Executive Functions in the Classroom: How they affect Learning and Behaviour

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Mentally healthy persons maintain many illusory beliefs, including:

- Overly positive view of themselves
- Convenient “forgetting” of negative facts about themselves
- Perceptions of having greater control over events than is actually the case
- “Unrealistic” optimism about themselves
- “Unrealistic” optimism about the future
- “Abnormal” cheerfulness
Newberg’s Best Ways to Exercise Your Brain

- Maintain Faith (Positive Belief System)
- Dialogue with Others
- Engage in Aerobic Exercise
- Meditate
- Yawn
- Consciously Relax
- Stay Intellectually Active
- Smile
Benefits of Yawning

- Stimulates alertness & concentration
- Optimizes brain activity and metabolism
- Improves cognitive functioning
- Increases memory recall
- Enhances consciousness and introspection
- Lowers stress
- Relaxes every part of your body
- Improves voluntary muscle control
- Enhances athletic skills
- Fine tunes your sense of time
- Increases empathy and social awareness
- Enhances pleasure and sensuality
EFs

Emotions

Thoughts

Perceptions

Actions
Executive Functions:

- Directive capacities of the mind
- Multiple in nature, not a single capacity
- Part of neural circuits that are routed through the frontal lobes
- Cue the use of other mental capacities
- Direct and control perceptions, thoughts, actions, and to some degree emotions
– **Naïve:** First exposure to the task; responses required immediately.

– **Practiced:** Time given to rehearse responses to the task; responses delivered after rehearsal period.
System 1 – Fast, effortless, automatic

System 2 – Slow, effortful, non-automatic
Things that are Taught to Automaticity in Early Elementary School

- Basic math facts and multiplication tables
Things that are Taught to Automaticity in Early Elementary School

- Basic math facts and multiplication tables
- The alphabet and sight word recognition
- Graphomotor functioning for quick handwriting of letters and words
– Novel: Second exposure to the task, but responses required immediately to a set of all new items.
– Naïve: First exposure to the task; responses required immediately; high demand for executive functions (EFs)
– Practiced: Time given to rehearse responses to the task; minimal demand for EFs
– Novel: Second exposure to the task, but responses required immediately to a set of all new items; moderate demand for EFs

– Source:
Executive functions are used to cue, direct, coordinate and integrate all the processes, skills, abilities, and knowledge bases used when reading writing or doing math.
An Integrative Model Specifying Processes, Abilities, Knowledge Bases, Skills, Memory and Achievement in Reading

- Executive Function processing at work
- Retrieval from Long Term Storage
- Working Memory
- Initial Registration (Immediate Memory)

- General & Specific Knowledge Lexicons
- Semantic Lexicon Word & Phrase Knowledge
- Language
- Reasoning
- Visuospatial

Comprehending Words and Text

- Decoding Unfamiliar and/or Nonsense Words
- Reading Familiar (Sight) Words
- Speed + Prosody = Reading Rate aka “Fluency”

- Phonological Processing
- Oral Motor Functioning
- Orthographic Processing
Interventions for Executive Functions Difficulties Related to Reading

Many executive functions difficulties related to reading are the result of a lack of adequate maturation of the neural networks involved in the use of these executive functions for reading.
Interventions for Executive Functions Difficulties Related to Reading

The most effective form of intervention for maturational difficulties with executive functions cues is increased practice of the complete act of reading, i.e., applying the integration of all processes, skills, abilities and lexicons while reading connected text while receiving feedback from an external source.
Key Concept

Assessment of the Use or Disuse of Executive Functions Hinges on Careful Observation of Behavior.
Behavior Observation and Inferences about Brain Function

What’s the difference between a Similarities Scaled Score of 12 (75\textsuperscript{th} percentile) …

…and a Similarities Scaled Score of 12 (75\textsuperscript{th} percentile)?
Task Performance is directed by Executive Functions or an Executive Functions substitute.

The neural networks used to perform a task depend on perceptions about how the task should be done.
Most of what a teacher says to students is intended to activate specific areas of the students’ brains.
The more specific the language used by a teacher, the more likely it is that students will be activating the necessary brain areas.
The concept of executive functions is not synonymous with the traditional concepts of intelligence or “IQ”

Executive functions are not directly assessed with standard intelligence tests
Directions for the Wisconsin Card Sorting Test (WCST):

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.
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.
The Wisdom of Kurt Lewin

“There is nothing more practical than a good theory.”

Known for his field theory of behavior that posits that human behavior is a function of an individual’s psychological environment.
What Are Executive Functions?

“Despite the frequency with which it is mentioned in the neuropsychological literature, the concept of executive functions is one that still awaits a formal definition. Research efforts aimed at exploring the different aspects of this construct have often yielded contradictory evidence, resulting in a lack of clarity and even controversy regarding the true nature of executive abilities.”

EF as the Conductor of the Brain’s Orchestra (i.e., EF as “g”)
Executive Functions Are Not a Unitary Trait

Appropriate Metaphors for Executive Functions:

- The conductor and section leaders of the mind’s Orchestra
- The management structure of a multinational mind corporation
- The coaching staff of team mind
Key Concept

Executive Functions cue and direct in different ways at different levels.
Co-Conductors in a Holarchical Model of EF

Self-Determination

Self-Realization

Self-Generation

Trans-Self Integration

Self-Regulation

Self-Activation

Activation
Co-Conductors in a Holarchical Model of EF

- Trans-Self Integration
- Self-Generation
- Self-Realization
- Self-Determination
- Self-Regulation
- Self-Activation
Domains of Functioning Directed by Executive Functions

**Action**
Executive control of modes of output including behavior in the external world and storage and retrieval of internal representations

**Cognition**
Executive control of thoughts and thought processing

**Perception**
Executive control of modes of perceptual input including external sensory stimuli (visual, auditory, kinesthetic) and internal (representational) stimuli

**Emotion**
Executive control of moods, feelings, and the processing of emotions
Holarchy vs Hierarchy
EF Tiers within the Holarchical Model of Executive Functions

- **Trans-Self Integration**
- **Self-Generation**
- **Self-Realization**
  - Self-Awareness
  - Other-Awareness
  - Self-Analysis
- **Self-Determination**
  - Goal setting
  - Long-range Planning & Foresight
- **Self-Regulation**
  - Perceive
  - Focus
  - Sustain
  - Energize
  - Initiate
  - Inhibit
  - Stop
  - Interrupt
  - Flexible
  - Shift
  - Modulate
  - Monitor
  - Correct
  - Balance
  - Gauge
  - Anticipate
  - Estimate Time
  - Analyze
  - Generate
  - Associate
  - Organize
  - Prioritize

**Self-Activation**
Initiation and “ramping up” of basic executive functions related to an awakened state of mind and to overcoming sleep inertia.
Executive Functions and Language

- It is important to recognize that language does not necessarily connote consciousness.
- Language can be used by executive functions as a form of conscious expression and as a tool to modify brain function.
Self Activation Interventions

- How do you take control of a brain whose control center is not awake?
System 1 – Fast, effortless, automatic

System 2 – Slow, effortful, non-automatic
Self Activation Interventions

- How do you take control of a brain whose control center is not awake?
- Use classical conditioning to create an automatically activated stimulus-response routine (alarm rings, get out of bed, turn on lights, get in the shower)
EF Tiers within the Holarchical Model of Executive Functions

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Generate
Associate
Organize
Prioritize

Self-Activation
Activation

Plan
Evaluate/Compare
Decide
Sense Time
Pace
Sequence
Execute
Hold
Manipulate
Store
Retrieve
Self Regulation

- A set of control capacities that cue and direct functioning across the domains of perception, emotion, cognition, and action
- The current model posits 33 self-regulation executive functions
33 Self-Regulation EFs

- Perceive
- Focus
- Sustain
- Energize
- Initiate
- Inhibit
- Stop
- Interrupt
- Flexible
- Shift
- Modulate
- Balance
- Monitor
- Correct
- Gauge
- Anticipate
- Est Time
- Analyze
- Generate
- Associate
- Plan
- Organize
- Prioritize
- Compare/Eval
- Decide
- Sense Time
- Pace
- Sequence
- Execute
- Hold
- Manipulate
- Store
- Retrieve
Key Concept

It is important to distinguish between Executive Functions and Executive Skills.
Executive Functions involve the part of the executive network that is used to become aware of the need for the use of executive skills and other mental capacities and used to cue and direct the use of the needed executive skills.
Executive Skills are responsible for cueing the specific areas of the brain needed to perform specific tasks (e.g., attending, inhibiting, modulating, planning, organizing, associating).
Co-Conductors in a Holarchical Model of EF

Executive Capacities

Executive Functions

Executive Skills
Key Concept

Self-regulation Executive Functions can be organized into 7 basic clusters.
Self Regulation Executive Function “Clusters”

**ATTENTION**
- Perceive
- Focus
- Sustain

**ENGAGEMENT**
- Energize
- Initiate
- Inhibit
- Stop
- Pause
- Flexible Shift

**OPTIMIZATION**
- Monitor
- Modulate
- Balance
- Correct

**EFFICIENCY**
- Sense Time
- Pace
- Sequence
- Execute

**MEMORY**
- Hold
- Manipulate
- Store
- Retrieve

**INQUIRY**
- Anticipate
- Gauge
- Analyze
- Estimate Time
- Compare

**SOLUTION**
- Generate
- Associate
- Prioritize
- Plan
- Organize
- Decide
EF Tiers within the Holarchical Model of Executive Functions

Trans-Self Integration

Self-Generation

Self-Realization
- Self-Awareness
- Other-Awareness
- Self-Analysis

Self-Determination
- Goal setting
- Long-range Planning & Foresight

Self-Regulation
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- Retrieve

Self-Activation

Activation
Self Realization (of self & others)

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

- Cues cognitive processes to access accumulated information about self and apply it in specific situations.
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. Attempts to align daily self-regulation with long-term goals.
EF Tiers within the Holarchical Model of Executive Functions

Perceive
Focus
Sustain
Energize
Initiate
Inhibit
Stop
Interrupt
Flexible
Shift
Modulate

Plan
Evaluate/Compare
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Trans-Self Integration

Self-Generation

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Goal setting
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Prioritize

Self-Activation
Self Generation

- Directs the posing of speculative questions related to the meaning and purpose of life and/or the ultimate source(s) of reality and physical existence, mind-body relationships, spirit, and soul; contemplates 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.
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.
Effective use of Executive Functions can vary by Arena of Involvement as well as by Domain of Functioning.
Arenas of Involvement

**Intrapersonal**
Control of Self in Relation to Self

**Interpersonal**
Control of Self in Relation to Others

**Environment**
Control of Self in Relation to Surroundings

**Symbol System**
Control of Self in Relation to Academics (Reading, Writing, Math)
Executive Functions are developing from birth; maturational delays can cause difficulties.

Key Concept
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.
Developmental Progression with a 30% Delay

Chronological Age
EF Development does not progress by continuous equal intervals
EF Development does not progress by continuous equal intervals
Virtually all individuals who struggle with psychological disorders exhibit executive function difficulties.
Executive Functions and Clinical Diagnoses

“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 Functions and Clinical Diagnoses

- Most of the clinical conditions described in the DSM-V reflect some form of Executive Dysfunction.
- The DSM-V can be thought of as “A User’s Guide to All the Things That Can Go Wrong With the Frontal Lobes”
Executive Functions and Clinical Diagnoses

- A sampling of conditions involving EF deficits:
  - Autism  Asperger’s Syndrome
  - ADHD and ADD
  - Conduct Disorder
  - Oppositional Defiant Disorder
  - Depression and/or Anxiety
  - Obsessive-Compulsive Disorder
  - Fetal Alcohol Syndrome
All individuals with ADHD exhibit EF deficits but not all individuals that exhibit EF deficits are ADHD.
All individuals with ADHD have executive functions deficits…

...but not all individuals with executive functions deficits have ADHD.
Executive Functions and ADHD

- EF and ADHD are not synonymous terms; rather ADHD is a condition involving EF deficits in:
  - Focus/Select, Sustain, Inhibit, Modulate
- Nearly all persons with ADHD also have additional self-regulation difficulties; the nature of these additional difficulties is what makes ADHD so variable from one person to the next and what causes confusion in diagnosis.
Different Constellations

Same Core

Perceive  Energize  Shift  Monitor  Est Time  Organize  Sense Time  Hold
Initiate  Flexible  Correct  Anticipate  Analyze  Plan  Sequence  Manipulate
Stop  Sustain  Associate  Evaluate  Execute  Store
Interrupt  Modulate  Generate  Decide  Retrieve

Focus  Sustain  Modulate  Inhibit

Alan Age 10

Katie Age 11

Perceive  Energize  Shift  Monitor  Est Time  Organize  Sense Time  Hold
Initiate  Flexible  Correct  Anticipate  Analyze  Plan  Sequence  Manipulate
Stop  Sustain  Associate  Evaluate  Execute  Store
Interrupt  Modulate  Generate  Decide  Retrieve

Focus  Sustain  Modulate  Inhibit

Different Constellations
Executive Functions and ADHD

- Pharmacological treatment of ADHD usually only addresses the problems associated with the EFs specific to ADHD (Inhibit, Modulate, Focus/Select, Sustain)

- Most persons with ADHD will require additional interventions to assist with the additional self-regulation difficulties that persist even when medication is being used effectively to treat the primary ADHD problems.
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 contrast, demonstrating what has been learned usually requires significant involvement of executive control processes.
Executive Functions activation can be internally or externally driven; EFs can cue the use of learned strategies.
Internal versus External Control

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.
Internal versus External Control

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 observed by others are often attributed to negative personal characteristics such as lack of responsibility, apathy, passive aggressive stance, or oppositional defiance.
Engagement of Self-Regulation

Executive Functions

Internal Command

Nucleus Accumbens

Internal Command Pathway: Intrinsically Rewarding

External Demand Pathway

External Demand

Extrinsic Rewards & Punishments

???
Engagement of Self-Regulation

Executive Functions

Teach how to self-regulate in a way that increases the desire to self-regulate

Internal Command

Nucleus Accumbens

Internal Command Pathway: Intrinsically Rewarding

External Demand Pathway

External Demand

Extrinsic Rewards & Punishments

???
Questions about Intelligence

- Do you believe it is possible to raise a child’s FSIQ from 70 to 100 through intervention?
- Can it be done in 6 months? A year? Two years?
# Martin’s WISC Score Changes

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Producing difficulties are different from learning difficulties; producing difficulties reflect poor use of executive functions.
Executive Function difficulties of a severe nature (especially in the Symbol System Arena) do not result in Learning Difficulties; they result in Producing Difficulties.
A General Model for Conceptualizing Learning and Producing Difficulties

Often NOT recognized as a Learning Disability, even when severe, unless an evaluation involving process assessment is done.

Recognized fairly quickly as a Learning Disability.

When severe, typically attributed to lack of motivation, character flaws, or behavior/personality problems.
EF Intervention Continuum

Orienting Strategies

External Control Strategies

Bridging Strategies

Internal Control Strategies