

The Role of Executive Functions in Childhood Learning and Behavior

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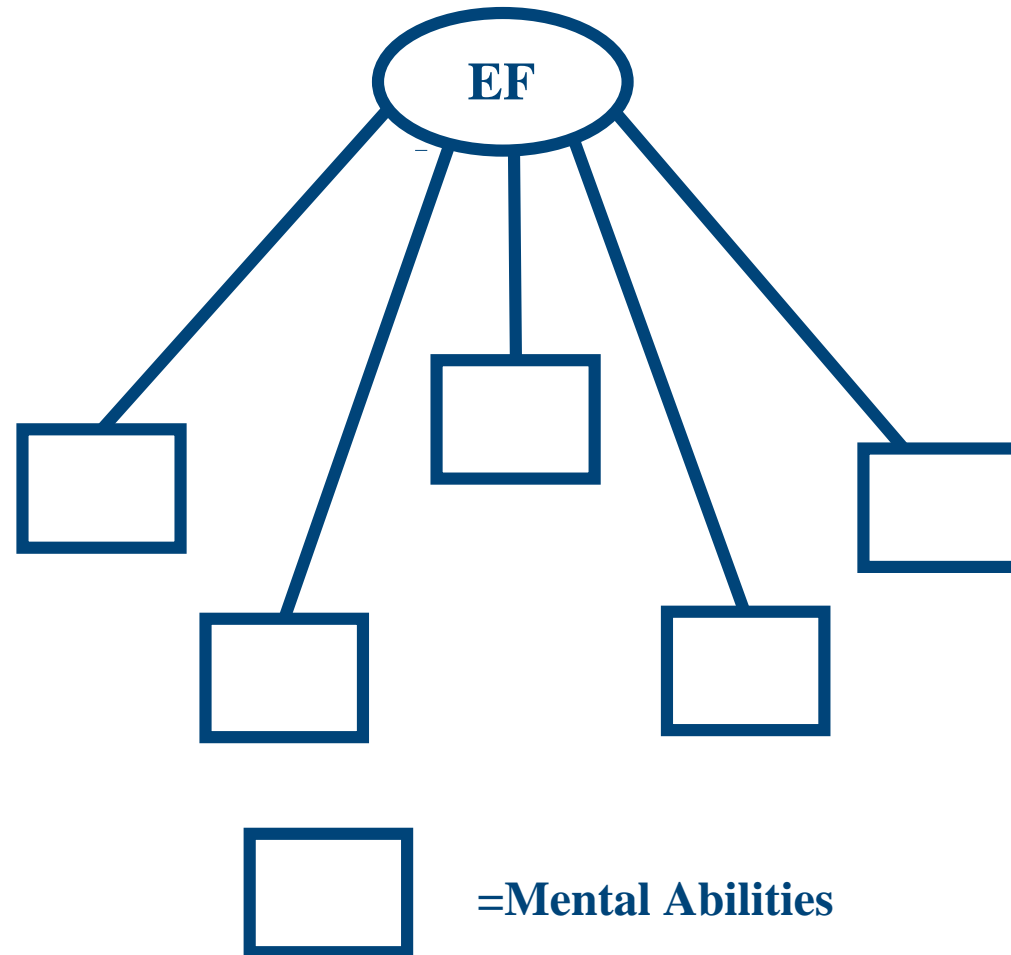
What are Executive Functions?

- **Directive capacities of the mind**
- **Multiple in nature, not a single capacity**
- **Cue the use of other mental abilities**
- **Direct and control perceptions, thoughts, actions, and to some degree emotions**
- **Part of neural circuits that are routed through the frontal lobes**

What are Executive Functions?

- Frequently referred to as “the CEO of the Brain” or the “Conductor of the Orchestra
- These metaphors
 - hint at the nature of EFs, but are far too accurate for effective understanding of the concept
 - Create the impression of a central control center or a singular control capacity

EF as the Conductor of the Brain's Orchestra

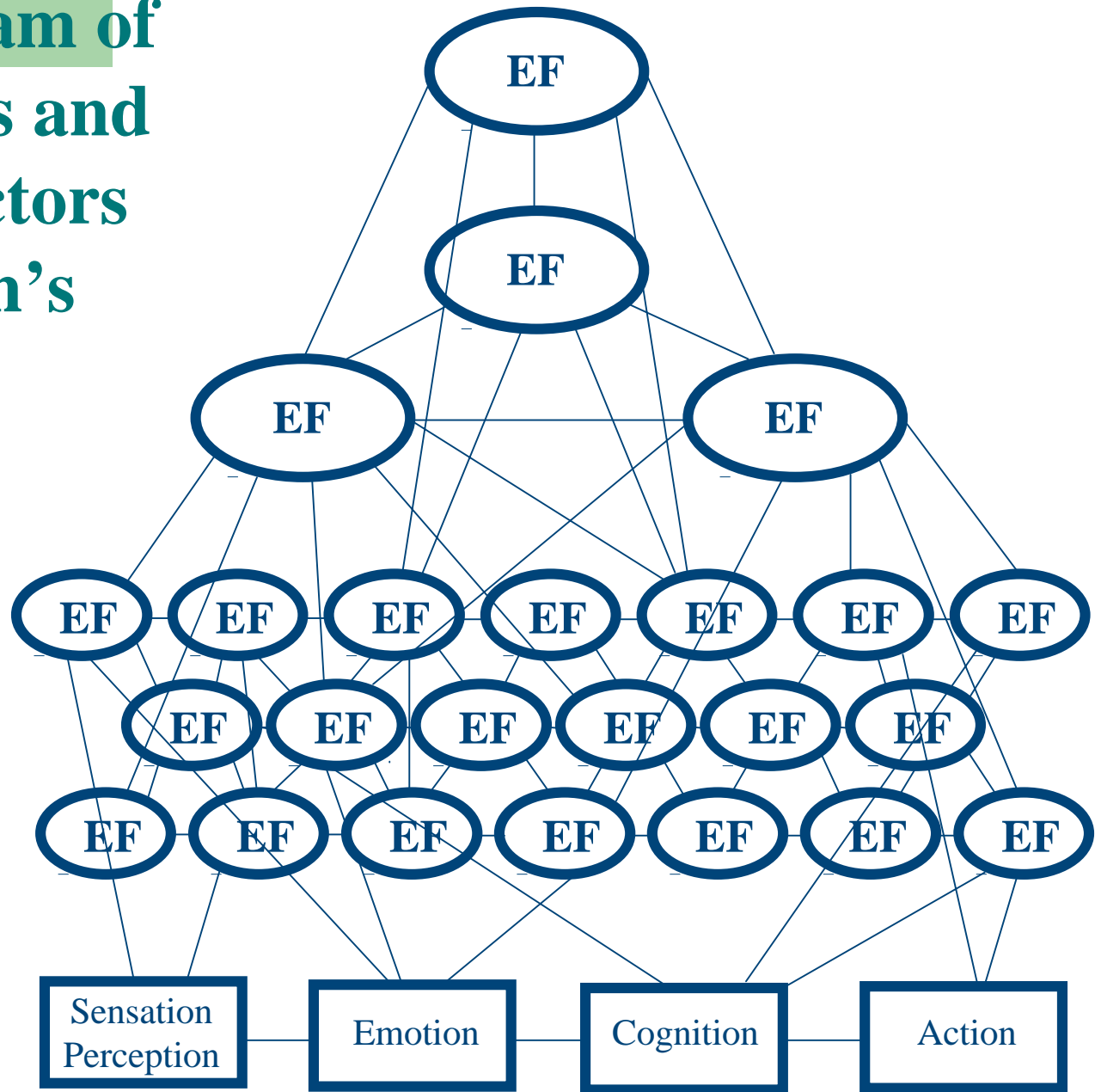


What are Executive Functions?

Better to think of Executive Functions as:

- **A Team of Conductors and Co-Conductors of a Mental Ability Orchestra**
- **The Coaching Staff of a Mental Ability Football Team**

EF as a Team of Conductors and Co-Conductors of the Brain's Orchestra



How are executive functions related to intelligence?

- **Broad theoretical definitions implicitly or explicitly include executive control processes as part of “Intelligence”**
- **Narrow theoretical definitions often include executive functions implicitly as part of problem-solving or reasoning in “Intelligence”**

Example of a narrow definition of intelligence

“The ability to carry on abstract thinking.”

(L.M. Terman)

Example of a broad definition of intelligence

Intelligence is the capacity to learn from experience, using metacognitive processes to enhance learning, and the ability to adapt to the surrounding environment, which may require different adaptations within different social and cultural contexts.

(Sternberg, 2003)

How are executive functions related to intelligence?

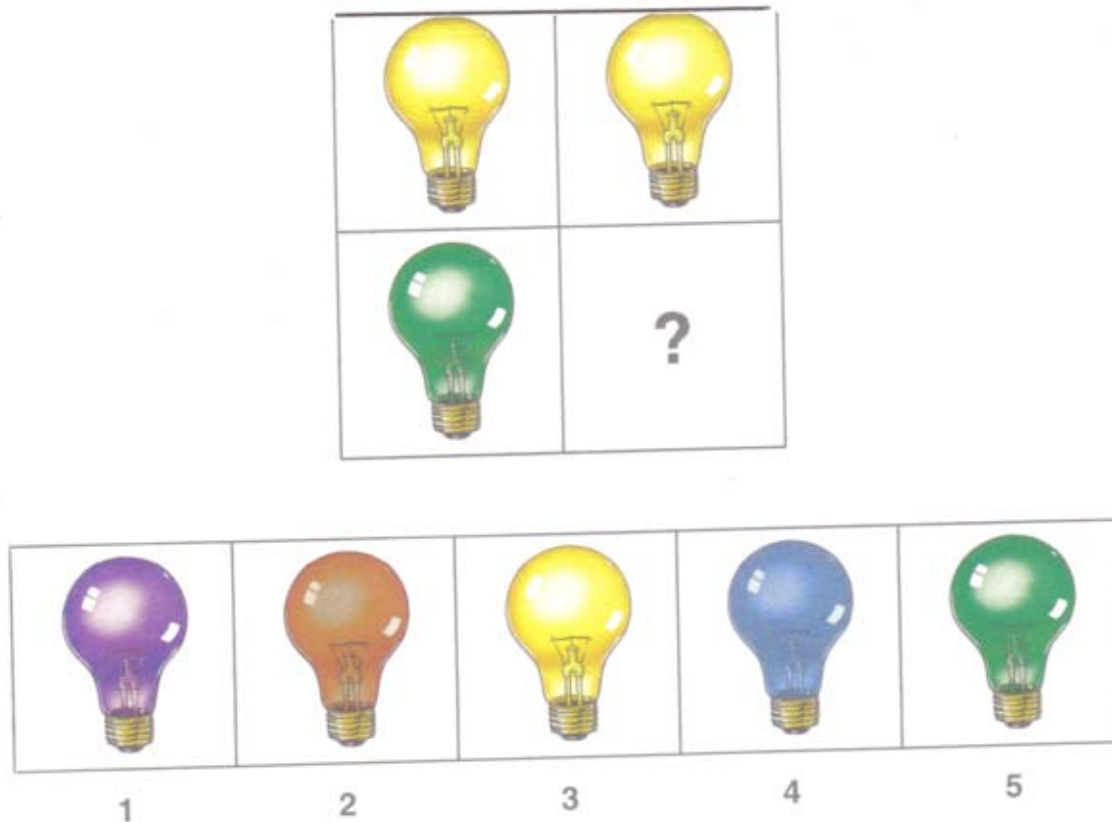
- **The operational definitions of intelligence used to guide test development typically do not include executive functions as a distinct component to be assessed.**
- **Many measures of intelligence involve executive control to some degree, but the role and effect of EFs are often minimized by the assessment procedures.**

How are executive functions related to intelligence?

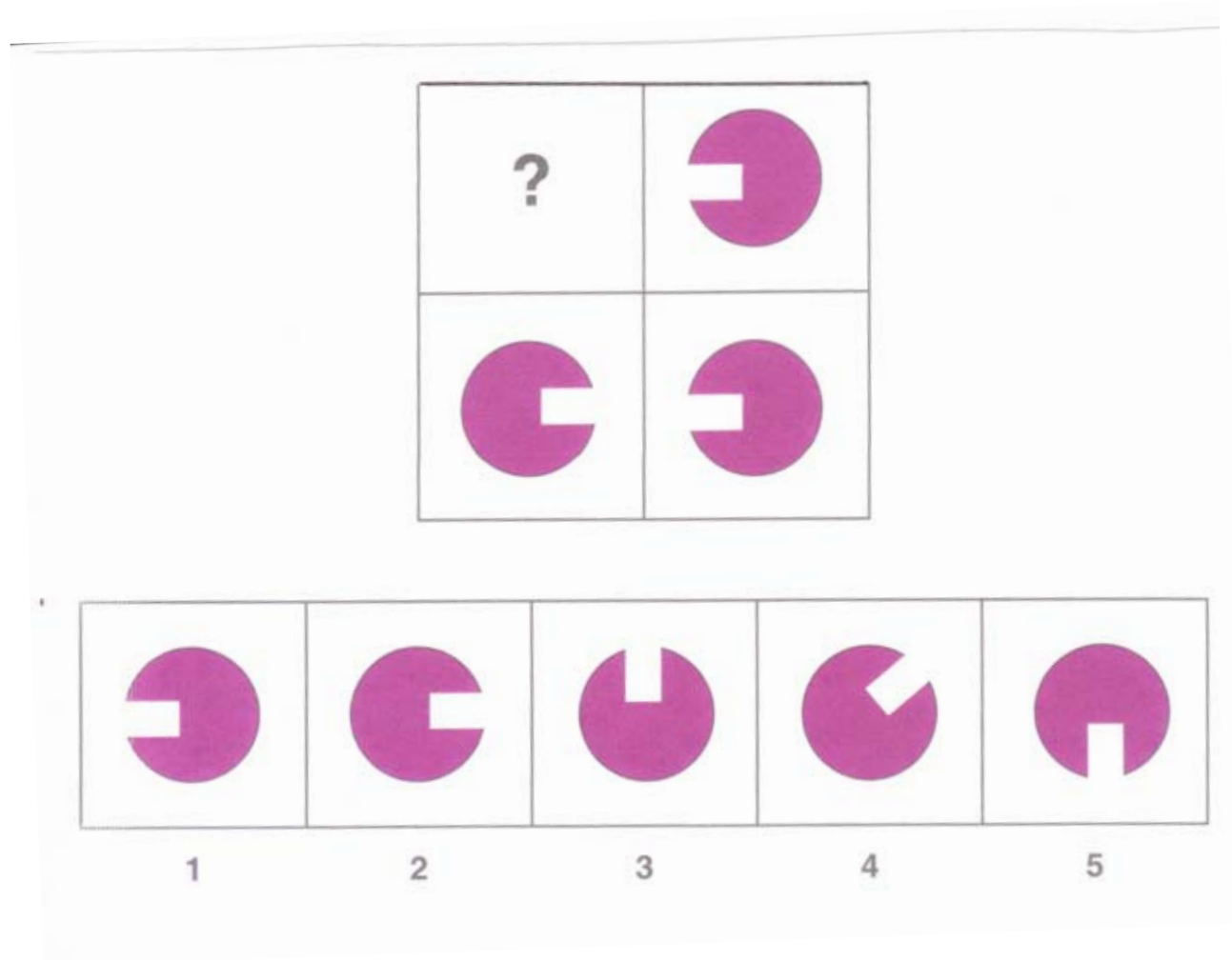
- **It is often necessary to include specific measures of executive control in an assessment in order to characterize the role of EFs in “intelligent” behavior.**
- **EF involvement can be understood through the application of a process approach while administering tasks developed to assess various cognitive abilities.**

Measuring intelligence with a reasoning task

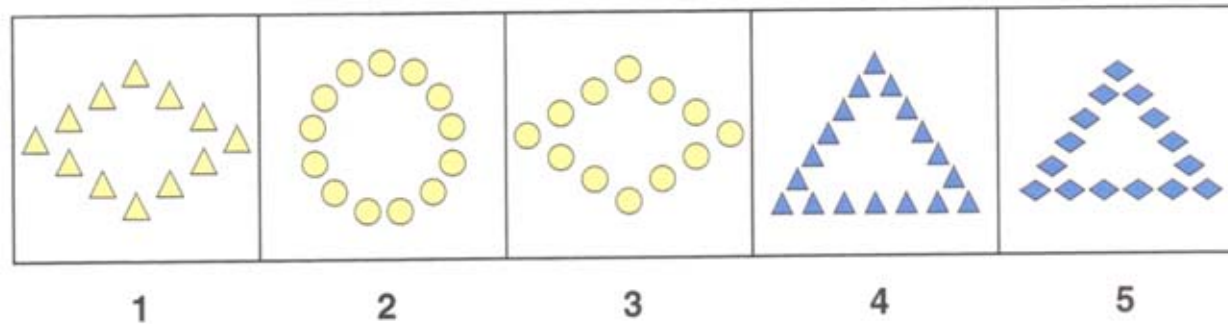
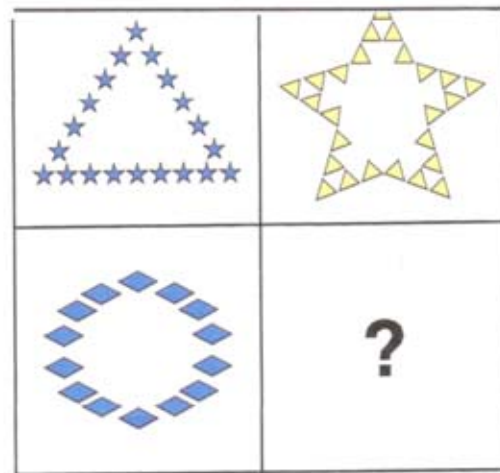
- The yellow one goes with the yellow one. Which one down here goes with the green one?



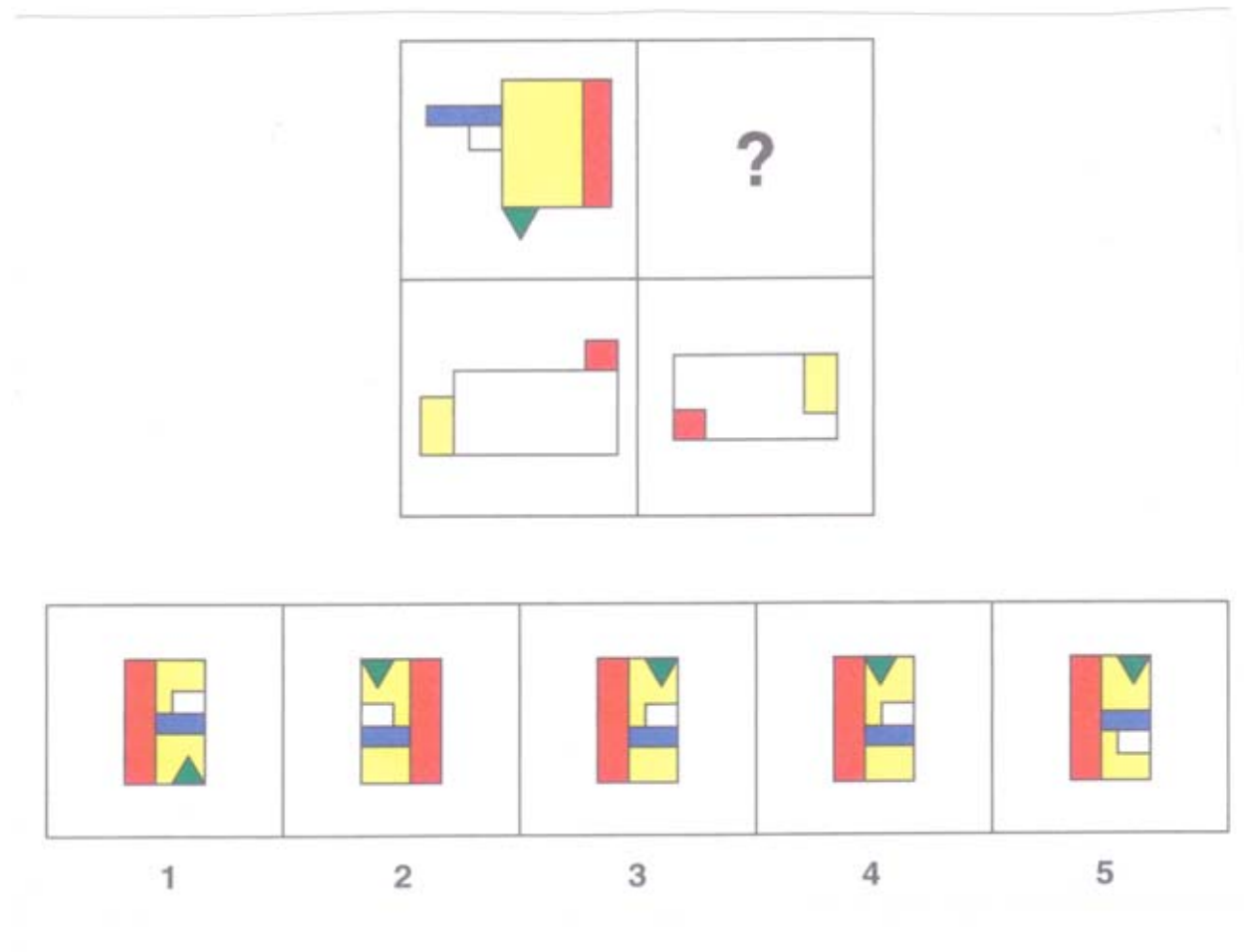
Measuring intelligence with a reasoning task



Measuring intelligence with a reasoning task

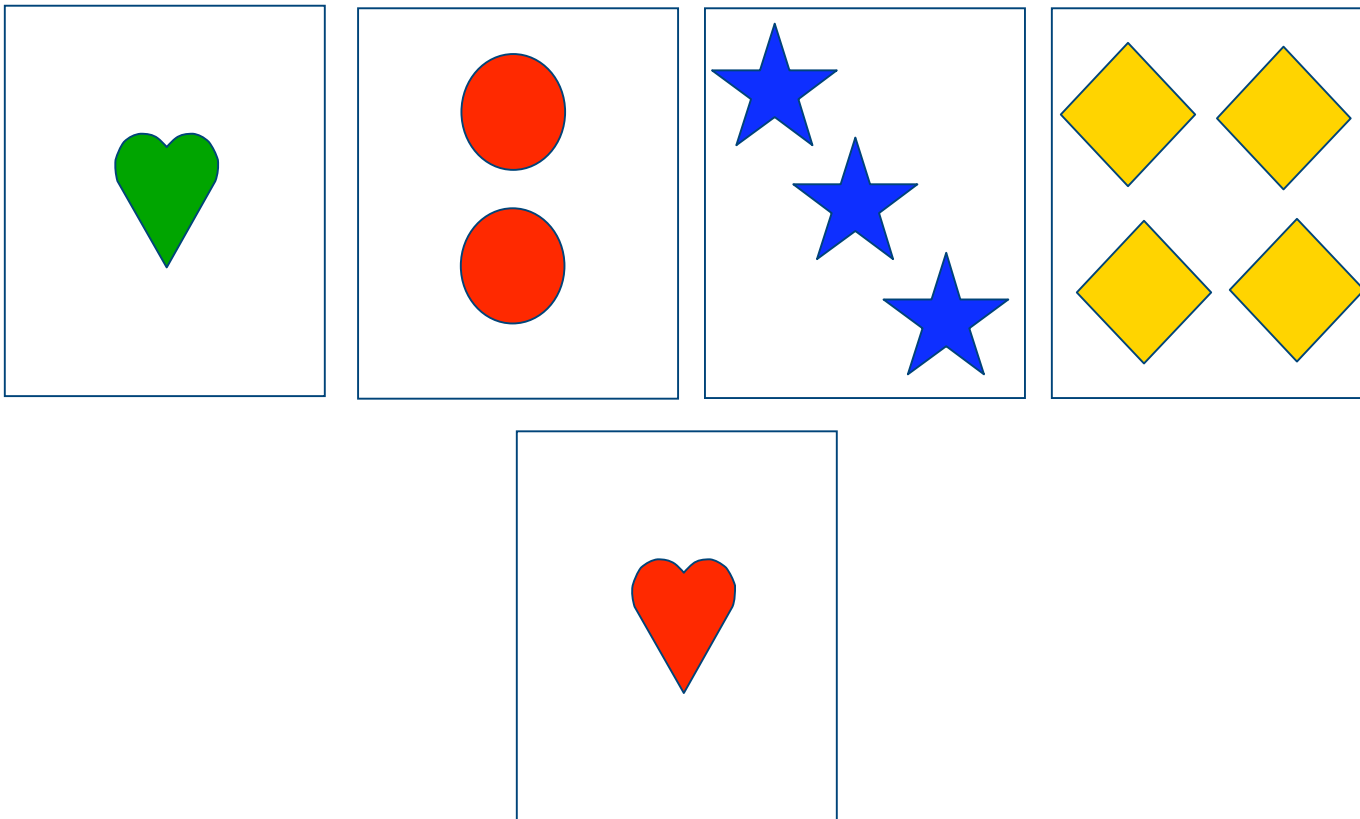


Measuring intelligence with a reasoning task

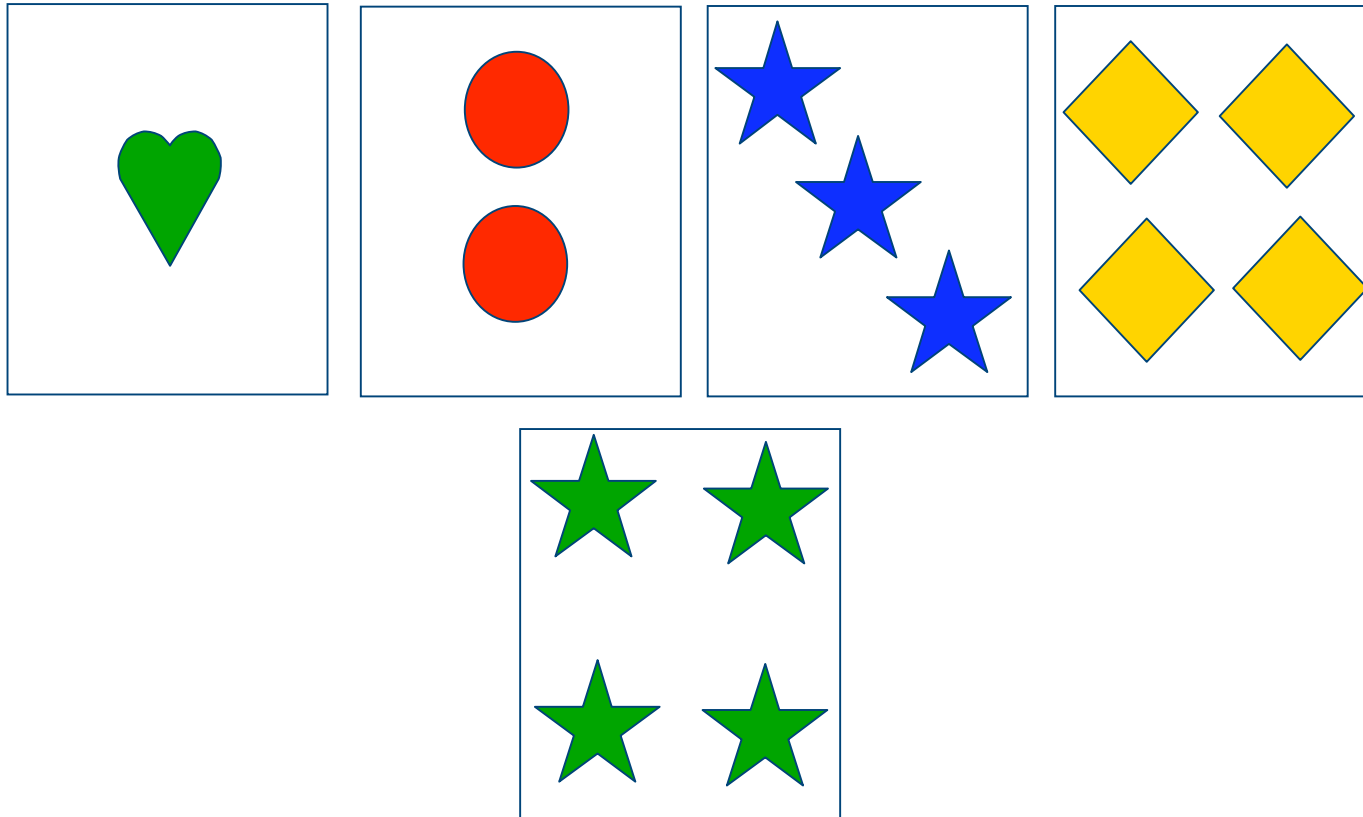


Measuring executive functions with a reasoning task

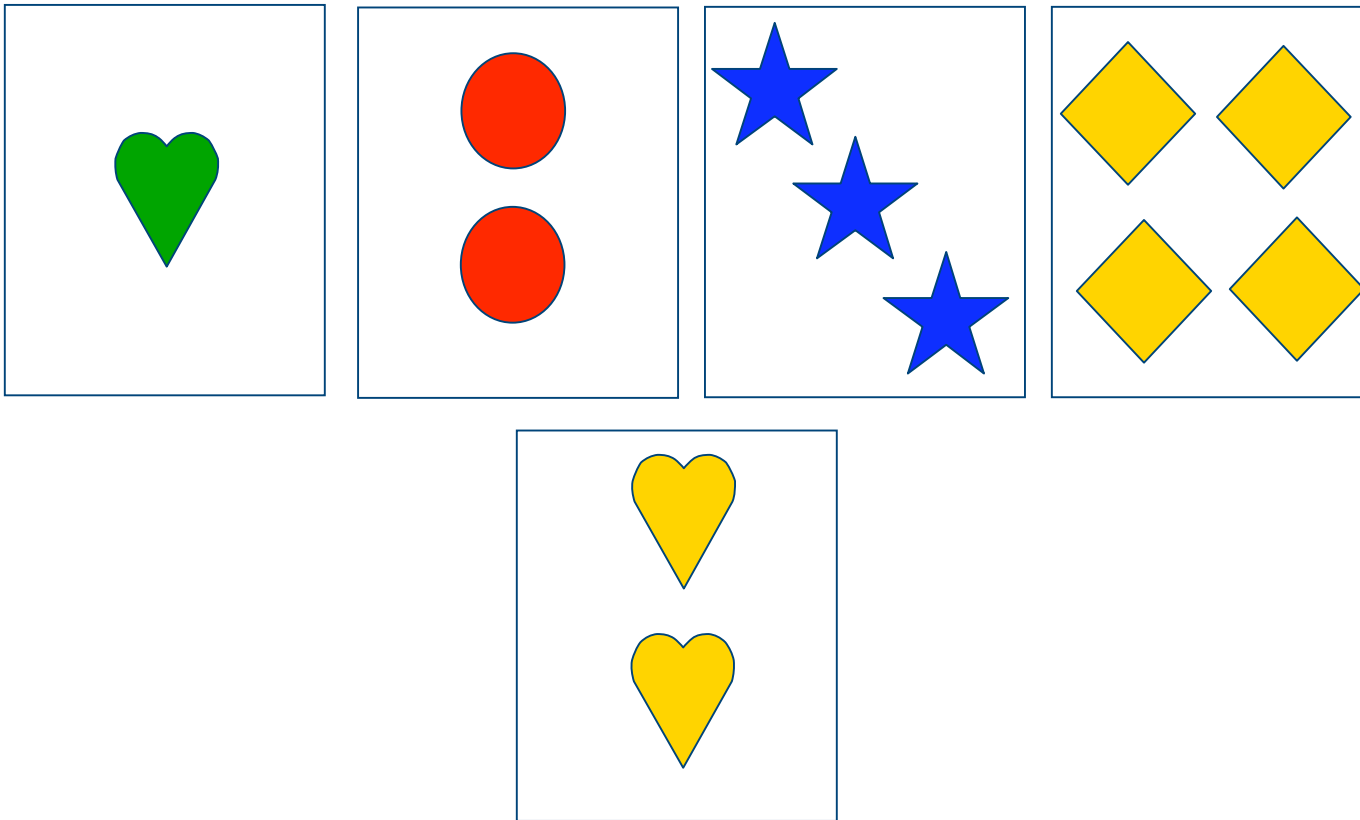
- I can't tell you much about how to do this task. Which of these do you think this one goes with? I'll tell you if your answer is right or wrong.



Measuring executive functions with a reasoning task



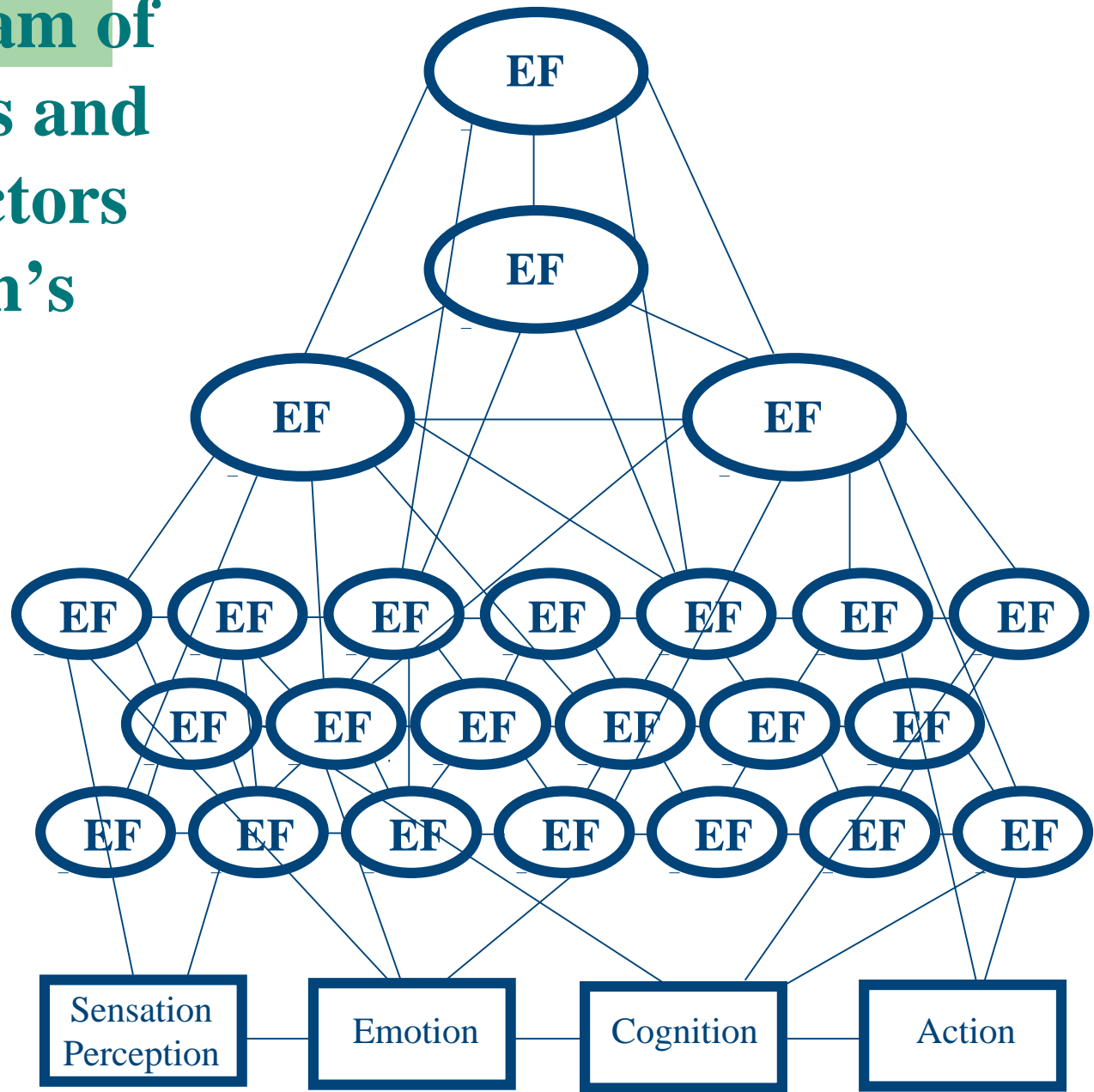
Measuring executive functions with a reasoning task



A Multidimensional Model of Executive Functions

- **Because the EF Conductors and Co-Conductors are a large group that function on many different levels or across many different lines of development, a multidimensional, Holarchical Model is needed to accurately portray their nature.**

EF as a Team of Conductors and Co-Conductors of the Brain's Orchestra



A Holarchical Developmental Model of Executive Function Capacities

V. Trans-self Integration

Sense of source, Cosmic consciousness

IV. Self Generation

Mind-Body Integration, Sense of Spirit

III. Self Control:

Self Realization

Self
Awareness

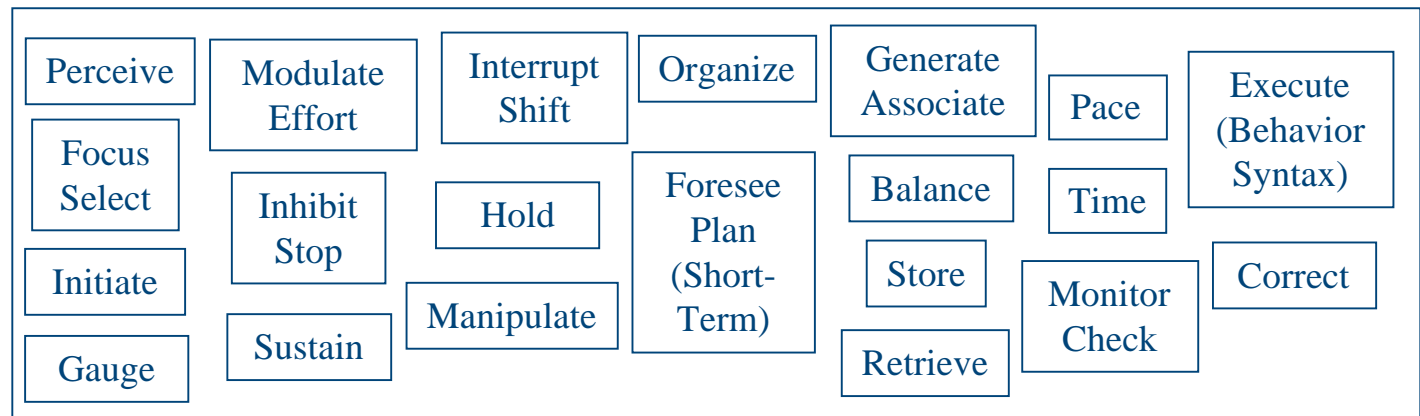
Self
Analysis

Self Determination

Goal
Generation

Long-Term
Foresight/Planning

II. Self Control: Self Regulation



I. Self Control: Self Activation

Awaken, Attend

A Holarchical Model of Executive Function Development

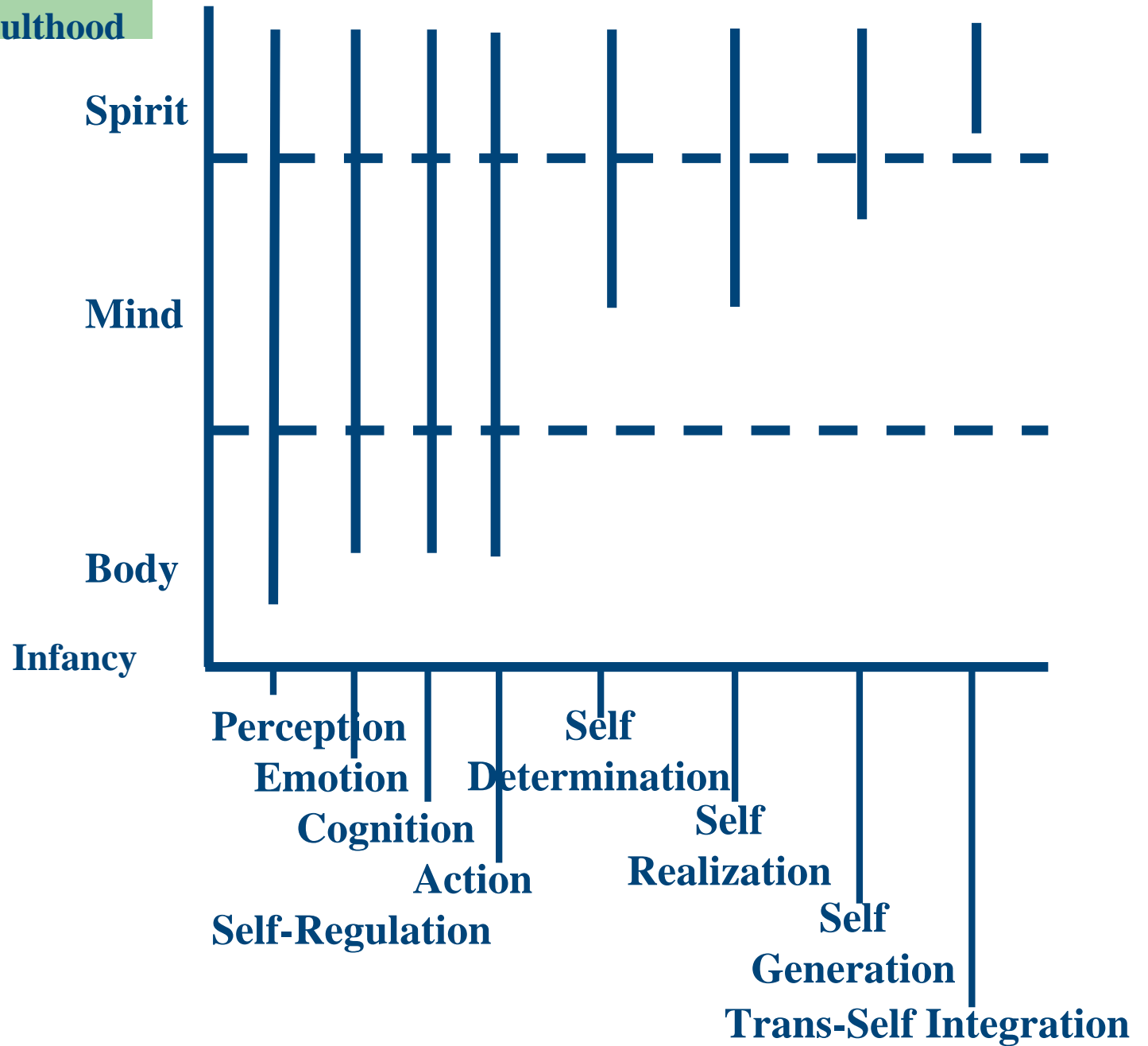
- **In a Holarchical Model, development progress across levels, but development at one level does not need to be mastered or completed before higher levels are engaged.**

A Holarchical Model of Executive Function Development

- **In the case of Executive Functions, Holarchical development levels can also be viewed as a set of independent developmental lines.**

EF Developmental Lines

Late
Adulthood



EF Developmental Levels/Lines

- **Self Activation**

- **Direction of the transition from a non-awake to an awake a state of mind.**
- **Overcoming Sleep Inertia**

EF Developmental Levels/Lines

- **Self Regulation**
 - **A set of control capacities that cue and direct functioning across the domains of sensation/perception, emotion, cognition, and action**
 - **The current model posits 21 self-regulation executive functions**

EF Developmental Levels/Lines

- **Self Regulation**

- **Perceive, Focus/Select, Initiate, Gauge, Modulate, Interrupt/Shift/Flexible, Inhibit/Stop, Sustain, Hold, Manipulate, Organize, Foresee/Plan, Generate/Associate, Balance, Store, Retrieve, Time, Pace, Monitor/Check, Execute, Correct**

EF Developmental Levels/Lines

- **Self Realization**
 - **Self Awareness and Self Analysis Capacities**
- **Self Determination**
 - **Foresight and Long-Term Planning and Goal Setting**

EF Developmental Levels/Lines

- **Self Generation**
 - Enables the posing of questions of the meaning of life
- **Trans-Self Integration**
 - Enables the search for unity consciousness and experiences of states beyond the self

Executive Functions are not Synonymous with Consciousness

- **Executive Functions can operate on a nonconscious as well as conscious level.**
- **Although the majority of executive function activity is carried out nonconsciously at the lower levels, all executive capacities can be consciously engaged.**
- **Upper level EF capacities typically are not accessed nonconsciously.**

Executive Function Variability

- **Executive control is highly dissociable; it can vary greatly depending on the domain of functioning that is being directed: sensation/perception, emotion, cognition, or action.**
- **Good executive control in one domain does not guarantee good executive control in the other domains; Poor control in one domain does not guarantee poor control in the other domains.**

Executive Function Variability

- **Executive control also varies depending on the Arena of Involvement**
- **The Four Arenas of Involvement are**
 - **Intrapersonal (Control in relation to the self)**
 - **Interpersonal (Control in relation to others)**
 - **Environment (Control in relation to the natural and man-made environment)**
 - **Symbol System (Control in relation to human made symbol and communication systems)**

Executive Function Development

- **Self-regulation executive functions are developing from the first years of life well into adulthood, and possibly throughout a person's entire lifetime.**
- **Large developmental shifts are noticeable, especially around adolescence.**
- **Because EFs are developmental in nature, natural maturational delays and lags are observed.**

Executive Function Development

- **Intraindividually, all EFs do not develop evenly. For any given individual, one EF can be more or less developed than any other EF at any given point in time.**
- **Interindividually, there is also great variation relative to chronological age. At the same age, different individuals will naturally vary considerably in their level of development of various EFs.**

Executive Function Development

- **Cultural change points (e.g., educational transitions to Preschool, Kindergarten, 1st grade, junior h.s., senior h.s., college, graduate school, and workplace entry) can serve to highlight EF developmental delays or significant deficiencies.**

Executive Function Development

- **Some EF-based clinical syndromes, such as ADHD, demonstrate clear patterns of delayed developmental progression. Barkley (1998) estimates developmental delays of about 30% associated with various EF processes such as Inhibit, Manipulate, Shift, Sustain, Time, Monitor, Correct.**

Executive Function Development

- **Most of the clinical conditions described in the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV) reflect some form of Executive Dysfunction**
- **The DSM-IV can be thought of as “A User’s Guide to All the Things That Can Go Wrong With the Frontal Lobes”**
- **Frontal lobe functions are operationally defined as Executive Functions and Working Memory processes**

Executive Function Development

“Deficits in PFC [prefrontal cortex, aka frontal lobes] function are evident in every neuropsychiatric disorder (indeed, the term “psychiatric problem” seems synonymous with PFC dysfunction).”

**Arnsten & Robbins 2002 in
*Principles of Frontal Lobe Function***

Executive Function Development

A sampling of conditions involving EF deficits:

- **Autism, Asperger's Syndrome**
- **ADHD and ADD**
- **Conduct Disorder and Oppositional Defiant Disorder**
- **Depression, Anxiety, Obsessive-Compulsive Disorder**
- **Fetal Alcohol Syndrome and Pre-natal Drug Exposure**

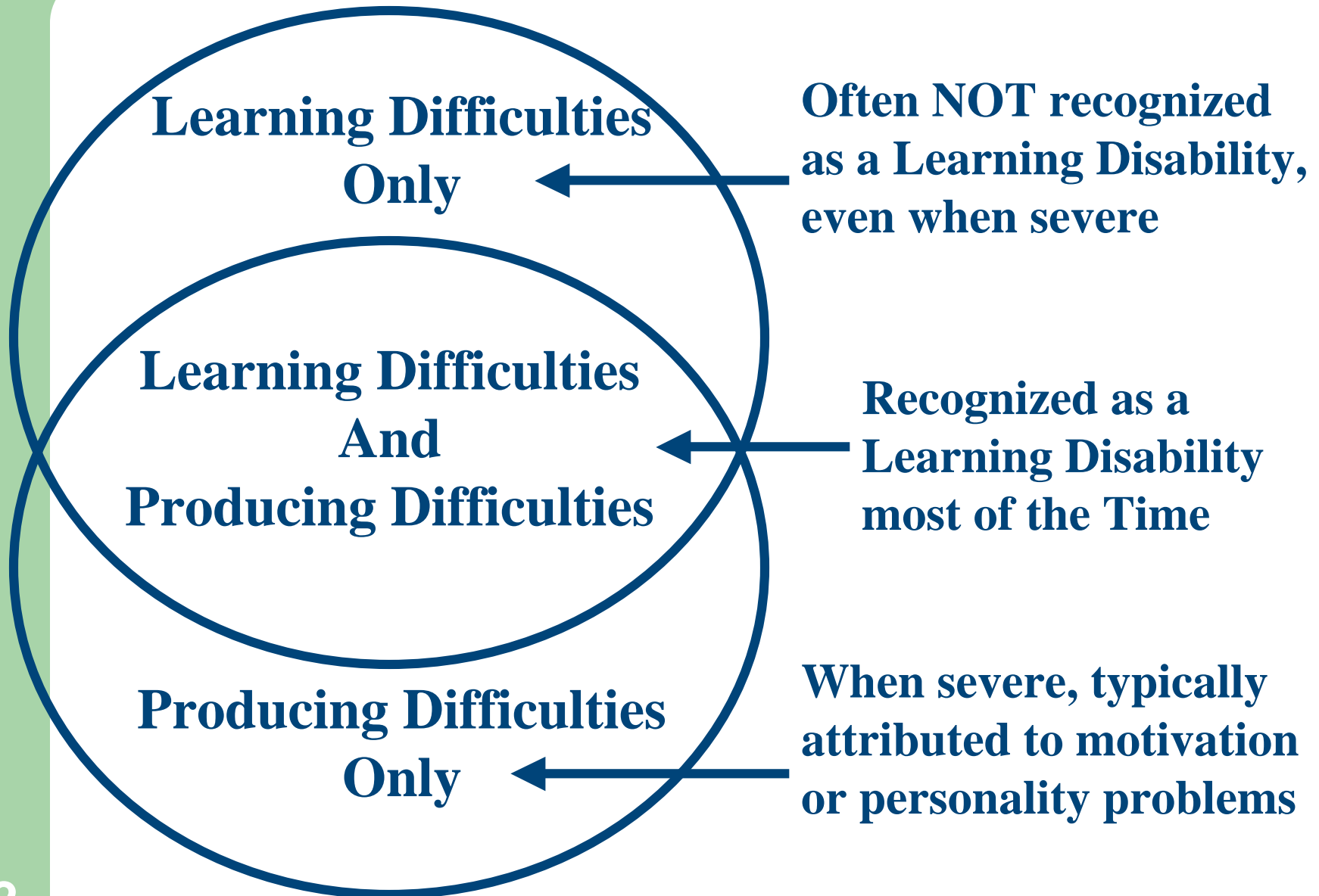
Executive Functions and School

- **Although executive functions are used to guide cognitive processing involved in new learning, many new learning situations are structured in ways that reduce the need for strong executive direction.**
- **In direct contrast, demonstrating what has been learned usually requires significant involvement of executive control processes.**

Executive Functions and School

- **As Martha Denkla has pointed out, Executive Function difficulties of a severe nature (especially in the Symbol System Arena) do not result in Learning Disabilities; they result in “Producing Disabilities.”**

Learning Difficulties and Producing Difficulties



Executive Functions and School

- **The more classroom instruction resembles our executive function test example (“figure out what we’re learning, I’ll tell you whether you are right or wrong”), the more a child’s executive difficulties will impact classroom learning and performance.**

Executive Functions and School

- **Test taking can be exceptionally difficult for a student with executive difficulties if the test format emphasizes executive demands over content knowledge.**

Executive Functions and School

- **A Test Example:**

a dark color

b r _ w _

Executive Functions and School

it's awfully old

_ N T _ Q _ _

Executive Functions and School

disappear

_ V _ P O _ A _ _

Executive Functions and School

due to chance of fate

__ RE __ I I _ Y

Executive Functions and School

no easy solution

M _ _ _ E _ Y

Executive Functions and School

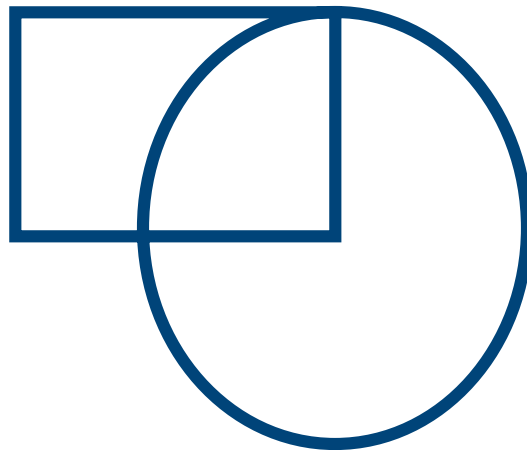
- **If the majority of the items on the test are like the last item, executive direction of retrieval processes is likely to be assessed much more than the actual retrieval of vocabulary knowledge.**

Executive Functions and School

- **In complex task production, the critical role of executive functions is often overlooked.**

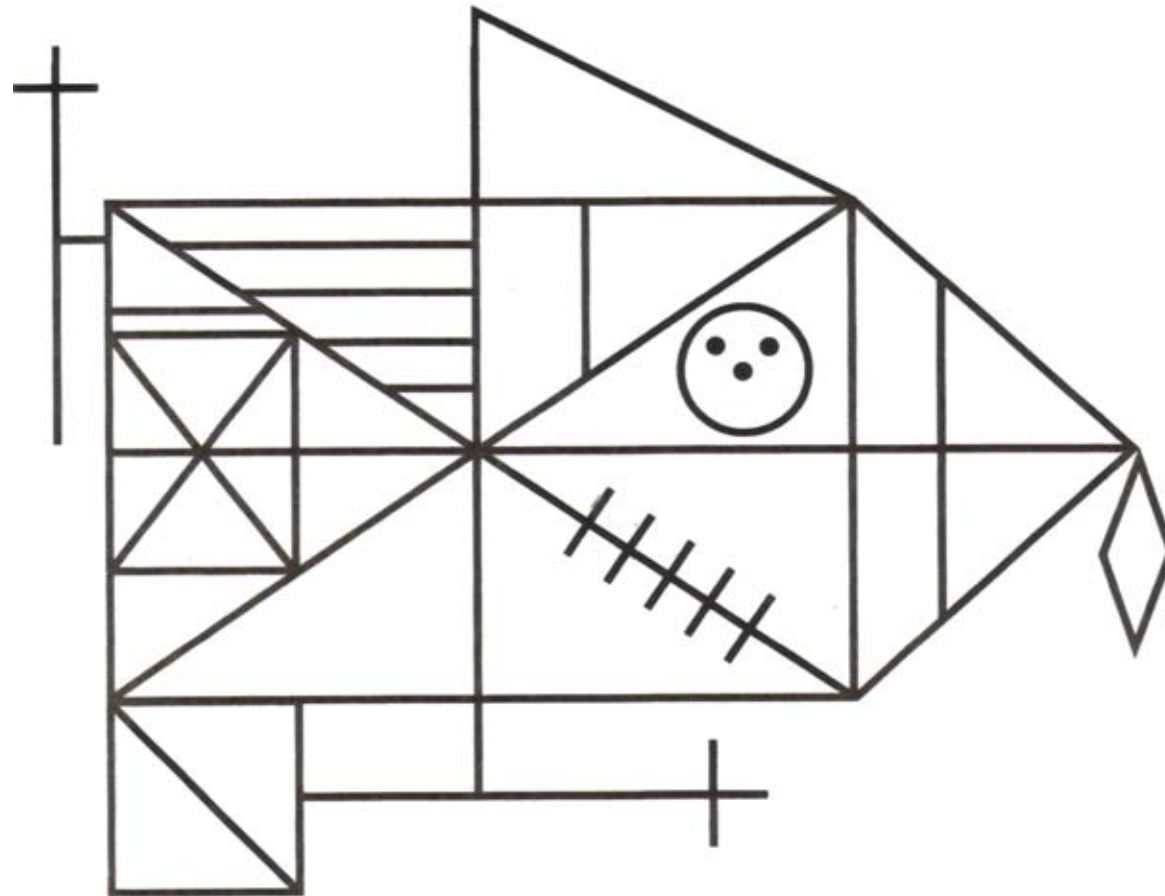
Executive Functions and School

- Draw this:




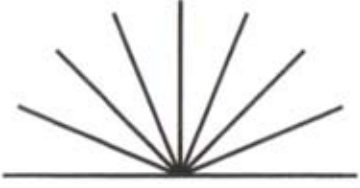

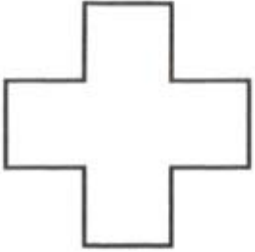
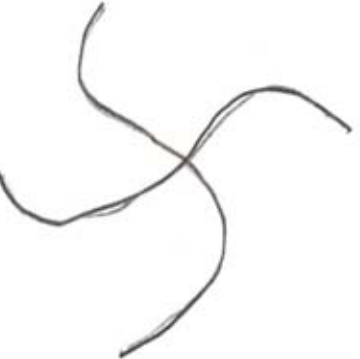

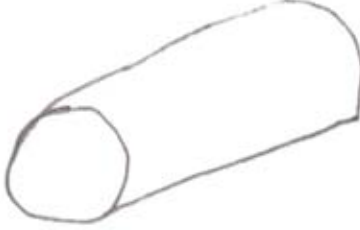
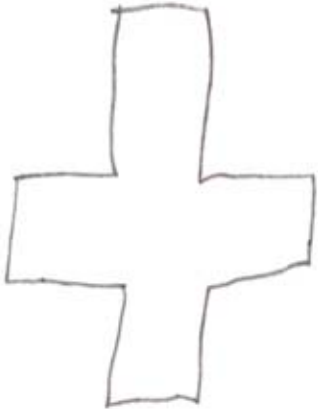
Executive Functions and School

- Now draw this:



Executive Functions and School

- James Age 10, NEPSY Design Copying:

| | | | |
|---|--|---|--|
|  |  |  |  |
| 12 | 13 | 14 | 15 |
|  |  |  |  |

Executive Functions and School

- James Age 10, Rey Complex Figure

Copy:



Executive Functions and School

- James Age 10, Rey Complex Figure Recall after 3 minutes



Executive Functions and School

- **As Martha Denkla has noted, executive functions are the dash (-) in tasks requiring visual – motor production.**

Executive Functions and School

- **In the classroom, the task most frequently impacted by executive function-driven producing difficulties is written expression.**

Executive Functions and School

- **What Evan told me:**

“My favorite game is rolling marbles. I think it is fun. I just learned it yesterday. It can be pretty hard at times. It can be fun and it’s interesting if you make it challenging. I like making the boxes to roll the marbles into. You probably need to be pretty skilled with eye hand coordination to do it. To get up the ramp you need to roll it really fast.”

Executive Functions and School

- What Evan wrote for me:

4:30

Prompt A
1. My favorite game is nabul rialing it is
fun. I like making
this box to rialest in
to Jan pretty gode as
well. It is rell entree
ing. It is so funo

Internal Command versus External Demand

- **The neural circuits for executive function activation are routed differently depending on whether the activation is based on an internally driven desire or command versus an external demand.**

The Production Paradox

- **Because internally driven production is much easier to accomplish than externally demanded production - especially for children with “producing difficulties”- their lack of production on demand often stands in stark contrast to their seemingly effortless production “when the spirit moves them.” The on-demand deficiencies are often attributed to negative qualities such as lack of responsibility, apathy, passive aggressive stance, or oppositional defiance.**

EF Implications for Classroom Instruction

- **To assure that executive function capacities are used to their fullest potential, it is important to state the goals of the learning process. Stating goals enables executive capacities, either consciously or nonconsciously, to engage the perceptions, emotions, thoughts, and actions, needed to achieve the goals.**

EF Implications for Classroom Instruction

- **In preschool, kindergarten and early elementary years, in many ways, teachers ARE their student 's frontal lobes.**
- **Providing executive prompts and cues are important to assure that children are engaged appropriately in the instructional process.**
- **Modeling good executive functions helps children see how they can self-regulate their own perceptions, emotions, thoughts and actions.**

EF Implications for Classroom Instruction

- **In late elementary, junior-senior high school, college, and even graduate school, effective teachers provide executive function prompts and model good executive function use.**

EF Implications for Classroom Instruction

- **Providing students with feedback about their performance enables them to engage executive capacities more effectively to learn from their mistakes and improve future performance**

Executive Function Difficulties and Achievement in Reading

- **Reading Decoding** – poor use of one or more self-regulation EFs (e.g., lack of attention to specific letters in words; saying words that “look” like the word on the page).
- **Rapid Automatic Naming** – poor executive control of language fluency processes.
- **Reading Comprehension** – poor direction of one or more self-regulation EFs (e.g., Focus, Sustain, Hold, Manipulate, Balance, Pace, Time, etc.) when reading for meaning.

Executive Function Difficulties and Achievement in Written Expression

- **Poor graphomotor control and lack of automaticity for handwriting.**
- **Poor organization of written material**
- **Poor retrieval cueing or poor generate cueing for idea generation or idea fluency when writing.**
- **Inability to use multiple self-regulation EFs at one time (e.g. hold, manipulate, retrieve with generate and execute).**

Executive Function Difficulties and Achievement in Mathematics

- **Poor cueing of Focus/Select, Monitor, and Correct functions when doing calculation routines.**
- **Poor cueing of hold, organize, manipulate and retrieve when setting up calculations or problems**
- **Poor cueing of organize, store, retrieve, execute when learning or applying rote knowledge (e.g. storing and retrieving multiplication tables).**

Executive Function Difficulties

- **Are they the result of**
 - **Disuse through Conscious Choice,**
 - **Disuse through Unconscious Choice,**
 - **Maturational Delay, or**
 - **Innate Deficiency?**

Executive Function Intervention

General Two-Stage Approach to Intervention:

- **Attempt to Affect Internal Change**
- **Apply External Control As Necessary**

Executive Function Intervention

- **General Literature Sources and Approaches for Intervention:**
 - **ADHD Interventions**
 - **TBI Interventions**
 - **Dynamic Assessment/Instrumental Enrichment**
 - **I Can Problem Solve (ICPS) program**
 - **Metacognition in Academics, especially Reading**
 - **Cognitive Behavior Therapy**
 - **OT/PT Motor Planning and Motor Praxis**
 - **Meditation**
 - **Psychopharmacology**

Executive Function Intervention

- **The Primary key to successful interventions for EF difficulties is the proper framing of the EF problem.**
 - **Do not attribute the EF difficulty to negative personal characteristics such as laziness, lack of motivation, apathy, irresponsibility, or obstinance.**
 - **State the problem in behavioral terms that indicate a behavior that can then be changed.**
 - **Identify ways to help the child change the behavior from negative to positive.**

Executive Function Intervention

- **Rewards for performance of the desired behaviors as the primary intervention should be used with great caution**
 - **Rewards do not teach the child how to reflect on and alter the behavior, they simply reward the presence of the desired behavior.**
 - **Reward programs imply that a child can do it if he/she wants to or is motivated enough to. This often leads away from the realization that many children who do want to change their behavior don't know what to do to change it.**

Executive Function Intervention



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*“We’re encouraging people to become involved
in their own rescue.”*

Executive Function Interventions

- **EF interventions vary based on the developmental lines they address**
 - **Self Regulation (REG)**
 - **Perception, Emotion, Cognition, Action**
 - **Self Determination (DET)**
 - **Self Realization (REAL)**
 - **Self Generation (GEN)**
 - **Trans-Self Integration (TRAN)**

Executive Function Interventions

- **Time (ALL LINES)**
 - (Natural maturational processes)
- **Pharmacological (REG)**
 - Medications for ADHD, mood disorders, etc.
- **Structuring the Environment (REG)**
 - External control substitutes for internal control deficiencies
- **Structuring Time (REG)**
 - Set time limits and monitor use

Executive Function Interventions

- **Teach Thinking and Organizational Skills in Addition to Content Knowledge (REG)**
 - Offer external strategies for possible internalization of performance based on minimal cues; instrumental enrichment; ICPS techniques
- **Provide Frequent Feedback About Task Performance (REG)**
 - External substitution for Internal Monitoring and Feedback Mechanism

Executive Function Interventions

- **Provide Immediate Rewards Directly tied to Performance Requirements (REG)**
 - **External Substitution for Internal Drive Mechanisms**
- **Provide External Cues for Behavior Syntax (REG)**
 - **Provide external lists that indicate the required behaviors in the required sequence**

Executive Function Interventions

- **Aligning External Demands with Internal Commands (Drives and Desires) (REG, DET, GEN)**
 - Use natural motivating mechanisms whenever possible
- **Engage the Services of a Cognitive Coach (REG)**
 - Make extensive use of an external executive function substitute

Executive Function Interventions

- **Increase Awareness (REAL)**

Raise consciousness of the specific difficulties that result from EF deficiencies; Use of videotaping for proof; Clearly define the problem; Let “autopilot” mechanisms do their work if possible

- **Verbal Mediation (REG, DET, REAL)**

- **Use of verbal cues and questions to guide thinking processes**

- **Relating and discussing social stories to provide basis for models of appropriate behavior**

Executive Function Interventions

- **Verbal Labeling/Language Building (ALL Levels)**
 - Providing a vocabulary for understanding of concepts that can be used to improve control of emotions, thought, and behavior
- **Encourage Symbiotic Relationships and Support Networks (REG, REAL)**
 - Enter into relationships where there is a mutual interdependence that enables deficiencies to be by-passed

Executive Function Interventions

- **Model Good Executive Function Performance (REG-ALL)**
 - Offer external guides for possible internalization of effective EF performance
- **Use of Cognitive Behavior Therapy**
 - Cognitive Behavior Therapy (REG, REAL, DET)
 - Mindfulness-Based Cognitive Behavior Therapy (ALL)

Executive Function Interventions

- **Use of Meditation Techniques (All Levels)**
 - Improving all forms of self-control through “quieting of the mind”
- **Use of Mindfulness-based Physical Exercise Programs (REG, DET)**
 - Yoga
 - Thai Chi

Executive Function Interventions

- **Use of Integrating and Integral Psychotherapeutic Techniques**
 - **Gestalt, Existential, and Humanistic therapies for DET, REAL, GEN**
 - **Psychosynthesis for DET, REAL, GEN**
 - **Improving or Developing “Magnetic Center”**
 - **Fostering development of internal control mechanisms through “strengthening of the will”**