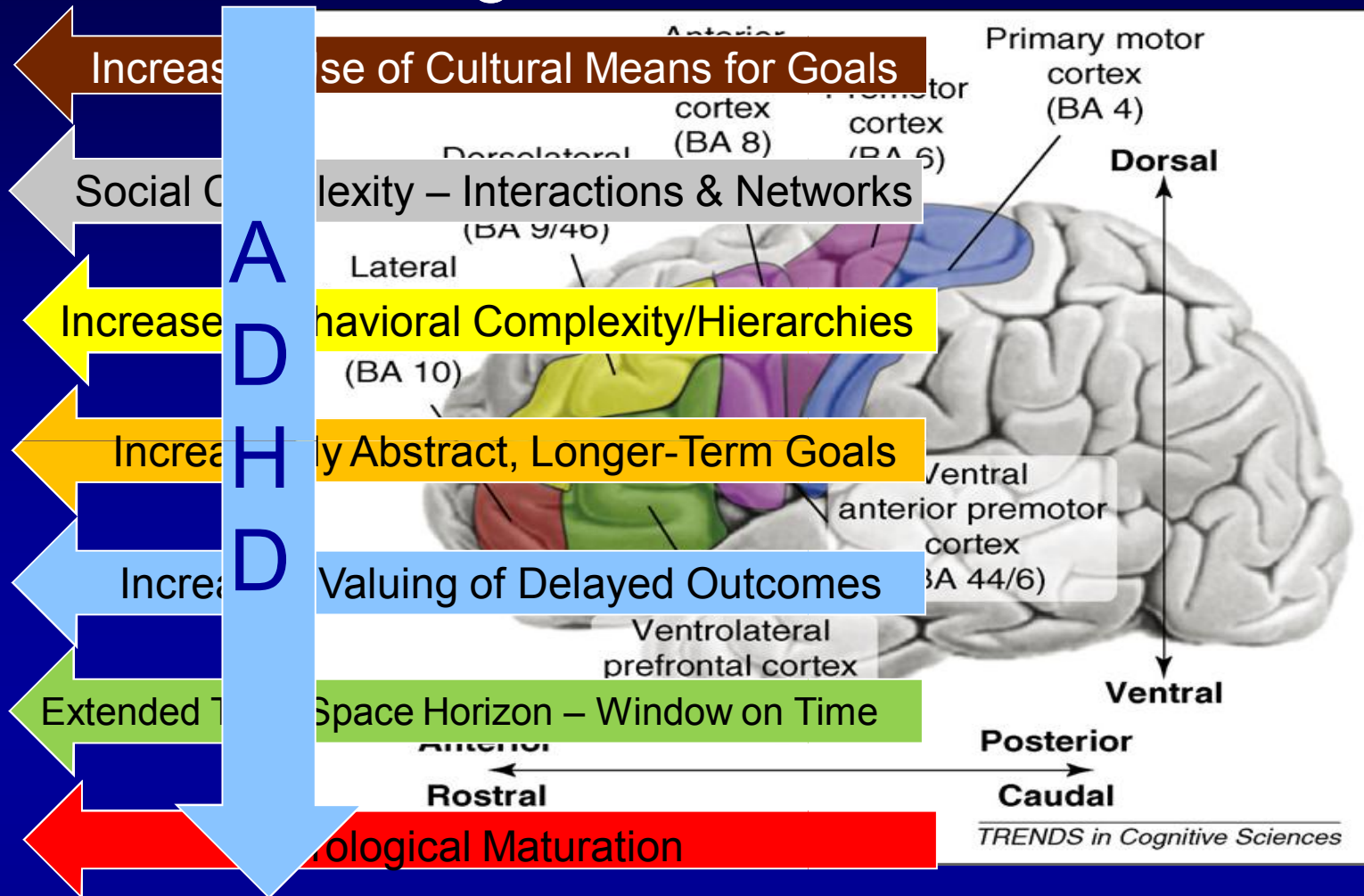


Figure 1. Badre, D. (2008). *Trends in Cognitive Sciences*, 12(5), 193-200.

6 Level Hierarchy of EF

ADHD

**Severe
PFC
Injury**

Principled - Mutualistic

Strategic - Cooperative

Tactical - Reciprocal

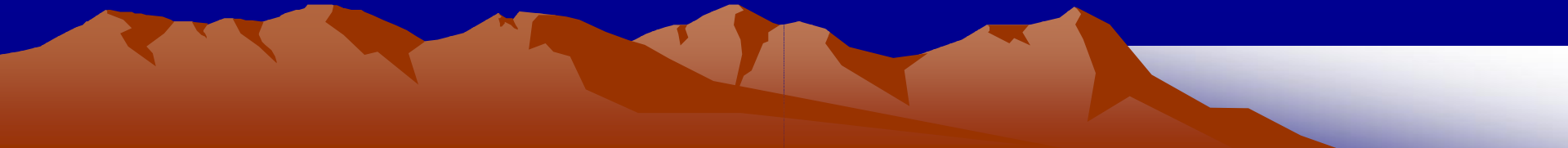
Methodical – Self-Reliant

Instrumental – Self-Directed

Pre-Executive (non-EF)

Understanding ADHD

- ADHD disrupts the 5 levels of EF/SR but especially the tactical and higher levels thereby creating a disorder of self-regulation across time
- ADHD can be considered as “Time Blindness” or a “Temporal Neglect Syndrome” (Myopia 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)
- It’s not an Attention Deficit but an Intention Deficit (Inattention to mental events & the future)

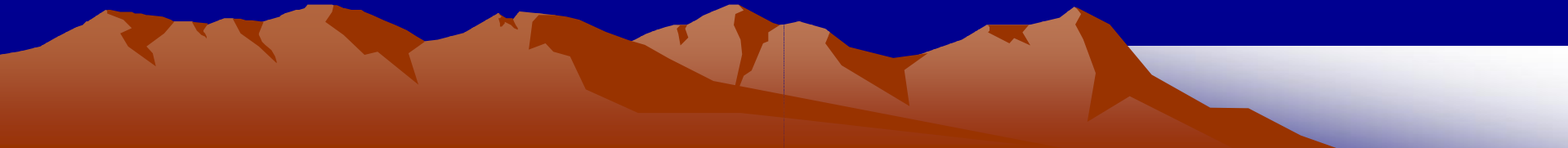


Understanding ADHD

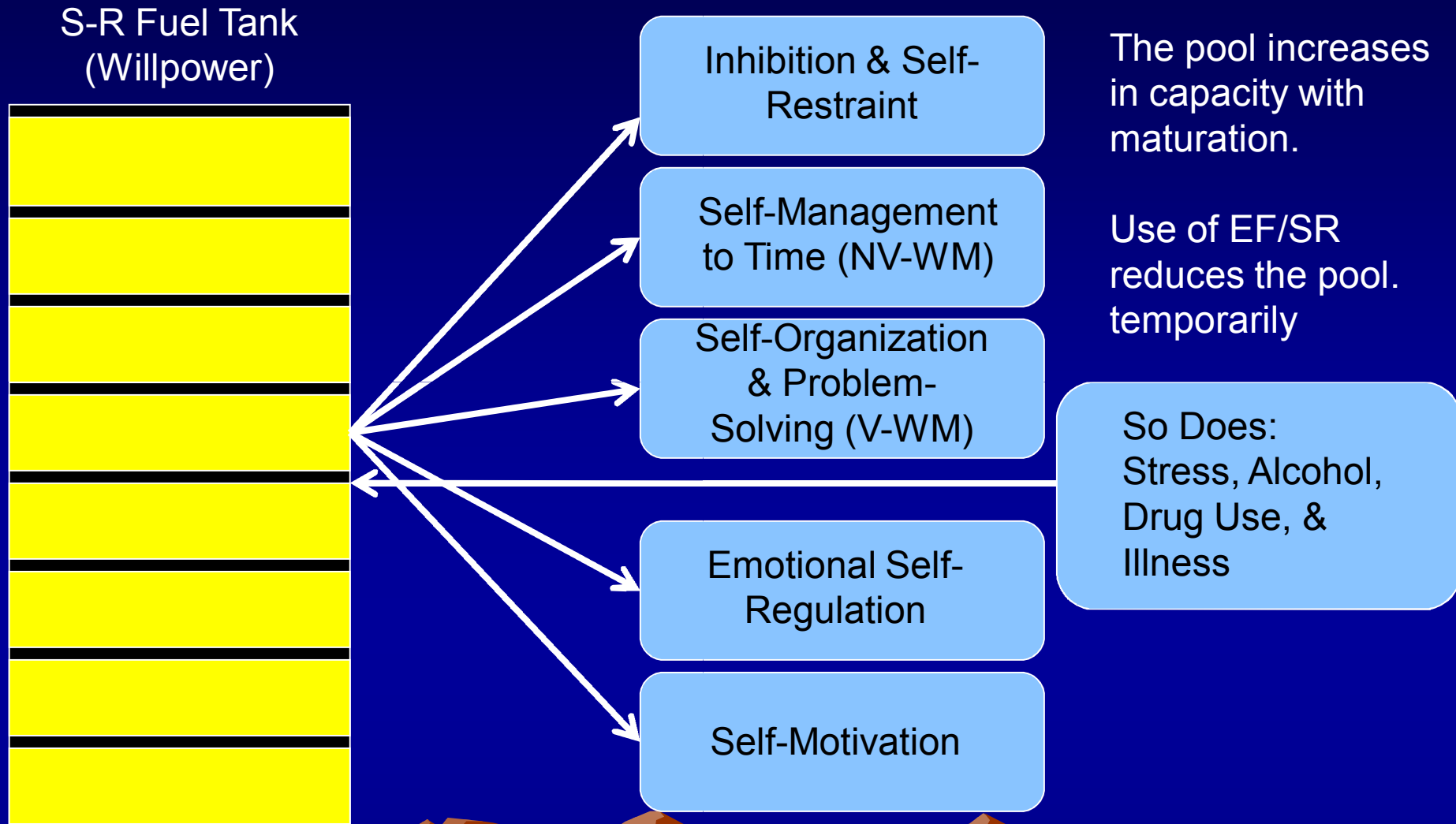
It's a Disorder of:

- Performance, not skill
- 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 may not)



Self-Regulatory Strength is a Limited Resource Pool



Understanding the S-R Resource Pool

- Acts of S-R require effort; this diminishes the pool
- Every type of EF activity depletes the pool temporarily
- This adversely affects all subsequent use of EF
- Sustained use of the EF/SR pool so depletes it that any subsequent attempts at EF/SR are at greater risk of failure
- This includes EF/SR used in work, social conduct, moral behavior and other situations where EF/SR would be necessary

From Bauer, I. M. & Baumeister, R. F. (2011). Self-regulatory strength. In K. Vohs & R. Baumeister (Eds.), *Handbook of Self-Regulation* (2nd ed.) (pp. 64-82). New York: Guilford Press

Implications for ADHD

- The extra effort SR requires in someone with ADHD may deplete this pool far more rapidly than in normal people
- And/or the pool may be smaller in those with ADHD making it more likely to be depleted by efforts at SR
- Requiring people with ADHD to simply try harder may deplete this pool so much that it leaves them at greater risk for failure in immediately subsequent situations that may require further SR
- There may be implications here for adverse after-effects from treatments that tax SR/EF during training periods such that following the training period the child or adult is at greater risk for poor self-regulation in subsequent social or academic situations

Implications for Treatment

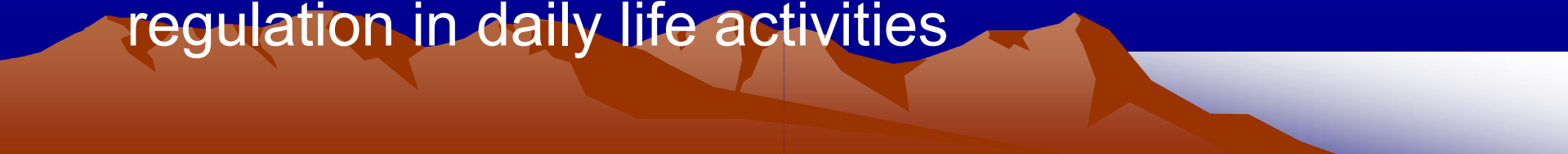
- Teaching skills is inadequate
- The key is to design prosthetic environments around the individual to compensate for their EF deficits
- Therefore, effective treatments are always those at the “point-of-performance”
- The EF deficits are neuro-genetic in origin
- Therefore, medications may be essential for most (but not all) cases – meds are neuro-genetic therapies
- But some evidence suggests some EFs may also be partly responsive to direct training
- While ADHD creates a diminished capacity: Does this excuse accountability?
 - (No! The problem is with time and timing, not with consequences)

More Treatment Implications

- Behavioral treatment is essential for restructuring natural settings to assist the EFs
 - They provide artificial prosthetic cues to substitute for the working memory deficits (signs, lists, cards, charts, posters)
 - They provide artificial prosthetic consequences in the large time gaps between consequences (accountability) (i.e., tokens, points, etc.)
 - But their effects do not generalize or endure after removal because they primarily address the motivational deficits in ADHD
- The compassion and willingness of others to make accommodations are vital to success
- A chronic disability perspective is most useful

How can we compensate for EF deficits?

By reverse engineering the EF system

- Externalize important information at key points of performance
 - Externalize time and time periods related to tasks and important deadlines
 - Break up lengthy tasks or ones spanning long periods of time into many small steps
 - Externalize sources of motivation
 - Externalize mental problem-solving
 - Replenish the SR Resource Pool (Willpower)
 - Practice incorporating the 5 strategies for emotional regulation in daily life activities
- 

Externalizing Working Memory

- Use externally (outside the individual) represented forms of information to remind the individual what is to be done at the point of performance
- This can be done by using sticky notes, cues, cards, lists, posters, signs, and other prompts of critical reminders at the point of performance
- For older kids and adults, also use personal journals, digital recording devices, Watch-Minder watches, day planners, personal organizers, computer organizers

Externalizing Time and the Future

Make time physical, external, and obvious

- timers, clocks, counters, and anything else that can signal time's passing

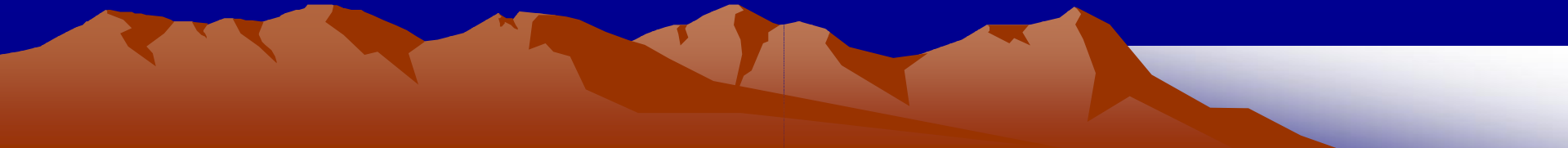
Break down future projects and goals into small pieces and do a piece a day (or more frequently).

Bring the Es, Rs, & Os of life close together



Make Motivation External

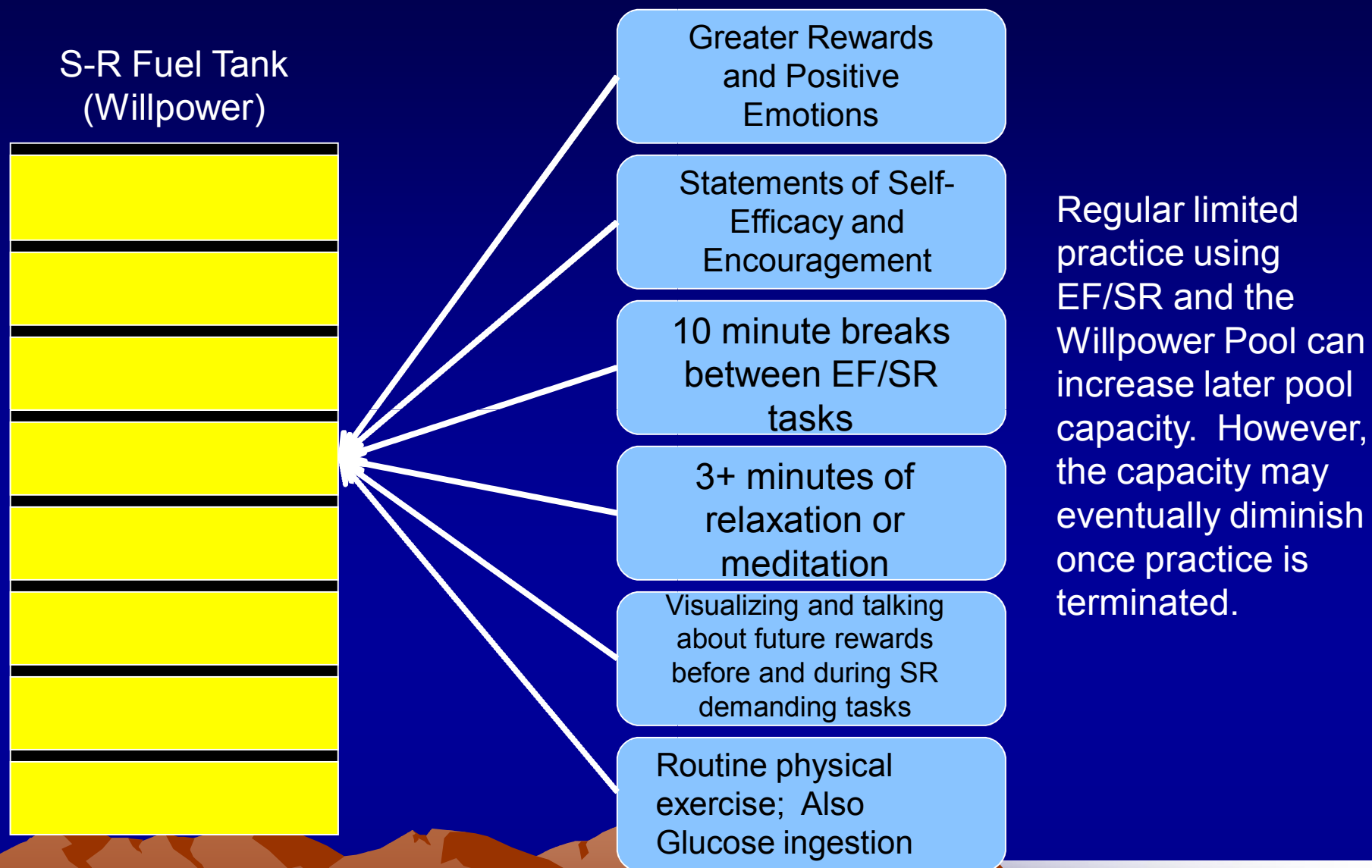
- Identify tasks and settings in which consequences are too delayed or nonexistent
- Put artificial consequences into these large gaps in time
 - Tokens, points, prizes, praise, privileges
- Increase accountability to others – more frequent check-ins with others to see that work is being done, goals are being met



Make Problem-Solving Manual

- When tasks normally require mental problem-solving (manipulating mental information, generating multiple ideas, etc.) make the mental information external, physical, or manual
- For math, use marbles, number lines, an abacas, etc. and calculators
- For words, use cards, paper, computer word processing programs

Replenishing the EF/SR Resource Pool



Conclusions

- The EF/SR system is multi-leveled and arranged in a hierarchy over maturation
 - ADHD disrupts behavioral inhibition and the internalization of the instrumental self-directed EFs producing a cascading of deficits into higher levels of EF
 - By disrupting EF/SR, ADHD affects:
 - Self-restrain or inhibit behavior, thoughts, words, emotions
 - Self-manage to time; anticipate and prepare for the future
 - Self-organize and problem solve across time
 - Self-motivate across time
 - Self-regulate emotions across time
- 

Conclusions

- Behavior in people with ADHD cannot be hierarchically organized and sustained in support of longer term goals and welfare
- This results in a serious and pervasive disorder of self-regulation across time and settings and impaired social functioning (reciprocity, cooperation, and mutualism)
- Preventing them from dealing effectively with the probable future and pursuing one's long-term goals and welfare
- Thereby requiring the design of prosthetic environments that compensate for EF/SR deficits while using neuro-genetic medicines to temporarily improve or normalize the instrumental self-directed EFs