Executive Functions: Definitions, Assessment, and Education/Intervention

Presented by

George McCloskey, Ph.D.

Philadelphia College of

Osteopathic Medicine

georgemcc@pcom.edu

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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**

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What are Executive Functions? Executive Functions are not a Unitary Trait or Construct

- **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**
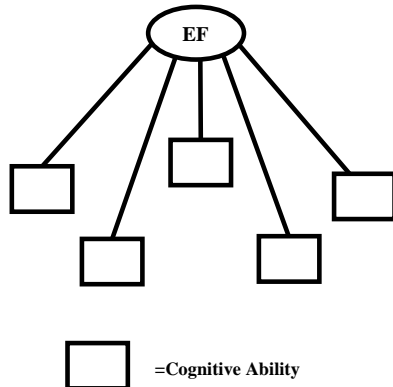
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What are Executive Functions? Executive Functions are not a Unitary Trait or Construct

- ❖**Martha Denkla warns against turning executive functions into the neuropsychologist's "g".**
- ❖**Elkhonon Goldberg refers to executive functions as the "S"(for smart) Factor.**
- ❖**Both Denkla and Goldberg use the analogy of the Orchestra Conductor as a metaphor for executive processes at work. (??)**

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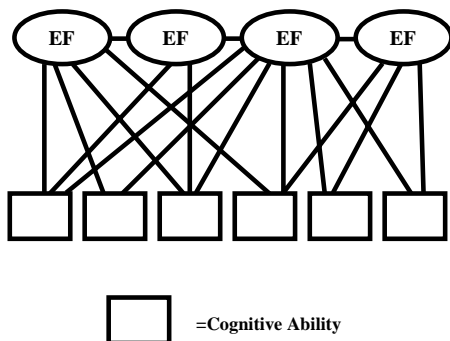## EF as the Conductor of the Brain's Orchestra (i.e., EF as "g")

☐ =Cognitive Ability

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What are Executive Functions? Executive Functions are not a Unitary Trait or Construct

❖ The orchestra conductor analogy feeds into the "homunculus problem," a paradox of infinite regress, or just a complex metaphysical maze.

❖ For practical everyday problem-solving in a more concrete manner, it is better to use the concept of a system of interrelated "co-conductors" rather than posit a single conductor.

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Self-Regulation EFs as Co-Conductors of the Brain's Orchestra

☐ =Cognitive Ability

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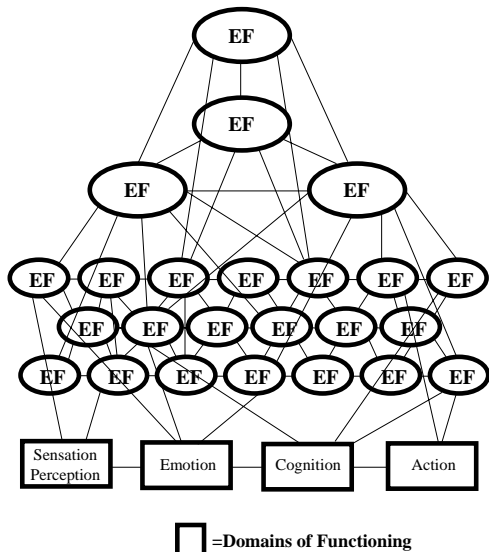## What are Executive Functions? Executive Functions are not a Unitary Trait or Construct

Even better to think of Executive Functions as:

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

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Co-Conductors in a Holarchical Model of EF

EF

EF

EF   EF

EF EF EF EF EF EF EF

EF EF EF EF EF EF

EF EF EF EF EF EF EF

| Sensation Perception | Emotion | Cognition | Action |

☐ =Domains of Functioning

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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"**

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Example of a narrow definition of intelligence

"The ability to carry on abstract thinking."

(L.M. Terman)

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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)

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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.

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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.

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EF and Intelligence

Examples of intelligence operationally-defined without explicit inclusion of EF:

❖Subscale and Composite Structures for:
  ❖Wechsler Scales
  ❖S-B V
  ❖WJ-III
  ❖DAS
  ❖K-ABC II

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EF and Intelligence

The quotes on the next few pages are from Spearman – the discoverer of the statistical phenomenon that he coined as "g" and which is now interpreted as the underpinning for a theory of "General Intelligence," – and from Arthur Jensen – widely thought to be the most prominent and vocal proponent of "g" and "general intelligence" today – attest to the lack of utility of the concept of general intelligence, especially in the context of clinical evaluation of mental processes.

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EF and Intelligence

Jensen stated: "…interpretation of a composite score based on many diverse items, it was argued, is preferable to interpreting the score as a measure of "general intelligence," with its implication that the test measures something broader and more general than just the arbitrary hodge-podge sample of particular skills and items of knowledge that compose the test. Spearman strongly disagreed with the idea of "intelligence in general." He dubbed it the "anarchic" theory of mental abilities. In his words:

"As for the prevalent procedure of throwing a miscellaneous collection of tests indiscriminately into a single pool this-whether or not justifiable by the theory which gave birth to it-certainly cannot be justified simply by claiming that the results give a "general level," and "average," or even a "sample." No genuine averaging, or sampling, of anybody's abilities is made, can be made, or even has really been attempted. When Binet borrowed the idea of such promiscuous pooling, he carried it into execution with a brilliancy that perhaps no other living man could have matched. But on the theoretical side, he tried to get away too cheaply. And this is the main cause of all the present trouble." (1927)

A.R. Jensen. (1998). The g Factor, page 33.

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EF and Intelligence

Jensen stated: "Although Spearman had proved the statistical existence of g, he admitted that he did not know what g is. What, one can ask, is g beyond the mathematical operations of factor analysis that reveal its presence in a collection of mental tests? Spearman described this problem as follows:

"But notice must be taken that this general factor g, like all measurements anywhere, is primarily not any concrete thing but only a value or magnitude. Further, that which this magnitude measures has not been defined by declaring what it is like, but only by pointing out where it can be found. It consists in just that constituent-whatever it may be-which is common to all the abilities interconnected by the tetrad equation. . . . Such a defining of g by site rather than by nature is just what is meant originally when its determination was said to be only "objective." Eventually, we may or may not find reason to conclude that g measures something that can appropriately be called "intelligence." Such a conclusion, however, would still never be the definition of g, but only a "statement about" it. (1927)

A.R. Jensen. (1998). The g Factor, page 35.

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EF and Intelligence

"My study of these two symposia and of many other equally serious attempts to define "intelligence" in purely verbal terms has convinced me that psychologists are incapable of reaching a consensus on its definition. It has proved to be a hopeless quest. Therefore, the term "intelligence" should be discarded altogether in scientific psychology, just as it discarded "animal magnetism" and as the science of chemistry discarded "phlogiston." "Intelligence" will continue, of course, in popular parlance and in literary usage, where it may serve a purpose only because it can mean anything the user intends, and where a precise and operational definition is not important.

Largely because of its popular and literary usage, the word "intelligence" has come to mean too many different things to many people (including psychologists). It has also become so fraught with value judgments, emotions, and prejudices as to render it useless in scientific discussion."

A.R. Jensen. (1998). The g Factor, p. 48.

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EF and Intelligence

❖Rather than attempt to understand Executive Functions in the context of general intelligence, it is better to view executive functions in the context of a broader "mental" model. This can be effectively accomplished by engaging in discussion and assessment of perception, cognitions, emotions, and actions and the role of executive functions in directing these capacities rather than discussing intelligence.

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A 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.**

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A Model of Executive Functions

❖**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.**

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A Developmental Model of Executive Function Capacities

V. Trans-self Integration

Sense of source, Cosmic consciousness

IV. Self Generation
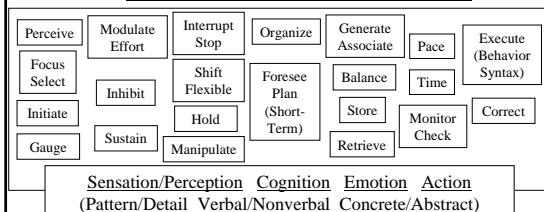
Mind-Body Integration, Sense of Spirit

III. Self Control:

Self Realization   **Self Determination**

Self Awareness	Self Analysis	Goal Generation	Long-Term Foresight/Planning

II. Self Control: Self Regulation

Perceive	Modulate Effort	Interrupt Stop	Organize	Generate Associate	Pace	Execute (Behavior Syntax)
Focus Select		Shift Flexible	Foresee Plan (Short-Term)	Balance	Time	
Initiate	Inhibit	Hold		Store	Monitor Check	Correct
Gauge	Sustain	Manipulate		Retrieve		

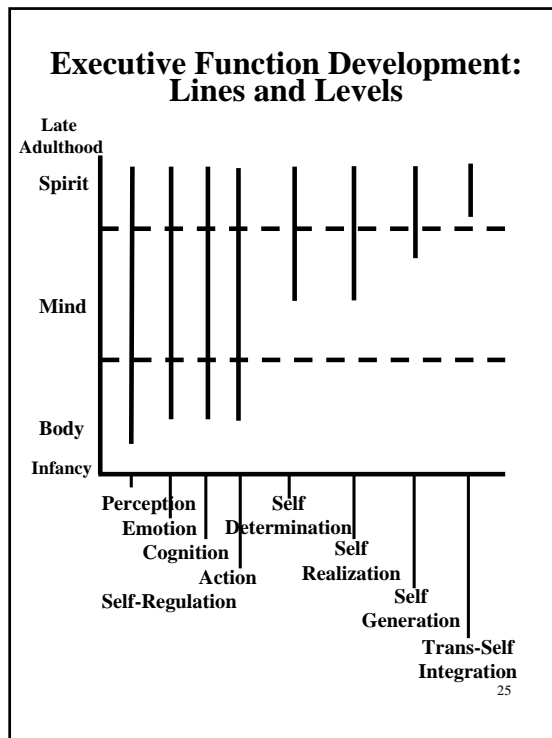| Sensation/Perception Cognition Emotion Action (Pattern/Detail Verbal/Nonverbal Concrete/Abstract) |
| --- |

I. Self Control: Self Activation

Awaken, Attend

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A Model of Executive Functions

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

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Executive Function Development: Lines and Levels

Late Adulthood

Spirit

Mind

Body

Infancy

Perception
Emotion
Cognition
Action
Self-Regulation
Self Determination
Self Realization
Self Generation
Trans-Self Integration

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EF Developmental Levels/Lines:

Self Activation

Initiation and "ramping up" of basic executive functions related to an awakened state of mind and to overcoming sleep inertia.

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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**

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EF Developmental Lines:
Self Regulation

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

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Perceive
(Self Regulation)

❖ **The Perceive executive function cues the use of basic cognitive processes in the accessing of stored mental schema and other types of stored knowledge bases that are used to engage the exterior (or interior) environment for the purposes of initially registering or taking in "new" information.**

❖ **Difficulties with the use of this function can result in misperceptions or loss of important information.**

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Initiate
(Self-Regulation)

❖ **The Initiate function cues oneself to begin to use cognitive abilities to process information or to begin to engage in a motor routine to provide a response.**

❖ **Lack of initiation does not reflect noncompliance or disinterest in a specific task, or a lack of ability to think about or perform a task, but rather a difficulty with beginning the process of engagement.**

❖ **The more immediate the demand for action (internal processing or external motor response) the more likely any difficulties with initiation will become observable.**

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Gauge
(Self-Regulation)

❖ **The Gauge function is used to accurately identify the demands of a task and cue the needed resources for effectively engaging with the task.**

❖ **Gauge difficulties include ineffective "sizing up" of a task to realize what abilities must be cued for successful completion.**

❖ **Individuals with gauge difficulties frequently misidentify or misunderstand task demands.**

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Modulate Effort
(Self-Regulation)

❖ **The Modulate function is used to accurately cue the amount of effort and energy required to effectively engage a task.**

❖ **Individuals with modulation difficulties frequently do not invest the necessary amount of effort required for successful completion of a task.**

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Focus/Select
(Self-Regulation)

❖ The Focus/Select function directs attention to the most relevant specifics of a given environment, situation, or content while downgrading or ignoring the less relevant elements.

❖ Focus/Select as defined here relates to where attention is directed to, or what attention is directed to, not how long the attention is sustained.

❖ Difficulties with Focus/Select can result in a loss of important information needed to register and process the most relevant information, and/or to act in the most appropriate manner, and can negatively impact new learning and/or demonstrating what has been learned.

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Shift/Interrupt - Flexibility
(Self-Regulation)

❖ The shift function is used to change focus, and/or alter processing or responding based on new, often unanticipated, demands of an environment, situation, or content.

❖ Shifting includes the ability to be flexible in response to new demands or conditions.

❖ Shifting involves transitioning from one cognitive framework to another, altering problem-solving based on changing conditions, and switching or alternating attention.

❖ Poor shifting results in rigid, inflexible approaches to encoding, processing, learning and/or performing and overuse of learned routines.

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Inhibit/Stop
(Self-Regulation)

❖ The Inhibit function enables one to resist acting on first impulse or to stop engaging in specific behavior when it is advantageous or appropriate to do so.

❖ Difficulties with inhibition often accompany brain injury and are a core deficit in ADHD.

❖ Difficulties with inhibition increase the likelihood of "disruptive behavior" and often reduce the quality of information processing or final products.

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Sustain
(Self-Regulation)

❖ The Sustain function cues continued attending, encoding, manipulating, storing, retrieving, or otherwise processing information for a prolonged period of time as well as cueing continued performance of a motor act for a prolonged period of time.

❖ Difficulties with sustaining effort usually result in inconsistent encoding, processing or performing over a prolonged period of time.

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Hold
(Self-Regulation)

❖The Hold function cues the necessary cognitive processes required to maintain information in working memory and to continuing cueing these processes until the information is processed, stored, retrieved, or acted on as desired.

❖Difficulties with the hold function result in inconsistencies or inefficiencies in working with and acting on information.

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Manipulate
(Self Regulation)

❖The Manipulate function cues the use of working memory or other cognitive processes for the manipulation of information that is being held in mind or continually accessed in the environment.

❖Difficulties with the manipulate function can result in a lack of active use of information that is currently available or could be made available if working memory processes were engaged.

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Organize
(Self-Regulation)

❖The Organize function cues the use of organization routines for purposes of integration of information, enhancement of meaning , or efficiency of performance as information is being encoded, held, manipulated, stored, retrieved, or acted on.

❖Difficulties with the organization function result in inefficient, fragmented, ineffective encoding, processing, and acting.

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Foresee/Plan
(Self-Regulation)

❖The Plan function cues engagement of the resources required to determine the most effective way to encode, manipulate, store, or retrieve information, or to carry out a motor act based on the information available and on anticipation of future conditions or events.

❖Difficulties with planning often result in disorganized, haphazard and ineffective encoding, manipulating, storing, or retrieving of information or poorly conceived and ineffective and/or inefficient approaches to novel problem-solving and/or the repeated conduct of routine activities.

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Generate/Associate
(Self-Regulation)

❖The Generate function cues the realization that problem-solving efforts are required and cues the use of resources required to carry out problem-solving routines as well as cueing processes needed in making associations.

❖Difficulties with the generate function result in problem-solving difficulties or failures even when superior problem-solving abilities have been demonstrated under conditions where the cueing of the use of such problem-solving abilities was provided by an external source.

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Store
(Self Regulation)

❖The Store function cues the movement of information from the present moment mental processing environment into "storage" for possible retrieval at a later time.

❖Difficulties with the Store function result in a lack of access to, or loss of, important information.

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Retrieve
(Self Regulation)

❖The Retrieve function cues the processes responsible for finding and accessing previously stored information. The more specific the demands or constraints placed on the retrieval process, the greater the requirement for precision cueing.

❖Difficulties with the Retrieval function result in an inability to respond to highly specific demands to make information accessible in a timely and efficient manner.

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Balance
(Self-Regulation)

❖The Balance function cues the use of pattern and detail processing operations in the right mix to enable effective registration, manipulation, storage, or retrieval of information, or to carry out motor acts in a balanced manner in an attempt to produce as high a quality of response as possible.

❖Difficulties with the Balance function result in encoding, storage, retrieval, or production that overemphasizes either a general pattern or specific detail elements.

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Time
(Self-Regulation)

❖ **The Time function cues the monitoring of the passage of time (How long have I been working?) or cue the use of time estimation (How long will this take? How much time is left? How much can I accomplish in 5 minutes?)**

❖ **Difficulties with the time function involve forgetting to keep track of time and not remembering to take time estimates into account, or not realizing, even in the presence of many contextual clues, that a time estimate would be beneficial.**

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Pace
(Self-Regulation)

❖ **The Pace function cues awareness of and regulation of rate of performance of mental or physical acts. It also enables the individual to regulate the trade-off between speed and accuracy when encoding, manipulating, storing, retrieving, and acting on information.**

❖ **Difficulties with the pace function involve a lack of checking to see if thoughts or actions are being carried out too slowly or too quickly for effective performance and/or an overemphasis on either speed or accuracy resulting in reduced efficiency.**

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Monitor
(Self-Regulation)

❖ **The Monitor function cues the use of appropriate routines for checking the accuracy of registration, manipulation, storage, and retrieval of information or the performance of, or final product of, a motor routine, and the monitoring of emotional states.**

❖ **Difficulties with the monitor function often result in careless errors due to a lack of adequate checking of thoughts, emotions, or work products.**

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Execute
(Self-Regulation)

❖ **The Execute function cues the performance of automated motor routines or other forms of response based on the demands of the situation, orchestrating the proper behavior syntax in the manner required for successful responding and performance.**

❖ **Difficulties with the execute function involve either a lack of realization that a response or action is required or would be advantageous at that point in time, result in a lack of timely or appropriate responding even in the presence of obvious cues for such action, and/or inadequate performance with respect to situational demands.**

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Correct
(Self-Regulation)

❖ **The Correct function cues appropriate routines for correcting errors or altering performance based on feedback from other modules.**

❖ **Difficulties with the correct function result in failure to correct errors or alter performance despite the fact that the errors or inadequacies of performance are identified and acknowledged.**

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EF Developmental Levels/Lines:
Self Realization

Directs cognitive processes that engage in self-awareness, self-reflection and self-analysis.

Cues cognitive processes to access accumulated information about self and apply it in specific situations to initiate, sustain, or alter behavior.

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EF Developmental Levels/Lines:
Self Determination

Foresight/Long-Term Planning and Goal Generation

Directs the use of cognitive processes to construct visions of the future and plans for action over longer periods of time. Directs reflection on the past for purposes of improving or altering behavior and thinking in the future.

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EF Developmental Levels/Lines:
Self Generation

Directs the posing of speculative questions related to the meaning and purpose of life and ultimate source(s) of reality and physical existence, mind-body relationships, spirit, and soul; existence beyond the physical plane.

Directs the generation of a philosophy of life used to guide self-awareness, self-realization and the other levels of executive function processes; serves as a basis for an ultimate source of intentional behavior direction.

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EF Developmental Levels/Lines:
Trans-Self Integration

Directs the engagement of mental processes that enable realization and experiencing of a trans-self state of ultimate or unity consciousness.

In most spiritual traditions, this state is considered the highest achievement of human consciousness and therefore very different from the maladaptive states characteristic of clinical diagnoses of dissociative states.

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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, all executive capacities can be consciously engaged.**
❖**Upper level EF capacities typically are not accessed nonconsciously.**

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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.**

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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)**

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Arenas of Involvement: Intra-Personal

❖**Intrapersonal Interactions; the arena where self-awareness and self –control directive processes are turned inward; the ability to control one's actions in relation to the self; self-discipline; the ability to avoid addictions and other self-destructive habits and behavior patterns; the ability to drive purposeful, positive behavior.**

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Arenas of Involvement: Inter-Personal

❖**Intrerpersonal Interactions; the arena where self-awareness and self-control directive processes are turned outward towards other human beings; the ability to control one's actions in relation to the others; the ability to take the perspective of others; the ability to generate a theory of mind that enables a person to understand, infer, and predict the motivations, needs, and desires of others; the ability to weigh the benefits of cooperative behavior over self-serving behavior.**

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Arenas of Involvement: Environment

❖**Interactions with both the naturally-occurring and the man-made physical world; directs cognition in relation to the environment and engagement of the environment, including behavior toward other animals and living organisms; interaction with machines and other man-made devices; includes the ability to avoid "accidents" by anticipating the impact and consequences of one's own actions in the physical environment.**

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Arenas of Involvement: Symbol System

❖**Interactions/manipulations of human-made symbol systems; directing cognitive processes in the act of "cold cognition"- thinking, seeing, speaking, writing involving culturally derived symbol systems; mediates learning and producing through interaction with information media such as words, numbers, figures, diagrams, schematics, programming codes and other "languages."**

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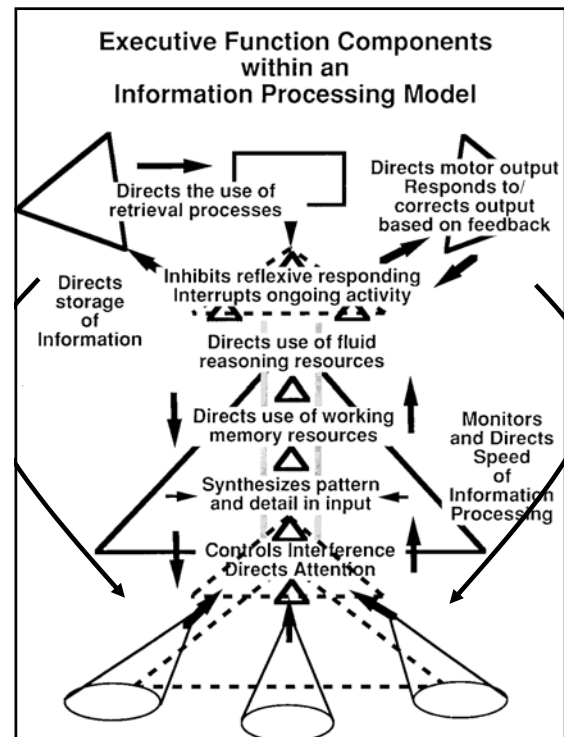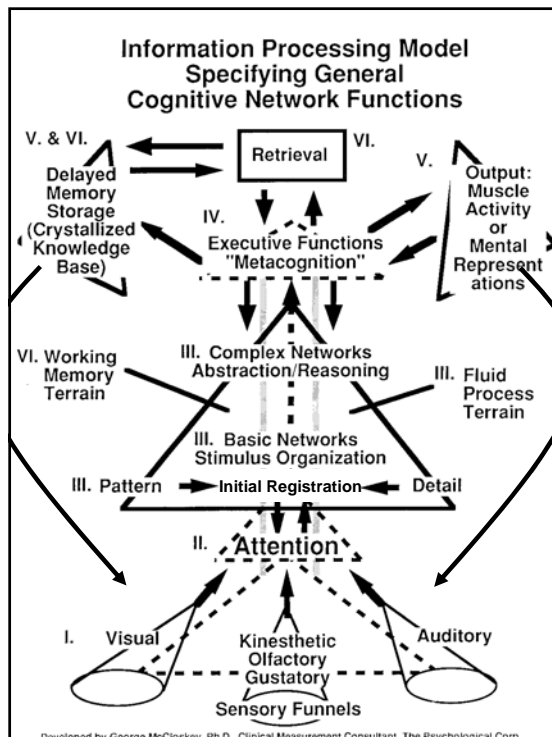**Executive Functions in the Context of a Cognitive Information Processing Model**

❖ Multiple executive functions direct, control, cue, or mediate multiple cognitive capacities.

❖ Executive functions direct, but do not carry out, information processing tasks such as initial registration of stimuli, manipulation of information in working memory, retrieval of information from long-term storage or performance of a motor act.

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Executive Functions in the Context of a Cognitive Information Processing Model

❖ It is important to note that emotions are an important component of a broader conceptualization of an information processing model.

❖ Executive Functions are involved in consciously mediating emotional reactions, initial registration of emotion, processing of emotion, and emotional responses.

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Information Processing Model Specifying General Cognitive Network Functions

Developed by George McCloskey, Ph.D., Clinical Measurement Consultant, The Psychological Corp.

Executive Function Components within an Information Processing Model

Executive Functions and Working Memory

❖ As directive or control processes, executive functions are not synonymous with working memory.

❖ Working memory processes involved in manipulating information in mind are dissociable from the executive processes that direct or cue the use of working memory resources.

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Executive Functions in Action

Executive Function performance can vary greatly depending on the Arena of Involvement, the domain of functioning (Perception, Emotion, Cognition, Action), and the specific, information processing capacities being directed.
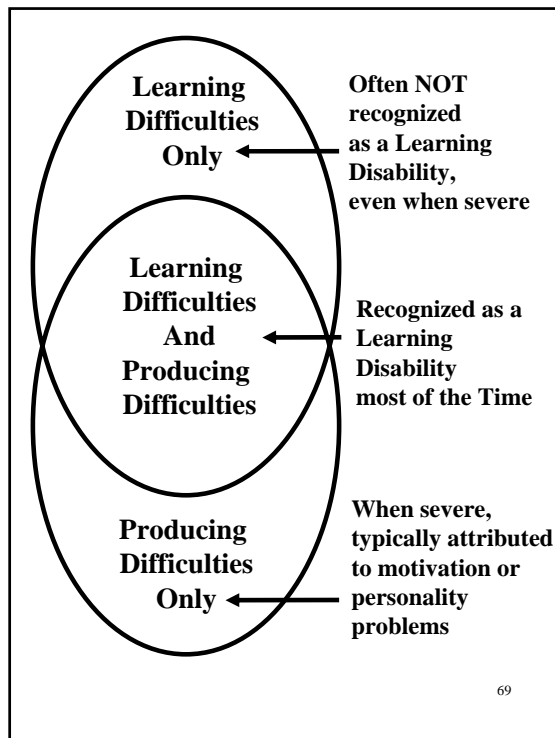
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The Role of Executive Functions in School

❖ 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 contrast, demonstrating what has been learned usually requires significant involvement of executive control processes.

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The Role of Executive Functions in 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."

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Learning Difficulties Only

Often NOT recognized as a Learning Disability, even when severe

Learning Difficulties And Producing Difficulties

Recognized as a Learning Disability most of the Time

Producing Difficulties Only

When severe, typically attributed to motivation or personality problems

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The Role of Executive Functions in School

❖**The more classroom instruction resembles tests of executive functions like the Wisconsin Card Sorting Test (figure out what we're learning, I'll tell you whether you are right or wrong), the more executive difficulties are going to impact classroom learning and performance.**

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Executive Functions in School

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

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Executive Functions in School

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

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Executive Functions in School

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

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Executive Functions in School

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

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Executive Functions in 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."

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Executive Functions in School

❖**What Evan wrote for me:**

My favorite game is …
"mabul

roling it is fun. I like making the box to role in to. Iam prety gode as well. It is rell inters ing. It is so fun

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**Executive Functions in School:
Internal Command vs
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.**

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**Executive Functions in School:
Internal Command vs
External Demand**

❖Because internally driven production is much easier to accomplish than externally demanded production 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.

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**Executive Functions and
Clinical Classifications**

❖**Most of the clinical conditions described in the 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 EFs and Working Memory processes**

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**Executive Functions and
Clinical Classifications**

"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*

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Executive Functions and Clinical Classifications

A sampling of conditions involving EF deficits:

Autism

Asperger's Syndrome

ADHD and ADD

Conduct Disorder

Oppositional Defiant Disorder

Depression

Anxiety

Obsessive-Compulsive Disorder

Fetal Alcohol Syndrome

Pre-natal Drug Exposure

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Development of Executive Functions

Self-regulation executive functions are developing from the first years of life on 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.

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Development of Executive Functions

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.

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Development of Executive Functions

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.

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Development of Executive Functions

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.

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Executive Function Assessment

❖Because Executive Functions are directive processes that interact with perceptual, emotional, cognitive, and motor functioning, Executive Functions must be assessed in tandem with abilities and skills.

❖Specific measures of Executive Functions always involve the assessment, to some degree, of an ability or skill other than executive function capacity.

❖For the most accurate observation or measurement of EFs, the contributions of other abilities and skills need to be minimized, controlled for, or acknowledged in some way.

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Executive Function Assessment

Executive Function assessment methods vary depending on the arena of involvement in which the EF(s) are operating, the perceptual, emotional, cognitive and/or motor abilities being directed by the EF(s), the specific processing demands involved in the activity, and the specific EFs that are in operation.

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Executive Function Assessment

The most effective approach to the assessment of executive functions involve:

❖Conducting a thorough semi-structured clinical interview

❖Using additional data collection methods to test hypotheses generated from the clinical interview

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Executive Function Assessment

The most effective approach to the assessment of executive functions involve:

❖**Conducting a thorough semi-structured clinical interview**
- ❖Identify arenas of involvement that are of concern, within the arenas:
- ❖Identify domains of functioning that are of concern
- ❖Identify the specific executive function levels that are of concern
- ❖Identify the specific executive functions that are of concern within the level
- ❖Identify any information processing capacity that might be of concern; try to determine if the difficulty is due to deficient executive control or deficient information processing capacity.

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Executive Function Assessment

The most effective approach to the assessment of executive functions involves:

❖**Use additional data collection methods to test hypotheses generated from the clinical interview:**
- ❖Parent, Teacher, Self Report Inventories
- ❖Background information/Record review
- ❖Individually-administered standardized testing (mostly Symbol System arena)
  - ❖Select instruments that directly assess the effects of executive control in the arenas of involvement and the specific domains of functioning that are of concern.

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Executive Function Assessment Across Arenas of Involvement

❖**Performance on Standardized Tasks (Symbol System and Environment Arenas only)**

❖**Behavior Ratings**

❖**Behavior Observations**

❖**Clinical Interviews**

❖**Anecdotal Records**

❖**Case History**

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Executive Function Assessment

Intrapersonal Arena

❖**Performance on Std Tasks – N/A**

❖**Behavior Rating Scales**
- ❖Self
- ❖Parent
- ❖Teacher

❖**Behavior Observations**

❖**Clinical Interviews**

❖**Anecdotal Records and Case History**

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Executive Function Assessment

Interpersonal
- ❖Performance on Std Tasks
  – N/A
- ❖Behavior Rating Scales
  - ❖Self
  - ❖Parent
  - ❖Teacher
- ❖Behavior Observations
- ❖Clinical Interviews
- ❖Anecdotal Records and
  Case History

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Executive Function Assessment

Environment
- ❖Performance on Std Tasks
  - ❖UFOV
- ❖Behavior Ratings (Items)
  - ❖Self
  - ❖Parent
  - ❖Teacher
- ❖Behavior Observations
- ❖Clinical Interviews
- ❖Anecdotal Records and
  Case History

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Executive Function Assessment

Symbol System Arena
- ❖Performance on Std. Tasks
  - ❖ EF combined w/ Cognitive
    - ❖Attention
    - ❖Encoding
    - ❖Working Memory
    - ❖Reasoning
    - ❖Retrieval/Storage
    - ❖Motor/Language
      Production

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Executive Function Assessment

**Symbol System Arena
(continued)**
- ❖Performance on Std. Tasks
  - ❖ EF combined w/
    Academic Skills
    - ❖Reading
    - ❖Mathematics
    - ❖Written Expression

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Executive Function Assessment

Symbol System Arena
(continued)

❖Behavior Rating Scales
  ❖ EF combined w/ everyday perception, emotion, cognition and action:
    ❖Self Ratings
    ❖Parent Ratings
    ❖Teacher Ratings

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Executive Function Assessment

Symbol System Arena
(continued)

❖Behavior Observations

❖Clinical Interviews

❖Anecdotal Records and Case History

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Executive Function Assessment
Interpretation of Performance

Symbol System Arena
(continued)
❖Performance on Std Tasks
  ❖Standard Scores
  ❖Standard Score contrasts
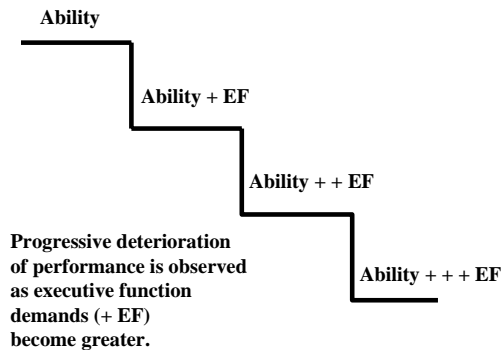 ❖Process-oriented observations
  ❖Testing the Limits
  ❖Task Mediation

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Executive Function Assessment
Methods (Symbol System):
Cascading Cognitive Ability/Skill
Decrements

❖Identify a specific cognitive ability domain baseline using a measure that minimizes EF involvement.

❖Select and use a measure that adds executive function demands to the baseline ability and observe the results.

❖Select a measure that adds even more executive function demands to the baseline ability and observe results.

❖Continue to add additional EF demands and observe results.

❖If present, EF deficiencies will result in decreasing proficiency with tasks as EF involvement is increased.

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Cascading Ability Decrement Due to Executive Dysfunction

Ability

Ability + EF

Ability + + EF

Progressive deterioration of performance is observed as executive function demands (+ EF) become greater.

Ability + + + EF

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Domains Used as Ability/Skill Baselines in EF Assessment

❖ Attention Processes
❖ Visual Processes
❖ Auditory Processes
❖ Language Processes
❖ Reasoning Processes
❖ Initial Registration Processes
❖ Long-Term Retrieval Processes
❖ Working Memory Processes
❖ Motor Abilities
❖ Reading Skills
❖ Writing Skills
❖ Math Skills

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EF Measurement

❖ Baseline Measures are used to document level of performance in an area of ability
❖ EF Measures add some aspect of EF to the assessment of an ability
❖ A task can be listed here as BOTH a Baseline and an EF measure. For example, good performance on Matrix Reasoning, can be used as a baseline indicator of the presence of good reasoning abilities. When poor performance is obtained on Matrix Reasoning and a process approach analysis reveals that poor performance was due primarily to inconsistent application of well-developed reasoning ability (easy items missed, many hard items correct), Matrix Reasoning performance is now considered an indicator of EF difficulties and qualifies as an EF measure. In a similar manner, Block Design can be an indicator of intact baseline ability when performed well, or an indicator of EF difficulties, in some instances, when performed poorly. Many tasks can be used in this way, and therefore many tasks are listed as both Baseline and EF measures.

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EF Measurement Attention

❖ Baseline Measures
  ❖ NEPSY Auditory Attention
  ❖ NEPSY Visual Attention 1
  ❖ NEPSY Knock & Tap Part 1
  ❖ DKEFS Visual Scanning
❖ EF Measures
  ❖ NEPSY Auditory Response Set
  ❖ NEPSY Visual Attention 2
  ❖ NEPSY Knock & Tap Part 2
  ❖ D-KEFS Number Sequencing, Letter Sequencing, and Number-Letter Switching

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EF Measurement
Visual Abilities

❖ **Baseline Measures**
   - ❖ **NEPSY Arrows**
   - ❖ **W4 Integrated Block Design MC**
   - ❖ **W4 Matrix Reasoning**
   - ❖ **W4 Symbol Search**
   - ❖ **W4 Picture Completion**
   - ❖ **PAL Receptive Coding**

❖ **EF Measures (Visual+Motor+EF)**
   - ❖ **W3 Picture Arrangement**
   - ❖ **W3 Object Assembly**
   - ❖ **W3 Coding**
   - ❖ **NEPSY Design Copy**
   - ❖ **Bender VMGT**
   - ❖ **DAS Recall of Designs**
   - ❖ **Rey Complex Figure Test**

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EF Measurement
Verbal Abilities

❖ **Baseline Measures**
   - ❖ **W4 Vocabulary**
   - ❖ **W4 Similarities**
   - ❖ **KAIT Auditory Comprehension**
   - ❖ **NEPSY Comprehension of Instruct**
   - ❖ **CELF 4 Concepts & Directions**
   - ❖ **CELF 4 Listening to Paragraphs**
   - ❖ **WIAT-II Oral Expression**

❖ **EF Measures**
   - ❖ **KAIT Definitions**
   - ❖ **KAIT Double Meanings**
   - ❖ **CELF 4 Word Classes**
   - ❖ **CELF 4 Semantic Relationships**
   - ❖ **DKEFS Verbal Fluency**
   - ❖ **NEPSY Verbal Fluency**
   - ❖ **DKEFS Color Word Interference**
   - ❖ **PAL RAN Tasks**

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EF Measurement
Reasoning Abilities

❖ **Baseline Measures**
   - ❖ **WASI Matrix Reasoning**
   - ❖ **KAIT Logical Steps**
   - ❖ **W4 Picture Arrangement**
   - ❖ **W4 Comprehension**
   - ❖ **W4 Block Design**

❖ **EF Measures**
   - ❖ **Wisconsin Card Sorting Test**
   - ❖ **D-KEFS 20 Questions**
   - ❖ **W4 Matrix Reasoning**
   - ❖ **W3 Picture Arrangement**
   - ❖ **W4 Block Design**
   - ❖ **W4 Picture Concepts**

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EF Measurement
Motor Abilities

❖ **Baseline Measures**
   - ❖ **D-KEFS Motor Speed**
   - ❖ **NEPSY Visuomotor Precis'n Task 1**
   - ❖ **PAL Alphabet Writing & Copying**

❖ **EF Measures**
   - ❖ **DKEFS Letter Sequencing**
   - ❖ **DKEFS Number Sequencing**
   - ❖ **DKEFS Number-Letter Switch**
   - ❖ **NEPSY Visuomotor Precis'n Task 2**
   - ❖ **PAL Alphabet Writing & Copying**
   - ❖ **NEPSY Design Copy**
   - ❖ **BVMGT**
   - ❖ **DAS Recall of Designs**
   - ❖ **RCFT**

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Examples of EF Problems in Reading Skills

❖ 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, Manipulate, Balance, etc.) when reading for meaning

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Examples of EF Problems in Writing Skills

❖ 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-regulaton EFs at one time (e.g. hold, manipulate, retrieve with generate and execute)

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Examples of EF Problems in Mathematics Skills

❖ Poor cueing of monitor and correct 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)

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EF Measurement Behavior Rating Scales

❖ Self, Parent, and Teacher ratings of Executive Functions

❖ Various types of rating scales can be used with individuals, parents, and teachers.

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EF Measurement
Behavior Rating Scales

❖ **Behavior Rating Inventory of Executive Functions (BRIEF)**
❖ **ADHD Scales:**
  ❖ **ADHD Rating Scale-IV**
  ❖ **Brown ADD Scale**
❖ **Behavior Assessments**
  ❖ **E.g., Specific Item Ratings on scales such as the BASC**

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EF Measurement
Behavior Rating Scales

❖ **The BRIEF assesses self-regulation EFs under the following headings:**
  ❖ **Inhibit**
  ❖ **Shift**
  ❖ **Emotional Control**
  ❖ **Initiate**
  ❖ **Working Memory**
  ❖ **Plan/Organize**
  ❖ **Org. of Materials**
  ❖ **Monitor**

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EF Measurement
Behavior Rating Scales

❖ **An example of using the BASC items:**
❖ **A child received highest ratings on these items:**
  ❖ **Has trouble concentrating**
  ❖ **Forgets things**
  ❖ **Changes moods quickly**
  ❖ **Repeats one activity over and over**
  ❖ **Is easily distracted**
  ❖ **Never completes homework from start to finish**

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EF Measurement
Behavior Rating Scales

❖ **An example of using the BASC items (Continued):**
❖ **A child received highest ratings on these items:**
  ❖ **Has a short attention span**
  ❖ **Argues when denied his own way**
  ❖ **Worries about things that cannot be changed**
  ❖ **Is easily upset**
  ❖ **Worries**
  ❖ **Never completes work on time**

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Executive Function Difficulties

Are they the result of

Disuse through Conscious Choice,

Disuse through Unconscious Choice,

Or

Innate Deficiency?

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Executive Function Intervention

General Two-Stage Approach:

❖**Attempt to Affect Internal Change**

❖**Apply External Control As Necessary**

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Executive Function Interventions

❖**General Literature Sources for Intervention Information:**
  ❖**ADHD Interventions**
  ❖**TBI Interventions**
  ❖**Dynamic Assessment/ Instrumental Enrichment Programs**
  ❖**I Can Problem Solve (ICPS) program**
  ❖**Metacognition applied to academics skill areas; especially reading**
  ❖**Cognitive Behavior Therapy**
  ❖**OT/PT Motor Planning and Motor Praxis**

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Executive Function Interventions

❖**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 obstinacy.**
  ❖**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.**

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Executive Function Interventions

❖**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.**

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Executive Function Interventions Lines and Levels

❖**EF interventions vary based on the developmental lines they address**

  ❖**Self Regulation**

    Perception, Emotion, Cognition, Action

  ❖**Self Determination**

  ❖**Self Realization**

  ❖**Self Generation**

  ❖**Trans-Self Integration**

❖**EF Interventions vary based on the developmental level they address**
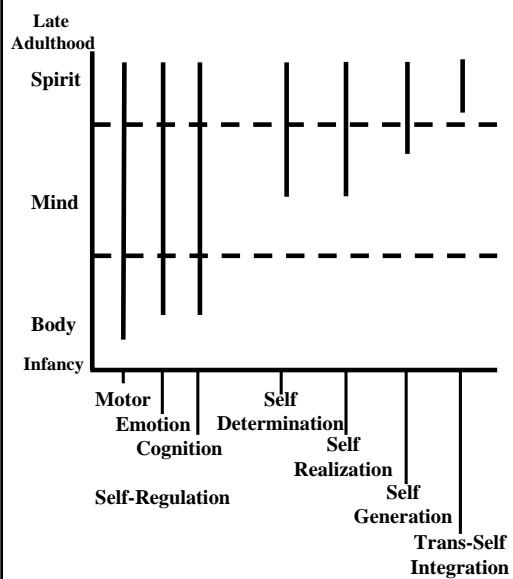
  ❖**Body**

  ❖**Mind**

  ❖**Spirit**

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Executive Function Development: Lines and Levels

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Executive Function Interventions

❖**Developmental Lines Code for Specific Interventions:**

  ❖**Self-Regulation = REG**

  ❖**Self-Determination = DET**

  ❖**Self-Realization = REAL**

  ❖**Self-Generation = GEN**

  ❖**Trans-**

    Self Integration = TRAN

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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

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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

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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

❖**Aligning External Demands with Internal Commands (Drives and Desires) (REG, DET, GEN)**

Use natural motivating mechanisms whenever possible

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Executive Function
Interventions

❖**Engage the Services of a Cognitive Coach (REG)**

Make extensive use of an external executive function substitute

❖**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.

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Executive Function Interventions

❖**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

❖**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

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Executive Function Interventions

❖**Encourage Symbiotic Relationships and Support Networks (REG, REAL)**

   Enter into relationships where there is a mutual interdependence that enables deficiencies to be by-passed

❖**Model Good Executive Function Performance (REG-ALL)**

   Offer external guides for possible internalization of effective EF performance

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Executive Function Interventions

❖**Use of Cognitive Behavior Therapy**

   ❖**Cognitive Behavior Therapy for REG, DET, REAL**

   ❖**Mindfulness-Based Cognitive Behavior Therapy for REG, DET, REAL, GEN**

❖**Use of Mindfulness-based Physical Exercise Programs (REG, DET)**

   ❖**Yoga**

   ❖**Thai Chi**

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Executive Function Interventions

❖**Use of Meditation Techniques (All Levels)**

   ❖**Improving all forms of self-control through "quieting of the mind" Use of Integrating and Integral Psychotherapeutic Techniques**

   ❖**Gestalt, Existential, and Humanistic therapies for DET, REAL, GEN**

❖**Psychosynthesis for DET, REAL, GEN, TRANS**

   ❖**Improving or Developing "Magnetic Center"**

   ❖**Fostering development of internal control mechanisms through "strengthening of the will"**

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